CULVERT CROSSING DESIGN REPORT for

Winsome Filing No. 3

El Paso County, Colorado

Prepared for:

Winsome LLC

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Monument, CO 80132

Prepared by:

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PCD File No. CDR-21-012

Project #: 196106001

Kimley»Horn

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West Kiowa Creek Culvert Crossing Design

Section 1: Project Background

The site is located on the northwest corner of Hodgen Road and Meridian Road in El Paso County, Colorado. Winsome Subdivision Filings No. 1, 2 and 3 comprise 768 acres of land with the West Kiowa Creek bisecting the property from southwest to northeast. Filings No. 1 and 2 are currently under development. Filing No. 3 is 349.5 acres and consists of 38, 5-acre single family lots. As part Filing No. 3, two reinforced concrete box culvert (RCBC) crossings across West Kiowa Creek (the "Site") are proposed. The property is zoned RR-2.5 and RR-5 (Rural Residential) and the crossings will provide access for 38 single family home 5 acre lots.

Culvert Crossing No. 1 is located just west of the Filing No. 2 and Filing No. 1 boundary on the proposed Alamar Way. Culvert Crossing No. 2 is located on Twinkling Star Lane, just north of Filing No. 2

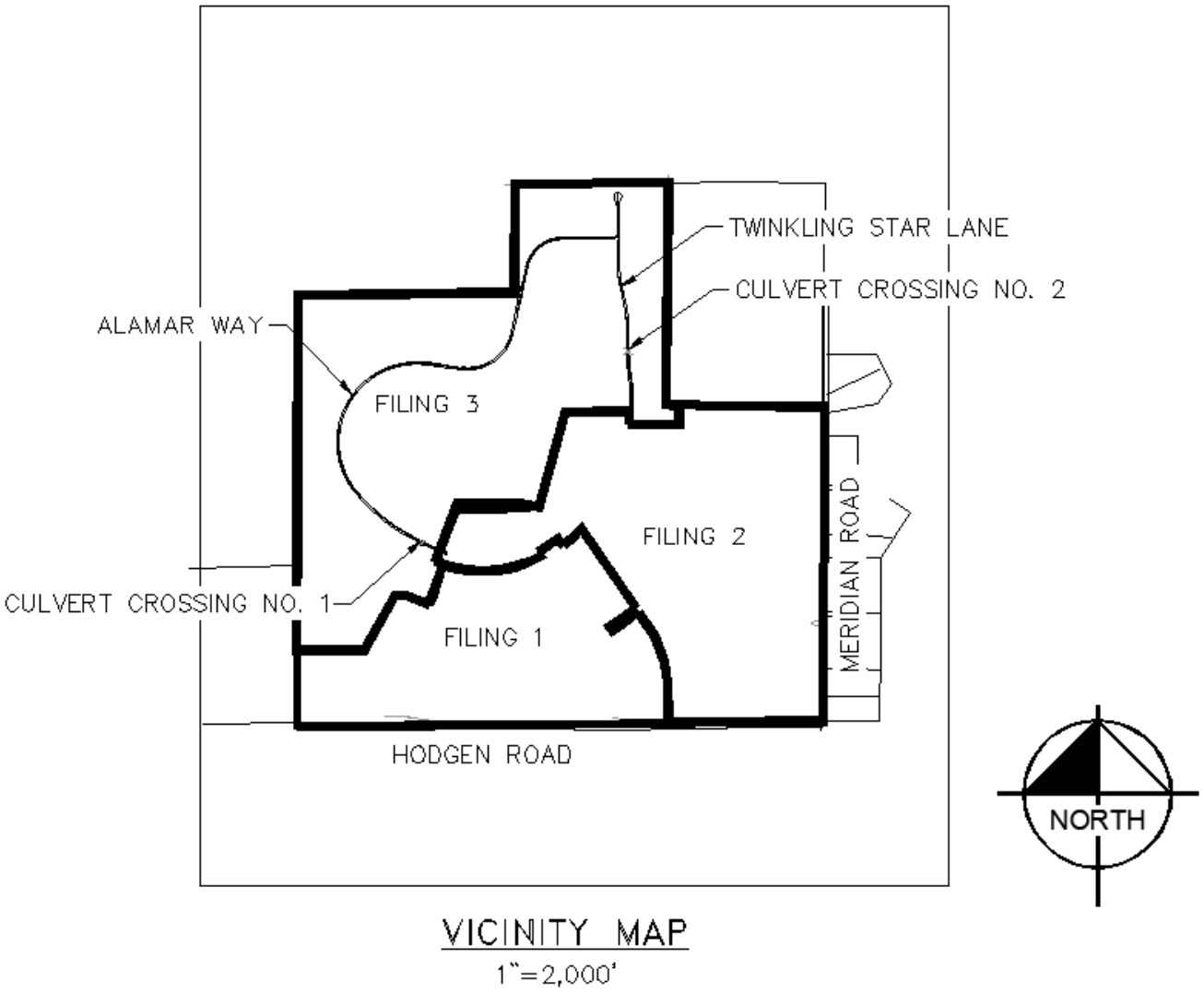

Figure 1: Vicinity Map

Purpose and Objective

The purpose of this Culvert Design Report is to outline the design criteria and design decisions and assumptions for the design of the RCBC. As part of the design the following documents were also prepared:

- *Hydraulic Report and Hydraulic Sections- This report details the hydraulic design of the RCBC*
- *Geotechnical Report-Provides recommendations for foundation and soil preparation*
- *Structure Selection Report-Details the decision for choosing the RCBC crossings*

Section 2: Culvert Design Criteria and Requirements

The design of the RCBC crossings were designed per the following criteria:

El Paso County "Drainage Criteria Manual", dated October 31, 2018 ("DCM")

El Paso County "Engineering Criteria Manual" Revision 6, dated December 13, 2016 ("ECM")

CDOT "Drainage Design Manual", 2019. ("CDOT DDM")

CDOT "M Standard Plans", 2019. ("CDOT Detail")

Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.

Culvert Design Criteria

Typical Sections

The proposed typical roadway sections for the RCBC crossings are based upon the El Paso County Low Volume Rural Local Roadway typical sections from the El Paso County ECM Manual detail SD_2-11 as shown in

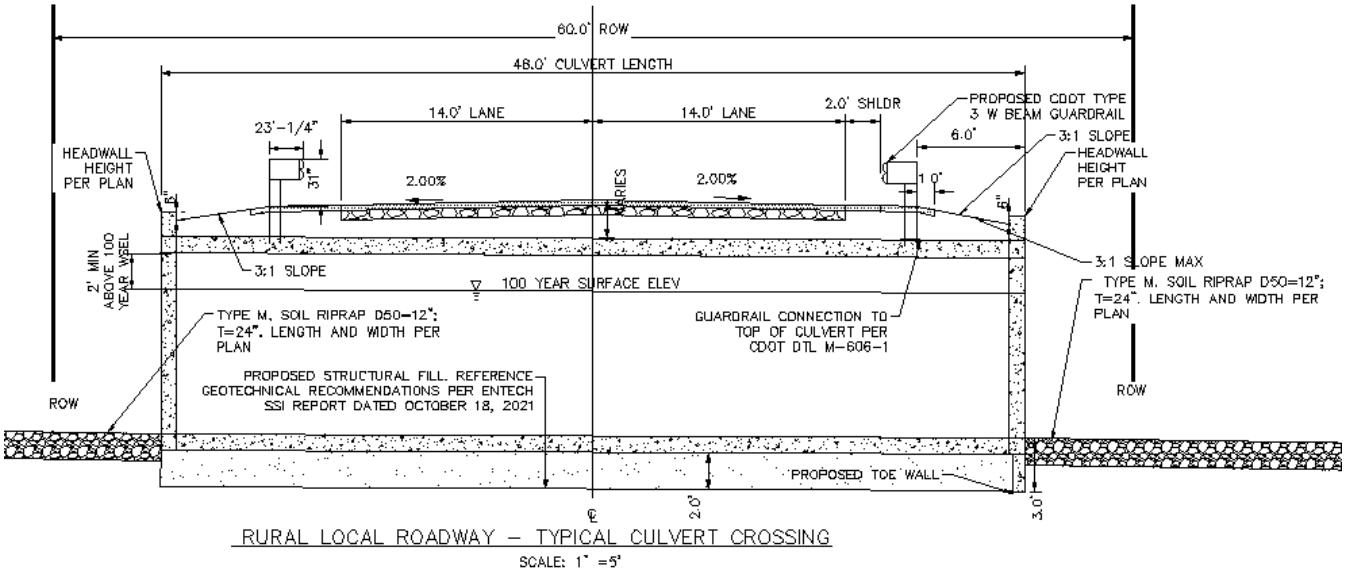

Figure 2: RCBC Crossing Typical Section

The typical section includes the following components:

- Two 12 foot travel lanes with 2 foot paved shoulder
- Type 3 W- Beam Guardrail on both sides
- 6 foot transition from top of headwall to edge of pavement
- Triple 7' H x 12' W Reinforced Concrete Box Culvert (RCBC)

Roadway Plan and Profile

Horizontal Requirements

The horizontal geometry of the road was set based on a 30-mph design speed. The ECM requires a minimum horizontal curve radius of 300 feet. All proposed horizontal curves on Alamar Way and Twinkling Star Lane have been designed accordingly. Culvert Crossing No. 1 is on a horizontal curve creating a small skew of 75 degrees with the alignment of the West Kiowa Creek. The horizontal location of both crossings was chosen to minimize the area of wetland impact.

Vertical Requirements

A proposed centerline vertical profile is included in the Culvert Construction Documents. This proposed profile shows the extension of the existing roadway in Alamar Way and Twinkling Star Lane across West Kiowa Creek and to the next crest curve across the Creek. County minimum longitudinal grades and K values for vertical curves were used. The minimum K values used were 19 for crest curves and 37 for sag curves. This criterion is based on a 30 MPH design speed.

Guardrail

Guardrail is provided in the typical section for the crossings and is required per Clear Zone Requirements, outlined in the ECM and AASHTO Roadside Design standards. Type 3 W Beam guardrail is proposed per CDOT Standard Detail M-606-1. The layout for the guardrail follows the guidance on Sheet 19 of the detail, Guardrail for Culverts with two-way traffic. The Length of Need, N, was calculated using the FHWA spreadsheet which is provided in the Appendix of this Report. The Approach Length of Need was rounded to 40 feet for the Approach Length of Need and 15 feet for the Opposing Length of Need. End Treatment with be provided with end anchorage on both ends of the guardrail will need to be provided per CDOT Standard Detail M-606-1.

Table 1: Roadway Design Criteria

Design Element	*Design Criteria*
Design Speed	***30 MPH***
Posted Speed	***30 MPH***
Minimum Radius of Horizontal Curvature	***300 Feet***
Projected ADT	***750 Vehicles per Day***
Guardrail Approach Length of Need	***40 Feet***
Guardrail Opposing Length of Need	***15 Feet***
End Anchorage	***39'-7" Foot-MFleat Terminal***
Minimum K Value (Crest)	***19***
Minimum K Value (Sag)	***37***

Wetlands

Both Culvert Crossings impact the delineated wetland area. Culvert Crossing No. 1 impacts approximately 11,460 SF or 0.26 acres of wetland area and Culvert Crossing No. 2 impacts approximately 6,942 SF or 0.16 acres of wetland area. These impacts trigger the need for a Nationwide 404 permit with the United States Army Corps of Engineers (USACE) which will be processed concurrently with the County review of the Culvert Construction Drawings. The impacts to the wetlands and preservation and enhancement strategies are provided in another report.

RCBC Design

The RCBC for each crossing were designed to meet the criteria of the County ECM and DCM. Size for the culvert was determined by hydraulic criteria outline in the Hydraulic Report, included in the Appendix. The culvert sizes and revised floodplain were approved by FEMA in the approved CLOMR (FEMA Case No: 19-08-0185R) as triple 10 ft X10 ft RCBC. However, during design, to minimize the impact to wetlands upstream and downstream the size

was modified to a 7 ft H x 12 ft W RCBC, for both culvert crossings use a triple 7 ft x 12 ft RCBC. The following variables are determined by detail M-601-3:

- S= 12 ft
- R=7 ft
- TW= 10 inches
- Tt= 13.5 inches
- Tb=11 inches
- H=12'-0 ½"

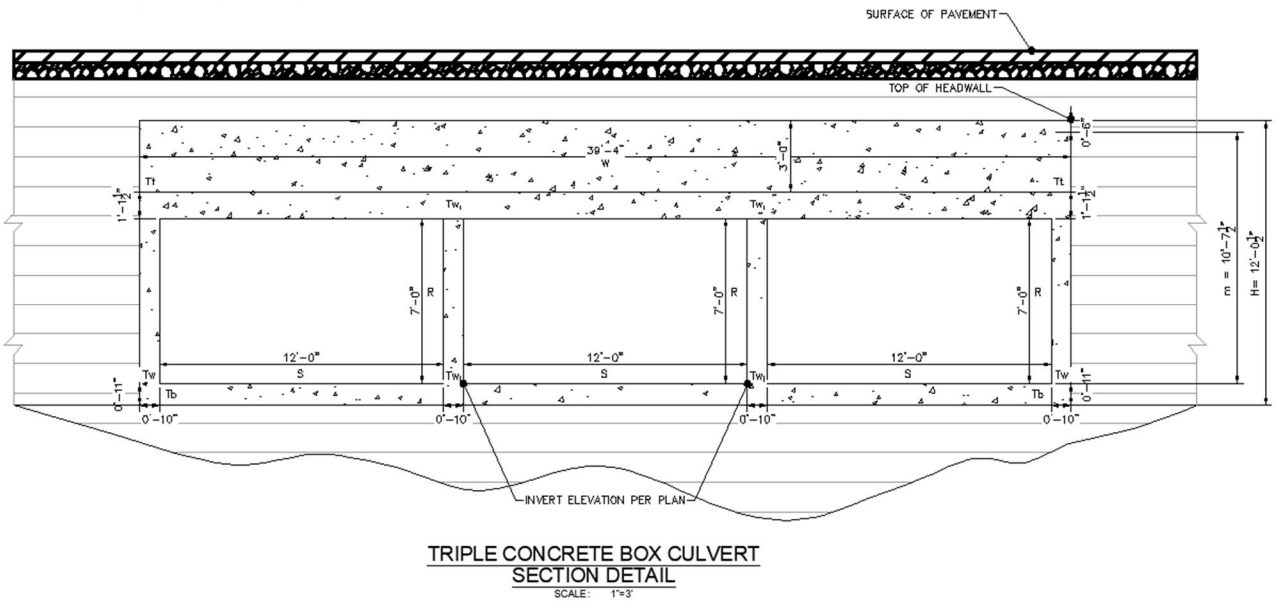

Figure 3: Triple RCBC Cross Section and Variables

The culverts were designed with two feet of freeboard in between the culvert low chord and the water surface profile for the 100 year event, per the section 6.4.2 of the DCM. Subgrade preparation and foundation preparation for the RCBC is provided in the Geotechnical Report, provided in the Appendix.

Structural Design

A structural check was completed based on the CDOT standard detail M-601-3 using the member sizes and reinforcing for an 8 ft H x 12 ft W box culvert. The standard detail provides the structural details necessary for construction and vertical reinforcement in the walls. A structural check was completed to verify that the 7 ft height of the culvert conforms with the structural details for the 8 ft height. See calculations supporting the 7 ft box in the Appendix. This methodology is consistent with the intent of note number 7 on Sheet 2 of Detail M-601-3: "When a (Rise) R of less than 6 feet is required, use the bar sizes and the slab and wall thicknesses for the 6 foot rise". The detail provides the necessary design for the triple RCBC based on the amount of fill over the RCBC.

Additionally, CDOT standard detail M-601-3 show a 1 ft tall headwall on the top of the slab. This was structurally modified to accommodate a 3 ft tall headwall, to maintain a 3:1 fill slope from the edge of pavement.

No additional structural design or analysis was completed with the project.

Wingwalls

The wingwalls for each Culvert Crossing were designed per the CDOT DDM and the CDOT standard detail M-601-20. The angle of each wingwall was determined by Table 9.5 of the CDOT DDM and are determined by the skew angle of the Culvert. As previously discussed, Culvert Crossing No. 1 has a skew of approximately 75 degrees.

Based on interpolation of the table. 75 degree and 45 degree angles were used for the wingwall flare angles on Culvert Crossing No. 1. Culvert Crossing No. 2 has no skew, thus 60 degree flare angles were used.

Table 9.5 Recommended wingwall flare angles (θ_a or θ_b)

Skew Angle, $\theta°$	$\theta_a°$	$\theta_b°$
90	60	60
80	50	70
70	45	80
60	40	90
50	30	90
40	20	100
30	15	105
< 30	Consult the Region Hydraulic Engineer	

Figure 4: Wingwall Flare Angles

The minimum length of the wingwalls were determined by the equations 9.2, 9.3, and 9.4 set forth by the CDOT DDM. The following values were determined from the equations:

- H=11'-1/8"
- k (height in feet of the lower end of the wingwall)= 3 feet
- m=11'-7-1/2" (Determined as 6 inches below special headwall design)
- Z= 4

The length of each wingwall varies with the actual grading and the wingwall does not exceed a 4:1 slope. Lengths over 30 feet are rounded the nearest four foot increment. Reference the Construction Documents for the length of each wingwall. A spill cone with slopes of 1.5:1 or flatter is allowable at the terminus of each wingwall. Reference Figure 5 for the typical wingwall layout per the CDOT DDM.

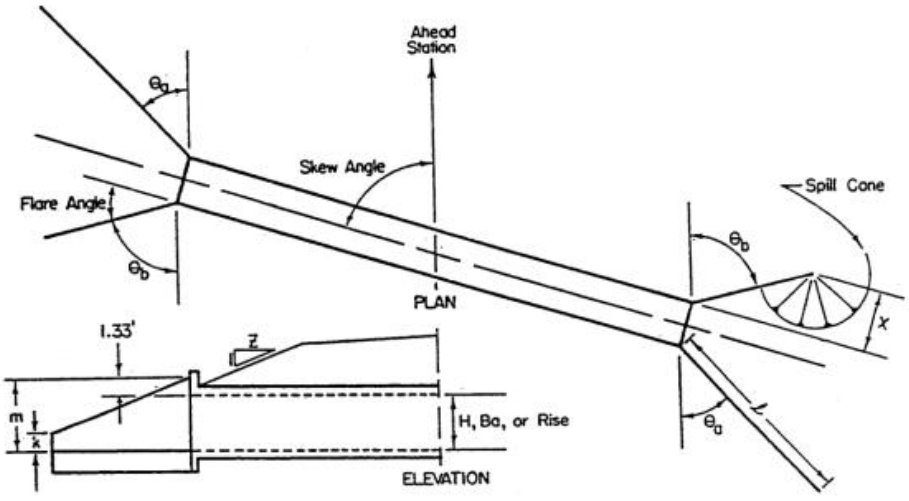

Figure 5. Typical Wingwall Layout

Section 3: Conclusion

The Culvert Crossing Design plans hereto mentioned adhere to the principles and criteria in the following documents:

CDOT Standard Detail M-601-3, Triple Concrete Box Culvert

CDOT Standard Detail M-601-20, Wingwalls for Pipe or Box Culverts

El Paso County “Drainage Criteria Manual”, dated October 31, 2018 (“DCM”)

El Paso County “Engineering Criteria Manual” Revision 6, dated December 13, 2016 (“ECM”)

CDOT “Drainage Design Manual”, 2019. (“CDOT DDM”)

Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.

Appendix A

Hydraulic Report

Final Hydraulic & Hydraulic Section Report

Winsome Subdivision Filing No. 3
El Paso County, Colorado

Prepared for:
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Monument, CO 80132

Prepared by:
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2 North Nevada Avenue, Suite 300
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(719) 453-0180
Contact: Brice Hammersland, P.E.

Project #: 196106001

Prepared: August 30, 2022

PCD File No. CDR-21-012

Kimley»Horn

CERTIFICATION

DESIGN ENGINEER'S STATEMENT

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

SIGNATURE (Affix Seal): _____

Brice Hammersland Date
Colorado P.E. No. 56012

OWNER/DEVELOPER'S STATEMENT

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

Winsome, LLC
Name of Developer

_____
Authorized Signature Date

Joe DesJardin
Printed Name

Director of Entitlements
Title

1864 Woodmoor Drive, Suite 100 Monument, CO 80132
Address:

EL PASO COUNTY

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

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

Conditions:

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PURPOSE

The purpose of this Hydraulic Report is to provide the culvert hydraulic calculations for the proposed Winsome Subdivision ("the Project") Filing No. 3 ("the Site") for Winsome LLC. The Project is located within the jurisdictional limits of El Paso County ("the County"). Thus, the guidelines for the hydraulic design components were based on the criteria for the County and City of Colorado Springs, described below.

PROJECT DESCRIPTION

The Project is located on approximately 349.5 acres of land, north of Hodgen Road and west of Meridian Road. A vicinity map has been provided in the **Appendix A** of this report. Filing No 3 will consist of 38 residential. The existing land use is undeveloped vacant land. The West Kiowa Creek ("the Creek") runs through the Site from southwest to northeast. Two roadway crossings are being proposed to cross the Creek and connect the Winsome Filing No 2 phase to the proposed Winsome Filing No 3 phase. Two reinforced concrete box culverts are being proposed at these crossings to allow access to the next phase of the Winsome development. Refer to the site vicinity map in **Appendix A**.

PREVIOUS REPORTS

A preliminary drainage report was completed for the overall Winsome subdivision. This was previously completed by The Vertex Companies. A CLOMR has been completed and approved by FEMA for the proposed box culverts analyzed within this report.

SOILS & GEOLOGY

NRCS soil data is available for this Site and it has been noted that soils onsite are generally USCS Type C and Type D. The NRCS soil data can be found in **Appendix B** as part of the excerpts from the approved PDR. There are no irrigation facilities within the Site.

An updated Topographic field survey was completed for the Project by Edward-James Surveying, Inc. dated November 3th, 2020 and is the basis for design for the drainage improvements.

A geotechnical report was completed by Entech Engineering Inc. dated October 18th, 2021. The report identifies ground water being encountered in the test borings at depths ranging from 2 to 9 feet. It should be noted that the ground water will impact the construction and excavation of the box culverts.

DRAINAGE CRITERIA

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

The culverts were sized to convey the flows from the Creek. Both proposed culverts are each 3 barrel 12' x 7' reinforced concrete box culverts (RCBC's) and have been designed to convey the 100-year storm event. Culvert calculations are provided in the **Appendix E** and culvert locations are provided in the construction documents. Refer to **Table 1** for 100-year design flows.

FLOODPLAIN STATEMENT

The roadway and culvert improvements are located within the 100-year FEMA Zone A floodplain as determined by the Flood Insurance Rate Map (FIRM) number 08041C0350G effective date, December 7, 2018 (see **Appendix C**). A Conditional Letter of Map Revision (CLOMR) was submitted and approved by Vertex per FEMA Case No. 19-08-0185R, dated 9/30/2019 as part of Winsome Filing No. 1 (see **Appendix D**).

DRAINAGE CONDITIONS

The Project is located on 349.5 acres of land consisting of vacant land with native vegetation and is classified as "Pasture and Meadow" per Table 6-6 of the City of Colorado Springs Drainage Criteria Manual. The Project is located within El Paso County's West Kiowa Creek Drainage Basin. Drainage flows from southwest to northeast overland over vacant land to the West Kiowa Creek.

For the proposed condition, stormwater will generally maintain historic flow patterns from southwest to northeast. The design 100-year storm event flows used to size both culverts were taken from the approved CLOMR and are listed in **Table 1**. Both culverts are designed to have 2-feet of freeboard from the 100-year water surface elevation to the top of box, per Criteria. Results of the culvert design are provided in **Appendix E**. The sizing of the box was analyzed as part of the approved Preliminary Drainage Report dated May 22, 2019. As part of the Preliminary Drainage Report a Conditional Letter of Map Revision (CLOMR) was completed and approved by FEMA. The CLOMR was approved on the assumption of the three 10'x 10' CDOT RCBC design. As part of this report the box culvert sizes were revised due to wetland impacts. The revised culverts are sized adequately to provide the necessary 2 ft of clearance between the bottom of structure to the 100-year flood elevation per El Paso County criteria. Refer to the Structural Selection Report for additional information regarding the selection of the RCBC. The CLOMR HEC-RAS model that was approved was updated with the revised culvert sizes and a BFE comparison table is in **Appendix G**. The results show the revised culverts decrease the WSELs upstream except for two cross-sections (6134 and 1826). The revised model shows an increase of 0.42' at cross-section 6134 and increase of 0.64' at cross-section 1826. With the increased WSELs at cross-section 6134 and 1826 the flows are still contained within the channel and are not anticipated to create adverse impacts.

***Table 1**. Proposed Culvert Data*

Culvert ID	Station	100-Year Design Flow (CFS)	Full Flow Capacity (CFS)	Normal Depth (Feet)	Percent Full in Normal Flow
1	5310	2,062	4,530	3.30	45.5%
2	1160	2,311	4,530	3.55	51.0%

Both culverts will impact existing wetlands, as shown on the Construction Documents in **Appendix F**. The culverts have been placed to reduce the impact to existing wetlands to the extent practicable.

Downstream energy dissipation/channel protection (outlet pad and rip-rap size(s)) are designed per Chapter 9 of the El Paso County Drainage Criteria Manual (DCM) and the Mile High Flood

District's (MHFD) Urban Storm Drainage Criteria Manual criteria. MHFD's UD-Culvert spreadsheet was used to calculate riprap protection sizing. Riprap protection will be provided upstream and downstream of each culvert, lining both the channel bottom and side slopes. Type M riprap will be used for the upstream and downstream culvert protection. In addition to providing riprap protection at the culverts riprap protection will also be placed at the downstream bend of culvert 2. Type M riprap will be used at this location. The culvert apron design deviates from the upstream and downstream concrete aprons within the approved CLOMR. Riprap is proposed to limit the impact to existing wetlands and will provide adequate energy dissipation. Calculations are provided as part of **Appendix E** with the channel/outlet protection design shown on the Culvert Plans in **Appendix F**.

SUMMARY

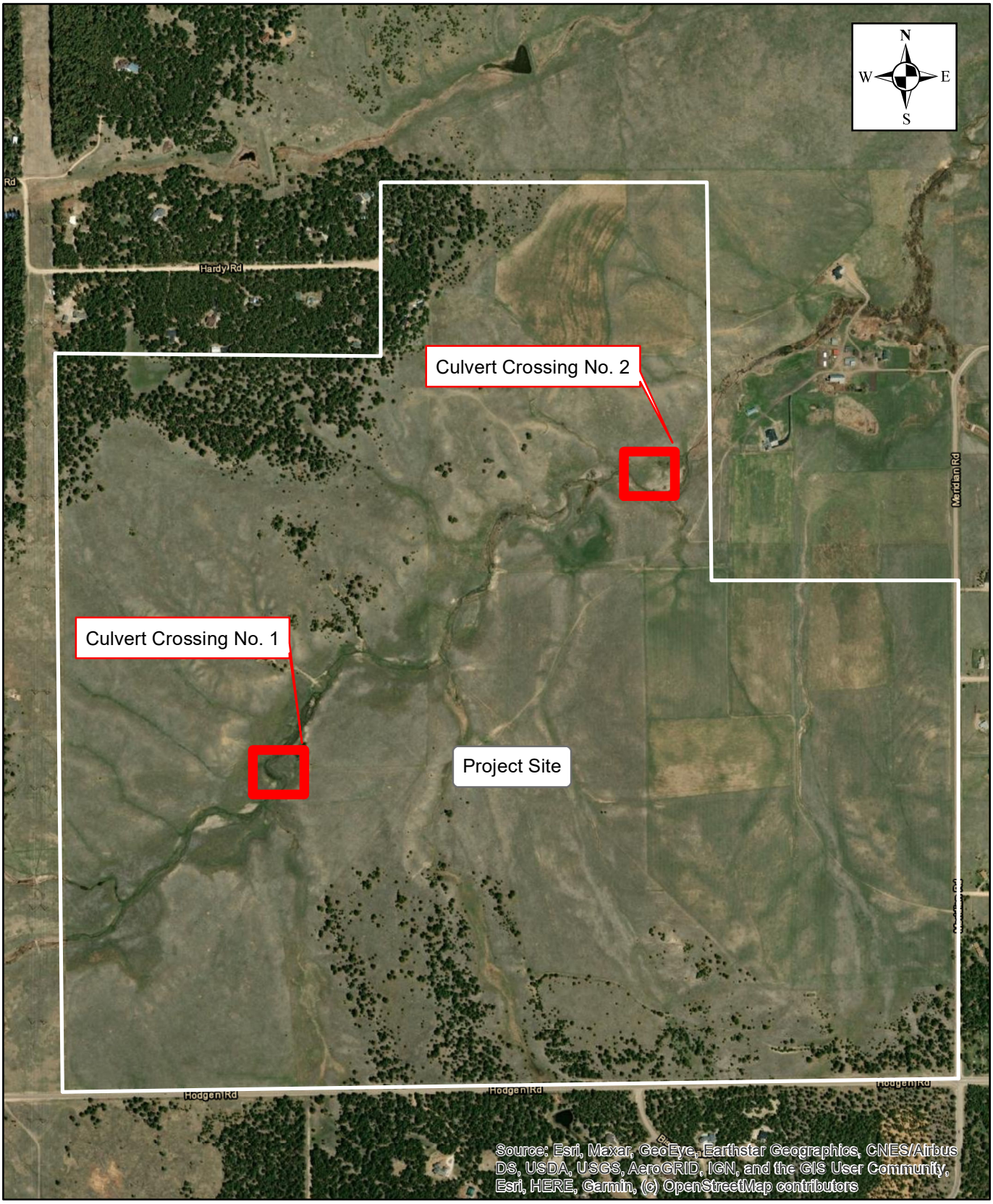
The proposed drainage design is to maintain the historic drainage patterns, the overall imperviousness and release rates for the Site. Runoff from the Site will flow overland to existing El Paso County drainage basins: The West Kiowa Creek Basin. The basin ultimately discharges to the West Kiowa Creek. The drainage design presented within this report conforms to the criteria presented in both the MANUAL and the Colorado Springs MANUAL. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments, including West Kiowa Creek. Kiowa Creek running through the project area has been identified as Waters of the U.S. (WOTUS). In addition to wetlands being identified within the project limits of Kiowa Creek. The proposed culverts will both have minor permanent impacts to the wetlands within Kiowa Creek. The improvements will impact 0.49 acres of wetlands. Additional permitting and reports will be completed by others for wetland mitigation measures.

REFERENCES

1. City of Colorado Springs “Drainage Criteria Manual (DCM) Volume 1”, dated May, 2014
2. El Paso County “Drainage Criteria Manual”, dated October 31, 2018
3. El Paso County “Engineering Criteria Manual” Revision 6, dated December 13, 2016
4. Chapter 6 and Section 3.2.1. of Chapter 13-City of Colorado Springs Drainage Criteria Manual, May 2014.
5. Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
6. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 008041C0350G effective date, December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).

APPENDIX

APPENDIX A: VICINITY MAP



0 500 1,000 2,000 Feet Kimley»Horn	**Winsome Filing No. 3**	**El Paso County Colorado**
	Figure 1: Location Map	

APPENDIX B: SOILS MAP

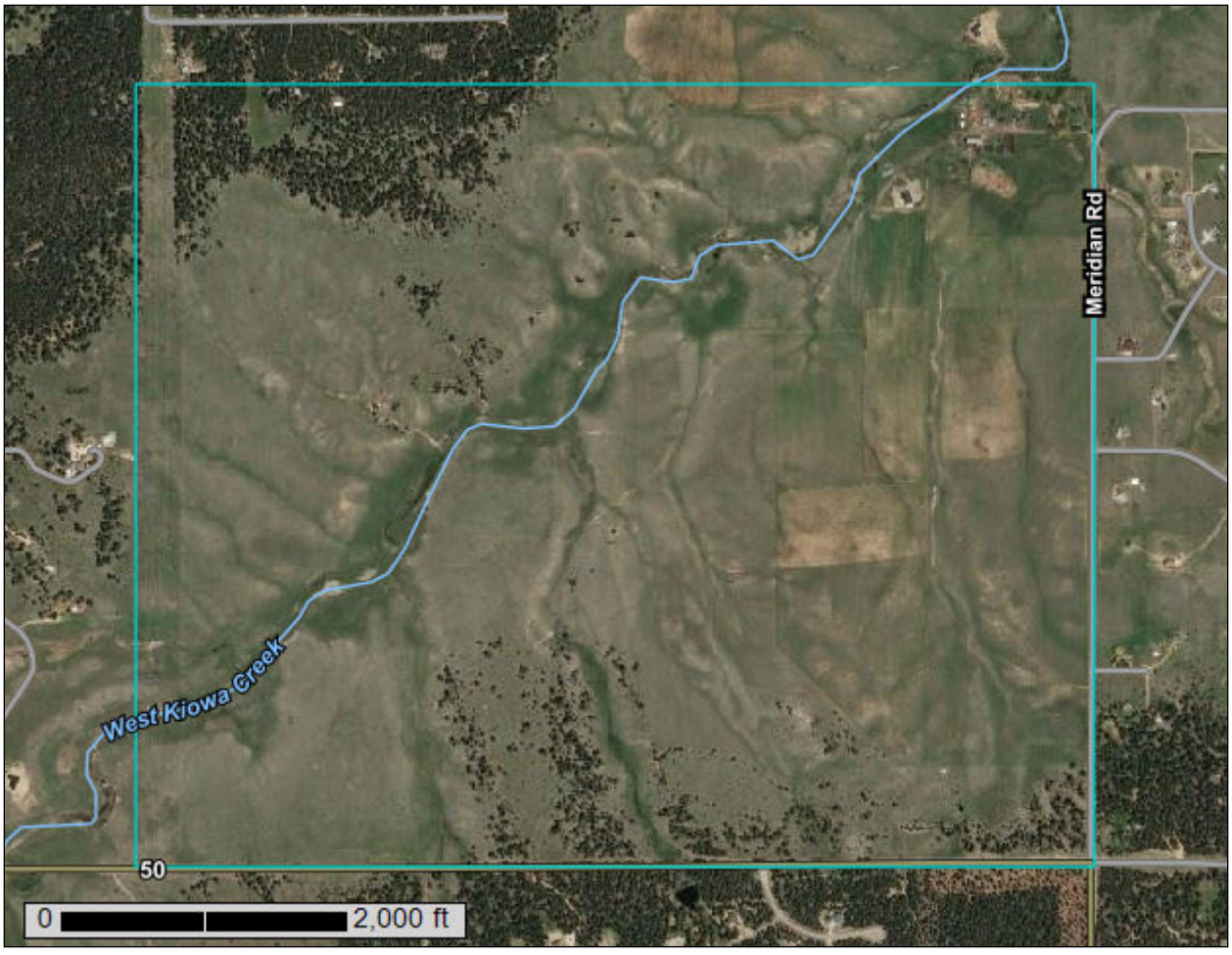
United States Department of Agriculture

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



July 9, 2021

Preface

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

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

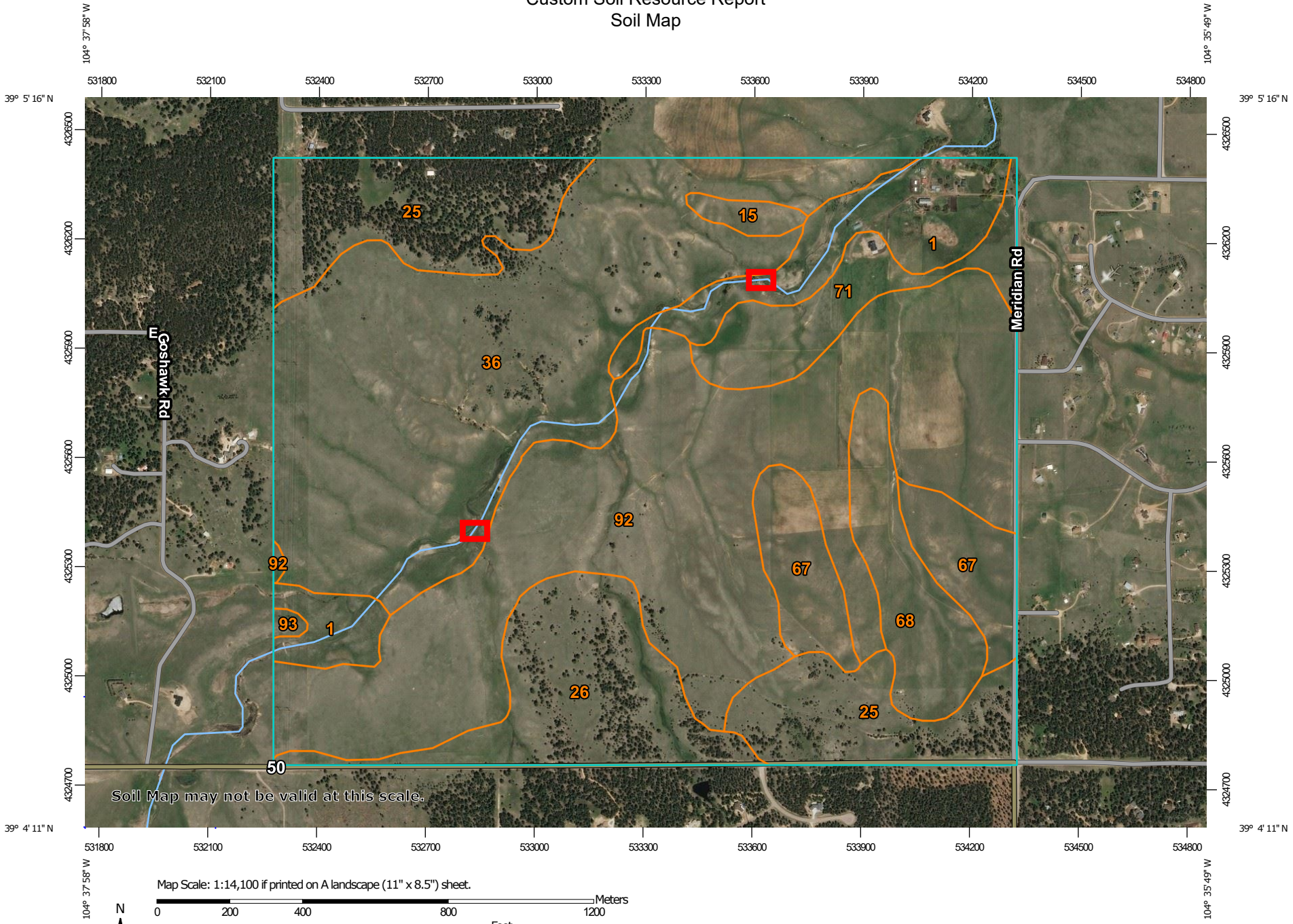
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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

Soil Map

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

Custom Soil Resource Report
Soil Map



Map Scale: 1:14,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 200 400 800 1200

Feet: 0 500 1000 2000 3000

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	57.3	6.8%
15	Brussett loam, 3 to 5 percent slopes	6.0	0.7%
25	Elbeth sandy loam, 3 to 8 percent slopes	102.8	12.1%
26	Elbeth sandy loam, 8 to 15 percent slopes	68.1	8.0%
36	Holderness loam, 8 to 15 percent slopes	233.8	27.6%
67	Peyton sandy loam, 5 to 9 percent slopes	45.6	5.4%
68	Peyton-Pring complex, 3 to 8 percent slopes	38.3	4.5%
71	Pring coarse sandy loam, 3 to 8 percent slopes	34.6	4.1%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	260.3	30.7%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	1.5	0.2%
Totals for Area of Interest		**848.1**	**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

1—Alamosa loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3670
Elevation: 7,200 to 7,700 feet
Farmland classification: Prime farmland if irrigated and reclaimed of excess salts and sodium

Map Unit Composition

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

Description of Alamosa

Setting

Landform: Flood plains, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 6 inches: loam
Bt - 6 to 14 inches: clay loam
Btk - 14 to 33 inches: clay loam
Cg1 - 33 to 53 inches: sandy clay loam
Cg2 - 53 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 12 to 18 inches
Frequency of flooding: NoneFrequent
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Very slightly saline to strongly saline (2.0 to 16.0 mmhos/cm)
Available water capacity: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: R048AY241CO
Hydric soil rating: Yes

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

15—Brussett loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 367k
Elevation: 7,200 to 7,500 feet
Frost-free period: 115 to 125 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Brussett

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits

Typical profile

A - 0 to 8 inches: loam
BA - 8 to 12 inches: loam
Bt - 12 to 26 inches: clay loam
Bk - 26 to 60 inches: silt loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): 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
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R048AY222CO
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

25—Elbeth sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 367x
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: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
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 capacity: 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

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
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 capacity: 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

Pleasant

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

Other soils

Percent of map unit:
Hydric soil rating: No

36—Holderness loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 3689
Elevation: 7,200 to 7,400 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Holderness

Setting

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

Typical profile

A - 0 to 9 inches: loam
Bt - 9 to 43 inches: clay loam
C - 43 to 60 inches: gravelly sandy clay loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R048AY222CO
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

67—Peyton sandy loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369d
Elevation: 6,800 to 7,600 feet
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 115 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
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 capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
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

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

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

Map Unit Composition

Peyton and similar soils: 40 percent
Pring and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): 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 capacity: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Description of Pring

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

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

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

Map Unit Setting

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

Map Unit Composition

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

Description of Pring

Setting

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

Typical profile

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

Properties and qualities

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

Interpretive groups

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

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
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

93—Tomah-Crowfoot complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 36bb
Elevation: 7,300 to 7,600 feet

Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R049XB216CO - Sandy Divide
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

Soil Information for All Uses

Soil Properties and Qualities

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

Soil Qualities and Features

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

Hydrologic Soil Group

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

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

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

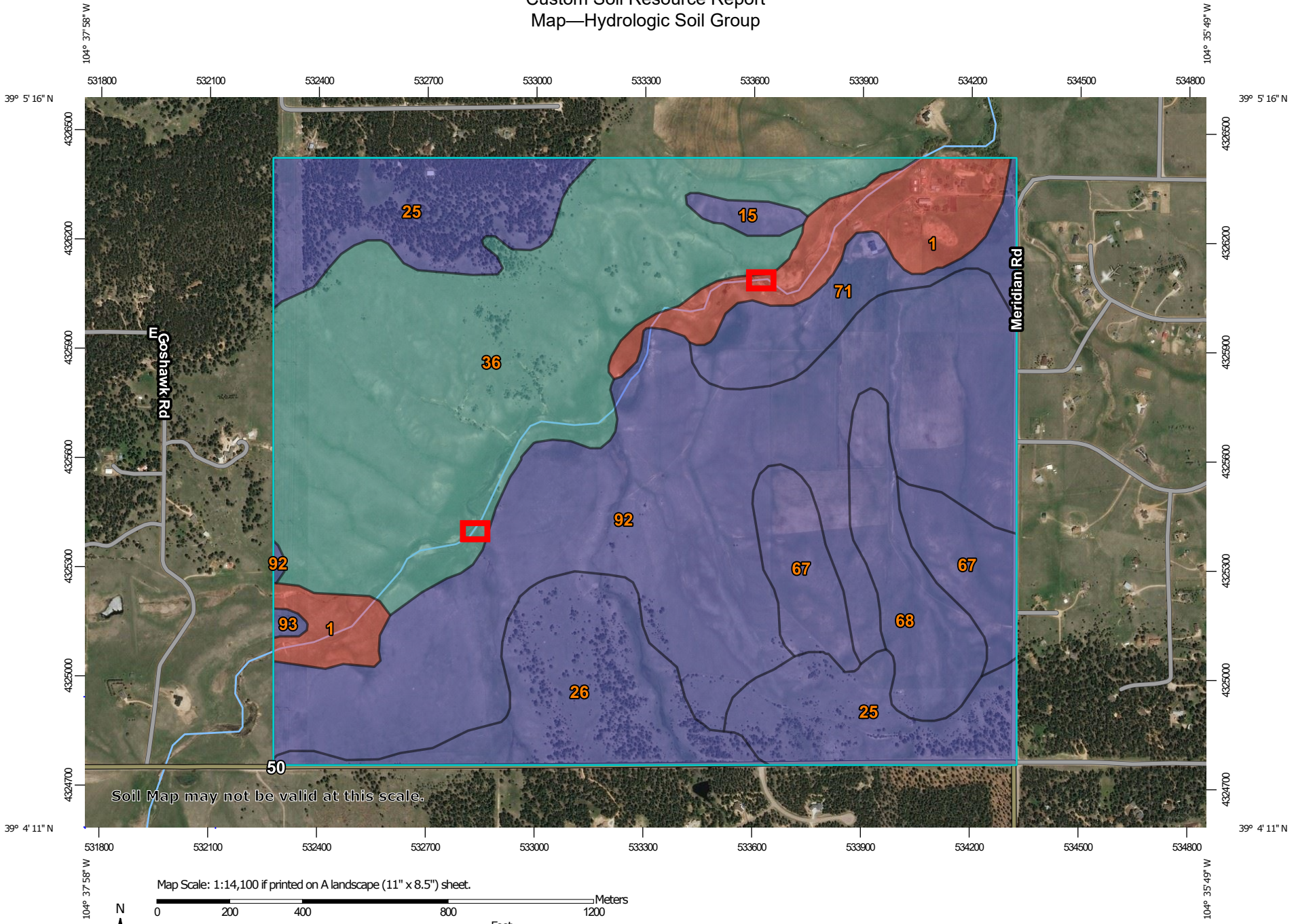
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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

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

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

Custom Soil Resource Report
Map—Hydrologic Soil Group



Map Scale: 1:14,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 200 400 800 1200

Feet: 0 500 1000 2000 3000

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	D	57.3	6.8%
15	Brussett loam, 3 to 5 percent slopes	B	6.0	0.7%
25	Elbeth sandy loam, 3 to 8 percent slopes	B	102.8	12.1%
26	Elbeth sandy loam, 8 to 15 percent slopes	B	68.1	8.0%
36	Holderness loam, 8 to 15 percent slopes	C	233.8	27.6%
67	Peyton sandy loam, 5 to 9 percent slopes	B	45.6	5.4%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	38.3	4.5%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	34.6	4.1%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	260.3	30.7%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	1.5	0.2%
Totals for Area of Interest			**848.1**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

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APPENDIX C: FEMA MAP

NOTES TO USERS

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

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

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

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

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

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

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

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

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

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

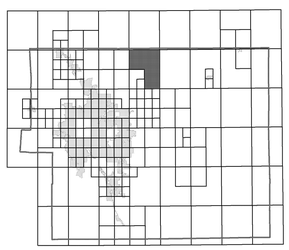
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this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

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

El Paso County Vertical Datum Offset Table

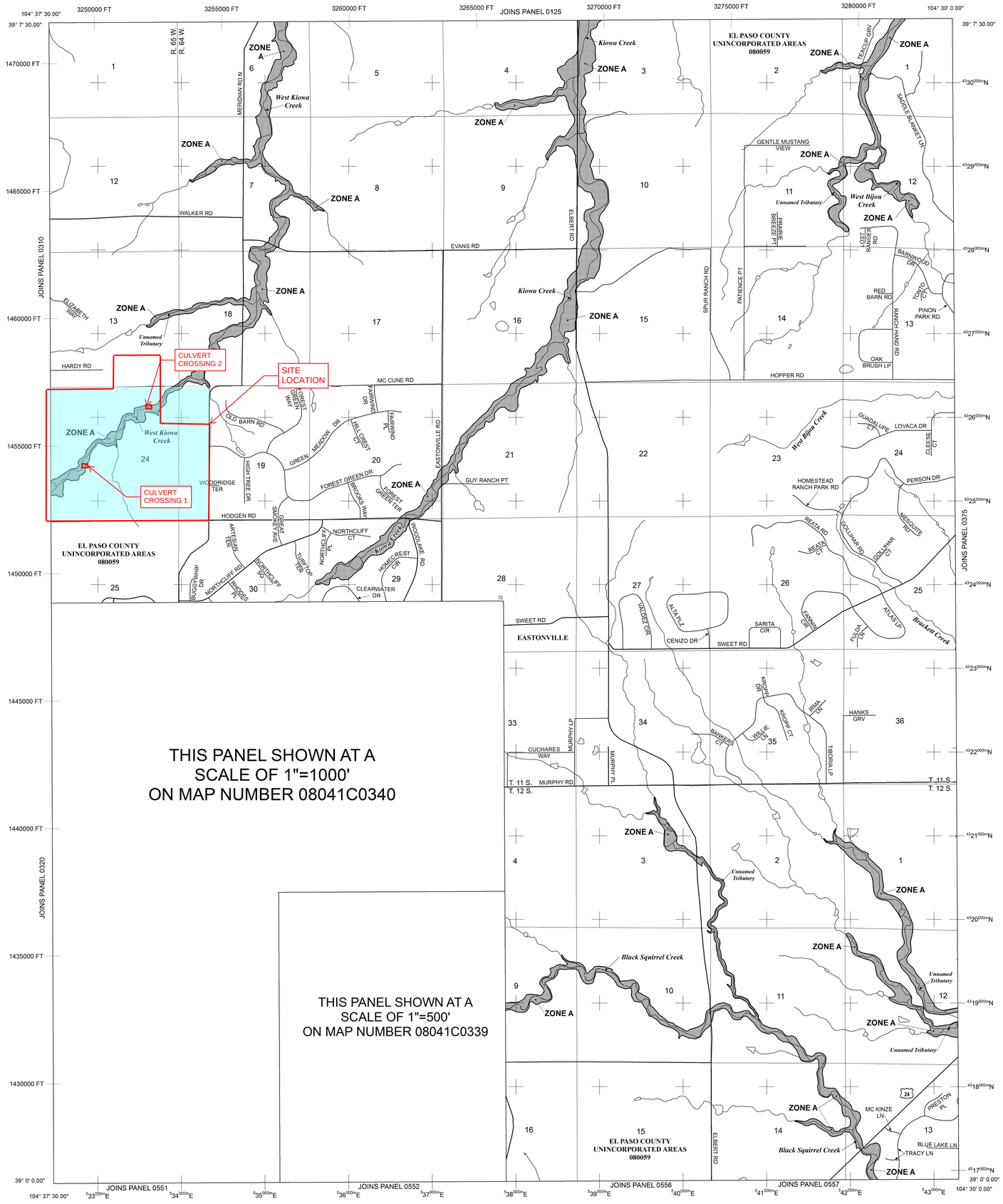
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



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

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

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

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

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

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

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

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

MAP SCALE 1" = 2000'
1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

PANEL 0350G

MAP REVISED DECEMBER 7, 2018

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 350 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0350	G

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

MAP NUMBER 08041C0350G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

APPENDIX D: FEMA CLOMR

McCune Ranch Subdivision
aka Winsome Subdivision
17480 Meridian Road North
Colorado Springs, Colorado 80924

REQUEST FOR CONDITIONAL LETTER OF MAP REVISION

FOR WEST KIOWA CREEK

COLORADO SPRINGS, COLORADO

JULY 1, 2019

PREPARED FOR:
PT McCune, LLC
Joseph W DesJardin
1864 Woodmoor Drive, Suite 100
Monument, Colorado 80132

PREPARED BY:
The Vertex Companies, Inc.
2420 W. 26th Avenue, Suite 100-D
Denver, Colorado 80211
PHONE: 303-623-9116

VERTEX Project: 49388
FEMA Case No: 19-08-0185R

Jason Priddy
Project Engineer

Lance VanDemark, P.E.
Project Manager

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   ii. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN CROSS SECTIONS
   iii. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN PROFILE
   iv. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN CROSS SECTIONS
   v. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN PROFILE
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1.0 INTRODUCTION

The purpose of this submittal is to request a Conditional Letter of Map Revision (CLOMR) for a flooding source in El Paso County, Colorado known as West Kiowa Creek. This request is requisite for a 760-acre property, known as the proposed McCune Ranch Subdivision (aka Winsome Subdidision). West Kiowa Creek, which flows across the property from west to east, is currently mapped as an approximate Zone A. Stormwater is directed from the contributing basins across the property along an approximate 1.25-mile flow path. The proposed development will affect FIRM map number 08041C0350G and 08041C0310G, effective December 7, 2018. Basin hydrology and hydraulics have been modeled and are included in this study to identify the Special Flood Hazard Area (SFHA). The basis of this request is to identify the floodplain boundary for the residential subdivision proposed for the site, and to assess the extent of flood risk relative to two proposed bridges.

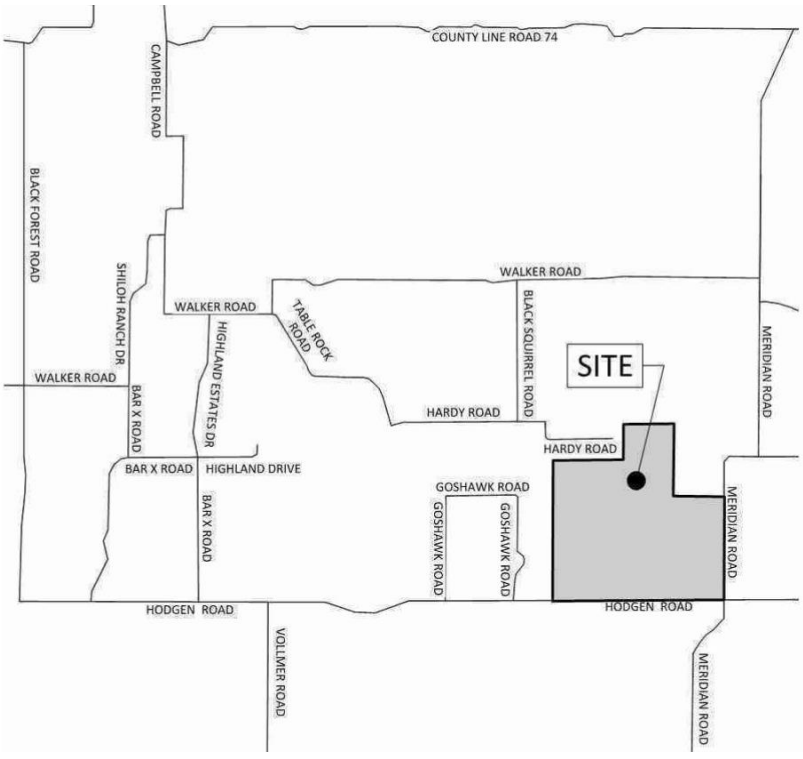
2.0 GENERAL LOCATION AND DESCRIPTION

The following report provides detailed drainage and floodplain information for existing and proposed conditions of the McCune Ranch Subdivision project. The intent of this report is to show the extent of flood risk through the proposed site, and the boundaries of the SFHA, as well as other storm events per FEMA requirements. The information given in this report is intended to provide data resulting from a detailed analysis of stormwater drainage and define the 100-year floodplain. Because the subject reach is currently an approximate Zone A, Base Flood Elevations (BFE's) will be defined. A floodway has not been delineated. This development is in a rural area and will consist of large-lot single family residential parcels, a small commercial area, preserved open space, as well as the roads and required utility infrastructure.

GENERAL LOCATION

The site is located at 17480 Meridian Road North or, more generally, at the northwest corner of Hodgen Road and Meridian Road North in unincorporated El Paso County. The subject property is undeveloped and situated in the West Half of Section 19, Township 11 South, Range 64 West of the 6th P.M., County of El Paso, State of Colorado.

The site is bounded to the south by Hodgen Road, to the east by Meridian Road North, and to the north and west by several parcels zoned primarily as Agricultural and Residential use with some Forest Land. On the east side of Median Road is Forest Green Subdivision, a low-density single-family development. On the south side of Hodgen Road is Bison Meadows Subdivision which is also a low-density single family residential subdivision. The remainder of properties surrounding the site have not yet been formally platted. The site has not been included in any previous drainage study.



DESCRIPTION OF PROPERTY

The existing site contains 766 acres of agricultural grazing land and dry farm land. Ground cover consists mainly of native grasses and shrubs and contains several stands of evergreen trees along its southern and northern boundary. Existing wetlands are present along West Kiowa Creek and its tributaries, wetland boundaries are located roughly 50 feet to either side of the thalweg of West Kiowa Creek and the drainageway way to the south of the creek on the property. There are no existing irrigation canals or ditches on the project site nor are there any major geologic features. The property generally slopes in a northeasterly direction with slopes ranging between 1-16%. Soils consist of Alamosa loam, Brussett loam, Cruckton sandy loam, Elbeth sandy loam, Holderness loam, Kettle gravelly loamy sands, Peyton sandy loam, Peyton-Pring complex, Pring course sandy loam, Tomah-Crowford loamy sands and Tomah-Crowfoot complex. Most of the site has soils classified in Hydrologic Soil Group B; however, the property also contains a mixture of soils from Hydrologic Soils Groups C and D located in the areas in and adjacent to West Kiowa Creek and its tributaries.

PROPOSED DEVELOPMENT

The development of this property will consist of 143 2.5 to 5-acre single family residential lots and the requisite public roads and stormwater infrastructure to serve them. Anticipated construction activities include earthwork and paving associated with the public roads, as well as the installation of culverts and detention ponds to convey and treat stormwater on the site. The primary access for the site will be from Hodgen Road and Meridian Road. A site plan for the project is included in the appendix.

3.0 PROPOSED DESIGN CONDITIONS

REGULATIONS

The hydrologic calculations in this report comply with the City of Colorado Springs/El Paso County Drainage Criteria Manuals, and FEMA drainage criteria. There are no previous drainage studies that cover this property.

EXISTING DRAINAGE

Historically, the runoff from the property flows into West Kiowa Creek, which bisects the site flowing from the southwest corner of the property to the northeast corner. There are 10 on-site sub-basins and 6 off-site sub-basin that contribute flows to West Kiowa Creek. The 10 on-site sub-basins correspond to the largest defined natural drainage channels that occur on site, while the 6 off-site basins are defined by the entire West Kiowa Creek watershed that is upstream from the subject property.

PROPOSED DRAINAGE

All existing drainage patterns will be maintained throughout the site to the extent possible. The path of the main thalweg is not altered, however 2 new box culverts are proposed at road crossings within the development. To calculate the design flows at points across the project, the existing basins were subdivided into 35 on-site sub-basins and 8 off-site sub-basins in the proposed condition. Stormwater detention ponds have been designed to control flow such that all flow off the site will be at or below historic averages.

PROPOSED BRIDGES

The project includes two triple box culverts at points where roads cross the floodplain. The culverts are sized at (3) 10’ wide x 10’ high totaling approximately 30’ wide x 10’ high of flow

area. In the 100-year storm there is no overtopping of the road. This condition meets local requirements for this road category. The length of both box culverts is sized to accommodate 2 lanes of traffic and road shoulder. Details of the proposed culverts is included in the appendix.

The culverts will have flared end sections with a concrete apron that funnels the entering water in and spreads the exiting flow out. A rip-rap bed will be used at the culvert exit points to address potential erosion. The culverts will be installed at grade with 0.5% slope and allow the passage of aquatic life.

HYDROLOGICAL AND HYDRAULIC CRITERIA

Topographic mapping was developed from LiDAR and field mapping conducted in 2011, and obtained from the licensed GIS data service of El Paso County. El Paso County GIS Services projects the contours in the Colorado Central Zone in State Plane (Feet) units using the NAD83 horizontal datum. The vertical datum is NAVD.

Since this project contains sub-basins over 100 acres, times of concentration and peak runoff values were calculated using the SCS TR-55 Hydrograph method as required by the City of Colorado Springs/El Paso County Drainage Criteria Manuals. The model utilizes the SCS Type II 24-hr rainfall distribution and rain gauge data for the county.

Hydraulic modeling of the floodplain was performed using HEC-RAS version 5.0. Manning's n-values of 0.03 for in channel areas and 0.035 for overbank areas were used in the model based on site observation and referencing within Ven Te Chow's Open Channel Hydraulics. Contraction and expansion coefficients are 0.1 and 0.3 respectively, for all cross sections except for the two box culverts where 0.3 and 0.5 are used at the appropriate sections.

4.0 HYDRAULIC MODEL RESULTS

A HEC-RAS section analysis was performed to identify the floodplain width for the different storm events. Pertinent model information is included in the appendix. The following tables summarize the results:

COMPARATIVE EXISTING AND PROPOSED SECTION DATA						
CROSS SECTION	EC 100-YEAR WSEL	PC 100-YEAR WSEL	WSEL IMPACT	EC TOP WIDTH	PC TOP WIDTH	TOP WIDTH IMPACT
72+34	7337.98	7338.11	0.13	62.28	63.12	0.84
69+69	7335.41	7335.52	0.11	63.13	64.11	0.98
67+63	7333.50	7333.63	0.13	63.51	64.92	1.41
65+42	7331.02	7331.14	0.12	72.18	74.22	2.04
63+02	7328.83	7328.85	0.02	76.66	76.90	0.24
61+34	7327.64	7327.28	-0.36	135.78	131.11	-4.67
58+12	7325.32	7326.47	1.15	129.67	201.82	72.15
54+80	7323.11	7326.65	3.54	177.66	349.50	171.84
53+75	7322.89	7326.35	3.46	136.48	278.31	141.83
53+10			CULVERT			
52+56	7321.54	7321.50	-0.04	111.61	110.20	-1.41
51+58	7318.63	7318.71	0.08	102.69	103.09	0.40
48+10	7316.70	7316.81	0.11	178.97	179.90	0.93
47+01	7316.60	7316.71	0.11	145.65	146.50	0.85
44+67	7315.62	7315.70	0.08	112.95	114.47	1.52
43+12	7314.33	7314.40	0.07	115.02	115.43	0.41
40+58	7310.97	7311.05	0.08	98.36	99.53	1.17
37+56	7308.35	7308.45	0.10	84.42	86.18	1.76
36+71	7307.43	7307.52	0.09	95.71	96.89	1.18
33+13	7304.27	7304.40	0.13	98.47	102.90	4.43
30+53	7300.93	7301.03	0.10	68.96	69.79	0.83
29+16	7299.69	7299.80	0.11	66.66	67.41	0.75
25+59	7297.05	7297.13	0.08	117.36	118.75	1.39
23+56	7294.53	7294.61	0.08	88.27	88.75	0.48
21+15	7292.39	7292.45	0.06	99.33	99.93	0.60

18+26	7289.01	7289.14	0.13	84.94	86.77	1.83
16+18	7288.55	7289.44	0.89	266.32	299.59	33.27
15+15	7286.83	7289.46	2.63	166.37	425.09	258.72
13+21	7285.19	7289.40	4.21	154.03	291.86	137.83
12+24	7284.44	7289.09	4.65	157.81	255.05	97.24
11+60			CULVERT			
11+05	7284.18	7283.36	-0.82	145.88	124.12	-21.76
10+07	7282.77	7282.73	-0.04	89.32	88.93	-0.39
8+93	7281.41	7281.40	-0.01	243.26	243.18	-0.08
6+78	7278.50	7278.47	-0.03	265.74	265.53	-0.21
4+40	7276.47	7276.45	-0.02	146.63	146.38	-0.25

5.0 SEDIMENT TRANSPORT

After visual observation and examining historical records, there are no indications that sediment or debris transport will impact base flood elevations (BFE). The stream appears to be in a stable state with no evidence that the structure has been recently influenced by sediment deposition, degrading of the bank or stream bed, or vegetative cover in the flow path. Further, the proposed stormwater detention ponds will help address potential sediment before it reaches the floodplain area. As a result, sediment transport is not included in this analysis.

6.0 SCOUR ANALYSIS

The potential for scour of the floodway, and the associated impacts on water surface elevations, were considered as a part of this analysis. The two box culverts have been designed with characteristics to help address this in major storm events. At the exit point of the culvert, a combination of flared wing walls, a concrete apron, and a rip-rap bed are proposed to reduce the velocity of the water and the impacts of scour.

7.0 ESA COMPLIANCE

An environmental features study dated October 1, 2018 has been prepared by Ecosystem Services for this project and is included in the appendix. Ecos has also provided a letter of "No Take" addressing ESA requirements. Further, a letter of "No Concern" from the US Fish and Wildlife Department has also been obtained and is included.

8.0 OPERATION AND MAINTAINANCE REQUIREMENTS

Metropolitan districts are being created for the neighborhood that will have the responsibility of maintaining drainage facilities and the floodplain area.

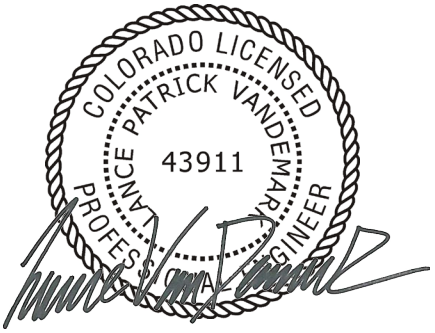
9.0 PROPOSED CONDITION BFE INCREASE

The Base (1-percent-annual-chance) Flood Elevation (BFE) increases to greater than 1.0 foot within the current, effective approximate Zone A immediately upstream of each of the two bridges. Fulfillment of the requirements set forth in 44 CFR 65.12 are described below:

a) Certification that no structures are affected by the increased BFE: Please see stamped certification on the next page.
b) Documentation of individual legal notice to all affected property owners, explaining the impact of the proposed action on their property: The only affected property owner is the applicant of this LOMR request, thus the applicant is apprised of the impact of the proposed development, de facto.
c) An evaluation of alternatives that would not result in an increase in BFE has been conducted. To access over half of the project area, the floodplain of this site must be crossed. Other bridge configurations are being considered, but due to the significant

expense associated with a bridge of this size, box culverts are currently being specified. Further, alternative road alignments and ingress/egress locations were considered but deemed infeasible for the project.

Certification that no structures will be affected by the rises in Base Flood Elevations (BFEs) as a result of the proposed project subject to this request. There are no existing structures currently within the boundary of the project.



Lance P. VanDemark PE, MSCE
VICE PRESIDENT – CIVIL ENGINEERING
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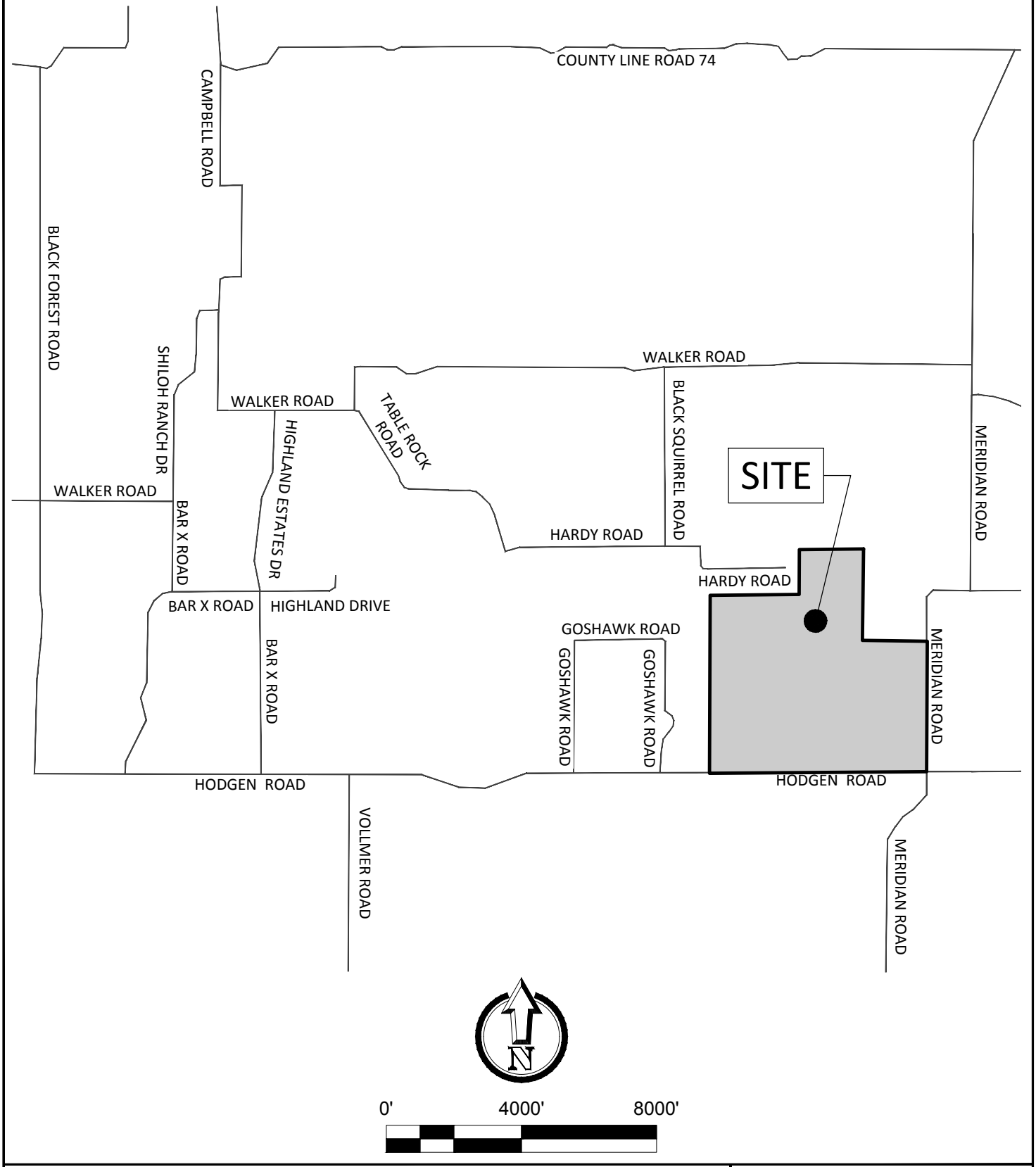
DENVER, CO 80211

A. REPRESENTATIVE PHOTOGRAPHS

B. WORKING MAPS AND OTHER REQUIRED DOCUMENTS

VICINITY MAP



VICINITY MAP

MCCUNE RANCH SUBDIVISION

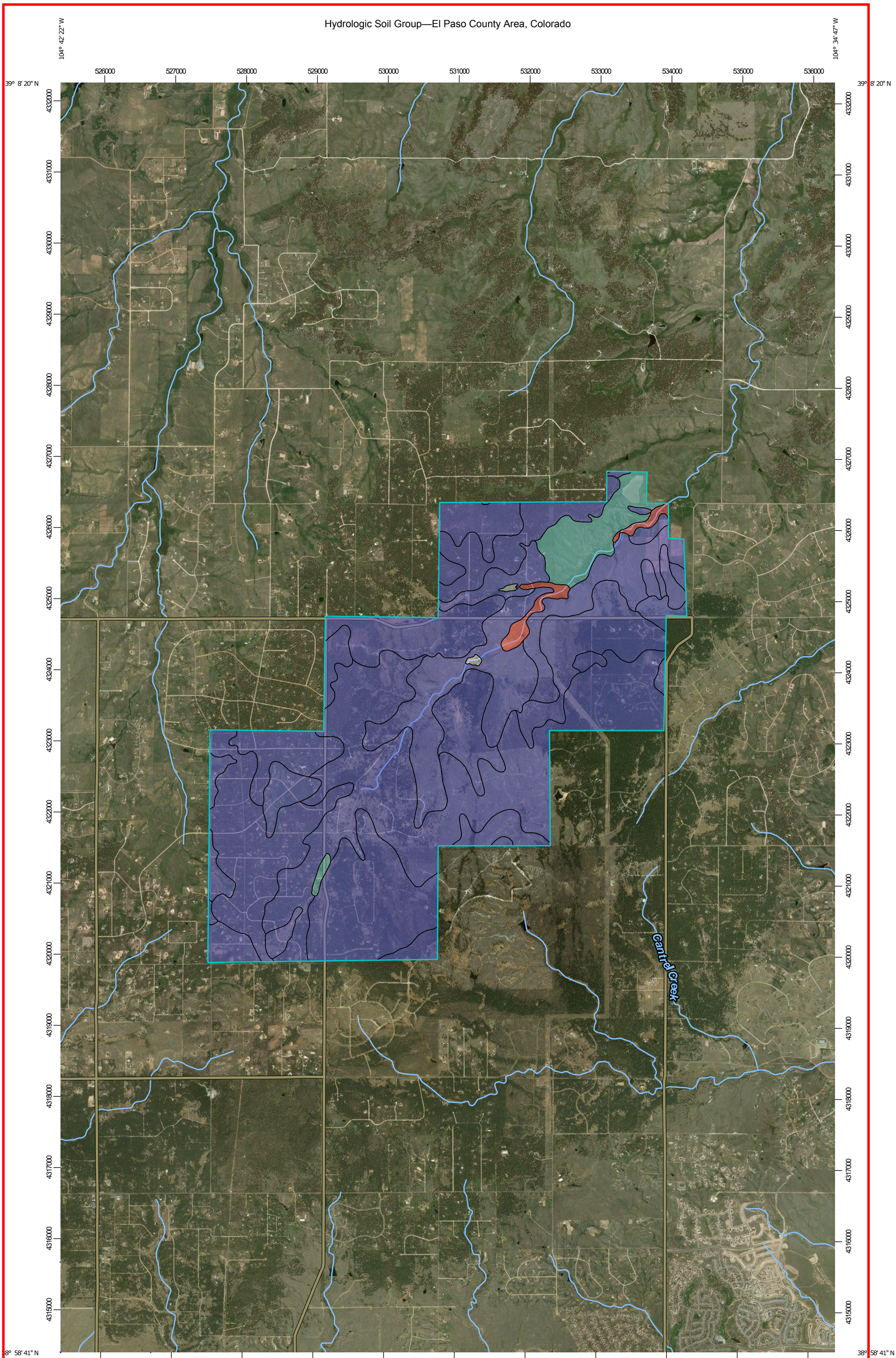
17480 MERIDIAN ROAD
ELBERT, COLORADO

File No.:	
Date:	10/04/2018
Drawn:	JCP
Checked:	LPV
Job No.:	49388

FIGURE 1

VERTEX®

Hydrologic Soil Group—El Paso County Area, Colorado



Map Scale: 1:50,000 if printed on B portrait (11" x 17") sheet.

Meters
0 500 1000 2000 3000

Feet
0 2000 4000 8000 12000

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 15, Oct 10, 2017

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

Date(s) aerial images were photographed: May 22, 2016—Mar 9, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Alamosa loam, 1 to 3 percent slopes	D	80.6	1.2%
15	Brussett loam, 3 to 5 percent slopes	B	6.0	0.1%
21	Cruckton sandy loam, 1 to 9 percent slopes	B	4.7	0.1%
25	Elbeth sandy loam, 3 to 8 percent slopes	B	2,081.3	31.8%
26	Elbeth sandy loam, 8 to 15 percent slopes	B	2,075.9	31.7%
34	Holderness loam, 1 to 5 percent slopes	C	15.5	0.2%
36	Holderness loam, 8 to 15 percent slopes	C	278.7	4.3%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	400.4	6.1%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	265.1	4.0%
67	Peyton sandy loam, 5 to 9 percent slopes	B	36.3	0.6%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	38.1	0.6%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	26.0	0.4%
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	661.6	10.1%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	574.4	8.8%
111	Water		10.0	0.2%
Totals for Area of Interest			**6,554.4**	**100.0%**

Description

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

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

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

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

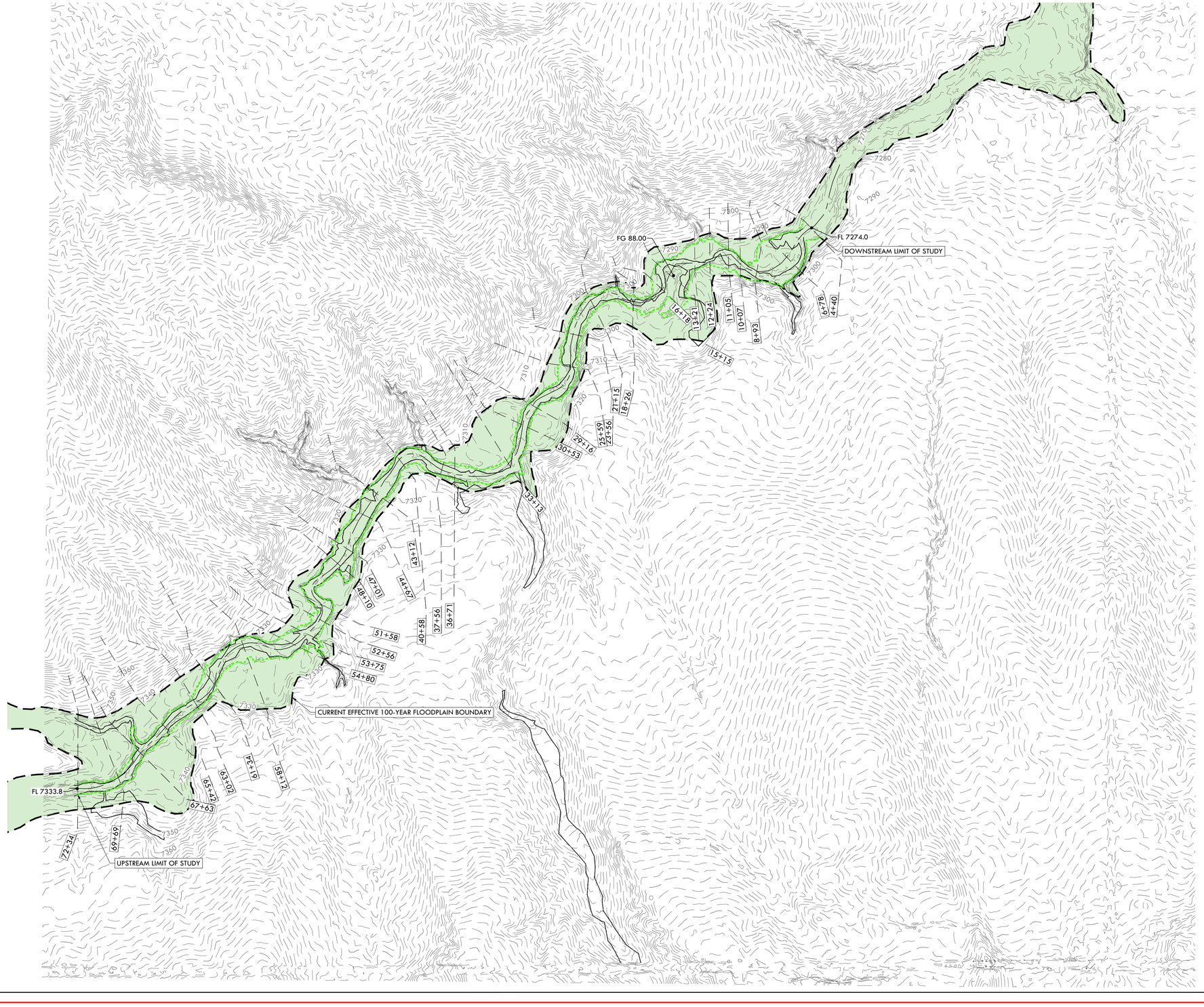
C. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN MAP

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

CASE #: 19-08-0185R



WEST KIOWA CREEK EXISTING CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR EC WSEL	100-YEAR EC TOP WIDTH INCLUDING INEFFICTIVE FLOW	100-YEAR EC TOP WIDTH EXCLUDING INEFFICTIVE FLOW
72+34	7337.98	62.28	62.28
69+69	7335.41	63.13	63.13
67+63	7333.50	63.51	63.51
65+42	7331.02	72.18	72.18
63+02	7328.83	76.66	76.66
61+34	7327.64	135.78	135.78
58+12	7325.32	129.67	129.67
54+80	7323.11	177.66	139.36
53+75	7322.89	136.48	136.48
53+10			
52+56	7321.54	111.61	111.61
51+58	7318.63	102.69	102.69
48+10	7316.70	178.97	178.97
47+01	7316.60	145.65	145.65
44+67	7315.62	112.95	112.95
43+12	7314.33	115.02	115.02
40+58	7310.97	98.36	98.36
37+56	7308.35	84.42	84.42
36+71	7307.43	95.71	95.71
33+13	7304.27	98.47	98.47
30+53	7300.93	68.96	68.96
29+16	7299.69	66.66	66.66
25+59	7297.05	117.36	117.36
23+56	7294.53	88.27	88.27
21+15	7292.39	99.33	99.33
18+26	7289.01	84.94	84.94
16+18	7288.55	266.32	266.32
15+15	7286.83	166.37	82.16
13+21	7285.19	154.03	154.03
12+24	7284.44	157.81	157.81
11+60			
11+05	7284.18	145.88	145.88
10+07	7282.77	89.32	89.32
8+93	7281.41	243.26	243.26
6+78	7278.50	265.74	265.74
4+40	7276.47	146.63	146.63
SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.			

BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88

0' 300' 600'

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COLORADO LICENSED
LANE PATRICK VANDENBERG
8/27/19
43911
PROFESSIONAL ENGINEER

100Y EC FLOODPLAIN

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
4	REVISED PER REVIEW COMMENTS 7/1/19
5	
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7	
8	
9	
10	

DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

2

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Tuesday, August 27, 2019 2:31:22 PM

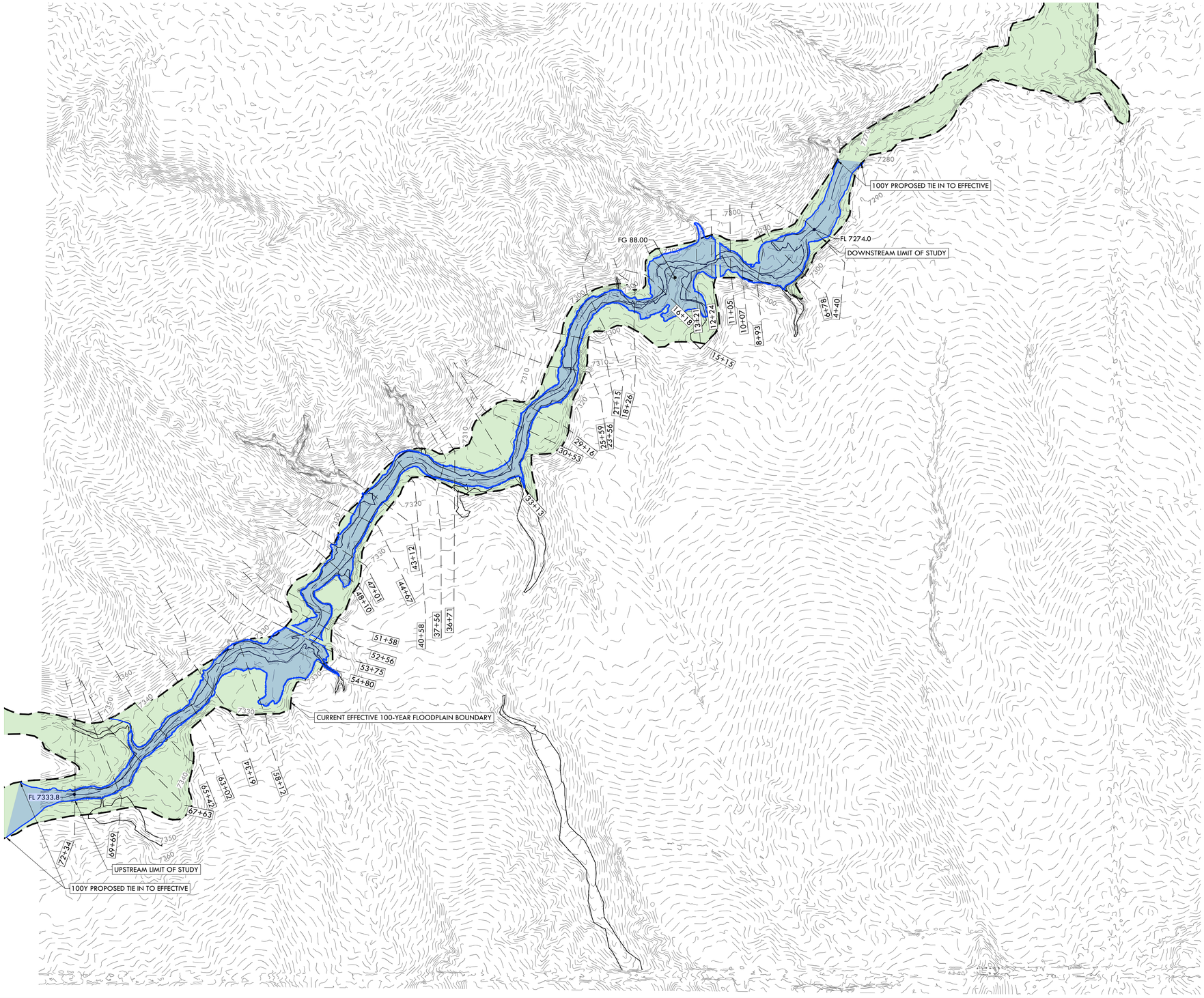
D. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN MAP

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

CASE #: 19-08-0185R



WEST KIOWA CREEK PROPOSED CONDITIONS 100-YEAR FLOOD DATA			
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65+42	7331.14	74.22	74.22
63+02	7328.85	76.90	76.90
61+34	7327.28	131.11	131.11
58+12	7326.47	201.82	169.96
54+80	7326.65	349.50	322.44
53+75	7326.35	278.31	62.88
53+10	CULVERT		
52+56	7321.50	110.20	66.00
51+58	7318.71	103.09	103.09
48+10	7316.81	179.90	179.90
47+01	7316.71	146.50	146.50
44+67	7315.70	114.47	114.47
43+12	7314.40	115.43	115.43
40+58	7311.05	99.53	99.53
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36+71	7307.52	96.89	96.89
33+13	7304.40	102.90	102.90
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23+56	7294.61	88.75	88.75
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13+21	7289.40	291.86	189.05
12+24	7289.09	255.05	62.76
11+60	CULVERT		
11+05	7283.36	124.12	60.69
10+07	7282.73	88.93	88.93
8+93	7281.40	243.18	243.18
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4+40	7276.45	146.38	146.38

SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.

BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88

0' 300' 600'

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100Y PC FLOODPLAIN

SITE: 17480 MERIDIAN ROAD
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NO.	REVISIONS
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10	

DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

1

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Tuesday, August 27, 2019 2:31:03 PM

E. ANNOTATED FIRMETTE MAPS

NOTES TO USERS

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

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

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

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

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

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

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

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

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

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

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

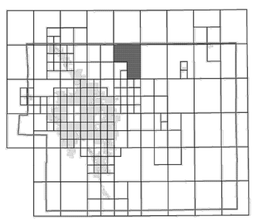
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

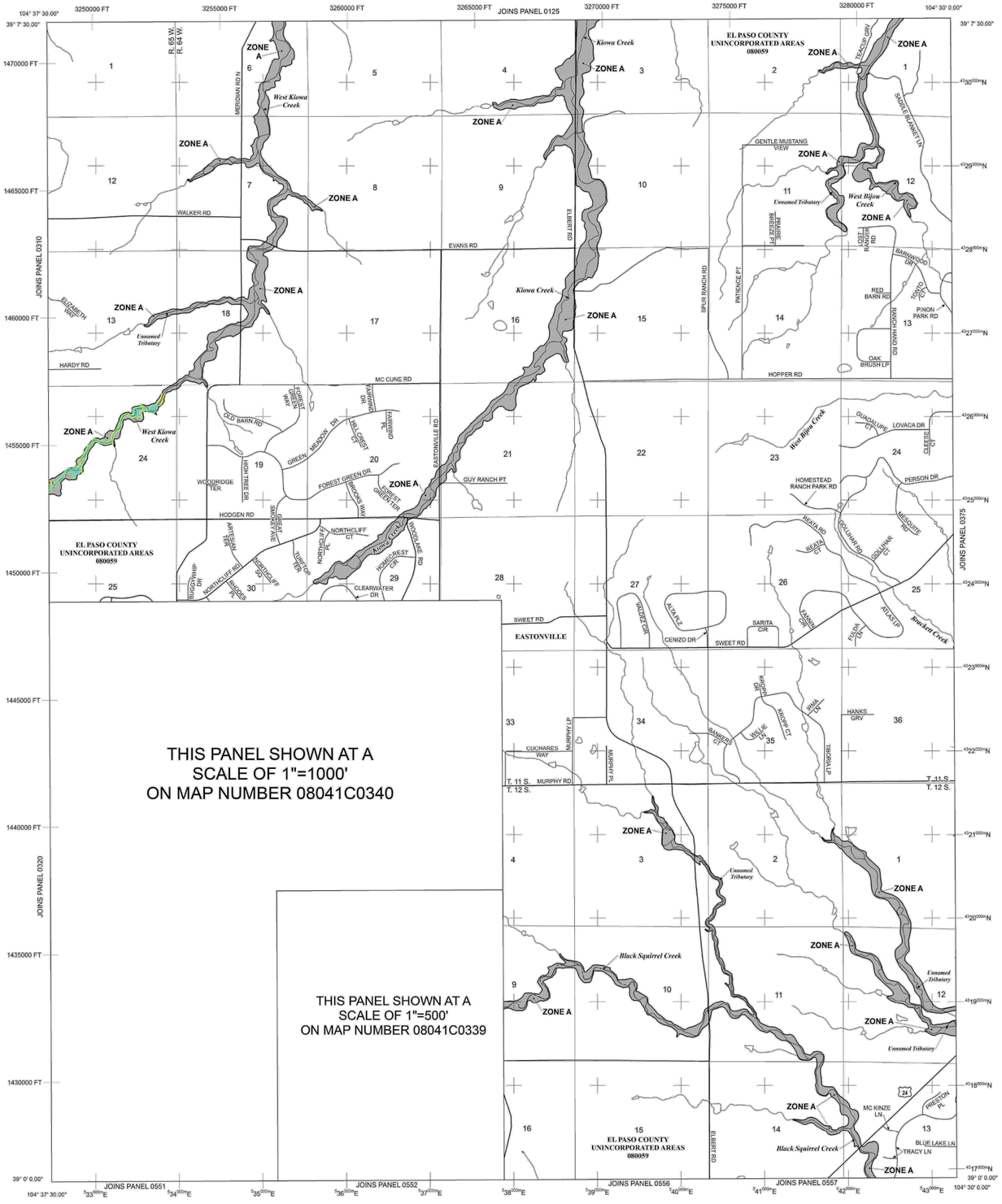
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



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

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

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

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

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

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

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

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

MAP SCALE 1" = 2000'
1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

PANEL 0350G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 350 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0350	G

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

MAP NUMBER 08041C0350G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

NOTES TO USERS

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

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

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

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

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

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

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

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

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

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

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

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

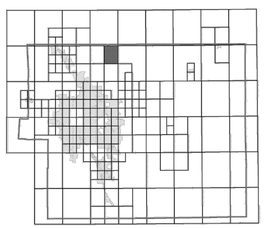
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this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

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

El Paso County Vertical Datum Offset Table

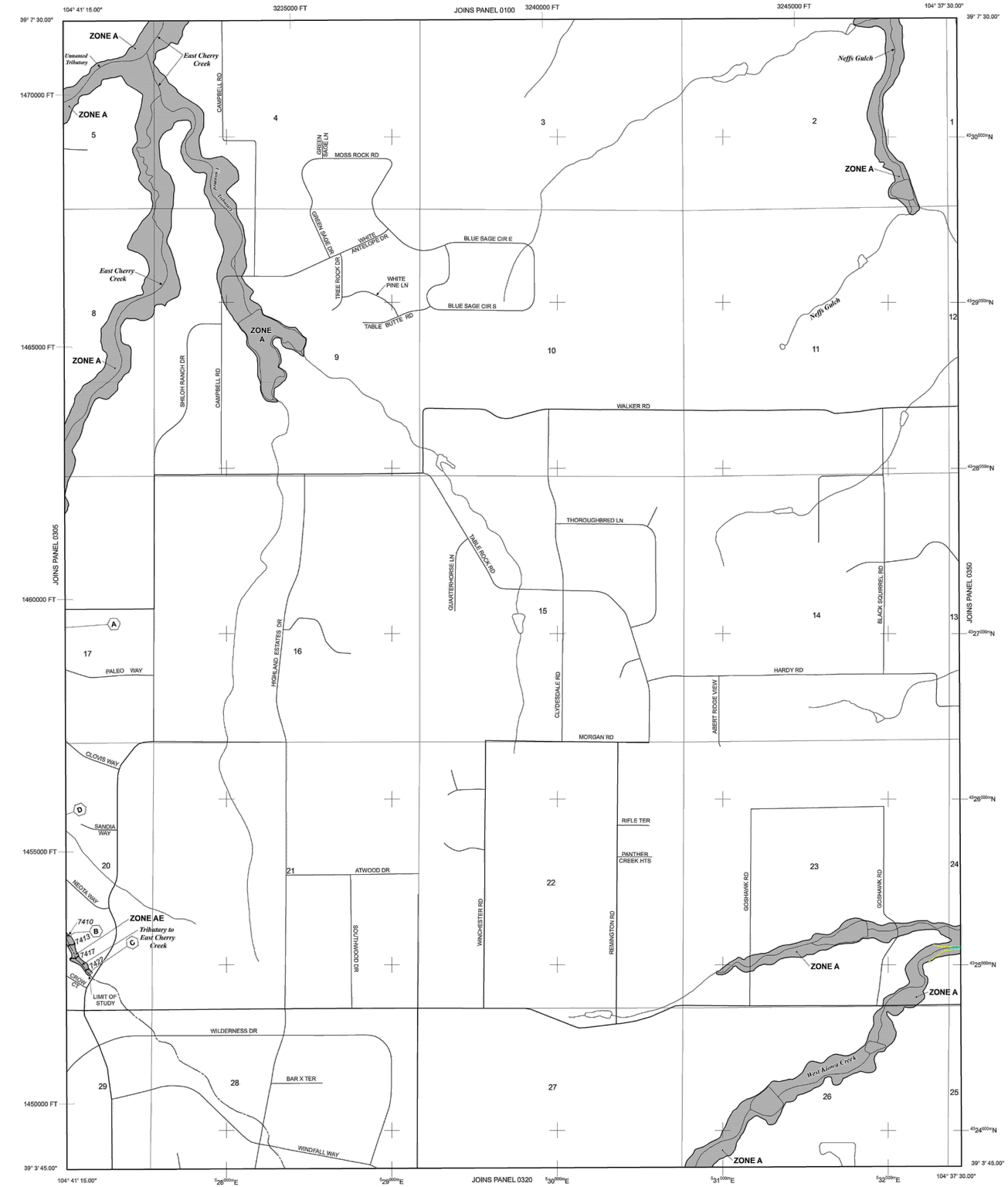
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



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

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



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 65 WEST.

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

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

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

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

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

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

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

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

PANEL 0310G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 310 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0310	G

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

MAP NUMBER 08041C0310G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

F. HYDRAULIC ANALYSIS

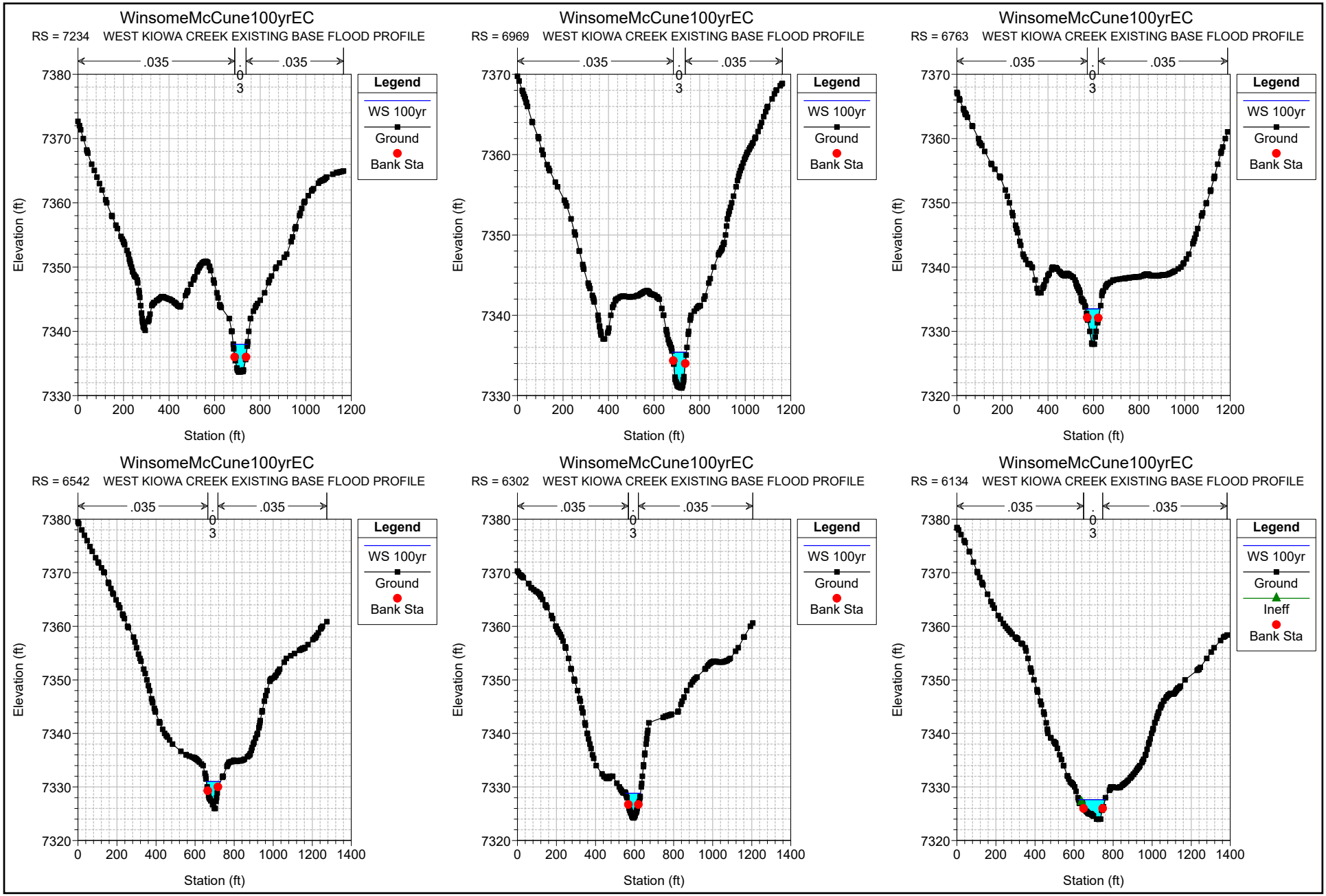
i. STUDIED 100 YEAR FLOODPLAIN DATA

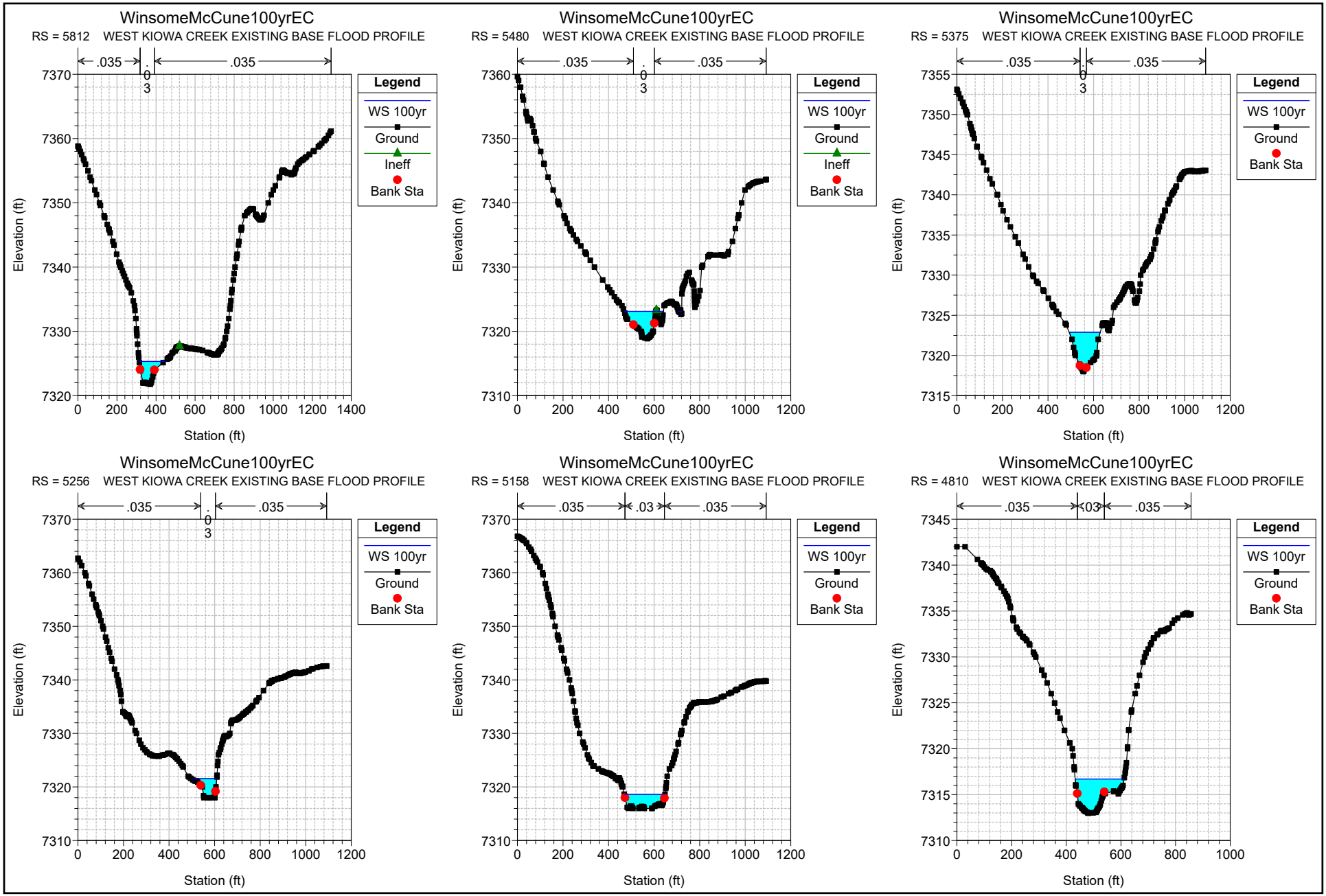
WEST KIOWA CREEK EXISTING CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR EC WSEL	100-YEAR EC TOP WIDTH INCLUDING INEFFICTIVE FLOW	100-YEAR EC TOP WIDTH EXCLUDING INEFFICTIVE FLOW
72+34	7337.98	62.28	62.28
69+69	7335.41	63.13	63.13
67+63	7333.50	63.51	63.51
65+42	7331.02	72.18	72.18
63+02	7328.83	76.66	76.66
61+34	7327.64	135.78	135.78
58+12	7325.32	129.67	129.67
54+80	7323.11	177.66	139.36
53+75	7322.89	136.48	136.48
53+10			
52+56	7321.54	111.61	111.61
51+58	7318.63	102.69	102.69
48+10	7316.70	178.97	178.97
47+01	7316.60	145.65	145.65
44+67	7315.62	112.95	112.95
43+12	7314.33	115.02	115.02
40+58	7310.97	98.36	98.36
37+56	7308.35	84.42	84.42
36+71	7307.43	95.71	95.71
33+13	7304.27	98.47	98.47
30+53	7300.93	68.96	68.96
29+16	7299.69	66.66	66.66
25+59	7297.05	117.36	117.36
23+56	7294.53	88.27	88.27
21+15	7292.39	99.33	99.33
18+26	7289.01	84.94	84.94
16+18	7288.55	266.32	266.32
15+15	7286.83	166.37	82.16
13+21	7285.19	154.03	154.03
12+24	7284.44	157.81	157.81
11+60			
11+05	7284.18	145.88	145.88
10+07	7282.77	89.32	89.32
8+93	7281.41	243.26	243.26
6+78	7278.50	265.74	265.74
4+40	7276.47	146.63	146.63
SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.			

WEST KIOWA CREEK PROPOSED CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR PC WSEL	100-YEAR PC TOP WIDTH INCLUDING INEFFICTIVE FLOW	100-YEAR PC TOP WIDTH EXCLUDING INEFFICTIVE FLOW
72+34	7338.11	63.12	63.12
69+69	7335.52	64.11	64.11
67+63	7333.63	64.92	64.92
65+42	7331.14	74.22	74.22
63+02	7328.85	76.90	76.90
61+34	7327.28	131.11	131.11
58+12	7326.47	201.82	169.96
54+80	7326.65	349.50	322.44
53+75	7326.35	278.31	62.88
53+10	CULVERT		
52+56	7321.50	110.20	66.00
51+58	7318.71	103.09	103.09
48+10	7316.81	179.90	179.90
47+01	7316.71	146.50	146.50
44+67	7315.70	114.47	114.47
43+12	7314.40	115.43	115.43
40+58	7311.05	99.53	99.53
37+56	7308.45	86.18	86.18
36+71	7307.52	96.89	96.89
33+13	7304.40	102.90	102.90
30+53	7301.03	69.79	69.79
29+16	7299.80	67.41	67.41
25+59	7297.13	118.75	118.75
23+56	7294.61	88.75	88.75
21+15	7292.45	99.93	99.93
18+26	7289.14	86.77	86.77
16+18	7289.44	299.59	299.59
15+15	7289.46	425.09	425.09
13+21	7289.40	291.86	189.05
12+24	7289.09	255.05	62.76
11+60	CULVERT		
11+05	7283.36	124.12	60.69
10+07	7282.73	88.93	88.93
8+93	7281.40	243.18	243.18
6+78	7278.47	265.53	265.53
4+40	7276.45	146.38	146.38
SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.			

F. HYDRAULIC ANALYSIS

ii. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN CROSS SECTIONS


WinsomeMcCune100yrEC
RS = 7234 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.035
.03
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 6969 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
WinsomeMcCune100yrEC
RS = 6763 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
WinsomeMcCune100yrEC
RS = 6542 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
WinsomeMcCune100yrEC
RS = 6302 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
WinsomeMcCune100yrEC
RS = 6134 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
Ineff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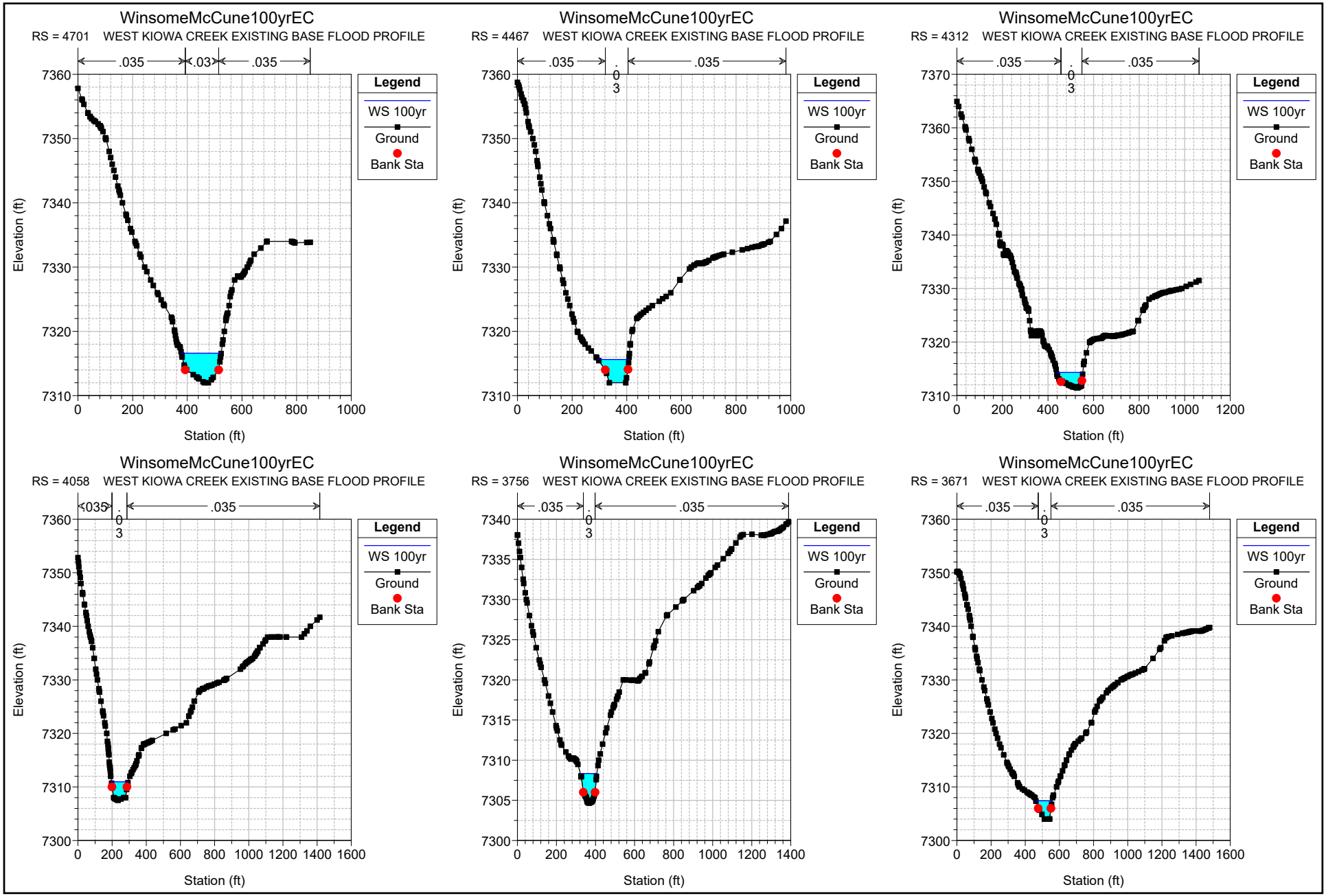
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 5480 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 5375 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 5256 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 5158 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 4810 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 4467 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 4312 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 4058 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
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.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
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.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
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.035
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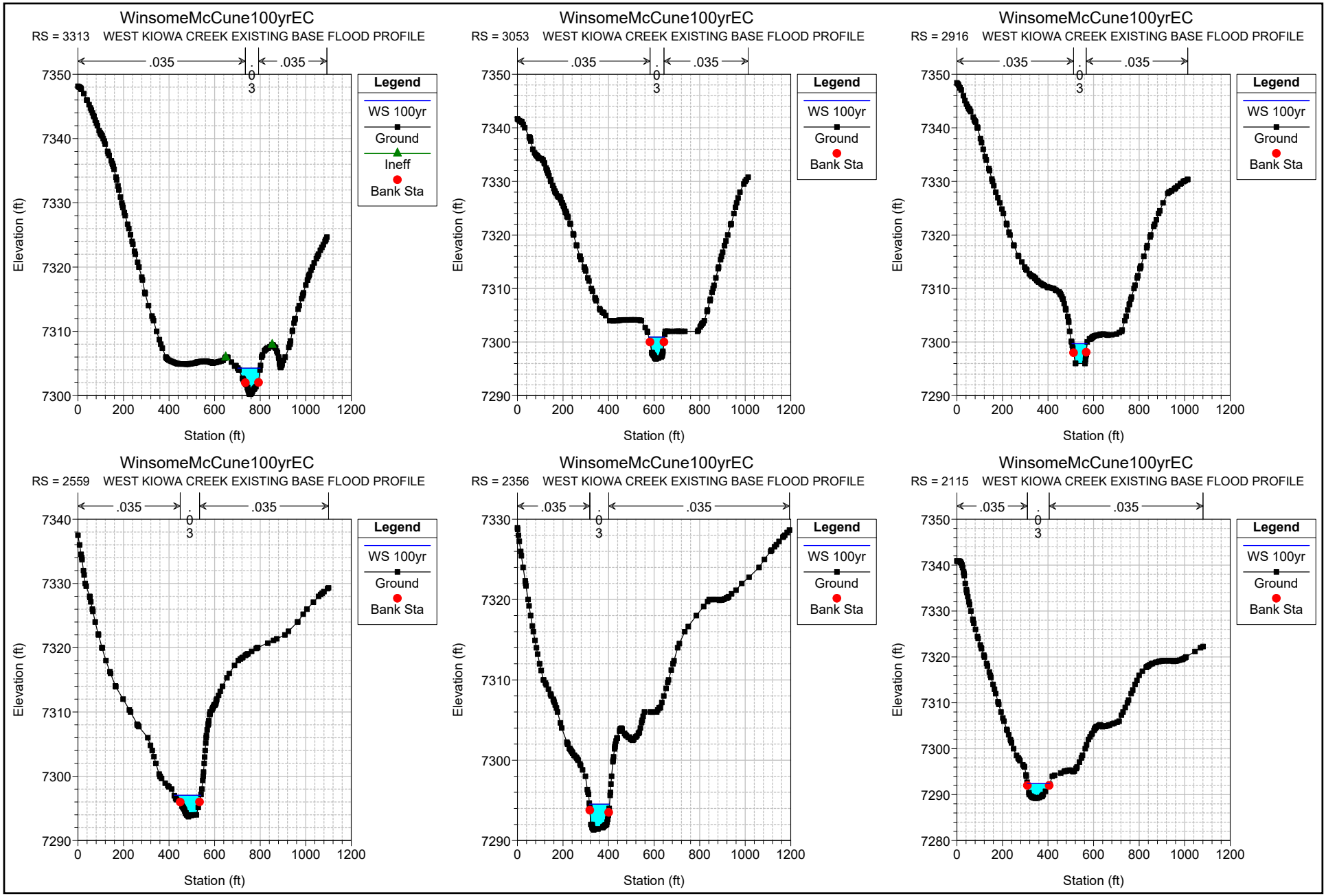
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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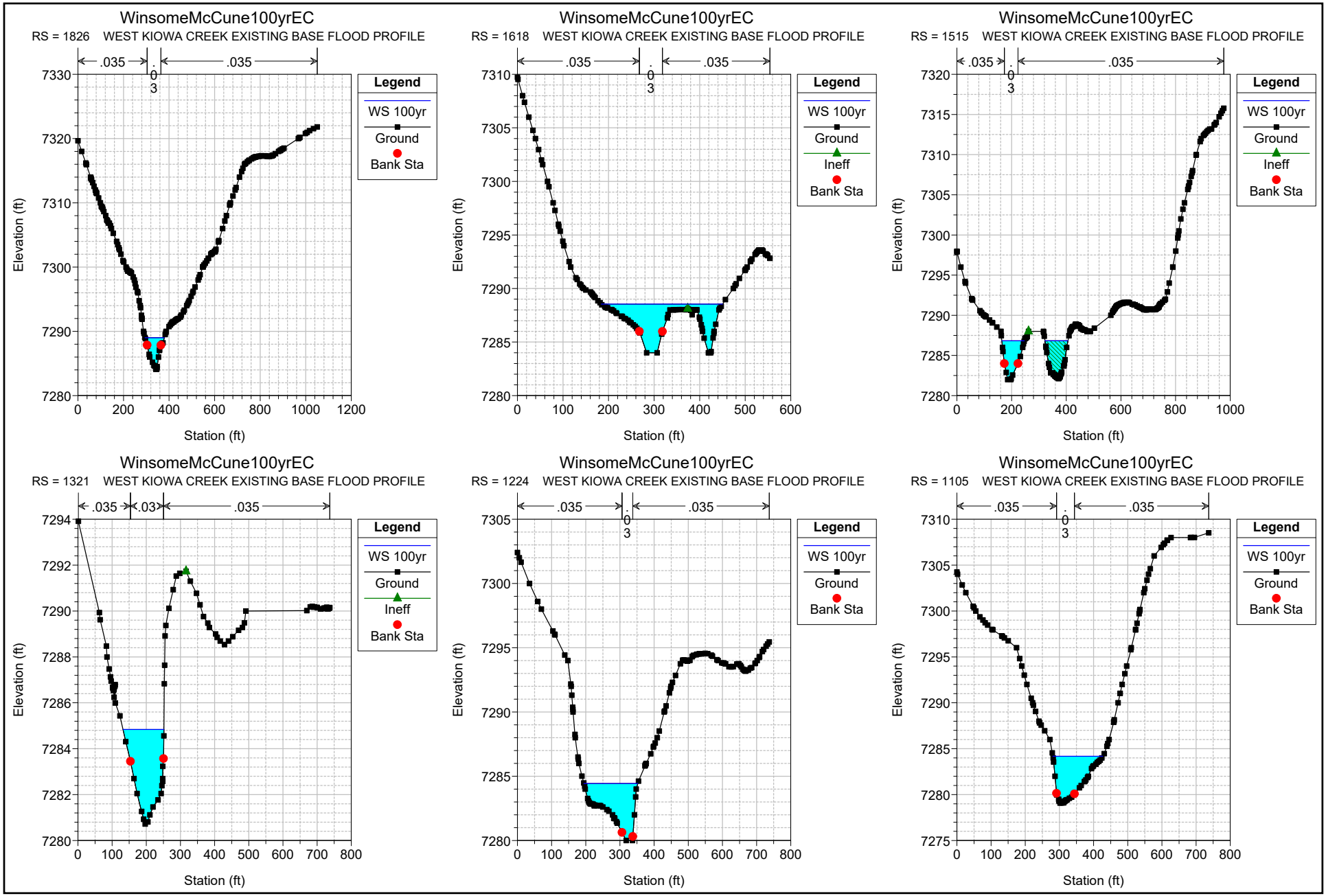
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 3053 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 2916 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 2559 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 2356 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 2115 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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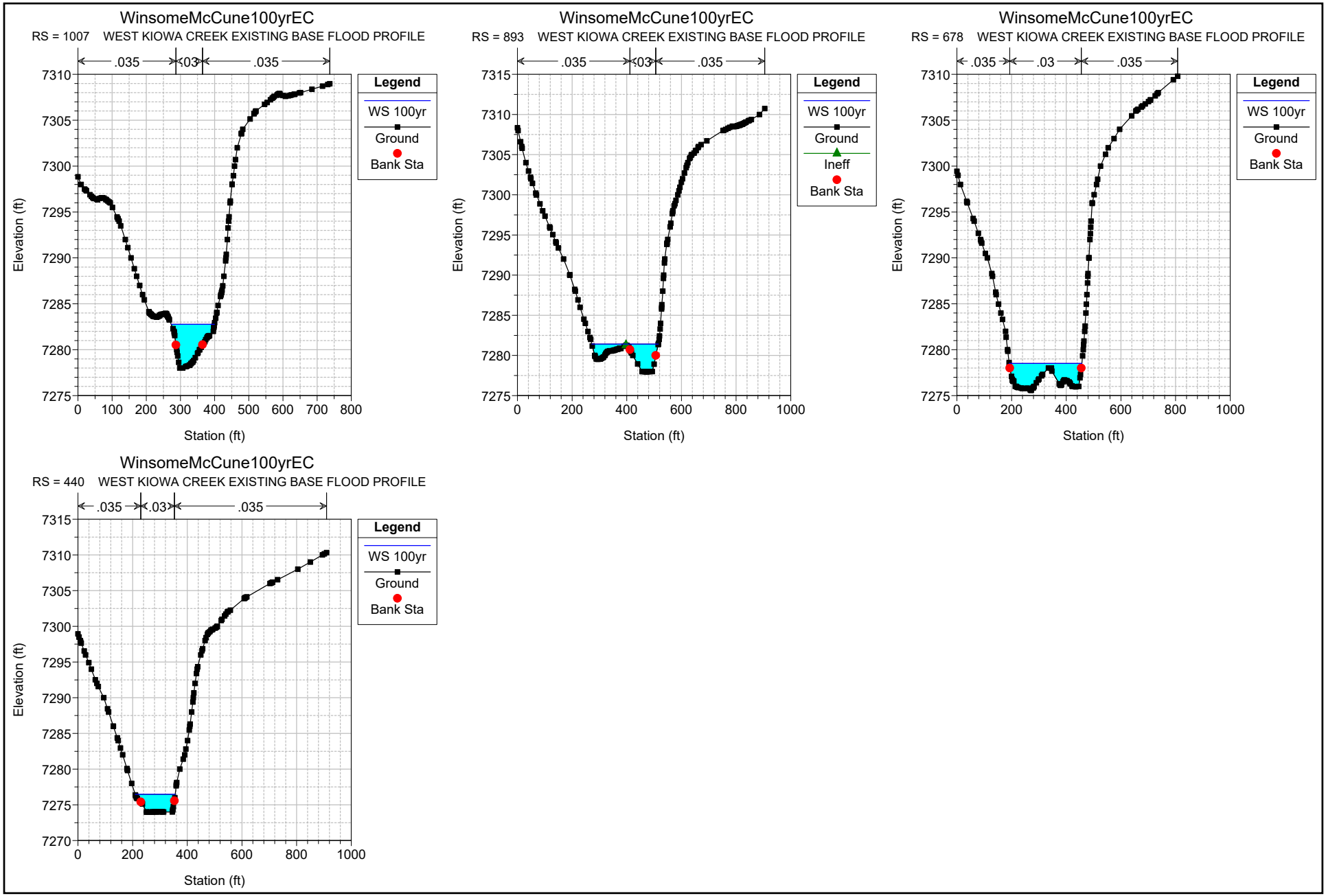
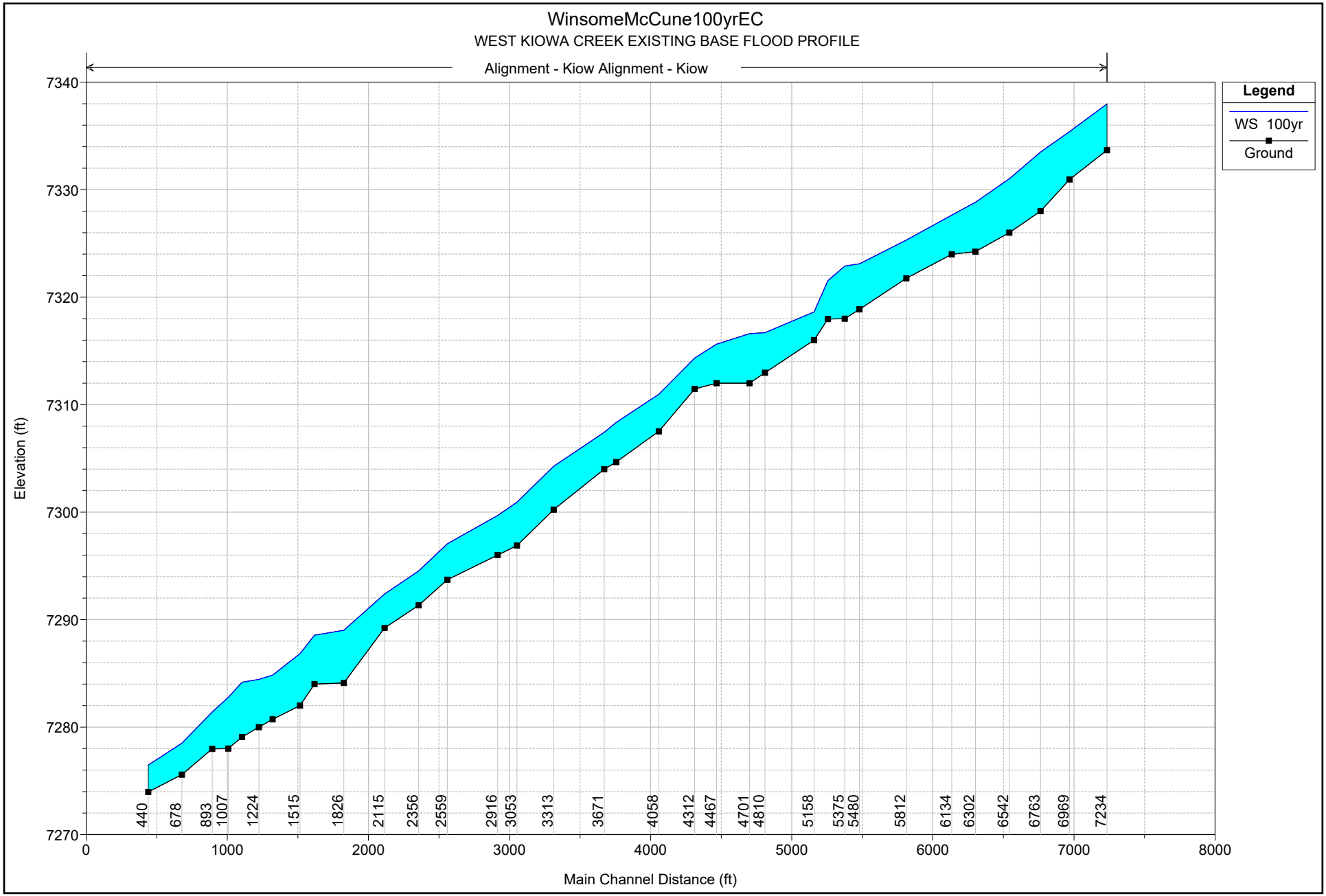
RS = 1826 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 1618 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 1515 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 1321 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 1224 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 1105 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrEC
RS = 1007 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 893 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 678 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrEC
RS = 440 WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

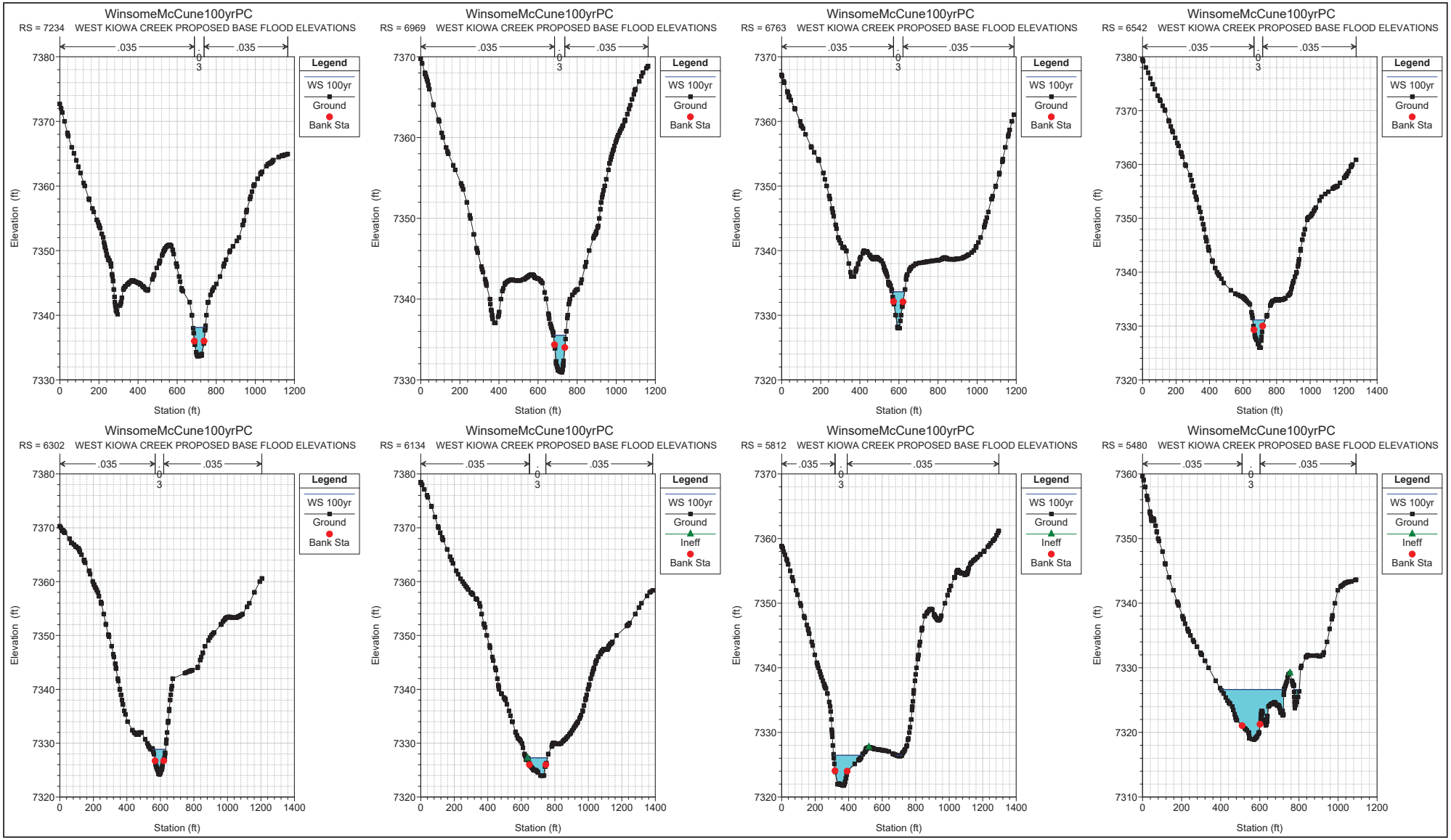
F. HYDRAULIC ANALYSIS

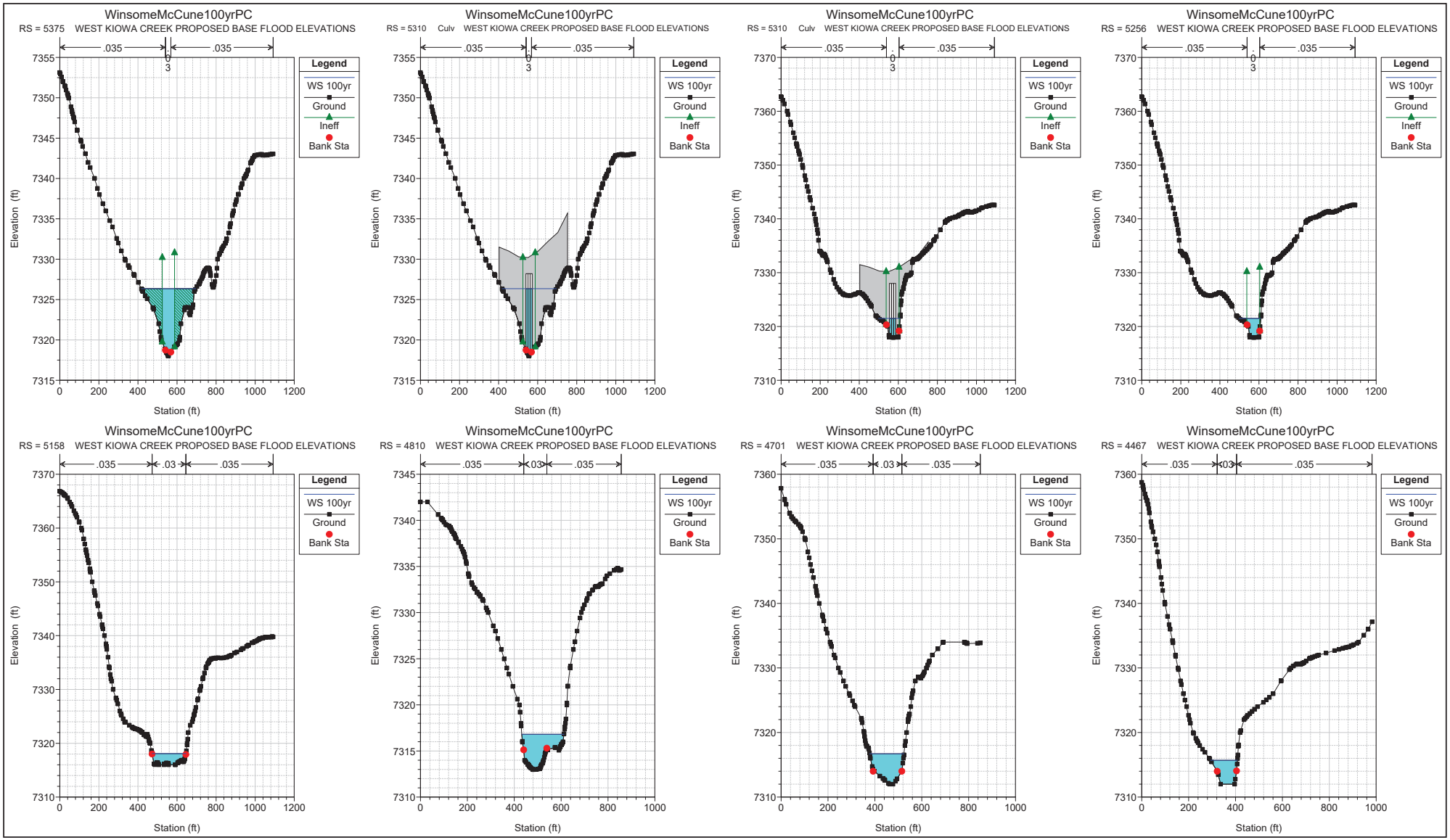
iii. STUDIED EXISTING CONDITION 100 YEAR FLOODPLAIN PROFILE

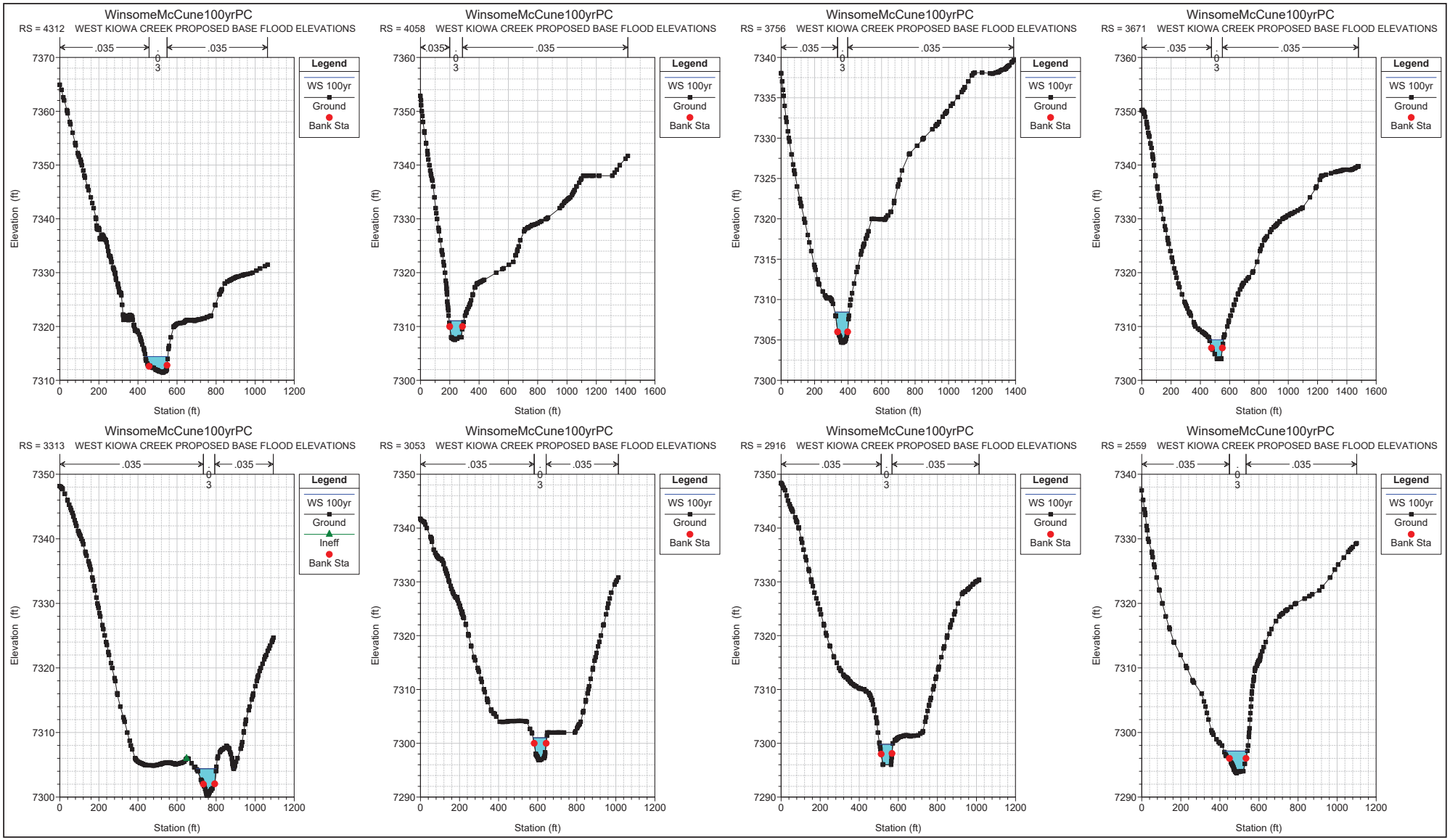

WinsomeMcCune100yrEC
WEST KIOWA CREEK EXISTING BASE FLOOD PROFILE
Alignment - Kiow Alignment - Kiow
Legend
WS 100yr
Ground
Elevation (ft)
Main Channel Distance (ft)
7340
7330
7320
7310
7300
7290
7280
7270
0
1000
2000
3000
4000
5000
6000
7000
8000
440
678
893
1007
1224
1515
1826
2115
2356
2559
2916
3053
3313
3671
4058
4312
4467
4701
4810
5158
5375
5480
5812
6134
6302
6542
6763
6969
7234

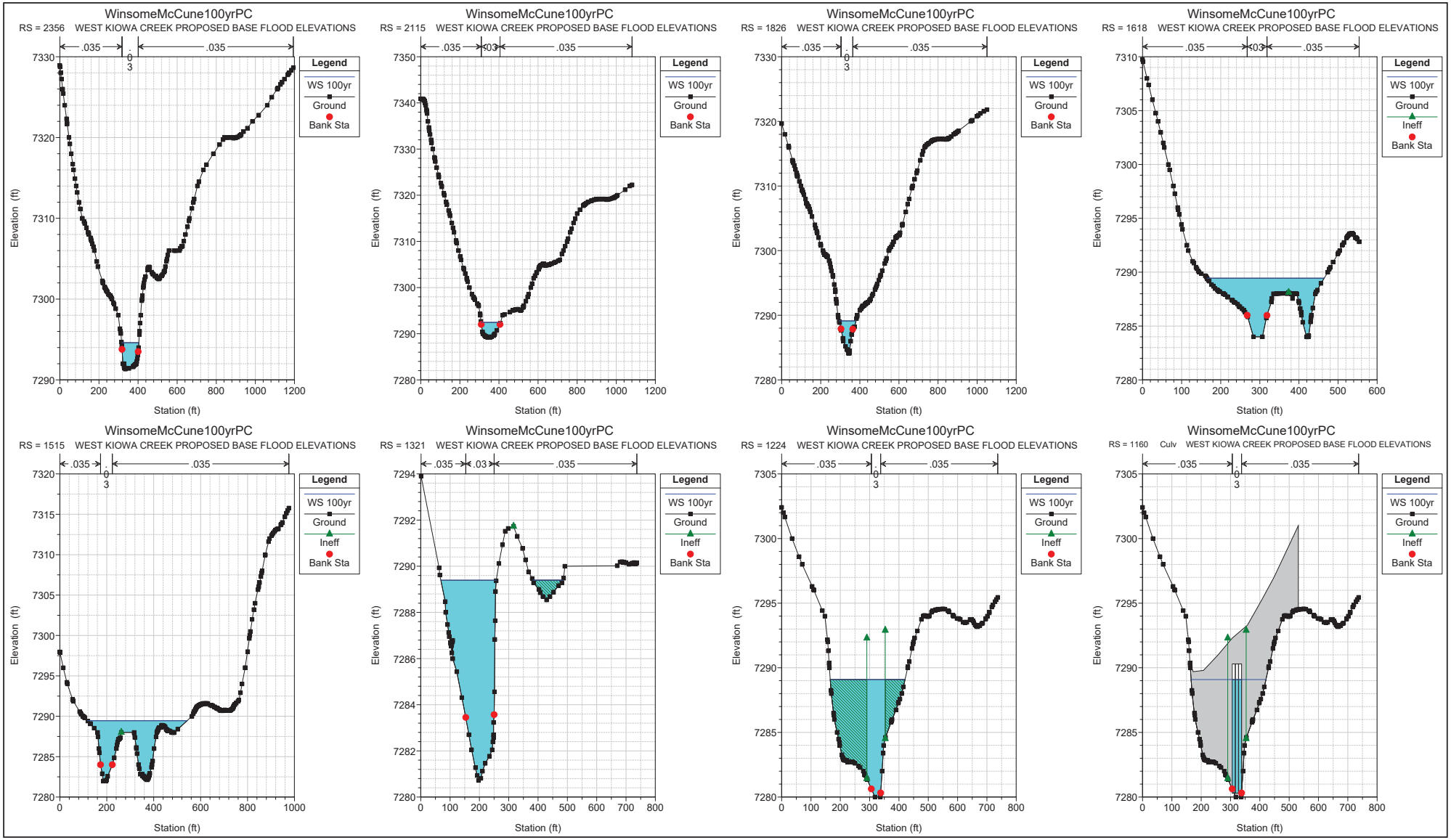
F. HYDRAULIC ANALYSIS

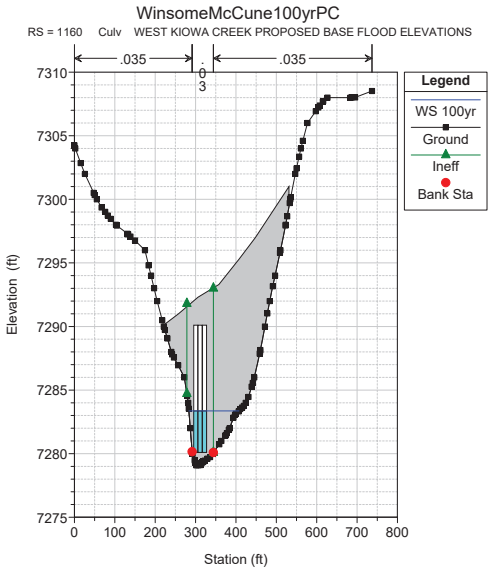
iv. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN CROSS SECTIONS

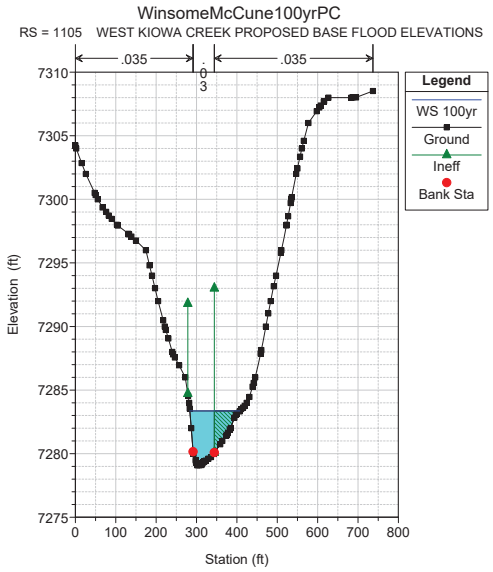

WinsomeMcCune100yrPC
RS = 7234 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 6969 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
WinsomeMcCune100yrPC
RS = 6763 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
WinsomeMcCune100yrPC
RS = 6542 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
WinsomeMcCune100yrPC
RS = 6302 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
WinsomeMcCune100yrPC
RS = 6134 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
Ineff
WinsomeMcCune100yrPC
RS = 5812 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
WinsomeMcCune100yrPC
RS = 5480 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS

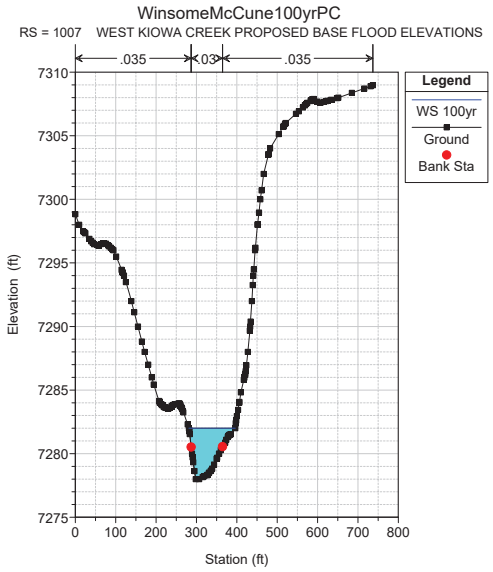

WinsomeMcCune100yrPC
RS = 5375 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 5310 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 5310 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 5256 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 5158 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 4810 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 4701 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 4467 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 4312 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 4058 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 3756 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 3671 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 3313 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 3053 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 2916 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 2559 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.035
0
3
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 2356 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 2115 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .03 .035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1826 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1618 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .03 .035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1515 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1321 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .03 .035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1224 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC
RS = 1160 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035 .035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 1160 Culv WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 1105 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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RS = 1007 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
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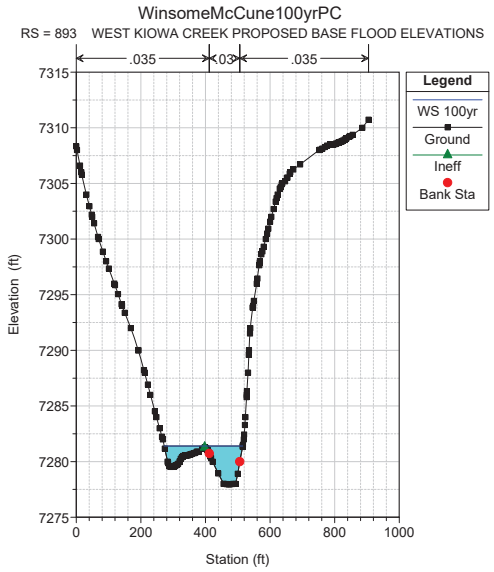
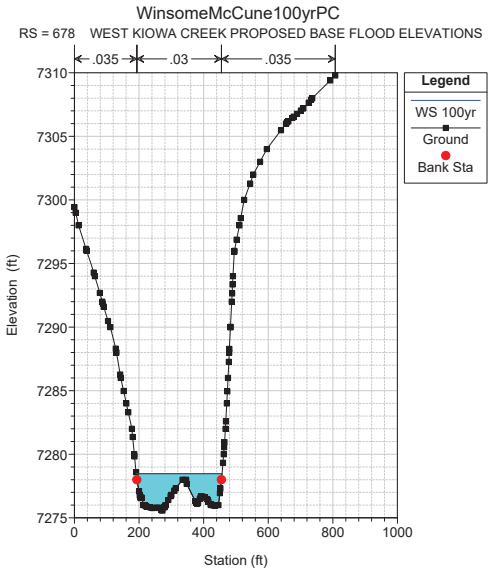
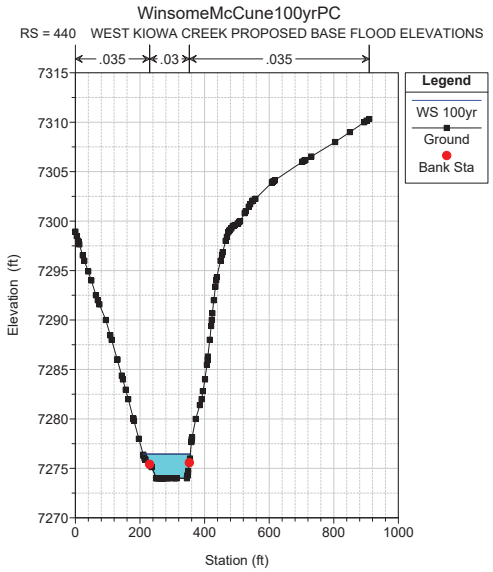
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

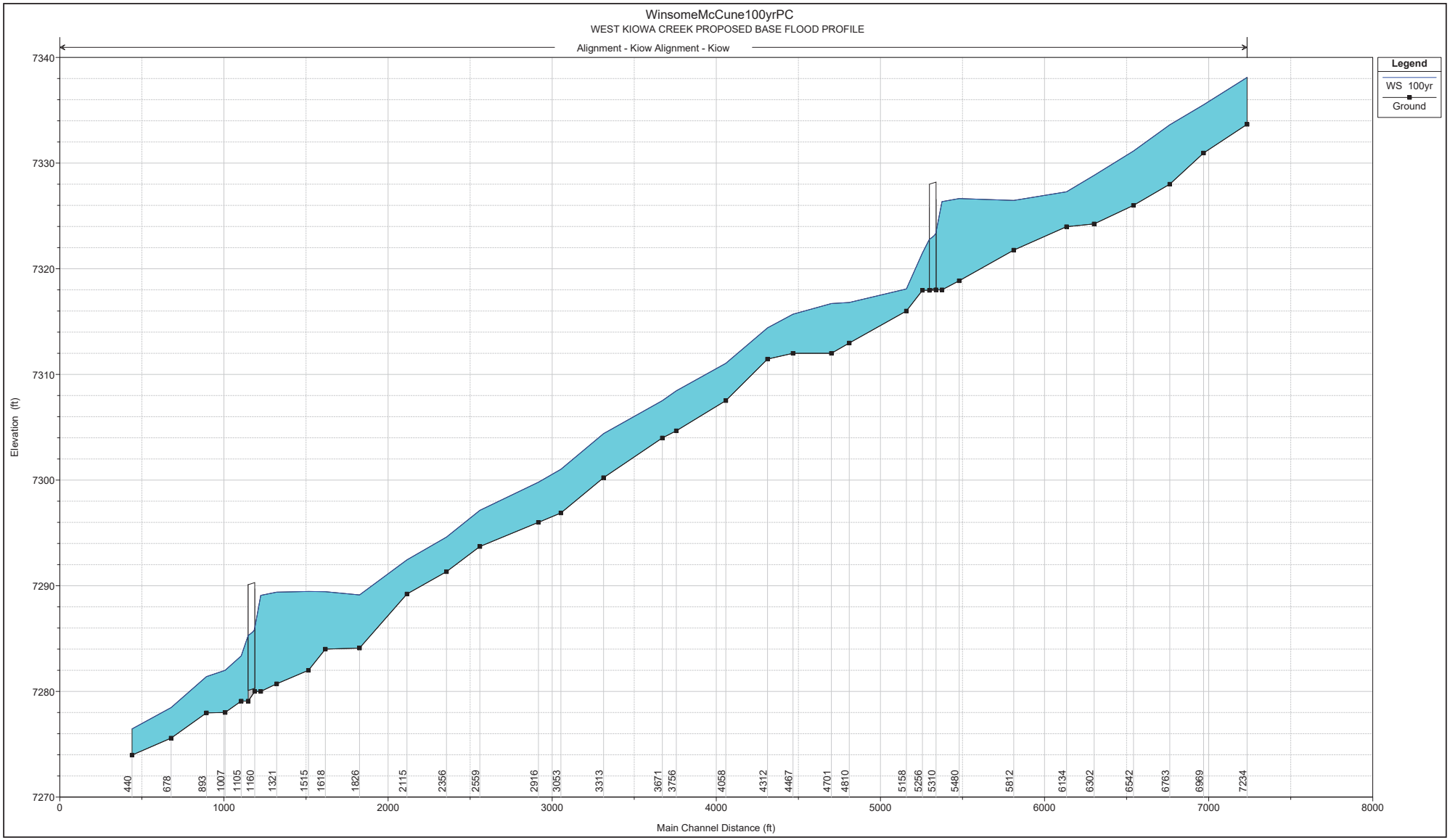

WinsomeMcCune100yrPC
RS = 893 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 678 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC
RS = 440 WEST KIOWA CREEK PROPOSED BASE FLOOD ELEVATIONS
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

F. HYDRAULIC ANALYSIS

v. STUDIED PROPOSED CONDITION 100 YEAR FLOODPLAIN PROFILE


WinsomeMcCune100yrPC
WEST KIOWA CREEK PROPOSED BASE FLOOD PROFILE
Alignment - Kiow Alignment - Kiow
Legend
WS 100yr
Ground
Elevation (ft)
Main Channel Distance (ft)
7340
7330
7320
7310
7300
7290
7280
7270
0
1000
2000
3000
4000
5000
6000
7000
8000
440
678
893
1007
1105
1160
1321
1515
1618
1826
2115
2356
2559
2916
3053
3313
3671
3756
4058
4312
4467
4701
4810
5158
5256
5310
5480
5812
6134
6302
6542
6763
6969
7234

F. HYDRAULIC ANALYSIS

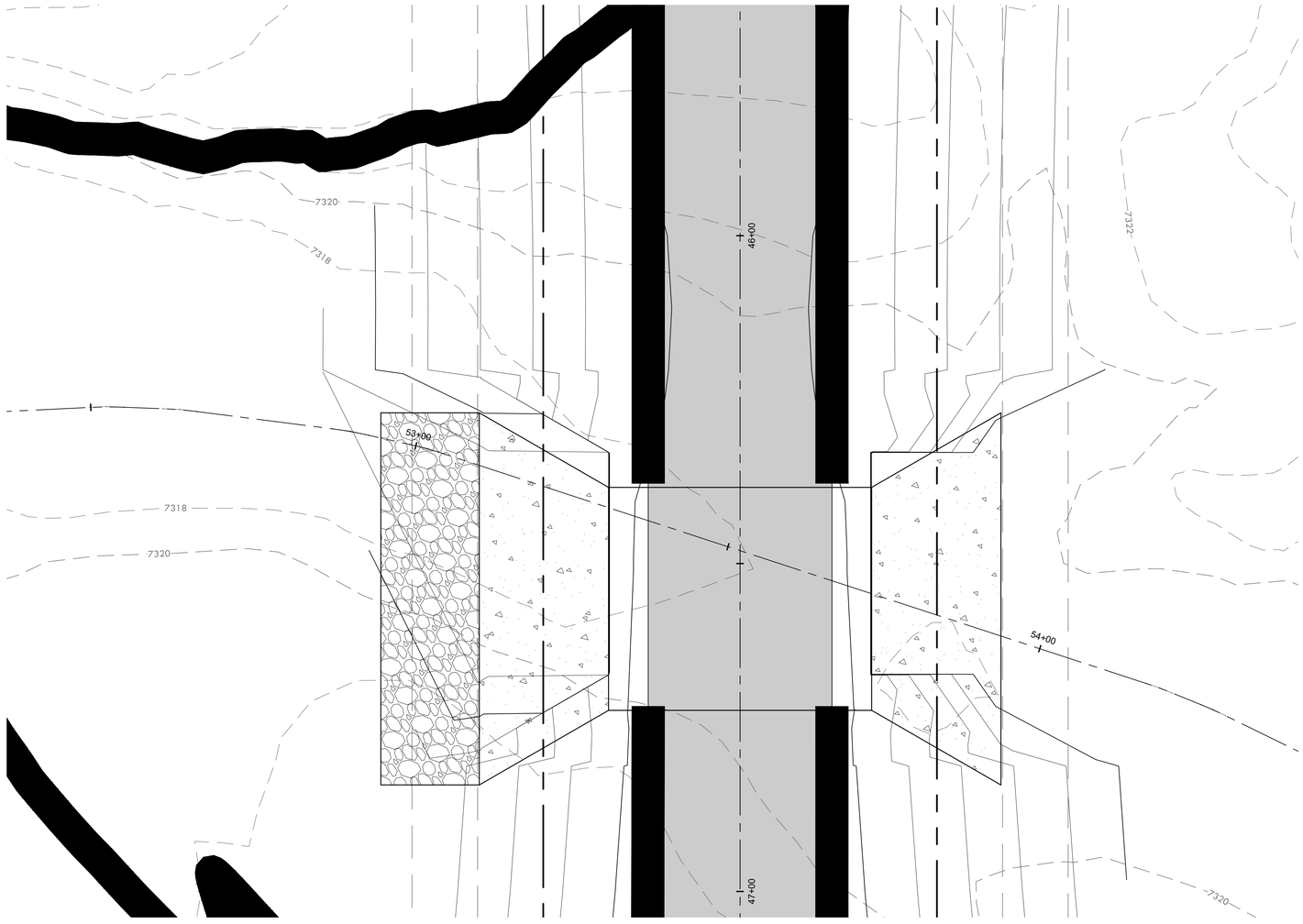
vi. PROPOSED BRIDGE DETAILS, DRAWINGS, AND SPECIFICATIONS

CD DRAWINGS

WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

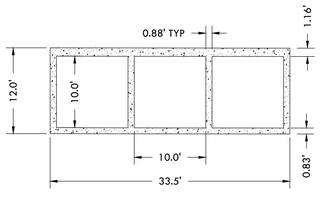
CASE #: 19-08-0185R

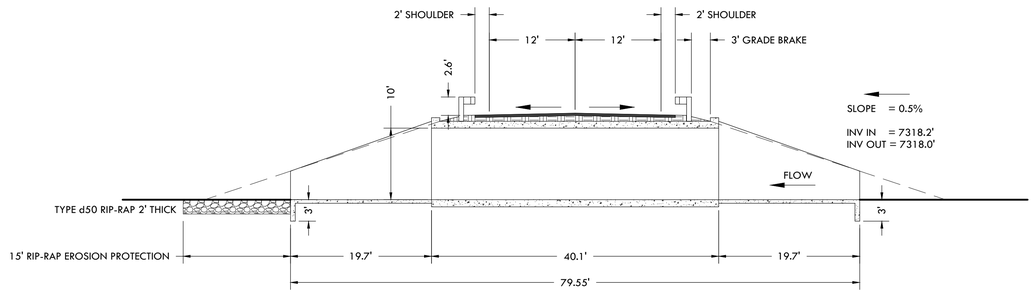


BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88





0' 10' 20'

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COLORADO LICENSED
LANCE PATRICK VANDEN
8/27/19
43911
PROFESSIONAL ENGINEER

BOX CULVERT 1 (UPSTREAM) DETAIL

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
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DATE: 11/12/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

1

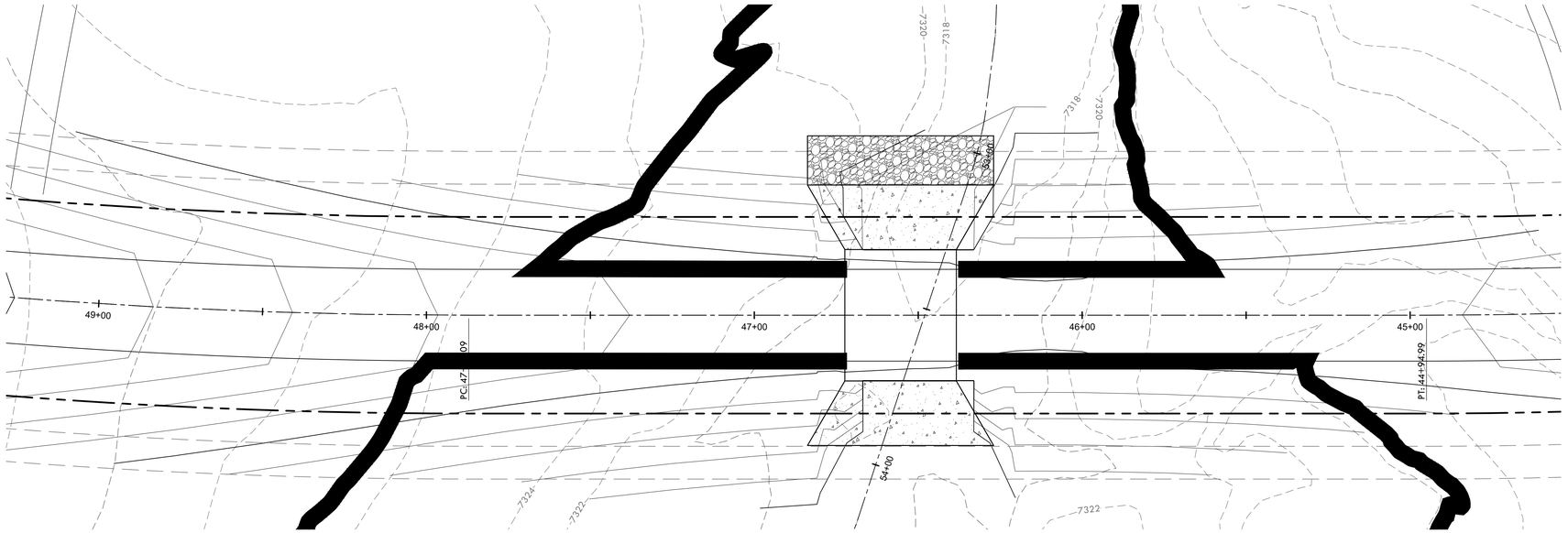
P:\Shared\Projects\49000-49999\49300-49399\49388.McCune Ranch\06-Engineering\Vertex Drawings\Exhibits\49388-EXH_BoxCulvertDetails.dwg
Tuesday, August 27, 2019 2:52:52 PM

CD DRAWINGS

WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

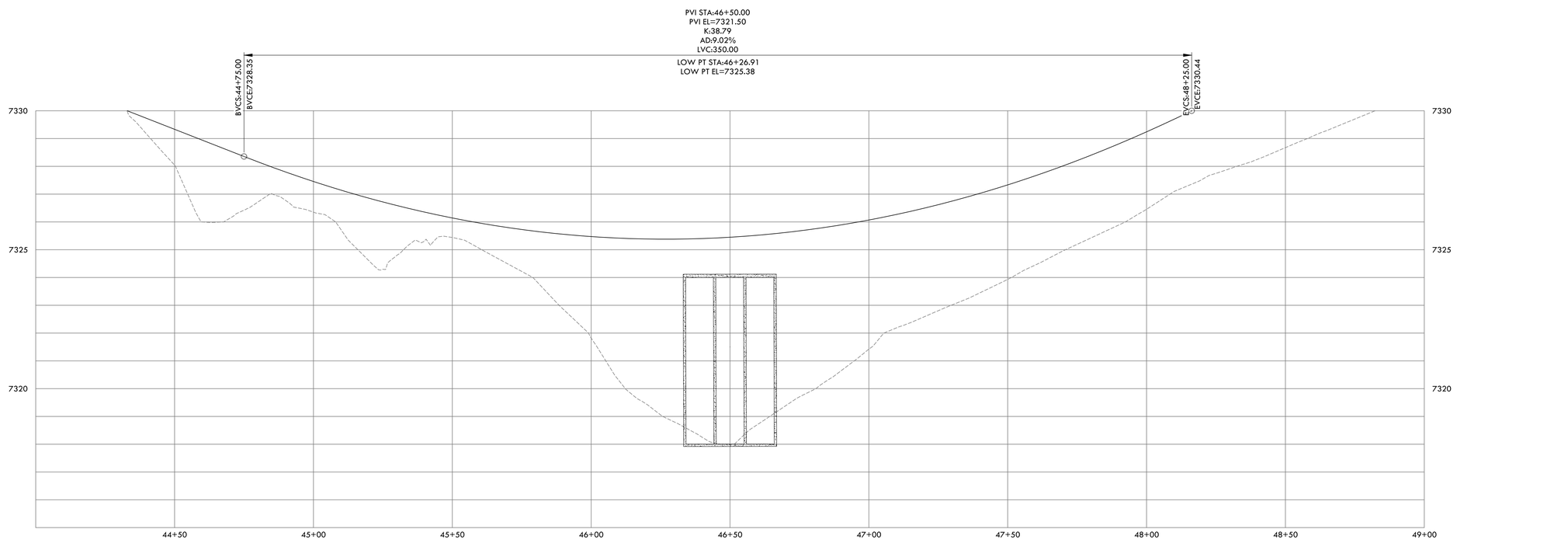
CASE #: 19-08-0185R



BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88



ALAMAR WAY PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'

0' 30' 60'

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COLORADO LICENSED
JAMES PATRICK VANDERHOOF
8/27/19
43911
PROFESSIONAL ENGINEER

ROAD PLAN AND PROFILE @ BOX CULVERT 1

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
4	
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8	
9	
10	

DATE: 3/19/19
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

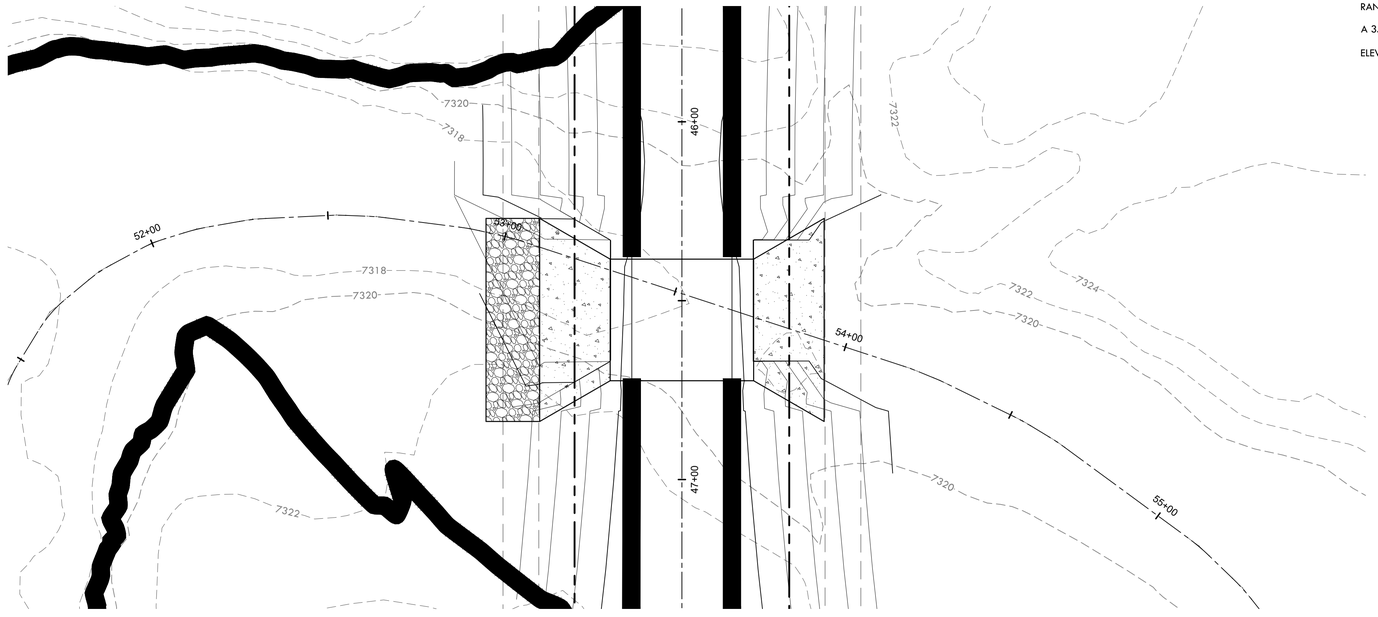
2

CD DRAWINGS

WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

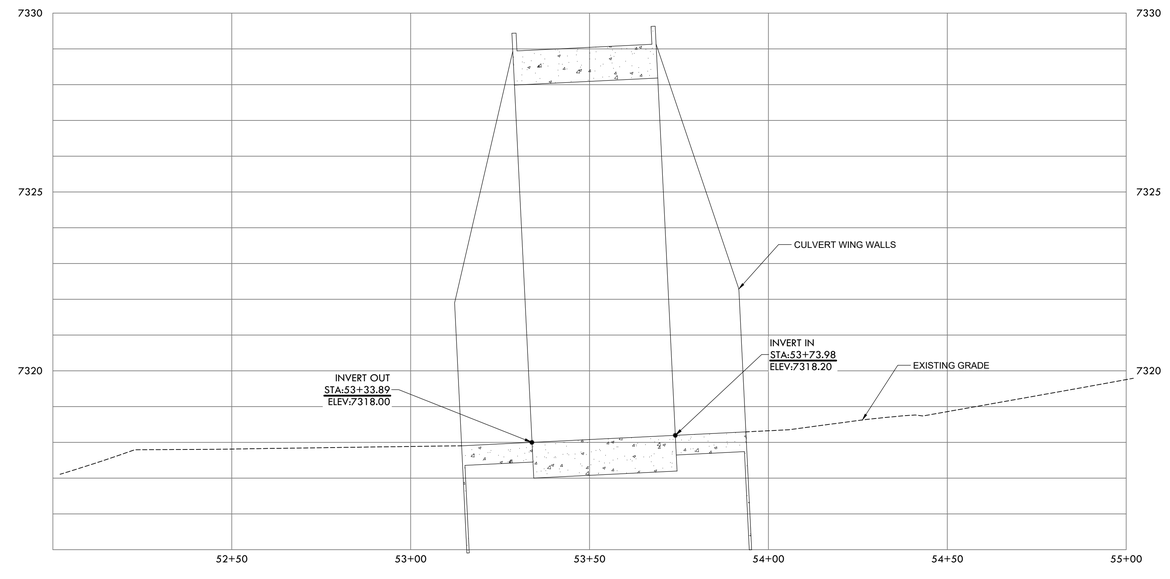
CASE #: 19-08-0185R



BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88



FLOODPLAIN ALIGNMENT PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'

0' 30' 60'

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COLORADO LICENSED
LUIS PATRICK VARGAS
43911
8/27/19
PROFESSIONAL ENGINEER

BOX CULVERT 1 FLOODPLAIN PROFILE

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
4	
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10	

DATE: 3/19/19
DRAWN BY: JCP
CHECKED BY: LPV
JOB#: 49388

3

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Tuesday, August 27, 2019 2:33:33 PM

CD DRAWINGS

WINSOME SUBDIVISION

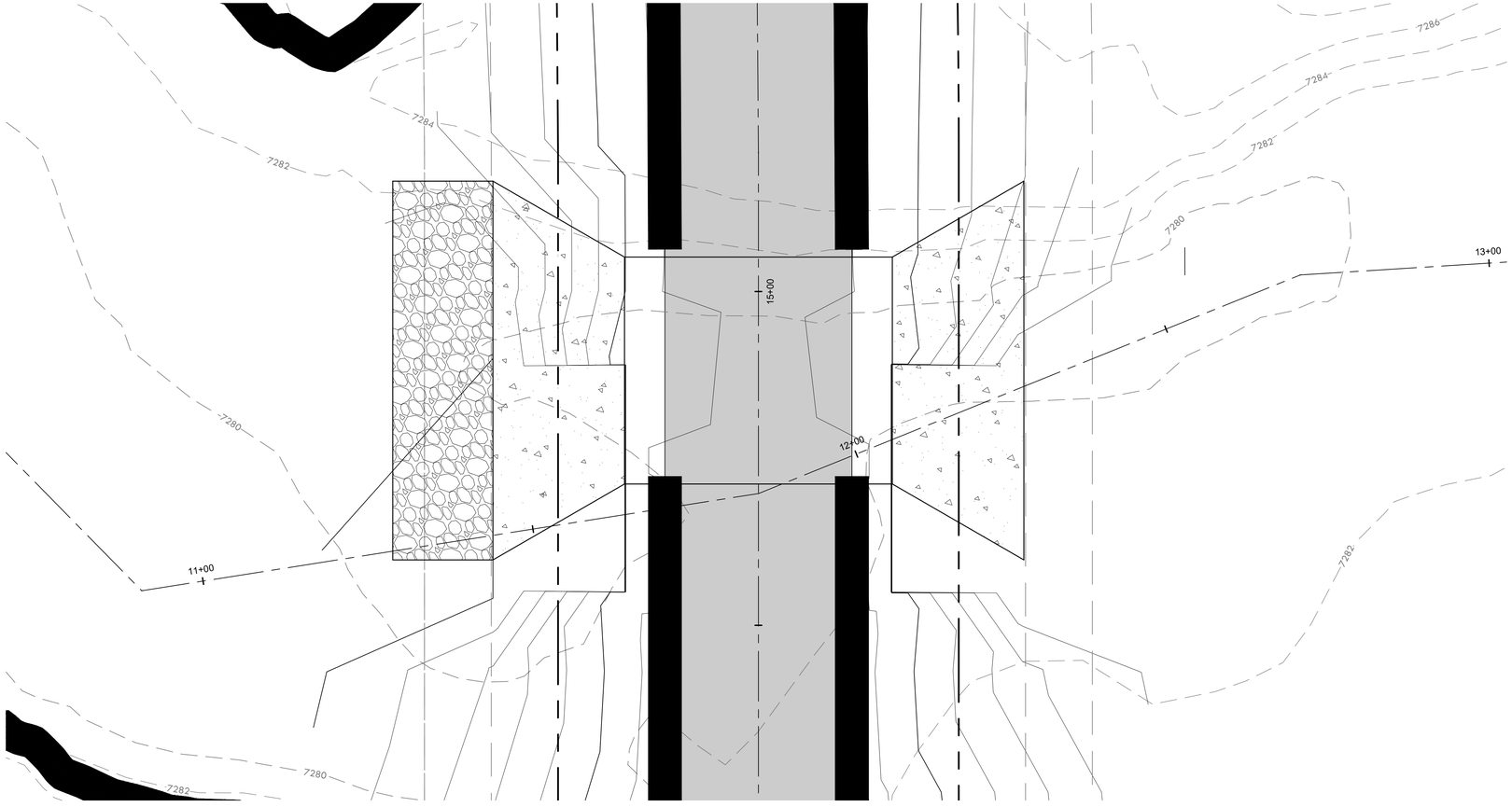
A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

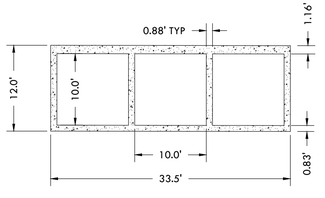
CASE #: 19-08-0185R

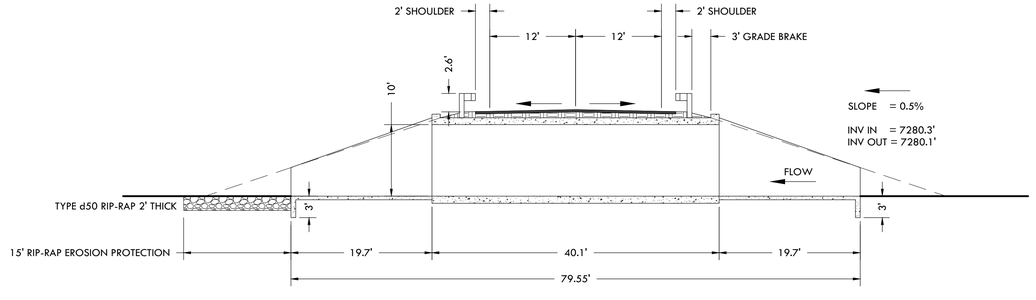
BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

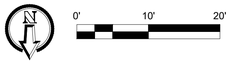
A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88









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LANCE PATRICK VANDERHOOF
8/27/19
43911
PROFESSIONAL ENGINEER

BOX CULVERT 2 (DOWNSTREAM) DETAIL

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
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DATE: 11/12/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB#: 49388

4

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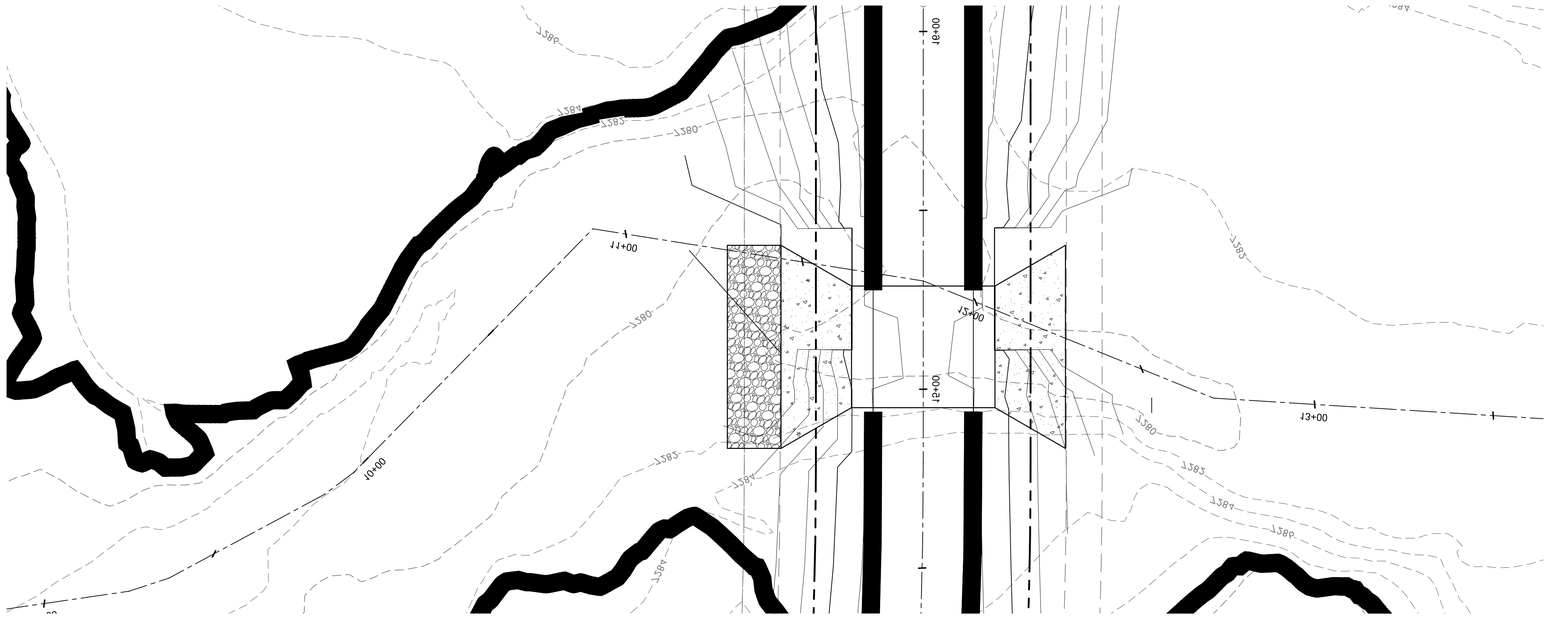
CD DRAWINGS

WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

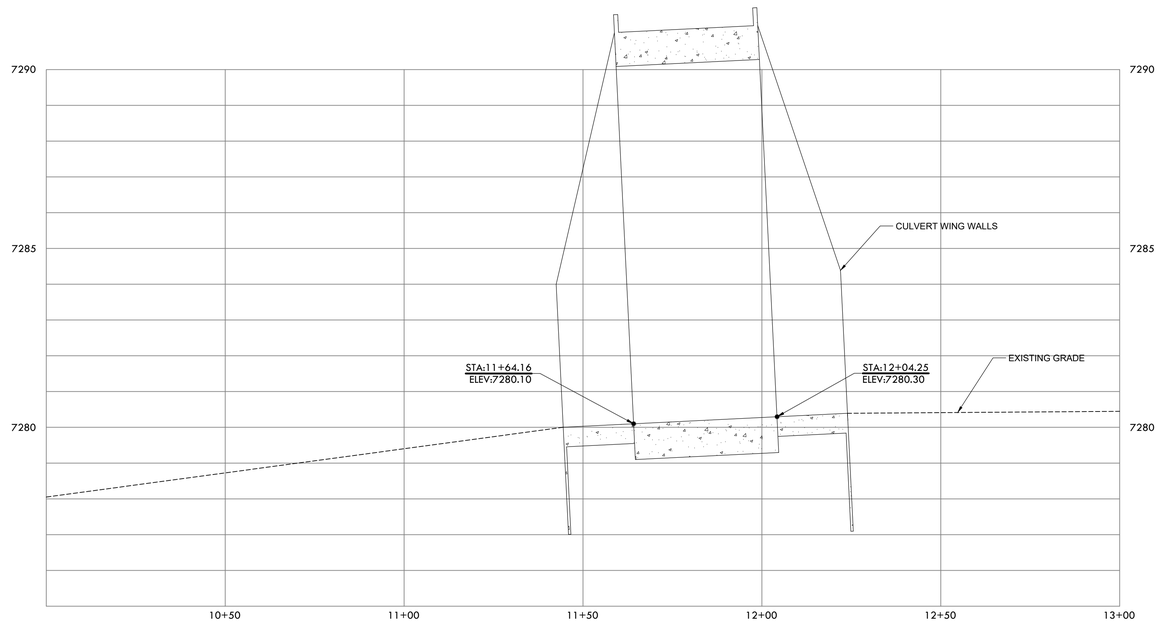
CASE #: 19-08-0185R



BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88



FLOODPLAIN ALIGNMENT PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'

0' 30' 60'

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43911
PROFESSIONAL ENGINEER

BOX CULVERT 2 FLOODPLAIN PROFILE

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
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JOB #: 49388

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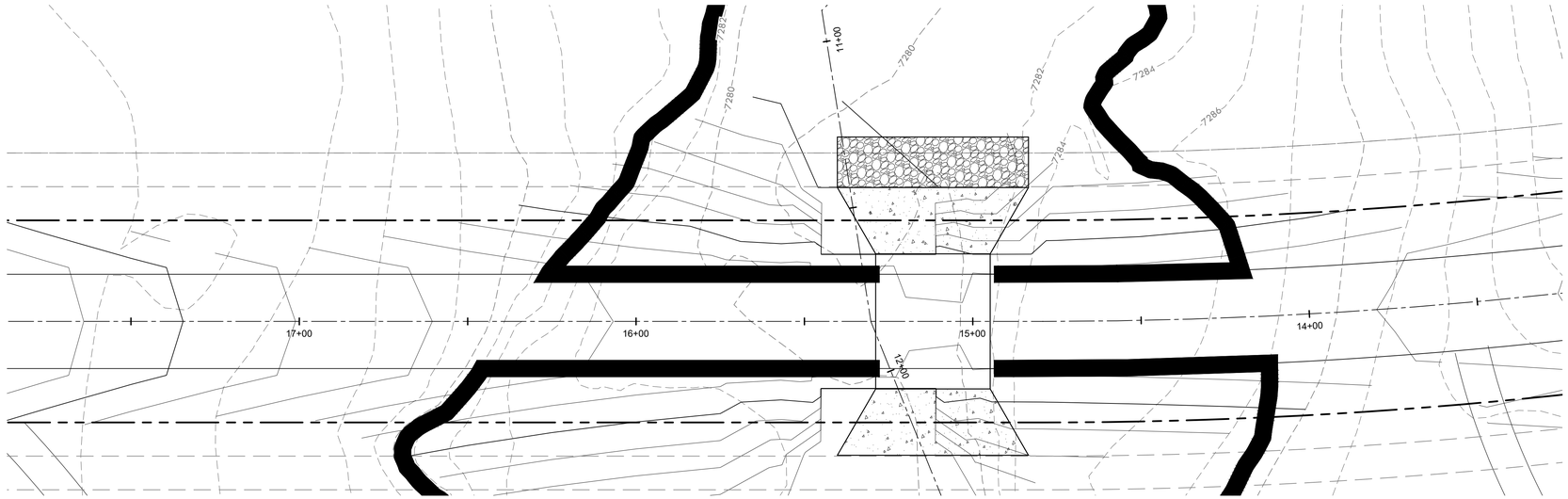
WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

CASE #: 19-08-0185R

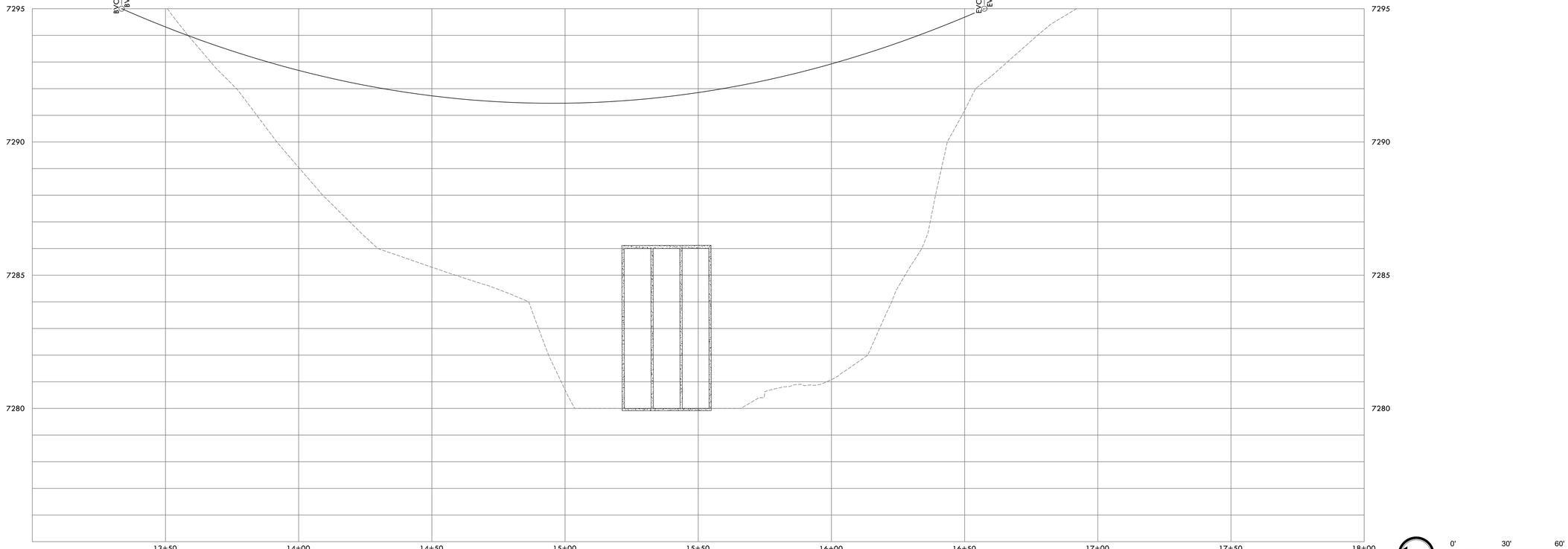


PVI STA:15+50.00
PVI EL=7285.00
K:36.94
AD:12.18%
LVC:450.00

LOW PT STA:14+95.48
LOW PT EL=7291.45

BVCS:13+25.00
BVCE:7295.38

EVCS:17+75.00
EVCE:7302.03



TWINKLING STAR LANE PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 2'

0' 30' 60'

BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88

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43911
PROFESSIONAL ENGINEER

ROAD PLAN AND PROFILE @ BOX CULVERT 2

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
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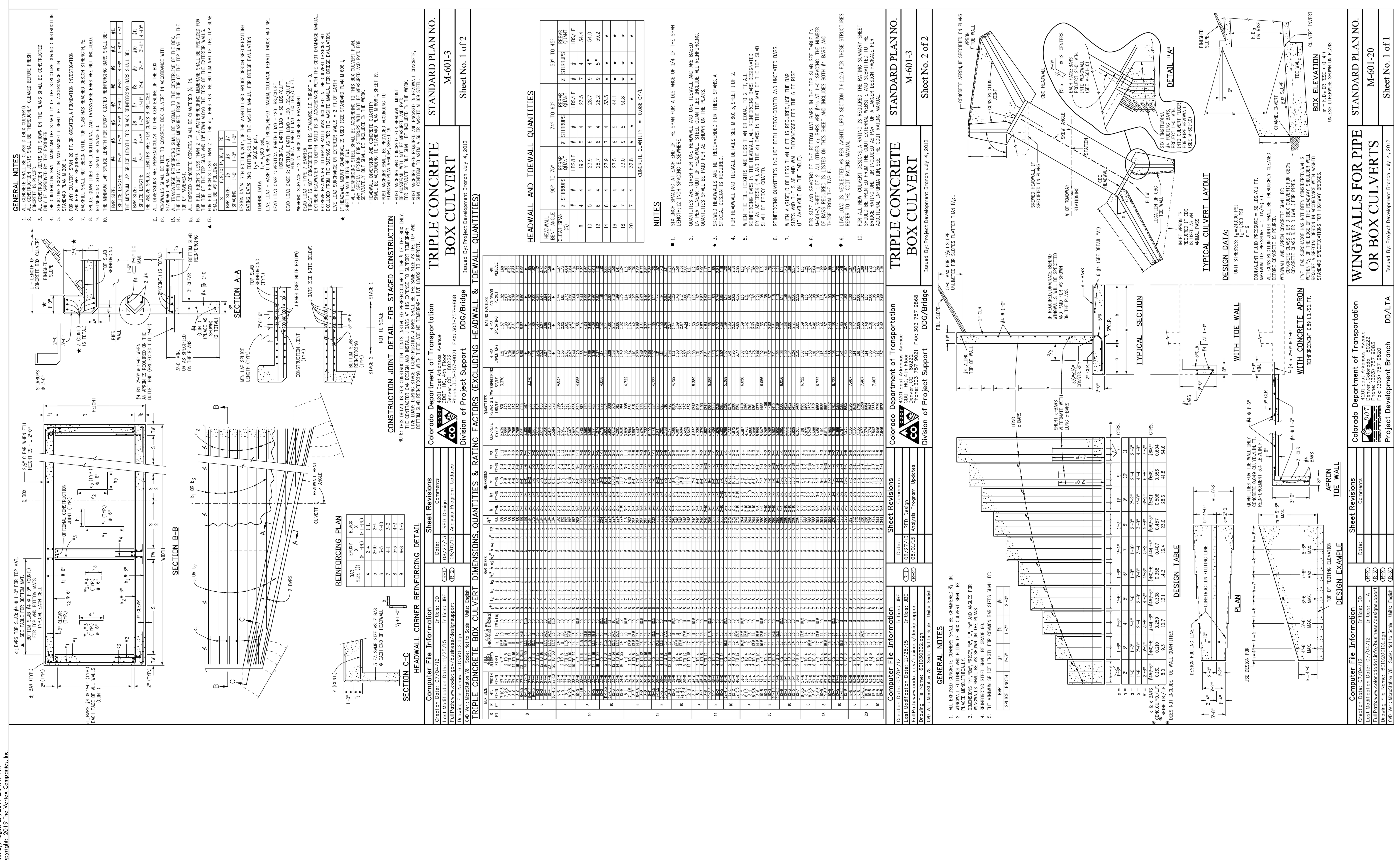
WINSOME SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

CASE #: 19-08-0185R



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BOX CULVERT SPECIFICATIONS

SITE: 1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
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G. PROJECT DRAINAGE REPORT

H. ENVIRONMENTAL ANALYSIS

i. ENDANGERED SPECIES "NO-TAKE" LETTER

ecos ecosystem services LLC

Proposal 2018-10-1

April 5, 2019

Joe Desjardin
ProTerra Properties, LLC
Director of Development
2475 Waynoka Place
Colorado Springs, Colorado 80915

RE: Winsome Ecological Report – Case #19-08-0185R, FEMA ESA Compliance

Dear Mr. Desjardin:

The U.S. Fish and Wildlife Service (USFWS) has completed their review of the Ecosystem Services, LLC (ecos) "Biological Assessment" presented in our *Natural Features and Wetland Report for the Winsome Property in El Paso County, Colorado* dated January 4, 2019 (Ecological Report) and concurs with our finding that this project will result in "no take" of threatened and endangered species regulated under the Endangered Species Act. To acknowledge their concurrence the USFWS placed a "stamp" on the cover of the Ecological Report indicating they have "No Concerns" which was signed by the USFWS and dated 4-2-2019. USFWS also wrote notes next to the stamp describing that the concurrence was based on the following facts:

1) the marginal Preble's meadow jumping mouse (PMJM) habitat onsite that is not connected to good habitat;
2) conservation measures will be implemented by the Project to protect riparian habitat; and
3) the Project committed to survey for Ute ladies-tresses orchid at wetland impact areas despite the presence of marginal habitat for this species.

Based on the findings of the Ecological Report as supported by the USFWS concurrence, ecos can confidently state that the Winsome Project presents no potential for take of threatened and endangered species listed under the Endangered Species Act.

Sincerely,

Ecosystem Services, LLC

Grant E. Gurnée

Grant E. Gurnée, P.W.S.
Restoration Ecologist – Wildlife Biologist

H. ENVIRONMENTAL ANALYSIS

ii. US FISH AND WILDLIFE “NO CONCERN” LETTER

ecos ecosystem services LLC

Informal Consultation Request

January 10, 2019

2019-TA-0422

U.S. FISH AND WILDLIFE SERVICE
☒ NO CONCERNS
☐ CONCUR NOT LIKELY TO ADVERSELY AFFECT
☐ NO COMMENT
for Leslie Ellwood 4-2-2019
Drue DeBerry DATE
Colorado and Nebraska Field Supervisor

- marginal Pronghorn habitat; not connected to good habitat
- Conservation measures will protect riparian areas
- will survey for WLTO; marginal habitat

Mr. Drue DeBerry
Acting Colorado Field Supervisor
U.S. Fish and Wildlife Service
Colorado Ecological Services Field Office
134 Union Blvd., Suite 670
Lakewood, Colorado 80228

RE: Request for Technical Assistance Regarding the Likelihood of Take of Federally-listed Threatened and Endangered Species resulting from the proposed development of the Winsome Project in El Paso County, Colorado

Dear Mr. DeBerry:

Ecosystem Services, LLC (ecos) has prepared the enclosed habitat evaluation on behalf of PT McCune, LLC to describe the physical/ecological characteristics of the Winsome Property (Site) and evaluate the potential effects of the proposed development project (Project) on the Federally-listed threatened and endangered (T&E) species protected under the Endangered Species Act (ESA).

The El Paso County Environmental Division has completed its review of the Winsome project (Project) and has requested the following: "Documentation from the U.S. Fish and Wildlife Service (USFWS) shall be provided to the Planning and Community Development Department prior to project commencement where the project will result in ground disturbing activity in habitat occupied or potentially occupied by threatened or endangered species and/or where development will occur within 300 feet of the centerline of a stream or within 300 feet of the 100 year floodplain, whichever is greater."

At this time there is no Federal action and no Federal agency is making a formal effects determination under Section 7 (a)(2) of the ESA. Therefore, ecos is requesting technical assistance from USFWS regarding PT McCune, LLC's (i.e., the non-federal party) responsibilities under the ESA, and specifically the likelihood of the Project (described herein) resulting in take of listed species. If the USFWS concurs with the findings presented herein we request that you issue an informal letter of concurrence for use in the El Paso County Project review process.

1.0 PROJECT DESCRIPTION and SITE LOCATION

The Site is situated in the northeastern corner of the Black Forest approximately 12.5 miles east of Monument and 7.3 miles east of Highway 83, in El Paso County, Colorado. The Site is located in the northwest corner of Hodgen and Meridian Roads. The Site is specifically located within Section 24, the south ¼ of Section 13, and the west ½ of Section 19, Township 11 South, Range 65 West in El Paso County, Colorado (refer to Figure 1).

The Applicant proposes to form a metropolitan district within El Paso County and develop the 766.66-acre Site as a residential community consisting of 5-acre and 2.5 acre single-family detached rural-residential lots and one 7.9-acre commercial lot, including trails, utilities, and streets and cul-de-sacs that provide access to each lot; and preserve 148.6 acres of open space along West Kiowa Creek (refer to Figure 2).

2.0 METHODOLOGY

2.1 Office Assessment

Ecos performed an office assessment in which available databases, resources, literature and field guides on local flora and fauna were reviewed to gather background information on the environmental setting of the Site. We consulted several organizations, agencies, and their databases, including:

- Colorado Department of Agriculture (CDA) Noxious Weed List;
- Colorado Natural Heritage Program (CNHP);
- Colorado Oil and Gas Conservation Commission (COGCC) GIS Online;
- Colorado Parks and Wildlife (CPW);
- El Paso County Black Forest Preservation Plan Update;
- Google Earth current and historic aerial imagery;
- CNHP Survey of Critical Biological Resources, El Paso County, Colorado;
- CNHP Survey of Critical Wetlands and Riparian Areas in El Paso and Pueblo Counties, Colorado;
- U.S. Fish and Wildlife Service (USFWS) Region 6;
- USFWS National Wetland Inventory (NWI); and
- U.S. Geological Survey (USGS).

2.2 Onsite Assessments

Following the collection and review of existing data and background information, ecos conducted a field assessment of the Site on September 5, 2018 to identify any potential impacts to natural resources associated with the Project. Field reconnaissance concentrated on identification of wetland habitat, waters of the U.S. and on the presence of habitat suitable to support threatened and endangered wildlife. Ecos conducted a follow-up field assessment on September 20, 2018 to gather additional data. Wetland habitat and waters of the U.S. boundaries, wildlife habitat, and vegetation communities were sketched on topographic and aerial base maps and located using a hand-held Global Positioning System as deemed necessary. Representative photographs were taken to assist in describing and documenting Site conditions and potential ecological impacts.

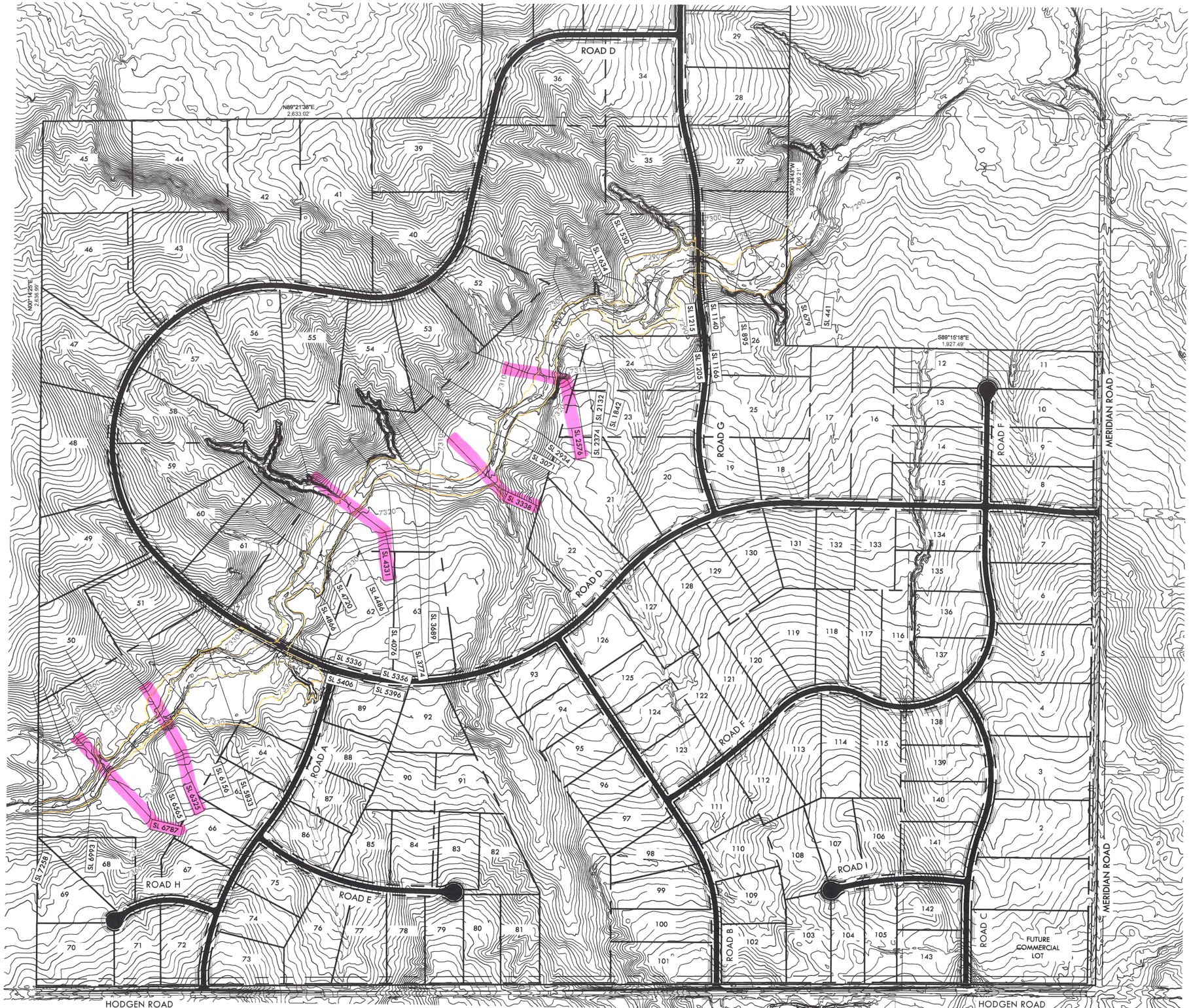
H. ENVIRONMENTAL ANALYSIS

iii. MC CUNE RANCH - NATURAL FEATURES AND WETLAND REPORT

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO



100Y FLOODPLAIN PC

100Y FLOODPLAIN EC

VERTEX

100Y FLOODPLAIN EC AND PC

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

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DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

Federal Emergency Management Agency

Washington, D.C. 20472

September 30, 2019

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

The Honorable Mark Waller
President, El Paso County
Board of Commissioners
200 South Cascade Avenue, Suite 100
Colorado Springs, CO 80903

IN REPLY REFER TO:
Case No.: 19-08-0185R

Community Name: El Paso County, CO
Community No.: 080059

104

Dear Mr. Waller:

We are providing our comments with the enclosed Conditional Letter of Map Revision (CLOMR) on a proposed project within your community that, if constructed as proposed, could revise the effective Flood Insurance Study (FIS) report and Flood Insurance Rate Map (FIRM) for your community.

If you have any questions regarding the floodplain management regulations for your community, the National Flood Insurance Program (NFIP) in general, or technical questions regarding this CLOMR, please contact the Director, Mitigation Division of the Federal Emergency Management Agency (FEMA) Regional Office in Denver, at (303) 235-4830, or the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP). Additional information about the NFIP is available on our website at https://www.fema.gov/national-flood-insurance-program.

Sincerely,

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

List of Enclosures:
Conditional Letter of Map Revision Comment Document

cc: Mr. Keith Curtis, P.E., CFM
Floodplain Administrator
Pikes Peak Regional Building Department

Mr. Joe DesJardin, P.E.
Director of Projects
PT McCune, LLC

Mr. Lance VanDemark, P.E., MSCE
Vice President – Civil Engineering
The Vertex Companies, Inc.

Federal Emergency Management Agency

Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT

COMMUNITY INFORMATION		PROPOSED PROJECT DESCRIPTION	BASIS OF CONDITIONAL REQUEST
COMMUNITY	El Paso County Colorado (Unincorporated Areas)	CULVERT DETENTION BASIN FILL	BASE MAP CHANGES HYDROLOGIC ANALYSIS HYDRAULIC ANALYSIS UPDATED TOPOGRAPHIC DATA
	COMMUNITY NO.: 080059		
IDENTIFIER	McCune Ranch Subdivision	APPROXIMATE LATITUDE AND LONGITUDE: 39.077, -104.621 SOURCE: USGS QUADRANGLE DATUM: NAD 83	

AFFECTED MAP PANELS			
TYPE: FIRM*	NO.: 08041C0310G	DATE: December 7, 2018	* FIRM - Flood Insurance Rate Map
TYPE: FIRM	NO.: 08041C0350G	DATE: December 7, 2018	

FLOODING SOURCE AND REACH DESCRIPTION

West Kiowa Creek – from approximately 5,000 feet upstream of Meridian Road North to approximately 1,640 feet downstream of Hodgen Road

PROPOSED PROJECT DESCRIPTION

Flooding Source	Proposed Project	Location of Proposed Project
West Kiowa Creek	2 New Triple 10'x10' Box Culverts	At approximately 6,220 feet upstream and 10,380 feet upstream of Meridian Road North
	6 New Detention Basins	Located throughout the proposed subdivision centered approximately 2,690 feet northwest of the intersection of Meridian Road and Forest Green Drive
	Fill Placement	At the proposed box culverts approximately 6,220 feet upstream and 10,380 feet upstream of Meridian Road North

SUMMARY OF IMPACTS TO FLOOD HAZARD DATA

Flooding Source	Effective Flooding	Proposed Flooding	Increases	Decreases
West Kiowa Creek	No BFEs*	BFEs	Yes	None
	Zone A	Zone AE	Yes	Yes
	Zone A	Zone A	None	Yes

* BFEs - Base (1-percent-annual-chance) Flood Elevations

COMMENT

This document provides the Federal Emergency Management Agency's (FEMA's) comment regarding a request for a CLOMR for the project described above. This document is not a final determination; it only provides our comment on the proposed project in relation to the flood hazard information shown on the effective National Flood Insurance Program (NFIP) map. We reviewed the submitted data and the data used to prepare the effective flood hazard information for your community and determined that the proposed project meets the minimum floodplain management criteria of the NFIP. Your community is responsible for approving all floodplain development and for ensuring that all permits required by Federal or State/Commonwealth law have been received. State/Commonwealth, county, and community officials, based on their knowledge of local conditions and in the interest of safety, may set higher standards for construction in the Special Flood Hazard Area (SFHA), the area subject to inundation by the base flood). If the State/Commonwealth, county, or community has adopted more restrictive or comprehensive floodplain management criteria, these criteria take precedence over the minimum NFIP criteria.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency

Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

To determine the changes in flood hazards that will be caused by the proposed project, we compared the hydraulic modeling reflecting the proposed project (referred to as the proposed conditions model) to the hydraulic modeling reflecting the existing conditions.

The table below shows the changes in the base flood water-surface elevations (WSELs).

Base Flood WSEL Comparison Table

Flooding Source: West Kiowa Creek		Base Flood WSEL Change (feet)	Location of maximum change
Proposed vs. Existing	Maximum increase	4.9	Approximately 6,260 feet upstream of Meridian Road North
	Maximum decrease	0.4	Approximately 11,160 feet upstream of Meridian Road North

NFIP regulations Subparagraph 60.3(b)(7) requires communities to ensure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management ordinances; therefore, responsibility for maintenance of the altered or relocated watercourse, including any related appurtenances such as bridges, culverts, and other drainage structures, rests with your community. We may request that your community submit a description and schedule of maintenance activities necessary to ensure this requirement.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

DATA REQUIRED FOR FOLLOW-UP LOMR

Upon completion of the project, your community must submit the data listed below and request that we make a final determination on revising the effective FIRM and FIS report. If the project is built as proposed and the data below are received, a revision to the FIRM and FIS report would be warranted.

• Detailed application and certification forms must be used for requesting final revisions to the maps. Therefore, when the map revision request for the area covered by this letter is submitted, Form 1, entitled "Overview and Concurrence Form," must be included. A copy of this form may be accessed at https://www.fema.gov/media-library/assets/documents/1343.

• The detailed application and certification forms listed below may be required if as-built conditions differ from the proposed plans. If required, please submit new forms, which may be accessed at https://www.fema.gov/media-library/assets/documents/1343, or annotated copies of the previously submitted forms showing the revised information.

Form 2, entitled "Riverine Hydrology and Hydraulics Form." Hydraulic analyses for as-built conditions of the base flood must be submitted with Form 2.

Form 3, entitled "Riverine Structures Form."

• A certified topographic work map showing the revised and effective base floodplain boundaries. Please ensure that the revised information ties in with the current effective information at the downstream and upstream ends of the revised reach.

• An annotated copy of the FIRM, at the scale of the effective FIRM, that shows the revised base floodplain boundary delineations shown on the submitted work map and how they tie-in to the base floodplain boundary delineations shown on the current effective FIRM at the downstream and upstream ends of the revised reach.

• As-built plans, certified by a registered Professional Engineer, of all proposed project elements.

• Documentation of the individual legal notices sent to property owners who will be affected by any widening or shifting of the base floodplain and/or any BFE establishment along West Kiowa Creek.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency

Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

DATA REQUIRED FOR FOLLOW-UP LOMR (continued)

• An officially adopted maintenance and operation plan for the six new detention basins within the subdivision. This plan, which may be in the form of a written statement from the community Chief Executive Officer, an ordinance, or other legislation, must describe the nature of the maintenance activities, the frequency with which they will be performed, and the title of the local community official who will be responsible for ensuring that the maintenance activities are accomplished.

• FEMA's fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps may be accessed at https://www.fema.gov/forms-documents-and-software/flood-map-related-fees. The fee at the time of the map revision submittal must be received before we can begin processing the request. Payment of this fee can be made through a check or money order, made payable in U.S. funds to the National Flood Insurance Program, or by credit card (Visa or MasterCard only). Please either forward the payment, along with the revision application, to the following address:

LOMC Clearinghouse
Attention: LOMR Manager
3601 Eisenhower Avenue, Suite 500
Alexandria, Virginia 22304-6426

or submit the LOMR using the Online LOMC portal at: https://hazards.fema.gov/femaportal/onlinelomc/signin

After receiving appropriate documentation to show that the project has been completed, FEMA will initiate a revision to the FIRM and FIS report. Because the flood hazard information (i.e., base flood elevations, base flood depths, SFHAs, zone designations, and/or regulatory floodways) will change as a result of the project, a 90-day appeal period will be initiated for the revision, during which community officials and interested persons may appeal the revised flood hazard information based on scientific or technical data.

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency

Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT (CONTINUED)

COMMUNITY INFORMATION (CONTINUED)

COMMUNITY REMINDERS

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Jeanine P. Petterson
Director, Mitigation Division
Federal Emergency Management Agency, Region VIII
Denver Federal Center, Building 710
P.O. Box 25267
Denver, CO 80225-0267
(303) 235-4830

This comment is based on the flood data presently available. If you have any questions about this document, please contact the FEMA Map Information eXchange (FMIX) toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on the FEMA website at https://www.fema.gov/national-flood-insurance-program.

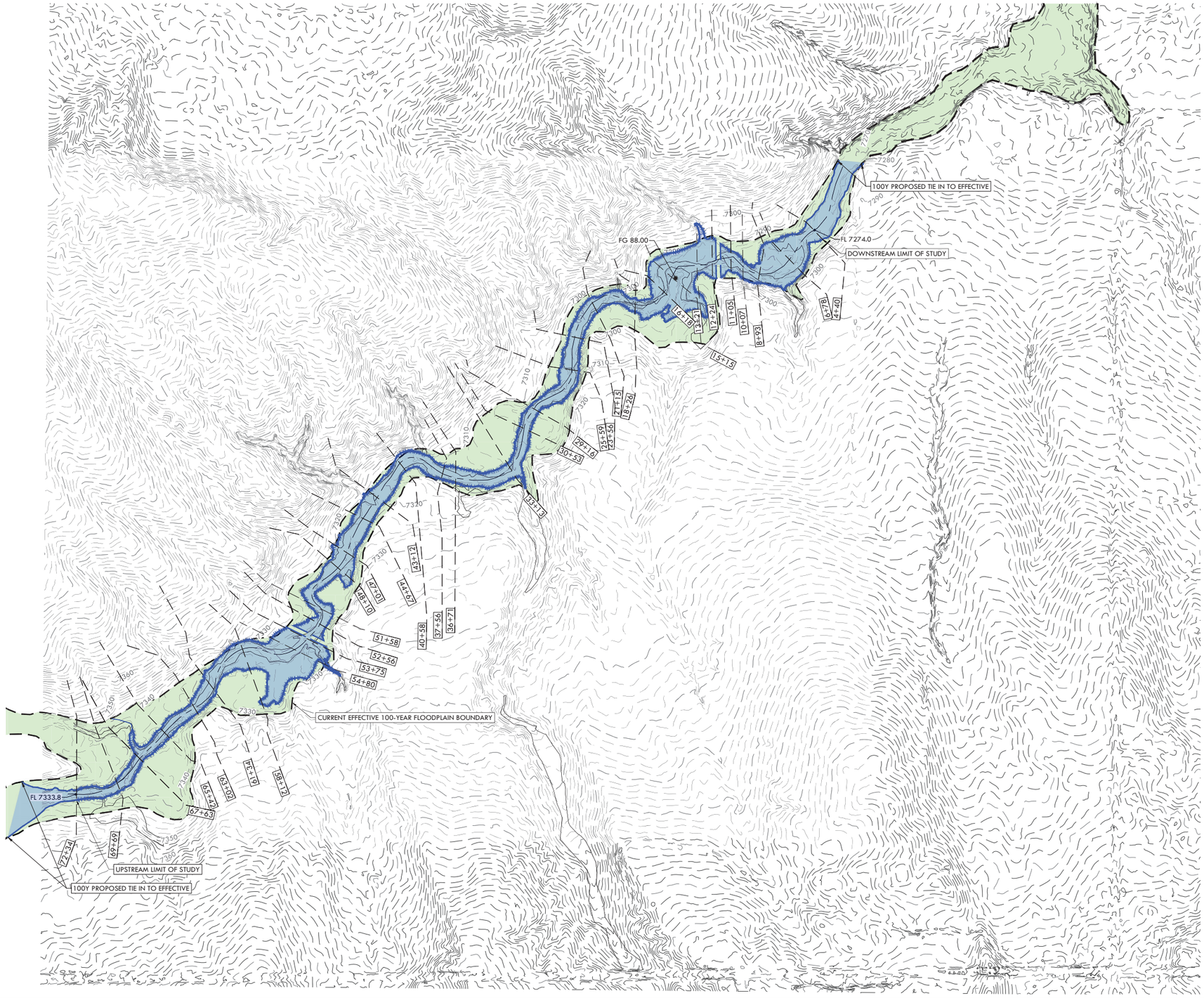
Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

FEMA CLOMR SUBMITTAL

MCCUNE RANCH SUBDIVISION

A PARCEL OF PROPERTY LOCATED IN SECTIONS 13 & 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M. AND IN THE WEST HALF OF THE WEST HALF OF SECTION 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M., COUNTY OF EL PASO, STATE OF COLORADO

CASE #: 19-08-0185R



WEST KIOWA CREEK PROPOSED CONDITIONS 100-YEAR FLOOD DATA			
CROSS SECTION	100-YEAR PC WSEL	100-YEAR PC TOP WIDTH INCLUDING INEFFICTIVE FLOW	100-YEAR PC TOP WIDTH EXCLUDING INEFFICTIVE FLOW
72+34	7338.11	63.12	63.12
69+69	7335.52	64.11	64.11
67+63	7333.63	64.92	64.92
65+42	7331.14	74.22	74.22
63+02	7328.85	76.90	76.90
61+34	7327.28	131.11	131.11
58+12	7326.47	201.82	169.96
54+80	7326.65	349.50	322.44
53+75	7326.35	278.31	62.88
53+10	CULVERT		
52+56	7321.50	110.20	66.00
51+58	7318.71	103.09	103.09
48+10	7316.81	179.90	179.90
47+01	7316.71	146.50	146.50
44+67	7315.70	114.47	114.47
43+12	7314.40	115.43	115.43
40+58	7311.05	99.53	99.53
37+56	7308.45	86.18	86.18
36+71	7307.52	96.89	96.89
33+13	7304.40	102.90	102.90
30+53	7301.03	69.79	69.79
29+16	7299.80	67.41	67.41
25+59	7297.13	118.75	118.75
23+56	7294.61	88.75	88.75
21+15	7292.45	99.93	99.93
18+26	7289.14	86.77	86.77
16+18	7289.44	299.59	299.59
15+15	7289.46	425.09	425.09
13+21	7289.40	291.86	189.05
12+24	7289.09	255.05	62.76
11+60	CULVERT		
11+05	7283.36	124.12	60.69
10+07	7282.73	88.93	88.93
8+93	7281.40	243.18	243.18
6+78	7278.47	265.53	265.53
4+40	7276.45	146.38	146.38

SKEW ANGLE APPLIED IN HEC-RAS OF 55° @ 51+58 AND 45° @ 10+07. DASHED LINE AT THESE CROSS SECTIONS REPRESENTS ADJUSTED ANGLE.

BENCHMARK: NORTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH P.M.

A 3.5" ALUMINUM CAP STAMPED "LS 12103"

ELEVATION IS 7429.30 NAVD88

0' 300' 600'

VERTEX
2420 W. 26th Avenue, Suite 100-D | Denver, CO 80211
Main: 303.623.9116 | VERTEXENG.COM

COLORADO LICENSED
LANDSCAPE ARCHITECT
8/27/19
43911
PROFESSIONAL ENGINEER

100Y PC FLOODPLAIN

SITE: 17480 MERIDIAN ROAD
ELBERT, COLORADO 80106

FOR: PT MCCUNE, LLC
1864 WOODMORE DR, SUITE 100
MONUMENT, COLORADO 80132

NO.	REVISIONS
1	REVISED PER REVIEW COMMENTS 3/26/19
2	REVISED PER REVIEW COMMENTS 4/2/19
3	REVISED PER REVIEW COMMENTS 6/5/19
4	REVISED PER REVIEW COMMENTS 7/1/19
5	
6	
7	
8	
9	
10	

DATE: 11/16/18
DRAWN BY: JCP
CHECKED BY: LPV
JOB #: 49388

1

P:\Shared Projects\49000-49999\49300-49399\49388\ArcGIS\Cone Ranch\06-Engineering\Vertex Drawings\FEMA CLOMR\49388-FloodPlains.dwg
Last Saved by JCP 2019.11.06 PM

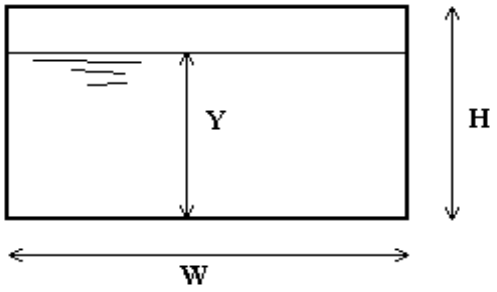
APPENDIX E: CULVERT HYDRAULICS

BEND STABILITY									
Channel ID	Curvature of the bend to the Channel Centerline (ft)	Channel Width at WSEL (ft)	Rc/T	Ratio of Channel Bend to Bottom Shear Stress	HEC-RAS Channel Shear 100-yr [psf]	Side Shear Stress on Channel [psf]	Tractive Force (Avg. of Seciton) for Soil Type B [psf]	Require Riprap Protection?	$\tau_b = K_b \tau_d$
XS 1105 (Culv 2)	125.0	124.12	1.01	2.00	1.97	3.94	0.6	Yes	Eqn 3.6, FHWA HEC 15

SUPERELEVATION						
Channel ID	C, coefficient	Average Velocity (fps)	Channel Width at WSEL (ft)	Channel Ceterline Radius of Curvature (ft)	Additional Height of Freeboard (ft)	$H = C \frac{v^2 W}{gR}$
XS 1105 (Culv 2)	1.0	11.02	124.12	125.00	3.74	Eqn 10-4, El Paso County DCM, Section 10.5.6

BOX CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Winsome Filing No 3
Box ID: Crossing 2- Station 1160



Design Information (Input)			
Box conduit invert slope	So =	0.0050	ft/ft
Box Manning's n-value	n =	0.0120	
Box Width	W =	36.00	ft
Box Height	H =	7.00	ft
Design discharge	**Q =**	**2311.00**	**cfs**

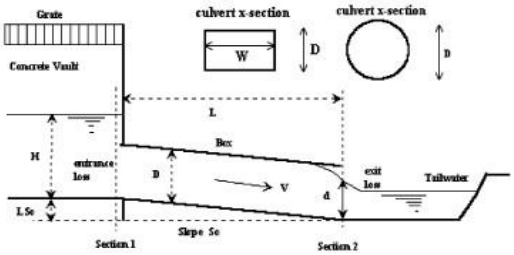
Full-flow capacity (Calculated)			
Full-flow area	Af =	252.00	sq ft
Full-flow wetted perimeter	Pf =	86.00	ft
Full-flow capacity	Qf =	4530.63	cfs

Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	3.55	ft
Flow area	An =	127.63	sq ft
Wetted perimeter	Pn =	43.09	ft
Flow velocity	Vn =	18.11	fps
Discharge	Qn =	2311.05	cfs
Percent Full	Flow =	51.0%	of full flow
Normal Depth Froude Number	Fr_n =	1.69	supercritical

Calculation of Critical Flow Condition			
Critical flow depth	Yc =	5.04	ft
Critical flow area	Ac =	181.41	sq ft
Critical flow velocity	Vc =	12.74	fps
Critical Depth Froude Number	Fr_c =	1.00	

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Winsome Filing No 3
Basin ID: Crossing 2- Station 1160
Status:



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = [ ] inches
Inlet Edge Type (choose from pull-down list): [Grooved End with Headwall]

OR:

Box Culvert: Barrel Height (Rise) in Feet — Height (Rise) = 7.00 ft.
Barrel Width (Span) in Feet — Width (Span) = 12.00 ft.
Inlet Edge Type (choose from pull-down list): [Square Edge w/ 90-15 Deg. Headwall]

Number of Barrels	No =	3	
Inlet Elevation at Culvert Invert	Inlet Elev =	7279.85	ft. elev.
Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.005	ft vert. / ft horiz.
Culvert Length in Feet	L =	48	ft.
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	K_b =	0	
Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.10
Sum of All Loss Coefficients	K_s =	1.60
Orifice Inlet Condition Coefficient	C_d =	0.82
Minimum Energy Condition Coefficient	KE_{low} =	0.4188

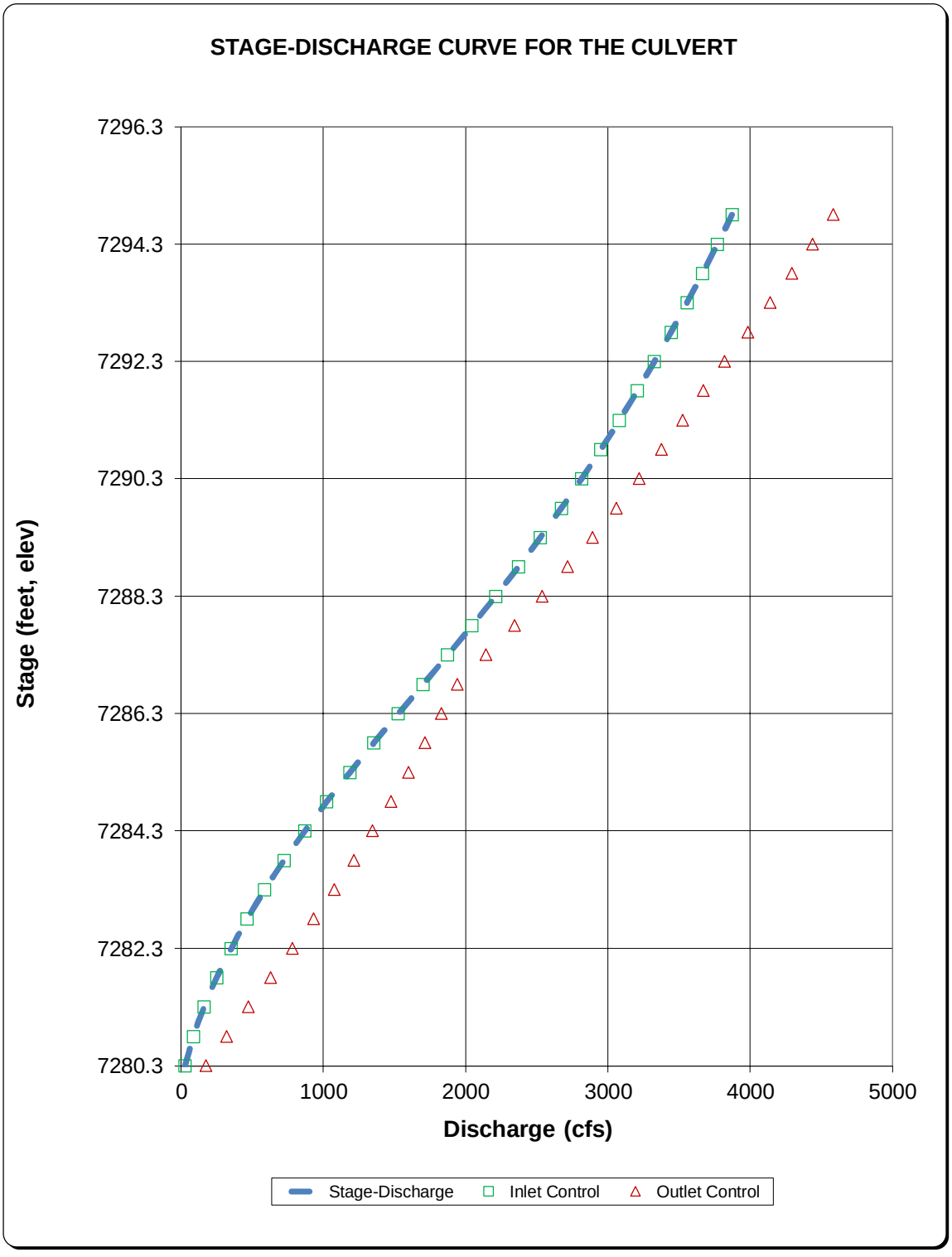
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
7280.30		27.60	176.18	**27.60**	Min. Energy. Eqn.	INLET
7280.80		84.60	320.52	**84.60**	Min. Energy. Eqn.	INLET
7281.30		159.60	474.80	**159.60**	Min. Energy. Eqn.	INLET
7281.80		249.00	630.56	**249.00**	Min. Energy. Eqn.	INLET
7282.30		350.70	783.90	**350.70**	Min. Energy. Eqn.	INLET
7282.80		463.20	932.55	**463.20**	Min. Energy. Eqn.	INLET
7283.30		585.90	1,075.97	**585.90**	Min. Energy. Eqn.	INLET
7283.80		722.40	1,213.95	**722.40**	Regression Eqn.	INLET
7284.30		868.20	1,346.69	**868.20**	Regression Eqn.	INLET
7284.80		1,022.70	1,474.37	**1,022.70**	Regression Eqn.	INLET
7285.30		1,185.00	1,597.57	**1,185.00**	Regression Eqn.	INLET
7285.80		1,353.30	1,716.26	**1,353.30**	Regression Eqn.	INLET
7286.30		1,525.80	1,831.03	**1,525.80**	Regression Eqn.	INLET
7286.80		1,699.80	1,942.24	**1,699.80**	Regression Eqn.	INLET
7287.30		1,872.90	2,144.25	**1,872.90**	Regression Eqn.	INLET
7287.80		2,043.00	2,345.52	**2,043.00**	Regression Eqn.	INLET
7288.30		2,208.60	2,536.48	**2,208.60**	Regression Eqn.	INLET
7288.80		2,368.80	2,718.46	**2,368.80**	Regression Eqn.	INLET
7289.30		2,522.70	2,892.77	**2,522.70**	Regression Eqn.	INLET
7289.80		2,670.60	3,059.96	**2,670.60**	Regression Eqn.	INLET
7290.30		2,812.50	3,220.97	**2,812.50**	Regression Eqn.	INLET
7290.80		2,948.40	3,376.36	**2,948.40**	Regression Eqn.	INLET
7291.30		3,078.90	3,526.51	**3,078.90**	Regression Eqn.	INLET
7291.80		3,204.60	3,672.17	**3,204.60**	Regression Eqn.	INLET
7292.30		3,325.20	3,819.70	**3,325.20**	Regression Eqn.	INLET
7292.80		3,441.90	3,983.90	**3,441.90**	Regression Eqn.	INLET
7293.30		3,554.40	4,141.73	**3,554.40**	Regression Eqn.	INLET
7293.80		3,663.30	4,293.75	**3,663.30**	Regression Eqn.	INLET
7294.30		3,768.60	4,440.53	**3,768.60**	Regression Eqn.	INLET
7294.80		3,870.90	4,582.63	**3,870.90**	Regression Eqn.	INLET

Processing Time: 01.10 Seconds

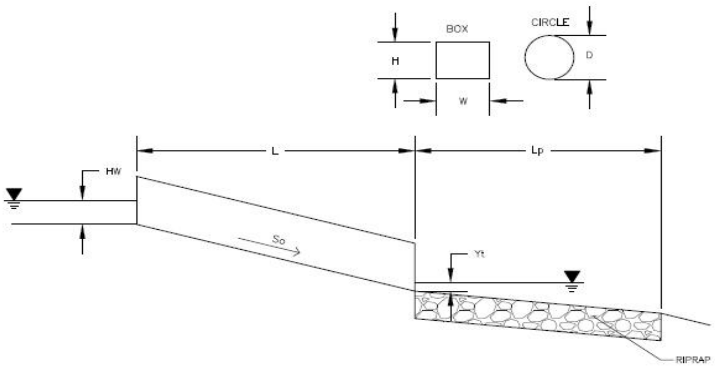
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Winsome Filing No 3
Basin ID: Crossing 2- Station 1160



Determination of Culvert Headwater and Outlet Protection

Project: Winsome Filing No 3
Basin ID: Crossing 2- Station 1160



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Ha to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	2311	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (Choose from pull-down list)			
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =	7	ft
	Barrel Width (Span) in Feet	Width (Span) =	12	ft
	Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	3	
	Inlet Elevation	Elev IN =	7279.85	ft
	Outlet Elevation **OR** Slope	So =	0.005	ft/ft
	Culvert Length	L =	48	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	4	ft/s

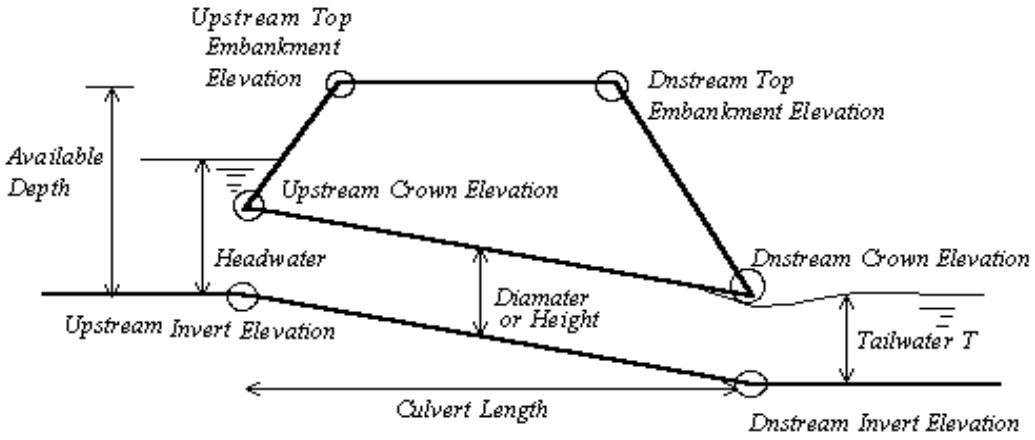
Required Protection (Output):

Tailwater Surface Height	Y_t =	2.80	ft
Flow Area at Max Channel Velocity	A_t =	192.58	ft^2
Culvert Cross Sectional Area Available	A =	84.00	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.10	
Sum of All Losses Coefficients	k_s =	1.60	ft
Culvert Normal Depth	Y_n =	4.06	ft
Culvert Critical Depth	Y_c =	5.04	ft
Tailwater Depth for Design	d =	6.02	ft
Adjusted Diameter **OR** Adjusted Rise	H_a =	5.53	ft
Expansion Factor	1/(2*tan(Θ)) =	5.10	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/WH^1.5 =	3.47	$ft^{0.5}/s$
Froude Number	Fr =	1.38	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/H =	0.51	
Inlet Control Headwater	HW_I =	8.77	ft
Outlet Control Headwater	HW_O =	7.86	
Design Headwater Elevation	**HW =**	**7,288.62**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H =**	**1.25**	
Minimum Theoretical Riprap Size	d_{50} =	9	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**M**	
Length of Protection	**L_p =**	**70**	**ft**
Width of Protection	**T =**	**26**	**ft**

Vertical Profile for the Culvert

Project = **Winsome Filing No 3**

Box ID = **Crossing 2-Station 1160**

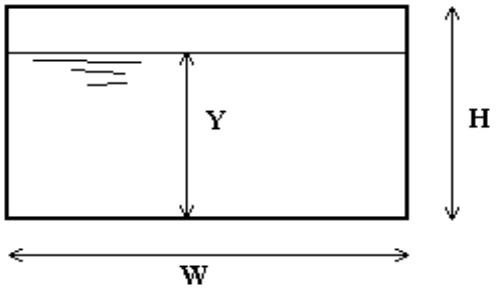


Culvert Information (Input)			
Barrel Diameter or Height	D or H =	84.00	inches
Barrel Length	L =	48.00	ft
Barrel Invert Slope	So =	0.0050	ft/ft
Downstream Invert Elevation	EDI =	7279.61	ft
Downstream Top Embankment Elevation	EDT =	7291.10	ft
Upstream Top Embankment Elevation	EUT =	7291.30	ft
Design Headwater Depth (not elev.)	Hw =	8.77	ft
Tailwater Depth (not elev.)	Yt =	7.86	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	11.45	ft
Design Hw/D ratio	Hw/D =	1.25	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7279.85	ft
Upstream Crown Elevation	EUC =	7286.85	ft
Upstream Soil Cover Depth	Upsoil =	4.45	ft
Downstream Invert Elevation	EDI =	7279.61	ft
Downstream Crown Elevation	EDC =	7286.61	ft
Downstream Soil Cover Depth	Dnsoil =	4.49	ft

BOX CONDUIT FLOW (Normal & Critical Depth Computation)

Project: Winsome Filing No 3
Box ID: Crossing 1- Station 5310



Design Information (Input)			
Box conduit invert slope	So =	0.0050	ft/ft
Box Manning's n-value	n =	0.0120	
Box Width	W =	36.00	ft
Box Height	H =	7.00	ft
Design discharge	**Q =**	**2062.00**	**cfs**

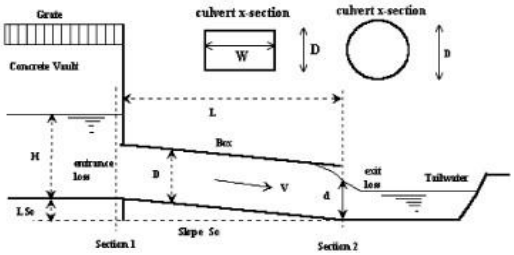
Full-flow capacity (Calculated)			
Full-flow area	Af =	252.00	sq ft
Full-flow wetted perimeter	Pf =	86.00	ft
Full-flow capacity	Qf =	4530.63	cfs

Calculations of Normal Flow Condition			
Normal flow depth (<H)	Yn =	3.30	ft
Flow area	An =	118.63	sq ft
Wetted perimeter	Pn =	42.59	ft
Flow velocity	Vn =	17.38	fps
Discharge	Qn =	2062.04	cfs
Percent Full	Flow =	45.5%	of full flow
Normal Depth Froude Number	Fr_n =	1.69	supercritical

Calculation of Critical Flow Condition			
Critical flow depth	Yc =	4.67	ft
Critical flow area	Ac =	168.14	sq ft
Critical flow velocity	Vc =	12.26	fps
Critical Depth Froude Number	Fr_c =	1.00	

CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Winsome Filing No 3
Basin ID: Crossing 1- Station 5310
Status:



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = [ ] inches
Inlet Edge Type (choose from pull-down list): [Grooved End with Headwall]

OR:

Box Culvert: Barrel Height (Rise) in Feet — Height (Rise) = 7.00 ft.
Barrel Width (Span) in Feet — Width (Span) = 12.00 ft.
Inlet Edge Type (choose from pull-down list): [Square Edge w/ 90-15 Deg. Headwall]

Number of Barrels	No =	3	
Inlet Elevation at Culvert Invert	Inlet Elev =	7318.25	ft. elev.
Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.005	ft vert. / ft horiz.
Culvert Length in Feet	L =	50	ft.
Manning's Roughness	n =	0.012	
Bend Loss Coefficient	K_b =	0	
Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.10
Sum of All Loss Coefficients	K_s =	1.60
Orifice Inlet Condition Coefficient	C_d =	0.82
Minimum Energy Condition Coefficient	KE_{low} =	0.4188

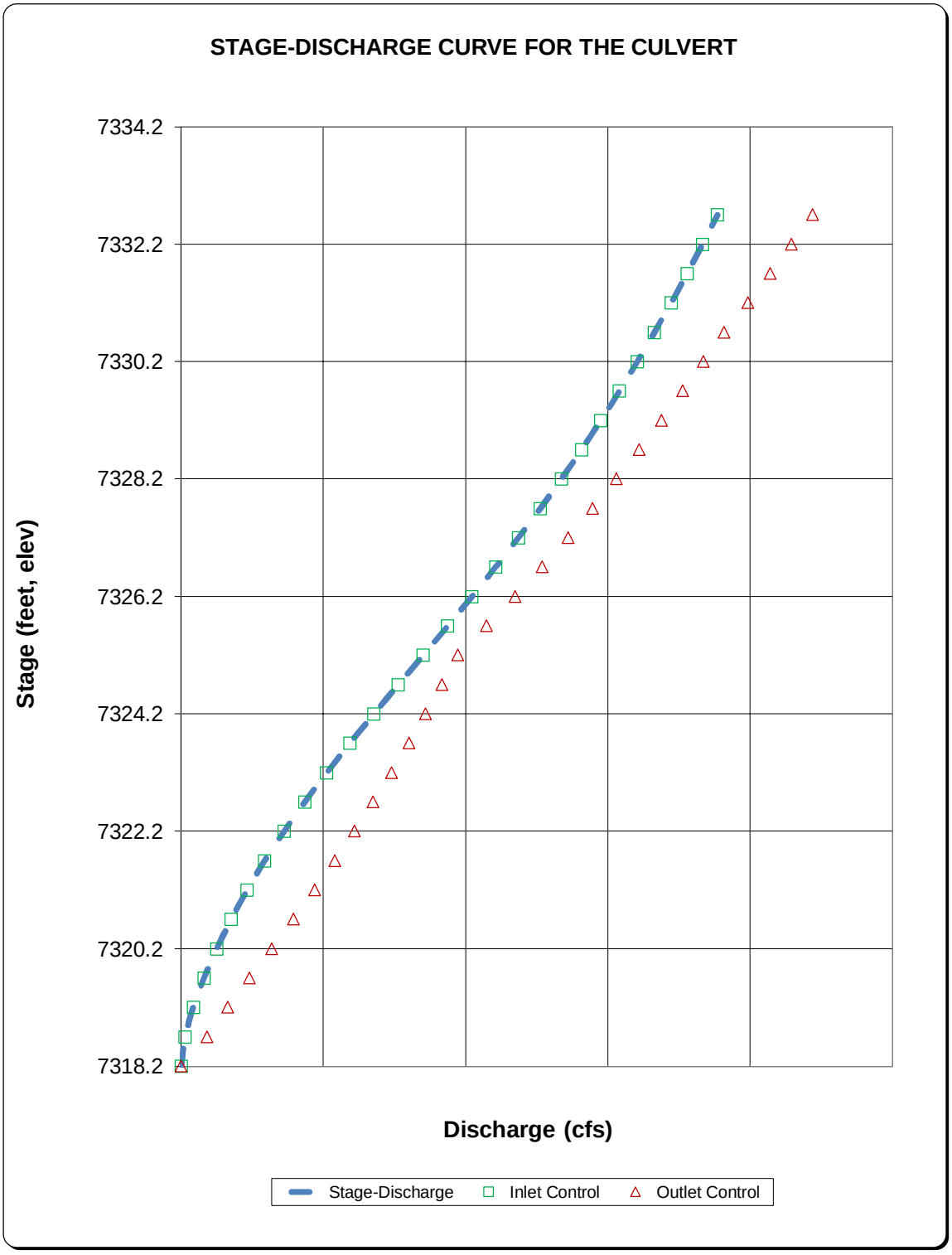
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
7318.20		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
7318.70		27.60	181.61	**27.60**	Min. Energy. Eqn.	INLET
7319.20		84.60	326.52	**84.60**	Min. Energy. Eqn.	INLET
7319.70		159.60	480.79	**159.60**	Min. Energy. Eqn.	INLET
7320.20		249.00	636.56	**249.00**	Min. Energy. Eqn.	INLET
7320.70		350.70	789.52	**350.70**	Min. Energy. Eqn.	INLET
7321.20		463.20	937.98	**463.20**	Min. Energy. Eqn.	INLET
7321.70		585.90	1,081.02	**585.90**	Min. Energy. Eqn.	INLET
7322.20		722.40	1,218.63	**722.40**	Regression Eqn.	INLET
7322.70		868.20	1,350.99	**868.20**	Regression Eqn.	INLET
7323.20		1,022.70	1,478.31	**1,022.70**	Regression Eqn.	INLET
7323.70		1,185.00	1,601.12	**1,185.00**	Regression Eqn.	INLET
7324.20		1,353.30	1,719.63	**1,353.30**	Regression Eqn.	INLET
7324.70		1,525.80	1,834.21	**1,525.80**	Regression Eqn.	INLET
7325.20		1,699.80	1,945.05	**1,699.80**	Regression Eqn.	INLET
7325.70		1,872.90	2,146.50	**1,872.90**	Regression Eqn.	INLET
7326.20		2,043.00	2,347.20	**2,043.00**	Regression Eqn.	INLET
7326.70		2,208.60	2,537.79	**2,208.60**	Regression Eqn.	INLET
7327.20		2,368.80	2,719.59	**2,368.80**	Regression Eqn.	INLET
7327.70		2,522.70	2,893.33	**2,522.70**	Regression Eqn.	INLET
7328.20		2,670.60	3,060.33	**2,670.60**	Regression Eqn.	INLET
7328.70		2,812.50	3,220.97	**2,812.50**	Regression Eqn.	INLET
7329.20		2,948.40	3,375.99	**2,948.40**	Regression Eqn.	INLET
7329.70		3,078.90	3,525.95	**3,078.90**	Regression Eqn.	INLET
7330.20		3,204.60	3,671.24	**3,204.60**	Regression Eqn.	INLET
7330.70		3,325.20	3,818.21	**3,325.20**	Regression Eqn.	INLET
7331.20		3,441.90	3,982.21	**3,441.90**	Regression Eqn.	INLET
7331.70		3,554.40	4,139.67	**3,554.40**	Regression Eqn.	INLET
7332.20		3,663.30	4,291.32	**3,663.30**	Regression Eqn.	INLET
7332.70		3,768.60	4,437.91	**3,768.60**	Regression Eqn.	INLET

Processing Time: 01.50 Seconds

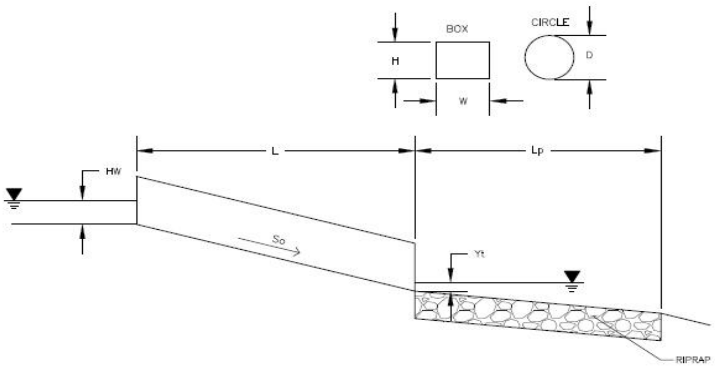
CULVERT STAGE-DISCHARGE SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

Project: Winsome Filing No 3
Basin ID: Crossing 1- Station 5310



Determination of Culvert Headwater and Outlet Protection

Project: Winsome Filing No 3
Basin ID: Crossing 1- Station 5310



Soil Type:
Choose One:
(●) Sandy
( ) Non-Sandy

Supercritical Flow! Using Ha to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	2062	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (Choose from pull-down list)			
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =	7	ft
	Barrel Width (Span) in Feet	Width (Span) =	12	ft
	Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 90-15 Deg. Headwall	
	Number of Barrels	No =	3	
	Inlet Elevation	Elev IN =	7318.25	ft
	Outlet Elevation **OR** Slope	So =	0.005	ft/ft
	Culvert Length	L =	50	ft
	Manning's Roughness	n =	0.012	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	4	ft/s

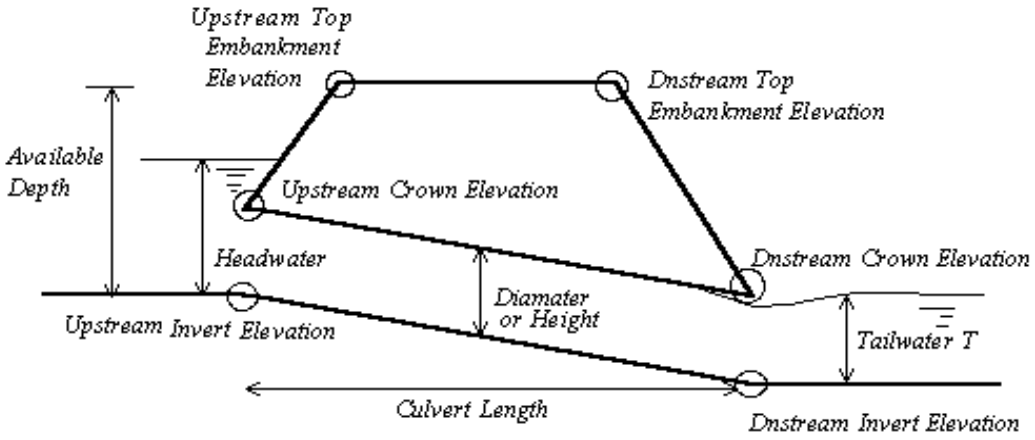
Required Protection (Output):

Tailwater Surface Height	Y_t =	2.80	ft
Flow Area at Max Channel Velocity	A_t =	171.83	ft^2
Culvert Cross Sectional Area Available	A =	84.00	ft^2
Entrance Loss Coefficient	k_e =	0.50	
Friction Loss Coefficient	k_f =	0.10	
Sum of All Losses Coefficients	k_s =	1.60	ft
Culvert Normal Depth	Y_n =	3.74	ft
Culvert Critical Depth	Y_c =	4.67	ft
Tailwater Depth for Design	d =	5.84	ft
Adjusted Diameter **OR** Adjusted Rise	H_a =	5.37	ft
Expansion Factor	1/(2*tan(Θ)) =	5.91	
Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/WH^1.5 =	3.09	$ft^{0.5}/s$
Froude Number	Fr =	1.40	**Supercritical!**
Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/H =	0.52	
Inlet Control Headwater	HW_I =	8.01	ft
Outlet Control Headwater	HW_O =	7.25	
Design Headwater Elevation	**HW =**	**7,326.26**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/H =**	**1.14**	
Minimum Theoretical Riprap Size	d_{50} =	8	in
Nominal Riprap Size	d_{50} =	9	in
UDFCD Riprap Type	**Type =**	**L**	
Length of Protection	**L_p =**	**70**	**ft**
Width of Protection	**T =**	**24**	**ft**

Vertical Profile for the Culvert

Project = **Winsome Filing No 3**

Box ID = **Crossing 1-Station 5310**



Culvert Information (Input)			
Barrel Diameter or Height	D or H =	84.00	inches
Barrel Length	L =	50.00	ft
Barrel Invert Slope	So =	0.0050	ft/ft
Downstream Invert Elevation	EDI =	7318.00	ft
Downstream Top Embankment Elevation	EDT =	7329.00	ft
Upstream Top Embankment Elevation	EUT =	7329.20	ft
Design Headwater Depth (not elev.)	Hw =	8.01	ft
Tailwater Depth (not elev.)	Yt =	7.25	ft

Culvert Hydraulics (Calculated)			
Available Headwater Depth	HW-a =	10.95	ft
Design Hw/D ratio	Hw/D =	1.14	
Culvert Vertical Profile			
Upstream Invert Elevation	EUI =	7318.25	ft
Upstream Crown Elevation	EUC =	7325.25	ft
Upstream Soil Cover Depth	Upsoil =	3.95	ft
Downstream Invert Elevation	EDI =	7318.00	ft
Downstream Crown Elevation	EDC =	7325.00	ft
Downstream Soil Cover Depth	Dnsoil =	4.00	ft

APPENDIX F: CULVERT PLANS

WINSOME FILING NO. 3

CULVERT CONSTRUCTION DOCUMENTS

A PORTION OF SECTIONS 13 AND 24, TOWNSHIP 11 SOUTH, RANGE 65 SOUTH, AND A PORTION OF THE WEST HALF SECTON 19, TOWNSHIP 11 SOUTH, RANGE 64 WEST OF THE 6TH P.M COUNTY OF EL PASO, STATE OF COLORADO

CONTACTS:

DEVELOPER:
WINSOME, LLC
1864 WOODMOOR DRIVE, SUITE 100
MONUMENT, CO 80132
TEL: (719) 476-0800
CONTACT: JOE DESJARDIN

PLANNER/LANDSCAPE ARCHITECT:
NES, INC
619 N CASCADE AVENUE, SUITE 200
COLORADO SPRINGS, CO 80903
TEL: (719) 471-0073
EMAIL: ABARLOW@NESCOLORADO.COM
CONTACT: ANDREA BARLOW

ENGINEER:
KIMLEY-HORN AND ASSOCIATES, INC.
2 NORTH NEVADA, SUITE 300
COLORADO SPRINGS, CO 80903
(719) 453-0180
EMAIL:
KEVIN.KOFFORD@KIMLEY-HORN.COM
CONTACT: KEVIN KOFFORD

SURVEY:
EDWARD JAMES SURVEYING, INC.
926 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
TEL: (719) 576-1216
CONTACT: JONATHAN TESSIN

EL PASO COUNTY PLANNING DEPARTMENT
2880 INTERNATIONAL CIRCLE, SUITE 110
COLORADO SPRINGS, CO 80910

PLANNING REVIEWER:
RYAN HOWSER
TEL: (719) 520-6313
EMAIL: RYANHOWSER@ELPASOCO.COM

ENGINEERING REVIEWER:
GILBERT LAFORCE
TEL: (719) 520-7945
EMAIL:
GILBERTLAFORCE@ELPASOCO.COM

EPC DPW STORMWATER TEAM:
CHRISTINA FURCHAK
(719) 433-4863
EMAIL:
CHRISTINAFURCHAK@ELPASOCO.COM

EPC PCD INSPECTIONS SUPERVISOR:
TEM: BRAD WALTERS
(719) 520-6819
EMAIL:BRADWALTERS@ELPASOCO.COM

FALCON FIRE DEPARTMENT:
AREA: FAL D2
FIRE CHIEF T. HARWIG
7030 OLD MERIDIAN ROAD
PAYTON, CO 80831
TEL: (719) 495-4050
EMAIL:
FALCONFIRE@FALCONFIREPD.ORG

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT:
WATER QUALITY CONTROL DIVISION
4300 CHERRY CREEK DRIVE SOUTH
DENVER, CO 80246
TEL: (303) 692-3500

LEGAL DESCRIPTION

TRACT OF LAND BEING A PORTION OF THE SOUTHEAST QUARTER OF SECTION 13, AND A PORTION OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH PRINCIPAL MERIDIAN, COUNTY OF EL PASO, STATE OF COLORADO, BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE WEST QUARTER CORNER OF SAID SECTION 24, SAID POINT BEING THE POINT OF BEGINNING; THENCE N00°14'25"E ON THE WEST LINE OF THE NORTHWEST QUARTER OF SAID SECTION 24, SAID LINE ALSO BEING ON THE WEST BOUNDARY OF PARCEL 4, AS RECORDED UNDER RECEPTION NUMBER 218900072, A DISTANCE OF 2,636.99 FEET TO THE NORTHWEST CORNER OF SAID SECTION 24; THENCE N89°21'38"E ON THE NORTH LINE OF THE NORTHWEST QUARTER OF SAID SECTION 24, A DISTANCE OF 2,633.02 FEET TO THE NORTH QUARTER CORNER OF SAID SECTION 24; THENCE N00°10'29"E ON THE WEST LINE OF THE SOUTH HALF OF THE SOUTH EAST QUARTER OF SECTION 13, TOWNSHIP 11 SOUTH, RANGE 65 WEST, A DISTANCE OF 1,321.95 FEET TO THE NORTHWEST CORNER OF THE SOUTH HALF OF THE SOUTHEAST QUARTER OF SAID SECTION 13; THENCE N89°20'26"E ON THE NORTH LINE OF THE SOUTH HALF OF THE SOUTHEAST QUARTER OF SAID SECTION 13, A DISTANCE OF 1,873.37 FEET; THENCE S00°34'43"W, A DISTANCE OF 2,706.21 FEET; THENCE S89°15'17"E, A DISTANCE OF 155.82 FEET; THENCE S00°17'06"W, A DISTANCE OF 239.06 FEET; THENCE N89°42'54"W, A DISTANCE OF 609.60 FEET TO A POINT ON CURVE; THENCE ON THE ARC OF A CURVE TO THE LEFT, WHOSE CENTER BEARS N85°44'53"W, HAVING A DELTA OF 05°13'06", A RADIUS OF 1,710.00 FEET, A DISTANCE OF 155.74 FEET TO A POINT ON CURVE; THENCE S89°02'00"W, A DISTANCE OF 60.00 FEET; S89°29'13"W, A DISTANCE OF 722.44 FEET; THENCE S15°45'23"W, A DISTANCE OF 1,195.74 FEET; THENCE N82°21'05"W, A DISTANCE OF 229.91 FEET; THENCE N89°29'30"W, A DISTANCE OF 757.49 FEET; THENCE S20°46'13"W, A DISTANCE OF 758.90 FEET TO A POINT ON CURVE; THENCE ON THE ARC OF A CURVE TO THE LEFT, WHOSE CENTER BEARS N22°56'03"E, HAVING A DELTA OF 03°42'28", A RADIUS OF 1,470.00 FEET, A DISTANCE OF 95.13 FEET TO A POINT ON CURVE; THENCE S19°13'35"W, A DISTANCE OF 60.00 FEET; THENCE S18°06'10"W, A DISTANCE OF 383.72 FEET TO A POINT OF CURVE; THENCE ON THE ARC OF A CURVE TO THE RIGHT, HAVING A DELTA OF 02°06'44", A RADIUS OF 1,790.00 FEET, A DISTANCE OF 65.99 FEET TO A POINT ON CURVE; THENCE N69°47'06"W, A DISTANCE OF 306.30 FEET; THENCE N89°45'39"W, A DISTANCE OF 128.26 FEET; THENCE S29°41'56"W, A DISTANCE OF 768.98 FEET; THENCE N89°41'23"W, A DISTANCE OF 820.25 FEET TO A POINT ON THE WEST LINE OF THE SOUTHWEST QUARTER OF SAID SECTION 24; THENCE N00°14'17"E ON THE WEST LINE OF SOUTHWEST QUARTER OF SAID SECTION 24 A DISTANCE OF 1,684.27 FEET TO THE POINT OF BEGINNING.

CONTAINING A CALCULATED AREA OF 15,222,954 SQUARE FEET OR 349.471 ACRES.

BENCHMARK

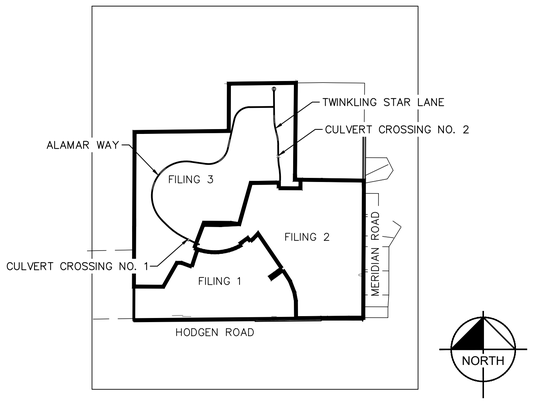
A 2.5" ALUMINUM CAP BEING A 30 FOOT WITNESS CORNER NORTH OF THE SOUTHWEST CORNER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6TH PRINCIPAL MERIDIAN.

BASIS OF BEARING

THE WEST LINE OF THE NORTHWEST QUARTER OF SECTION 24, TOWNSHIP 11 SOUTH, RANGE 65 WEST OF THE 6 PRINCIPAL MERIDIAN MONUMENTED ON THE SOUTHERLY END BY A 2-1/2" ALUMINUM CAP STAMPED "LS 28658" AND AT THE NORTHERLY END BY A 3-1/2" ALUMINUM CAP STAMPED "LS 12103" BEING ASSUMED TO BEAR N00°14'25"E A DISTANCE OF 2636.99 FEET AS SHOWN IN LAND SURVEY PLAT RECORDED UNDER RECEPTION 218900072 RECORDS OF EL PASO COUNTY, COLORADO.

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

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



VICINITY MAP
1"=2,000'

FLOODPLAIN NOTE

FEDERAL EMERGENCY MANAGEMENT AGENCY, FLOOD INSURANCE RATE MAP, MAP NUMBER 08041C0350G, EFFECTIVE DECEMBER 7, 2018 INDICATES THE AREA IN THE VICINITY OF THIS PARCEL OF LAND TO BE IN ZONE X (AREA DETERMINED TO BE OUT OF THE 500 YEAR FLOODPLAIN). A CONDITIONAL LETTER OF MAP REVISION HAS BEEN PROCESSED AND APPROVED FOR THIS REACH OF WEST KIOWA CREEK.

LEGEND

- LOT BOUNDARY LINE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- EFFECTIVE 100 YEAR FLOODPLAIN
- PROPOSED 100 YEAR FLOODPLAIN PER CLOMR
- DELINEATED WETLAND
- UTILITY EASEMENT
- R.O.W. LINE
- EDGE OF PAVEMENT

SEQUENCE NOTES:

THIS PLANS TO BE CONSTRUCTED WITH THE FOLLOWING:

- GRADING TO BE INCLUDED BY PCD NO. EGP215 (WINSOME FILING NO. 3 EARLY GRADING PERMIT)
- ROADWAY CONSTRUCTION TO INCLUDED BY PCD NO. VR222 (WINSOME FILING NO. 3 FINAL PLAT)

SHEET INDEX:

OWNER'S STATEMENT

I, THE OWNER/DEVELOPER HAVE READ AND WILL COMPLY WITH THE REQUIREMENTS OF THE GRADING AND EROSION CONTROL PLAN AND ALL OF THE SPECIFIED IN THESE DETAILED PLANS AND SPECIFICATIONS.

OWNER SIGNATURE DATE

JOE DESJARDIN, DIRECTOR OF ENTITLEMENTS
WINSOME, LLC
1864 WOODMOOR DRIVE, SUITE 100
MONUMENT, CO 80132

ENGINEER'S STATEMENT

THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE CRITERIA ESTABLISHED BY THE COUNTY FOR DETAILED ROADWAY, DRAINAGE, GRADING AND EROSION CONTROL PLANS AND SPECIFICATIONS, AND SAID PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH APPLICABLE MASTER DRAINAGE PLANS AND MASTER TRANSPORTATION PLANS. SAID PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE PARTICULAR ROADWAY AND DRAINAGE FACILITIES ARE DESIGNED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF. I ACCEPT RESPONSIBILITY FOR ANY LIABILITY CAUSED BY ANY NEGLIGENT ACTS, ERRORS OR OMISSIONS ON MY PART IN PREPARATION OF THESE DETAILED PLANS AND SPECIFICATIONS.

COLORADO LICENSED KEVIN KOFFORD 57234 PROFESSIONAL ENGINEER

8/31/2022
KEVIN KOFFORD, PE (CO #57234) – KIMLEY-HORN AND ASSOCIATES, INC. DATE

EL PASO COUNTY

COUNTY PLAN REVIEW IS PROVIDED ONLY FOR GENERAL CONFORMANCE WITH COUNTY DESIGN CRITERIA. THE COUNTY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, DIMENSIONS, AND/OR ELEVATIONS WHICH SHALL BE CONFIRMED AT THE JOB SITE. THE COUNTY THROUGH THE APPROVAL OF THIS DOCUMENT ASSUMES NO RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT. FILED IN ACCORDANCE WITH THE REQUIREMENTS OF THE EL PASO COUNTY LAND DEVELOPMENT CODE, DRAINAGE CRITERIA MANUAL VOLUMES 1 AND 2, AND ENGINEERING CRITERIA MANUAL, AS AMENDED.

IN ACCORDANCE WITH ECM SECTION 1.12, THESE CONSTRUCTION DOCUMENTS WILL BE VALID FOR CONSTRUCTION FOR A PERIOD OF 2 YEARS FROM THE DATE SIGNED BY THE EL PASO COUNTY ENGINEER. IF CONSTRUCTION HAS NOT STARTED WITHIN THOSE 2 YEARS, THE PLANS WILL NEED TO BE RESUBMITTED FOR APPROVAL, INCLUDING PAYMENT OF REVIEW FEES AT THE PLANNING AND COMMUNITY DEVELOPMENT DIRECTOR'S DISCRETION.

JOSHUA PALMER, PE INTERIM COUNTY ENGINEER/ECM ADMINISTRATOR DATE

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

Kimley»Horn
2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
COVER SHEET

COLORADO LICENSED KEVIN KOFFORD 57234 PROFESSIONAL ENGINEER 8/31/2022

PROJECT NO.
196106001

SHEET
1

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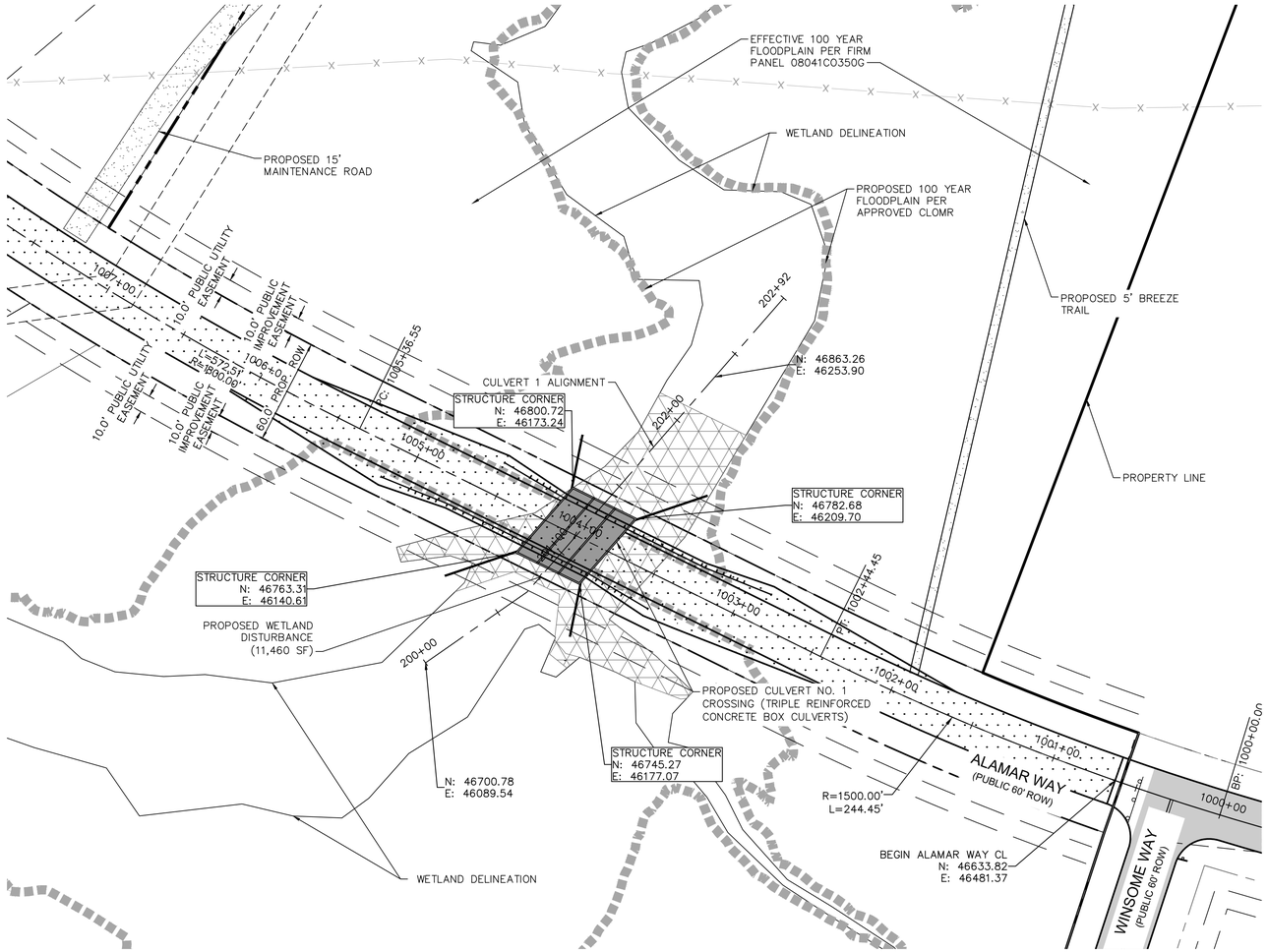
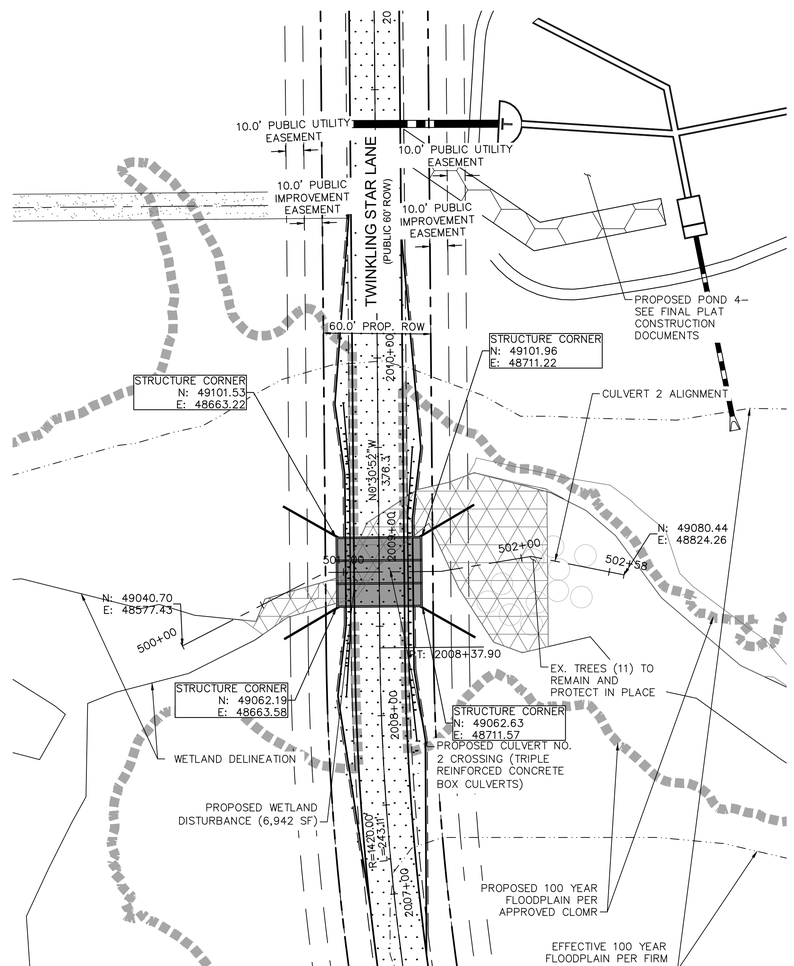


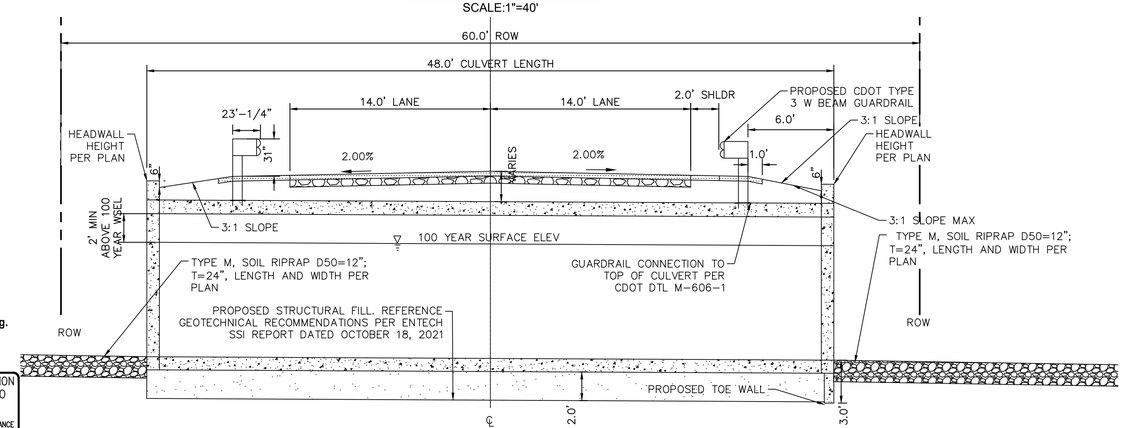


GRAPHIC SCALE IN FEET
0 20 40 80

NORTH

CULVERT CROSSING NO. 2
SCALE: 1"=40'

CULVERT CROSSING NO. 1
SCALE:1"=40'



RURAL LOCAL ROADWAY – TYPICAL CULVERT CROSSING
SCALE: 1" =5'

GRAPHIC SCALE IN FEET
0 20 40 80

NORTH

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

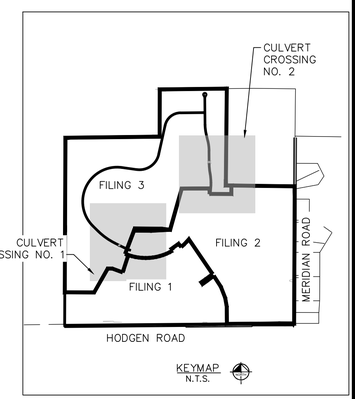
CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

NOTES

1. ROADWAY LAYOUT IS FOR REFERENCE ONLY. REFERENCE WINSOME FILING NO. 3 CONSTRUCTION DOCUMENTS FOR ROADWAY PLAN AND PROFILES
2. GUARDRAIL WILL BE INSTALLED WITH INSTALLATION OF THE REINFORCED CONCRETE BOX CULVERTS AND THIS PLAN. REFERENCE SHEETS 3 – 4. FOR GUARDRAIL DETAILS

LEGEND

	PROPERTY LINE
5430	EXISTING MAJOR CONTOUR
5431	EXISTING MINOR CONTOUR
5430	PROPOSED MAJOR CONTOUR
5431	PROPOSED MINOR CONTOUR
	WETLAND DELINEATION BOUNDARY
	PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR
	EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G
	WETLAND DISTURBANCE AREA



PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

Kimley»Horn
2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
HORIZONTAL CONTROL

COLORADO LICENSED KEVIN REX KOFFORD 57234 8/31/2022 PROFESSIONAL ENGINEER

PROJECT NO. 196106001

SHEET 2

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LEGEND

- PROPERTY LINE
- 5430 — EXISTING MAJOR CONTOUR
- 5431 — EXISTING MINOR CONTOUR
- **5430** — PROPOSED MAJOR CONTOUR
- 5431 — PROPOSED MINOR CONTOUR
- WETLAND DELINEATION BOUNDARY
- PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR
- EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G
- PROPOSED 100 YR WATER SURFACE ELEVATION (WSEL)
- PROPOSED RIPRAP

PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR

END END ANCHORAGE STA:1005+12.90 OFF:19.00'LT

BREAKPOINT STA:1005+12.89 OFF: 24.92'LT

100 YEAR WSEL: 7325.49

BEGIN END ANCHORAGE STA:1004+72.92 OFF:16.00'LT

WETLAND DELINEATION

TYPE M, SOIL RIPRAP D50=12"; T=24". EXTEND RIPRAP TO 7326.49' TO PROVIDE 1' OF FREEBOARD. REFERENCE RIPRAP DETAIL ON SHEET 10. (570 SY)

PROPOSED TYPE 3 W-BEAM (31 INCHES) PER CDOT STANDARD DETAIL M-606-1

60.0' ROW

PC: 1005+36.55

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

END END ANCHORAGE STA:1004+53.52 OFF:19.00'RT

BREAKPOINT STA:1004+53.50 OFF: 24.92'RT

BEGIN END ANCHORAGE STA:1004+13.88 OFF:16.00'RT

100 YEAR WSEL: 7321.50

70'X ~100' TYPE M, SOIL RIPRAP D50=12"; T=24". EXTEND RIPRAP TO 7322.50' TO PROVIDE 1' OF FREEBOARD. REFERENCE RIPRAP DETAIL ON SHEET 10. (644 SY)

EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G

WETLAND DELINEATION

DIRECTION OF FLOW

75.2° SKEW

CULVERT 1 ALIGNMENT

PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR

END END ANCHORAGE STA:1003+84.71 OFF:16.00'LT

BREAKPOINT STA:1003+45.07 OFF: 24.92'LT

BEGIN END ANCHORAGE STA:1003+45.04 OFF:19.00'LT

GRADE IN SWALE AROUND THE WINGWALL TO PROVIDE POSITIVE DRAINAGE

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

ALAMAR WAY (PUBLIC 60' ROW)

PROPOSED TYPE 3 W- BEAM (31 INCHES) PER CDOT STANDARD DETAIL M-606-1

END END ANCHORAGE STA:1003+25.42 OFF:16.00'RT

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

BREAKPOINT STA:1002+85.67 OFF: 24.92'RT

BEGIN END ANCHORAGE STA:1002+85.64 OFF:19.00'RT

PT: 1002+44.45

EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G

CULVERT CROSSING NO. 1

FILING 3

FILING 2

FILING 1

MERIDIAN ROAD

HODGEN ROAD

KEYMAP N.T.S.

NORTH

GRAPHIC SCALE IN FEET
0 10 20 40

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

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

CULVERT CROSSING NO. 1
SCALE:1"=20'

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

Kimley»Horn
2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
CULVERT 1-SITE PLAN

COLORADO LICENSED KEVIN REX KOFFORD 57234 8/31/2022 PROFESSIONAL ENGINEER

PROJECT NO. 196106001

SHEET 3

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_SP-Exhibit.dwg Kofford, Kevin 8/31/2022 8:23 AM

LEGEND

- PROPERTY LINE
- EXISTING MAJOR CONTOUR (5430)
- EXISTING MINOR CONTOUR (5431)
- PROPOSED MAJOR CONTOUR (5430)
- PROPOSED MINOR CONTOUR (5431)
- WETLAND DELINEATION BOUNDARY
- PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR
- EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G
- PROPOSED 100 YR WATER SURFACE ELEVATION (WSEL)
- PROPOSED RIPRAP

POND 4

END END ANCHORAGE
STA: 2009+74.43
OFF: 19.00'LT

BREAKPOINT
STA: 2009+74.41
OFF: 24.92'LT

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

100 YEAR WSEL=7287.56

BEGIN END ANCHORAGE
STA: 2009+34.78
OFF: 16.00'LT

TYPE M, SOIL RIPRAP D50=12"; T=24". EXTEND RIPRAP TO 7288.56' TO PROVIDE 1' OF FREEBOARD. REFERENCE RIPRAP DETAIL ON SHEET 10. (521 SY)

PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR MODEL

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

END END ANCHORAGE
STA: 2009+49.43
OFF: 19.00'RT

BREAKPOINT
STA: 2009+49.41
OFF: 24.92'RT

BEGIN END ANCHORAGE
STA: 2009+09.96
OFF: 16.00'RT

PROPOSED TYPE 3 W- BEAM (31 INCHES) PER CDOT STANDARD DETAIL M-606-1

70' X ~88'
TYPE M, SOIL RIPRAP D50=12"; T=24". EXTEND RIPRAP TO 7284.24 TO PROVIDE 1' OF FREEBOARD. REFERENCE RIPRAP DETAIL ON SHEET 10
(925 SY)

EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G

100 YEAR WSEL=7283.24

CULVERT 2 ALIGNMENT

4:1 SLOPE WITH EMBANKMENT/SCOUR PROTECTION SOIL PROTECTION TYPE M, RIPRAP D50=12"; T=24". REFERENCE RIPRAP DETAIL ON SHEET 10. REFERENCE DRAINAGE REPORT FOR CALCULATIONS
(479 SY)

DIRECTION OF FLOW

WETLAND DELINEATION

PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR MODEL

END END ANCHORAGE
STA: 2008+50.81
OFF: 16.00'LT

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

BREAKPOINT
STA: 2008+11.77
OFF: 24.92'LT

BEGIN END ANCHORAGE
STA: 2008+11.67
OFF: 19.00'LT

PROPOSED TYPE 3 W- BEAM (31 INCHES) PER CDOT STANDARD DETAIL M-606-1

END END ANCHORAGE
STA: 2008+25.58
OFF: 16.00'RT

PROPOSED MFLEAT END ANCHORAGE PER STANDARD DETAIL M-606-1

BREAKPOINT
STA: 2007+85.46
OFF: 25.03'RT

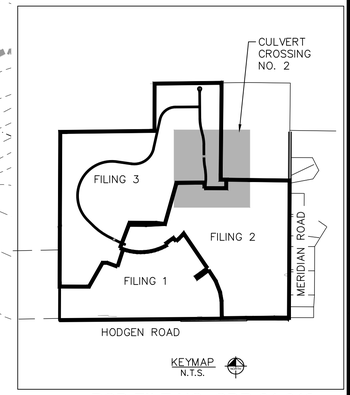
BEGIN END ANCHORAGE
STA: 2007+85.61
OFF: 19.00'RT

60.0' ROW

TWINKLING STAR LANE
(PUBLIC 60' ROW)

EFFECTIVE 100 YEAR FLOODPLAIN PER FIRM PANEL 08041C0350G

PROPOSED 100 YEAR FLOODPLAIN PER APPROVED CLOMR MODEL



NORTH

GRAPHIC SCALE IN FEET
0 10 20 40

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CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES

CULVERT CROSSING NO. 2
SCALE: 1"=20'

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
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CHECKED BY: KRK
DATE: 9/3/2021

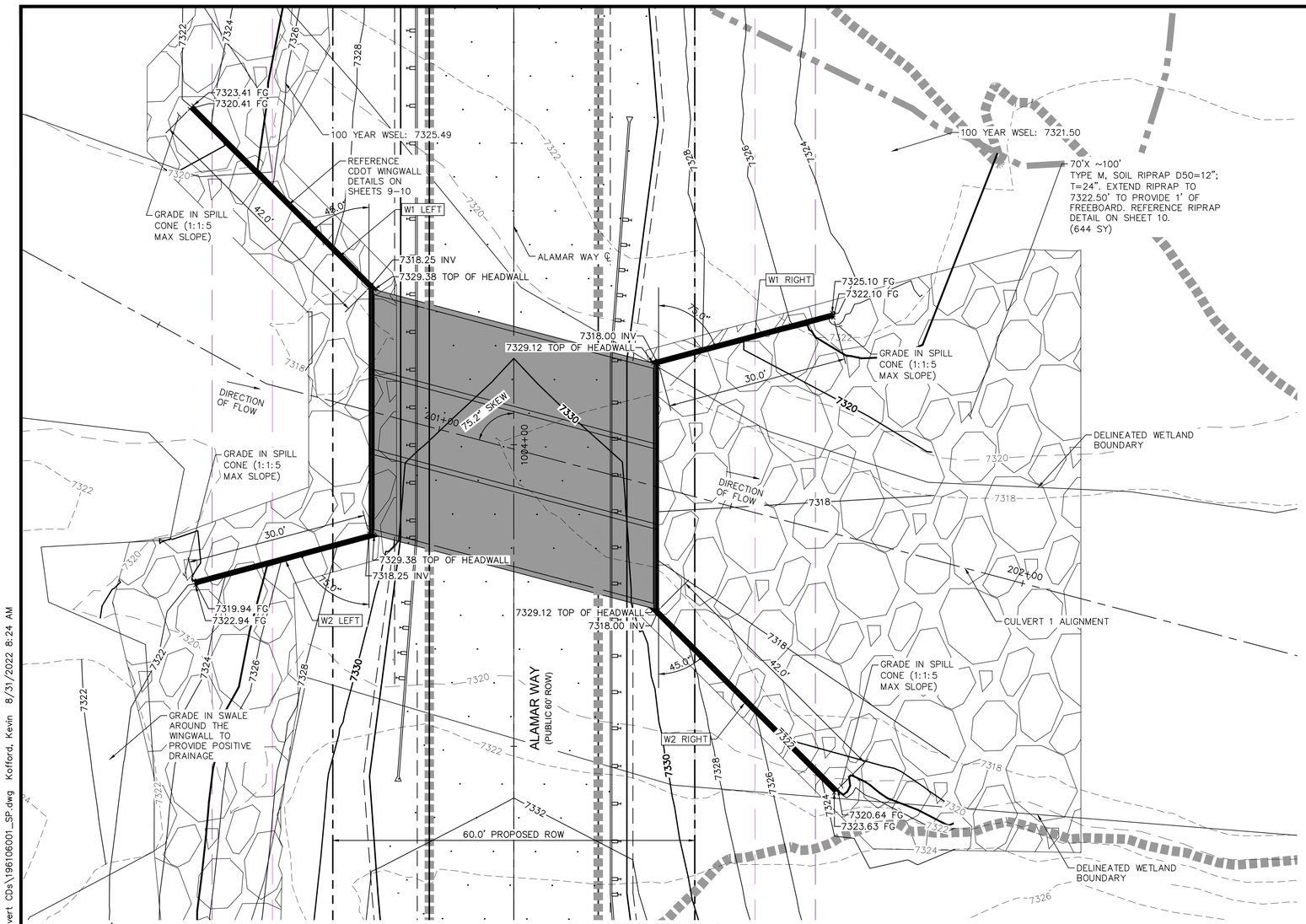
WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
CULVERT 2-SITE PLAN

COLORADO LICENSED
KEVIN REX KOFFORD
57236
8/31/2022
PROFESSIONAL ENGINEER

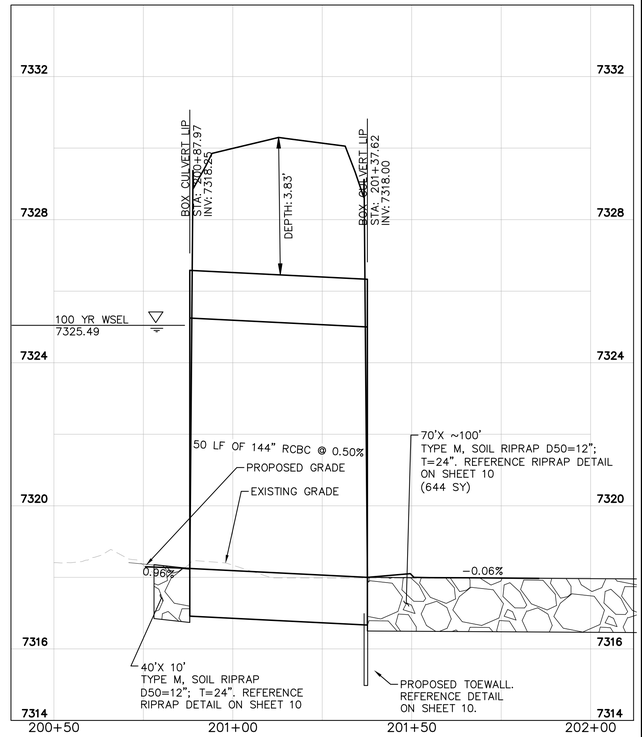
PROJECT NO.
196106001

SHEET
4

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_SP-Exhibit.dwg Kofford, Kevin 8/31/2022 8:23 AM



CULVERT CROSSING NO. 1
SCALE:1"=10'



GRAPHIC SCALE IN FEET
0 10 20 40
HORIZONTAL
0 1 2 4
VERTICAL

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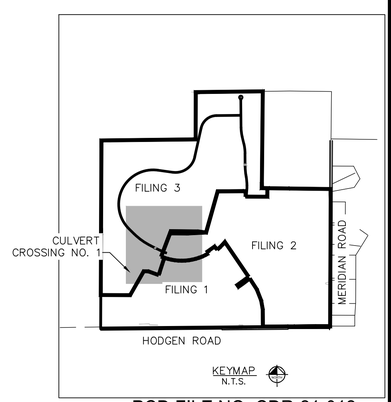
WINGWALL DIMENSION SUMMARY

LOCATION	h (FT)*	k (FT)	LENGTH (FT)	m**	θ (DEG)
W1 RIGHT	12'-0 1/2"	3	30	10'- 7 ½ "	75
W2 RIGHT	12'-0 1/2"	3	42	10'- 7 ½ "	45
W1 LEFT	12'-0 1/2"	3	42	10'- 7 ½ "	45
W2 LEFT	12'-0 1/2"	3	30	10'- 7 ½ "	75

*HEIGHT IS FROM BOTTOM OF SLAB TO TOP OF MODIFIED HEADWALL PER DETAIL ON SHEET 10
**M IS DIFFERENT VALUE THAN STANDARD EQUATION DUE TO MODIFIED HEADWALL HEIGHT



PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
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DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS

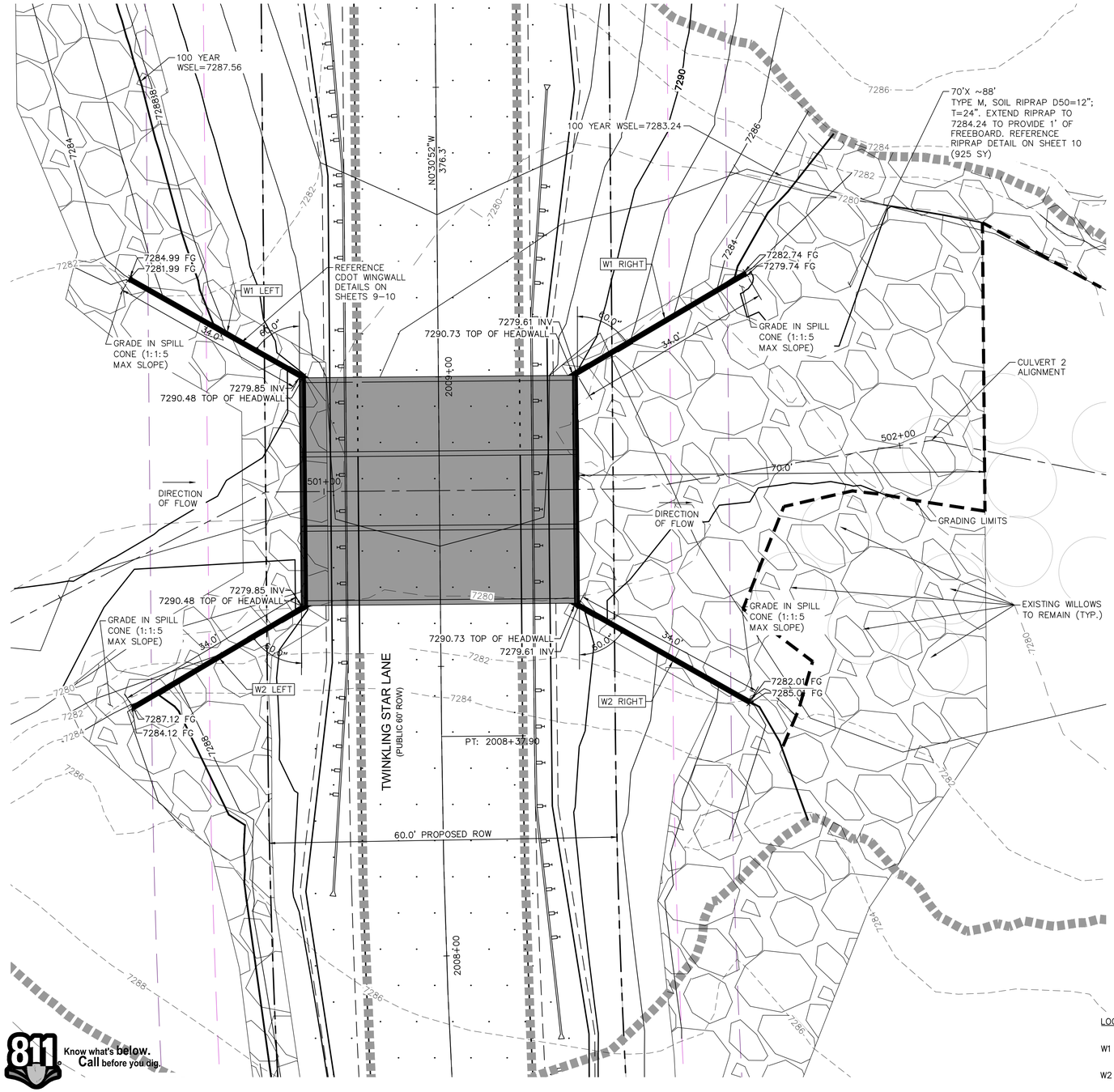
CULVERT 1-PLAN & PROFILE

COLORADO LICENSED
KEVIN REX KOFFORD
57234
8/31/2022
PROFESSIONAL ENGINEER

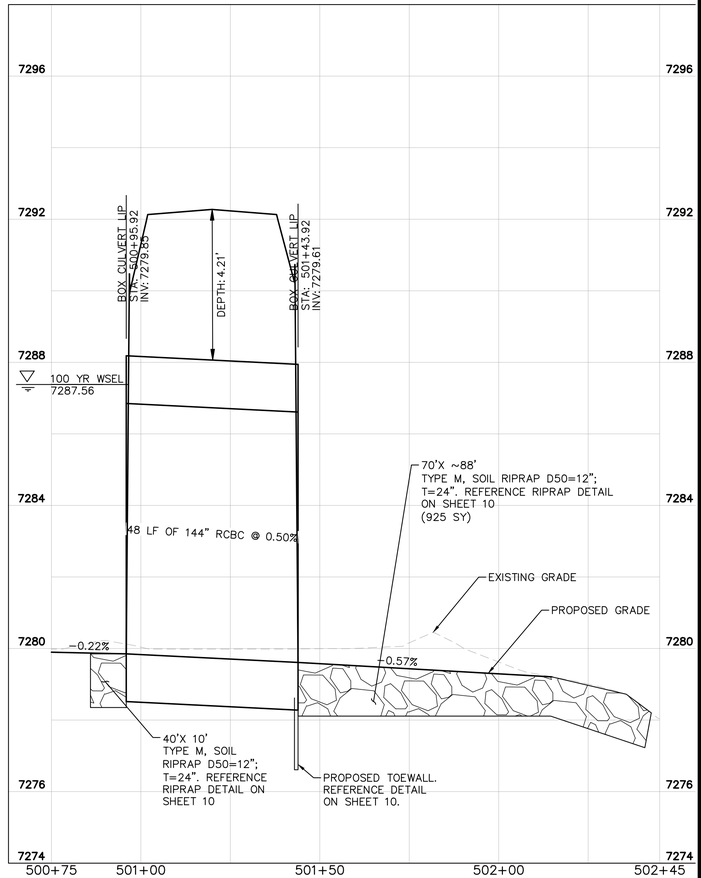
PROJECT NO.
196106001

SHEET
5

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_SP.dwg Kofford, Kevin 8/31/2022 8:24 AM



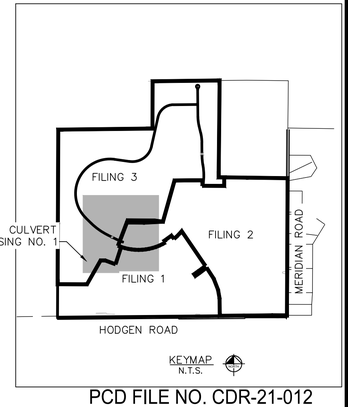
CULVERT CROSSING NO. 2
SCALE: 1"=40'



WINGWALL DIMENSION SUMMARY

LOCATION	h (FT)*	k (FT)	LENGTH (FT)	m**	Θ (DEG)
W1 RIGHT	12'-0 1/2"	3	34	10'- 7 1/2"	60
W2 RIGHT	12'-0 1/2"	3	34	10'- 7 1/2"	60
W1 LEFT	12'-0 1/2"	3	34	10'- 7 1/2"	60
W2 LEFT	12'-0 1/2"	3	34	10'- 7 1/2"	60

*HEIGHT IS FROM BOTTOM OF SLAB TO TOP OF MODIFIED HEADWALL PER DETAIL ON SHEET 10
**M IS DIFFERENT VALUE THAN STANDARD EQUATION DUE TO MODIFIED HEADWALL HEIGHT



PCD FILE NO. CDR-21-012

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NORTH

NO.	REVISION	BY	DATE	APPR.
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DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS

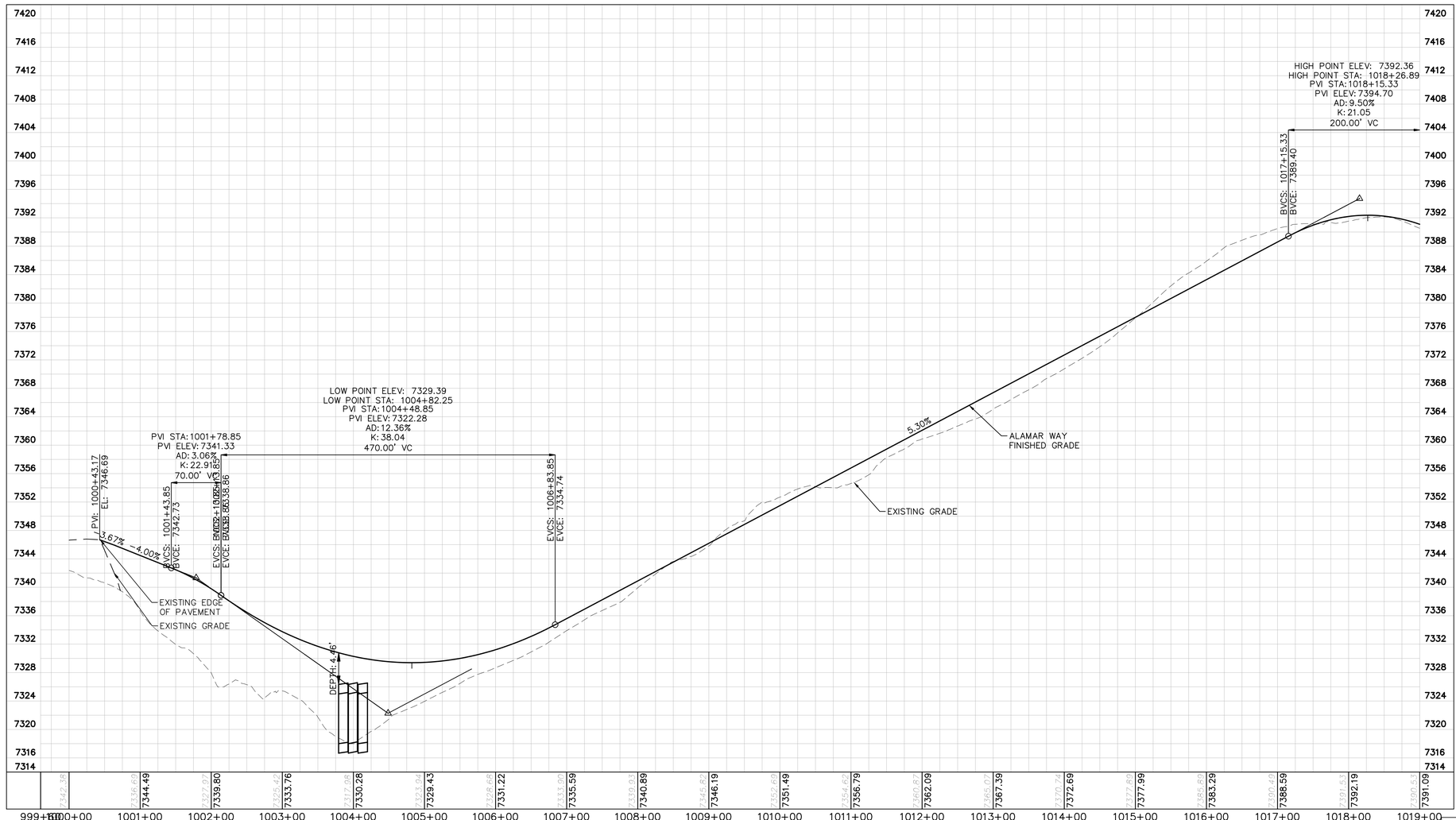
CULVERT 2-PLAN & PROFILE

COLORADO LICENSED KEVIN REX KIRKPATRICK 57234 8/31/2022 PROFESSIONAL ENGINEER

PROJECT NO. 196106001

SHEET 6

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_SP.dwg Kofford, Kevin 8/31/2022 8:24 AM



CULVERT CROSSING NO. 1- PROFILE
SCALE:1"=80'

NOTE: THIS PROFILE IS FOR REFERENCE ONLY. REFERENCE WINSOME FILING NO. 3 (SF229) FOR FULL ROADWAY PLAN AND PROFILES.

GRAPHIC SCALE IN FEET
0 40 80 160
HORIZONTAL

0 4 8 16
VERTICAL

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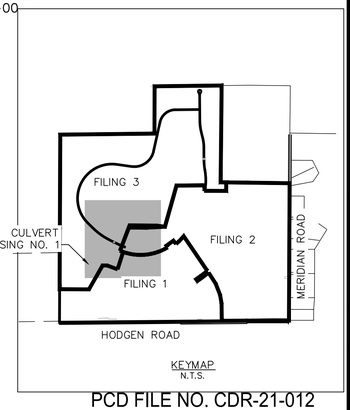

KEYMAP
N.T.S.

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
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Kimley»Horn
2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

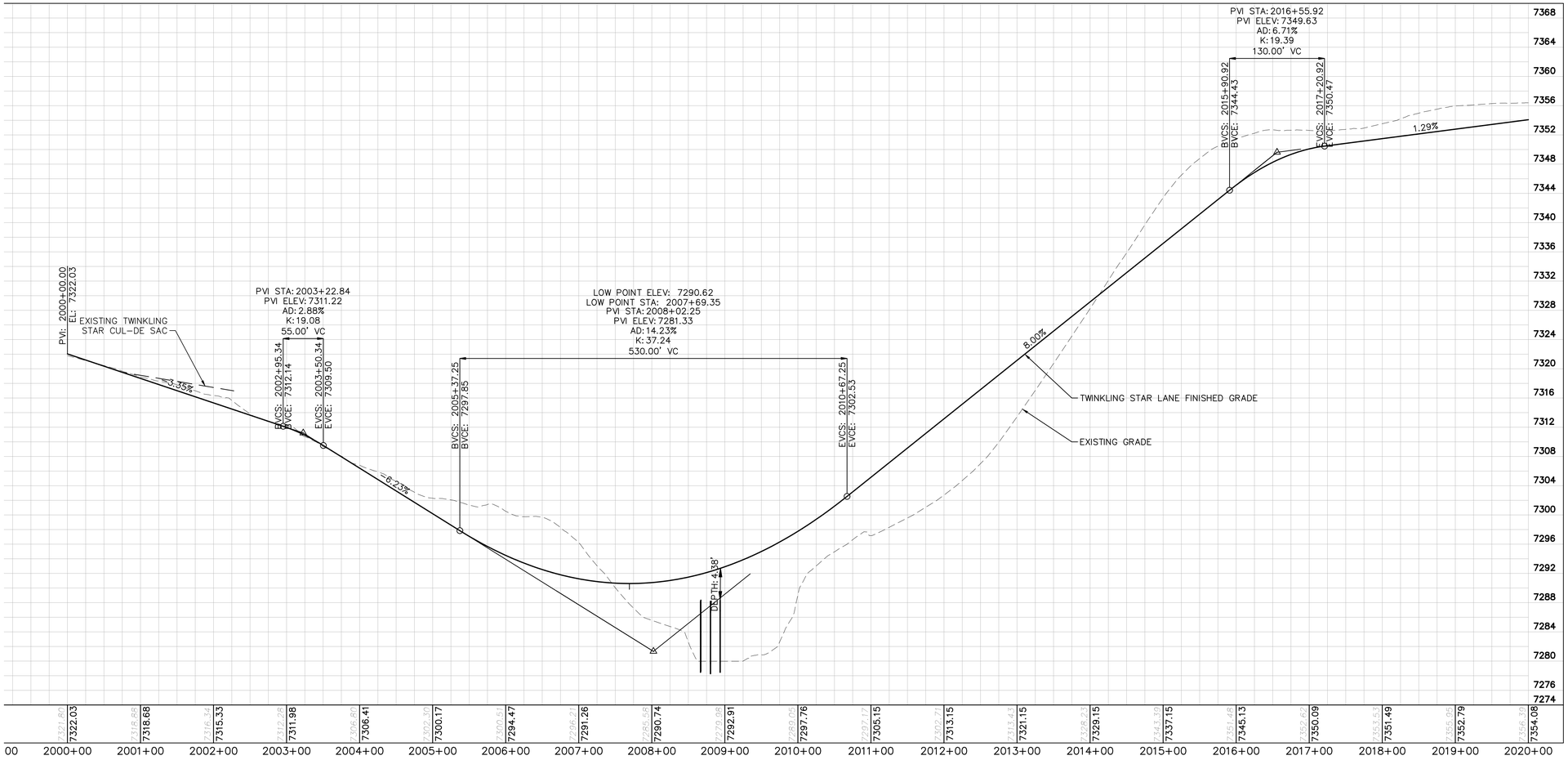
WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
ALAMAR WAY PROFILE

COLORADO LICENSED
JEFFREY REX KOFFORD
57234
8/31/2022
PROFESSIONAL ENGINEER

PROJECT NO.
196106001

SHEET
7

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_RD.dwg Kofford, Kevin 8/31/2022 8:25 AM



CULVERT CROSSING NO. 2-FILE
SCALE: 1"=80'

GRAPHIC SCALE IN FEET
0 40 80 160
HORIZONTAL

0 4 8 16
VERTICAL

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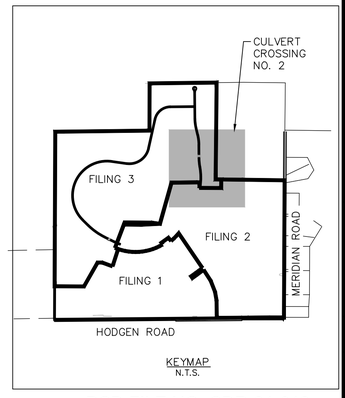
NOTE: THIS PROFILE IS FOR REFERENCE ONLY. REFERENCE WINSOME FILING NO. 3 (SF229) FOR FULL ROADWAY PLAN AND PROFILES.



KEYMAP
N.T.S.

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
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DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS

TWINKLING STAR LANE PROFILE

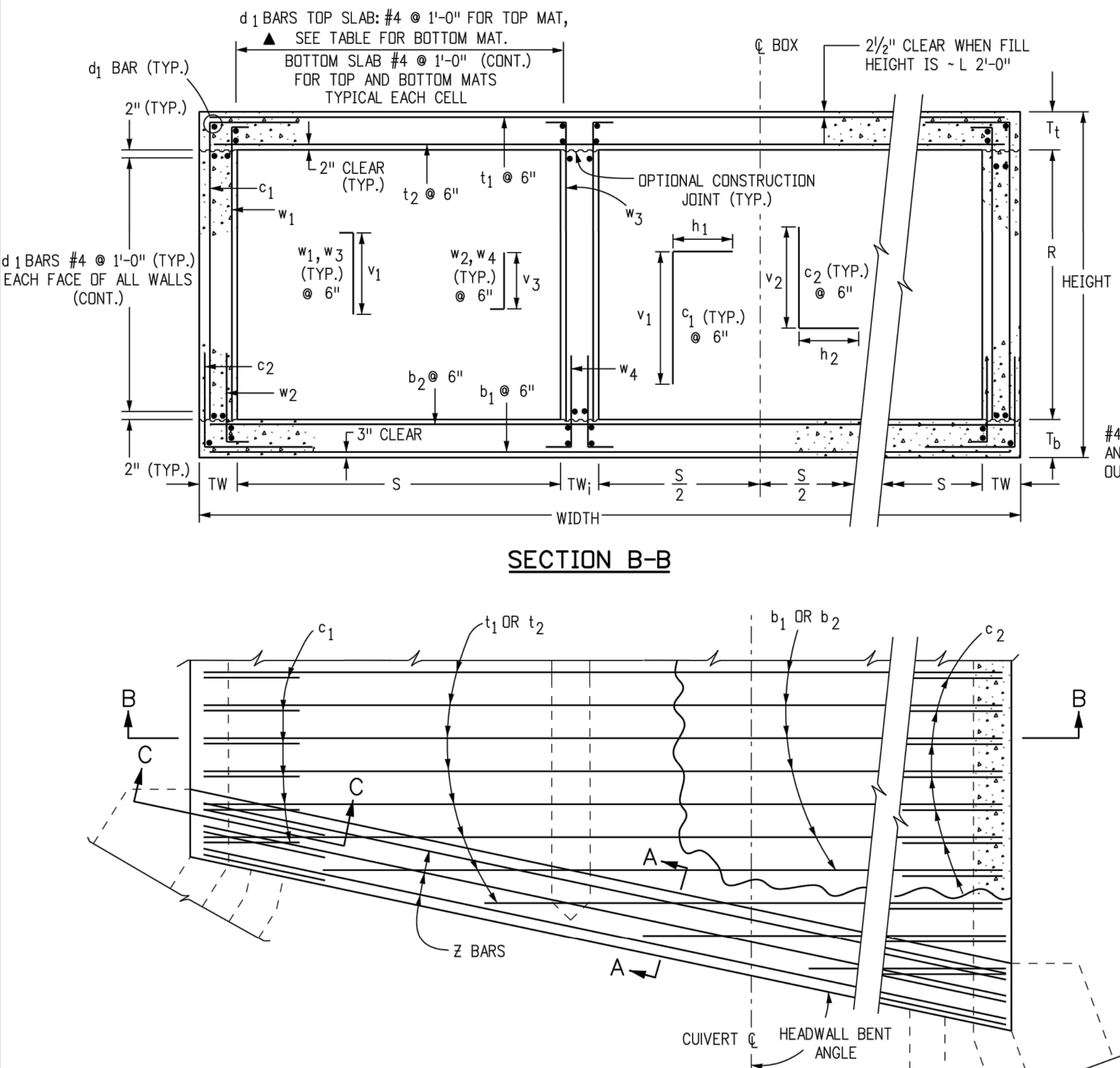
COLORADO LICENSED
KEVIN REX KOFFORD
57234
8/31/2022
PROFESSIONAL ENGINEER

PROJECT NO.
196106001

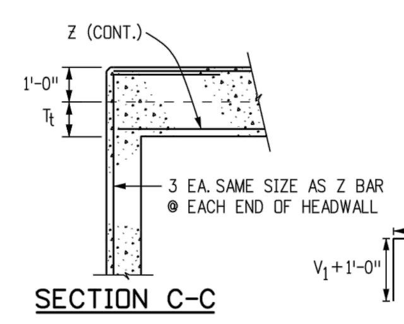
SHEET
8

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_RD.dwg Kofford, Kevin 8/31/2022 8:25 AM

REFERENCE MODIFIED HEADWALL DETAIL ON SHEET 10



SECTION B-B

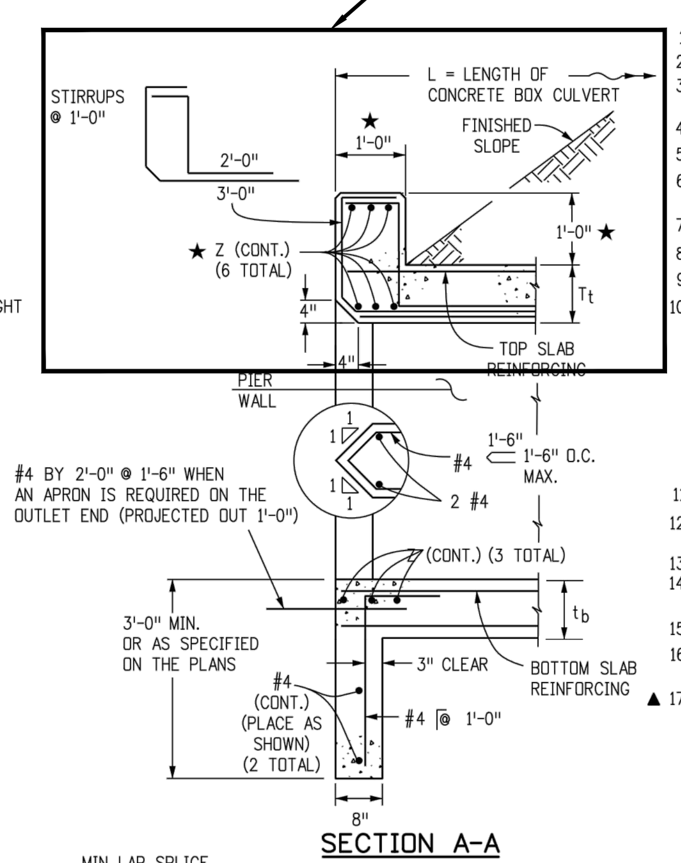


SECTION C-C

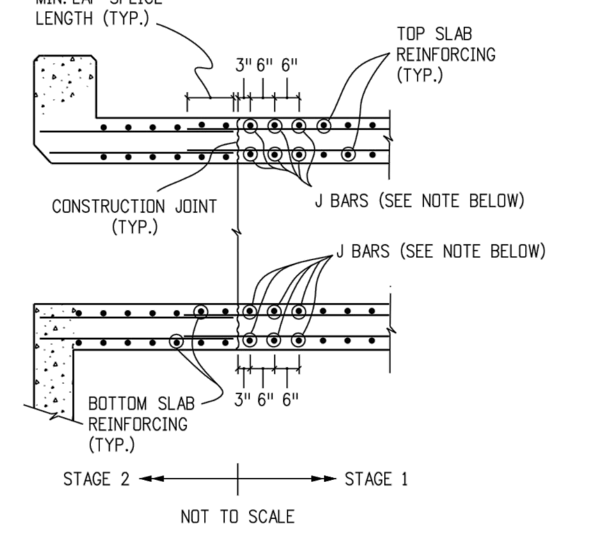
HEADWALL CORNER REINFORCING DETAIL

REINFORCING PLAN

BAR SIZE (#)	EPOXY X (FT.-IN.)	BLACK X (FT.-IN.)
4	2-4	1-11
5	2-10	2-4
6	3-5	2-10
7	4-1	3-3
8	5-3	4-3
9	6-8	5-5



SECTION A-A



CONSTRUCTION JOINT DETAIL FOR STAGED CONSTRUCTION

NOTE: THIS DETAIL IS FOR CONSTRUCTION JOINTS INSTALLED PERPENDICULAR TO THE ℄ OF THE BOX ONLY. THE CONTRACTOR CAN DESIGN AND INSTALL J BARS AT HIS EXPENSE TO SUPPORT TEMPORARY LIVE LOADS DURING STAGE 1 CONSTRUCTION. J BARS SHALL BE THE SAME SIZE AS THE TOP AND BOTTOM SLAB REINFORCING WHEN THERE ARE NO TEMPORARY LIVE LOADS TO SUPPORT.

GENERAL NOTES

1. ALL CONCRETE SHALL BE CLASS D (BOX CULVERT).
2. ALL CONSTRUCTION JOINTS SHALL BE THOROUGHLY CLEANED BEFORE FRESH CONCRETE IS PLACED.
3. ALL CONSTRUCTION JOINTS NOT SHOWN ON THE PLANS SHALL BE CONSTRUCTED ONLY IF APPROVED BY THE ENGINEER.
4. THE CONTRACTOR SHALL MAINTAIN THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION.
5. STRUCTURE EXCAVATION AND BACKFILL SHALL BE IN ACCORDANCE WITH STANDARD PLAN M-206-1.
6. FOR ANY CULVERT SPAN 20 FT. OR GREATER, A FOUNDATION INVESTIGATION AND REPORT ARE REQUIRED.
7. BACKFILL SHALL NOT BEGIN UNTIL TOP SLAB HAS REACHED DESIGN STRENGTH, f'c.
8. SPLICE QUANTITIES FOR LONGITUDINAL AND TRANSVERSE BARS ARE NOT INCLUDED.
9. REINFORCING STEEL SHALL BE GRADE 60.
10. THE MINIMUM LAP SPLICE LENGTH FOR EPOXY COATED REINFORCING BARS SHALL BE:

BAR SIZE:	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH:	1'-3"	1'-7"	2'-5"	2'-10"	3'-8"	4'-8"	5'-11"	7'-3"

THE MINIMUM LAP SPLICE LENGTH FOR BLACK REINFORCING BARS SHALL BE:

BAR SIZE:	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH:	1'-1"	1'-4"	1'-7"	1'-11"	2'-6"	3'-1"	3'-11"	4'-10"

THE ABOVE SPLICE LENGTHS ARE FOR CLASS B SPLICES.

11. ALL DIMENSIONS ARE PERPENDICULAR TO THE CENTERLINE OF THE BOX.
12. WINGWALLS SHALL BE TIED TO CONCRETE BOX CULVERT IN ACCORDANCE WITH STANDARD PLAN M-601-20.
13. ALL TRANSVERSE REINFORCING SHALL BE NORMAL TO THE CENTERLINE OF THE BOX.
14. THE FILL HEIGHT IS THE DISTANCE MEASURED FROM THE TOP OF THE TOP SLAB TO THE TOP OF PAVEMENT.
15. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾ IN.
16. FOR FILL HIEGHTS LESS THAN 2 FT, A WATERPROOFING MEMBRANE SHALL BE PROVIDED FOR THE TOP OF THE TOP SLAB AND 18" DOWN ALONG THE TOPS OF THE EXTERIOR WALLS.

▲ 17. FOR FILL HIEGHTS LESS THAN 2 FT. THE d_1 BARS FOR THE BOTTOM MAT OF THE TOP SLAB SHALL BE AS FOLLOWS:

S	8, 9, 10	14, 16, 18	20
BAR SIZE:	#5	#6	#7
SPACING	1'-0"	1'-0"	1'-0"

DESIGN DATA: 7TH EDITION, 2014, OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

RATING DATA: 2ND EDITION, 2011, OF THE AASHTO MANUAL FOR BRIDGE EVALUATION

LOADING DATA: f_y = 60,000 psi., f'_c = 4,500 psi.,

LIVE LOAD = AASHTO LRFD, HL-93 TRUCK, HL-93 TANDEM, COLORADO PERMIT TRUCK AND NRL

DEAD LOAD CASE 1: VERTICAL EARTH LOAD = 120 LBS./CU. FT. HORIZONTAL EARTH LOAD = 30 LBS./CU.FT.

DEAD LOAD CASE 2: VERTICAL EARTH LOAD = 120 LBS./CU. FT. HORIZONTAL EARTH LOAD = 60 LBS./CU. FT.

WEARING SURFACE - 12 IN. THICK CONCRETE PAVEMENT.
DEAD LOAD - TYPE 7 BARRIER.
THRUST IS NOT CONSIDERED IN THIS STANDARD, I.E. THRUST = 0.
EXTREME HEADWATER TO DEPTH RATIO IS IN ACCORDANCE WITH THE CDOT DRAINAGE MANUAL.
EXTREME HEADWATER TO DEPTH RATIO WAS INCLUDED IN THE CULVERT DESIGNS BUT EXCLUDED FROM THE RATINGS AS PER THE AASHTO MANUAL FOR BRIDGE EVALUATION.
LIVE LOAD SURCHARGE ON EXTERIOR WALLS = 2 FT. OF EARTH

★ IF HEADWALL MOUNT GUARDRAIL IS USED (SEE STANDARD PLAN M-606-1, SHEET 19 AND NOTES BELOW):
- ALL REINFORCING STEEL SHALL BE ACCORDING TO THIS BOX CULVERT PLAN.
- ANY SPECIAL DESIGN FOR STIRRUPS WILL NOT BE MEASURED AND PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK.
- HEADWALL DIMENSION AND CONCRETE QUANTITY SHALL BE ACCORDING TO STANDARD PLAN M-606-1, SHEET 19.
- POST ANCHORS SHALL BE PROVIDED ACCORDING TO STANDARD PLAN M-606-1, SHEET 19.
- POST ANCHORS AND CONCRETE FOR HEADWALL MOUNT OF GUARDRAIL WILL NOT BE MEASURED AND PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK.
- POST ANCHORS WHEN REQUIRED AND ENCASED IN HEADWALL CONCRETE, SHALL CONFORM TO ASTM A 36 OR AASHTO M 169 STEEL.

18. SEE M-603-3 FOR PRECAST CONCRETE BOX CULVERT DETAILS.

Computer File Information			Sheet Revisions	
Creation Date: 07/04/12	Initials: DDG		Date:	Comments
Last Modification Date: 04/05/19	Initials: JBE	(R-X)	08/27/13	LRFD Design
Full Path: www.codot.gov/business/designsupport		(R-X)	08/01/15	Analysis Program Updates
Drawing File Name: 601030102.dgn		(R-X)	04/05/19	Clarified this sheet is for Cast-In-Place CBC only, not for Pre-Cast CBC. Changed title and added Gen. Note 18.
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English		(R-X)		

Colorado Department of Transportation
2829 West Howard Place
CDOT HQ, 3rd Floor
Denver, CO 80204
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Division of Project Support DDG/Bridge

TRIPLE CONCRETE BOX CULVERT (CAST-IN-PLACE)

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-3

Sheet No. 1 of 2

TRIPLE CONCRETE BOX CULVERT DIMENSIONS, QUANTITIES & RATING FACTORS (EXCLUDING HEADWALL & TOEWALL QUANTITIES)

BOX SIZE S FT	BOX SIZE R FT	HT. FT-IN	WIDTH FT-IN	FILL HEIGHT ALLOWED FT-FT	T_t	T_b	TW & TW_i	t_1* #	t_2 #	b_1 #	b_2 #	w_1* & w_2 #	w_3* & w_4 #	c_1* #	c_2 #	d_1▲ NO.	h_1 FT-IN	h_2 FT-IN	v_1 FT-IN	v_2 FT-IN	v_3 FT-IN	CONCRETE CY/LF	REBAR STL LBS/LF	WATERPROOFING SY/LF	HL-93 INVENTORY	HL-93 OPERATING	COLORADO PERMIT	NRL VEHICLE
8	6	7-10.5	27-4	< 2	12.5	10	10	5	6	5	6	4	4	5	5	168	3-5	2-4	6-10	2-4	1-11	2.639	531	3.370	1.21	1.57	1.82	1.69
		7-9.5	27-4	2 TO 8	10.5	11	10	4	5	4	5	4	4	5	5	168	2-6	2-4	6-8	3-2	2-0	2.555	429		1.47	1.90	2.07	1.83
		8-0	27-4	8 TO 12	11	13	10	4	5	4	5	4	4	5	5	168	2-6	2-4	6-9	3-4	2-2	2.765	432		3.38	4.39	4.80	5.22
		8-0	27-4	12 TO 16	11	13	10	4	4	4	4	5	5	5	5	168	2-6	2-4	6-9	3-4	2-2	2.765	462		6.80	8.81	9.35	8.63
		8-0	27-4	16 TO 20	11	13	10	5	4	4	5	4	4	5	5	168	2-4	2-4	6-9	3-2	2-2	2.765	482		1.69	2.19	2.20	2.27
		8-3.5	27-4	20 TO 25.9	13	14.5	10	5	5	5	5	5	5	5	5	168	2-6	2-4	6-11	2-4	2-3	3.061	523		6.80	8.82	8.50	5.95
		8-4.5	27-10	26 TO 30	13.5	15	11.5	5	6	5	6	5	5	5	5	168	3-3	2-6	6-11	3-6	2-4	3.300	587		◆	◆	◆	◆
	8	9-10.5	27-4	< 2	12.5	10	10	5	6	5	6	4	4	5	5	184	3-5	2-4	8-10	3-1	1-11	2.886	566	3.370	1.21	1.57	1.82	1.65
		9-9.5	27-4	2 TO 8	10.5	11	10	4	5	4	5	4	4	5	5	175	2-6	2-4	8-8	3-2	2-0	2.801	461		1.46	1.89	2.00	1.82
		10-0	27-4	8 TO 12	11	13	10	4	5	4	5	4	4	5	5	184	2-6	2-4	8-9	3-4	2-2	3.012	464		3.45	4.47	4.89	5.12
		10-0	27-4	12 TO 16	11	13	10	5	4	4	5	4	4	5	5	184	2-6	2-4	8-9	2-4	2-2	3.012	460		2.53	3.27	3.47	3.73
		10-4	27-4	16 TO 20	13.5	14.5	10	5	4	5	5	4	4	5	5	184	3-3	2-4	8-11	3-5	2-2	3.350	490		3.07	3.98	3.84	2.72
		10-4	27-6	20 TO 25.9	13.5	14.5	10.5	5	6	5	6	6	6	5	5	184	3-3	2-4	8-11	3-6	2-3	3.414	675		1.78	2.32	2.23	1.56
		10-4.5	27-10	26 TO 30	13.5	15	11.5	5	6	5	5	5	5	5	5	184	3-3	2-6	8-11	3-6	2-4	3.584	578		◆	◆	◆	◆
10	6	8-0	33-4	< 2	14	10	10	6	7	6	7	5	5	5	5	192	3-5	2-4	6-11	3-1	1-11	3.210	796	4.037	1.20	1.55	1.44	1.37
		7-9	33-4	2 TO 8	11	10	10	6	7	6	7	5	5	5	5	192	2-6	2-4	6-9	2-4	1-11	2.901	774		1.56	2.02	1.81	1.73
		8-1	33-4	8 TO 12	11.5	13.5	10	5	7	5	7	5	5	5	5	192	2-6	2-4	6-9	3-4	2-2	3.313	721		2.81	3.65	3.73	4.04
		8-2.5	33-4	12 TO 16	12	14.5	10	6	6	5	7	5	5	5	5	192	2-6	2-4	6-10	3-7	2-4	3.467	720		2.67	3.47	3.58	3.84
		8-6	33-4	16 TO 22	14	16	10	6	5	6	5	5	5	5	5	192	2-6	2-4	7-0	3-7	2-5	3.827	658		2.44	3.17	3.04	3.14
	8	10-0	33-6	< 2	14	10	10.5	6	7	6	7	5	5	5	5	208	3-5	2-4	8-11	3-1	1-11	3.519	840	4.056	1.20	1.56	1.40	1.33
		9-11.5	33-4	2 TO 6	11.5	12	10	6	7	6	7	5	5	5	5	208	2-6	2-4	8-9	2-4	2-0	3.405	817		1.65	2.14	2.44	2.39
		10-1	33-4	6 TO 8	11.5	13.5	10	5	7	5	7	5	5	5	5	208	2-6	2-4	8-9	3-3	2-0	3.560	760		3.11	4.04	3.99	4.60
		10-1	33-4	8 TO 12	11.5	13.5	10	5	7	5	7	5	5	5	5	208	2-6	2-4	8-9	3-5	2-2	3.560	763		2.85	3.69	3.76	4.07
		10-5	33-4	12 TO 16	13.5	15.5	10	5	7	5	7	5	5	5	5	208	2-6	2-4	8-11	3-7	2-4	3.971	768		3.36	4.36	4.60	4.04
		10-6	33-4	16 TO 22	14	16	10	6	7	6	7	5	5	5	5	208	2-6	2-4	9-0	3-7	2-5	4.074	831		2.37	3.08	2.93	2.10
	10	12-0	33-6	< 2	14	10	10.5	6	7	6	7	5	5	5	5	224	3-5	2-4	10-11	2-4	1-11	3.778	879	4.056	1.17	1.52	1.36	1.30
		11-10.5	33-6	2 TO 8	11.5	11	10.5	6	7	6	7	5	5	5	5	224	2-6	2-4	10-9	3-2	2-0	3.623	864		1.65	2.14	2.15	2.06
		12-0.5	33-4	8 TO 12	11.5	13	11	5	7	5	7	5	5	5	5	224	2-6	2-5	10-9	3-4	2-2	3.904	808		3.09	4.00	3.92	3.08
		12-3	33-4	12 TO 14	12.5	14.5	10	5	5	5	5	5	5	5	5	224	2-6	2-4	10-10	3-6	2-3	4.012	675		1.68	2.17	2.10	1.50
		12-5	33-6	14 TO 16	13.5	15.5	10.5	5	7	5	7	5	5	5	5	224	2-6	2-4	10-11	3-7	2-4	4.295	812		1.59	2.06	1.99	1.41
		12-6	34-0	16 TO 22	14	16	12	6	7	6	7	5	5	6	6	224	2-10	2-8	11-0	2-4	2-5	4.630	914		1.40	1.82	1.75	1.24
12	6	8-1	39-6	< 2	15	10	10.5	6	7	6	7	5	5	5	5	216	3-9	2-4	7-0	3-1	1-11	3.826	905	4.722	1.03	1.33	1.14	1.15
		7-11.5	39-4	2 TO 4	12.5	11	10	6	7	6	7	5	5	5	5	203	2-6	2-4	6-10	3-2	2-0	3.594	881		1.34	1.74	1.46	1.55
		8-2	39-4	4 TO 8	13.5	12.5	10	5	7	5	7	5	5	5	5	216	2-6	2-4	6-11	3-7	2-5	3.897	818		1.10	1.42	1.27	1.36
		8-6.5	39-4	8 TO 10	14.5	16	10	5	7	5	7	5	5	5	5	216	3-3	2-4	7-0	3-7	2-5	4.443	823		2.22	2.88	2.82	3.06
		8-8	39-6	10 TO 12	16	16	10.5	6	5	6	5	5	5	5	5	216	3-3	2-4	7-2	2-4	2-3	4.679	735		3.48	4.51	4.97	5.27
		8-8	39-8	12 TO 16	16	16	11	6	5	6	5	5	5	5	5	216	3-3	2-5	7-2	3-7	2-5	4.733	745		2.48	3.22	3.40	3.59
		8-11	39-8	16 TO 18	17	18	11	6	5	6	5	5	5	5	5	216	3-3	2-4	7-3	3-9	2-7	5.100	748		2.09	2.71	2.79	2.86
	8	10-1.5	39-6	< 2	15	10.5	10.5	6	7	6	7	5	5	6	6	232	3-9	2-8	9-0	3-5	1-11	4.146	984	4.722	1.07	1.39	1.19	1.20
		9-11.5	39-4	2 TO 4	12.5	11	10	6	7	6	7	5	5	5	5	232	2-6	2-4	8-10	3-1	2-0	3.841	923		1.31	1.70	1.44	1.52
		10-2.5	39-4	4 TO 8	13.5	13	10	5	5	5	5	5	5	5	5	232	2-6	2-4	8-11	2-4	2-2	4.205	695		1.15	1.50	1.34	1.43
		10-9.5	39-8	8 TO 12	16	17.5	11	5	5	5	5	5	5	5	5	232	3-3	2-5	9-2	3-9	2-6	5.188	716		2.51	3.26	2.93	3.11
		10-11	39-8	12 TO 18	17	18	11	6	5	6	5	5	5	5	5	232	3-3	2-5	9-3	3-9	2-7	5.371	790		1.98	2.57	2.63	2.71
	10	12-3	39-6	< 2	16	11	10.5	6	7	6	7	5	5	6	6	248	4-4	2-8	11-1	2-8	2-0	4.588	1030	4.722	1.11	1.44	1.23	1.24
		11-11.5	39-4	2 TO 4	12.5	11	10	6	7	6	7	5	5	5	5	248	2-6	2-4	10-10	3-1	2-0	4.087	964		1.30	1.69	1.43	1.50
		12-4.5	39-4	4 TO 8	13.5	15	10	5	5	5	5	5	5	5	5	248	2-6	2-4	10-11	2-4	2-2	4.694	739		1.60	2.07	2.17	2.61
		12-9.5	39-8	8 TO 12	16	17.5	11	5	5	5	5	5	5	5	5	248	3-3	2-5	11-2	3-9	2-6	5.459	757		2.57	3.34	3.00	3.06
		12-11	39-8	12 TO 18	17	18	11	6	5	6	5	5	5	5	5	248	3-3	2-5	11-3	3-9	2-7	5.643	832		1.36	1.77	1.70	1.21
14	6	8-3	45-6	< 2	16	11	10.5	7	8	7	8	5	5	5	5	240	3-9	2-4	7-1	3-2	2-0	4.569	1243	5.389	1.00	1.30	1.10	1.12
		8-1	45-4	2 TO 4	13	12	10	7	8	7	8	5	5	5	5	240	2-6	2-4	6-11	3-3	2-1	4.239	1196		1.31	1.69	1.67	1.69
		8-2	45-4	4 TO 8	13	13	10	7	8	7	8	5	5	5	5	240	2-6	2-4	6-11	2-4	2-2	4.379	1193		1.98	2.57	2.82	2.90
		8-5	45-8	8 TO 12	14	15	11	7	8	7	8	5	5	6	6	240	2-10	2-9	7-0	3-10	2-4	4.902	1242		3.51	4.54	3.93	4.17
	8	10-3.5	45-6	< 2	16	11.5	10.5	7	8	7	8	5	5	5	5	256	3-9	2-4	9-1	3-2	2-0	4.899	1284	5.389	1.04	1.35	1.14	1.16
		10-1	45-4	2 TO 4	13	12	10	7	8	7	8	5	5	5	5	256	2-6	2-4	8-11	3-3	2-1	4.486	1237		1.43	1.86	1.63	1.65
		10-2	45-4	4 TO 8	13	13	10	7	8	7	8	5	5	5	5	256	2-6	2-4	8-11	3-4	2-2	4.626	1238		2.10	2.73	2.76	2.84
		10-5	46-0	8 TO 12	14	15	12	7	8	7	8	5	5	6	6	256	2-10	2-10	9-0	2-4	2-4	5.302	1285		3.52	4.56	3.95	4.19
	10	12-4.5	45-6	< 2	16.5	12	10.5	7	8	7	8	5	5	5	5	272	3-9	2-4	11-2	3-2	2-1	5.299	1328	5.389	1.07	1.39	1.18	1.20
		12-1	45-4	2 TO 4	13	12	10	7	8	7	8	5	5	5	5	272	2-6	2-4	10-11	3-3	2-1	4.733	1278		1.41	1.83	1.61	1.62
		12-2	45-4	4 TO 8	13	13	10	7	8	7	8	5	5	5	5	272	2-6	2-4	10-11	3-4	2-2	4.872	1280		1.95	2.53	2.62	2.81
		12-5.5	46-0	8 TO 12	14	15.5	12	7	8	7	8	5	5	6	6	272	2-10	2-10	11-0	3-11	2-4	5.670	1561		3.77	4.89	4.56	3.99
16	6	8-5	51-6	< 2	16.5	12.5	10.5	7	8	7	8	5	5	6	6	264	4-4	2-8	7-2	2-4	2-1	5.387	1410	6.056	1.07	1.39	1.13	1.18
		8-1.5	51-4	2 TO 4	13	12	10	7	8	7	8	5	5	6	6	264	2-10	2-8	6-11	3-8	2-1	4.781	1359		1.25	1.62	1.31	1.37
		8-2	51-4	4 TO 6	13	13	10	7	8	7	8	5	5	6	6	264	2-10	2-10	6-11	3-8	2-2	4.860	1361		1.64	2.13	1.75	1.77
		8-3.5	51-4	6 TO 8	13.5	14	10	7	8	7	8	5	5	6	6	264	2-10	2-8	6-11	3-9	2-3	5.098	1361		1.75	2.27	1.87	1.92
		8-6	51-8	8 TO 10	14.5	15.5	11	7	8	7	8	5	5	6	6	264	3-8	2-9	7-0	3-11	2-4	5.599	1377		2.06	2.68	2.21	2.28
	8	10-5	51-6	< 2	16.5	12.5	10.5	7	8	7	8	5	5	6	6	280	4-4	2-8	9-2	2-4	2-1	5.647	1455	6.056	1.02	1.33	1.08	1.13
		10-3	51-4	2 TO 4	14	13	10	7	8	7	8	5	5	6	6	280	2-10	2-8	9-0	3-8	2-1	5.265	1406		1.31	1.70	1.38	1.44
		10-3	51-4	4 TO 6	14	13	10	7	8	7	8	5	5	6	6	280	2-10	2-8	9-0	3-8	2-2	5.265	1406		1.57	2.03	1.67	1.70
		10-4.5	51-4	6 TO 8	14	14.5	10	7	8	7	8	5	5	6	6	280	2-10	2-8	9-0	3-10	2-4	5.503	1410		2.01	2.61	2.15	2.21
		10-6.5	51-8	8 TO 10	15	15.5	11	7	8	7	8	6	6	6	6	280	3-8	2-9	9-1	3-11	2-4	5.950	1519		1.99	2.58	2.13	2.21
	10	12-6	51-6	< 2	17	13	10.5	7	8	7	8	5	5	6	6	296	4-4	2-8	11-2	2-4	2-1	6.065	1500	6.056	1.06	1.37	1.12	1.16
		12-3	51-4	2 TO 4	14	13	10	7	8	7	8	5	5	6	6	296	2-10	2-8	11-0	3-8	2-2	5.512	1452		1.30	1.68	1.36	1.43
		12-3	51-4	4 TO 6	14	13	10	7	8	7	8	5	5	6	6	296	2-10	2-8	11-0	3-8	2-2	5.512	1452		1.54	2.00	1.64	1.68
		12-5	51-4	6 TO 8	14	15	10	7	8	7	8	5	5	6	6	296	2-10	2-8	11-0	3-10	2-4	5.829	1455		2.24	2.91	2.50	2.57
		12-7	51-8	8 TO 10	15	16	11	7	8	7	8	5	5	6	6	296	3-8	2-9	11-1	3-11	2-5	6.301	1469		2.35	3.05	2.52	2.61
18	6	8-6.5	57-6	< 2	17	13.5	10.5	7	8	7	8	5	5	7	7	288	5-0	3-1	7-2	2-4	2-1	6.191	1589	6.722	1.07	1.39	1.09	1.16
		8-5	57-4	2 TO 4	15	14	10	7	8	7	8	5	5	6	6	288	3-8	2-9	7-1	3-9	2-3	5.872	1499		1.15	1.50	1.15	1.25
		8-6.5	57-8	4 TO 6	15.5	15	11	7	8	7	8	5	5	6	6	288	3-8	2-9	7-1	3-10	2-4	6.243	1507		1.50	1.94	1.52	1.57
		8-9	57-8	6 TO 8	16	17	11	7	8	7	8	5	5	6	6	288	3-8	2-9	7-2	4-0	2-6	6.688	1512		1.91	2.48	1.98	2.04
	8	10-6.5	57-6	< 2	17	13.5	10.5	7	8	7	8	5	5	7	7	304	5-0	3-1	9-2	4-1	2-1	6.450	1653	6.722	1.02	1.33	1.05	1.11
		10-5	57-4	2 TO 4	15	14	10	7	8	7	8	5	5	6	6	304	3-8	2-8	9-1	2-4	2-3	6.119	1535		1.13	1.46	1.13	1.22
		10-6.5	57-8	4 TO 6	15.5	15	11	7	8	7	8	5	5	6	6	304	3-8	2-9	9-1	3-10	2-4	6.515	1552		1.44	1.87	1.47	1.52
		10-9	57-8	6 TO 8	16	17	11	7	8	7	8	5	5	6	6	304	3-8	2-9	9-2	4-0	2-6	6.960	1557		1.88	2.44	1.93	1.99
	10	12-7	57-6	< 2	17	14	10.5	7	8	7	8	5	5	7	7	320	5-0	3-1	11-2	4-1	2-2	6.798	1703	6.722	1.06	1.38	1.08	1.15
		12-5	57-4	2 TO 4	15	14	10	7	8	7	8	5	5	6	6	320	3-8	2-8	11-1	3-9	2-3	6.366	1589		1.11	1.44	1.11	1.20
		12-6.5	57-8	4 TO 6	15.5	15	11	7	8	7	8	5	5	6	6	320	3-8	2-9	11-1	2-4	2-4	6.787	1588		1.41	1.83	1.43	1.49
		12-9	57-8	6 TO 8	16	17	11	7	8	7	8	5	5	6	6	320	3-8	2-9	11-2	4-0	2-6	7.231	1602		1.85	2.40	1.90	1.97
20	6	8-8	63-8	< 2	18	14	11	8	9	8	9	6	6	7	7	312	5-0	3-2	7-3	4-2	2-6	7.103	2195	7.407	1.00	1.30	1.00	1.07
		8-8	63-8	2 TO 4	16	16	11	7	8	7	8	5	5	6	6	312	3-8	2-9	7-2	3-11	2-5	7.103	1639		1.14	1.47	1.13	1.25
		8-8	63-8	4 TO 6	16	16	11	8	8	8	8	5	5	6	6	312	3-8	2-9	7-2	3-11	2-5	7.103	1798		1.61	2.09	2.00	2.27
	8	10-8.5	63-8	< 2	18	14.5	11	8	9	8	9	6	6	7	7	328	5-0	3-2	9-3	2-4	2-6	7.473	2259	7.407	1.02	1.33	1.02	1.09
		10-8	63-8	2 TO 4	16	16	11	7	8	7	8	5	5	6	6	328	3-8	2-9	9-2	3-11	2-5	7.374	1684		1.14	1.48	1.10	1.22
		10-8	63-8	4 TO 6	16	16	11	8	8	8	8	5	5	6	6	328	3-8	2-9	9-2	3-11	2-5	7.374	1843		1.83	2.38	2.08	2.21
	10	12-9	63-8	< 2	18	15	11	8	9	8	9	6	6	7	7	344	5-0	3-2	11-3	4-3	2-6	7.843	2335	7.407	1.06	1.37	1.05	1.13
		12-8	63-8	2 TO 4	16	16	11	7	8	7	8	5	5	6	6	344	3-8	2-9	11-2	3-11	2-5	7.646	1729		1.12	1.46	1.09	1.20
		12-8	63-8	4 TO 6	16	16	11	8	8	8	8	5	5	6	6	344	3-8	2-9	11-2	2-4	2-5	7.646	1878		1.87	2.43	2.05	2.18

HEADWALL AND TOEWALL QUANTITIES

HEADWALL BENT ANGLE	90° TO 75°			74° TO 60°			59° TO 45°		
CLEAR SPAN (S)	Z	STIRRUPS	REBAR QUANT.	Z	STIRRUPS	REBAR QUANT.	Z	STIRRUPS	REBAR QUANT.
	#	#	LBS/LF	#	#	LBS/LF	#	#	LBS/LF
8	4	4	19.2	5	4	23.5	7	4	34.4
10	5	4	23.9	6	4	28.7	9	4■	54.0
12	6	4	28.7	6	4	28.2	9	5■	59.2
14	6	4	27.9	7	4	33.5	★	★	★
16	6	4	27.5	8	5	44.1	★	★	★
18	7	4	33.0	9	5	51.8	★	★	★
20	7	4	32.8	★	★	★	★	★	★
CONCRETE QUANTITY = 0.086 CY/LF									

NOTES

■ 1. SIX INCH SPACING AT EACH END OF THE SPAN FOR A DISTANCE OF 1/4 OF THE SPAN LENGTH; 12 INCH SPACING ELSEWHERE.

2. QUANTITIES ARE GIVEN FOR ONE HEADWALL AND ONE TOEWALL AND ARE BASED ON PER LINEAR FOOT OF HEADWALL. STEEL QUANTITIES INCLUDE ALL REINFORCING. QUANTITIES SHALL BE PAID FOR AS SHOWN ON THE PLANS.

★ 3. SKEWED HEADWALLS ARE NOT RECOMMENDED FOR THESE SPANS. A SPECIAL DESIGN IS REQUIRED.

4. FOR HEADWALL AND TOEWALL DETAILS SEE M-601-3, SHEET 1 OF 2.

5. WHEN THE FILL HEIGHTS ARE LESS THAN OR EQUAL TO 2 FT, ALL REINFORCING BARS IN THE HEADWALL, ALL REINFORCING BARS DESIGNATED BY AN ASTERISK (*), AND THE d_1 BARS IN THE TOP MAT OF THE TOP SLAB SHALL BE EPOXY COATED.

6. REINFORCING QUANTITIES INCLUDE BOTH EPOXY-COATED AND UNCOATED BARS.

7. WHEN A (RISE) R OF LESS THAN 6 FT IS REQUIRED, USE THE BAR SIZES AND THE SLAB AND WALL THICKNESSES FOR THE 6 FT RISE (IF AVAILABLE ON THE TABLE).

▲ 8. FOR SIZE AND SPACING OF THE BOTTOM MAT BARS IN THE TOP SLAB SEE TABLE ON M-601-3, SHEET 1 OF 2. ALL OTHER d_1 BARS ARE #4's AT 1'-0" SPACING. THE NUMBER OF BARS REQUIRED IS LISTED ON THIS SHEET AND INCLUDES BOTH #4 BARS AND THOSE FROM THE TABLE.

◆ 9. LIVE LOAD IS NEGLECTED AS PER AASHTO LRFD SECTION 3.6.1.2.6. FOR THESE STRUCTURES REFER TO THE CDOT RATING MANUAL.

10. FOR ALL NEW CULVERT DESIGNS, A RATING IS REQUIRED. THE RATING SUMMARY SHEET SHOULD BE PRINTED FROM THE CDOT EXTERNAL WEBSITE AND SUBMITTED TO THE BRIDGE RATING UNIT OR INCLUDED AS PART OF A LARGER DESIGN PACKAGE. FOR ADDITIONAL INFORMATION, SEE THE CDOT RATING MANUAL.

Computer File Information			Sheet Revisions	
Creation Date: 07/04/12	Initials: DDG		Date:	Comments
Last Modification Date: 04/05/19	Initials: JBE	(R-X)	08/27/13	LRFD Design
Full Path: www.codot.gov/business/designsupport		(R-X)	08/01/15	Analysis Program Updates
Drawing File Name: 601030202.dgn		(R-X)	04/05/19	Clarified this sheet is for Cast-In-Place CBC only, not for Pre-Cast CBC. Changed title and added Gen. Note 18.
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English		(R-X)		

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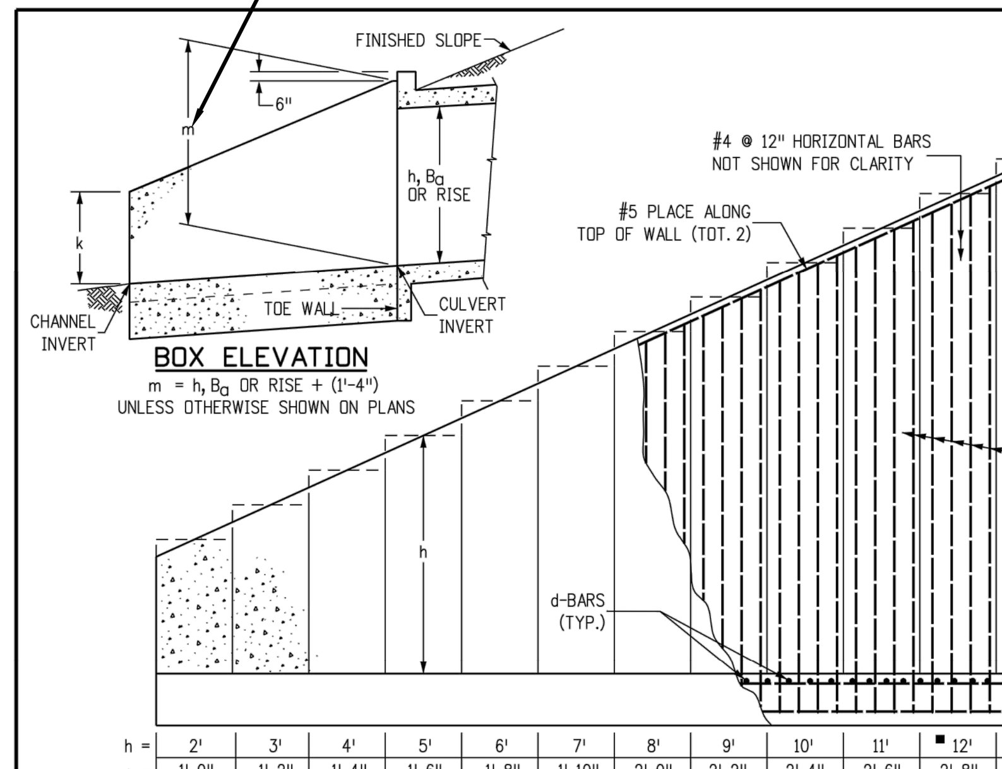
TRIPLE CONCRETE BOX CULVERT (CAST-IN-PLACE)

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-3

Sheet No. 2 of 2

REFERENCE MODIFIED M VALUE ON SHEET 10



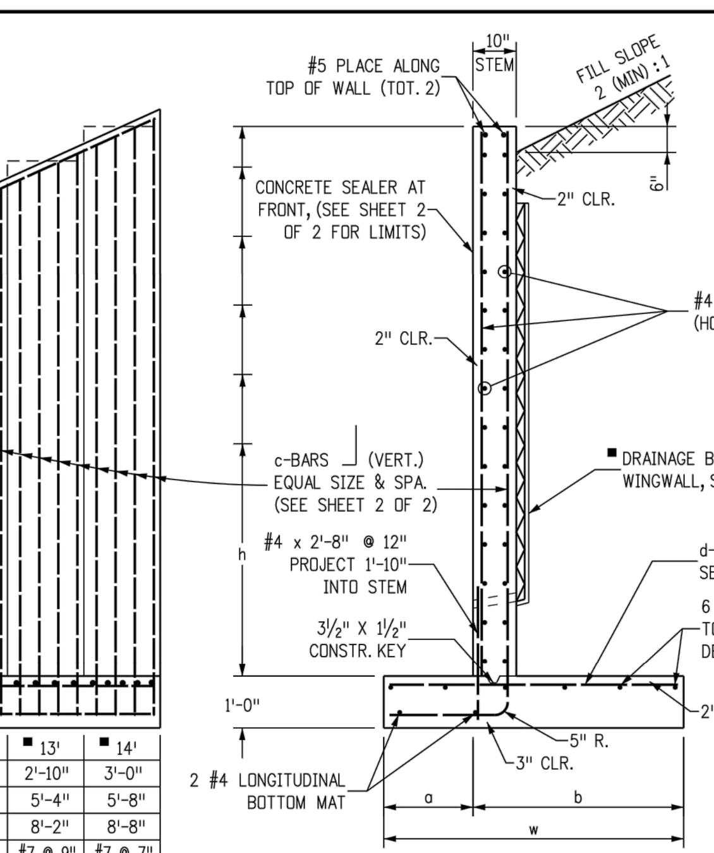
BOX ELEVATION

m = h, B_a OR RISE + (1'-4") UNLESS OTHERWISE SHOWN ON PLANS

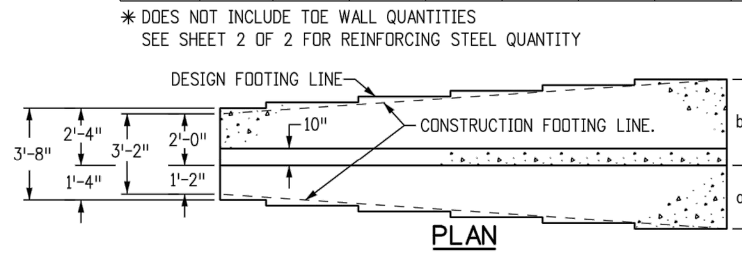
h =	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	■ 12'	■ 13'	■ 14'
a =	1'-0"	1'-2"	1'-4"	1'-6"	1'-8"	1'-10"	2'-0"	2'-2"	2'-4"	2'-6"	2'-8"	2'-10"	3'-0"
b =	1'-8"	2'-0"	2'-4"	2'-8"	3'-0"	3'-4"	3'-8"	4'-0"	4'-4"	4'-8"	5'-0"	5'-4"	5'-8"
w =	2'-8"	3'-2"	3'-8"	4'-2"	4'-8"	5'-2"	5'-8"	6'-2"	6'-8"	7'-2"	7'-8"	8'-2"	8'-8"
d-BARS	#4 @ 9"	#4 @ 9"	#4 @ 9"	#4 @ 9"	#4 @ 9"	#4 @ 9"	#5 @ 11"	#5 @ 10"	#5 @ 10"	#5 @ 8"	#6 @ 8"	#7 @ 9"	#7 @ 7"
* CONC. CY/LF	0.161	0.210	0.259	0.309	0.358	0.407	0.457	0.506	0.556	0.605	0.654	0.704	0.753

* DOES NOT INCLUDE TOE WALL QUANTITIES SEE SHEET 2 OF 2 FOR REINFORCING STEEL QUANTITY

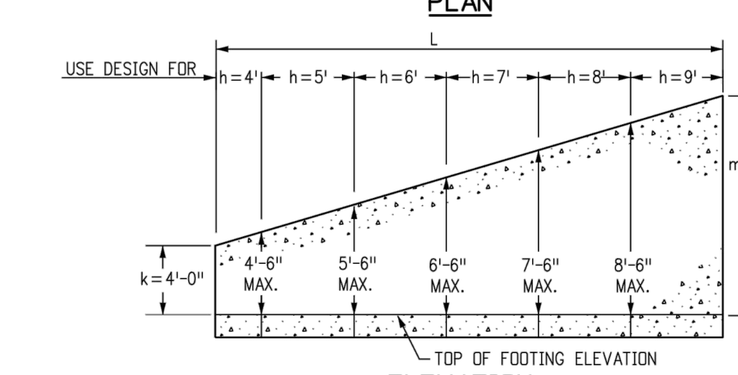
■ REQUIRED DRAINAGE BEHIND WINGWALLS SEE NOTE 6



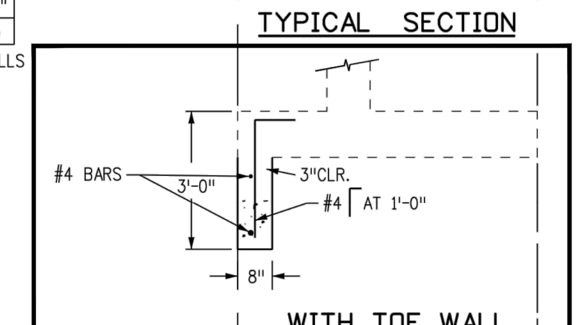
TYPICAL SECTION



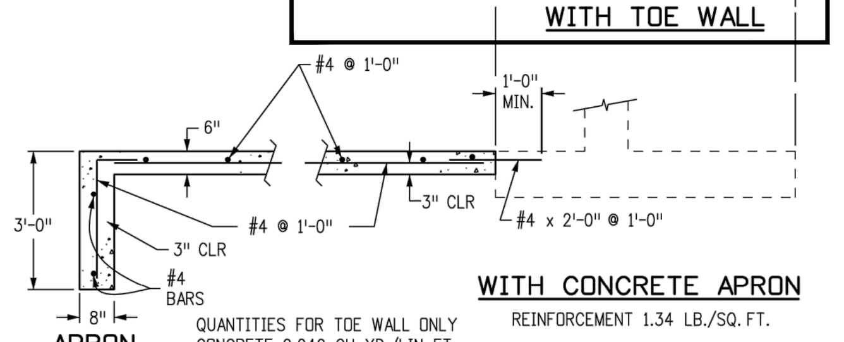
PLAN



ELEVATION DESIGN EXAMPLE



WITH TOE WALL

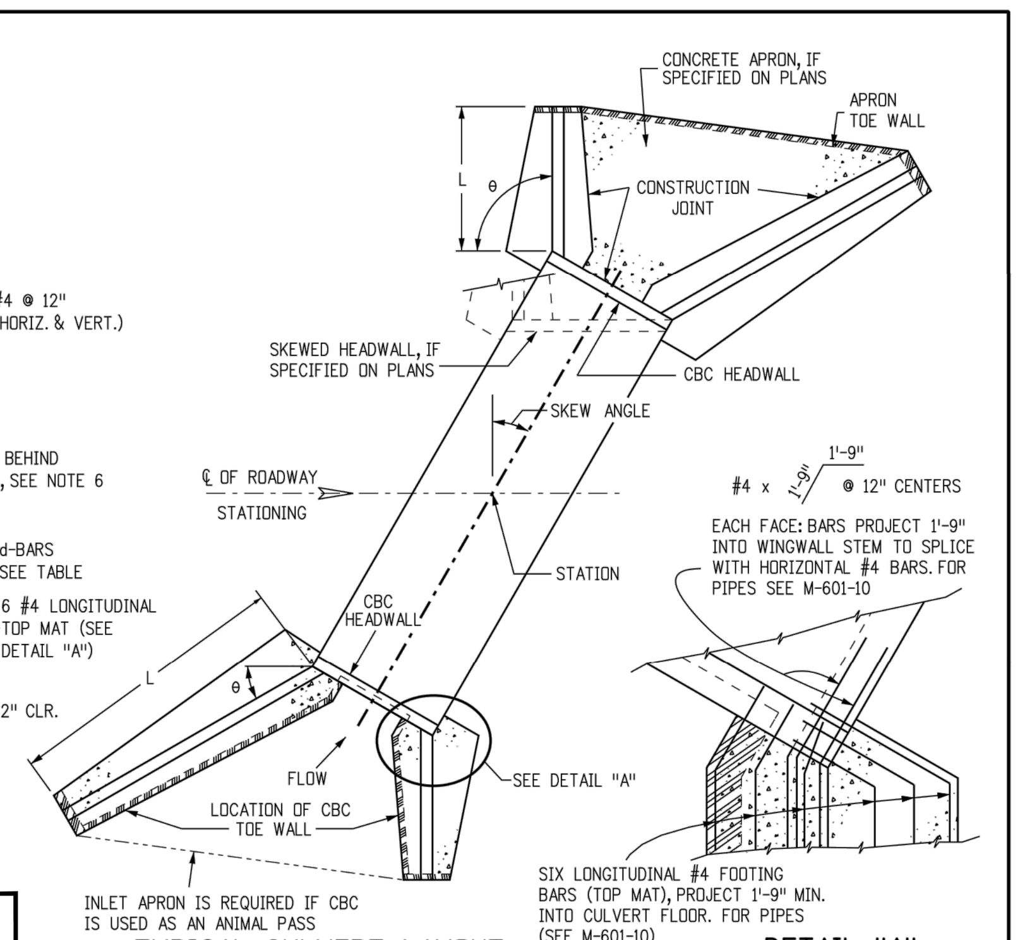


APRON TOE WALL

QUANTITIES FOR TOE WALL ONLY
CONCRETE 0.049 CU. YD./LIN. FT.
REINFORCEMENT 5.1 LB./LIN. FT.

WITH CONCRETE APRON

REINFORCEMENT 1.34 LB./SQ. FT.



TYPICAL CULVERT LAYOUT

DETAIL "A"

DESIGN DATA:

AASHTO LRFD EIGHTH EDITION, 2017
DESIGN METHOD: LOAD AND RESISTANCE FACTOR DESIGN, YIELD LINE METHOD

REINFORCED CONCRETE:
CONCRETE CLASS D (BOX CULVERT): f'_c = 4,500 PSI
REINFORCING STEEL: f_y = 60,000 PSI

LOADING:
AT-REST EARTH (FLUID) PRESSURE FOR CONCRETE STEM DESIGN = 55 PCF FOR 2 (MIN.) : 1 SLOPED BACKFILL
ACTIVE EARTH (FLUID) PRESSURE FOR CONCRETE FOOTING DESIGN = 40 PCF FOR 2 (MIN.) : 1 SLOPED BACKFILL
LIVE LOAD SURCHARGE = 2'
MINIMUM RESISTANCE FOR SOIL BEARING = 5.5 KSF
SOIL BEARING RESISTANCE FACTOR = 0.45

GENERAL NOTES:

1. ALL EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED ¾ IN.
2. WINGWALL FOOTING AND FLOOR OF BOX CULVERT SHALL BE PLACED MONOLITHICALLY.
3. DIMENSIONS "h", "k", "L", "m" AND ANGLE "θ" FOR WINGWALL SHALL BE AS SHOWN ON THE PLANS.
4. MINIMUM CLASS B LAP SPLICE LENGTH FOR BLACK REINFORCING BARS:

BAR SIZE:	#4	#5	#6	#7
SPLICE LENGTH:	1'- 6"	1'-11"	2'-3"	2'-7"

5. DESIGN DOES NOT CONSIDER ANY SCOUR EFFECTS.
6. WINGWALL DRAIN SHALL BE REQUIRED IF "h" ≥ 12.0 FT., SEE SHEET 2 OF 2 FOR DETAILS.

Computer File Information			Sheet Revisions	
Creation Date: 07/04/12	Initials: HHB		Date:	Comments
Last Modification Date: 09/04/18	Initials:	(R-X)	09/04/18	LRFD Design
Full Path: www.codot.gov/business/designsupport		(R-X)		
Drawing File Name: 6010200102.dgn		(R-X)		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English		(R-X)		

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WINGWALLS FOR PIPE OR BOX CULVERTS

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-20

Sheet No. 1 of 2

c-BARS AND REINFORCING STEEL QUANTITY (EXCLUDE TOE WALL)

* REINFORCING STEEL QUANTITY INCLUDES STEM AND FOOTING QUANTITIES, BUT DOES NOT INCLUDE TOE WALL QUANTITIES.

L (MULTIPLE OF m)		≤ (1.0 x m)		≤ (1.25 x m)		≤ (1.5 x m)		≤ (1.75 x m)		≤ (2.0 x m)		≤ (2.25 x m)		≤ (2.5 x m)		≤ (2.75 x m)		≤ (3.0 x m)		≤ (3.25 x m)		≤ (3.5 x m)	
m (FT)	k (FT)	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.	c-BARS	* REINF. LB./L.F.
14	4	#4 @ 10"	53.60	#5 @ 10"	57.95	#5 @ 10"	57.10	#5 @ 8"	60.22	#5 @ 7"	62.43	#5 @ 7"	62.09	#5 @ 6"	65.38	#5 @ 6"	65.15	#6 @ 8"	67.10	#6 @ 8"	66.94	#6 @ 7"	70.66
	5	#4 @ 10"	55.86	#5 @ 10"	60.46	#5 @ 10"	59.60	#5 @ 8"	62.89	#5 @ 7"	65.23	#5 @ 7"	64.88	#5 @ 6"	68.34	#5 @ 6"	68.11	#6 @ 8"	70.17	#6 @ 8"	70.00	#6 @ 7"	73.90
	6	#5 @ 10"	64.43	#6 @ 10"	70.60	#6 @ 10"	69.69	#6 @ 8"	74.93	#6 @ 8"	74.45	#6 @ 7"	78.30	#6 @ 6"	83.64	#6 @ 6"	83.40	#6 @ 6"	83.22	#6 @ 6"	83.05	#7 @ 7"	89.64
	7	#5 @ 10"	67.29	#6 @ 10"	73.76	#6 @ 10"	72.83	#6 @ 8"	78.32	#6 @ 8"	77.84	#6 @ 7"	81.87	#6 @ 6"	87.45	#6 @ 6"	87.21	#6 @ 6"	87.02	#6 @ 6"	86.86	#7 @ 7"	93.73
	8	#5 @ 8"	74.71	#6 @ 8"	83.46	#6 @ 7"	87.09	#6 @ 6"	92.54	#7 @ 7"	99.47	#7 @ 7"	99.08	#7 @ 6"	107.11	#7 @ 6"	106.86	#7 @ 6"	106.66	#7 @ 6"	106.49	#7 @ 6"	106.35
	9	#5 @ 8"	78.10	#6 @ 8"	87.23	#6 @ 7"	91.03	#6 @ 6"	96.72	#7 @ 7"	103.93	#7 @ 7"	103.54	#7 @ 6"	111.90	#7 @ 6"	111.65	#7 @ 6"	111.45	#7 @ 6"	111.28	#7 @ 6"	111.13
13	4	#4 @ 10"	50.51	#4 @ 10"	49.25	#5 @ 10"	53.71	#5 @ 10"	53.09	#5 @ 10"	52.36	#5 @ 9"	53.85	#5 @ 8"	55.54	#5 @ 7"	57.85	#5 @ 7"	57.67	#5 @ 7"	57.51	#6 @ 9"	59.93
	5	#4 @ 10"	52.66	#4 @ 10"	51.37	#5 @ 10"	56.09	#5 @ 10"	55.46	#5 @ 10"	54.99	#5 @ 9"	56.29	#5 @ 8"	58.08	#5 @ 7"	60.51	#5 @ 7"	60.33	#5 @ 7"	60.17	#6 @ 9"	62.72
	6	#4 @ 10"	54.92	#5 @ 10"	59.48	#5 @ 9"	60.31	#6 @ 9"	67.56	#6 @ 9"	67.08	#6 @ 9"	66.70	#6 @ 8"	69.53	#6 @ 8"	69.28	#6 @ 7"	73.12	#6 @ 7"	72.95	#6 @ 7"	72.81
	7	#4 @ 10"	57.36	#5 @ 10"	62.16	#5 @ 9"	63.05	#6 @ 9"	70.66	#6 @ 9"	70.16	#6 @ 9"	69.78	#6 @ 8"	72.75	#6 @ 8"	72.50	#6 @ 7"	76.52	#6 @ 7"	76.35	#6 @ 7"	76.20
	8	#5 @ 10"	66.39	#6 @ 10"	72.82	#6 @ 8"	77.97	#6 @ 7"	81.68	#6 @ 7"	81.19	#6 @ 6"	86.67	#6 @ 6"	86.37	#7 @ 7"	93.18	#7 @ 7"	92.97	#7 @ 7"	92.80	#7 @ 7"	92.64
	9	#5 @ 10"	69.37	#6 @ 10"	76.10	#6 @ 8"	81.49	#6 @ 7"	85.37	#6 @ 7"	84.87	#6 @ 6"	90.59	#6 @ 6"	90.29	#7 @ 7"	97.39	#7 @ 7"	97.18	#7 @ 7"	97.00	#7 @ 7"	96.85
12	2	#4 @ 10"	43.91	#4 @ 10"	42.65	#4 @ 10"	41.82	#4 @ 10"	41.22	#4 @ 10"	40.78	#4 @ 9"	41.29	#5 @ 10"	44.61	#5 @ 10"	44.37	#5 @ 10"	44.18	#5 @ 10"	44.01	#5 @ 10"	43.87
	3	#4 @ 10"	45.82	#4 @ 10"	44.55	#4 @ 10"	43.71	#4 @ 10"	43.11	#4 @ 10"	42.66	#4 @ 9"	43.22	#5 @ 10"	46.75	#5 @ 10"	46.51	#5 @ 10"	46.32	#5 @ 10"	46.15	#5 @ 10"	46.01
	4	#4 @ 10"	47.80	#4 @ 10"	46.51	#4 @ 10"	45.65	#5 @ 10"	50.06	#5 @ 10"	49.59	#5 @ 10"	49.23	#5 @ 10"	48.94	#5 @ 10"	48.69	#5 @ 9"	50.00	#5 @ 8"	51.72	#5 @ 8"	51.57
	5	#4 @ 10"	49.84	#4 @ 10"	48.53	#4 @ 10"	47.66	#5 @ 10"	52.33	#5 @ 10"	51.85	#5 @ 10"	51.48	#5 @ 10"	51.19	#5 @ 10"	50.94	#5 @ 9"	52.33	#5 @ 8"	54.14	#5 @ 8"	54.00
	6	#4 @ 10"	51.99	#4 @ 10"	50.65	#5 @ 10"	55.34	#5 @ 8"	58.41	#5 @ 8"	57.93	#6 @ 10"	60.60	#6 @ 10"	60.29	#6 @ 9"	62.42	#6 @ 9"	62.22	#6 @ 9"	62.04	#6 @ 8"	64.89
	7	#4 @ 10"	54.30	#5 @ 10"	58.80	#5 @ 10"	57.87	#5 @ 8"	61.10	#5 @ 8"	60.61	#6 @ 10"	63.43	#6 @ 10"	63.11	#6 @ 9"	65.35	#6 @ 9"	65.15	#6 @ 9"	64.97	#6 @ 8"	67.96
	8	#5 @ 10"	62.91	#5 @ 10"	61.45	#5 @ 7"	67.46	#5 @ 6"	70.68	#5 @ 6"	70.20	#6 @ 7"	76.44	#6 @ 7"	76.13	#6 @ 7"	75.87	#6 @ 6"	81.30	#6 @ 6"	81.12	#6 @ 6"	80.98
	9	#5 @ 10"	65.64	#5 @ 10"	64.15	#5 @ 7"	70.44	#5 @ 6"	73.82	#5 @ 6"	73.33	#6 @ 7"	79.86	#6 @ 7"	79.54	#6 @ 7"	79.28	#6 @ 6"	84.95	#6 @ 6"	84.77	#6 @ 6"	84.62
11	2	#4 @ 10"	41.70	#4 @ 10"	40.42	#4 @ 10"	39.57	#4 @ 10"	38.96	#4 @ 10"	38.50	#4 @ 10"	38.15	#4 @ 10"	37.87	#4 @ 10"	37.63	#4 @ 9"	38.25	#5 @ 10"	41.46	#5 @ 10"	41.31
	3	#4 @ 10"	43.57	#4 @ 10"	42.27	#4 @ 10"	41.40	#4 @ 10"	40.79	#4 @ 10"	40.33	#4 @ 10"	39.97	#4 @ 10"	39.69	#4 @ 10"	39.45	#4 @ 9"	40.12	#5 @ 10"	43.54	#5 @ 10"	43.39
	4	#4 @ 10"	45.48	#4 @ 10"	44.16	#4 @ 10"	43.28	#4 @ 10"	42.66	#4 @ 9"	43.09	#5 @ 10"	46.57	#5 @ 10"	46.27	#5 @ 10"	46.02	#5 @ 10"	45.82	#5 @ 10"	45.65	#5 @ 10"	45.50
	5	#4 @ 10"	47.46	#4 @ 10"	46.10	#4 @ 10"	45.21	#4 @ 10"	44.58	#4 @ 9"	45.06	#5 @ 10"	48.74	#5 @ 10"	48.44	#5 @ 10"	48.19	#5 @ 10"	47.99	#5 @ 10"	47.81	#5 @ 10"	47.67
	6	#4 @ 10"	49.52	#4 @ 10"	48.14	#4 @ 9"	48.23	#5 @ 10"	51.88	#5 @ 10"	51.38	#5 @ 9"	52.57	#5 @ 9"	52.27	#5 @ 8"	53.99	#5 @ 8"	53.79	#5 @ 7"	56.16	#5 @ 7"	56.01
	7	#4 @ 10"	51.73	#4 @ 10"	50.31	#4 @ 9"	50.43	#5 @ 10"	54.29	#5 @ 10"	53.78	#5 @ 9"	55.04	#5 @ 9"	54.73	#5 @ 8"	56.55	#5 @ 8"	56.35	#5 @ 7"	58.84	#5 @ 7"	58.70
	8	#4 @ 10"	54.00	#5 @ 10"	58.44	#5 @ 8"	57.45	#5 @ 8"	60.64	#5 @ 7"	62.92	#5 @ 6"	66.25	#5 @ 6"	65.94	#5 @ 6"	65.69	#6 @ 8"	67.76	#6 @ 8"	67.57	#6 @ 7"	71.45
	9	#4 @ 10"	56.20	#5 @ 10"	60.87	#5 @ 10"	59.85	#5 @ 8"	63.21	#5 @ 7"	65.60	#5 @ 6"	69.09	#5 @ 6"	68.78	#5 @ 6"	68.52	#6 @ 8"	70.69	#6 @ 8"	70.51	#6 @ 7"	74.57
10	2	#4 @ 10"	39.84	#4 @ 10"	38.53	#4 @ 10"	37.65	#4 @ 10"	37.03	#4 @ 10"	36.57	#4 @ 10"	36.20	#4 @ 10"	35.91	#4 @ 10"	35.67	#4 @ 10"	35.48	#4 @ 9"	36.07	#4 @ 9"	35.93
	3	#4 @ 10"	41.68	#4 @ 10"	40.35	#4 @ 10"	39.47	#4 @ 10"	38.84	#4 @ 10"	38.36	#4 @ 10"	38.00	#4 @ 10"	37.71	#4 @ 10"	37.46	#4 @ 10"	37.27	#4 @ 9"	37.91	#4 @ 9"	37.76
	4	#4 @ 10"	43.58	#4 @ 10"	42.22	#4 @ 10"	41.31	#4 @ 10"	40.67	#4 @ 10"	40.19	#4 @ 10"	39.82	#4 @ 10"	39.53	#4 @ 10"	39.28	#4 @ 10"	39.08	#4 @ 9"	39.77	#4 @ 9"	39.63
	5	#4 @ 10"	45.53	#4 @ 10"	44.14	#4 @ 10"	43.21	#4 @ 10"	42.56	#4 @ 10"	42.07	#5 @ 10"	46.44	#5 @ 10"	46.13	#5 @ 10"	45.87	#5 @ 10"	45.67	#5 @ 10"	45.49	#5 @ 10"	45.34
	6	#4 @ 10"	47.58	#4 @ 10"	46.14	#4 @ 10"	45.20	#4 @ 10"	44.53	#4 @ 10"	44.03	#5 @ 10"	48.67	#5 @ 10"	48.35	#5 @ 10"	48.08	#5 @ 10"	47.88	#5 @ 10"	47.69	#5 @ 10"	47.54
	7	#4 @ 10"	49.79	#4 @ 10"	48.31	#4 @ 10"	47.34	#5 @ 10"	51.97	#5 @ 10"	51.45	#5 @ 10"	51.04	#5 @ 9"	52.29	#5 @ 9"	52.03	#5 @ 8"	53.79	#5 @ 8"	53.61	#5 @ 7"	56.00
	8	#4 @ 10"	52.06	#4 @ 10"	50.54	#4 @ 10"	49.54	#5 @ 10"	54.43	#5 @ 10"	53.89	#5 @ 10"	53.47	#5 @ 9"	54.80	#5 @ 9"	54.53	#5 @ 8"	56.39	#5 @ 8"	56.20	#5 @ 7"	58.72
9	2	#4 @ 10"	38.01	#4 @ 10"	36.75	#4 @ 10"	35.85	#4 @ 10"	35.21	#4 @ 10"	34.73	#4 @ 10"	34.36	#4 @ 10"	34.06	#4 @ 10"	33.81	#4 @ 10"	33.61	#4 @ 10"	33.44	#4 @ 10"	33.30
	3	#4 @ 10"	39.93	#4 @ 10"	38.56	#4 @ 10"	37.64	#4 @ 10"	36.99	#4 @ 10"	36.51	#4 @ 10"	36.13	#4 @ 10"	35.83	#4 @ 10"	35.58	#4 @ 10"	35.38	#4 @ 10"	35.21	#4 @ 10"	35.06
	4	#4 @ 10"	41.81	#4 @ 10"	40.40	#4 @ 10"	39.47	#4 @ 10"	38.81	#4 @ 10"	38.31	#4 @ 10"	37.93	#4 @ 10"	37.63	#4 @ 10"	37.37	#4 @ 10"	37.17	#4 @ 10"	36.99	#4 @ 10"	36.84
	5	#4 @ 10"	43.75	#4 @ 10"	42.30	#4 @ 10"	41.35	#4 @ 10"	40.67	#4 @ 10"	40.17	#4 @ 10"	39.78	#4 @ 10"	39.47	#4 @ 10"	39.20	#4 @ 9"	39.86	#5 @ 10"	43.28	#5 @ 10"	43.12
	6	#4 @ 10"	45.79	#4 @ 10"	44.30	#4 @ 10"	43.31	#4 @ 10"	42.62	#4 @ 10"	42.10	#4 @ 10"	41.71	#4 @ 10"	41.39	#4 @ 10"	41.12	#4 @ 9"	41.82	#5 @ 10"	45.46	#5 @ 10"	45.30
	7	#4 @ 10"	48.04	#4 @ 10"	46.50	#4 @ 10"	45.49	#4 @ 10"	44.77	#5 @ 10"	49.29	#5 @ 10"	48.86	#5 @ 10"	48.53	#5 @ 10"	48.24	#5 @ 10"	48.03	#5 @ 10"	47.84	#5 @ 10"	47.67
	8	#4 @ 10"	50.43	#4 @ 10"	48.84	#4 @ 10"	47.80	#4 @ 10"	47.06	#5 @ 10"	51.83	#5 @ 10"	51.40	#5 @ 10"	51.05	#5 @ 10"	50.77	#5 @ 10"	50.54	#5 @ 10"	50.35	#5 @ 10"	50.18
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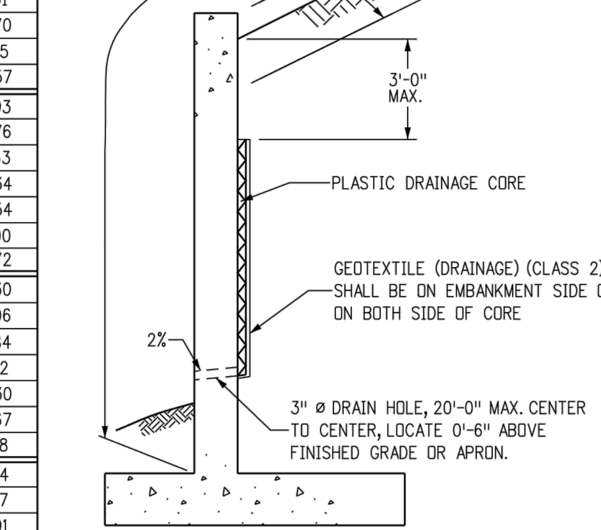
	3	#4 @ 10"	38.23	#4 @ 10"	36.80	#4 @ 10"	35.85	#4 @ 10"	35.18	#4 @ 10"	34.67	#4 @ 10"	34.28	#4 @ 10"	33.97	#4 @ 10"	33.70	#4 @ 10"	33.50	#4 @ 10"	33.32	#4 @ 10"	33.17
	4	#4 @ 10"	40.09	#4 @ 10"	38.61	#4 @ 10"	37.64	#4 @ 10"	36.95	#4 @ 10"	36.44	#4 @ 10"	36.04	#4 @ 10"	35.72	#4 @ 10"	35.45	#4 @ 10"	35.25	#4 @ 10"	35.07	#4 @ 10"	34.91
	5	#4 @ 10"	41.99	#4 @ 10"	40.47	#4 @ 10"	39.47	#4 @ 10"	38.76	#4 @ 10"	38.24	#4 @ 10"	37.83	#4 @ 10"	37.50	#4 @ 10"	37.23	#4 @ 10"	37.02	#4 @ 10"	36.84	#4 @ 10"	36.68
	6	#4 @ 10"	43.97	#4 @ 10"	42.40	#4 @ 10"	41.36	#4 @ 10"	40.64	#4 @ 10"	40.10	#4 @ 10"	39.68	#4 @ 10"	39.35	#4 @ 10"	39.07	#4 @ 9"	43.33	#5 @ 10"	43.13	#5 @ 10"	42.96
	7	#4 @ 10"	46.19	#4 @ 10"	44.56	#4 @ 10"	43.49	#4 @ 10"	42.74	#4 @ 10"	42.18	#4 @ 10"	41.75	#4 @ 10"	41.41	#4 @ 10"	41.13	#4 @ 9"	45.65	#5 @ 10"	45.45	#5 @ 10"	45.28
7	2	#4 @ 10"	34.90	#4 @ 10"	33.44	#4 @ 10"	32.47	#4 @ 10"	31.78	#4 @ 10"	31.27	#4 @ 10"	30.86	#4 @ 10"	30.54	#4 @ 10"	30.27	#4 @ 9"	30.06	#4 @ 10"	29.88	#4 @ 10"	29.72
	3	#4 @ 10"	36.73	#4 @ 10"	35.23	#4 @ 10"	34.23	#4 @ 10"	33.53	#4 @ 10"	33.00	#4 @ 10"	32.59	#4 @ 10"	32.26	#4 @ 10"	31.99	#4 @ 10"	31.78	#4 @ 10"	31.59	#4 @ 10"	31.43
	4	#4 @ 10"	38.59	#4 @ 10"	37.04	#4 @ 10"	36.01	#4 @ 10"	35.29	#4 @ 10"	34.75	#4 @ 10"	34.33	#4 @ 10"	33.99	#4 @ 10"	33.71	#4 @ 10"	33.50	#4 @ 10"	33.31	#4 @ 10"	33.14
	5	#4 @ 10"	40.48	#4 @ 10"	38.86	#4 @ 10"	37.80	#4 @ 10"	37.06	#4 @ 10"	36.50	#4 @ 10"	36.07	#4 @ 10"	35.73	#4 @ 10"	35.44	#4 @ 10"	35.22	#4 @ 10"	35.03	#4 @ 10"	34.86
	6	#4 @ 10"	42.39	#4 @ 10"	40.71	#4 @ 10"	39.61	#4 @ 10"	38.84	#4 @ 10"	38.26	#4 @ 10"	37.82	#4 @ 10"	37.47	#4 @ 10"	37.17	#4 @ 10"	36.95	#4 @ 10"	36.75	#4 @ 10"	36.58

EXAMPLE:

SELECT THE c-BARS SIZE, SPACING AND STEEL QUANTITY FOR A 25.0 FEET LONG WINGWALL WITH m = 11.8 FT. AND k = 6.3 FT.

SOLUTION:

1. DETERMINE WINGWALL LENGTH IN MULTIPLE OF m:
   L / m = 25.0 / 11.8 = 2.12
   L = (2.12 x m), USE L ≤ (2.25 x m)
2. ROUND TO REAREST WHOLE NUMBER FOR m AND k:
   m = 11.8 FT., USE m = 12.0 FT.
   k = 6.3 FT., USE k = 6.0 FT.
3. DETERMINE c-BARS BY USING THE TABLE:
   L ≤ (2.25 x m)
   m = 12
   k = 6
   c-BARS: #6 @ 10"
   REINF. STEEL = 60.60 LB / LF
4. DETERMINE REINFORCING STEEL QUANTITY OF WHOLE WINGWALL:
   REINFORCING STEEL QUANTITY = 25.0 x 60.60 = 1,515 LB.



LIMITS OF CONCRETE SEALER AND WINGWALL DRAIN DETAILS

NOTES: 1. THE GEOCOMPOSITE SHALL BE SECURED TO THE WALL TO PREVENT MOVEMENT DURING BACKFILLING.

2. COST OF GEOCOMPOSITE DRAIN AND CONCRETE SEALER SHALL BE INCLUDED IN THE WORK.

Computer File Information			Sheet Revisions	
Creation Date: 07/04/12	Initials: HHB		Date:	Comments
Last Modification Date: 09/04/18	Initials:	(R-X)	09/04/18	LRFD Design
Full Path: www.codot.gov/business/designsupport		(R-X)		
Drawing File Name: 6010200202.dgn		(R-X)		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English		(R-X)		

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Division of Project Support HHB

WINGWALLS FOR PIPE OR BOX CULVERTS

Issued By: Project Development Branch July 4, 2012

STANDARD PLAN NO. M-601-20

Sheet No. 2 of 2

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

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Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

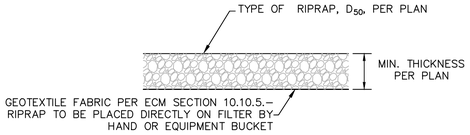
WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
CULVERT DETAILS

COLORADO LICENSED KEVIN REX KOFFORD 57234 8/31/2022 PROFESSIONAL ENGINEER

PROJECT NO. 196106001

SHEET 9

PCD FILE NO. CDR-21-012



1. D50 = MEAN PARTICLE SIZE (INTERMEDIATE DIMENSION) BY WEIGHT.
2. RIP RAP SHALL BE PER PLAN AND SHALL BE MIXED WITH 30% SOIL TO 70% RIP RAP.
3. RIP RAP SECTION THICKNESS SHALL BE 2.0 TIMES THE SPECIFIED MEAN PARTICLE SIZE (I.E. D50 X 2.0 MINIMUM) PER ECM SECTION 10.10.3.
4. ALL RIP RAP SHALL BE UNDERLAIN WITH GEOTEXTILE FILTER FABRIC FOR STABILIZATION.
5. RIP RAP SHALL WRAP AROUND AND EXTEND 2' MIN. BEHIND FLUME AND FLARED END SECTIONS.

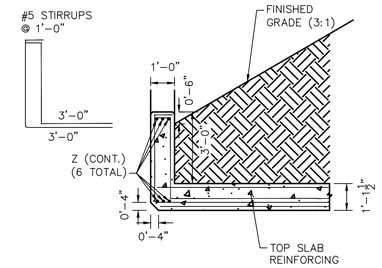
TYPICAL RIPRAP SECTION DETAIL

Table 9.5 Recommended wingwall flare angles (θ_a or θ_b)

Skew Angle, θ°	θ_a°	θ_b°
90	60	60
80	50	70
70	45	80
60	40	90
50	30	90
40	20	100
30	15	105
< 30	Consult the Region Hydraulic Engineer	

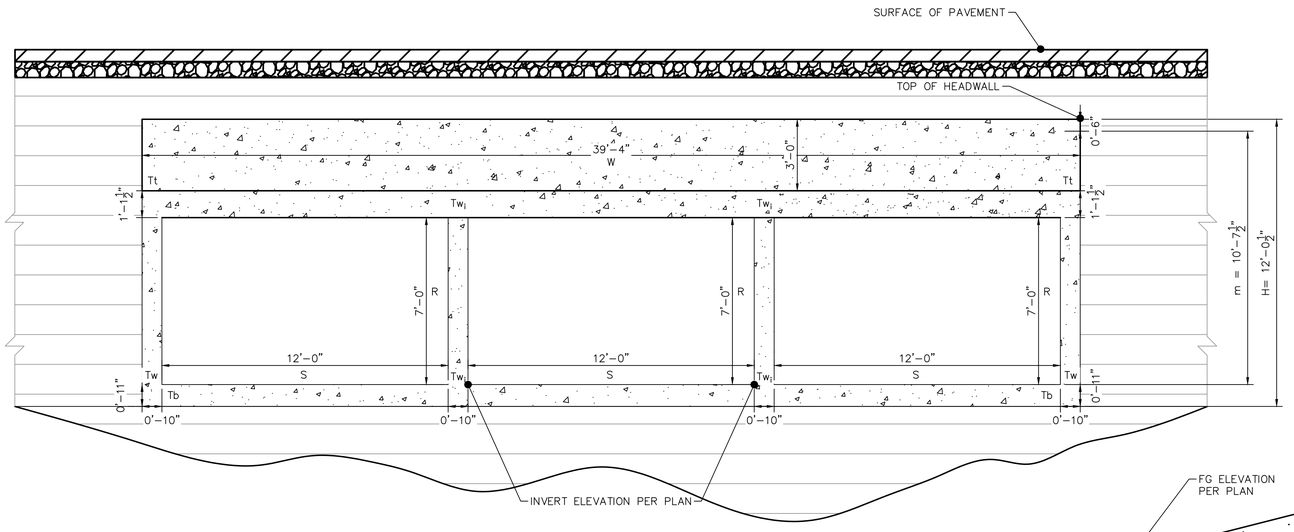
NO SKEW–CULVERT 2

75° SKEW–CULVERT 1



MODIFIED CULVERT HEADWALL SECTION DETAIL (A-A) FROM M-601-3

SCALE: 1"=3'



TRIPLE CONCRETE BOX CULVERT SECTION DETAIL

SCALE: 1"=3'

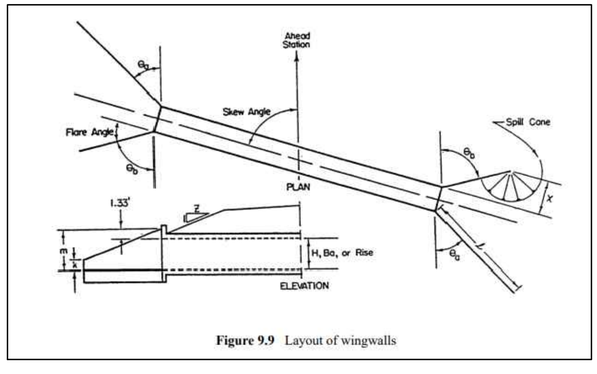
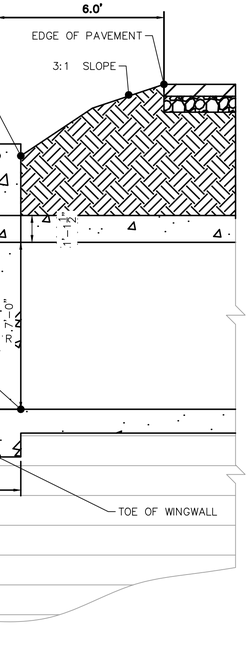


Figure 9.9 Layout of wingwalls

WINGWALL SPILL CONE CDOT DRAINAGE MANUAL FIGURE 9.9



WINGWALL (BOX CULVERT) SECTION DETAIL

SCALE: 1"=3'

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

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DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS

CULVERT DETAILS

COLORADO LICENSED KEVIN REX KOFFORD 57234 8/31/2022 PROFESSIONAL ENGINEER

PROJECT NO. 196106001

SHEET 10

PCD FILE NO. CDR-21-012

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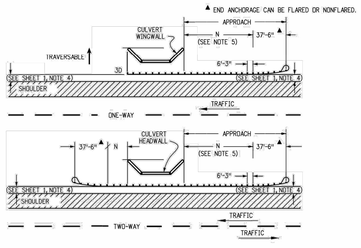
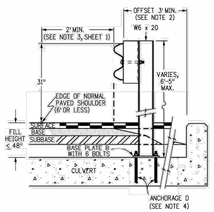
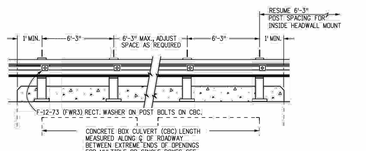
GUARDRAIL APPLICATION DETAILS



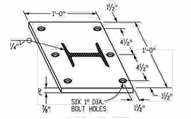
GUARDRAIL FOR CULVERTS



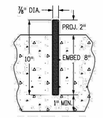
INSIDE MOUNT ON CBC



RAIL PLACEMENT FOR INSIDE MOUNT



BASE PLATE B
(FOR INSIDE MOUNT)



ANCHORAGE D
(FOR INSIDE MOUNT)

NOTES

1. LOCATION AND LENGTH OF MEDIAN GUARDRAIL APPROACHES TO CULVERTS WITH FULL HEADWALL AND WINGWALLS SHALL BE AS SHOWN FOR BRIDGES ON SHEET 15. THE GUARDRAIL TYPE 3 SHALL CONTINUE ACROSS THE CULVERT AS SHOWN ON THIS SHEET.
2. RIGHT SHOULDER BOX CULVERT TREATMENT IS SHOWN ON THIS SHEET FOR CULVERTS 20 FT. OR LESS IN LENGTH.
3. CONSTRUCTION AND PAYMENT FOR FILL HEIGHTS SHALL BE INCLUDED IN THE COST OF THE GUARDRAIL TYPE 3.
4. ANCHORAGE D: SIX BOLTS FOR BASE PLATE "B" WITH INSIDE MOUNT. THE BOLTS SHALL BE 7/8 IN. DIA X 10 IN. HIGH STRENGTH RODS THREADED FULL LENGTH AND ALL GALVANIZED. RODS SHALL BE CAST-IN-PLACE FOR NEW STRUCTURES. FOR EXISTING STRUCTURES, THE RODS SHALL BE INSTALLED IN 1-1/4 IN. DIA HOLES WITH NON-SHRINK GROUT OR EPOXY CONFORMING TO ASTM C 881. IF THE THICKNESS OF A CULVERT'S TOP PANEL REQUIRES BOLTS TO BE LESS THAN 10 IN. HIGH, THE BOLTS SHALL BE APPROVED BY THE ENGINEER.
5. THE GUARDRAIL LENGTH DIMENSION "N" IS THE LENGTH AS DETERMINED BY THE LENGTH OF NEED COMPUTATION AND IS SHOWN ON THE PLANS. THE MINIMUM IS 12 FT.-6 IN. WHERE SITE CONDITIONS ALLOW, THE OVERALL REQUIRED LENGTH OF NEED CAN INCLUDE THE LENGTH OF TRANSITION, THE LENGTH OF RAIL ON, AND ANY REDIRECTIVE LENGTH IN THE RAIL END TREATMENT.
6. ALL POSTS, BASE PLATES, AND ANCHOR BOLTS SHALL BE FABRICATED FROM ASTM A 36 STEEL. THE ABOVE MATERIAL, W-BEAM, AND ALL ANCHOR BOLTS AND MISCELLANEOUS BOLTS, NUTS, AND WASHERS SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH SECTION 509. CONCRETE, REINFORCING STEEL, AND STRUCTURAL STEEL ELEMENTS SHALL BE IN ACCORDANCE WITH SECTIONS 601, 602, AND 509, RESPECTIVELY.
7. POST ANCHORS, ENCASED IN CONCRETE, SHALL BE ASTM A 36 STEEL, AND NEED NOT BE GALVANIZED.
8. PRIOR TO INSTALLATION OF GUARDRAIL ON CULVERTS, THREE SETS OF WORKING DRAWINGS WHICH COMPLY WITH THE REQUIREMENTS OF SECTION 105 SHALL BE SUBMITTED TO THE ENGINEER FOR INFORMATION ONLY.

Computer File Information		Sheet Revisions		
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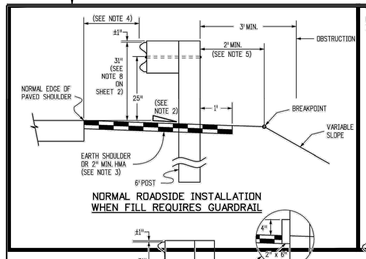
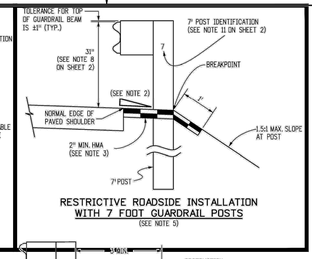
MIDWEST GUARDRAIL SYSTEM (MGS) TYPE 3 W-BEAM 31 INCHES
Issued by the Project Development Branch: July 31, 2019

STANDARD PLAN NO. M-606-1
Standard Sheet No. 19 of 19
Project Sheet Number:

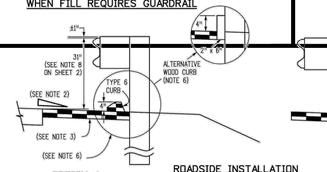
TYPICAL APPLICATION WITH EXCEPTION OF THE CULVERT CROSS SECTION



NORMAL ROADSIDE INSTALLATION
WHEN FILL REQUIRES GUARDRAIL

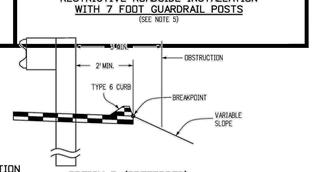


RESTRICTIVE ROADSIDE INSTALLATION
WITH 7 FOOT GUARDRAIL POSTS
(SEE NOTE 5)

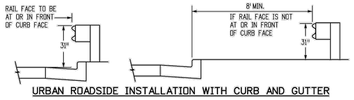


OPTION A

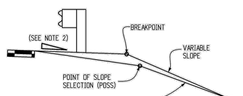
ROADSIDE INSTALLATION
WITH EROSION CONTROL CURB



OPTION B (PREFERRED)



URBAN ROADSIDE INSTALLATION WITH CURB AND GUTTER



EMBANKMENT WITH GUARDRAIL

(NOTE: THE CATCHPOINT REMAINS THE SAME AS THAT FOR "NORMAL" FILL SLOPE. FOR THE WIDER "2" DISTANCES, THE VARIABLE SLOPE MAY "CATCH" AT THE POSS.)

LOCATION	SPACING
ALL LOCATIONS EXCEPT BRIDGE RAIL LOCATIONS	6'-3"
BRIDGE OR STRUCTURE APPROACH	SEE SHEETS 11 & 19

NORMAL CENTER-TO-CENTER POST SPACING

APPLICATION OVER THE CULVERT. REFERENCE TYPICAL SECTION ON SHEET 2

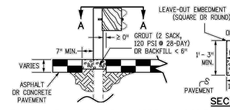
GENERAL NOTES (CONTINUE ON SHEET 2)

1. ALL GUARDRAILS SHOWN ARE MASH 2016 TL-3 COMPLIANT.
2. RATE OF SLOPE DEPENDS ON GUARDRAIL LOCATION:
   A. FOR GUARDRAIL FACE 2 FT. OR LESS FROM THE NORMAL EDGE OF PAVED SHOULDER, CONTINUE THE RATE OF SLOPE OF THE NORMAL PAVED SHOULDER TO THE BREAKPOINT.
   B. FOR GUARDRAIL FACE MORE THAN 2 FT. FROM THE NORMAL EDGE OF THE PAVED SHOULDER, THE SLOPE SHALL BE 10:1 OR FLATTER.
3. WHEN SPECIFIED ON THE PLANS, EXTEND A 2 IN. MINIMUM THICKNESS PAVED SURFACE TO 1 FT. BEHIND THE GUARDRAIL POSTS OR TO THE EROSION CONTROL CURB AS SHOWN ON PLANS. ASPHALT CUTTING & PATCHING OR OTHER APPROVED METHOD SHALL BE USED TO MINIMIZE DAMAGE TO ALL PAVED SURFACES UNDER GUARDRAIL INSTALLATIONS. ALL REPAIRS TO THE PAVED AREA WILL NOT BE MEASURED AND PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE COST OF THE WORK. A MINIMUM 3 IN. THICK FIBER REINFORCED CONCRETE PAVEMENT MAY ALSO BE USED FOR PAVING BENEATH THE GUARDRAIL. INSTALL THE POST IN A ½ IN. OVERSIZED FORMED HOLE FOR GUARDRAIL RUNS AND TERMINALS AS DIRECTED. PAYMENT FOR THIS PAVED SURFACE WILL BE MADE UNDER A PAVEMENT OR CONCRETE PAY ITEM WITH QUANTITIES SHOWN ON THE PLANS.
4. THE MINIMUM GUARDRAIL OFFSET FROM PAVED SHOULDER EDGE SHALL BE:
   0 FT. FOR SHOULDERS 8 FT. OR WIDER
   2 FT. FOR SHOULDERS 6 FT. OR LESS

   THE GUARDRAIL OFFSET FROM PAVED INSIDE SHOULDER EDGE OF A DIVIDED HIGHWAY SHALL BE;
   0 FT. MINIMUM FOR SHOULDERS 6 FT. OR WIDER
   2 FT. DESIRABLE FOR 4 FT. SHOULDERS

   THE ABOVE 2 FT. GUARDRAIL TO SHOULDER OFFSET IS DESIRABLE BUT NOT REQUIRED FOR:
   A. FOR AN EXISTING HIGHWAY WITH A DESIGN SPEED LESS THAN 50 MPH, THE MINIMUM OFFSET IS 4 FT. FROM THE TRAVELED WAY.
   B. FOR A ONE-WAY ONE-LANE RAMP, AND WHERE ONE OR MORE OF THE FOLLOWING ARE TRUE:
      (1) THE NON-OFFSET GUARDRAIL BEGINS AT LEAST 100 FT. BEYOND RAMP NOSE.
      (2) THE NON-OFFSET GUARDRAIL IS NOT LOCATED ON THE RAMP EXIT OR ENTRANCE CURVE CONNECTION TO THE MAJOR HIGHWAY.
      (3) THE RAMP SHOULDERS ARE 4 FT. OR WIDER.

   USE OF GREATER THAN MINIMUM OFFSET DIMENSIONS IS ENCOURAGED TO MEET THE DESIRABLE GOAL OF PLACING THE GUARDRAIL AS FAR AS POSSIBLE FROM THE TRAVEL WAY, EVEN FOR SHORT DISTANCES, WHILE PROVIDING A SMOOTH CHANGE IN GUARDRAIL ALIGNMENT.
5. IF 2 FT. CANNOT BE PROVIDED BETWEEN THE BACK OF THE GUARDRAIL POST AND THE BREAKPOINT, USE 7 FT. GUARDRAIL POSTS. REFER TO THE "RESTRICTIVE ROADSIDE INSTALLATION" DETAIL.
6. WHEN SPECIFIED ON THE PLANS, INSTALL 4 IN. HIGH TYPE 6 CURB WITH ITS FACE AT OR BEHIND THE RAIL FACE. AS AN ALTERNATIVE WHEN SPECIFIED ON THE PLANS, INSTALL A 2 IN. x 6 IN. TREATED (AASHTO M 133) WOOD CURB. FASTEN WITH A 4 IN. LAG BOLT AND WASHER AT EACH WOOD POST, OR WITH A 1/4 IN. DIA. BOLT WITH WASHER AND NUT AT EACH STEEL POST. IF THE 2 IN. x 6 IN. WOOD CURB IS SPECIFIED, IT WILL BE INCLUDED IN THE COST OF THE GUARDRAIL. IF APPROVED BY THE ENGINEER, A 2 IN. x 4 IN. TREATED WOOD CURB MAY BE SUBSTITUTED FOR THE 2 IN. x 6 IN. CURB AND SET ON TOP OF PAVEMENT SURFACE AND ATTACHED AS DESCRIBED ABOVE. NO SPLICING SHALL BE ALLOWED IN WOOD CURBS. ADJACENT BOARDS SHALL BE BUTTED TOGETHER AND BOLTED AT A POST LOCATION. JOINTS SHALL BE LOCATED AT THE POSTS.



SECTION A-A

LEAVE-OUT AREA FOR GUARDRAIL POSTS LOCATED IN PAVEMENT

NOTE: LEAVE-OUT AREAS SHALL BE PROVIDED FOR ALL GUARDRAIL POSTS LOCATED IN PAVEMENT TO ALLOW THE POSTS TO ROTATE IN THEIR EMBEDMENT SUCH THAT VEHICLE IMPACT LOADS ARE DISTRIBUTED THROUGH THE POST INTO THE EMBEDMENT MATERIAL PRIOR TO THE POSTS BREAKING PREMATURELY.

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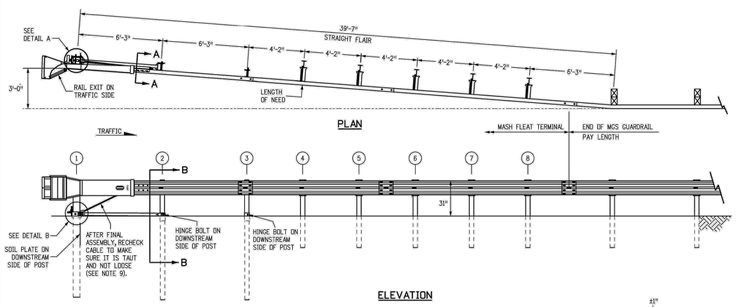
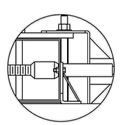
MIDWEST GUARDRAIL SYSTEM (MGS) TYPE 3 W-BEAM 31 INCHES
Issued by the Project Development Branch: July 31, 2019

STANDARD PLAN NO. M-606-1
Standard Sheet No. 1 of 19
Project Sheet Number:

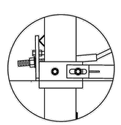
OFFSET NOTES

1. POST OFFSET DIMENSIONS ARE GIVEN TO THE CENTER OF THE TRAFFIC FACE OF POSTS.
2. THE GUARDRAIL BETWEEN POST (1) THRU (8) IS ON A STRAIGHT LINE FLARE.

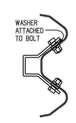




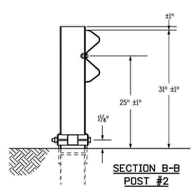
DETAIL A
IMPACT HEAD CONNETION



DETAIL B
POST #1 CONNECTION



SECTION A-A
ANCHOR BRACKET



SECTION B-B
POST #2

MFLEAT TERMINAL
(MASH CERTIFIED)

NOTES

1. THE END ANCHORAGE (FLARED) SHALL BE THE MFLEAT TERMINAL, AS MANUFACTURED BY ROAD SYSTEMS INC. (TELEPHONE #: 432-263-2435). ONE END ANCHORAGE (FLARED) SHALL INCLUDE ALL POST, RAIL, AND ALL HARDWARE ITEMS REQUIRED FOR A COMPLETE UNIT. THE END ANCHORAGE (FLARED) SHALL BE INSTALLED CONFORMING TO THE MANUFACTURER'S RECOMMENDATIONS. THE CONTRACTOR SHALL PROVIDE A COPY OF THE MANUFACTURER'S INSTALLATION INSTRUCTIONS AND PARTS LIST TO THE ENGINEER PRIOR TO INSTALLATION OF THE DEVICE.
2. RETROREFLECTOR TABS SHALL NOT BE USED ON END ANCHORAGE POSTS.
3. DELINEATION SHALL BE APPLIED TO THE END PIECE, AND SHALL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK.
4. AESTHETIC TREATMENT OPTIONS MAY BE AVAILABLE WITH PRIOR APPROVAL OF THE PROJECT ENGINEER. CONTACT THE MANUFACTURER FOR APPROVED AESTHETIC TREATMENT OPTIONS.
5. ALL BOLTS, NUTS, CABLE ASSEMBLIES, CABLE ANCHORS AND BEARING PLATES SHALL BE GALVANIZED.
6. THE LOWER SECTIONS OF THE POSTS 1, 2, AND 3 SHALL NOT PROTRUDE MORE THAN 4 INCHES ABOVE THE GROUND (MEASURED ALONG A 5 FOOT CORD). SITE GRADING MAY BE NECESSARY TO MEET THIS REQUIREMENT.
7. THE LOWER SECTIONS OF THE HINGED POSTS SHOULD NOT BE DRIVEN WITH THE UPPER POST ATTACHED. IF THE POST IS PLACED IN A DRILLED HOLE, THE BACKFILL MATERIAL MUST BE SATISFACTORILY COMPACTED TO PREVENT SETTLEMENT.
8. WHEN COMPETENT ROCK IS ENCOUNTERED, A 12 INCH DIA. POST HOLE, DRILLED 20 INCHES DEEP INTO THE ROCK SURFACE SHALL BE USED IF APPROVED BY THE ENGINEER FOR POSTS 1 AND/OR 2. GRANULAR MATERIAL SHALL BE PLACED IN THE BOTTOM OF THE HOLE, APPROXIMATELY 2.5 INCHES DEEP TO PROVIDE DRAINAGE. THE FIRST AND/OR SECOND POST SHALL BE FIELD CUT TO LENGTH, PLACED IN THE HOLE AND BACKFILLED WITH SUITABLE BACKFILL. THE SOIL PLATE MAY BE TRIMMED IF REQUIRED.
9. THE BREAKAWAY CABLE ASSEMBLY SHALL BE TAUT. A LOCKING DEVICE (VICE GRIPS OR CHANNEL LOCK PLIERS) SHOULD BE USED TO PREVENT THE CABLE FROM TWISTING WHEN TIGHTENING NUTS.

END ANCHORAGES (FLARED)

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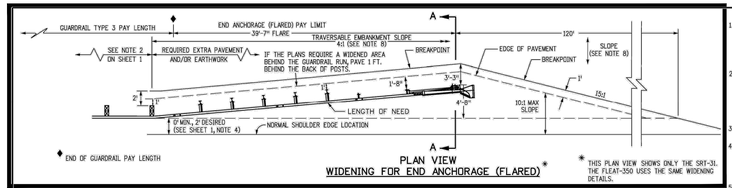
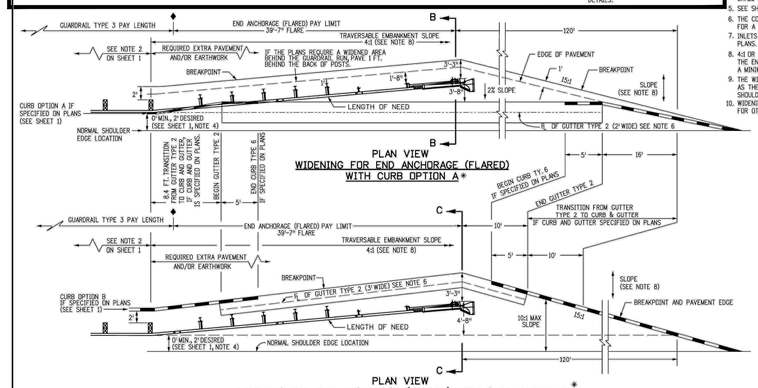
STANDARD PLAN NO. M-606-1
Standard Sheet No. 6 of 19
Project Sheet Number:



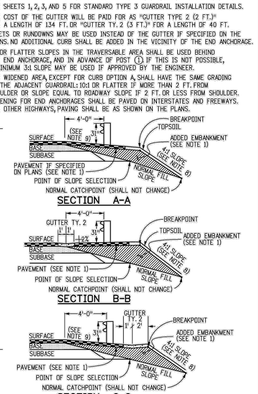
PLAN VIEW
WIDENING FOR END ANCHORAGE (FLARED)

THIS PLAN VIEW SHOWS ONLY THE SRT-31. THE FLEAT-350 USES THE SAME WIDENING DETAILS.



NOTES

1. PAYMENT FOR THE ADDED EMBANKMENT (APPROXIMATELY 45 CU. YDS.) FOR THE FLARE SHALL BE AS FOLLOWS:
   A. UNDER PAY ITEM 203 WHEN THE CONTRACT PLAN INCLUDES PAY ITEM 203
   B. INCLUDED IN THE COST OF THE END ANCHORAGE (FLARED) WHEN THE CONTRACT PLANS DO NOT INCLUDE PAY ITEM 203. THE ADDED EMBANKMENT SHALL BE CONSTRUCTED IN ACCORDANCE WITH SUBSECTION 203.07, AASHTO T 99.
2. WHEN THE WIDENED AREA IS PAVED, PAYMENT FOR THE PAVEMENT (APPROX. 70 SQ. YDS.) SHALL BE AS FOLLOWS:
   A. UNDER PAY ITEM 403 OR 412 WHEN THE CONTRACT PLAN INCLUDES PAY ITEM 403 OR 412
   B. INCLUDED IN THE COST OF THE END ANCHORAGE (FLARED) WHEN THE CONTRACT PLAN DOES NOT INCLUDE PAY ITEM 403 OR 412 (SEE SHEET 1, NOTE 2 FOR PAVEMENT TYPES)
3. CONCRETE PAVED AREAS SHALL HAVE THEIR TAPERED ENDS SQUARED OFF AS DIRECTED BY THE ENGINEER.
4. WHEN OVERLAY PAVING, THE FINISHED SURFACE AT EACH POST SHALL NOT BE ABOVE THE TOP BREAKAWAY SLOT OR STRUT ASSEMBLY. THE WIDENED AREA AT THE FLARED END ANCHORAGE SHOULD NOT BE OVERLAYED UNLESS PAVEMENT CONDITIONS WARRANT IT BEING OVERLAYED. ANY OVERLAY PAVEMENT ABUTTING THE FLARED END ANCHORAGE SHALL BE TAPERED TO PREVENT A DROP IN THE PAVED SURFACE BELOW THE RAIL.
5. SEE SHEETS 1, 2, 3, AND 5 FOR STANDARD TYPE 3 GUARDRAIL INSTALLATION DETAILS.
6. THE COST OF THE GUTTER WILL BE PAID FOR AS "GUTTER TYPE 2 (2 FT.)" FOR A LENGTH OF 134 FT. OR "GUTTER TY. 2 (3 FT.)" FOR A LENGTH OF 40 FT.
7. INLETS OR RUNDOWNS MAY BE USED INSTEAD OF THE GUTTER IF SPECIFIED ON THE PLANS. NO ADDITIONAL CURB SHALL BE ADDED IN THE VICINITY OF THE END ANCHORAGE.
8. 4:1 OR FLATTER SLOPES IN THE TRAVERSABLE AREA SHALL BE USED BEHIND THE END ANCHORAGE, AND IN ADVANCE OF POST (1) IF THIS IS NOT POSSIBLE, A MINIMUM 3:1 SLOPE MAY BE USED IF APPROVED BY THE ENGINEER.
9. THE WIDENED AREA, EXCEPT FOR CURB OPTION A, SHALL HAVE THE SAME GRADING AS THE ADJACENT GUARDRAIL: 10:1 OR FLATTER IF WIDE THAN 2 FT. FROM SHOULDER OR SLOPE EQUAL TO ROADWAY SLOPE IF 2 FT. OR LESS FROM SHOULDER.
10. WIDENING FOR END ANCHORAGES SHALL BE PAVED ON INTERSTATES AND FREEWAYS. FOR OTHER HIGHWAYS, PAVING SHALL BE AS SHOWN ON THE PLANS.



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STANDARD PLAN NO. M-606-1
Standard Sheet No. 7 of 19
Project Sheet Number:

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

Kimley»Horn
2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
GUARDRAIL DETAILS

COLORADO LICENSED KEVIN R. KRUEGER 57234 8/31/2022 PROFESSIONAL ENGINEER

PROJECT NO. 196106001

SHEET 11

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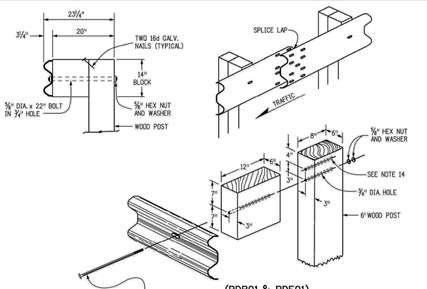
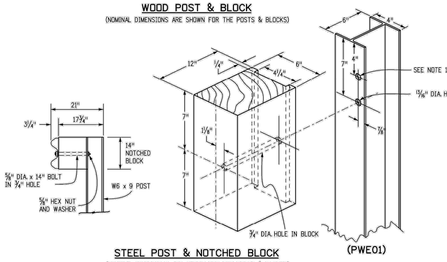
STANDARD GUARDRAIL DETAILS



(PDB01 & PDE01)

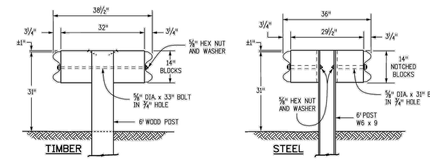
WOOD POST & BLOCK

(NOMINAL DIMENSIONS ARE SHOWN FOR THE POSTS & BLOCKS)



STEEL POST & NOTCHED BLOCK

(NOMINAL DIMENSIONS ARE SHOWN FOR THE POSTS & BLOCKS)



DOUBLE BLOCK AND GUARDRAIL TYPE 3 (DOUBLE) FOR MEDIAN BARRIER

GENERAL NOTES (CONTINUED FROM SHEET 1)

7. SEE SHEETS 7 AND 9 FOR CURB TREATMENTS AT GUARDRAIL TERMINALS.
8. IF THIS DIMENSION WILL BE LESS THAN 28 INCHES, RESET GUARDRAIL HEIGHT TO 28 INCHES OR ABOVE.
9. ALL W-BEAM SPLICES, AND SPLICES OF TERMINAL CONNECTORS TO W-BEAM SHALL BE LAPPED IN THE DIRECTION OF TRAFFIC UNLESS OTHERWISE NOTED IN THE PLANS OR BY THE MANUFACTURER.
10. MATERIAL TYPE AND SHAPE OF POSTS AND BLOCKS SHALL BE THE SAME THROUGHOUT THE PROJECT EXCEPT WHEN SPECIFIC POSTS AND BLOCKS ARE SPECIFIED, i.e. AT END ANCHORAGES AND BOX CULVERTS.
11. WHEN SPECIFIED IN THE CONTRACT, 7 FT. POSTS SHALL BE INSTALLED INSTEAD OF THE STANDARD 6 FT. POSTS. THE 7 FT. POSTS SHALL BE MARKED WITH THE NUMBER 7 TO ENSURE PERMANENT INDENTIFICATION. STEEL POSTS SHALL BE STAMPED PRIOR TO GALVANIZING. THE NUMBER 7 SHALL BE A MINIMUM 2 IN. TALL AND LOCATED AS SHOWN ON THE ELEVATION VIEW ON SHEET 1.
12. THE STANDARD 3 IN. X 1⅝ IN. X ⅜ IN. RECTANGULAR WASHER USED UNDER POST BOLT HEADS IN THE PAST MAY REMAIN IN EXISTING INSTALLATIONS BUT SHALL NOT BE USED IN NEW CONSTRUCTION, REPAIRS, OR RESETTING OF RAIL EXCEPT WHEN SPECIFICALLY IDENTIFIED ON THE STANDARD PLAN.
13. STANDARD GALVANIZED ROUND STEEL WASHERS SHALL BE USED UNDER ALL NUTS IN CONTACT WITH WOOD POSTS.
14. AN ADDITIONAL HOLE SHALL BE PROVIDED IN THE POSTS TO FACILITATE FUTURE RAISING OF THE RAIL ELEMENTS AND BLOCKS FOR OVERLAYS. POSTS PROVIDED MAY ALSO HAVE ADDITIONAL HOLES (UP TO 4 PER FLANGE) FOR MEDIAN GUARDRAIL APPLICATION.
15. RETROREFLECTOR TABS SHALL BE INSTALLED AT 25 FT. INTERVALS (SEE SHEETS 6 AND 8 FOR EXCEPTIONS). RETROREFLECTOR TABS WILL NOT BE PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE WORK. THE TABS SHALL BE INSTALLED ON SPLICE BOLTS, NOT ON POST BOLTS AND SHALL BE MOUNTED SO THE BOLT SLOT FACES AWAY FROM TRAFFIC, AND THE RETROREFLECTOR SURFACE FACES THE APPROACHING TRAFFIC FOR ONE-WAY ROADS. FOR TWO-WAY ROADS, BOTH SIDES OF THE TABS SHALL BE RETROREFLECTIVE, SO THAT DELINEATION IS PROVIDED FOR BOTH DIRECTIONS OF TRAVEL. THE RETROREFLECTIVE SHEETING COLOR SHALL MATCH THE COLOR OF THE ADJACENT TRAVEL WAY EDGE LINE. SEE THE RETROREFLECTOR TAB DETAIL ON SHEET 3.
16. AT THE TIME OF INSTALLATION, WOOD POSTS OR BLOCKS WITH SEASONING CHECKS GREATER THAN ¼ IN. SHALL NOT BE USED WHEN THE CHECK EXTENDS THE FULL LENGTH OF THE PIECE.
17. WOOD BLOCKS SHALL BE CUT FROM THE SAME CROSS-SECTION, SPECIES, AND GRADE, AND SHALL RECEIVE THE SAME PRESERVATIVE TREATMENT AS THE POSTS WHEN WOOD POSTS ARE USED.
18. REFERENCES SUCH AS @@POST@@, @@POST01@@, AND @@PWE01@@ IN THIS STANDARD PLAN SPECIFY HARDWARE DETAILS FROM 619A GUIDE TO STANDARDIZED HIGHWAY BARRIER HARDWARE" PREPARED BY THE AASHTO-AGC-ARTBA JOINT COOPERATIVE COMMITTEE.
19. RAIL BLOCKS MANUFACTURED FROM SYNTHETIC MATERIAL WILL BE ACCEPTED AS ALTERNATIVES TO WOOD BLOCKS FOR USE WITH STEEL POSTS PROVIDED THAT THE BLOCKS HAVE RECEIVED FHWA APPROVAL.
20. WOOD POSTS SHALL BE MADE OF TIMBER WITH AN EXTREME FIBER STRESS IN BENDING OF 1200 PSI STRESS GRADING AND POST DIMENSIONS SHALL CONFORM WITH THE RULES OF THE WEST COAST INSPECTION BUREAU, OR THE SOUTHERN PINE BUREAU, OR THE WESTERN WOOD PRODUCTS ASSOCIATION. TIMBER FOR POSTS SHALL BE EITHER ROUGH SAWN (UNPLANED) OR S4S (SURFACED FOUR SIDES) WITH NOMINAL DIMENSIONS INDICATED. ONLY ONE TYPE OF SURFACE FINISH SHALL BE USED FOR POSTS AND BLOCKS IN ANY ONE CONTINUOUS LENGTH OF GUARDRAIL.
21. GLULAM POSTS AND BLOCKS WILL BE ACCEPTED AS ALTERNATIVES PROVIDED THAT THE SUPPLIED MATERIALS HAVE RECEIVED FHWA APPROVAL AND ARE CERTIFIED AS IDENTICAL TO THE SPECIMENS USED FOR TESTING AND APPROVAL.
22. PRESSURE TREATMENT OF POSTS AND BLOCKS SHALL CONFORM TO AASHTO M 133 EXCEPT THAT BLOCKS NEED NOT BE INCISED. PRESERVATION ASSAY RETENTION REPORTS SHALL BE SUBMITTED TO THE ENGINEER. THE CONTRACTOR SHALL CERTIFY THAT THE SPECIES AND GRADE MEET THE REQUIREMENTS OF THE CONTRACT.
23. W-BEAM AND THRIE-BEAM GUARDRAIL POSTS SHALL BE MANUFACTURED USING AASHTO M 270 (ASTM A 709) GRADE 36 STEEL, UNLESS CORROSION RESISTANT STEEL IS REQUIRED, IN WHICH CASE THE POST SHALL BE MANUFACTURED FROM AASHTO M 270 (ASTM A 709) GRADE 50W STEEL. THE DIMENSIONS OF THE CROSS-SECTION SHALL CONFORM TO A W6 X 9 SECTION AS DEFINED IN AASHTO M 160 (ASTM A 6). W6 X 8.5 WIDE FLANGE STEEL POSTS ARE AN ACCEPTABLE ALTERNATIVE TO THE W6 X 9.
24. AFTER THE SECTION IS CUT AND ALL HOLES ARE DRILLED OR PUNCHED THE COMPONENT SHALL BE ZINC-COATED CONFORMING TO AASHTO M 111 (ASTM A 123) UNLESS CORROSION-RESISTANT STEEL IS USED. WHEN CORROSION-RESISTANT STEEL IS USED THE PORTION OF THE POST TO BE EMBEDDED IN SOIL SHALL BE ZINC-COATED CONFORMING TO AASHTO M 111 (ASTM A 123) AND THE PORTION ABOVE THE SOIL SHALL NOT BE ZINC-COATED, PAINTED OR OTHERWISE TREATED.
25. FIELD MODIFICATION TO RAIL ELEMENTS IS ALLOWED PER MANUFACTURER'S RECOMMENDATIONS, OR WITH THE APPROVAL OF THE STANDARDS AND SPECIFICATIONS UNIT. POSTS SHALL NOT BE MODIFIED. COMPONENTS ON WHICH THE SPELTER COATING HAS BEEN DAMAGED SHALL BE EITHER REGALVANIZED OR RECOATED IN CONFORMANCE WITH AASHTO M 36, OR PAINTED WITH ONE FULL BRUSH COAT OF ZINC RICH PAINT CONFORMING TO MILITARY SPECIFICATION DOD-P-21035A.

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CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	BOX		

Colorado Department of Transportation		MIDWEST GUARDRAIL SYSTEM (MGS) TYPE 3 W-BEAM 31 INCHES	STANDARD PLAN NO. M-606-1
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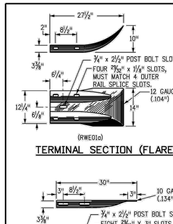
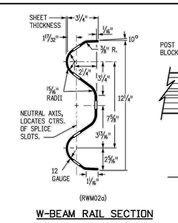
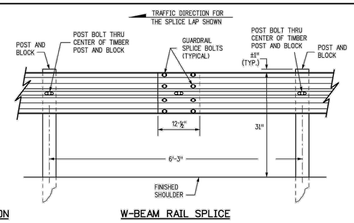
Project Development Branch	JBK	Issued by the Project Development Branch: July 31, 2019	Project Sheet Number:



TERMINAL SECTION (FLARED)

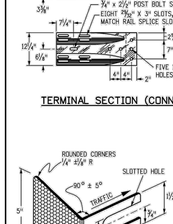


W-BEAM RAIL SECTION

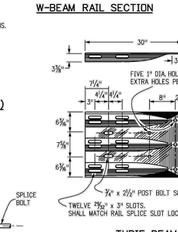


W-BEAM RAIL SPLICE

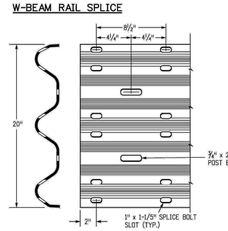
PART	MATERIAL SPEC.	GALVANIZING SPEC.	CORROSION-RESISTANT SPEC.
W-BEAM RAIL & TERMINAL SECTIONS	AASHTO M 180, CLASS A OR B	AASHTO M 180, TYPE 1 OR 2	AASHTO M 180, TYPE 4
BASE PLATE	ASTM A 36	AASHTO M 111	N.A.
NUTS, BOLTS & STUDS FOR GENERAL USE	ASTM A 307		AASHTO M 232, CLASS C
HIGH STRENGTH BOLTS & NUTS	ASTM A 325		OR
HIGH STRENGTH STUDS & NUTS	ASTM A 449		ASTM B 695 CLASS 50 TYPE 1
ROUND STEEL WASHERS	ASTM F 436		
RECTANGULAR WASHERS	AASHTO M 180		
OTHER FITTINGS	ASTM A 36	AASHTO M 111	



TERMINAL SECTION (CONNECTOR)



THRIE BEAM TERMINAL SECTION (CONNECTOR)



THRIE BEAM DETAIL

THE TABULATION OF GUARDRAIL WILL SPECIFY THE TYPE OF CORROSION PROTECTION: GALVANIZED OR CORROSION - RESISTANT STEEL.

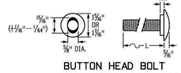
STEEL POSTS SHALL HAVE THE SAME CORROSION PROTECTION AS SPECIFIED FOR THE METAL BEAM RAIL, PUNCHING, DRILLING, CUTTING, OR WELDING OF POSTS WILL NOT BE PERMITTED AFTER GALVANIZING.

RECTANGULAR WASHER

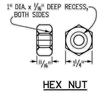
(TO BE USED ONLY WHERE SPECIFIED.)

RETROREFLECTOR TAB

NOTE: RETROREFLECTOR TABS SHALL BE MANUFACTURED FROM 12 TO 14 GAUGE STEEL AND SHALL CONFORM TO THE REQUIREMENTS OF S STANDARD S-612-1.



BUTTON HEAD BOLT WITH OVAL SHOULDER



WASHER

HEX NUT

DIAMETER & TYPE (INCHES)	12" BLOCKS L = LENGTH (INCHES)	THREAD LENGTH (INCHES)	INTENDED USE	AASHTO-AGC-ARTBA STANDARD NUMBER	NO. BOLTS, NUTS & WASHERS
⅝	11¼	FULL (1 ⅛")	ALL RAIL SPLICES	FBB01	8 PER SPLICE*
BUTTONHEAD OVAL SHLDR.	22	MIN. 2½	SINGLE BLOCK & POST (TIMBER)	FBB04	1 PER POST
	33	MIN. 2	DOUBLE BLOCK & POST (TIMBER)	FBB05	1 PER POST
	14	MIN. 2	FASTEN NOTCHED BLOCK TO STEEL POST	FBB03	1 PER BLOCK
WASHERS NOT USED AT RAIL SPLICES					

Computer File Information		Sheet Revisions	
Creation Date: 07/31/19		Date:	Comments:
Designer Initials: JBK	BOX		
Last Modification Date: 03/05/20	BOX		
Detailer Initials: LTA	BOX		
CAD Ver.: MicroStation V8 Scale: Not to Scale Units: English	BOX		

Colorado Department of Transportation		MIDWEST GUARDRAIL SYSTEM (MGS) TYPE 3 W-BEAM 31 INCHES	STANDARD PLAN NO. M-606-1
2829 West Howard Place, CDOT HQ, 3rd Floor, Denver, CO 80204, Phones: 303-757-9021 FAX: 303-757-9868			Standard Sheet No. 3 of 19
Project Development Branch	JBK	Issued by the Project Development Branch: July 31, 2019	Project Sheet Number:

PCD FILE NO. CDR-21-012

NO.	REVISION	BY	DATE	APPR.
3	COUNTY RESUBMITTAL #3	KRK	8/31/22	KRK
2	COUNTY RESUBMITTAL #2	KRK	4/6/22	KRK
1	COUNTY RESUBMITTAL #1	KRK	1/21/22	KRK

Kimley»Horn
2021 KIMLEY-HORN AND ASSOCIATES, INC.
2 North Nevada Avenue Suite 300
Colorado Springs, Colorado 80903 (719) 453-0180

DESIGNED BY: KRK
DRAWN BY: JRH
CHECKED BY: KRK
DATE: 9/3/2021

WINSOME FILING NO. 3
EL PASO COUNTY, COLORADO
CONSTRUCTION DOCUMENTS
GUARDRAIL DETAILS

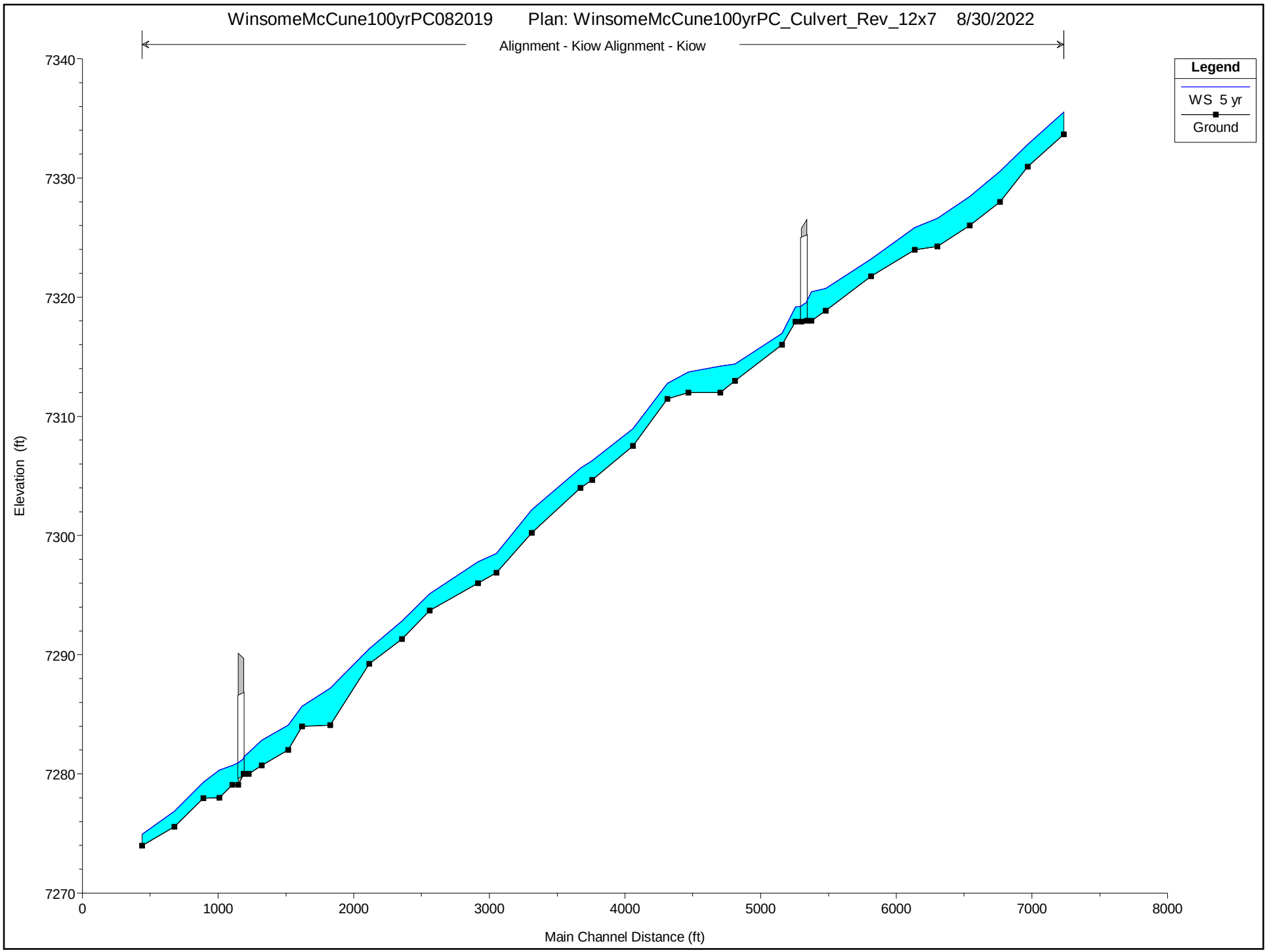
COLORADO LICENSED KEVIN REX KOFFORD 57234 PROFESSIONAL ENGINEER 8/31/2022

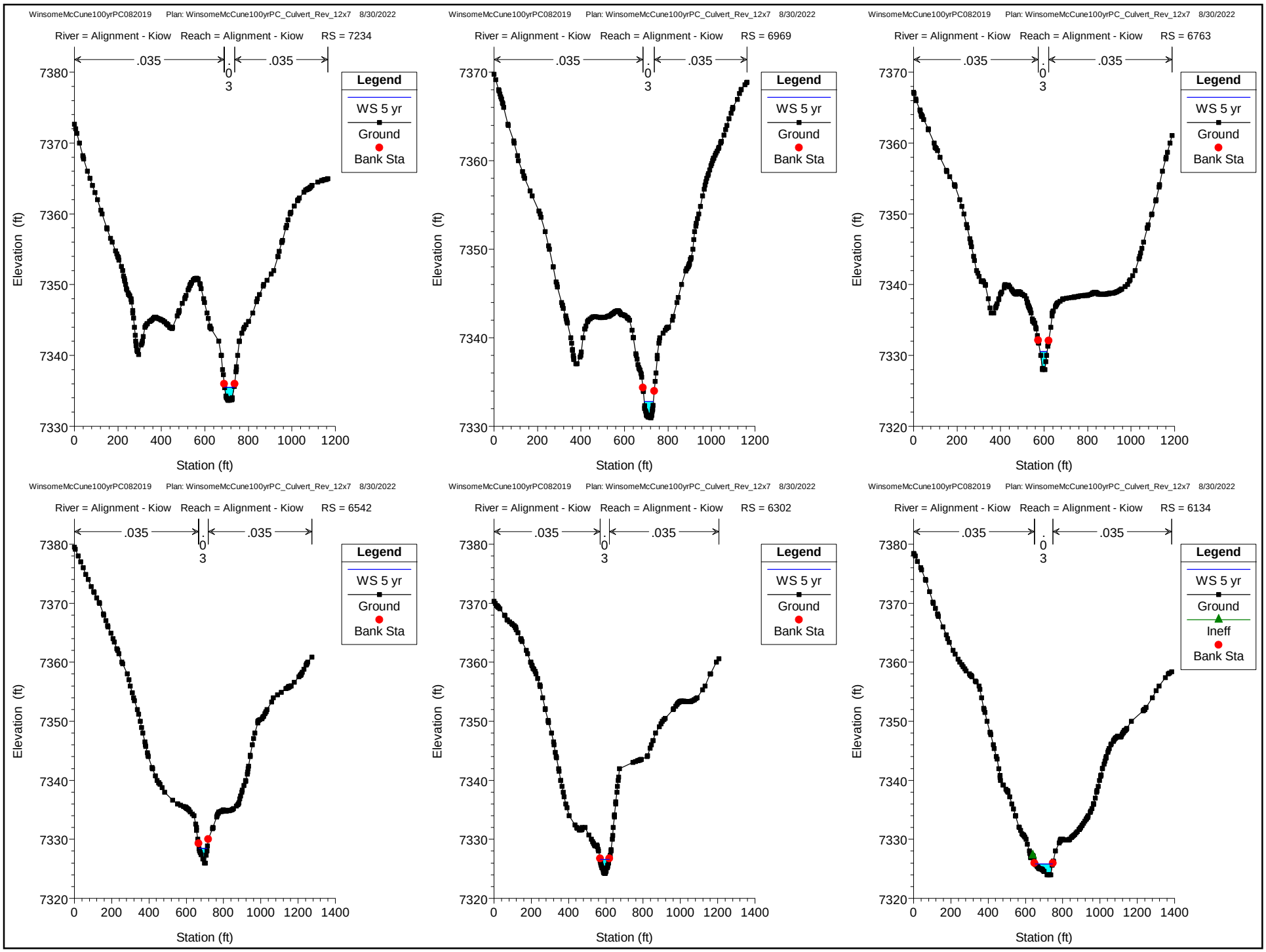
PROJECT NO. 196106001

SHEET 12

K:\COS_Civil\196106001_Winsome Filing No. 3\CADD\PlanSheets\Culvert CDs\196106001_DT.dwg Kofford, Kevin 8/31/2022 8:25 AM

APPENDIX G: HEC-RAS RESULTS – PROPOSED CONDITIONS


WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
Alignment - Kiow Alignment - Kiow
Legend
WS 5 yr
Ground
Elevation (ft)
7340
7330
7320
7310
7300
7290
7280
7270
0
1000
2000
3000
4000
5000
6000
7000
8000
Main Channel Distance (ft)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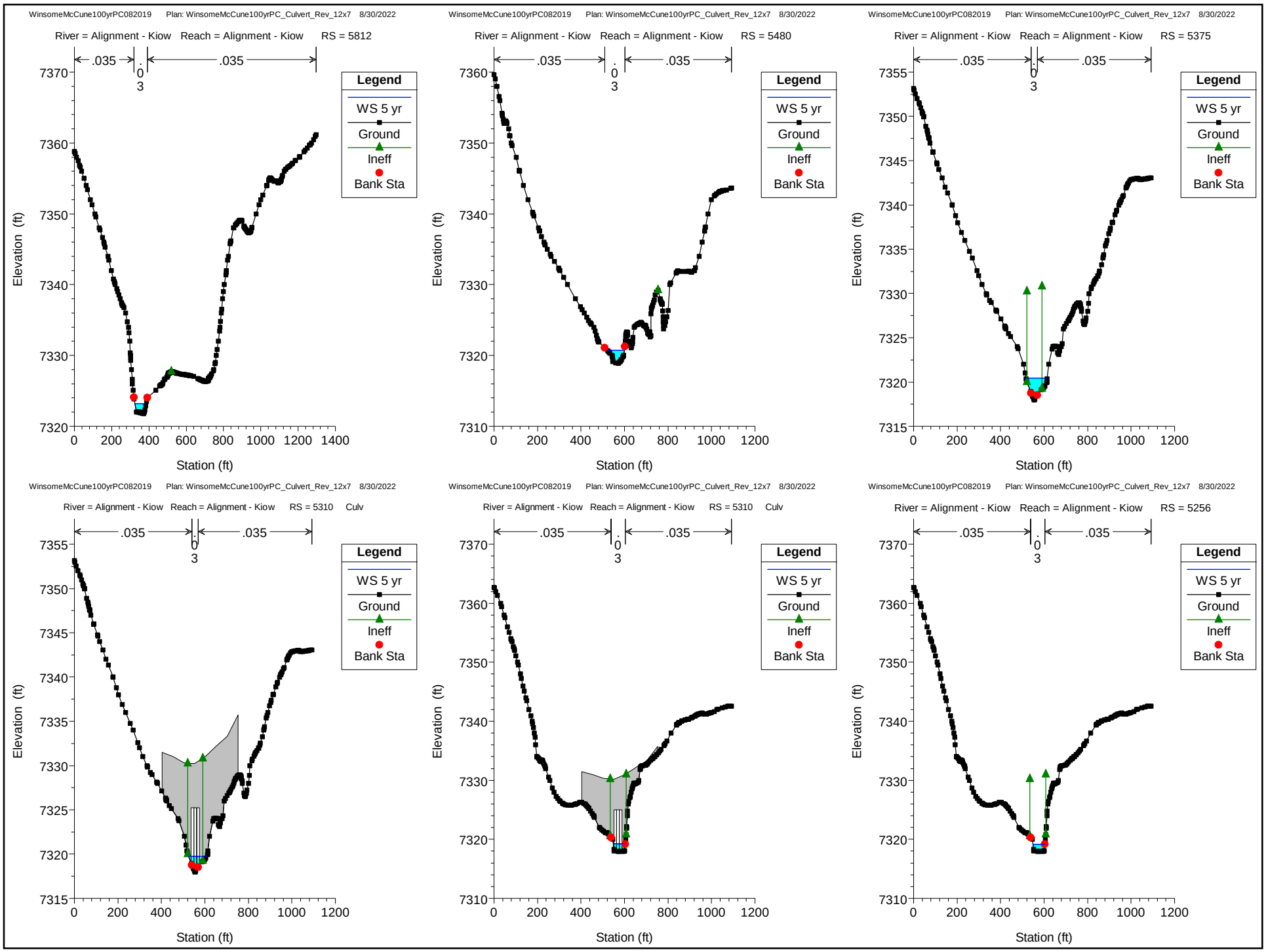
River = Alignment - Kiow Reach = Alignment - Kiow RS = 7234
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6969
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6763
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6542
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6302
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6134
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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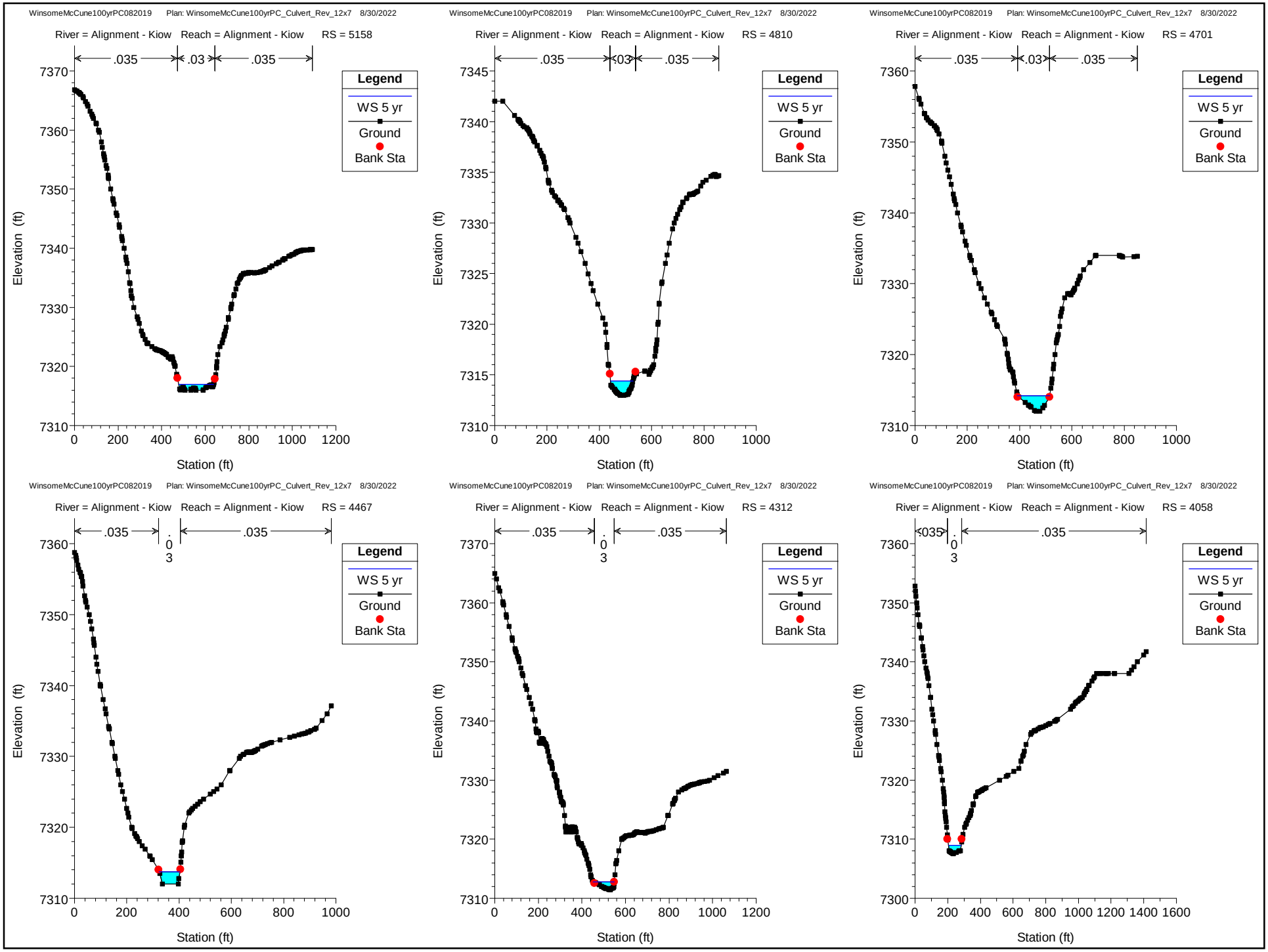
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5812
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5480
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5375
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5310 Culv
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5310 Culv
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5256
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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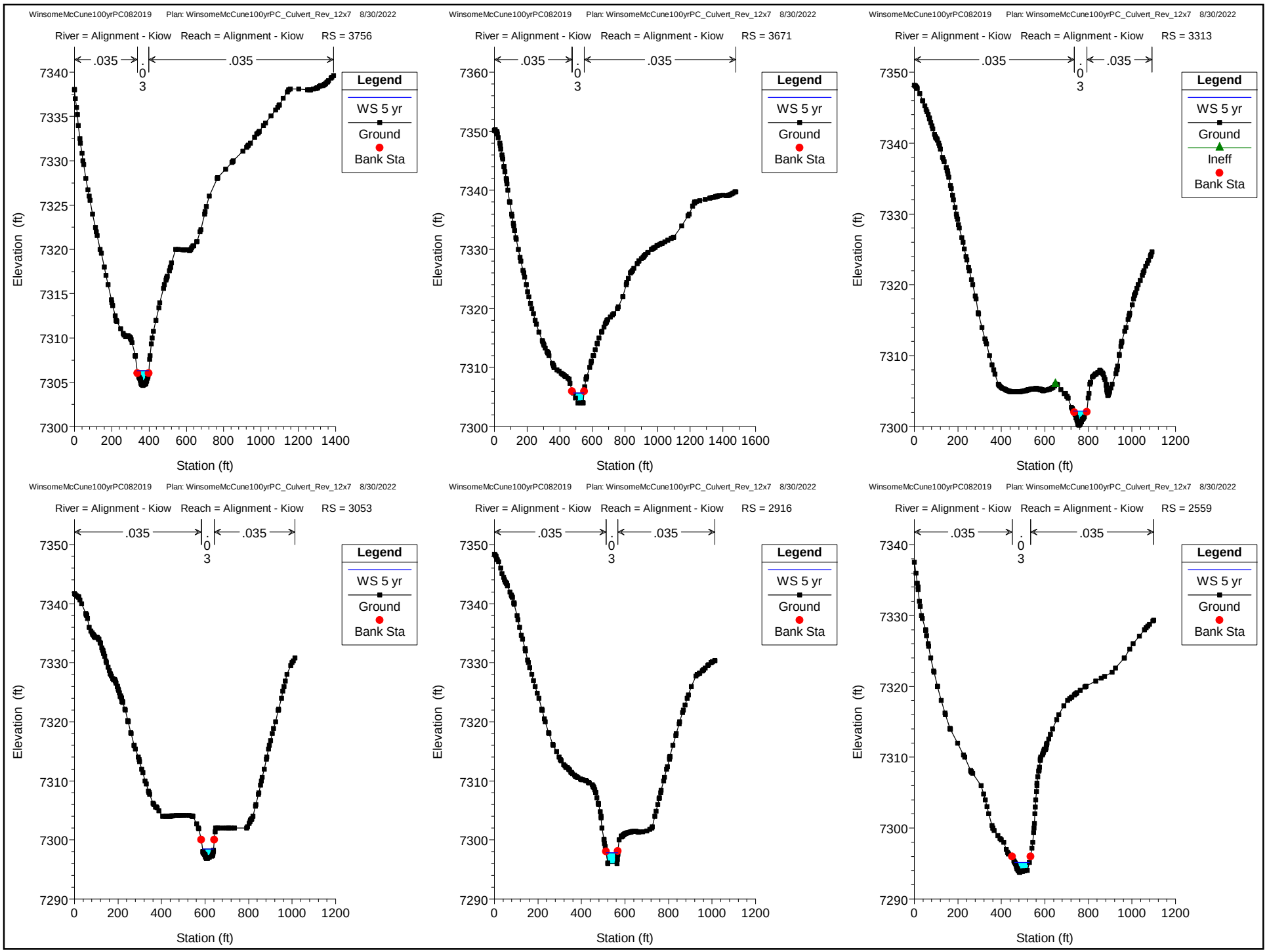
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5158
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4810
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4701
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4467
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4312
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4058
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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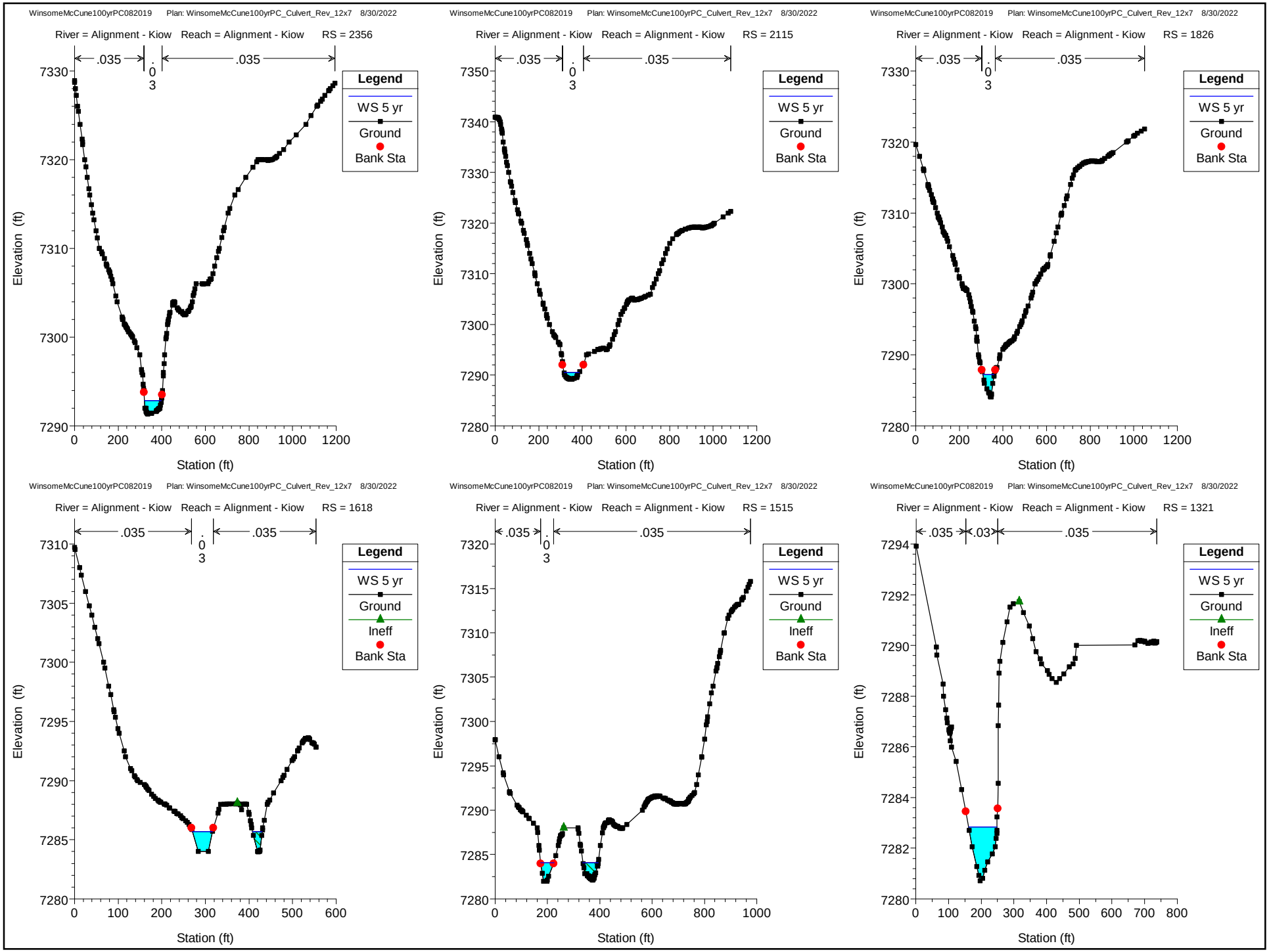
River = Alignment - Kiow Reach = Alignment - Kiow RS = 3756
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 3671
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 3313
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 3053
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2916
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2559
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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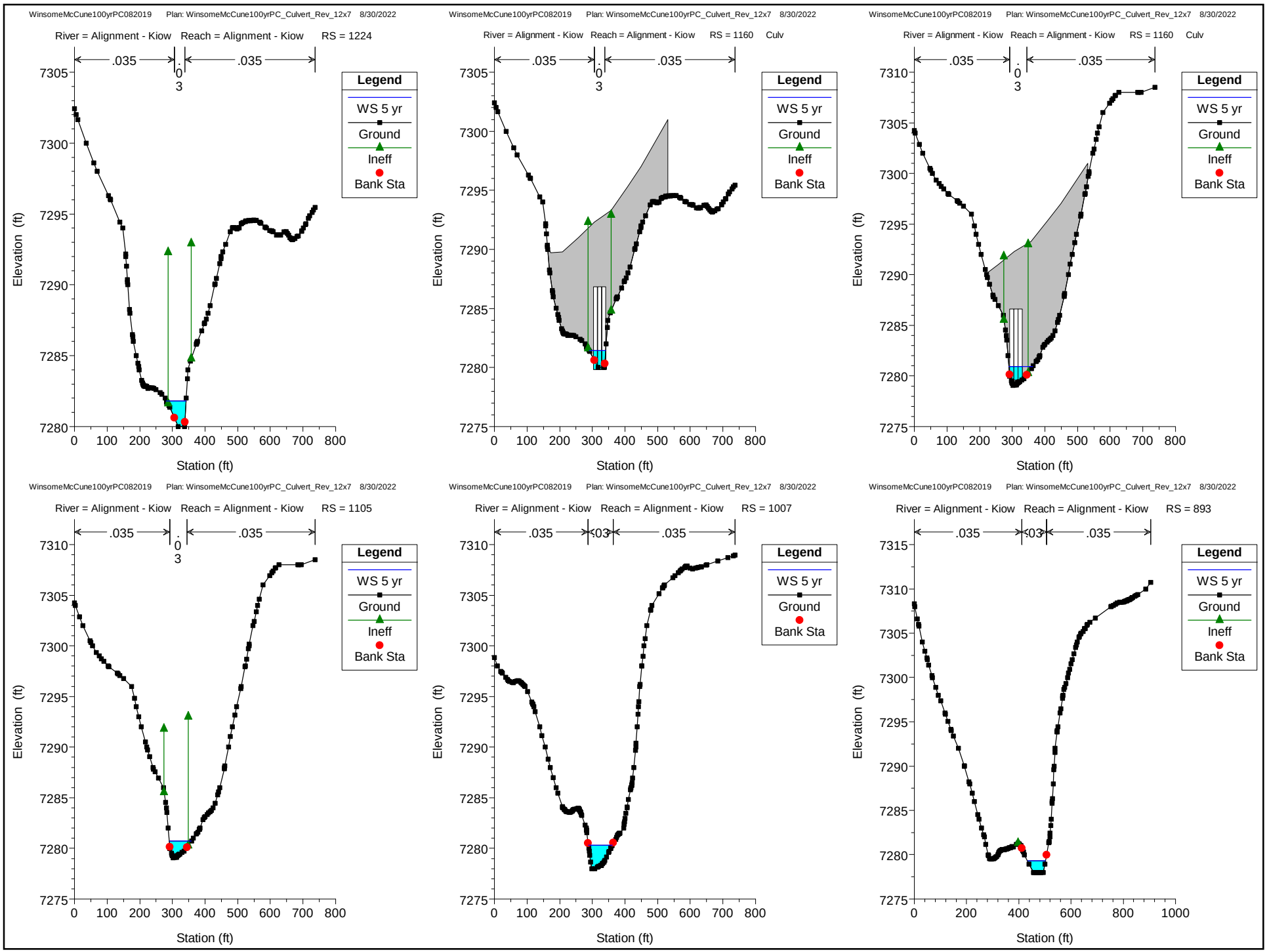
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2356
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2115
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1826
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1618
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1515
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1321
.035
.03
.035
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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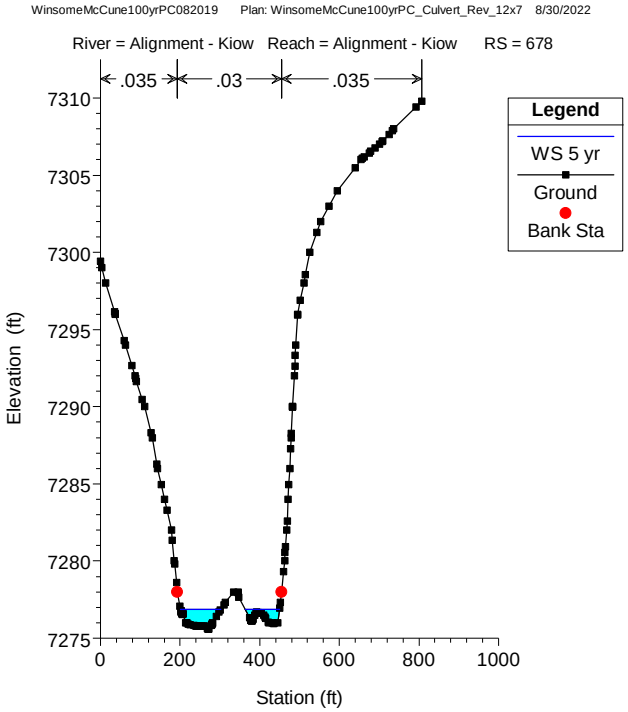
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1224
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1160 Culv
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1160 Culv
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1105
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1007
River = Alignment - Kiow Reach = Alignment - Kiow RS = 893
.035
.03
Legend
WS 5 yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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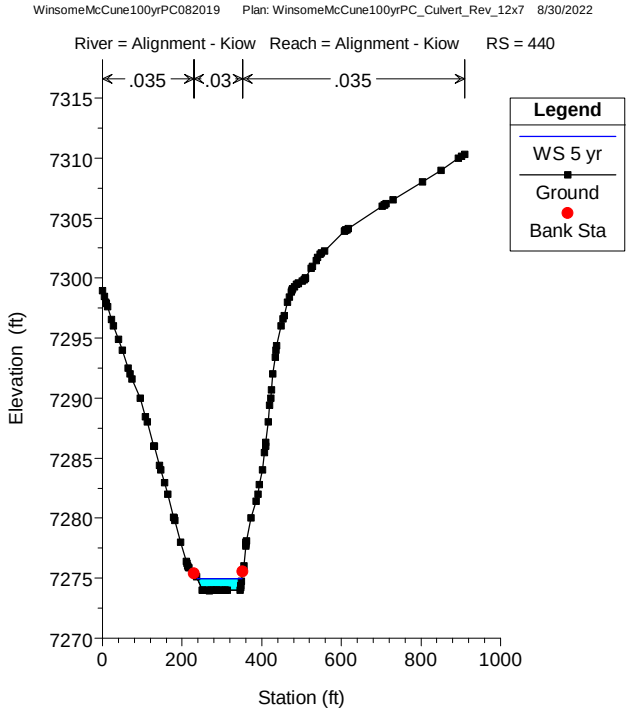
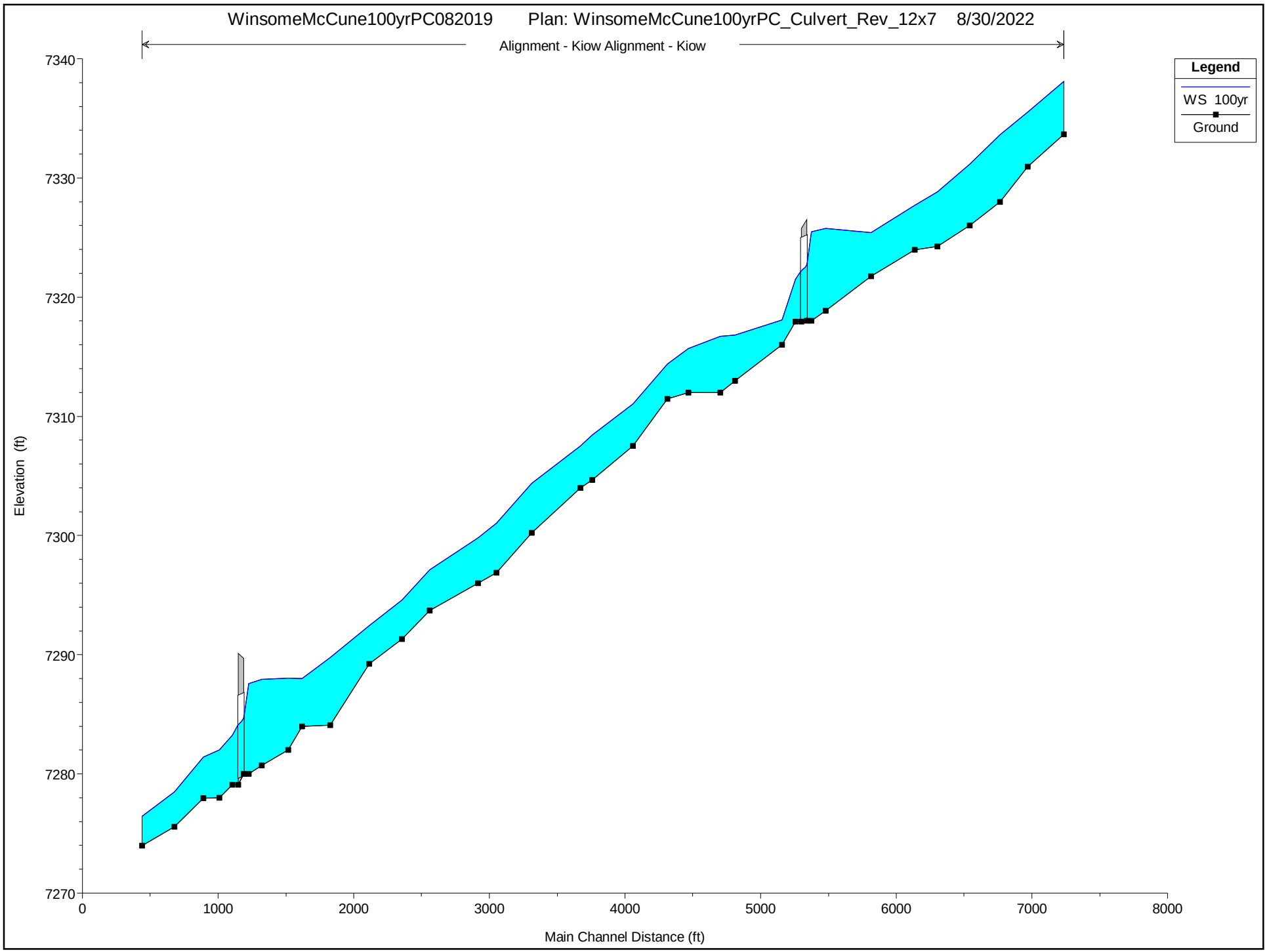
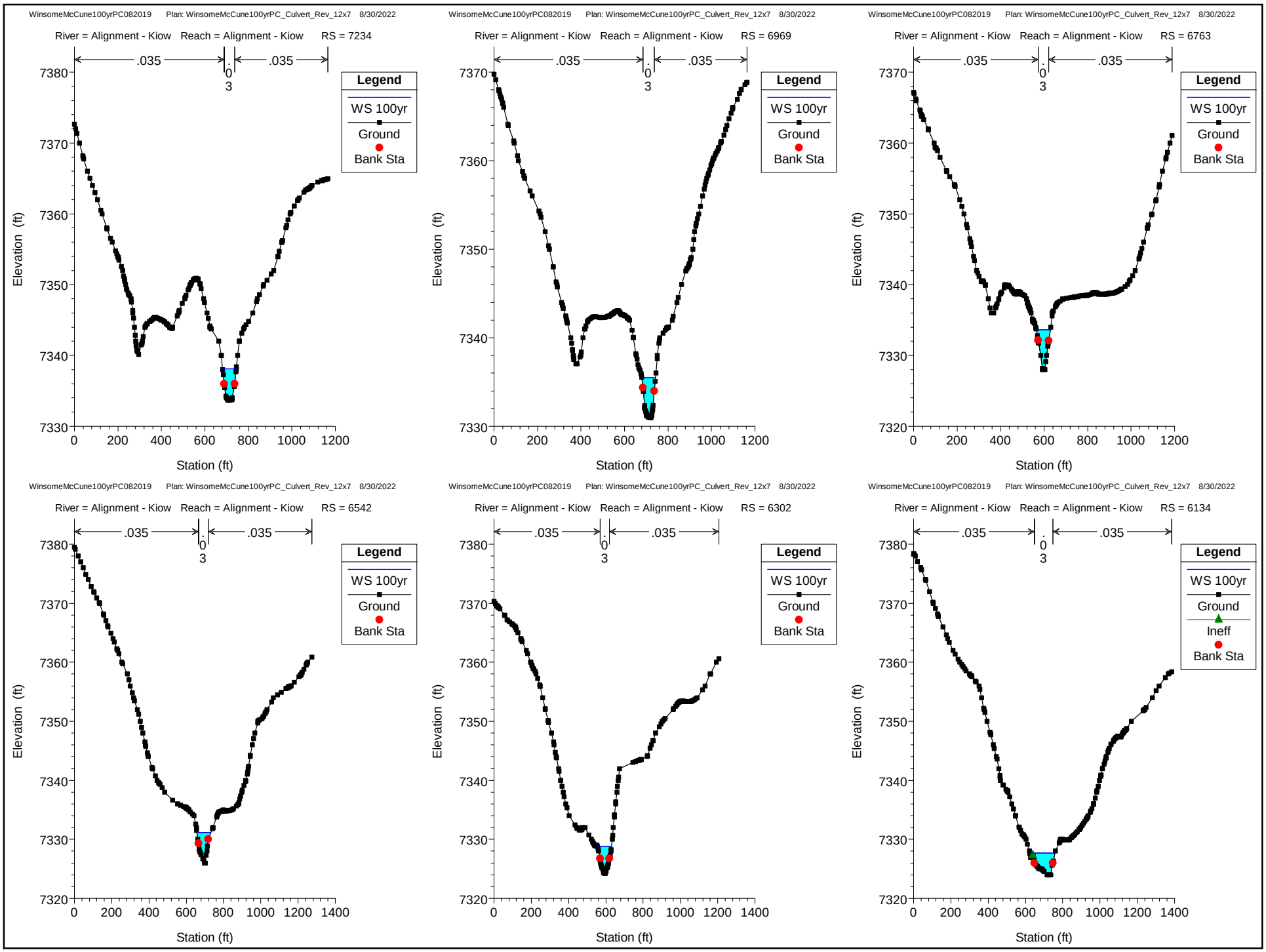
River = Alignment - Kiow Reach = Alignment - Kiow RS = 678
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7310
7305
7300
7295
7290
7285
7280
7275
0
200
400
600
800
1000

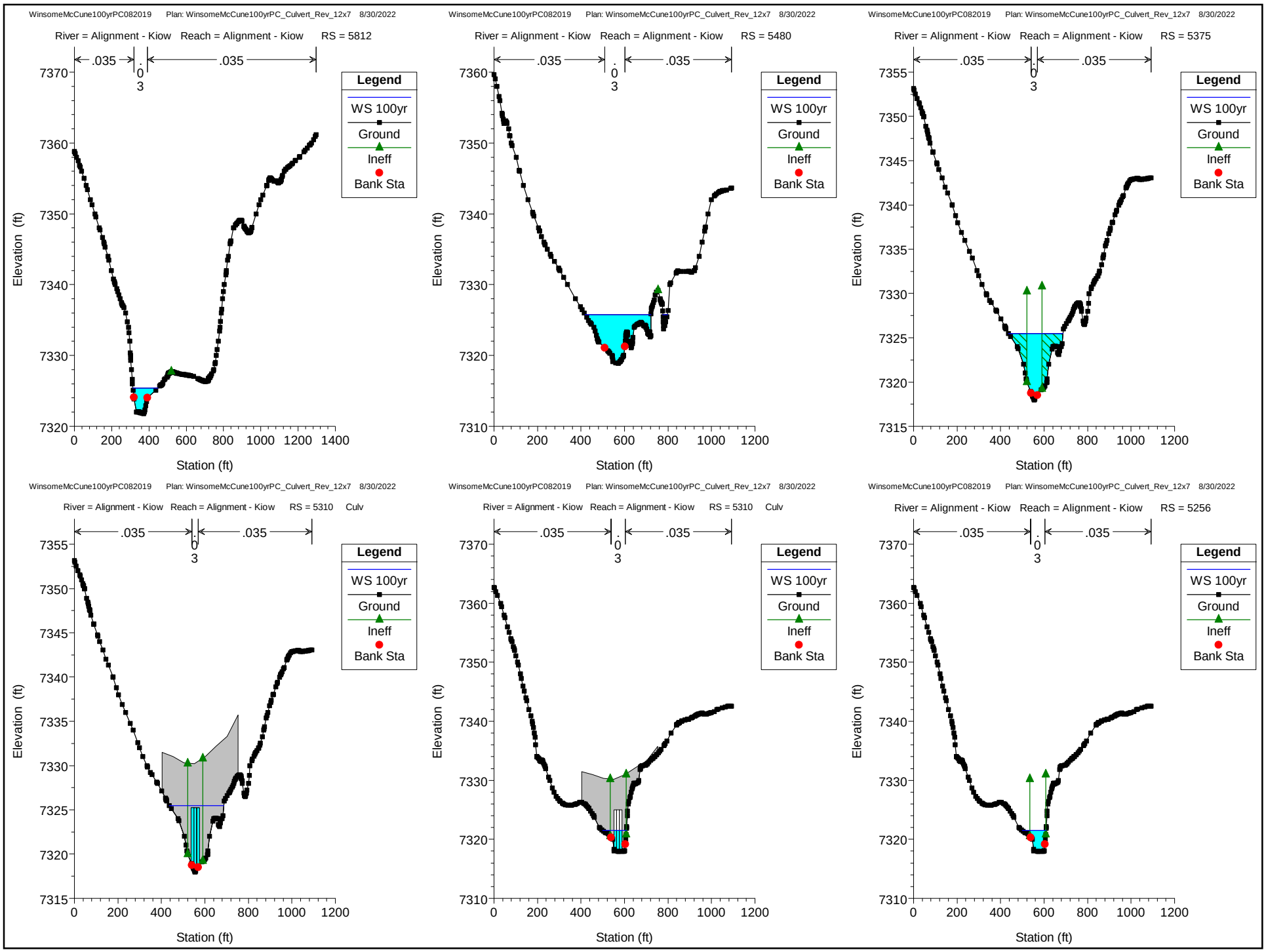

WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 440
.035
.03
.035
Legend
WS 5 yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7315
7310
7305
7300
7295
7290
7285
7280
7275
7270
0
200
400
600
800
1000

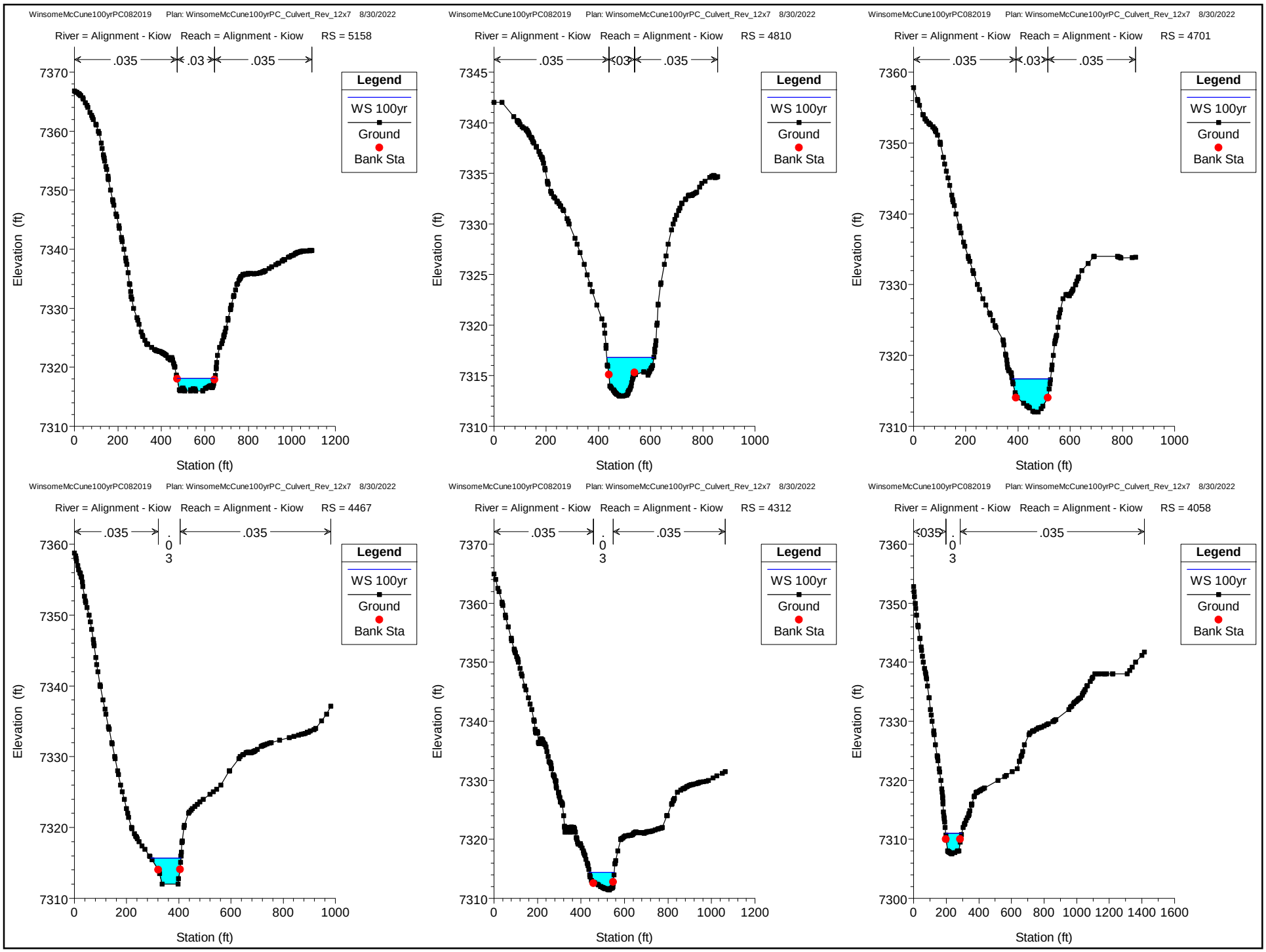
HEC-RAS Plan: PROP-12x7 River: Alignment - Kiow Reach: Alignment - Kiow Profile: 5 yr

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - Kiow	7234	5 yr	370.10	7333.67	7335.54	7335.41	7336.09	0.009469	5.94	62.27	45.18	0.89
Alignment - Kiow	6969	5 yr	370.10	7330.95	7332.82	7332.75	7333.43	0.010569	6.29	58.82	42.41	0.94
Alignment - Kiow	6763	5 yr	370.10	7328.00	7330.54	7330.47	7331.29	0.010237	6.90	53.62	32.58	0.95
Alignment - Kiow	6542	5 yr	370.10	7326.00	7328.45	7328.34	7329.03	0.009763	6.11	60.61	43.04	0.91
Alignment - Kiow	6302	5 yr	370.10	7324.24	7326.62		7327.04	0.006811	5.18	71.47	49.81	0.76
Alignment - Kiow	6134	5 yr	370.10	7323.98	7325.83	7325.46	7326.03	0.004712	3.64	101.60	91.36	0.61
Alignment - Kiow	5812	5 yr	370.10	7321.76	7323.20	7323.18	7323.70	0.012041	5.68	65.11	60.70	0.97
Alignment - Kiow	5480	5 yr	370.10	7318.86	7320.74	7320.37	7321.00	0.005627	4.05	91.44	80.08	0.67
Alignment - Kiow	5375	5 yr	370.10	7318.00	7320.45	7319.78	7320.63	0.002187	3.84	117.13	97.79	0.46
Alignment - Kiow	5310		Culvert									
Alignment - Kiow	5256	5 yr	370.10	7317.96	7319.18	7319.18	7319.74	0.012780	6.00	61.65	55.16	1.00
Alignment - Kiow	5158	5 yr	370.10	7316.00	7316.94	7316.79	7317.12	0.007419	3.34	110.84	159.90	0.71
Alignment - Kiow	4810	5 yr	370.10	7312.97	7314.40		7314.66	0.006666	4.15	89.24	85.80	0.72
Alignment - Kiow	4701	5 yr	370.10	7312.00	7314.23		7314.31	0.001485	2.29	161.59	124.27	0.35
Alignment - Kiow	4467	5 yr	370.10	7312.00	7313.74		7313.88	0.002213	3.07	120.66	79.54	0.44
Alignment - Kiow	4312	5 yr	370.10	7311.45	7312.75	7312.75	7313.15	0.014383	5.08	73.17	96.73	1.01
Alignment - Kiow	4058	5 yr	370.10	7307.52	7308.97		7309.26	0.006583	4.29	86.28	78.01	0.72
Alignment - Kiow	3756	5 yr	370.10	7304.66	7306.29	7306.23	7306.76	0.010574	5.48	67.81	62.96	0.91
Alignment - Kiow	3671	5 yr	370.10	7303.99	7305.66	7305.40	7305.99	0.007083	4.67	79.20	66.50	0.75
Alignment - Kiow	3313	5 yr	370.10	7300.23	7302.17	7302.17	7302.70	0.012272	5.82	63.80	61.34	0.98
Alignment - Kiow	3053	5 yr	370.10	7296.89	7298.49	7298.47	7299.07	0.011987	6.09	60.82	50.89	0.98
Alignment - Kiow	2916	5 yr	370.10	7296.00	7297.80		7298.08	0.004113	4.31	85.86	53.75	0.60
Alignment - Kiow	2559	5 yr	370.10	7293.71	7295.13	7295.13	7295.63	0.013443	5.66	65.41	66.74	1.01
Alignment - Kiow	2356	5 yr	370.10	7291.33	7292.83		7293.10	0.005909	4.17	88.78	77.14	0.69
Alignment - Kiow	2115	5 yr	370.10	7289.22	7290.52	7290.52	7291.00	0.013774	5.59	66.25	70.11	1.01
Alignment - Kiow	1826	5 yr	370.10	7284.10	7287.21		7287.45	0.002979	3.99	92.81	51.29	0.52
Alignment - Kiow	1618	5 yr	370.10	7284.00	7285.69	7285.69	7286.31	0.012016	6.34	58.40	68.69	0.99
Alignment - Kiow	1515	5 yr	408.40	7282.00	7284.08	7284.08	7284.70	0.011581	6.31	64.81	109.84	0.98
Alignment - Kiow	1321	5 yr	408.40	7280.72	7282.83	7282.42	7283.05	0.004208	3.75	108.97	86.03	0.59
Alignment - Kiow	1224	5 yr	408.40	7280.00	7281.81	7281.81	7282.43	0.009059	6.66	70.01	61.14	0.91
Alignment - Kiow	1160		Culvert									
Alignment - Kiow	1105	5 yr	408.40	7279.08	7280.71	7280.71	7281.31	0.012090	6.23	66.93	67.82	0.99
Alignment - Kiow	1007	5 yr	408.40	7278.00	7280.31		7280.52	0.003072	3.64	112.25	73.25	0.52
Alignment - Kiow	893	5 yr	408.40	7277.97	7279.31	7279.31	7279.84	0.013412	5.81	70.32	68.90	1.01
Alignment - Kiow	678	5 yr	408.40	7275.58	7276.86		7277.01	0.006287	3.11	131.37	186.32	0.65
Alignment - Kiow	440	5 yr	408.40	7273.97	7274.93	7274.81	7275.21	0.009008	4.26	95.97	111.31	0.81


WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
Alignment - Kiow Alignment - Kiow
Legend
WS 100yr
Ground
Elevation (ft)
7340
7330
7320
7310
7300
7290
7280
7270
0
1000
2000
3000
4000
5000
6000
7000
8000
Main Channel Distance (ft)

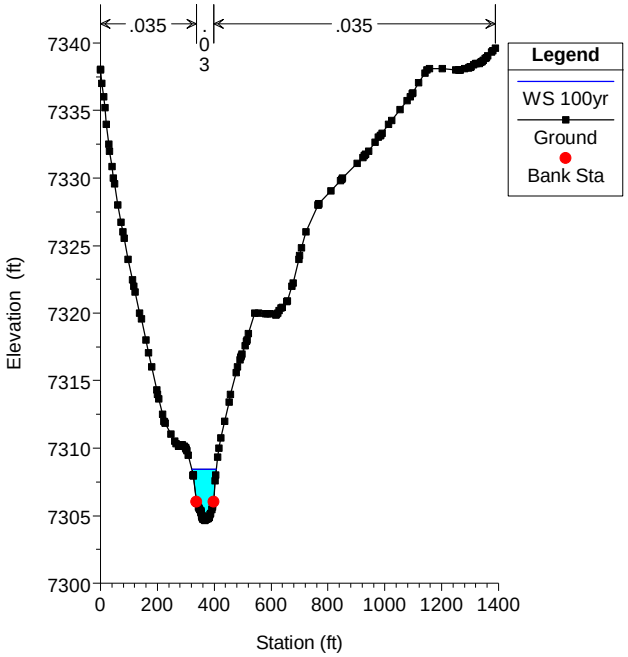

WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 7234
.035
.035
.03
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6969
.035
.035
.03
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6763
.035
.035
.03
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6542
.035
.035
.03
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6302
.035
.035
.03
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 6134
.035
.035
.03
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5812
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5480
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5375
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5310 Culv
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5310 Culv
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5256


WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 5158
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4810
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4701
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4467
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4312
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 4058
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

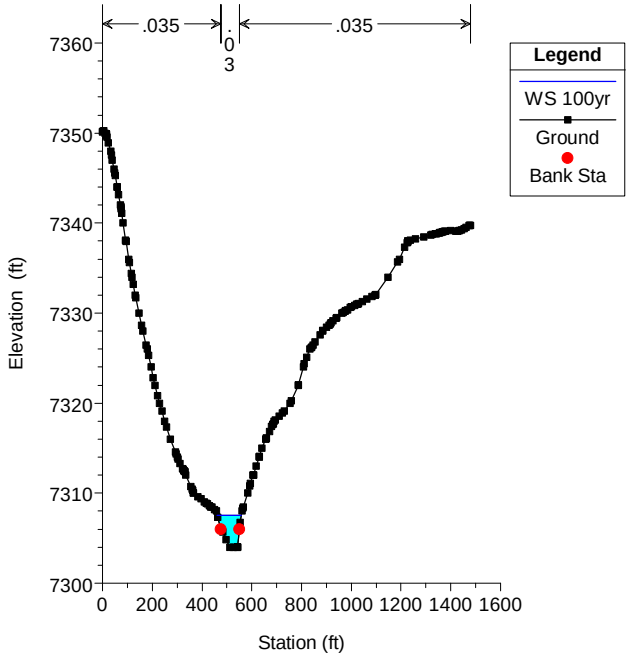
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 3756



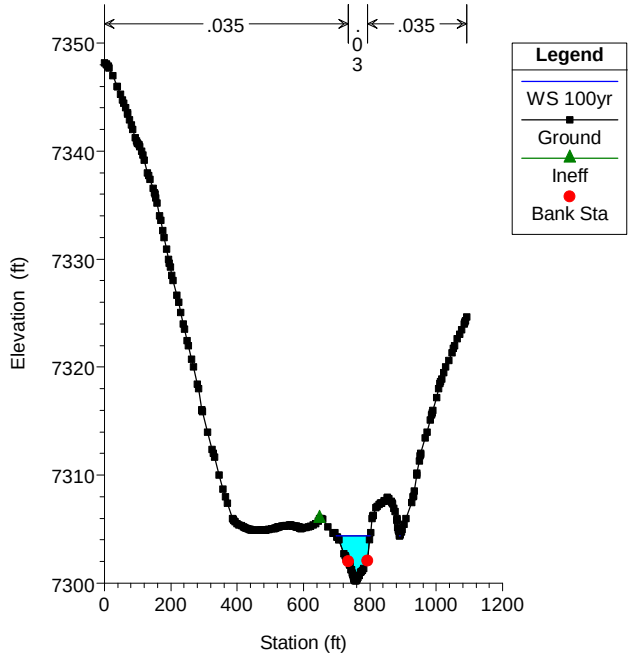
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 3671



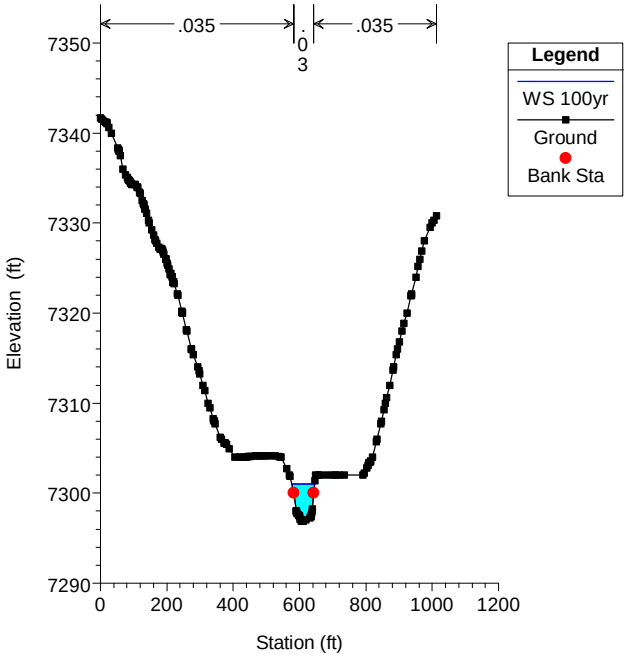
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 3313



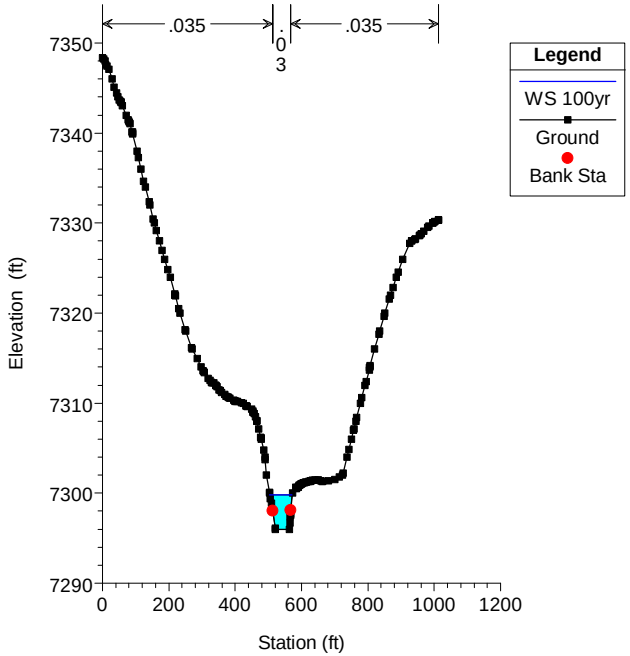
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 3053



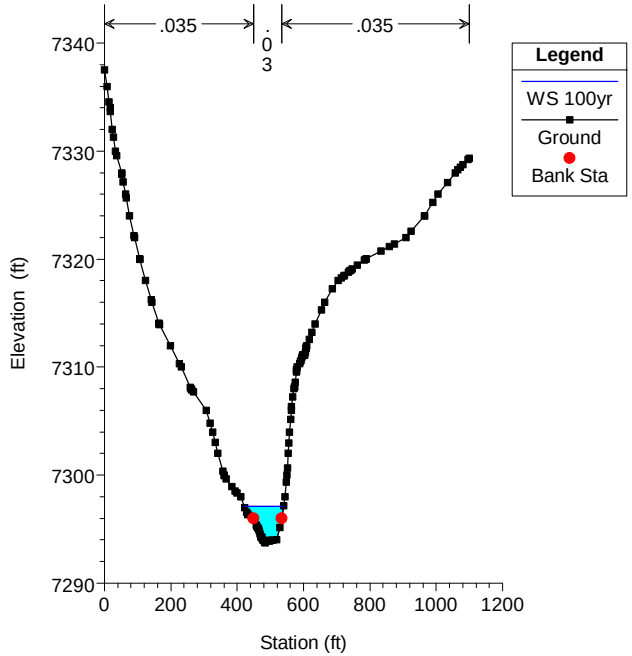
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

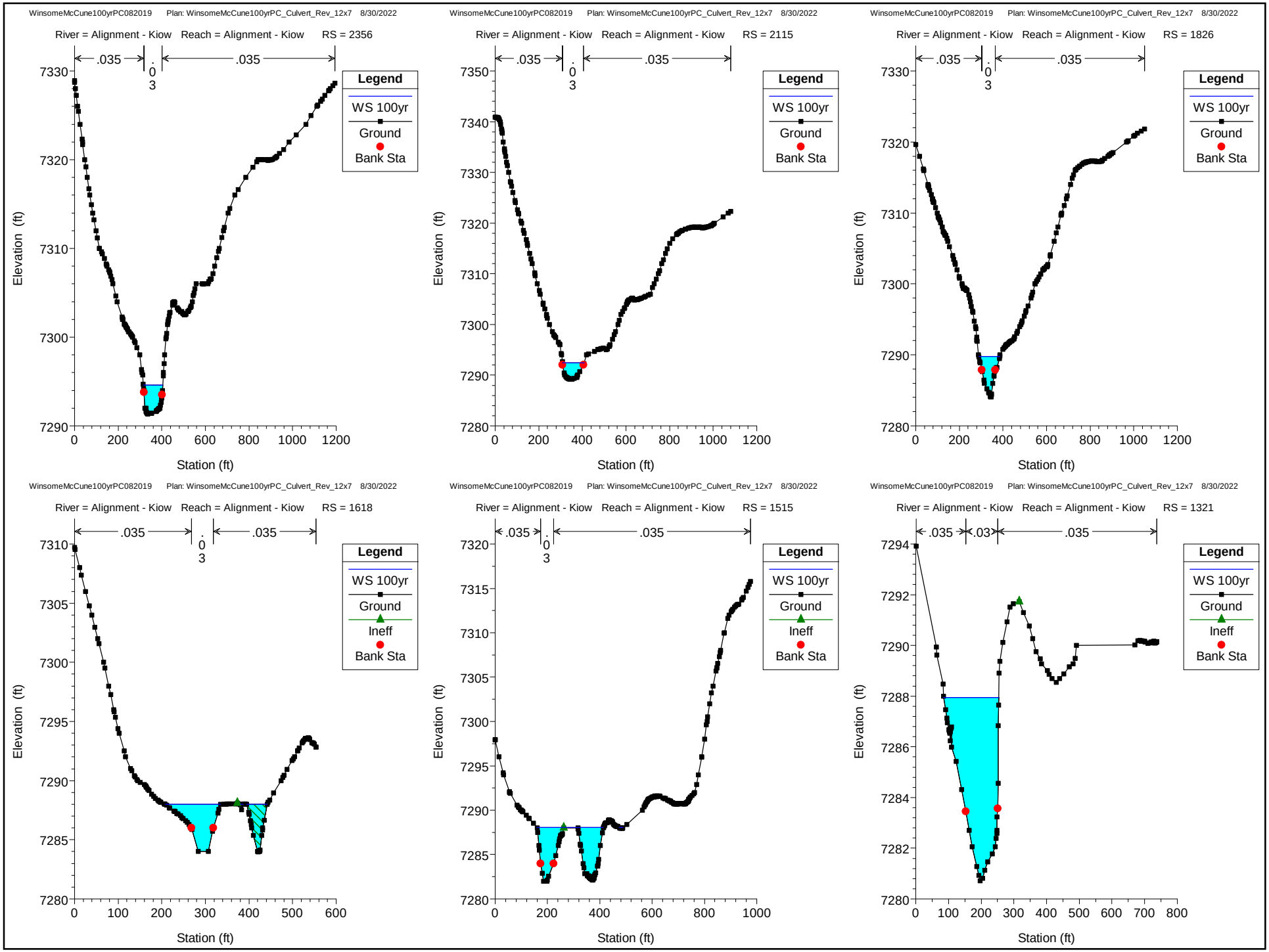
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2916

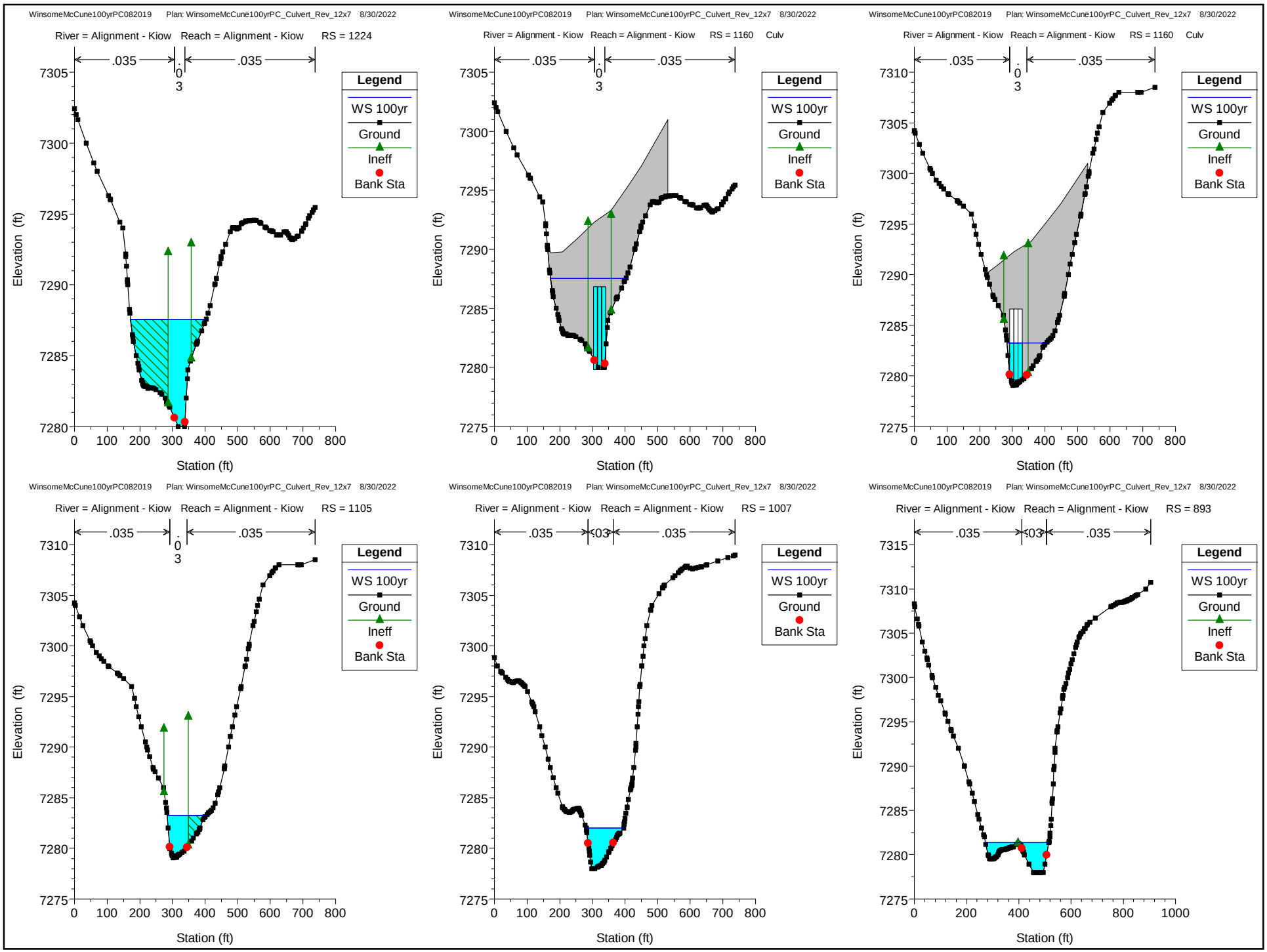


WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 2559

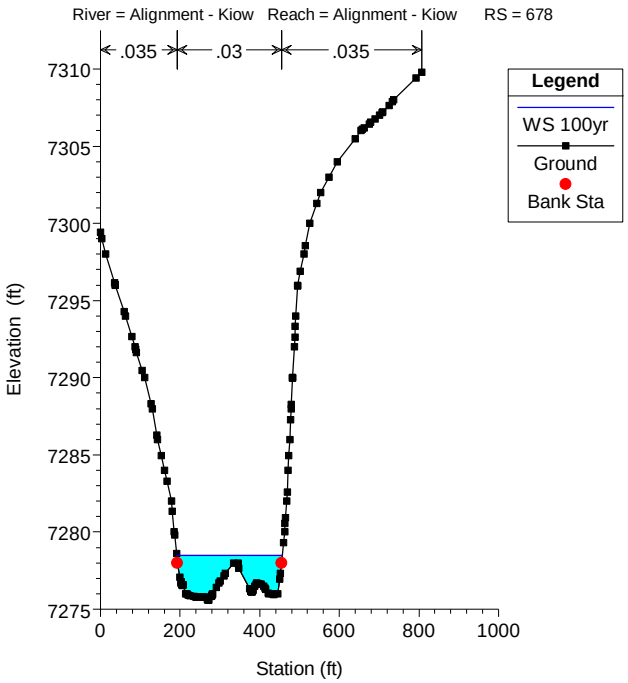



WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2356
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 2115
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1826
.035
.03
.035
Legend
WS 100yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1618
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1515
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1321
.035
.03
.035
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1224
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1160 Culv
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1160 Culv
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1105
River = Alignment - Kiow Reach = Alignment - Kiow RS = 1007
River = Alignment - Kiow Reach = Alignment - Kiow RS = 893
.035
.03
Legend
WS 100yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

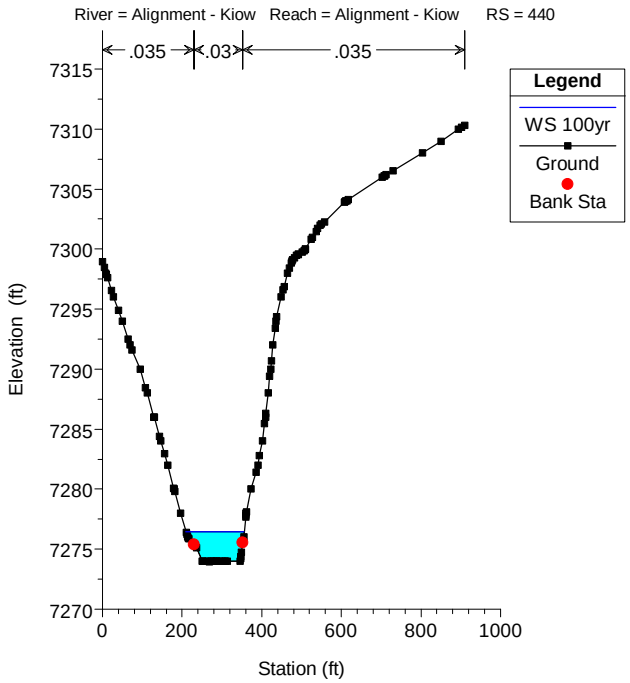
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 678



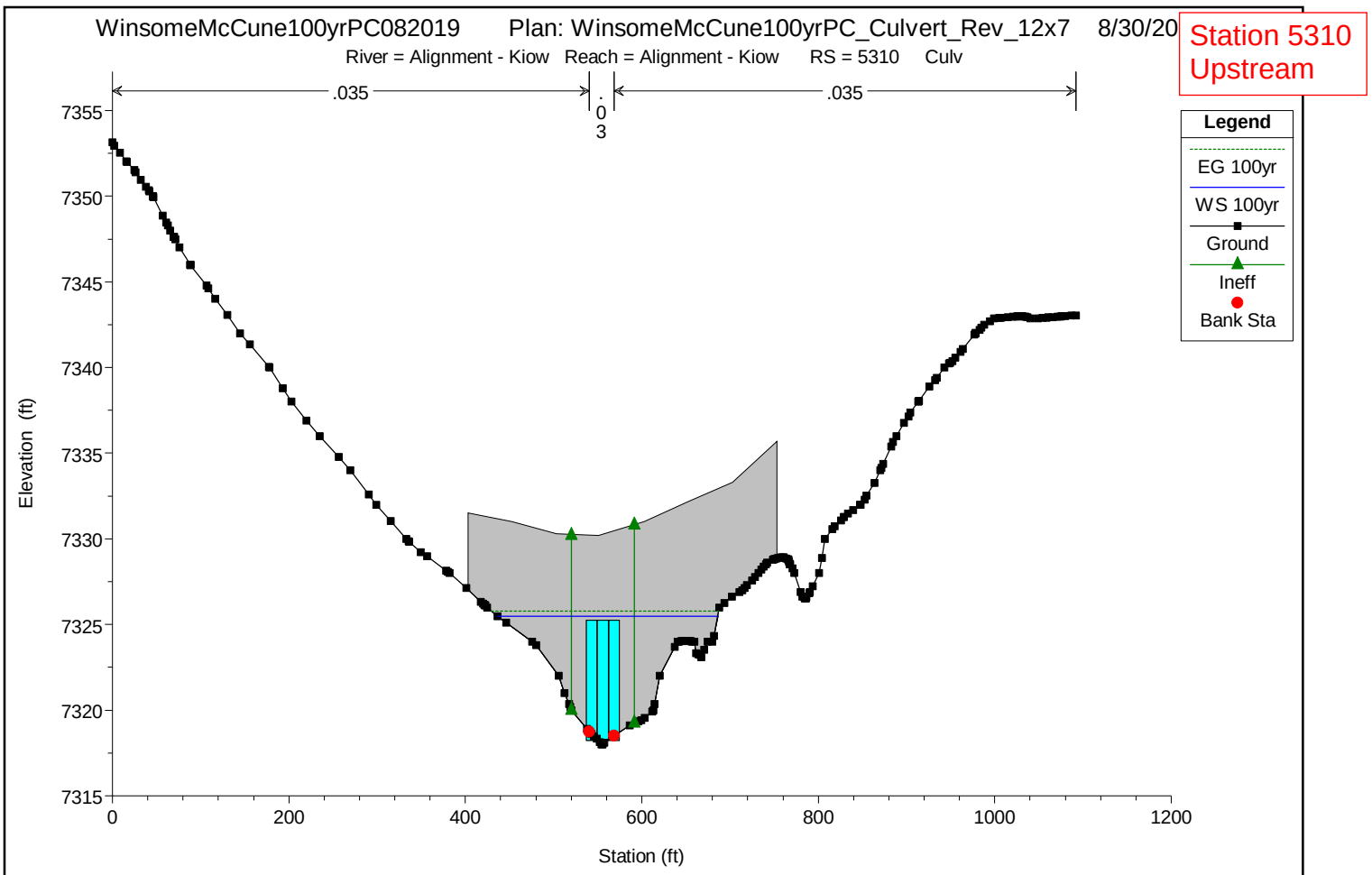
WinsomeMcCune100yrPC082019 Plan: WinsomeMcCune100yrPC_Culvert_Rev_12x7 8/30/2022

River = Alignment - Kiow Reach = Alignment - Kiow RS = 440

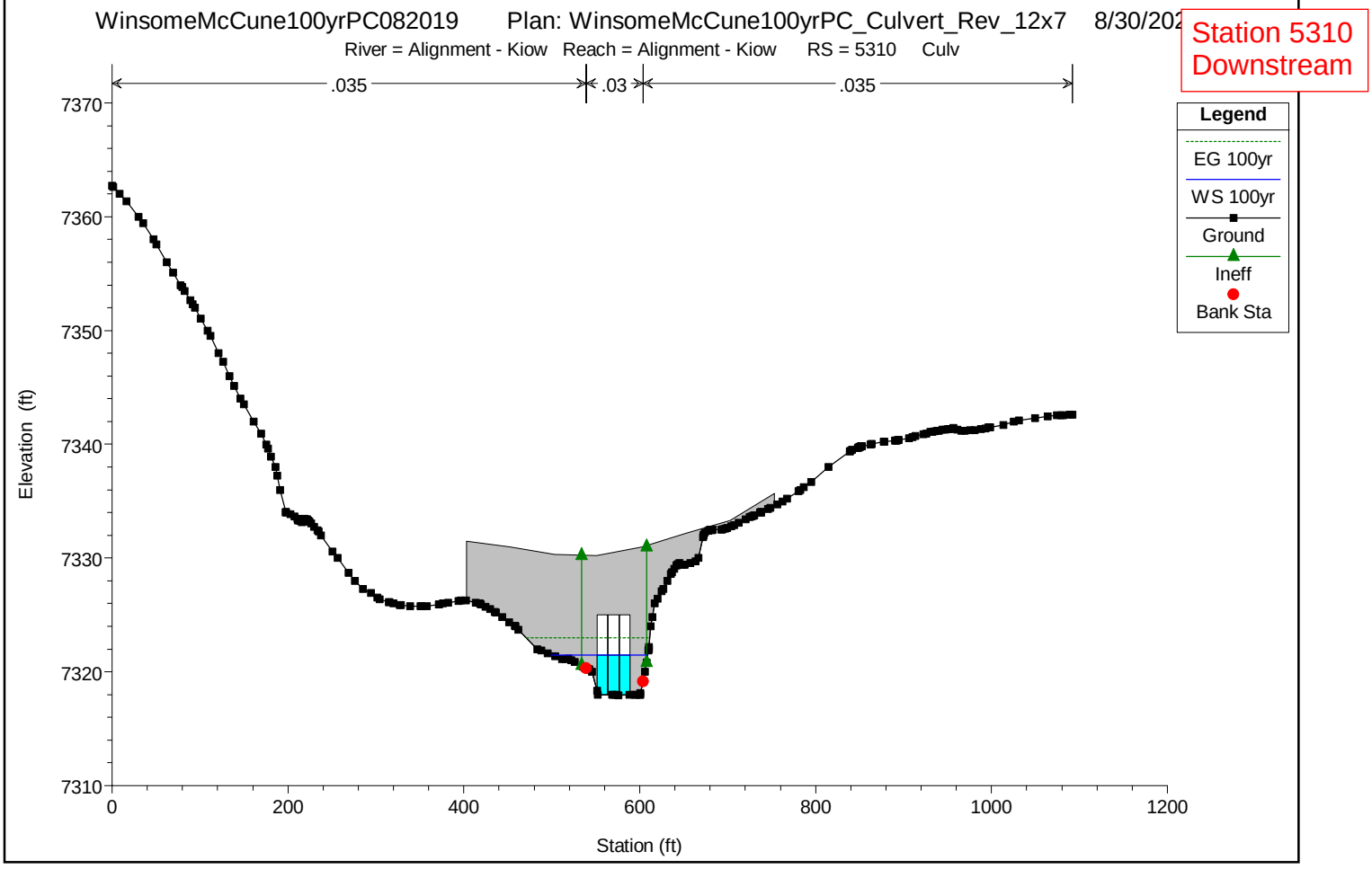


HEC-RAS Plan: PROP-12x7 River: Alignment - Kiow Reach: Alignment - Kiow Profile: 100yr

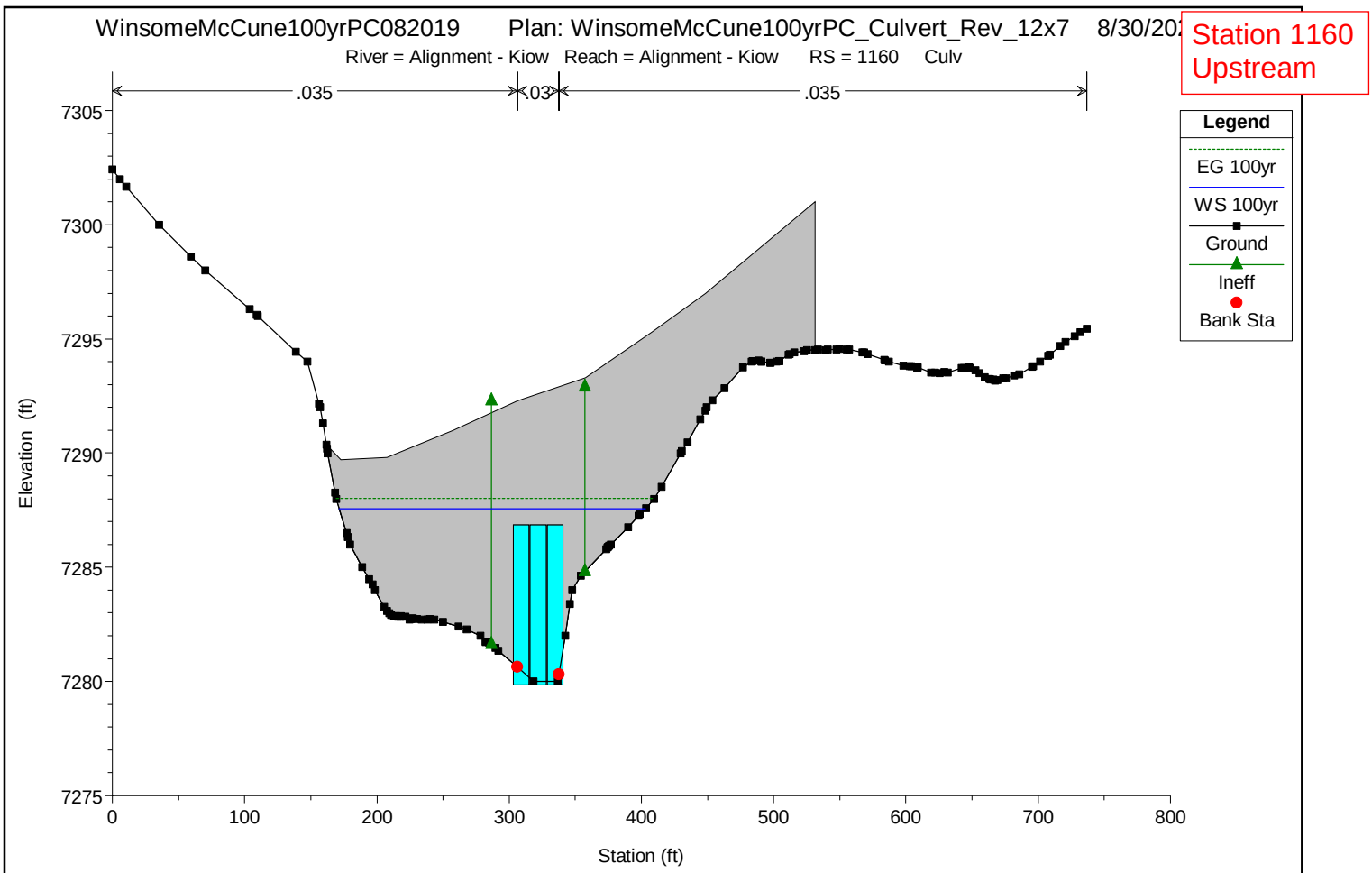
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Alignment - Kiow	7234	100yr	2062.00	7333.67	7338.11	7338.11	7339.82	0.007808	10.62	203.44	63.12	0.96
Alignment - Kiow	6969	100yr	2062.00	7330.95	7335.52	7335.52	7337.23	0.008122	10.54	201.24	64.11	0.97
Alignment - Kiow	6763	100yr	2062.00	7328.00	7333.63	7333.63	7335.36	0.007613	10.64	202.72	64.92	0.95
Alignment - Kiow	6542	100yr	2062.00	7326.00	7331.14	7331.14	7332.77	0.007616	10.34	210.57	74.22	0.94
Alignment - Kiow	6302	100yr	2062.00	7324.24	7328.85	7328.85	7330.48	0.008182	10.51	213.37	76.90	0.97
Alignment - Kiow	6134	100yr	2062.00	7323.98	7327.70	7327.28	7328.43	0.004817	6.99	315.15	136.57	0.72
Alignment - Kiow	5812	100yr	2062.00	7321.76	7325.42	7325.42	7326.54	0.007067	8.74	265.48	134.06	0.88
Alignment - Kiow	5480	100yr	2062.00	7318.86	7325.78	7322.36	7325.86	0.000257	2.61	1063.32	325.19	0.19
Alignment - Kiow	5375	100yr	2062.00	7318.00	7325.49	7321.87	7325.80	0.000719	4.94	474.37	249.60	0.33
Alignment - Kiow	5310		Culvert									
Alignment - Kiow	5256	100yr	2062.00	7317.96	7321.50	7321.50	7322.98	0.008647	9.85	215.73	110.20	0.98
Alignment - Kiow	5158	100yr	2062.00	7316.00	7318.09	7317.97	7318.81	0.009036	6.82	302.44	174.44	0.91
Alignment - Kiow	4810	100yr	2062.00	7312.97	7316.81		7317.22	0.002562	5.49	432.85	179.90	0.54
Alignment - Kiow	4701	100yr	2062.00	7312.00	7316.71		7316.99	0.001273	4.30	498.21	146.50	0.39
Alignment - Kiow	4467	100yr	2062.00	7312.00	7315.70		7316.46	0.003967	7.06	310.02	114.47	0.67
Alignment - Kiow	4312	100yr	2062.00	7311.45	7314.40	7314.40	7315.52	0.009313	8.66	250.97	115.43	0.98
Alignment - Kiow	4058	100yr	2062.00	7307.52	7311.05		7311.99	0.005706	7.78	269.61	99.53	0.79
Alignment - Kiow	3756	100yr	2062.00	7304.66	7308.45	7308.45	7309.89	0.008179	9.87	225.72	86.18	0.96
Alignment - Kiow	3671	100yr	2062.00	7303.99	7307.52	7307.52	7308.82	0.008446	9.26	233.99	96.89	0.96
Alignment - Kiow	3313	100yr	2062.00	7300.23	7304.40	7304.40	7305.69	0.007483	9.53	246.48	102.90	0.92
Alignment - Kiow	3053	100yr	2062.00	7296.89	7301.03	7300.93	7302.53	0.007861	9.87	212.40	69.79	0.94
Alignment - Kiow	2916	100yr	2062.00	7296.00	7299.80	7299.80	7301.43	0.008115	10.30	207.11	67.41	0.96
Alignment - Kiow	2559	100yr	2062.00	7293.71	7297.13	7297.13	7298.28	0.008328	8.71	252.01	118.75	0.94
Alignment - Kiow	2356	100yr	2062.00	7291.33	7294.61	7294.47	7295.81	0.007973	8.80	236.71	88.75	0.92
Alignment - Kiow	2115	100yr	2062.00	7289.22	7292.45	7292.45	7293.67	0.009879	8.87	233.28	99.93	1.00
Alignment - Kiow	1826	100yr	2062.00	7284.10	7289.78	7289.14	7290.72	0.004049	7.97	283.71	95.99	0.70
Alignment - Kiow	1618	100yr	2062.00	7284.00	7287.99	7287.99	7289.48	0.008489	10.37	243.90	180.55	0.98
Alignment - Kiow	1515	100yr	2311.00	7282.00	7288.04	7286.79	7288.25	0.000940	4.58	745.26	268.21	0.35
Alignment - Kiow	1321	100yr	2311.00	7280.72	7287.95	7284.40	7288.12	0.000427	3.43	767.14	168.63	0.24
Alignment - Kiow	1224	100yr	2311.00	7280.00	7287.56	7284.45	7288.02	0.001026	6.04	445.62	231.51	0.39
Alignment - Kiow	1160		Culvert									
Alignment - Kiow	1105	100yr	2311.00	7279.08	7283.24	7283.24	7285.02	0.008309	10.90	221.71	119.93	0.99
Alignment - Kiow	1007	100yr	2311.00	7278.00	7282.00	7282.00	7283.28	0.007622	9.22	267.84	114.74	0.92
Alignment - Kiow	893	100yr	2311.00	7277.97	7281.40	7281.40	7282.14	0.006191	7.48	387.38	243.18	0.81
Alignment - Kiow	678	100yr	2311.00	7275.58	7278.47		7278.80	0.003528	4.56	507.30	265.53	0.58
Alignment - Kiow	440	100yr	2311.00	7273.97	7276.45	7276.42	7277.46	0.009002	8.12	294.09	146.38	0.95



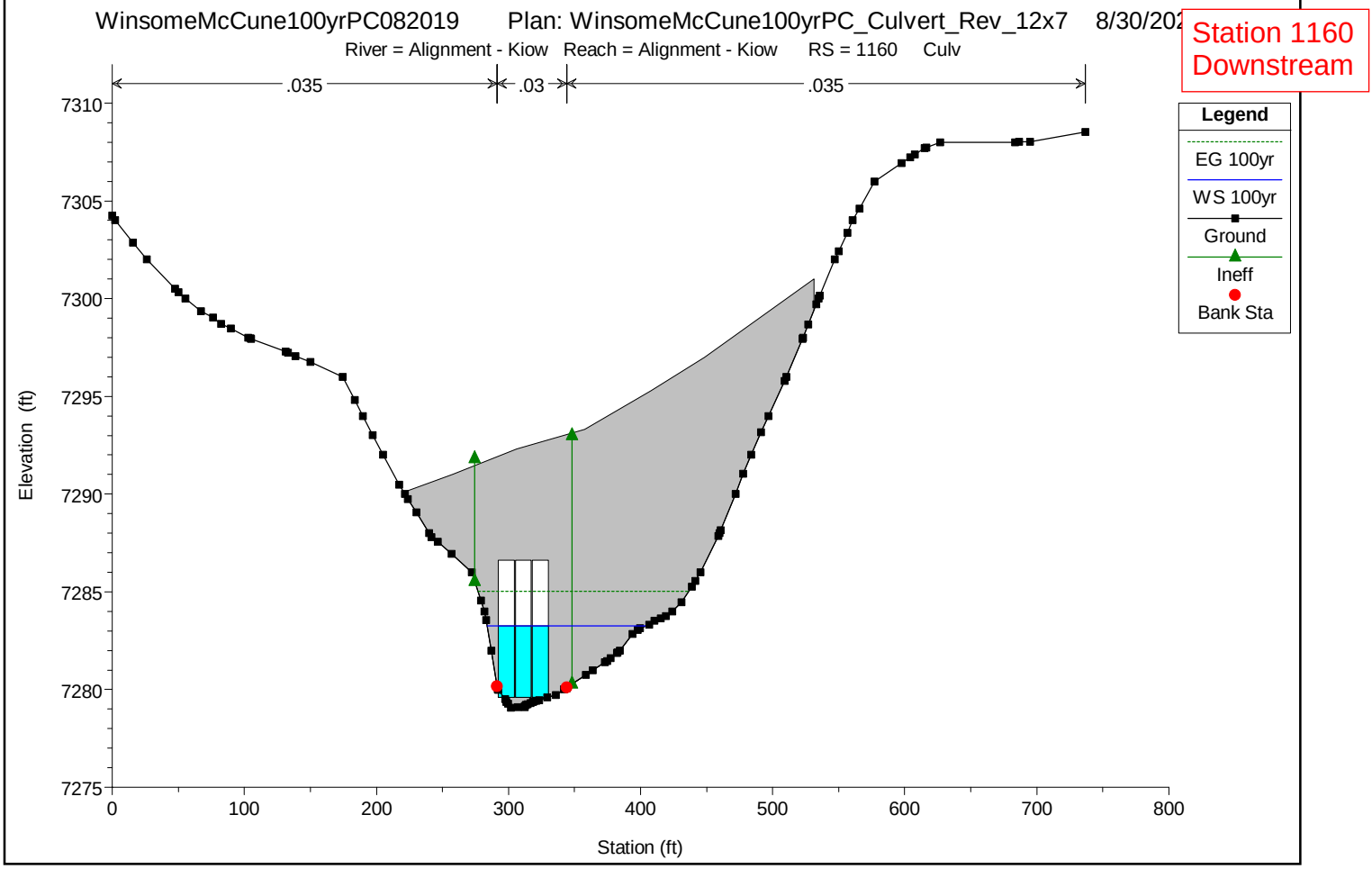
Station 5310 Upstream



Station 5310 Downstream



Station 1160 Upstream



Station 1160 Downstream

WSEL COMPARISON TABLE

Cross Section	Approved CLOMR 100-Year WSEL	Proposed Conditions 100-Year WSEL	Change (CLOMR WSELs -Proposed WSELs)
72+34	7338.11	7338.11	0.00
69+69	7335.52	7335.52	0.00
67+63	7333.63	7333.63	0.00
65+42	7331.14	7331.14	0.00
63+02	7328.85	7328.85	0.00
61+34	7327.28	7327.7	0.42
58+12	7326.47	7325.42	-1.05
54+80	7326.65	7325.78	-0.87
53+75	7326.35	7325.49	-0.86
53+10			0.00
52+56	7321.50	7321.5	0.00
51+58	7318.09	7318.09	0.00
48+10	7316.81	7316.81	0.00
47+01	7316.71	7316.71	0.00
44+67	7315.70	7315.7	0.00
43+12	7314.40	7314.4	0.00
40+58	7311.05	7311.05	0.00
37+56	7308.45	7308.45	0.00
36+71	7307.52	7307.52	0.00
33+13	7304.40	7304.4	0.00
30+53	7301.03	7301.03	0.00
29+16	7299.80	7299.8	0.00
25+59	7297.13	7297.13	0.00
23+56	7294.61	7294.61	0.00
21+15	7292.45	7292.45	0.00
18+26	7289.14	7289.78	0.64
16+18	7289.44	7287.99	-1.45
15+15	7289.46	7288.04	-1.42
13+21	7289.40	7287.95	-1.45
12+24	7289.09	7287.56	-1.53
11+60			0.00
11+05	7283.36	7283.24	-0.12
10+07	7282.00	7282	0.00
8+93	7281.40	7281.4	0.00
6+78	7278.47	7278.47	0.00
4+40	7276.45	7276.45	0.00

Appendix B

Geotechnical Report

ENTECH
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SUBSURFACE SOIL INVESTIGATION
WINSOME SUBDIVISION – WEST KIOWA CREEK
BOX CULVERT CROSSINGS
EL PASO COUNTY, COLORADO

Prepared for:

Winsome, LLC
1864 Woodmoor Drive, Suite 100
Monument, CO 80132

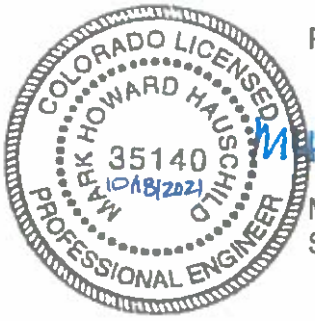
Attn: Joe DesJardin

October 18, 2021

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford, P.G.
Geologist



Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

LLL

Encl.

Entech Job No. 211992
AA projects\2021\211992ssi

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SUBSURFACE SOIL INVESTIGATION
WINSOME SUBDIVISION – WEST KIOWA CREEK
BOX CULVERT CROSSINGS
EL PASO COUNTY, COLORADO

1.0 INTRODUCTION

Winsome, LLC is planning the construction of two culvert crossings over West Kiowa Creek for Alamar Way and Twinkling Star Lane in the Winsome Subdivision located in northeastern El Paso County, Colorado. The approximate location of the site is shown on the Vicinity Map, Figure 1. The planned layout of the proposed culverts is shown on Figures 2 and 3, the Site Plan/Test Boring Location Map.

This report describes the subsurface investigation conducted for the planned bridges and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling test borings at eight (8) locations at the corners of the planned culverts, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. The drilling was completed by others, and the field logging and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech's understanding that the project will consist of the construction of two culvert crossings over West Kiowa Creek for Alamar Way and Twinkling Star Lane in the Winsome Subdivision. At the time of drilling, the site for the proposed culvert crossing were undisturbed areas in West Kiowa Creek. Water was observed flowing in the creek during our site investigation. Current vegetation on the site consisted of grasses and small shrubs.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling eight (8) locations near the corners of the planned culverts. The borings were drilled to depths 15 to 20 feet below the existing ground surface using a track-mounted continuous flight auger-drilling rig supplied and operated by Vine Laboratories. Boring Logs descriptive of the subsurface conditions encountered during drilling are presented in Appendix A. At the conclusion of drilling, observations of groundwater levels were made in each of the open borings. The approximate locations of the test borings are indicated on Figures 2 and 3.

Soil samples were obtained/attempted from the borings utilizing the Standard Penetration Test (ASTM D-1586) using split spoon and California Samplers. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the Test Boring Logs. It should be understood that the soil descriptions shown on the Test Boring Logs may vary between boring location and sample depth.

It should also be noted that the lines of stratigraphic separation shown on the Test Boring Logs represent approximate boundaries between soil types and the actual stratigraphic transitions may be more gradual and vary with location. The Test Boring Logs are presented in Appendix A.

Moisture Content, ASTM D-2216, was obtained in the laboratory for all recovered samples. Grain-Size, ASTM D-422, and Atterberg Limits, ASTM D-4318, were determined for various samples for the purpose of classification and to obtain pertinent engineering characteristics. Volume change testing was performed on selected samples using the FHA Swell Test in order to evaluate potential expansion characteristics of the soil and bedrock. Sulfate testing was performed on select samples to determine the corrosive characteristics of the soils. The Laboratory Test Results are included in Appendix B and summarized in Table 1.

4.0 SUBSURFACE CONDITIONS

One (1) soil type and two (2) bedrock types were encountered in the borings drilled for the subsurface investigation: Type 1: slightly silty to silty sand and clean sand (SM-SW, SM, SW), Type 2: slightly silty to silty sandstone (SM-SW. SM), and Type 3: sandy claystone (CL). The soils were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

4.1 Soil and Rock

Soil Type 1 is a slightly silty to silty sand and clean sand (SM-SW, SM, SW). The sand was encountered in all of the test borings at the existing ground surface extending to depth 14 feet and extending to the termination (15 feet deep) of Test Boring Nos. 1, 1A, and 3A. Standard Penetration Testing conducted on the sand resulted in an SPT N-value of 2 to 27 bpf, which indicates very loose to medium states. Moisture content and grain size testing resulted in a moisture content of 5 to 34 percent with approximately 5 to 23 percent of the soil size particles passing the No. 200 sieve. FHA Swell Testing resulted in an expansion pressure of 60 psf, indicating a low expansion potential. Atterberg limit testing was performed on a sample which resulted in a liquid limit of no value with a plastic index of non-plastic. Sulfate testing performed on samples of the sand resulted in less than 0.01 percent sulfate by weight, indicating the sand exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Soil Type 2 is a slightly silty to silty sandstone bedrock (SM-SW, SM). The sandstone was encountered in five of the test borings at depths of 14 feet bgs and extending to termination of the borings (15 to 20 feet). Weathered sandstone was encountered in Test Boring Nos. 1, 1A, and 3A at approximately 14 feet. Standard Penetration Testing conducted on the sandstone resulted in N-values of 50 to greater than 50 bpf, indicating the sandstone is dense to very dense states. Moisture content and grain size testing resulted in moisture contents of 9 to 17 percent with approximately 22 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing was performed on a sample of sand and resulted in a liquid limit of no value with a plastic index of non-plastic. Sulfate testing performed on a sample of the sandstone resulted in 0.00 percent sulfate by weight, indicating the sandstone exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Soil Type 3 is a sandy claystone bedrock (CL). The claystone was encountered in Test Boring No. 2A at 14 feet bgs and extending to the termination of the test boring (20 feet). Standard Penetration Testing conducted on the soil resulted in N-values of greater than 50 bpf, indicating hard consistencies. Moisture content and grain size testing resulted in moisture contents of 13 and 14 percent with approximately 90 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing resulted in a liquid limit of 43 and a plastic index of 21. FHA Swell Testing resulted in an expansion pressure of 1690 psf, indicating a moderate expansion potential. Sulfate testing performed on a sample of the siltstone resulted in less than 0.01 percent sulfate by weight, indicating the siltstone exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs. Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

4.2 Groundwater

Groundwater was encountered at depths ranging from 2 to 9 feet in the test borings drilled on this site. Groundwater will affect the construction and excavation for the box culverts on this site. Dewatering of the culvert crossings will be needed during construction. Unstable conditions will be encountered where excavations approach the groundwater level. Stabilization using shot rock or geogrids will likely be necessary. It should be noted that groundwater levels, observed at the time of the subsurface investigation, could change due to seasonal variations, changes in land runoff characteristics and future development including of nearby areas.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled in the culvert crossing footprints. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

The construction will consist of two culvert crossings over West Kiowa Creek for Alamar Way and Twinkling Star Lane in the Winsome Subdivision. The proposed crossings are expected to utilize reinforced concrete box culverts with riprap soil protection.

Subsurface soil conditions encountered in the test borings drilled for the planned crossings consisted of slightly silty to silty sand overlying silty sandstone and sandy claystone. Bedrock was encountered at depth of 14 feet in the 5 of the 8 test borings. Weathered bedrock was encountered in other borings at 14 feet. The surficial sands and were encountered in very loose to medium dense states. The very loose samples are likely associated with the groundwater levels and possibly slough in the borings as they were caving during drilling. The underlying sandstone was encountered in dense to very dense states, and the underlying claystone was encountered at hard consistencies.

5.1 Foundation Recommendations

The subsurface investigation was performed to gather soil and bedrock information for use in providing foundation recommendations and design values for the proposed bridge structures. Recommendations for bridge supports using driven H-piles, shallow spread footings, and parameters for retaining walls are provided.

5.1.1 Deep Foundation Systems

Driven H-Piles

Based on evaluation of the site subsurface conditions, it is believed that H-piles will achieve most of their compressive strength through end bearing and skin friction in the underlying sandstone and claystone bedrock (Soil Types 2 and 3). Some frictional resistance will also be developed in the overburden sand (Soil Type 1). Design parameters for use in the H-pile design, which include allowable end bearing, side resistance, and resisting factors are presented in Table 2. L Pile parameters for the sand, sandstone, and claystone are also included in Table 2. The recommendations and parameters apply to piles spaced by horizontal distances of at least 3 times the pile width. If the piles are spaced closer, reductions in the allowable pile capacity may be warranted. The following unit weights are recommended for the site soil and bedrock.

Unit weight of native overburden sand	120 pcf
Unit weight of sandstone bedrock	125 pcf
Unit weight of claystone bedrock	125 pcf

It is recommended that full-time observation of the H-pile installation be performed to compile driving logs for each pile. At a minimum, the log should include: the driving resistance per foot of pile and per inch of pile over the last 3 inches; the pile driver make and model; rated energy; pile cushion/condition; observed damage; and final pile top location. The guidance set forth in the State of Colorado Standard Specifications for Road and Bridge Construction, Section 502, Piling, is recommended. Piles should be driven 10 feet into bedrock or refusal, if shallower.

Helical Piers

Helical piers may be appropriate for the proposed foundation on this site. The helical piers should be ICBO approved and installed in accordance with the manufacturer's requirements. The following guidance is provided with respect to the use of helical piers to support the planned structure.

- Helical piers are expected to develop the majority of their support capacity by way of contact with competent native soils or bedrock. Helical piers generally are capable of supporting a 25-kip vertical load per pier when achieving the minimum torque requirements. Specific helical pier loads should be determined by the foundation designer. Helical pier depths of approximately 20 feet are anticipated. The piers may need to be pre-drilled to achieve the recommended torque and depths. Drilling of a test pier at each creek crossing is recommended.

- A Soils Engineer should observe the installation of the helical piers to evaluate that the piers are penetrating into the expected bearing strata as described in this report. Full time observation during helical pier installation for new construction is currently required by the Regional Building Department in El Paso County.

5.1.2 Shallow Foundation Parameters

Structures associated with the bridges can be supported with shallow foundations resting on a uniform bearing pad of structural fill. It should be noted that due to shallow groundwater on this site and the active West Kiowa Creek, extensive subgrade improvements/stabilization are anticipated if shallow foundations are used. The foundation members should bear on uniform pad (minimum 2 to 3 feet thick) of structural fill/gravel placed according to the "Structural Fill" paragraph. Any topsoil or highly organic soils must be removed and the existing subgrade cleared of any debris prior to excavation. Loose soils beneath foundation components will require removal and recompaction. Any expansive soils encountered beneath the foundation will require removal and replacement with non-expansive structural fill compacted according to the "Structural Fill" paragraph. Any new fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill as approved by Entech.

Any import material should be approved by Entech prior to hauling to the site. It is anticipated that large rock (8 to 12 inches) may be required to stabilize the subgrade. Geogrid may also be required to establish a stable subgrade in the creek bed.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for recompacted site sands and for imported granular structural fill, an allowable bearing capacity of 3000 psf is recommended. Footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection. Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs which should limit total and differential vertical movements to one inch and ½ inch, respectively.

Foundation excavations are recommended to extend at least 3 feet horizontally beyond the foundation limits in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of 1½ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe overexcavated subgrades as well as the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth and other subgrade improvements, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

5.1.3 Retaining Wall Parameters

The following values are recommended for use in designing retaining walls with unbalanced lateral loading that may be associated with this project. Roadway/Vehicle surcharge loading is required for wall design.

Recommended Design Values – Lateral Loading

Equivalent fluid density for lateral earth pressure (active), pcf (site granular soils)	45
Equivalent fluid density for lateral earth pressure (passive), pcf	300
Equivalent fluid density for lateral earth pressure (at rest), pcf	60
Soil density (compacted sand), pcf	125
Angle of Internal Friction (loose silty sand)	26°
Angle of Internal Friction (compacted silty sand)	34°
Coefficient of sliding between concrete and silty gravelly sand	0.35
Bearing capacity of sand, psf	2400 psf
Bearing capacity of sandstone, psf	3500 psf

*Note: The above lateral loading design values are for level back slope angles and no surcharge loads. If wall backfill is submerged, water pressures must be taken into account as additional wall loading. If backfill slope angles are greater than zero degrees, or if the backfill is surcharged, the design values must be adjusted to account for additional lateral loading.

Structures associated with the bridges can be supported with shallow foundations resting on a uniform bearing pad of structural fill/stabilized soils. It should be noted that due to shallow groundwater on this site and the active West Kiowa Creek, extensive subgrade improvements are anticipated to support shallow foundations. The foundation members should bear on uniform pad (minimum 2 to 3 feet thick) of structural fill placed according to the "Structural Fill" paragraph. Any topsoil or highly organic soils must be removed and the existing subgrade cleared of any debris prior to excavation. Loose soils beneath foundation components will require removal and recompaction. Areas that require stabilization will likely use shot rock and geogrids/geofabrics. Specific recommendations should be field determined during grading. Any expansive soils encountered beneath the foundation will require removal and replacement with non-expansive structural fill compacted according to the "Structural Fill" paragraph. Any new fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill as approved by Entech. Any import material should be approved by Entech prior to hauling to the site.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for recompacted site sands and for imported granular structural fill, an allowable bearing capacity of 3000 psf is recommended. Footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection. Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs which should limit total and differential vertical movements to one inch and ½ inch, respectively.

Foundation excavations are recommended to extend at least 3 feet horizontally beyond the foundation limits in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of 1½ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe overexcavated subgrades as well as the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth and other subgrade improvements, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

5.2 Site Seismic Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2015 International Building Code (IBC), the site meets the conditions of a Site Class D.

5.3 Surface and Subsurface Drainage

Positive surface drainage must be maintained around structures to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation components is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from structures.

5.4 Concrete

Soluble sulfate testing was conducted on samples of the site soils to evaluate the potential for sulfate attack on concrete placed below the surface grade. The test results indicated 0.00 to less than 0.01 percent soluble sulfate by weight for the site soils. The test results indicate the sulfate component of the in-place site soils present a negligible exposure threat to concrete placed below grade that comes into contact with the site soils.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in foundation excavations prior to the placement of concrete. If standing water is present in the foundation excavations, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.5 Foundation Excavation Observations

Subgrade preparation for bridge foundations and associated improvements should be observed by Entech Engineering prior to construction of the foundation elements in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Pile driving should be observed to verify proper embedment or refusal. Piles should be driven 10 feet into bedrock or refusal. Entech should make final recommendations for over-excavation or stabilization, if required, at the time of excavation observation, if necessary.

5.6 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within ±2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill.

New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components. All fill placed within the foundation areas should be non-expansive and be compacted to a minimum of 95 percent of the soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Fill material placed beneath slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to achieving adequate compaction, usually within ±2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from the structure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of fill material.

5.7 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within ±2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

Trench backfill placement should be performed in accordance with El Paso County specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

5.8 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12-inches and moisture conditioned to ± 2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches, beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

5.9 Excavation Stability

Excavation sidewalls must be properly sloped, benched and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

5.10 Winter Construction

In the event construction of the planned construction occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to eliminate burial of snow, ice or frozen material within the planned construction area.

5.11 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- H-Pile Installation
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components and retaining walls.
- Placement/compaction of utility bedding and trench backfill.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use of Winsome, LLC with application to the construction of two culvert crossings over West Kiowa Creek for Alamar Way and Twinkling Star Lane in the Winsome Subdivision located in northeastern El Paso County, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT WINSOME LLC
PROJECT WINSOME, FILING 3
JOB NO. 211992

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			18.7	NV	NP	<0.01			SM	SAND, SILTY
1	2	5			15.8	NV	NP				SM	SAND, SILTY
1	4	5			22.5				60		SM	SAND, SILTY
1	1A	2-3			7.2	NV	NP	<0.01			SM-SW	SAND, SLIGHTLY SILTY
1	3A	1-2			4.7						SW	SAND
1	4A	5			9.5						SM-SW	SAND, SLIGHTLY SILTY
2	3	15			22.1	NV	NP	0.00			SM	SANDSTONE, SILTY
3	2A	15			90.2	43	21	<0.01	1690		CL	CLAYSTONE, SANDY

TABLE 2

Alamar Way and Twinkling Star Lane over West Kiowa Creek Bridge - LPile Design Parameters

Depth Below Existing Ground Surface		Groundwater Elevation (ft) Below Existing Ground	Soil/Rock Description	Axial Pile Capacity Parameters		PRELIMINARY LPile Parameters					
Top	Bottom			Allowable Side Resistance (ksf)	Allowable End Bearing (ksf)	p-y Curve	Unit Weight γ[1] (pcf)	Peak Friction Angle ϕ (deg)	Initial Static Modulus of Subgrade Reaction, k (pci)	Undrained Cohesion s_u (psf)	Strain Factor ε_{50} (in/in)
0	0 to 15 BOE	2 to 9	Slightly Silty Sand	—	—	Sand	120 62[1]	32	25 20[1]	N/A	N/A
14	15 to 20 BOE		Slightly Silty Sandstone	3	30	Sand	125 67[1]	34	225 125[1]	N/A	N/A
14	20 BOE		Sandy Claystone	3	30	Clay	115 57[1]	N/A	500	1500	0.007

[1] = Submerged

FIGURES

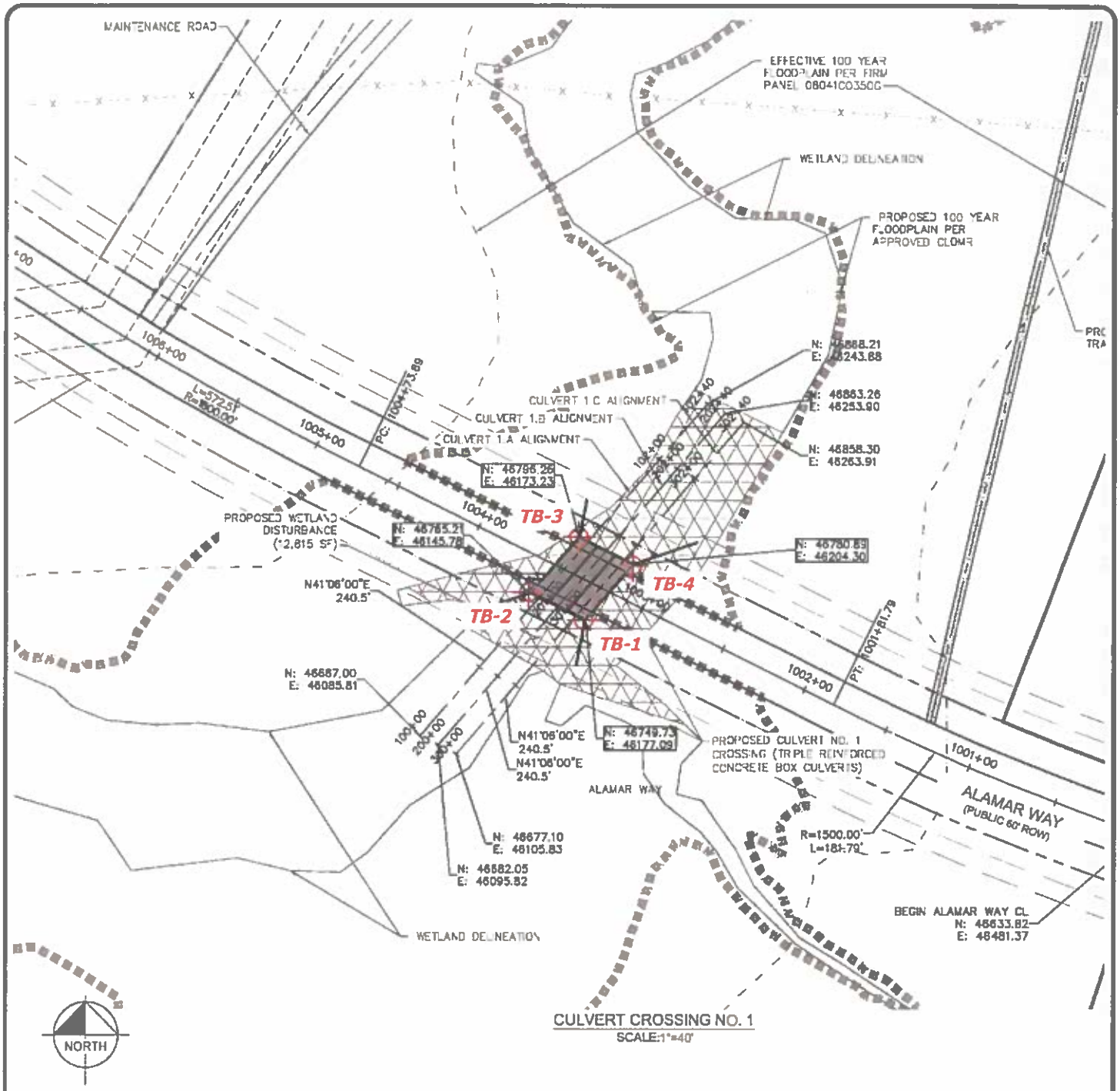
ENTECH
ENGINEERING, INC.
565 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP
WINSOME SUBDIVISION – W. KIOWA CREEK
BOX CULVERT CROSSINGS
EL PASO COUNTY, CO
FOR: WINSOME, LLC

DRAWN:	DATE:	CHECKED:	DATE:
LLL	9/16/21		

JOB NO.: 211992

FIG NO.: 1



TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

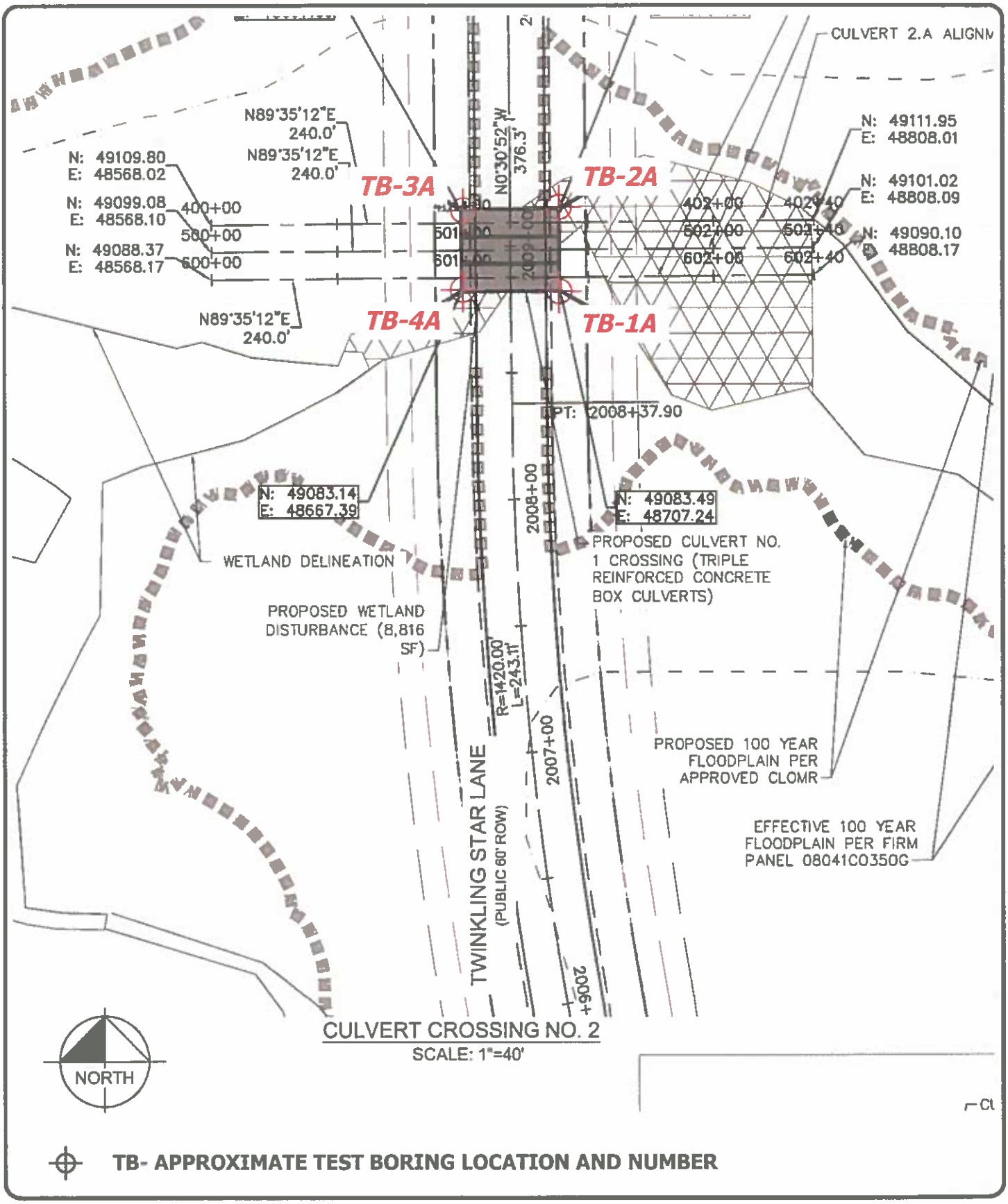
ENTECH ENGINEERING, INC.
303 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

SITE PLAN/TEST BORING LOCATION MAP
WINSOME SUBDIVISION – W. KIOWA CREEK
BOX CULVERT CROSSING NO. 1
EL PASO COUNTY, CO
FOR: WINSOME, LLC

DRAWN:	DATE:	CHECKED:	DATE:
LLL	9/16/21		

JOB NO.: 211992

FIG NO.: 2



CULVERT CROSSING NO. 2

SCALE: 1"=40'

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

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

SITE PLAN/TEST BORING LOCATION MAP
WINSOME SUBDIVISION – W. KIOWA CREEK
BOX CULVERT CROSSING NO. 2
EL PASO COUNTY, CO
FOR: WINSOME, LLC

DRAWN:	DATE:	CHECKED:	DATE:
LLL	9/16/21		

JOB NO.: 211992

FIG NO.: 3

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 8/28/2021
Job # 211992

REMARKS

BRIDGE 1

WATER @ 2', 8/28/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY LOOSE TO MEDIUM DENSE, WET					
5			2	18.3	1
10			4	28.0	1
WEATHERED SANDSTONE, SILTY, BROWN 15			24	9.2	1
20					

TEST BORING NO. 2
DATE DRILLED 8/28/2021
CLIENT WINSOME LLC
LOCATION WINSOME, FILING 3

REMARKS

BRIDGE 1

WATER @ 4', 8/28/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, LOOSE, WET					
5			4	16.4	1
10			7	24.0	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, WET 15			50/8"	8.8	2
20			50/8"	10.2	2

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

TEST BORING LOG

DRAWN:	DATE:	CHECKED: LLL	DATE: 9/8/21

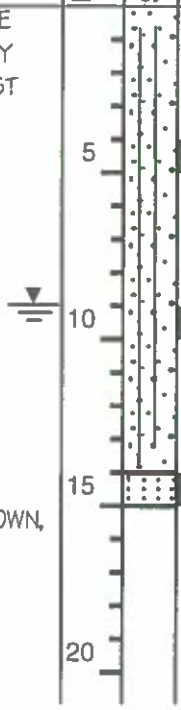
JOB NO. 211992
FIG NO. A- 1

TEST BORING NO. 3
DATE DRILLED 8/28/2021
Job # 211992

REMARKS

BRIDGE 1

WATER @ 9', 8/28/21



Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
5		3	33.8	1
10		2	10.5	1
15		50 8"	10.2	2
20				

SAND, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY LOOSE TO VERY DENSE, MOIST TO WET

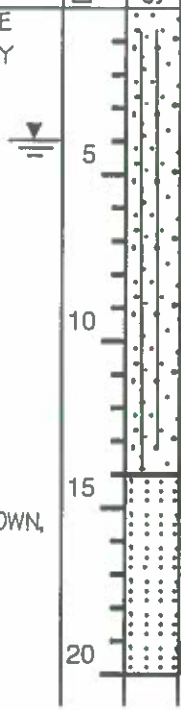
SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, WET

TEST BORING NO. 4
DATE DRILLED 8/28/2021
CLIENT WINSOME LLC
LOCATION WINSOME, FILING 3

REMARKS

BRIDGE 1

WATER @ 4', 8/28/21



Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
5		2	15.0	1
10		3	20.3	1
15		50 9"	16.5	2
20		50	13.7	2

SAND, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY LOOSE TO VERY DENSE, WET

SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE TO DENSE, WET

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

TEST BORING LOG

DRAWN	DATE	CHECKED:	DATE:
		LLL	9/8/21

JOB NO. 211992

FIG NO. A- 2

TEST BORING NO. 1 A
DATE DRILLED 8/28/2021
Job # 211992

REMARKS

BRIDGE 2

WATER @ 4', 8/28/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, LOOSE, WET					
5			4	12.2	1
10			5	11.7	1
CLAYEY LENS					
WEATHERED SANDSTONE, CLAYEY, BROWN 15			22	11.3	2
20					

TEST BORING NO. 2 A
DATE DRILLED 8/28/2021
CLIENT WINSOME LLC
LOCATION WINSOME, FILING 3

REMARKS

BRIDGE 2

WATER @ 4', 8/28/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, LOOSE, WET					
5			7	12.8	1
10			3	26.7	1
CLAYSTONE, SANDY, BROWN, HARD, WET 15			50/9"	13.6	3
20			50/11"	12.9	3

ENTECH
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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO. 211992

FIG NO. A- 3

TEST BORING NO. 3 A
DATE DRILLED 8/28/2021
Job # 211992

REMARKS

BRIDGE 2

WATER @ 4', 8/28/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			*	9.5	1
5			4	23.5	1
10			5	23.6	1
15			27	12.9	1
					2
20					

SAND, CLEAN TO SILTY, FINE TO COARSE GRAINED, GRAY BROWN TO DARK BROWN, LOOSE TO MEDIUM DENSE, MOIST TO WET

WEATHERED SANDSTONE, CLAYEY, BROWN

* - BULK SAMPLE TAKEN

TEST BORING NO. 4 A
DATE DRILLED 8/28/2021
CLIENT WINSOME LLC
LOCATION WINSOME, FILING 3

REMARKS

BRIDGE 2

WATER @ 4', 8/28/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			4	13.0	1
10			6	4.8	1
15			50/3"	12.6	2
20					

SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, LOOSE TO VERY DENSE, WET

SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, WET

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

TEST BORING LOG

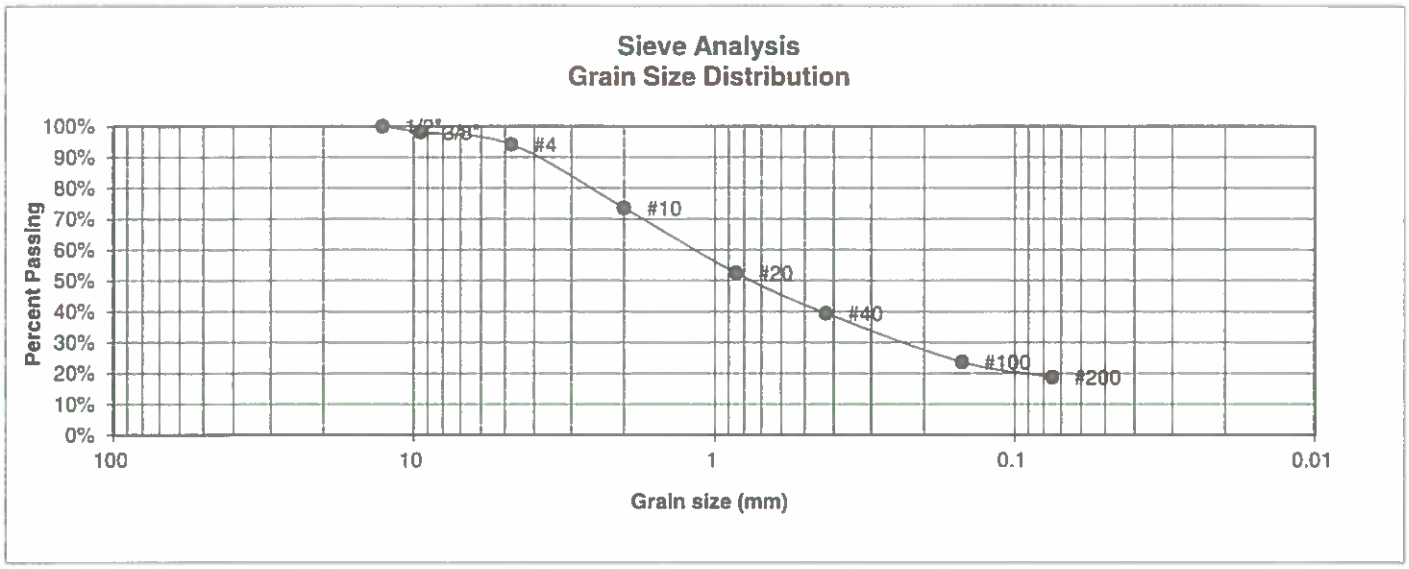
DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO. 211992

FIG NO. A- 4

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	WINSOME LLC
SOIL TYPE #	1	PROJECT	WINSOME, FILING 3
TEST BORING #	1	JOB NO.	211992
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.2%
4	94.1%
10	73.6%
20	52.5%
40	39.5%
100	23.7%
200	18.7%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

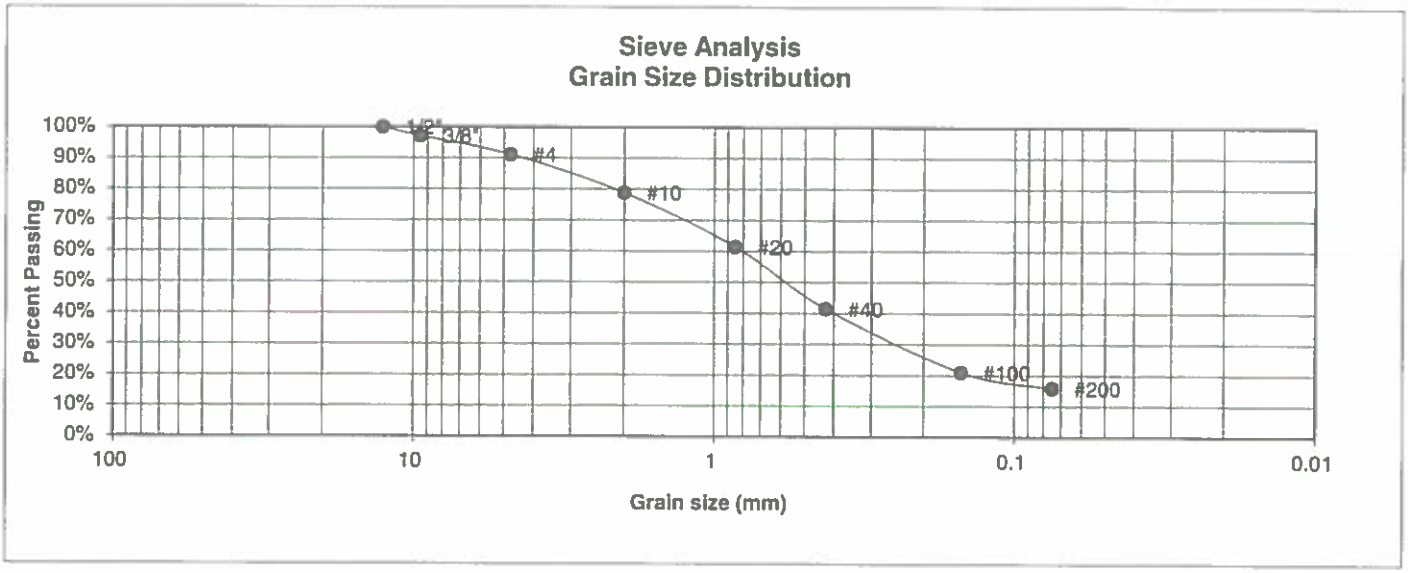
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO.: 211992

FIG NO.: B-1

UNIFIED CLASSIFICATION	SM	CLIENT	WINSOME LLC
SOIL TYPE #	1	PROJECT	WINSOME, FILING 3
TEST BORING #	2	JOB NO.	211992
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.2%
4	91.1%
10	78.8%
20	61.4%
40	41.4%
100	21.0%
200	15.8%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

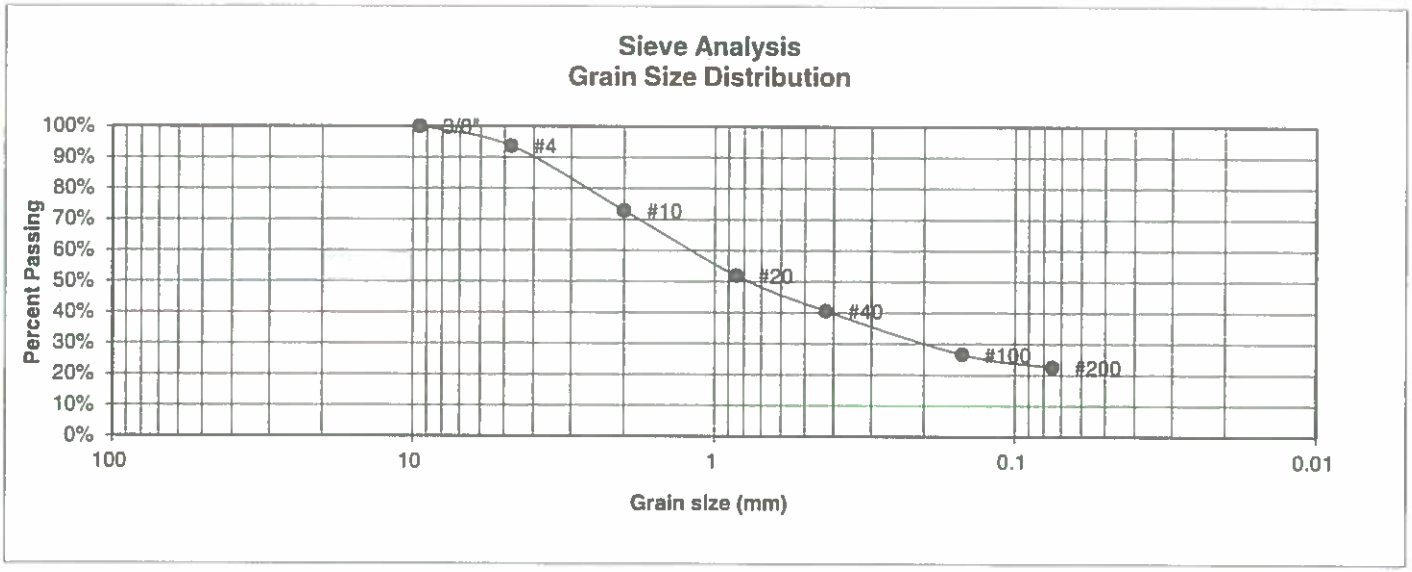
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO. 211992

FIG NO. B-2

UNIFIED CLASSIFICATION	SM	CLIENT	WINSOME LLC
SOIL TYPE #	1	PROJECT	WINSOME, FILING 3
TEST BORING #	4	JOB NO.	211992
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.7%
10	72.8%
20	52.0%
40	40.6%
100	26.6%
200	22.5%

Atterberg Limits

Plastic Limit	
Liquid Limit	
Plastic Index	

Swell

Moisture at start	9.9%
Moisture at finish	19.7%
Moisture increase	9.8%
Initial dry density (pcf)	104
Swell (psf)	60

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

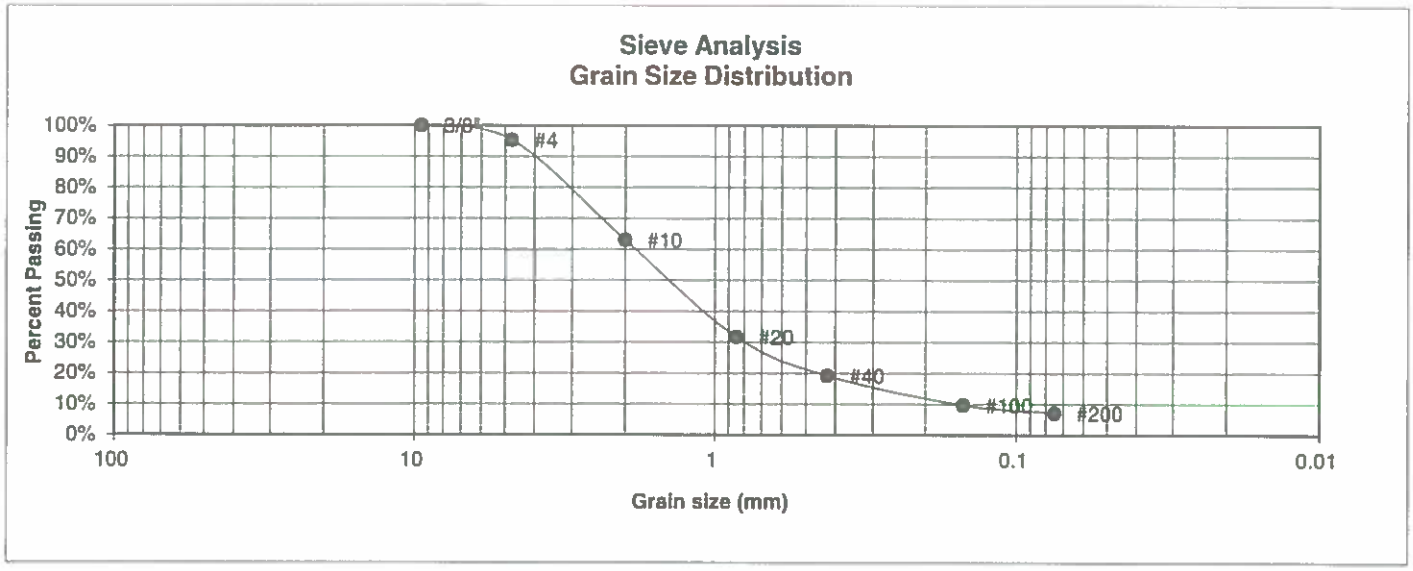
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO.: 211992

FIG NO.: B-3

UNIFIED CLASSIFICATION	SM-SW	CLIENT	WINSOME LLC
SOIL TYPE #	1	PROJECT	WINSOME, FILING 3
TEST BORING #	1A	JOB NO.	211992
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	95.3%
10	63.0%
20	31.8%
40	19.2%
100	9.8%
200	7.2%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

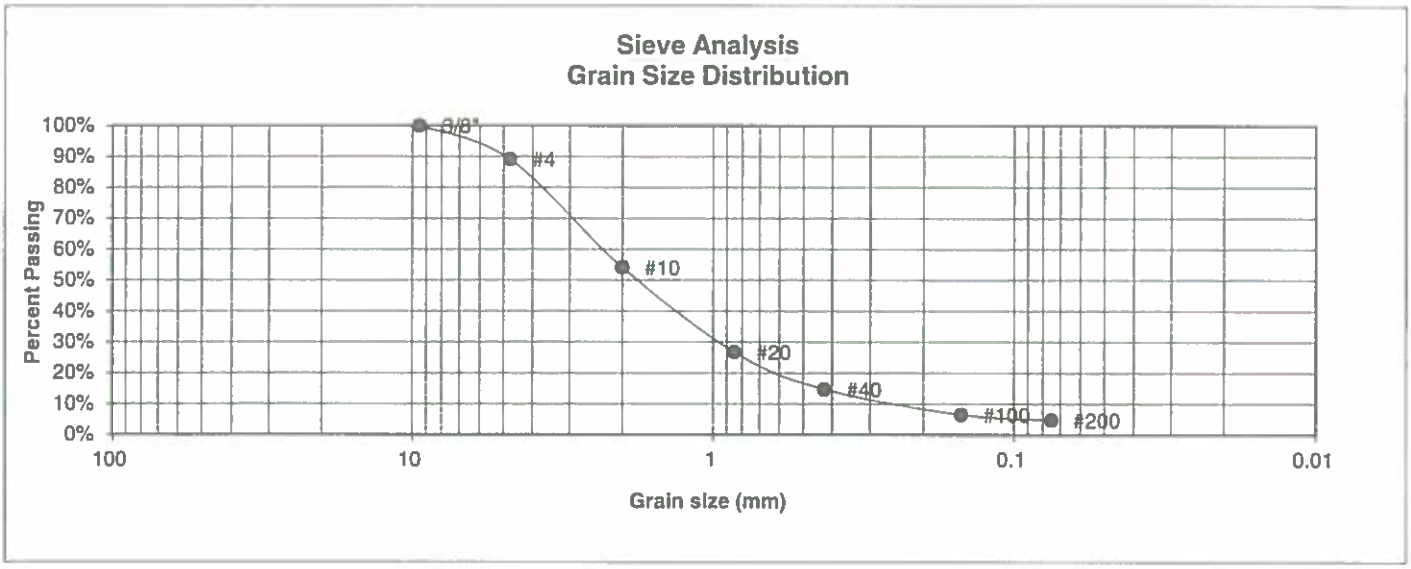
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO. 211992

FIG NO. B-4

UNIFIED CLASSIFICATION	SW	CLIENT	WINSOME LLC
SOIL TYPE #	1	PROJECT	WINSOME, FILING 3
TEST BORING #	3A	JOB NO.	211992
DEPTH (FT)	1-2	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.1%
10	54.1%
20	26.8%
40	14.7%
100	6.5%
200	4.7%

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

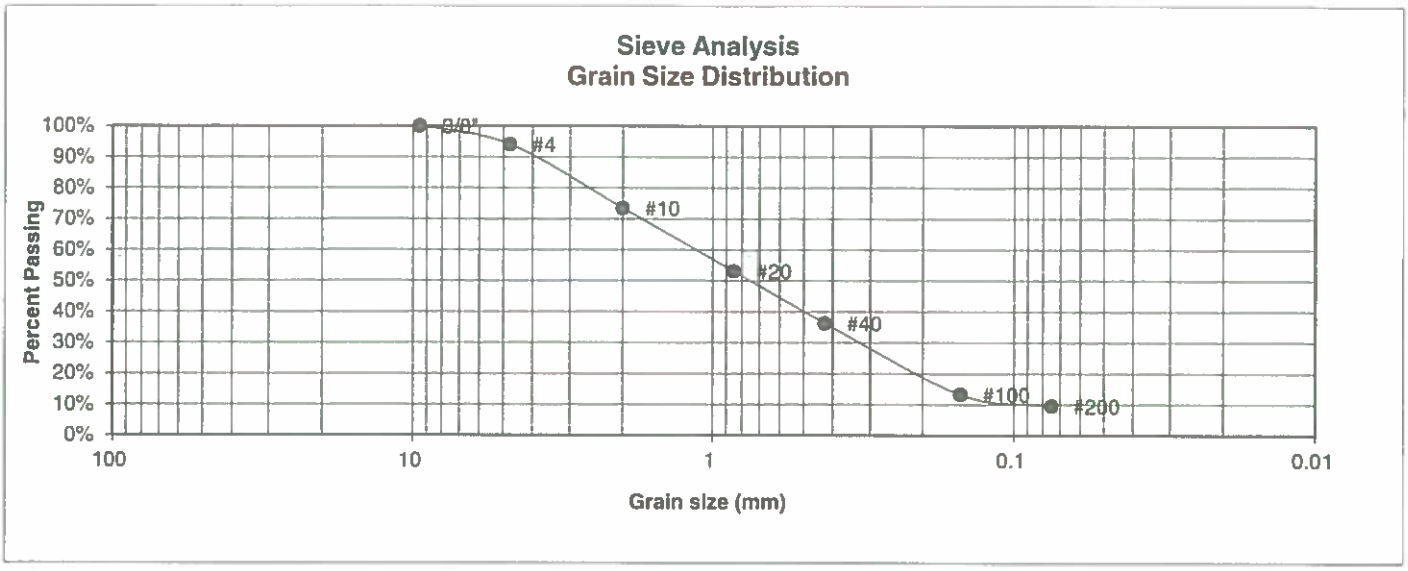
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO.: 211992

FIG NO.: B-5

UNIFIED CLASSIFICATION	SM-SW	CLIENT	WINSOME LLC
SOIL TYPE #	1	PROJECT	WINSOME, FILING 3
TEST BORING #	4A	JOB NO.	211992
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.1%
10	73.5%
20	53.1%
40	36.3%
100	13.3%
200	9.5%

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

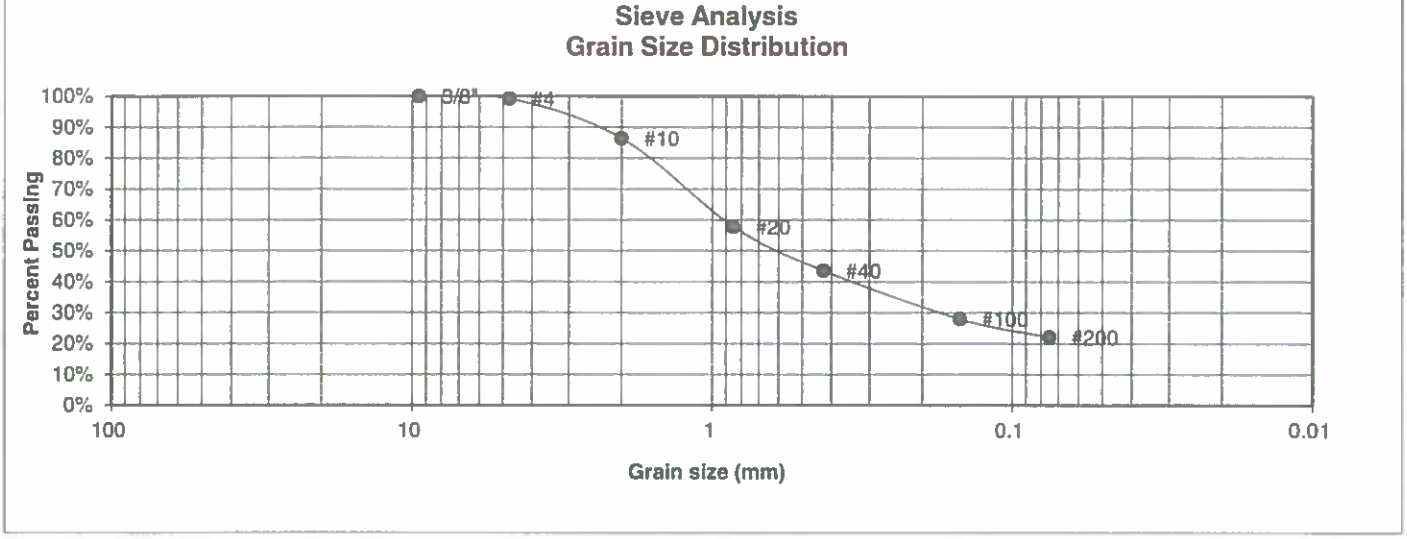
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO.: 211992

FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	WINSOME LLC
SOIL TYPE #	2	PROJECT	WINSOME, FILING 3
TEST BORING #	3	JOB NO.	211992
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.2%
10	86.4%
20	57.8%
40	43.6%
100	28.0%
200	22.1%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

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

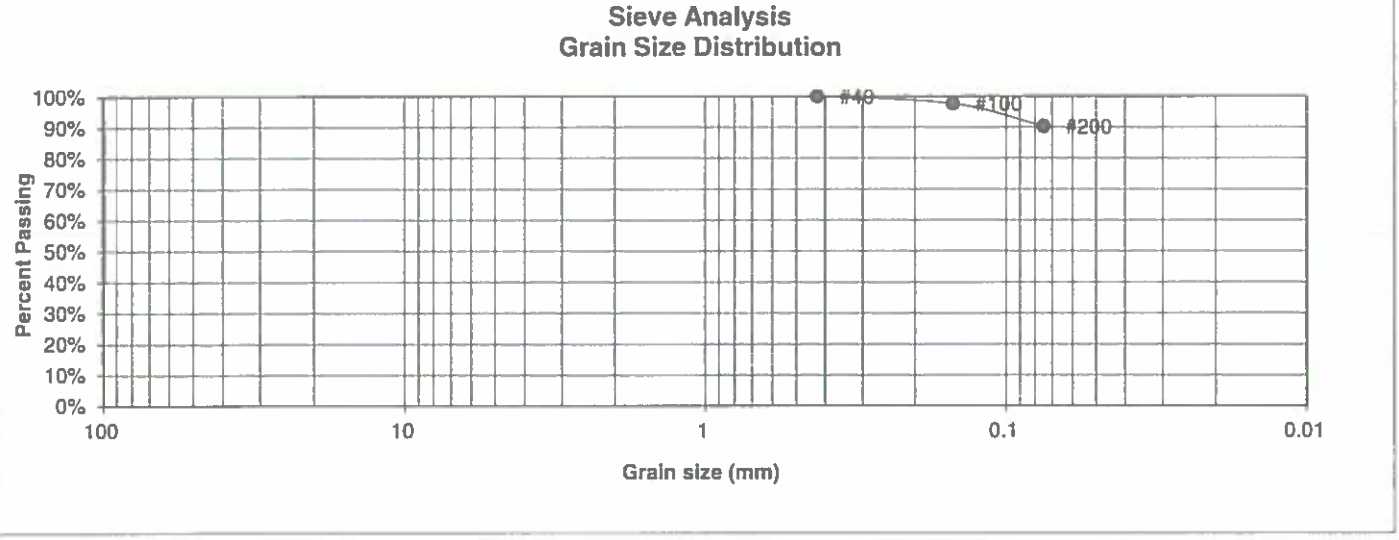
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO.: 211992

FIG NO.: B-7

UNIFIED CLASSIFICATION	CL	CLIENT	WINSOME LLC
SOIL TYPE #	3	PROJECT	WINSOME, FILING 3
TEST BORING #	2A	JOB NO.	211992
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	100.0%
100	97.6%
200	90.2%

Atterberg Limits	
Plastic Limit	22
Liquid Limit	43
Plastic Index	21

Swell	
Moisture at start	15.5%
Moisture at finish	23.0%
Moisture increase	7.4%
Initial dry density (pcf)	100
Swell (psf)	1690

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

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO.: 211992

FIG NO.: B-8

CLIENT	WINSOME LLC	JOB NO.	211992
PROJECT	WINSOME, FILING 3	DATE	9/8/2021
LOCATION	WINSOME, FILING 3	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	2-3	1	SM	<0.01
TB-1A	2-3	1	SM	<0.01
TB-3	15	2	SM-SW	0.00
TB-2A	15	3	CL	<0.01

QC BLANK PASS

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

LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	9/8/21

JOB NO. 211992

FIG NO. B-9

Appendix C

Structural Calculations

STRUCTURAL DESIGN DOCUMENTATION for

Winsome Filing No. 3

El Paso County, Colorado

Prepared for:

Winsome LLC

1864 Woodmoor Drive, Suite 100

Monument, CO 80132

Prepared by:

Kimley-Horn and Associates, Inc.

2 North Nevada Avenue, Suite 300

Colorado Springs, Colorado 80903

Prepared: August 31, 2022

PCD File No. CDR-21-012

Project #: 196106001

2022-0831

Kimley»Horn

STRUCTURAL DESIGN DOCUMENTATION
Winsome Filing No. 3
El Paso County, Colorado

The following calculations have been prepared to analyze a CDOT Standard Box Culvert for a three-cell 12-ft span (S) by 7-ft rise (R) culvert. The member thicknesses and the reinforcing steel are based on the details provided in Standard Plan No. M-601-3 for a 12-ft span by 8-ft rise culvert. Culvert #1 has a max fill height of 3.83-ft and uses the details for a fill height for 2-4-ft of fill. Culvert #2 has a max fill height of 4.21-ft and used the details for 4-8-ft of fill.

Spec.: LRFD 7th ed. 2014-2016
Type of Culvert: Cast-in-Place

Physical Dimensions

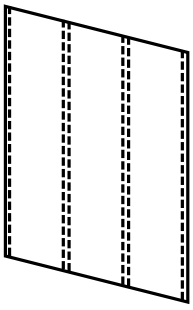
Clear Span:	12'-0"
Clear Height:	7'-0"
Top Slab:	1'- 1/2"
Bottom Slab:	11"
Ext. Wall:	10"
Int. Wall:	10"
Fill Depth:	3.30 ft
Length:	54'-0"
Skew Angle:	14.80 deg
Left Skew Angle:	75.20 deg
Right Skew Angle:	75.20 deg
Bottom Slab Support:	Full Slab
Top Haunch, Width:	0"
Top Haunch, Height:	0"
Bottom Haunch, Width:	0"
Bottom Haunch, Height:	0"

Loads

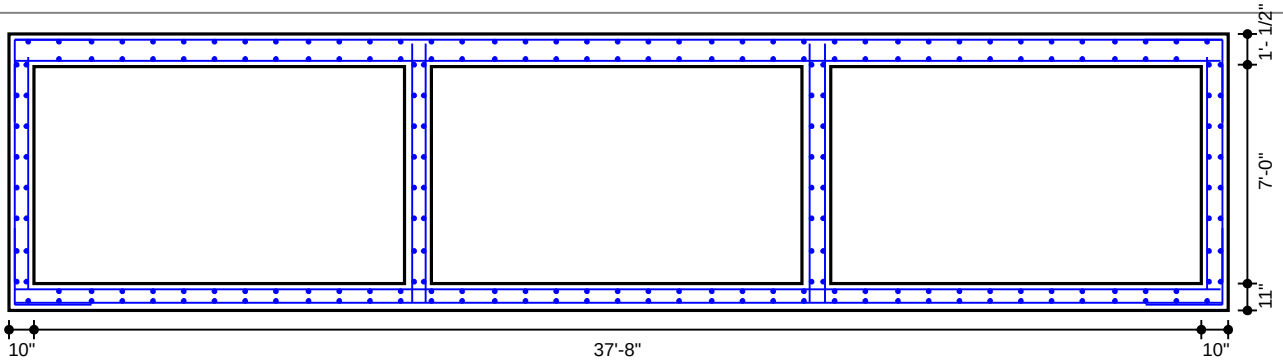
Live Load	
Vehicle Names:	HL-93
Traffic Direction:	Parallel
Eq. Height of Soil:	2.77 ft (Calc'd)
Max No. of Lanes:	1
Dead Load	
Future Wearing Surface:	0.037 klf
Additional Dead Load:	0.000 klf
Concentrated Loads:	none
Lateral Soil Loads	
Eq. Fluid Press. Max:	60.00 pcf
Eq. Fluid Press. Min:	30.00 pcf
Consider Int. Water Press.:	no

Material Properties

Concrete	
Strength, f'c:	4.500 ksi
Density:	0.150 kcf
Elasticity, Ec:	4435 ksi
Type:	Normal wt
Steel	
Yield, fy:	60 ksi
Allow Stress:	36 ksi
Elasticity, Es:	29000 ksi
Soil	
Density:	0.120 kcf
Exposure Factor	
Class 1 Exposure	
Reinforcement Covers	
Ext. Cover Top Slab:	2 1/2"
Ext. Cover Bottom Slab	3"
Ext. Cover Walls	2"
Int. Cover Walls	2"
Int. Cover Top Slab	2"
Int. Cover Bottom Slab	2"



Plan View



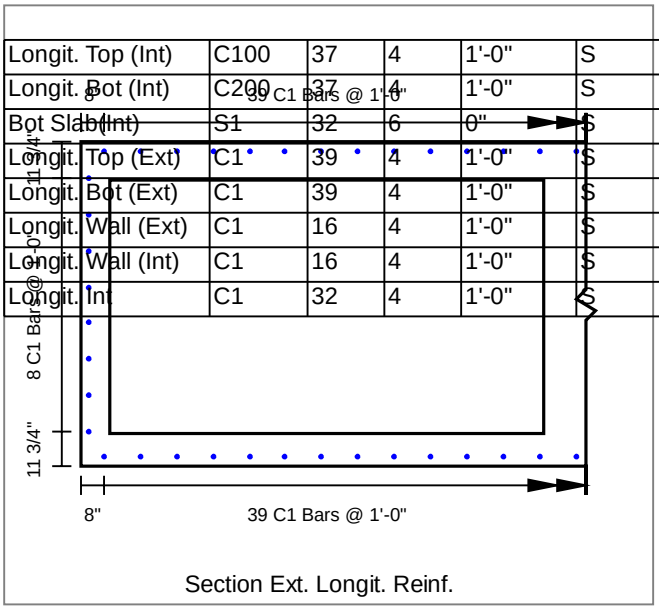
Typical Section

Concrete Summary
Volume of Concrete: 3.717 cy/ft Total Volume of Concrete: 200.722 cy

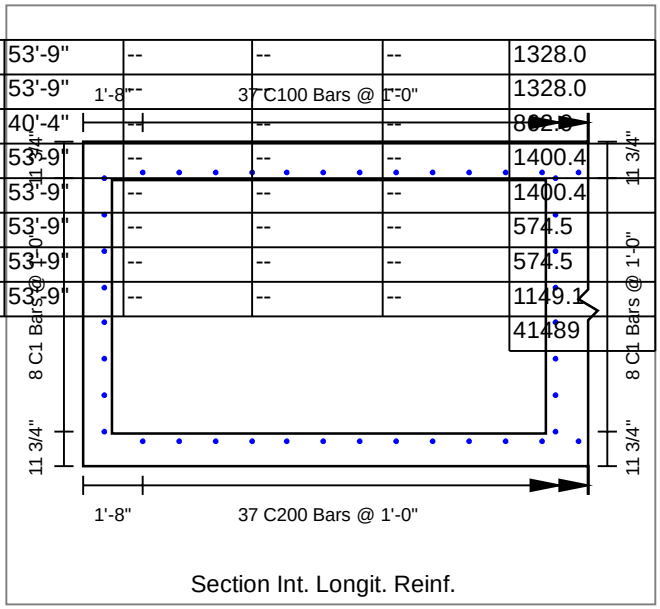
Reinforcing Steel Bar Schedule (lb)

Location	Mark	Qty	Size	Spacing	Type	Length	Hor.Leg	Ver.Leg	Tot.Weight
Top Slab(Int)	A100 (AS2)	88	7	6"	S	38'-11"	--	--	7000.0
Top Slab(Int)	A101	4	7	6"	S	34'-9"	--	--	284.0
Top Slab(Int)	A102	4	7	6"	S	30'-11"	--	--	253.0
Top Slab(Int)	A103	4	7	6"	S	27'-2"	--	--	222.0
Top Slab(Int)	A104	4	7	6"	S	23'-4"	--	--	191.0
Top Slab(Int)	A105	4	7	6"	S	19'-7"	--	--	160.0
Top Slab(Int)	A106	4	7	6"	S	15'-10"	--	--	129.0
Top Slab(Int)	A107	4	7	6"	S	12'-0"	--	--	98.0
Top Slab(Int)	A108	4	7	6"	S	8'-3"	--	--	67.0
Top Slab(Int)	A109	4	7	6"	S	4'-5"	--	--	36.0
Bot Slab(Int)	A200 (AS3)	88	6	6"	S	38'-11"	--	--	5144.0
Bot Slab(Int)	A201	4	6	6"	S	34'-9"	--	--	209.0
Bot Slab(Int)	A202	4	6	6"	S	30'-11"	--	--	186.0
Bot Slab(Int)	A203	4	6	6"	S	27'-2"	--	--	163.0
Bot Slab(Int)	A204	4	6	6"	S	23'-4"	--	--	140.0
Bot Slab(Int)	A205	4	6	6"	S	19'-7"	--	--	118.0
Bot Slab(Int)	A206	4	6	6"	S	15'-10"	--	--	95.0
Bot Slab(Int)	A207	4	6	6"	S	12'-0"	--	--	72.0
Bot Slab(Int)	A208	4	6	6"	S	8'-3"	--	--	50.0
Bot Slab(Int)	A209	4	6	6"	S	4'-5"	--	--	27.0
Top Slab(Ext)	A300 (AS7)	88	6	6"	S	38'-11"	--	--	5144.0
Top Slab(Ext)	A301	4	6	6"	S	34'-9"	--	--	209.0
Top Slab(Ext)	A302	4	6	6"	S	30'-11"	--	--	186.0
Top Slab(Ext)	A303	4	6	6"	S	27'-2"	--	--	163.0
Top Slab(Ext)	A304	4	6	6"	S	23'-4"	--	--	140.0
Top Slab(Ext)	A305	4	6	6"	S	19'-7"	--	--	118.0
Top Slab(Ext)	A306	4	6	6"	S	15'-10"	--	--	95.0
Top Slab(Ext)	A307	4	6	6"	S	12'-0"	--	--	72.0
Top Slab(Ext)	A308	4	6	6"	S	8'-3"	--	--	50.0
Top Slab(Ext)	A309	4	6	6"	S	4'-5"	--	--	27.0
Bot Slab(Ext)	A400 (AS8)	88	6	6"	S	38'-11"	--	--	5144.0
Bot Slab(Ext)	A401	4	6	6"	S	34'-9"	--	--	209.0
Bot Slab(Ext)	A402	4	6	6"	S	30'-11"	--	--	186.0
Bot Slab(Ext)	A403	4	6	6"	S	27'-2"	--	--	163.0
Bot Slab(Ext)	A404	4	6	6"	S	23'-4"	--	--	140.0
Bot Slab(Ext)	A405	4	6	6"	S	19'-7"	--	--	118.0
Bot Slab(Ext)	A406	4	6	6"	S	15'-10"	--	--	95.0
Bot Slab(Ext)	A407	4	6	6"	S	12'-0"	--	--	72.0
Bot Slab(Ext)	A408	4	6	6"	S	8'-3"	--	--	50.0
Bot Slab(Ext)	A409	4	6	6"	S	4'-5"	--	--	27.0
Corner(Top)	A1 (AS1)	216	5	6"	L	5'-2"	2'-6"	2'-8"	1164.0
Corner(Bot)	A2 (AS1)	216	5	6"	L	5'-0"	2'-6"	2'-6"	1126.0
Wall(Int)	B1 (AS4)	108	5	1'-0"	S	7'-6"	--	--	845.0
Wall(Ext)	B2 (AS1)	108	5	1'-0"	S	7'-0"	--	--	789.0
Int Wall	B3	216	5	1'-0"	S	8'-5"	--	--	1896.0

Longit. Top (Int)	C100	37	4	1'-0"	S	53'-9"	--	--	--	1328.0
Longit. Bot (Int)	C200	37	4	1'-0"	S	53'-9"	--	--	--	1328.0
Bot Slab(Int)	S1	32	6	0"	S	40'-4"	--	--	--	862.8
Longit. Top (Ext)	C1	39	4	1'-0"	S	53'-9"	--	--	--	1400.4
Longit. Bot (Ext)	C1	39	4	1'-0"	S	53'-9"	--	--	--	1400.4
Longit. Wall (Ext)	C1	16	4	1'-0"	S	53'-9"	--	--	--	574.5
Longit. Wall (Int)	C1	16	4	1'-0"	S	53'-9"	--	--	--	574.5
Longit. Int	C1	32	4	1'-0"	S	53'-9"	--	--	--	1149.1
										41489



Section Ext. Longit. Reinf.



Section Int. Longit. Reinf.

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

RATINGS SUMMARY
==========

	Flexure					Shear				
Truck	Fill	Member	Location	IR	OR	Fill	Member	Location	IR	OR
(AA) HL-93	3.30	3	TOP	1.70	2.20	3.30	2	RT	1.14	1.47

Filename: 3 cell 7x12 skew.etcx

Culvert #1

REINFORCEMENT SUMMARY
=====================

M dimension = 1.66 ft (method of equivalent capacity)
= 3.94 ft (method of contraflexure - ASTM)

Reinforcing Steel Schedule

Location	Bar Mark	Qty	Size	Type	Spacing (in)	As,prv (in2/ft)	Length (ft-in)	Wgt (lbs)	H Leg (ft-in)	V Leg (ft-in)
Top Slab (int)	A100 (AS2)	88	7	STR	6.00	1.200	38-11	7000		
	A101	4	7	STR	6.00	---	34- 9	284		
	A102	4	7	STR	6.00	---	30-11	253		
	A103	4	7	STR	6.00	---	27- 2	222		
	A104	4	7	STR	6.00	---	23- 4	191		
	A105	4	7	STR	6.00	---	19- 7	160		
	A106	4	7	STR	6.00	---	15-10	129		
	A107	4	7	STR	6.00	---	12- 0	98		
	A108	4	7	STR	6.00	---	8- 3	67		
	A109	4	7	STR	6.00	---	4- 5	36		
Bot Slab (int)	A200 (AS3)	88	6	STR	6.00	0.880	38-11	5144		
	A201	4	6	STR	6.00	---	34- 9	209		
	A202	4	6	STR	6.00	---	30-11	186		
	A203	4	6	STR	6.00	---	27- 2	163		
	A204	4	6	STR	6.00	---	23- 4	140		
	A205	4	6	STR	6.00	---	19- 7	118		
	A206	4	6	STR	6.00	---	15-10	95		
	A207	4	6	STR	6.00	---	12- 0	72		
	A208	4	6	STR	6.00	---	8- 3	50		
	A209	4	6	STR	6.00	---	4- 5	27		
Top Slab (ext)	A300 (AS7)	88	6	STR	6.00	0.880	38-11	5144		
	A301	4	6	STR	6.00	---	34- 9	209		
	A302	4	6	STR	6.00	---	30-11	186		
	A303	4	6	STR	6.00	---	27- 2	163		
	A304	4	6	STR	6.00	---	23- 4	140		
	A305	4	6	STR	6.00	---	19- 7	118		
	A306	4	6	STR	6.00	---	15-10	95		
	A307	4	6	STR	6.00	---	12- 0	72		
	A308	4	6	STR	6.00	---	8- 3	50		
	A309	4	6	STR	6.00	---	4- 5	27		
Bot Slab (ext)	A400 (AS8)	88	6	STR	6.00	0.880	38-11	5144		
	A401	4	6	STR	6.00	---	34- 9	209		
	A402	4	6	STR	6.00	---	30-11	186		
	A403	4	6	STR	6.00	---	27- 2	163		
	A404	4	6	STR	6.00	---	23- 4	140		
	A405	4	6	STR	6.00	---	19- 7	118		
	A406	4	6	STR	6.00	---	15-10	95		
	A407	4	6	STR	6.00	---	12- 0	72		
	A408	4	6	STR	6.00	---	8- 3	50		
	A409	4	6	STR	6.00	---	4- 5	27		
Corner (Top)	A1 (AS1)	216	5	L-BAR	6.00	0.620	5- 2	1164	2- 6	2- 8
Corner (Bottom)	A2 (AS1)	216	5	L-BAR	6.00	0.620	5- 0	1126	2- 6	2- 6
Ext Wall (int)	B1 (AS4)	108	5	STR	12.00	0.310	7- 6	845		
Ext Wall (ext)	B2 (AS1)	108	5	STR	12.00	0.310	7- 0	789		
Int Wall	B3	216	5	STR	12.00	0.310	8- 5	1896		
Top Slab (int- 1)	C100 (AS5)	37	4	STR	12.00	0.200	53- 9	1328		
Bot Slab (int- 1)	C200	37	4	STR	12.00	0.200	53- 9	1328		
Edge Beam(1)	S1	32	6	STR	0.00	---	40- 4	862		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	53- 9	1400		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	53- 9	1400		
Temperature (1)	C1 (AS6)	16	4	STR	12.00	0.200	53- 9	575		
Temperature (1)	C1 (AS6)	16	4	STR	12.00	0.200	53- 9	575		
Temperature (1)	C1 (AS6)	32	4	STR	12.00	0.200	53- 9	1149		
							Total	41489		

Note: A denotes flexural steel, B denotes vertical steel, C denotes longitudinal steel

AS Bar Marks

Location	As prv in2/ft
Transverse Side Wall - Outside Face (AS1)	0.620
Transverse Top Slab - Inside Face (AS2)	1.200
Transverse Bottom Slab - Inside Face (AS3)	0.880
Transverse Side Wall - Inside Face (AS4)	0.310
Distribution Top Slab - Inside Face (AS5)	0.200
Distribution Top Slab - OutSide Face (AS6)	0.200
Transverse Top Slab - Outside Face (AS7)	0.880
Transverse Bottom Slab - Outside Face (AS8)	0.880

Notes: 1.) Final areas of steel provided must be checked in analysis mode

Culvert #1

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	5	1-10
B3	5	1-10
C1	4	1- 6
C100	4	1- 6
C200	4	1- 6

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

Project: Winsome Filing No. 3
Task : 3-12-ft x 7-ft_skewed
Client :
Job No.: 196106001

CULVERT PROPERTIES
==========
Type of Culvert: Cast-in-Place Specification : LRFD 7th Edition w/ 2015 and 2016 Interims
Operating Mode : Analysis

Physical Dimensions

No. of Boxes: 3 Name: 3Cell CIP 12x7
Clear Span : 12.0000 ft Fill Depth : 3.30 ft
Clear Height: 7.0000 ft Center Skew : 14.80 deg Left Skew: 75.20 deg Right Skew: 75.20 deg
Length : 54.0000 ft Bottom Slab Support: Full Slab
Haunches: Top, Length: 0.0000 in Height: 0.0000 in
Bottom, Length: 0.0000 in Height: 0.0000 in
Member Thicknesses: Top Slab: 12.5000 in Bot Slab: 11.0000 in
Ext Wall: 10.0000 in Int Wall: 10.0000 in
Wall Joint: None

Material Properties

Concrete: Strength,f'c : 4.500 ksi Density : 0.150 kcf Elasticity,Ec: 4435 ksi
Type : Normal Weight Density Modification Factor : 1.00
Fr Factor : 0.24 Gamma1 : 1.60 Gamma3 : 0.75
Steel: Yield,fy : 60.00 ksi fss Limit : 0.60fy Elasticity,Es: 29000 ksi
Yield,fyv : 60.00 ksi Diameter : 1.000 in Type : Rebar
Soil: Density : 0.120 kcf Slope Factor: 1.150 (B1 Installation)
Poisson's : 0.5
Fe Factor : 1.150 (Maximum for Compacted Fill)
Serviceability, Gamma-e: 1.00

Loads

Live Load: Vehicle: (AA) HL-93 - Design Vehicle

Axle No.	Weight(k)	Dist. From Previous(ft)
1	8.00	0.00
2	32.00	14.00
3	32.00	14.00

Gage Width: 6.00 ft, Tread Width: 20.00 in, Tread Length: 10.00 in
Include Tandem: yes
Tandem: Axle 1: 25.00 k, Axle 2: 25.00 k, Axle Spacing: 4.00 ft
Lane Load: 0.00 klf, P-Moment: 0.00 k, P-Shear: 0.00 k
Combine: Truck + Lane Or Tandem + Lane
Inventory Rating Load Factor: 1.75 Operating Rating Load Factor: 1.35
Design Load Combinations: Strength I
Override MPF: no
Override DLA: no
Include Lane Load : no Max. No. of Lanes: Computed by Program
Traffic Direction** : Lanes Parallel to Main Reinforcement
Neglect Live Load for Large Fill Depths: yes
Apply Surcharge at Fill Depths > 2 ft : yes
Compute Surcharge Depth: yes
Dead Load: Future Wearing Surface : 0.04 klf Add. Dead Load : 0.00 klf
Concentrated Loads : none
Lateral Soil Loads: Max. Equiv. Fluid Press.: 60.00 pcf Min. Equiv. Fluid Press. : 30.00 pcf
Include Additional Uniform Horiz. Load: no
Include Additional Uniform Vert. Load: no
Buoyancy Check : no
Fluid Pressures : Apply Water Press. : no
Foundation Model : Rigid

Load and Resistance Factors

	Max	Min
DC:	1.250	0.900
DW:	1.500	0.650
EV:	1.300	0.900
EH:	1.350	0.900
WA:	1.000	
EQ:	1.000	

LL I : 1.750 LL II : 1.350
Ductility: 1.000 Importance: 1.000 Redundancy, non-earth: 1.000 Redundancy, earth: 1.050
Condition: 1.000 System : 1.000
Phi Shear: 0.900 Phi Moment: 1.000 PM Compression: 0.750 PM Tension : 0.900
Load Factor Multipliers, Design Mode: 1.00 Analysis Mode: 1.00

Reinforcement

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

Reinforcement Covers : Exterior Interior
Top Slab: 2.5000 in 2.0000 in
Walls : 2.0000 in 2.0000 in
Bot Slab: 3.0000 in 2.0000 in

Assigned reinforcement:

Location	Mark	Size	Spacing (in)
Top Slab Inside	A100 (AS2)	7	6.0000
Bottom Slab Inside	A200 (AS3)	6	6.0000
Top Slab Outside	A300 (AS7)	6	6.0000
Bottom Slab Outside	A400 (AS8)	6	6.0000
Top Corner	A1 (AS1)	5	6.0000
Bottom Corner	A2 (AS1)	5	6.0000
Ext. Wall Inside	B1 (AS4)	5	12.0000
Ext. Wall Outside	B2 (AS1)	5	12.0000
Interior Wall	B3	5	12.0000
Longitudinal	C1 (AS6)	4	12.0000
Top Distribution	C100 (AS5)	4	12.0000
Bottom Distribution	C200	4	12.0000

Analysis Options

LL Analysis : Automatically Set Traffic Direction to Account for Skew Effects: yes (**Will override previo
Limit LL Distribution Width to Culvert Length for: All Fill Depths
Combine Longitudinal Axle Distribution Overlaps: Yes, Max of 2 Axles
Combine Transverse Axle Distribution Overlaps: No
Axle Placement Increment for Moving Load Analysis: 20
Include Impact on Bottom Slab: no
Always Distribute Wheel Load: yes
Reinforcement: Always Include Distribution Steel: yes
Distribution Slab Provided: no
User Defined Longitudinal Steel: yes
Max. As used in Vc Calcs: 2.00 in2/ft
Distribute Minimum Reinforcement per Face: no
Use individual Member Thicknesses for Min Steel: yes
Epoxy coat steel: top bars, if fill < 2'
Use M-dimension for bar length calcs.: no
Slenderness : Checked K Factor: 2.00
Analysis Modeling : Use Haunches in the Structural Analysis Model: no
Crit. Section: Consider Haunches when Selecting Critical Section Locations: no
Use Max. Moment with Max. Shear at the Critical Section for Shear: yes
Flexure : Ignore Axial Thrust: yes
Use Eq. 12.10.4.2.4a-1: no
Shear : Always Check Iterative Beta Method
Environmental: Apply envirnomental duribility factors: no

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

ANALYSIS RESULTS
==========

Top Slab Thickness = 12.50 in
Bottom Slab Thickness = 11.00 in
Exterior Wall Thickness = 10.00 in
Interior Wall Thickness = 10.00 in

Modular Ratio (N) = 6.54 Max. Steel Ratio = 0.023
Design Span = 12.83 ft Design Height = 7.98 ft
Design Fill Depth = 3.30 ft

Volume of Concrete: 3.717 cy/ft Weight of Steel: 766 lb/ft

M dimension = 1.66 ft (method of equivalent capacity)
= 3.94 ft (method of contraflexure - ASTM)

Reinforcing Steel Schedule

Location	Bar Mark	Qty	Size	Type	Spacing (in)	As,prv (in2/ft)	Length (ft-in)	Wgt (lbs)	H Leg (ft-in)	V Leg (ft-in)
Top Slab (int)	A100 (AS2)	88	7	STR	6.00	1.200	38-11	7000		
	A101	4	7	STR	6.00	---	34- 9	284		
	A102	4	7	STR	6.00	---	30-11	253		
	A103	4	7	STR	6.00	---	27- 2	222		
	A104	4	7	STR	6.00	---	23- 4	191		
	A105	4	7	STR	6.00	---	19- 7	160		
	A106	4	7	STR	6.00	---	15-10	129		
	A107	4	7	STR	6.00	---	12- 0	98		
	A108	4	7	STR	6.00	---	8- 3	67		
	A109	4	7	STR	6.00	---	4- 5	36		
Bot Slab (int)	A200 (AS3)	88	6	STR	6.00	0.880	38-11	5144		
	A201	4	6	STR	6.00	---	34- 9	209		
	A202	4	6	STR	6.00	---	30-11	186		
	A203	4	6	STR	6.00	---	27- 2	163		
	A204	4	6	STR	6.00	---	23- 4	140		
	A205	4	6	STR	6.00	---	19- 7	118		
	A206	4	6	STR	6.00	---	15-10	95		
	A207	4	6	STR	6.00	---	12- 0	72		
	A208	4	6	STR	6.00	---	8- 3	50		
	A209	4	6	STR	6.00	---	4- 5	27		
Top Slab (ext)	A300 (AS7)	88	6	STR	6.00	0.880	38-11	5144		
	A301	4	6	STR	6.00	---	34- 9	209		
	A302	4	6	STR	6.00	---	30-11	186		
	A303	4	6	STR	6.00	---	27- 2	163		
	A304	4	6	STR	6.00	---	23- 4	140		
	A305	4	6	STR	6.00	---	19- 7	118		
	A306	4	6	STR	6.00	---	15-10	95		
	A307	4	6	STR	6.00	---	12- 0	72		
	A308	4	6	STR	6.00	---	8- 3	50		
	A309	4	6	STR	6.00	---	4- 5	27		
Bot Slab (ext)	A400 (AS8)	88	6	STR	6.00	0.880	38-11	5144		
	A401	4	6	STR	6.00	---	34- 9	209		
	A402	4	6	STR	6.00	---	30-11	186		
	A403	4	6	STR	6.00	---	27- 2	163		
	A404	4	6	STR	6.00	---	23- 4	140		
	A405	4	6	STR	6.00	---	19- 7	118		
	A406	4	6	STR	6.00	---	15-10	95		
	A407	4	6	STR	6.00	---	12- 0	72		
	A408	4	6	STR	6.00	---	8- 3	50		
	A409	4	6	STR	6.00	---	4- 5	27		
Corner (Top)	A1 (AS1)	216	5	L-BAR	6.00	0.620	5- 2	1164	2- 6	2- 8
Corner (Bottom)	A2 (AS1)	216	5	L-BAR	6.00	0.620	5- 0	1126	2- 6	2- 6
Ext Wall (int)	B1 (AS4)	108	5	STR	12.00	0.310	7- 6	845		
Ext Wall (ext)	B2 (AS1)	108	5	STR	12.00	0.310	7- 0	789		
Int Wall	B3	216	5	STR	12.00	0.310	8- 5	1896		
Top Slab (int- 1)	C100 (AS5)	37	4	STR	12.00	0.200	53- 9	1328		
Bot Slab (int- 1)	C200	37	4	STR	12.00	0.200	53- 9	1328		
Edge Beam(1)	S1	32	6	STR	0.00	---	40- 4	862		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	53- 9	1400		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	53- 9	1400		
Temperature (1)	C1 (AS6)	16	4	STR	12.00	0.200	53- 9	575		
Temperature (1)	C1 (AS6)	16	4	STR	12.00	0.200	53- 9	575		
Temperature (1)	C1 (AS6)	32	4	STR	12.00	0.200	53- 9	1149		
							Total	41489		

Note: A denotes flexural steel, B denotes vertical steel, C denotes longitudinal steel

AS Bar Marks

Location	As prv in2/ft

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

Transverse Side Wall - Outside Face (AS1)	0.620
Transverse Top Slab - Inside Face (AS2)	1.200
Transverse Bottom Slab - Inside Face (AS3)	0.880
Transverse Side Wall - Inside Face (AS4)	0.310
Distribution Top Slab - Inside Face (AS5)	0.200
Distribution Top Slab - OutSide Face (AS6)	0.200
Transverse Top Slab - Outside Face (AS7)	0.880
Transverse Bottom Slab - Outside Face (AS8)	0.880

Notes: 1.) Final areas of steel provided must be checked in analysis mode

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	5	1-10
B3	5	1-10
C1	4	1- 6
C100	4	1- 6
C200	4	1- 6

Output for Skewed Ends

End Layout	Total Width (ft)	Skew (deg)	Skew Offset (ft)	Skew Length (ft)
Left	39.333	75.2	10.392	40.683
Right	39.333	75.2	10.392	40.683

>>>Warning: The adequacy of the edge beam reinforcement must be hand checked and increased if necessary.

Summary of Ratings Table:

	Flexure					Shear				
Truck	Fill	Member	Location	IR	OR	Fill	Member	Location	IR	OR
(AA) HL-93	3.30	3	TOP	1.70	2.20	3.30	2	RT	1.14	1.47

Critical Sections Summary: Flexure

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	5.50	-8.85	15.32	22.58	7.69	22.58	1.00	0.62	10.18	6.61	8.57	AA	3.30
MID	47.88	1.60	3.12	11.60	7.69	11.60	1.00	0.31	10.18	7.25	9.39	AA	3.30
MID-	47.88	-7.78	15.08	11.60	7.69	11.60	1.00	0.31	10.18	1.74	2.25	AA	3.30
TOP	6.25	-13.66	15.32	22.58	7.69	22.58	1.00	0.62	10.18	1.97	2.55	AA	3.30

Member 2: (Top Slab), Thickness = 12.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-11.64	4.20	28.78	9.69	28.78	1.00	0.62	15.91	3.16	4.10	AA	3.30
MID	61.60	26.20	0.14	55.67	10.06	55.67	1.00	1.20	15.91	2.64	3.43	AA	3.30
RT	5.00	-26.71	1.79	39.82	9.63	39.82	1.00	0.88	15.91	1.81	2.35	AA	3.30

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	5.50	-1.94	23.30	11.60	7.69	11.60	1.00	0.31	10.18	6.34	8.22	AA	3.30
MID	47.88	3.83	9.89	11.60	7.69	11.60	1.00	0.31	10.18	3.64	4.72	AA	3.30
TOP	6.25	-5.89	23.30	11.60	7.69	11.60	1.00	0.31	10.18	1.70	2.20	AA	3.30

Member 4: (Bottom Slab), Thickness = 11.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-8.28	5.07	22.58	7.69	22.58	1.00	0.62	12.32	6.66	8.64	AA	3.30
MID	61.60	11.84	0.61	35.42	8.63	35.42	1.00	0.88	12.32	8.16	10.58	AA	3.30
RT	5.00	-16.67	2.27	31.02	7.63	31.02	1.00	0.88	12.32	4.17	5.40	AA	3.30

Member 5: (Top Slab - Interior Cell), Thickness = 12.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-25.57	1.31	39.82	9.63	39.82	1.00	0.88	15.91	1.92	2.49	AA	3.30
MID	77.00	20.58	2.82	55.67	10.06	55.67	1.00	1.20	15.91	3.20	4.15	AA	3.30
RT	5.00	-25.57	1.31	39.82	9.63	39.82	1.00	0.88	15.91	1.92	2.49	AA	3.30

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

Member 7: (Bottom Slab - Interior Cell), Thickness = 11.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-15.72	1.99	31.02	7.63	31.02	1.00	0.88	12.32	4.48	5.80	AA	3.30
MID	77.00	7.96	3.90	35.42	8.63	35.42	1.00	0.88	12.32	13.37	17.34	AA	3.30
RT	5.00	-15.72	1.99	31.02	7.63	31.02	1.00	0.88	12.32	4.48	5.80	AA	3.30

Critical Sections Summary: Vertical Shear

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	12.70	3.76	-8.8	15.32	7.28	15.93	3.021	17.70a	0.00	0.00	0.00	9.92	12.86	AA	3.30
MID	47.88	0.76	1.6	3.12	7.48	21.62	3.990	24.02a	0.00	0.00	0.00	41.63	53.97	AA	3.30
MID-	47.88	0.76	-7.8	15.08	7.48	15.71	2.900	17.46a	0.00	0.00	0.00	13.92	18.05	AA	3.30
TOP	13.45	-3.45	-13.7	15.32	7.28	13.01	2.468	14.46a	0.00	0.00	0.00	5.62	7.29	AA	3.30

Member 2: (Top Slab), Thickness = 12.50 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	14.00	12.98	-11.6	4.20	9.69	17.32	n/a	19.24c	0.00	0.00	0.00	1.46	1.90	AA	3.30
MID	77.00	2.40	26.2	0.14	10.06	16.72	2.295	18.58a	0.00	0.00	0.00	5.50	7.13	AA	3.30
RT	14.00	15.16	-26.7	1.79	9.63	16.57	n/a	18.41c	0.00	0.00	0.00	1.14	1.47	AA	3.30

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	12.70	1.21	-1.9	23.30	7.48	27.86	5.142	30.96a	0.00	0.00	0.00	22.29	28.89	AA	3.30
MID	47.88	1.21	3.8	9.89	7.48	20.25	3.737	22.50a	0.00	0.00	0.00	16.19	20.99	AA	3.30
TOP	13.45	1.20	-5.9	23.30	7.48	27.30	5.038	30.33a	0.00	0.00	0.00	23.50	30.47	AA	3.30

Member 4: (Bottom Slab), Thickness = 11.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	12.92	5.79	-8.3	5.07	7.69	14.53	2.611	16.15a	0.00	0.00	0.00	7.55	9.78	AA	3.30
MID	77.00	0.17	11.8	0.61	8.63	17.31	2.772	19.23a	0.00	0.00	0.00	NC	NC	AA	3.30
RT	12.92	7.37	-16.7	2.27	7.63	12.83	n/a	14.26c	0.00	0.00	0.00	4.06	5.26	AA	3.30

Member 5: (Top Slab - Interior Cell), Thickness = 12.50 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	14.00	14.10	-25.6	1.31	9.63	16.52	n/a	18.35c	0.00	0.00	0.00	1.24	1.61	AA	3.30
MID	77.00	4.00	20.6	2.82	10.06	18.33	2.516	20.36a	0.00	0.00	0.00	4.58	5.94	AA	3.30
RT	14.00	14.10	-25.6	1.31	9.63	16.52	n/a	18.35c	0.00	0.00	0.00	1.24	1.61	AA	3.30

Member 7: (Bottom Slab - Interior Cell), Thickness = 11.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	12.92	6.54	-15.7	1.99	7.63	12.84	2.326	14.27a	0.00	0.00	0.00	5.02	6.50	AA	3.30
MID	77.00	0.20	8.0	3.90	8.63	20.82	3.335	23.14a	0.00	0.00	0.00	99.99	99.99	AA	3.30
RT	12.92	6.54	-15.7	1.99	7.63	12.84	2.326	14.27a	0.00	0.00	0.00	5.02	6.50	AA	3.30

Vc Calculation By: a - Iterative Beta, b - Constant Beta, c - Box Culvert, d - Standard/Arema

Analysis Results: Fill Depth = 3.30 ft

Load Parameters:

Fe = 1.02 Surcharge Depth : 2.77 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of Wall	Top of Wall
Horizontal Earth Load	0.708	0.229
Live Load Surcharge	0.166	0.166
Internal Water Pressure	0.000	0.000

Unfactored Moments due to All Loads: (k-ft)

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa
Member 1: (Exterior Wall)						
Bottom						
1- 0	-1.69	-2.39	-0.22	-1.47	-0.50	0.00
1- 1	-1.56	-2.32	-0.21	0.04	-0.03	0.00
1- 2	-1.44	-2.24	-0.21	1.12	0.32	0.00
1- 3	-1.31	-2.17	-0.20	1.82	0.58	0.00
1- 4	-1.18	-2.09	-0.19	2.15	0.72	0.00
1- 5	-1.06	-2.01	-0.19	2.16	0.76	0.00
1- 6	-0.93	-1.94	-0.18	1.87	0.70	0.00
1- 7	-0.80	-1.86	-0.17	1.31	0.52	0.00
1- 8	-0.68	-1.79	-0.16	0.51	0.25	0.00
1- 9	-0.55	-1.71	-0.16	-0.49	-0.14	0.00
1-10	-0.43	-1.64	-0.15	-1.67	-0.63	0.00
Top						
Member 2: (Top Slab)						
Left						
2- 0	-0.43	-1.64	-0.15	-1.70	-0.63	0.00
2- 1	0.52	0.85	0.08	-1.48	-0.55	0.00
2- 2	1.20	2.69	0.25	-1.26	-0.47	0.00
2- 3	1.63	3.85	0.35	-1.05	-0.39	0.00
2- 4	1.80	4.36	0.40	-0.83	-0.31	0.00
2- 5	1.72	4.20	0.39	-0.62	-0.23	0.00
2- 6	1.37	3.37	0.31	-0.40	-0.15	0.00
2- 7	0.77	1.89	0.17	-0.19	-0.07	0.00
2- 8	-0.09	-0.26	-0.02	0.03	0.01	0.00
2- 9	-1.20	-3.07	-0.28	0.24	0.09	0.00
2-10	-2.57	-6.55	-0.60	0.46	0.17	0.00
Right						
Member 3: (Interior Wall)						
Bottom						
3- 0	0.35	0.53	0.05	-0.24	-0.08	0.00
3- 1	0.33	0.52	0.05	-0.24	-0.08	0.00
3- 2	0.31	0.51	0.05	-0.23	-0.08	0.00
3- 3	0.29	0.51	0.05	-0.23	-0.08	0.00
3- 4	0.27	0.50	0.05	-0.23	-0.08	0.00
3- 5	0.25	0.49	0.04	-0.22	-0.08	0.00
3- 6	0.23	0.48	0.04	-0.22	-0.08	0.00
3- 7	0.22	0.47	0.04	-0.22	-0.08	0.00
3- 8	0.20	0.46	0.04	-0.21	-0.08	0.00
3- 9	0.18	0.45	0.04	-0.21	-0.08	0.00
3-10	0.16	0.45	0.04	-0.21	-0.08	0.00
Top						
Member 4: (Bottom Slab)						
Left						
4- 0	-1.69	-2.39	-0.22	-1.47	-0.50	0.00
4- 1	-0.01	0.19	0.02	-1.28	-0.43	0.00
4- 2	1.24	2.10	0.19	-1.08	-0.37	0.00
4- 3	2.07	3.35	0.31	-0.89	-0.30	0.00
4- 4	2.46	3.94	0.36	-0.70	-0.24	0.00
4- 5	2.43	3.86	0.35	-0.51	-0.17	0.00
4- 6	1.97	3.12	0.29	-0.32	-0.11	0.00
4- 7	1.08	1.72	0.16	-0.13	-0.05	0.00
4- 8	-0.24	-0.35	-0.03	0.06	0.02	0.00
4- 9	-1.98	-3.08	-0.28	0.25	0.08	0.00
4-10	-4.15	-6.47	-0.59	0.44	0.15	0.00
Right						
Member 5: (Top Slab - Interior Cell)						

Unfactored Shears due to All Loads: (k)

M-PT	Vdc	Vev	Vdw	Veh	Vls	Vwa
Member 1: (Exterior Wall)						
Bottom						
1- 0	0.16	0.09	0.01	2.16	0.65	0.00
1- 1	0.16	0.09	0.01	1.61	0.51	0.00
1- 2	0.16	0.09	0.01	1.11	0.38	0.00
1- 3	0.16	0.09	0.01	0.64	0.25	0.00
1- 4	0.16	0.09	0.01	0.21	0.12	0.00
1- 5	0.16	0.09	0.01	-0.19	-0.02	0.00
1- 6	0.16	0.09	0.01	-0.54	-0.15	0.00
1- 7	0.16	0.09	0.01	-0.86	-0.28	0.00
1- 8	0.16	0.09	0.01	-1.14	-0.42	0.00
1- 9	0.16	0.09	0.01	-1.38	-0.55	0.00
1-10	0.16	0.09	0.01	-1.58	-0.68	0.00
Top						
Member 2: (Top Slab)						
Left						
2- 0	0.84	2.20	0.20	0.17	0.06	0.00
2- 1	0.63	1.68	0.15	0.17	0.06	0.00
2- 2	0.43	1.17	0.11	0.17	0.06	0.00
2- 3	0.23	0.65	0.06	0.17	0.06	0.00
2- 4	0.03	0.13	0.01	0.17	0.06	0.00
2- 5	-0.17	-0.38	-0.04	0.17	0.06	0.00
2- 6	-0.37	-0.90	-0.08	0.17	0.06	0.00
2- 7	-0.57	-1.42	-0.13	0.17	0.06	0.00
2- 8	-0.77	-1.93	-0.18	0.17	0.06	0.00
2- 9	-0.97	-2.45	-0.23	0.17	0.06	0.00
2-10	-1.17	-2.97	-0.27	0.17	0.06	0.00
Right						
Member 3: (Interior Wall)						
Bottom						
3- 0	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 1	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 2	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 3	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 4	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 5	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 6	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 7	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 8	-0.02	-0.01	0.00	0.00	0.00	0.00
3- 9	-0.02	-0.01	0.00	0.00	0.00	0.00
3-10	-0.02	-0.01	0.00	0.00	0.00	0.00
Top						
Member 4: (Bottom Slab)						
Left						
4- 0	1.48	2.27	0.21	0.15	0.05	0.00
4- 1	1.14	1.75	0.16	0.15	0.05	0.00
4- 2	0.81	1.23	0.11	0.15	0.05	0.00
4- 3	0.47	0.72	0.07	0.15	0.05	0.00
4- 4	0.14	0.20	0.02	0.15	0.05	0.00
4- 5	-0.19	-0.32	-0.03	0.15	0.05	0.00
4- 6	-0.53	-0.84	-0.08	0.15	0.05	0.00
4- 7	-0.86	-1.35	-0.12	0.15	0.05	0.00
4- 8	-1.19	-1.87	-0.17	0.15	0.05	0.00
4- 9	-1.53	-2.39	-0.22	0.15	0.05	0.00
4-10	-1.86	-2.90	-0.27	0.15	0.05	0.00
Right						
Member 5: (Top Slab - Interior Cell)						

Bottom						
5- 0	-2.42	-6.11	-0.56	0.25	0.09	0.00
5- 1	-1.26	-3.12	-0.29	0.25	0.09	0.00
5- 2	-0.36	-0.80	-0.07	0.25	0.09	0.00
5- 3	0.29	0.86	0.08	0.25	0.09	0.00
5- 4	0.67	1.85	0.17	0.25	0.09	0.00
5- 5	0.80	2.19	0.20	0.25	0.09	0.00
5- 6	0.67	1.85	0.17	0.25	0.09	0.00
5- 7	0.29	0.86	0.08	0.25	0.09	0.00
5- 8	-0.36	-0.80	-0.07	0.25	0.09	0.00
5- 9	-1.26	-3.12	-0.29	0.25	0.09	0.00
5-10	-2.42	-6.11	-0.56	0.25	0.09	0.00
Top						

Bottom						
5- 0	1.00	2.58	0.24	0.00	0.00	0.00
5- 1	0.80	2.07	0.19	0.00	0.00	0.00
5- 2	0.60	1.55	0.14	0.00	0.00	0.00
5- 3	0.40	1.03	0.09	0.00	0.00	0.00
5- 4	0.20	0.52	0.05	0.00	0.00	0.00
5- 5	0.00	0.00	0.00	0.00	0.00	0.00
5- 6	-0.20	-0.52	-0.05	0.00	0.00	0.00
5- 7	-0.40	-1.03	-0.09	0.00	0.00	0.00
5- 8	-0.60	-1.55	-0.14	0.00	0.00	0.00
5- 9	-0.80	-2.07	-0.19	0.00	0.00	0.00
5-10	-1.00	-2.58	-0.24	0.00	0.00	0.00
Top						

Member 7: (Bottom Slab - Interior Cell)

Left						
7- 0	-3.80	-5.94	-0.55	0.20	0.07	0.00
7- 1	-1.88	-2.96	-0.27	0.20	0.07	0.00
7- 2	-0.38	-0.64	-0.06	0.20	0.07	0.00
7- 3	0.69	1.02	0.09	0.20	0.07	0.00
7- 4	1.33	2.02	0.19	0.20	0.07	0.00
7- 5	1.55	2.35	0.22	0.20	0.07	0.00
7- 6	1.33	2.02	0.19	0.20	0.07	0.00
7- 7	0.69	1.02	0.09	0.20	0.07	0.00
7- 8	-0.38	-0.64	-0.06	0.20	0.07	0.00
7- 9	-1.88	-2.96	-0.27	0.20	0.07	0.00
7-10	-3.80	-5.94	-0.55	0.20	0.07	0.00
Right						

Member 7: (Bottom Slab - Interior Cell

Left						
7- 0	1.67	2.58	0.24	0.00	0.00	0.00
7- 1	1.33	2.07	0.19	0.00	0.00	0.00
7- 2	1.00	1.55	0.14	0.00	0.00	0.00
7- 3	0.67	1.03	0.09	0.00	0.00	0.00
7- 4	0.33	0.52	0.05	0.00	0.00	0.00
7- 5	0.00	0.00	0.00	0.00	0.00	0.00
7- 6	-0.33	-0.52	-0.05	0.00	0.00	0.00
7- 7	-0.67	-1.03	-0.09	0.00	0.00	0.00
7- 8	-1.00	-1.55	-0.14	0.00	0.00	0.00
7- 9	-1.33	-2.07	-0.19	0.00	0.00	0.00
7-10	-1.67	-2.58	-0.24	0.00	0.00	0.00
Right						

Unfactored Thrusts due to All Loads: (k)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	0.84	2.20	0.20	0.17	0.06	0.00
2	-0.16	-0.09	-0.01	1.58	0.68	0.00
3	2.17	5.55	0.51	-0.17	-0.06	0.00
4	0.16	0.09	0.01	2.16	0.65	0.00
5	-0.13	-0.08	-0.01	1.58	0.68	0.00
7	0.13	0.08	0.01	2.16	0.65	0.00

---------- Analysis Truck, HL-93 ----------

Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
Truck	1	1.355	4.63	
	2	1.355	4.63	14.00
	3	0.339	4.63	14.00
Tandem	1	1.136	8.63	

***Distributed loads may have been intensified due to axle overlap between lanes

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
Distribution Width : 12.18 ft
Impact Factor : 1.19
Distribution Width : 0.00 ft
Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	1.355	4.63	6.42
	2	1.355	4.63	-7.58
	3	0.339	4.63	-21.58

Maximum +Moment : 10.03 k-ft
Corresponding Moment at End : -4.62 k-ft
Coincident Bottom Slab Load : 0.07 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	1.355	4.63	20.28
	2	1.355	4.63	6.28
	3	0.339	4.63	-7.72

Maximum -Moment : -11.63 k-ft
Corresponding Moment at Mid : 8.75 k-ft
Coincident Bottom Slab Load : 0.14 k/ft

Maximum +Shear in Top Slab

Truck	1	1.355	4.63	15.15
	2	1.355	4.63	1.15
	3	0.339	4.63	-12.85

Maximum +Shear : 5.43 k
Corresponding Shear at Mid : -0.94 k
Coincident Bottom Slab Load : 0.12 k/ft

Maximum -Shear in Top Slab

Truck	1	1.355	4.63	24.52
	2	1.355	4.63	10.52
	3	0.339	4.63	-3.48

Maximum -Shear : -5.53 k
Corresponding Shear at Mid : 0.74 k
Coincident Bottom Slab Load : 0.14 k/ft

Eriksson Culvert v5.0.0

Culvert #1
Filename: 3 cell 7x12 skew.etcx

Maximum +Moment in Top Slab
Tandem 1 1.136 8.63 6.24
Maximum +Moment : 11.93 k-ft
Corresponding Moment at End : -6.44 k-ft
Coincident Bottom Slab Load : 0.11 k/ft

Maximum -Moment in Top Slab
Tandem 1 1.136 8.63 7.06
Maximum -Moment : -11.70 k-ft
Corresponding Moment at Mid : 11.75 k-ft
Coincident Bottom Slab Load : 0.11 k/ft

Maximum +Shear in Top Slab
Tandem 1 1.136 8.63 17.15
Maximum +Shear : 6.66 k
Corresponding Shear at Mid : -0.54 k
Coincident Bottom Slab Load : 0.11 k/ft

Maximum -Shear in Top Slab
Tandem 1 1.136 8.63 8.52
Maximum -Shear : -6.97 k
Corresponding Shear at Mid : 0.32 k
Coincident Bottom Slab Load : 0.11 k/ft

Unfactored Moments and Shears due to Truck Loads: (k-ft, k)

	Truck				Tandem				Lane			
M-PT	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-
Member 1: (Exterior Wall)												
Bottom												
1- 0	0.02	-1.27	0.29	-0.55	0.00	-0.96	0.31	-0.64	0.00	0.00	0.00	0.00
1- 1	0.00	-1.09	0.29	-0.55	0.00	-0.72	0.31	-0.64	0.00	0.00	0.00	0.00
1- 2	0.00	-1.06	0.29	-0.55	0.00	-0.97	0.31	-0.64	0.00	0.00	0.00	0.00
1- 3	0.00	-1.36	0.29	-0.55	0.00	-1.66	0.31	-0.64	0.00	0.00	0.00	0.00
1- 4	0.00	-1.72	0.29	-0.55	0.00	-2.25	0.31	-0.64	0.00	0.00	0.00	0.00
1- 5	0.00	-2.17	0.29	-0.55	0.05	-2.75	0.31	-0.64	0.00	0.00	0.00	0.00
1- 6	0.03	-2.60	0.29	-0.55	0.33	-3.26	0.31	-0.64	0.00	0.00	0.00	0.00
1- 7	0.32	-3.04	0.29	-0.55	0.61	-3.77	0.31	-0.64	0.00	0.00	0.00	0.00
1- 8	0.62	-3.48	0.29	-0.55	0.90	-4.27	0.31	-0.64	0.00	0.00	0.00	0.00
1- 9	0.85	-3.91	0.29	-0.55	1.18	-4.78	0.31	-0.64	0.00	0.00	0.00	0.00
1-10	1.07	-4.35	0.29	-0.55	1.46	-5.29	0.31	-0.64	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	1.07	-4.35	5.12	-0.33	1.46	-5.29	6.07	-0.49	0.00	0.00	0.00	0.00
2- 1	2.72	-1.11	4.44	-0.34	1.75	-1.09	5.19	-0.49	0.00	0.00	0.00	0.00
2- 2	5.94	-0.06	3.72	-0.54	6.21	-0.03	4.12	-0.56	0.00	0.00	0.00	0.00
2- 3	8.45	-0.27	2.99	-1.13	9.12	-0.43	3.10	-0.66	0.00	0.00	0.00	0.00
2- 4	9.87	-0.62	2.28	-1.83	10.25	-1.04	2.17	-1.20	0.00	0.00	0.00	0.00
2- 5	10.03	-1.01	1.62	-2.54	10.14	-1.66	1.36	-1.91	0.00	0.00	0.00	0.00
2- 6	8.99	-1.43	1.02	-3.22	9.46	-2.29	0.69	-2.79	0.00	0.00	0.00	0.00
2- 7	6.85	-1.85	0.52	-3.87	7.27	-2.91	0.17	-3.83	0.00	0.00	0.00	0.00
2- 8	3.83	-3.72	0.13	-4.48	3.29	-3.53	0.13	-4.91	0.00	0.00	0.00	0.00
2- 9	0.83	-6.68	0.10	-5.01	0.94	-4.30	0.09	-5.82	0.00	0.00	0.00	0.00
2-10	0.85	-10.46	0.08	-5.34	1.06	-9.73	0.09	-6.48	0.00	0.00	0.00	0.00
Right												
Member 3: (Interior Wall)												
Bottom												
3- 0	1.60	-0.99	0.57	-0.57	1.33	-1.20	0.71	-0.66	0.00	0.00	0.00	0.00
3- 1	1.13	-0.55	0.57	-0.57	0.81	-0.65	0.71	-0.66	0.00	0.00	0.00	0.00
3- 2	0.67	-0.16	0.57	-0.57	0.55	-0.12	0.71	-0.66	0.00	0.00	0.00	0.00
3- 3	0.48	-0.16	0.57	-0.57	0.57	-0.29	0.71	-0.66	0.00	0.00	0.00	0.00
3- 4	0.88	-0.38	0.57	-0.57	1.11	-0.81	0.71	-0.66	0.00	0.00	0.00	0.00
3- 5	1.33	-0.78	0.57	-0.57	1.67	-1.33	0.71	-0.66	0.00	0.00	0.00	0.00
3- 6	1.78	-1.21	0.57	-0.57	2.24	-1.86	0.71	-0.66	0.00	0.00	0.00	0.00
3- 7	2.23	-1.65	0.57	-0.57	2.80	-2.39	0.71	-0.66	0.00	0.00	0.00	0.00
3- 8	2.68	-2.10	0.57	-0.57	3.37	-2.92	0.71	-0.66	0.00	0.00	0.00	0.00
3- 9	3.13	-2.55	0.57	-0.57	3.94	-3.44	0.71	-0.66	0.00	0.00	0.00	0.00
3-10	3.58	-3.00	0.57	-0.57	4.51	-3.97	0.71	-0.66	0.00	0.00	0.00	0.00
Top												
Member 4: (Bottom Slab)												
Left												
4- 0	0.02	-1.27	0.88	0.00	0.00	-0.96	0.63	0.00	0.00	0.00	0.00	0.00
4- 1	0.67	-0.34	0.68	0.00	0.81	-0.30	0.49	0.00	0.00	0.00	0.00	0.00
4- 2	1.38	0.00	0.49	0.00	1.50	0.00	0.36	0.00	0.00	0.00	0.00	0.00
4- 3	1.76	0.00	0.30	0.00	1.78	0.00	0.22	0.00	0.00	0.00	0.00	0.00
4- 4	1.88	0.00	0.11	0.00	1.87	0.00	0.08	0.00	0.00	0.00	0.00	0.00
4- 5	1.76	0.00	0.00	-0.20	1.80	0.00	0.00	-0.13	0.00	0.00	0.00	0.00
4- 6	1.38	0.00	0.00	-0.40	1.54	0.00	0.00	-0.27	0.00	0.00	0.00	0.00
4- 7	0.77	0.00	0.00	-0.59	1.11	0.00	0.00	-0.41	0.00	0.00	0.00	0.00
4- 8	0.29	-0.61	0.00	-0.79	0.34	-0.69	0.00	-0.54	0.00	0.00	0.00	0.00
4- 9	0.00	-1.65	0.00	-0.99	0.00	-1.53	0.00	-0.68	0.00	0.00	0.00	0.00
4-10	0.00	-3.04	0.00	-1.18	0.00	-2.48	0.00	-0.82	0.00	0.00	0.00	0.00
Right												
Member 5: (Top Slab - Interior Cell)												
Bottom												
5- 0	1.30	-9.99	5.29	-0.44	1.53	-8.74	6.32	-0.53	0.00	0.00	0.00	0.00
5- 1	1.22	-6.44	4.89	-0.47	0.85	-4.58	5.59	-0.53	0.00	0.00	0.00	0.00

5- 2	4.16	-3.79	4.29	-0.47	3.52	-3.90	4.50	-0.53	0.00	0.00	0.00	0.00
5- 3	6.35	-2.62	3.64	-0.98	7.09	-3.22	3.42	-0.63	0.00	0.00	0.00	0.00
5- 4	7.60	-2.06	2.97	-1.62	8.80	-2.55	2.42	-0.80	0.00	0.00	0.00	0.00
5- 5	7.83	-1.50	2.29	-2.29	9.01	-1.87	1.54	-1.54	0.00	0.00	0.00	0.00
5- 6	7.60	-2.06	1.62	-2.97	8.80	-2.55	0.80	-2.42	0.00	0.00	0.00	0.00
5- 7	6.35	-2.62	0.98	-3.64	7.09	-3.22	0.63	-3.42	0.00	0.00	0.00	0.00
5- 8	4.16	-3.79	0.47	-4.29	3.52	-3.90	0.53	-4.50	0.00	0.00	0.00	0.00
5- 9	1.22	-6.44	0.47	-4.89	0.85	-4.58	0.53	-5.59	0.00	0.00	0.00	0.00
5-10	1.30	-9.99	0.44	-5.29	1.53	-8.74	0.53	-6.32	0.00	0.00	0.00	0.00

Top

Member 7: (Bottom Slab - Interior Cell)

Left

7- 0	0.00	-2.70	1.06	0.00	0.00	-2.83	0.82	0.00	0.00	0.00	0.00	0.00
7- 1	0.00	-1.47	0.87	0.00	0.00	-1.86	0.68	0.00	0.00	0.00	0.00	0.00
7- 2	0.19	-0.75	0.67	0.00	0.25	-0.98	0.55	0.00	0.00	0.00	0.00	0.00
7- 3	0.77	-0.20	0.47	0.00	0.85	-0.16	0.41	0.00	0.00	0.00	0.00	0.00
7- 4	0.98	0.00	0.28	0.00	1.11	0.00	0.27	0.00	0.00	0.00	0.00	0.00
7- 5	1.02	0.00	0.09	-0.09	1.20	0.00	0.11	-0.11	0.00	0.00	0.00	0.00
7- 6	0.98	0.00	0.00	-0.28	1.11	0.00	0.00	-0.27	0.00	0.00	0.00	0.00
7- 7	0.77	-0.20	0.00	-0.47	0.85	-0.16	0.00	-0.41	0.00	0.00	0.00	0.00
7- 8	0.19	-0.75	0.00	-0.67	0.25	-0.98	0.00	-0.55	0.00	0.00	0.00	0.00
7- 9	0.00	-1.47	0.00	-0.87	0.00	-1.86	0.00	-0.68	0.00	0.00	0.00	0.00
7-10	0.00	-2.70	0.00	-1.06	0.00	-2.83	0.00	-0.82	0.00	0.00	0.00	0.00

Right

Note: Unfactored live load results computed at 3.30 ft and 0 ft fill depths, per LRFD 3.6.1.2.6

Filename: 3 cell 7x12 skew.etcx

Culvert #1

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-8.5	9.54	14.90	6.00	28.24
A2	Bot Corner Bar	-6.2	9.54	8.65	6.00	51.98
A100	Top Slab (int)	12.5	1.85	13.04	6.00	34.99
A300	Top Slab (ext)	-16.4	0.90	24.88	6.00	16.33
A200	Bot Slab (int)	5.6	2.70	8.06	6.00	57.58
A400	Bot Slab (ext)	-11.0	1.48	20.80	6.00	19.41
B2	Ext Wall (ext)	-4.9	9.39	9.71	12.00	45.80

Strength Limit State at Critical Sections: Flexure

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
BOT	5.50	-8.85	15.32	22.58	7.69	22.58	1.00	0.62	10.18	6.61	8.57
MID	47.88	1.60	3.12	11.60	7.69	11.60	1.00	0.31	10.18	7.25	9.39
MID-	47.88	-7.78	15.08	11.60	7.69	11.60	1.00	0.31	10.18	1.74	2.25
TOP	6.25	-13.66	15.32	22.58	7.69	22.58	1.00	0.62	10.18	1.97	2.55

Member 2: (Top Slab), Thickness = 12.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-11.64	4.20	28.78	9.69	28.78	1.00	0.62	15.91	3.16	4.10
MID	61.60	26.20	0.14	55.67	10.06	55.67	1.00	1.20	15.91	2.64	3.43
RT	5.00	-26.71	1.79	39.82	9.63	39.82	1.00	0.88	15.91	1.81	2.35

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
BOT	5.50	-1.94	23.30	11.60	7.69	11.60	1.00	0.31	10.18	6.34	8.22
MID	47.88	3.83	9.89	11.60	7.69	11.60	1.00	0.31	10.18	3.64	4.72
TOP	6.25	-5.89	23.30	11.60	7.69	11.60	1.00	0.31	10.18	1.70	2.20

Member 4: (Bottom Slab), Thickness = 11.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-8.28	5.07	22.58	7.69	22.58	1.00	0.62	12.32	6.66	8.64
MID	61.60	11.84	0.61	35.42	8.63	35.42	1.00	0.88	12.32	8.16	10.58
RT	5.00	-16.67	2.27	31.02	7.63	31.02	1.00	0.88	12.32	4.17	5.40

Member 5: (Top Slab - Interior Cell), Thickness = 12.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-25.57	1.31	39.82	9.63	39.82	1.00	0.88	15.91	1.92	2.49
MID	77.00	20.58	2.82	55.67	10.06	55.67	1.00	1.20	15.91	3.20	4.15
RT	5.00	-25.57	1.31	39.82	9.63	39.82	1.00	0.88	15.91	1.92	2.49

Member 7: (Bottom Slab - Interior Cell), Thickness = 11.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-15.72	1.99	31.02	7.63	31.02	1.00	0.88	12.32	4.48	5.80
MID	77.00	7.96	3.90	35.42	8.63	35.42	1.00	0.88	12.32	13.37	17.34
RT	5.00	-15.72	1.99	31.02	7.63	31.02	1.00	0.88	12.32	4.48	5.80

Notes: Mu - Resisting moment under pure flexure, Ma - Allowable moment under applied axial load

Strength Limit State at Critical Sections: Vertical Shear

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
BOT	12.70	3.76	-8.8	15.32	7.28	15.93	3.021	33.66	17.70a	0.00	0.00	0.00	9.92	12.86
MID	47.88	0.76	1.6	3.12	7.48	21.62	3.990	30.36	24.02a	0.00	0.00	0.00	41.63	53.97
MID-	47.88	0.76	-7.8	15.08	7.48	15.71	2.900	34.37	17.46a	0.00	0.00	0.00	13.92	18.05
TOP	13.45	-3.45	-13.7	15.32	7.28	13.01	2.468	36.37	14.46a	0.00	0.00	0.00	5.62	7.29

Member 2: (Top Slab), Thickness = 12.50 in

Loc	Dist.	Design Shear	Corr. Moment	Corr. A. F.	Dv	phi*Vn	Beta	Theta	Vc	Vs	Av	Max. Spac	Load Ratings IR	OR

Eriksson Culvert v5.0.0

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	(in)	(k)	(k-ft)	(k)	(in)	(k)			(k)	(k)	(in2)	(in)		
LT	14.00	12.98	-11.6	4.20	9.69	17.32	n/a	n/a	19.24c	0.00	0.00	0.00	1.46	1.90
MID	77.00	2.40	26.2	0.14	10.06	16.72	2.295	39.73	18.58a	0.00	0.00	0.00	5.50	7.13
RT	14.00	15.16	-26.7	1.79	9.63	16.57	n/a	n/a	18.41c	0.00	0.00	0.00	1.14	1.47

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
BOT	12.70	1.21	-1.9	23.30	7.48	27.86	5.142	27.64	30.96a	0.00	0.00	0.00	22.29	28.89
MID	47.88	1.21	3.8	9.89	7.48	20.25	3.737	31.12	22.50a	0.00	0.00	0.00	16.19	20.99
TOP	13.45	1.20	-5.9	23.30	7.48	27.30	5.038	27.81	30.33a	0.00	0.00	0.00	23.50	30.47

Member 4: (Bottom Slab), Thickness = 11.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	12.92	5.79	-8.3	5.07	7.69	14.53	2.611	35.93	16.15a	0.00	0.00	0.00	7.55	9.78
MID	77.00	0.17	11.8	0.61	8.63	17.31	2.772	35.88	19.23a	0.00	0.00	0.00	NC	NC
RT	12.92	7.37	-16.7	2.27	7.63	12.83	n/a	n/a	14.26c	0.00	0.00	0.00	4.06	5.26

Member 5: (Top Slab - Interior Cell), Thickness = 12.50 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	14.00	14.10	-25.6	1.31	9.63	16.52	n/a	n/a	18.35c	0.00	0.00	0.00	1.24	1.61
MID	77.00	4.00	20.6	2.82	10.06	18.33	2.516	38.35	20.36a	0.00	0.00	0.00	4.58	5.94
RT	14.00	14.10	-25.6	1.31	9.63	16.52	n/a	n/a	18.35c	0.00	0.00	0.00	1.24	1.61

Member 7: (Bottom Slab - Interior Cell), Thickness = 11.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	12.92	6.54	-15.7	1.99	7.63	12.84	2.326	37.50	14.27a	0.00	0.00	0.00	5.02	6.50
MID	77.00	0.20	8.0	3.90	8.63	20.82	3.335	33.41	23.14a	0.00	0.00	0.00	99.99	99.99
RT	12.92	6.54	-15.7	1.99	7.63	12.84	2.326	37.50	14.27a	0.00	0.00	0.00	5.02	6.50

Vc Calculation By: a - Iterative Beta, b - Constant Beta, c - Box Culvert, d - Standard/Arema

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

Culvert #1

Load Combination Results at Tenth Points: (k-ft, k)

M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior Wall)						
Bottom						
1- 0	-6.605	-10.867	3.611	15.321	5.073	0.615
1- 1	-3.532	-7.350	3.118	15.321	4.067	0.264
1- 2	-1.185	-6.292	3.118	15.082	3.115	-0.063
1- 3	0.423	-6.635	3.118	15.082	2.217	-0.364
1- 4	1.336	-7.165	3.118	15.082	1.373	-0.642
1- 5	1.598	-7.777	3.118	15.082	0.758	-1.069
1- 6	1.252	-8.581	3.118	15.082	0.530	-1.804
1- 7	0.340	-9.557	3.118	15.082	0.327	-2.486
1- 8	-0.812	-10.686	3.850	15.082	0.148	-3.113
1- 9	-1.520	-12.571	3.611	15.321	-0.007	-3.686
1-10	-1.512	-15.718	3.611	15.321	-0.136	-4.204
Top						
Member 2: (Top Slab)						
Left						
2- 0	-1.528	-15.754	0.136	4.204	15.321	3.118
2- 1	5.738	-3.068	0.136	4.204	12.750	2.463
2- 2	15.593	0.932	0.136	3.202	9.850	1.428
2- 3	23.121	2.833	0.136	3.202	7.040	-0.605
2- 4	26.200	3.895	0.136	3.202	4.585	-2.853
2- 5	25.801	4.117	0.136	3.202	2.396	-5.116
2- 6	23.079	1.957	0.136	4.204	0.328	-7.338
2- 7	16.415	-1.670	0.136	4.204	-1.463	-9.503
2- 8	6.268	-6.997	2.552	1.789	-2.117	-12.355
2- 9	-3.393	-17.654	3.202	1.789	-2.772	-14.965
2-10	-7.370	-31.067	3.202	1.789	-3.426	-17.156
Right						
Member 3: (Interior Wall)						
Bottom						
3- 0	3.882	-1.354	9.892	23.301	1.208	-1.204
3- 1	3.022	-0.413	9.892	23.301	1.208	-1.204
3- 2	2.178	0.280	9.892	6.698	1.208	-1.204
3- 3	1.970	0.155	9.892	23.301	1.208	-1.204
3- 4	2.889	-0.786	9.892	23.301	1.208	-1.204
3- 5	3.834	-1.737	9.892	23.301	1.208	-1.204
3- 6	4.787	-2.690	9.892	23.301	1.208	-1.204
3- 7	5.743	-3.646	9.892	23.301	1.208	-1.204
3- 8	6.699	-4.601	9.892	23.301	1.208	-1.204
3- 9	7.658	-5.557	9.892	23.301	1.208	-1.204
3-10	8.616	-6.514	9.892	23.301	1.208	-1.204
Top						
Member 4: (Bottom Slab)						
Left						
4- 0	-6.605	-10.867	0.615	5.073	7.082	3.704
4- 1	0.866	-2.895	0.615	5.073	5.546	2.930
4- 2	6.642	0.861	0.615	4.423	4.016	2.156
4- 3	10.149	3.131	0.615	4.423	2.489	1.382
4- 4	11.836	4.408	0.615	4.423	0.966	0.571
4- 5	11.647	4.691	0.615	4.423	-0.166	-0.972
4- 6	9.638	3.981	0.615	4.423	-0.940	-2.511
4- 7	5.790	2.277	0.615	4.423	-1.714	-4.049
4- 8	-0.108	-1.990	3.420	2.267	-2.488	-5.588
4- 9	-4.110	-9.834	4.423	2.267	-3.263	-7.126
4-10	-8.793	-19.958	4.423	2.267	-4.037	-8.665
Right						
Member 5: (Top Slab - Interior Cell)						
Bottom						
5- 0	-7.247	-29.521	3.227	1.315	16.197	3.272
5- 1	-3.468	-17.361	3.227	1.315	13.891	2.617
5- 2	6.164	-8.312	2.820	1.315	10.962	1.963
5- 3	14.573	-3.829	2.820	1.315	8.430	0.339
5- 4	19.550	-0.665	2.820	1.315	6.222	-1.804
5- 5	20.583	1.181	2.820	1.315	4.002	-4.002
5- 6	19.550	-0.665	2.820	1.315	1.804	-6.222
5- 7	14.573	-3.829	2.820	1.315	-0.339	-8.430
5- 8	6.164	-8.312	2.820	1.315	-1.963	-10.962
5- 9	-3.468	-17.361	3.227	1.315	-2.617	-13.891
5-10	-7.247	-29.521	3.227	1.315	-3.272	-16.197
Top						
Member 7: (Bottom Slab - Interior Cell)						
Left						

Culvert #1

Eriksson Culvert v5.0.0

Filename: 3 cell 7x12 skew.etcx

7- 0	-8.474	-18.505	4.398	1.994	7.827	3.870
7- 1	-4.004	-9.924	4.398	1.994	6.289	3.096
7- 2	-0.527	-3.022	4.398	1.994	4.750	2.322
7- 3	4.289	1.956	3.899	4.398	3.212	1.548
7- 4	7.045	3.446	3.899	4.398	1.679	0.774
7- 5	7.963	3.943	3.899	4.398	0.199	-0.199
7- 6	7.045	3.446	3.899	4.398	-0.774	-1.679
7- 7	4.289	1.956	3.899	4.398	-1.548	-3.212
7- 8	-0.527	-3.022	4.398	1.994	-2.322	-4.750
7- 9	-4.004	-9.924	4.398	1.994	-3.096	-6.289
7-10	-8.474	-18.505	4.398	1.994	-3.870	-7.827

Right

Spec.: LRFD 7th ed. 2014-2016
Type of Culvert: Cast-in-Place

Physical Dimensions

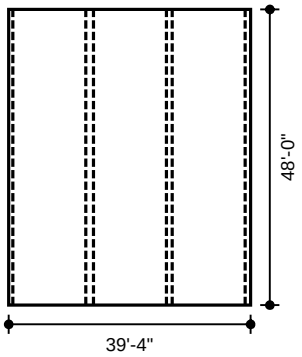
Clear Span:	12'-0"
Clear Height:	7'-0"
Top Slab:	1'-1 1/2"
Bottom Slab:	1'-1"
Ext. Wall:	10"
Int. Wall:	10"
Fill Depth:	4.75 ft
Length:	48'-0"
Skew Angle:	0.00 deg
Left Skew Angle:	90.00 deg
Right Skew Angle:	90.00 deg
Bottom Slab Support:	Full Slab
Top Haunch, Width:	0"
Top Haunch, Height:	0"
Bottom Haunch, Width:	0"
Bottom Haunch, Height:	0"

Loads

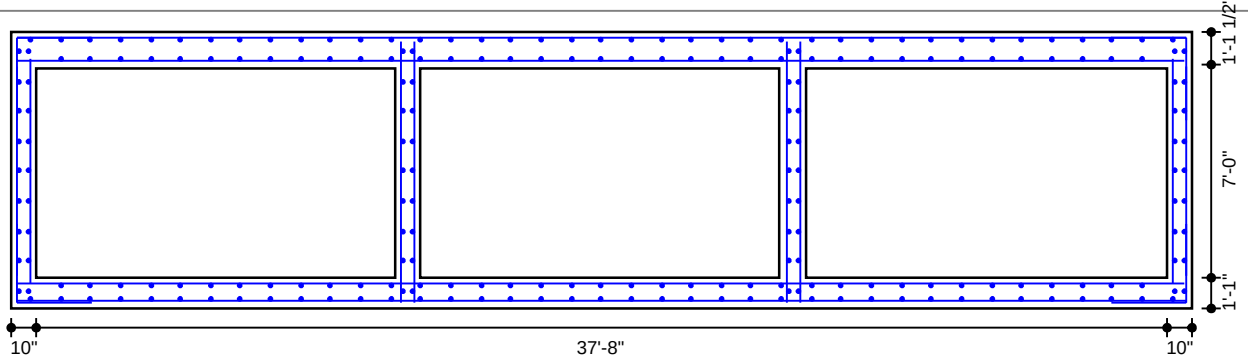
Live Load	
Vehicle Names:	HL-93
Traffic Direction:	Parallel
Eq. Height of Soil:	2.60 ft (Calc'd)
Max No. of Lanes:	1
Dead Load	
Future Wearing Surface:	0.037 klf
Additional Dead Load:	0.000 klf
Concentrated Loads:	none
Lateral Soil Loads	
Eq. Fluid Press. Max:	60.00 pcf
Eq. Fluid Press. Min:	30.00 pcf
Consider Int. Water Press.:	no

Material Properties

Concrete	
Strength, f'c:	4.500 ksi
Density:	0.150 kcf
Elasticity, Ec:	4435 ksi
Type:	Normal wt
Steel	
Yield, fy:	60 ksi
Allow Stress:	36 ksi
Elasticity, Es:	29000 ksi
Soil	
Density:	0.120 kcf
Exposure Factor	
Class 1 Exposure	
Reinforcement Covers	
Ext. Cover Top Slab:	2"
Ext. Cover Bottom Slab	3"
Ext. Cover Walls	2"
Int. Cover Walls	2"
Int. Cover Top Slab	2"
Int. Cover Bottom Slab	2"



Plan View

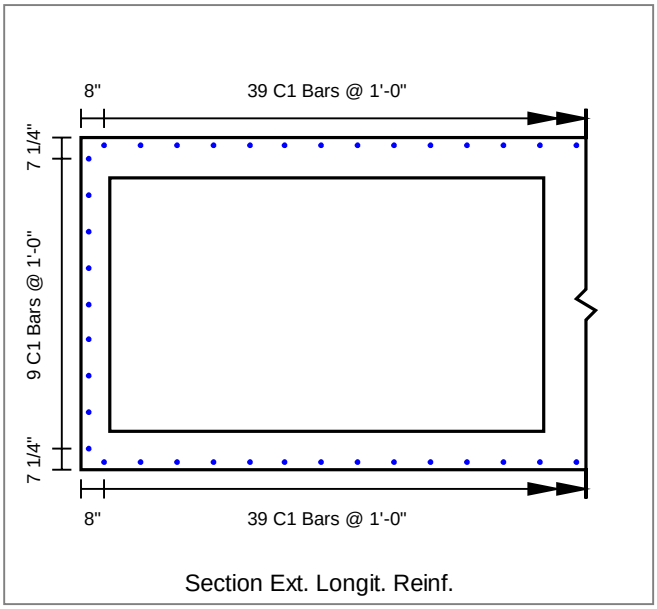


Typical Section

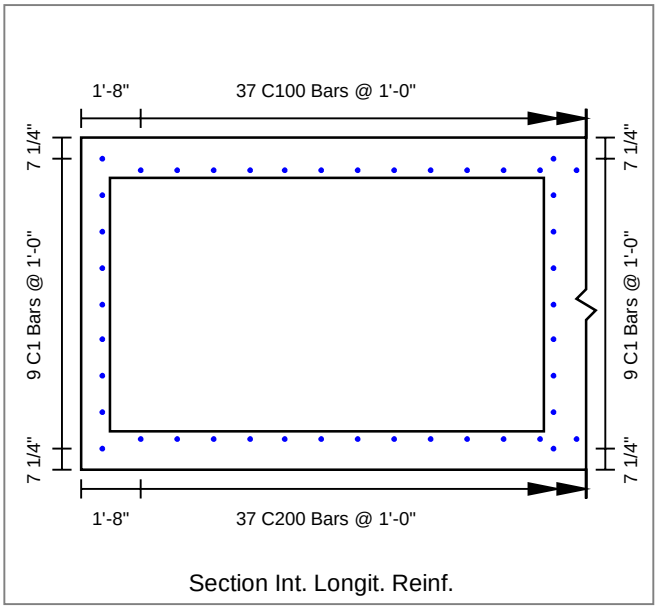
Concrete Summary
Volume of Concrete: 4.081 cy/ft Total Volume of Concrete: 195.901 cy

Reinforcing Steel Bar Schedule (lb)

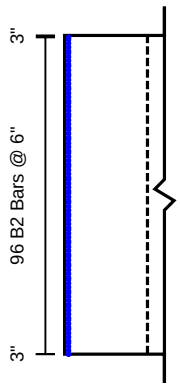
Location	Mark	Qty	Size	Spacing	Type	Length	Hor.Leg	Ver.Leg	Tot.Weight
Top Slab(Int)	A100 (AS2)	96	5	6"	S	38'-11"	--	--	3897.0
Bot Slab(Int)	A200 (AS3)	96	5	6"	S	38'-11"	--	--	3897.0
Top Slab(Ext)	A300 (AS7)	96	5	6"	S	38'-11"	--	--	3897.0
Bot Slab(Ext)	A400 (AS8)	96	5	6"	S	38'-11"	--	--	3897.0
Corner(Top)	A1 (AS1)	192	5	6"	L	5'-3"	2'-6"	2'-9"	1051.0
Corner(Bot)	A2 (AS1)	192	5	6"	L	5'-2"	2'-6"	2'-8"	1035.0
Wall(Int)	B1 (AS4)	192	5	6"	S	7'-6"	--	--	1502.0
Wall(Ext)	B2 (AS1)	192	5	6"	S	7'-0"	--	--	1402.0
Int Wall	B3	384	5	6"	S	8'-9"	--	--	3504.0
Longit. Top (Int)	C100 (AS5)	37	4	1'-0"	S	47'-9"	--	--	1180.0
Longit. Bot (Int)	C200	37	4	1'-0"	S	47'-9"	--	--	1180.0
Longit. Top (Ext)	C1 (AS6)	39	4	1'-0"	S	47'-9"	--	--	1244.1
Longit. Bot (Ext)	C1 (AS6)	39	4	1'-0"	S	47'-9"	--	--	1244.1
Longit. Wall (Ext)	C1 (AS6)	18	4	1'-0"	S	47'-9"	--	--	574.2
Longit. Wall (Int)	C1 (AS6)	18	4	1'-0"	S	47'-9"	--	--	574.2
Longit. Int	C1 (AS6)	36	4	1'-0"	S	47'-9"	--	--	1148.4
									31227



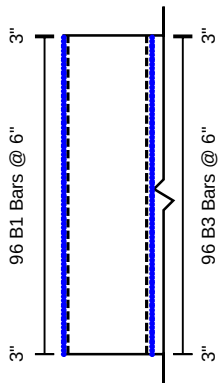
Section Ext. Longit. Reinf.



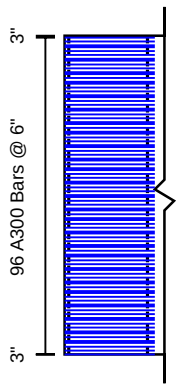
Section Int. Longit. Reinf.



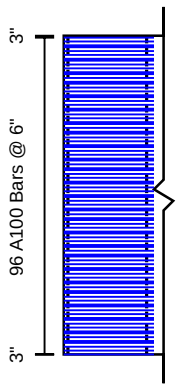
Ext. Wall Reinf.



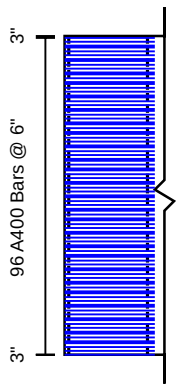
Int. Wall Reinf.



Top Slab Ext. Reinf.

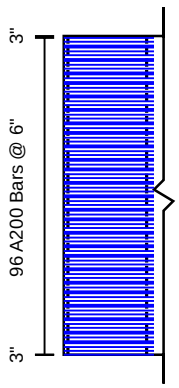


Top Slab Int. Reinf.

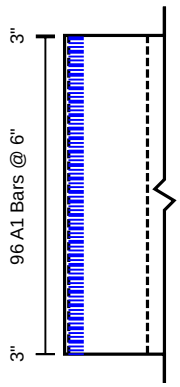


Bottom Slab Ext. Reinf.

31227

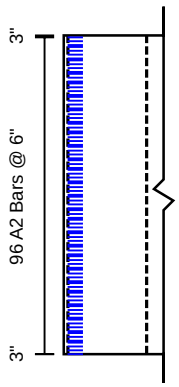


Bottom Slab Int. Reinf.



Top Slab Corner Reinf.

31227



Bottom Slab Corner Reinf.

RATINGS SUMMARY

	Flexure					Shear				
Truck	Fill	Member	Location	IR	OR	Fill	Member	Location	IR	OR
(AA) HL-93	4.75	2	RT	1.34	1.73	4.75	2	RT	1.55	2.01

REINFORCEMENT SUMMARY

M dimension = 1.66 ft (method of equivalent capacity)
= 3.65 ft (method of contraflexure - ASTM)

Reinforcing Steel Schedule

Location	Bar Mark	Qty	Size	Type	Spacing (in)	As,prv (in2/ft)	Length (ft-in)	Wgt (lbs)	H Leg (ft-in)	V Leg (ft-in)
Top Slab (int)	A100 (AS2)	96	5	STR	6.00	0.620	38-11	3897		
Bot Slab (int)	A200 (AS3)	96	5	STR	6.00	0.620	38-11	3897		
Top Slab (ext)	A300 (AS7)	96	5	STR	6.00	0.620	38-11	3897		
Bot Slab (ext)	A400 (AS8)	96	5	STR	6.00	0.620	38-11	3897		
Corner (Top)	A1 (AS1)	192	5	L-BAR	6.00	0.620	5- 3	1051	2- 6	2- 9
Corner (Bottom)	A2 (AS1)	192	5	L-BAR	6.00	0.620	5- 2	1035	2- 6	2- 8
Ext Wall (int)	B1 (AS4)	192	5	STR	6.00	0.620	7- 6	1502		
Ext Wall (ext)	B2 (AS1)	192	5	STR	6.00	0.620	7- 0	1402		
Int Wall	B3	384	5	STR	6.00	0.620	8- 9	3504		
Top Slab (int- 1)	C100 (AS5)	37	4	STR	12.00	0.200	47- 9	1180		
Bot Slab (int- 1)	C200	37	4	STR	12.00	0.200	47- 9	1180		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	47- 9	1244		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	47- 9	1244		
Temperature (1)	C1 (AS6)	18	4	STR	12.00	0.200	47- 9	574		
Temperature (1)	C1 (AS6)	18	4	STR	12.00	0.200	47- 9	574		
Temperature (1)	C1 (AS6)	36	4	STR	12.00	0.200	47- 9	1148		
							Total	31227		

Note: A denotes flexural steel, B denotes vertical steel, C denotes longitudinal steel

AS Bar Marks

Location	As prv in2/ft
Transverse Side Wall - Outside Face (AS1)	0.620
Transverse Top Slab - Inside Face (AS2)	0.620
Transverse Bottom Slab - Inside Face (AS3)	0.620
Transverse Side Wall - Inside Face (AS4)	0.620
Distribution Top Slab - Inside Face (AS5)	0.200
Distribution Top Slab - OutSide Face (AS6)	0.200
Transverse Top Slab - Outside Face (AS7)	0.620
Transverse Bottom Slab - Outside Face (AS8)	0.620

Notes: 1.) Final areas of steel provided must be checked in analysis mode

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	5	1-10
B3	5	1-10
C1	4	1- 6
C100	4	1- 6
C200	4	1- 6

Project: Winsome Filing No. 3
Task : 3 cell 12-ft wide by 7-ft high
Client :
Job No.: 196106001

CULVERT PROPERTIES

Type of Culvert: Cast-in-Place Specification : LRFD 7th Edition w/ 2015 and 2016 Interims
Operating Mode : Analysis

Physical Dimensions

No. of Boxes: 3 Name: 3Cell CIP 12x7
Clear Span : 12.0000 ft Fill Depth : 4.75 ft
Clear Height: 7.0000 ft Center Skew : 0.00 deg Left Skew: 90.00 deg Right Skew: 90.00 deg
Length : 48.0000 ft Bottom Slab Support: Full Slab
Haunches: Top, Length: 0.0000 in Height: 0.0000 in
Bottom, Length: 0.0000 in Height: 0.0000 in
Member Thicknesses: Top Slab: 13.5000 in Bot Slab: 13.0000 in
Ext Wall: 10.0000 in Int Wall: 10.0000 in
Wall Joint: None

Material Properties

Concrete: Strength,f'c : 4.500 ksi Density : 0.150 kcf Elasticity,Ec: 4435 ksi
Type : Normal Weight Density Modification Factor : 1.00
Fr Factor : 0.24 Gamma1 : 1.60 Gamma3 : 0.75
Steel: Yield,fy : 60.00 ksi fss Limit : 0.60fy Elasticity,Es: 29000 ksi
Yield,fyv : 60.00 ksi Diameter : 1.000 in Type : Rebar
Soil: Density : 0.120 kcf Slope Factor: 1.150 (B1 Installation)
Poisson's : 0.5
Fe Factor : 1.150 (Maximum for Compacted Fill)
Serviceability, Gamma-e: 1.00

Loads

Live Load: Vehicle: (AA) HL-93 - Design Vehicle

Axle No.	Weight(k)	Dist. From Previous(ft)
1	8.00	0.00
2	32.00	14.00
3	32.00	14.00

Gage Width: 6.00 ft, Tread Width: 20.00 in, Tread Length: 10.00 in
Include Tandem: yes
Tandem: Axle 1: 25.00 k, Axle 2: 25.00 k, Axle Spacing: 4.00 ft
Lane Load: 0.00 klf, P-Moment: 0.00 k, P-Shear: 0.00 k
Combine: Truck + Lane Or Tandem + Lane
Inventory Rating Load Factor: 1.75 Operating Rating Load Factor: 1.35
Design Load Combinations: Strength I
Override MPF: no
Override DLA: no
Include Lane Load : no Max. No. of Lanes: Computed by Program
Traffic Direction** : Lanes Parallel to Main Reinforcement
Neglect Live Load for Large Fill Depths: yes
Apply Surcharge at Fill Depths > 2 ft : yes
Compute Surcharge Depth: yes
Dead Load: Future Wearing Surface : 0.04 klf Add. Dead Load : 0.00 klf
Concentrated Loads : none
Lateral Soil Loads: Max. Equiv. Fluid Press.: 60.00 pcf Min. Equiv. Fluid Press. : 30.00 pcf
Include Additional Uniform Horiz. Load: no
Include Additional Uniform Vert. Load: no
Buoyancy Check : no
Fluid Pressures : Apply Water Press. : no
Foundation Model : Rigid

Load and Resistance Factors

	Max	Min
DC:	1.250	0.900
DW:	1.500	0.650
EV:	1.300	0.900
EH:	1.350	0.900
WA:	1.000	
EQ:	1.000	

LL I : 1.750 LL II : 1.350
Ductility: 1.000 Importance: 1.000 Redundancy, non-earth: 1.000 Redundancy, earth: 1.050
Condition: 1.000 System : 1.000
Phi Shear: 0.900 Phi Moment: 1.000 PM Compression: 0.750 PM Tension : 0.900
Load Factor Multipliers, Design Mode: 1.00 Analysis Mode: 1.00

Reinforcement

Reinforcement Covers :

	Exterior	Interior
Top Slab:	2.0000 in	2.0000 in
Walls :	2.0000 in	2.0000 in
Bot Slab:	3.0000 in	2.0000 in

Assigned reinforcement:

Location	Mark	Size	Spacing (in)
Top Slab Inside	A100 (AS2)	5	6.0000
Bottom Slab Inside	A200 (AS3)	5	6.0000
Top Slab Outside	A300 (AS7)	5	6.0000
Bottom Slab Outside	A400 (AS8)	5	6.0000
Top Corner	A1 (AS1)	5	6.0000
Bottom Corner	A2 (AS1)	5	6.0000
Ext. Wall Inside	B1 (AS4)	5	6.0000
Ext. Wall Outside	B2 (AS1)	5	6.0000
Interior Wall	B3	5	6.0000
Longitudinal	C1 (AS6)	4	12.0000
Top Distribution	C100 (AS5)	4	12.0000
Bottom Distribution	C200	4	12.0000

Analysis Options

LL Analysis : Automatically Set Traffic Direction to Account for Skew Effects: yes (**Will override previo
Limit LL Distribution Width to Culvert Length for: All Fill Depths
Combine Longitudinal Axle Distribution Overlaps: Yes, Max of 2 Axles
Combine Transverse Axle Distribution Overlaps: No
Axle Placement Increment for Moving Load Analysis: 20
Include Impact on Bottom Slab: no
Always Distribute Wheel Load: yes
Reinforcement: Always Include Distribution Steel: yes
Distribution Slab Provided: no
User Defined Longitudinal Steel: yes
Max. As used in Vc Calcs: 2.00 in2/ft
Distribute Minimum Reinforcement per Face: no
Use individual Member Thicknesses for Min Steel: yes
Epoxy coat steel: top bars, if fill < 2'
Use M-dimension for bar length calcs.: no
Slenderness : Checked K Factor: 2.00
Analysis Modeling : Use Haunches in the Structural Analysis Model: no
Crit. Section: Consider Haunches when Selecting Critical Section Locations: no
Use Max. Moment with Max. Shear at the Critical Section for Shear: yes
Flexure : Ignore Axial Thrust: yes
Use Eq. 12.10.4.2.4a-1: no
Shear : Always Check Iterative Beta Method
Environmental: Apply envirnomental duribility factors: no

ANALYSIS RESULTS
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Top Slab Thickness = 13.50 in
Bottom Slab Thickness = 13.00 in
Exterior Wall Thickness = 10.00 in
Interior Wall Thickness = 10.00 in

Modular Ratio (N) = 6.54 Max. Steel Ratio = 0.023
Design Span = 12.83 ft Design Height = 8.10 ft
Design Fill Depth = 4.75 ft

Volume of Concrete: 4.081 cy/ft Weight of Steel: 656 lb/ft

M dimension = 1.66 ft (method of equivalent capacity)
= 3.65 ft (method of contraflexure - ASTM)

Reinforcing Steel Schedule

Location	Bar Mark	Qty	Size	Type	Spacing (in)	As,prv (in2/ft)	Length (ft-in)	Wgt (lbs)	H Leg (ft-in)	V Leg (ft-in)
Top Slab (int)	A100 (AS2)	96	5	STR	6.00	0.620	38-11	3897		
Bot Slab (int)	A200 (AS3)	96	5	STR	6.00	0.620	38-11	3897		
Top Slab (ext)	A300 (AS7)	96	5	STR	6.00	0.620	38-11	3897		
Bot Slab (ext)	A400 (AS8)	96	5	STR	6.00	0.620	38-11	3897		
Corner (Top)	A1 (AS1)	192	5	L-BAR	6.00	0.620	5- 3	1051	2- 6	2- 9
Corner (Bottom)	A2 (AS1)	192	5	L-BAR	6.00	0.620	5- 2	1035	2- 6	2- 8
Ext Wall (int)	B1 (AS4)	192	5	STR	6.00	0.620	7- 6	1502		
Ext Wall (ext)	B2 (AS1)	192	5	STR	6.00	0.620	7- 0	1402		
Int Wall	B3	384	5	STR	6.00	0.620	8- 9	3504		
Top Slab (int- 1)	C100 (AS5)	37	4	STR	12.00	0.200	47- 9	1180		
Bot Slab (int- 1)	C200	37	4	STR	12.00	0.200	47- 9	1180		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	47- 9	1244		
Temperature (1)	C1 (AS6)	39	4	STR	12.00	0.200	47- 9	1244		
Temperature (1)	C1 (AS6)	18	4	STR	12.00	0.200	47- 9	574		
Temperature (1)	C1 (AS6)	18	4	STR	12.00	0.200	47- 9	574		
Temperature (1)	C1 (AS6)	36	4	STR	12.00	0.200	47- 9	1148		
							Total	31227		

Note: A denotes flexural steel, B denotes vertical steel, C denotes longitudinal steel

AS Bar Marks

Location	As prv in2/ft
Transverse Side Wall - Outside Face (AS1)	0.620
Transverse Top Slab - Inside Face (AS2)	0.620
Transverse Bottom Slab - Inside Face (AS3)	0.620
Transverse Side Wall - Inside Face (AS4)	0.620
Distribution Top Slab - Inside Face (AS5)	0.200
Distribution Top Slab - OutSide Face (AS6)	0.200
Transverse Top Slab - Outside Face (AS7)	0.620
Transverse Bottom Slab - Outside Face (AS8)	0.620

Notes: 1.) Final areas of steel provided must be checked in analysis mode

Splice Lengths Table:

Bar Mark	Size	Splice Length (ft-in)
B1	5	1-10
B3	5	1-10
C1	4	1- 6
C100	4	1- 6
C200	4	1- 6

Summary of Ratings Table:

Truck	Flexure Fill	Flexure Member	Flexure Location	Flexure IR	Flexure OR	Shear Fill	Shear Member	Shear Location	Shear IR	Shear OR
(AA) HL-93	4.75	2	RT	1.34	1.73	4.75	2	RT	1.55	2.01

Critical Sections Summary: Flexure

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	Load Ratings OR	Load Ratings Truck	Fill Depth (ft)

BOT	6.50	-8.28	14.25	22.58	7.69	22.58	1.00	0.62	10.18	8.83	11.44	AA	4.75
MID	48.63	1.77	4.08	22.58	7.69	22.58	1.00	0.62	10.18	16.84	21.82	AA	4.75
MID-	48.63	-6.24	13.98	22.58	7.69	22.58	1.00	0.62	10.18	5.79	7.51	AA	4.75
TOP	6.75	-13.09	14.25	22.58	7.69	22.58	1.00	0.62	10.18	2.24	2.90	AA	4.75

Member 2: (Top Slab), Thickness = 13.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-11.18	4.69	33.43	11.19	33.43	1.00	0.62	18.56	4.35	5.64	AA	4.75
MID	61.60	26.91	0.69	33.43	11.19	33.43	1.00	0.62	18.56	1.39	1.80	AA	4.75
RT	5.00	-28.53	2.07	33.43	11.19	33.43	1.00	0.62	18.56	1.34	1.73	AA	4.75

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	6.50	-2.19	26.25	22.58	7.69	22.58	1.00	0.62	10.18	12.85	16.66	AA	4.75
MID	48.63	3.15	13.50	22.58	7.69	22.58	1.00	0.62	10.18	10.06	13.05	AA	4.75
TOP	6.75	-4.50	26.25	22.58	7.69	22.58	1.00	0.62	10.18	4.22	5.47	AA	4.75

Member 4: (Bottom Slab), Thickness = 13.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-8.04	5.36	28.78	9.69	28.78	1.00	0.62	17.21	11.05	14.32	AA	4.75
MID	61.60	15.15	0.85	31.88	10.69	31.88	1.00	0.62	17.21	6.38	8.27	AA	4.75
RT	5.00	-19.68	2.24	28.78	9.69	28.78	1.00	0.62	17.21	3.35	4.34	AA	4.75

Member 5: (Top Slab - Interior Cell), Thickness = 13.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-27.49	1.68	33.43	11.19	33.43	1.00	0.62	18.56	1.43	1.85	AA	4.75
MID	77.00	20.43	3.56	33.43	11.19	33.43	1.00	0.62	18.56	1.91	2.47	AA	4.75
RT	5.00	-27.49	1.68	33.43	11.19	33.43	1.00	0.62	18.56	1.43	1.85	AA	4.75

Member 7: (Bottom Slab - Interior Cell), Thickness = 13.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	5.00	-18.84	1.98	28.78	9.69	28.78	1.00	0.62	17.21	3.60	4.67	AA	4.75
MID	77.00	8.89	4.38	31.88	10.69	31.88	1.00	0.62	17.21	13.04	16.91	AA	4.75
RT	5.00	-18.84	1.98	28.78	9.69	28.78	1.00	0.62	17.21	3.60	4.67	AA	4.75

Critical Sections Summary: Vertical Shear

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	13.70	3.81	-8.3	14.25	7.28	16.09	3.051	17.87a	0.00	0.00	0.00	11.53	14.95	AA	4.75
MID	48.63	0.45	1.8	4.08	7.28	24.14	4.579	26.82a	0.00	0.00	0.00	64.38	83.46	AA	4.75
MID-	48.63	0.45	-6.2	13.98	7.28	20.66	3.919	22.96a	0.00	0.00	0.00	20.50	26.57	AA	4.75
TOP	13.95	-3.79	-13.1	14.25	7.28	13.07	2.479	14.52a	0.00	0.00	0.00	6.00	7.78	AA	4.75

Member 2: (Top Slab), Thickness = 13.50 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	14.90	11.45	-11.2	4.69	11.19	19.78	n/a	21.97c	0.00	0.00	0.00	2.24	2.91	AA	4.75
MID	77.00	1.19	26.9	0.69	11.19	17.43	n/a	19.37c	0.00	0.00	0.00	8.59	11.13	AA	4.75
RT	14.90	14.22	-28.5	2.07	11.19	18.52	n/a	20.58c	0.00	0.00	0.00	1.55	2.01	AA	4.75

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
BOT	13.70	1.03	-2.2	26.25	7.28	27.23	5.165	30.26a	0.00	0.00	0.00	25.27	32.75	AA	4.75
MID	48.63	1.03	3.2	13.50	7.28	26.57	5.040	29.53a	0.00	0.00	0.00	24.65	31.96	AA	4.75
TOP	13.95	1.00	-4.5	26.25	7.28	26.92	5.106	29.91a	0.00	0.00	0.00	28.29	36.67	AA	4.75

Member 4: (Bottom Slab), Thickness = 13.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	14.36	6.55	-8.0	5.36	9.69	18.80	2.681	20.89a	0.00	0.00	0.00	11.99	15.54	AA	4.75
MID	77.00	0.30	15.1	0.85	10.69	17.58	2.272	19.54a	0.00	0.00	0.00	NC	NC	AA	4.75
RT	14.36	8.78	-19.7	2.24	9.69	15.93	n/a	17.70c	0.00	0.00	0.00	5.55	7.19	AA	4.75

Member 5: (Top Slab - Interior Cell), Thickness = 13.50 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	14.90	12.70	-27.5	1.68	11.19	18.43	n/a	20.48c	0.00	0.00	0.00	1.80	2.33	AA	4.75
MID	77.00	2.77	20.4	3.56	11.19	17.65	n/a	19.61c	0.00	0.00	0.00	6.37	8.25	AA	4.75
RT	14.90	12.70	-27.5	1.68	11.19	18.43	n/a	20.48c	0.00	0.00	0.00	1.80	2.33	AA	4.75

Member 7: (Bottom Slab - Interior Cell), Thickness = 13.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn	Beta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR	Truck	Fill Depth (ft)
LT	14.36	7.59	-18.8	1.98	9.69	15.84	n/a	17.60c	0.00	0.00	0.00	7.12	9.23	AA	4.75
MID	77.00	0.19	8.9	4.38	10.69	23.20	2.999	25.78a	0.00	0.00	0.00	99.99	99.99	AA	4.75
RT	14.36	7.59	-18.8	1.98	9.69	15.84	n/a	17.60c	0.00	0.00	0.00	7.12	9.23	AA	4.75

Vc Calculation By: a - Iterative Beta, b - Constant Beta, c - Box Culvert, d - Standard/Arema

Analysis Results: Fill Depth = 4.75 ft

Load Parameters:

Fe = 1.02 Surcharge Depth : 2.60 ft

Applied Horizontal Loads: (k/ft)

Load Description	Bottom of Wall	Top of Wall
Horizontal Earth Load	0.805	0.319
Live Load Surcharge	0.156	0.156
Internal Water Pressure	0.000	0.000

Unfactored Moments due to All Loads: (k-ft)

M-PT	Mdc	Mev	Mdw	Meh	Mls	Mwa
Member 1: (Exterior Wall)						
Bottom						
1- 0	-1.30	-2.41	-0.15	-2.24	-0.60	0.00
1- 1	-1.21	-2.39	-0.15	-0.37	-0.14	0.00
1- 2	-1.13	-2.36	-0.15	0.99	0.22	0.00
1- 3	-1.04	-2.34	-0.15	1.89	0.47	0.00
1- 4	-0.96	-2.31	-0.15	2.36	0.62	0.00
1- 5	-0.87	-2.29	-0.14	2.42	0.67	0.00
1- 6	-0.78	-2.26	-0.14	2.12	0.61	0.00
1- 7	-0.70	-2.24	-0.14	1.48	0.46	0.00
1- 8	-0.61	-2.21	-0.14	0.54	0.20	0.00
1- 9	-0.53	-2.19	-0.14	-0.68	-0.17	0.00
1-10	-0.44	-2.16	-0.14	-2.14	-0.63	0.00
Top						
Member 2: (Top Slab)						
Left						
2- 0	-0.44	-2.16	-0.14	-2.17	-0.63	0.00
2- 1	0.58	1.44	0.09	-1.90	-0.55	0.00
2- 2	1.32	4.07	0.26	-1.62	-0.47	0.00
2- 3	1.78	5.74	0.36	-1.35	-0.39	0.00
2- 4	1.97	6.46	0.41	-1.08	-0.31	0.00
2- 5	1.87	6.20	0.39	-0.81	-0.23	0.00
2- 6	1.50	4.99	0.32	-0.53	-0.15	0.00
2- 7	0.85	2.82	0.18	-0.26	-0.08	0.00
2- 8	-0.07	-0.32	-0.02	0.01	0.00	0.00
2- 9	-1.28	-4.42	-0.28	0.29	0.08	0.00
2-10	-2.76	-9.48	-0.60	0.56	0.16	0.00
Right						
Member 3: (Interior Wall)						
Bottom						
3- 0	0.33	0.65	0.04	-0.26	-0.07	0.00
3- 1	0.31	0.64	0.04	-0.25	-0.07	0.00
3- 2	0.29	0.63	0.04	-0.25	-0.07	0.00
3- 3	0.27	0.62	0.04	-0.24	-0.07	0.00
3- 4	0.25	0.61	0.04	-0.24	-0.07	0.00
3- 5	0.23	0.60	0.04	-0.24	-0.07	0.00
3- 6	0.21	0.59	0.04	-0.23	-0.06	0.00
3- 7	0.19	0.58	0.04	-0.23	-0.06	0.00
3- 8	0.17	0.57	0.04	-0.22	-0.06	0.00
3- 9	0.15	0.56	0.04	-0.22	-0.06	0.00
3-10	0.13	0.55	0.03	-0.21	-0.06	0.00
Top						
Member 4: (Bottom Slab)						
Left						
4- 0	-1.30	-2.41	-0.15	-2.24	-0.60	0.00
4- 1	0.42	1.21	0.08	-1.95	-0.52	0.00
4- 2	1.68	3.86	0.24	-1.67	-0.44	0.00
4- 3	2.49	5.55	0.35	-1.39	-0.37	0.00
4- 4	2.86	6.28	0.40	-1.10	-0.29	0.00
4- 5	2.77	6.05	0.38	-0.82	-0.22	0.00
4- 6	2.23	4.86	0.31	-0.53	-0.14	0.00
4- 7	1.23	2.71	0.17	-0.25	-0.07	0.00
4- 8	-0.21	-0.41	-0.03	0.03	0.01	0.00
4- 9	-2.10	-4.49	-0.28	0.32	0.08	0.00
4-10	-4.45	-9.53	-0.60	0.60	0.16	0.00
Right						
Member 5: (Top Slab - Interior Cell)						

Unfactored Shears due to All Loads: (k)

M-PT	Vdc	Vev	Vdw	Veh	Vls	Vwa
Member 1: (Exterior Wall)						
Bottom						
1- 0	0.11	0.03	0.00	2.61	0.63	0.00
1- 1	0.11	0.03	0.00	1.98	0.50	0.00
1- 2	0.11	0.03	0.00	1.39	0.38	0.00
1- 3	0.11	0.03	0.00	0.83	0.25	0.00
1- 4	0.11	0.03	0.00	0.32	0.12	0.00
1- 5	0.11	0.03	0.00	-0.16	0.00	0.00
1- 6	0.11	0.03	0.00	-0.59	-0.13	0.00
1- 7	0.11	0.03	0.00	-0.99	-0.26	0.00
1- 8	0.11	0.03	0.00	-1.34	-0.38	0.00
1- 9	0.11	0.03	0.00	-1.66	-0.51	0.00
1-10	0.11	0.03	0.00	-1.94	-0.64	0.00
Top						
Member 2: (Top Slab)						
Left						
2- 0	0.90	3.18	0.20	0.21	0.06	0.00
2- 1	0.69	2.43	0.15	0.21	0.06	0.00
2- 2	0.47	1.68	0.11	0.21	0.06	0.00
2- 3	0.25	0.93	0.06	0.21	0.06	0.00
2- 4	0.04	0.18	0.01	0.21	0.06	0.00
2- 5	-0.18	-0.57	-0.04	0.21	0.06	0.00
2- 6	-0.40	-1.32	-0.08	0.21	0.06	0.00
2- 7	-0.61	-2.07	-0.13	0.21	0.06	0.00
2- 8	-0.83	-2.82	-0.18	0.21	0.06	0.00
2- 9	-1.05	-3.57	-0.23	0.21	0.06	0.00
2-10	-1.26	-4.32	-0.27	0.21	0.06	0.00
Right						
Member 3: (Interior Wall)						
Bottom						
3- 0	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 1	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 2	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 3	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 4	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 5	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 6	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 7	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 8	-0.02	-0.01	0.00	0.01	0.00	0.00
3- 9	-0.02	-0.01	0.00	0.01	0.00	0.00
3-10	-0.02	-0.01	0.00	0.01	0.00	0.00
Top						
Member 4: (Bottom Slab)						
Left						
4- 0	1.51	3.19	0.20	0.22	0.06	0.00
4- 1	1.16	2.44	0.15	0.22	0.06	0.00
4- 2	0.81	1.69	0.11	0.22	0.06	0.00
4- 3	0.46	0.94	0.06	0.22	0.06	0.00
4- 4	0.11	0.19	0.01	0.22	0.06	0.00
4- 5	-0.25	-0.55	-0.04	0.22	0.06	0.00
4- 6	-0.60	-1.30	-0.08	0.22	0.06	0.00
4- 7	-0.95	-2.05	-0.13	0.22	0.06	0.00
4- 8	-1.30	-2.80	-0.18	0.22	0.06	0.00
4- 9	-1.65	-3.55	-0.23	0.22	0.06	0.00
4-10	-2.00	-4.30	-0.27	0.22	0.06	0.00
Right						
Member 5: (Top Slab - Interior Cell)						

Bottom						
5- 0	-2.63	-8.92	-0.57	0.34	0.10	0.00
5- 1	-1.37	-4.60	-0.29	0.34	0.10	0.00
5- 2	-0.40	-1.23	-0.08	0.34	0.10	0.00
5- 3	0.29	1.17	0.07	0.34	0.10	0.00
5- 4	0.71	2.62	0.17	0.34	0.10	0.00
5- 5	0.85	3.10	0.20	0.34	0.10	0.00
5- 6	0.71	2.62	0.17	0.34	0.10	0.00
5- 7	0.29	1.17	0.07	0.34	0.10	0.00
5- 8	-0.40	-1.23	-0.08	0.34	0.10	0.00
5- 9	-1.37	-4.60	-0.29	0.34	0.10	0.00
5-10	-2.63	-8.92	-0.57	0.34	0.10	0.00
Top						

Bottom						
5- 0	1.08	3.75	0.24	0.00	0.00	0.00
5- 1	0.87	3.00	0.19	0.00	0.00	0.00
5- 2	0.65	2.25	0.14	0.00	0.00	0.00
5- 3	0.43	1.50	0.09	0.00	0.00	0.00
5- 4	0.22	0.75	0.05	0.00	0.00	0.00
5- 5	0.00	0.00	0.00	0.00	0.00	0.00
5- 6	-0.22	-0.75	-0.05	0.00	0.00	0.00
5- 7	-0.43	-1.50	-0.09	0.00	0.00	0.00
5- 8	-0.65	-2.25	-0.14	0.00	0.00	0.00
5- 9	-0.87	-3.00	-0.19	0.00	0.00	0.00
5-10	-1.08	-3.75	-0.24	0.00	0.00	0.00
Top						

Member 7: (Bottom Slab - Interior Cell)

Left						
7- 0	-4.12	-8.87	-0.56	0.34	0.09	0.00
7- 1	-2.09	-4.55	-0.29	0.34	0.09	0.00
7- 2	-0.51	-1.18	-0.07	0.34	0.09	0.00
7- 3	0.62	1.22	0.08	0.34	0.09	0.00
7- 4	1.29	2.67	0.17	0.34	0.09	0.00
7- 5	1.52	3.15	0.20	0.34	0.09	0.00
7- 6	1.29	2.67	0.17	0.34	0.09	0.00
7- 7	0.62	1.22	0.08	0.34	0.09	0.00
7- 8	-0.51	-1.18	-0.07	0.34	0.09	0.00
7- 9	-2.09	-4.55	-0.29	0.34	0.09	0.00
7-10	-4.12	-8.87	-0.56	0.34	0.09	0.00
Right						

Member 7: (Bottom Slab - Interior Cell

Left						
7- 0	1.76	3.75	0.24	0.00	0.00	0.00
7- 1	1.41	3.00	0.19	0.00	0.00	0.00
7- 2	1.05	2.25	0.14	0.00	0.00	0.00
7- 3	0.70	1.50	0.09	0.00	0.00	0.00
7- 4	0.35	0.75	0.05	0.00	0.00	0.00
7- 5	0.00	0.00	0.00	0.00	0.00	0.00
7- 6	-0.35	-0.75	-0.05	0.00	0.00	0.00
7- 7	-0.70	-1.50	-0.09	0.00	0.00	0.00
7- 8	-1.05	-2.25	-0.14	0.00	0.00	0.00
7- 9	-1.41	-3.00	-0.19	0.00	0.00	0.00
7-10	-1.76	-3.75	-0.24	0.00	0.00	0.00
Right						

Unfactored Thrusts due to All Loads: (k)

Member	Pdc	Pev	Pdw	Peh	Pls	Pwa
1	0.90	3.18	0.20	0.21	0.06	0.00
2	-0.11	-0.03	0.00	1.94	0.64	0.00
3	2.35	8.06	0.51	-0.21	-0.06	0.00
4	0.11	0.03	0.00	2.61	0.63	0.00
5	-0.08	-0.02	0.00	1.93	0.64	0.00
7	0.08	0.02	0.00	2.62	0.63	0.00

---------- Analysis Truck, HL-93 ----------

Vehicle	Axle No.	Weight (k/ft)	Length (ft)	Dist. From Previous (ft)
Truck	1	0.832	6.30	
	2	0.832	6.30	14.00
	3	0.208	6.30	14.00
Tandem	1	0.795	10.30	

***Distributed loads may have been intensified due to axle overlap between lanes

Live Load Parameters:

Traffic Direction is Parallel to Main Reinforcement
Distribution Width : 13.85 ft
Impact Factor : 1.13
Distribution Width : 0.00 ft
Lane Load: 0.000 k/ft

Truck Positions That Cause Maximum Results:

Maximum +Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.832	6.30	6.36
	2	0.832	6.30	-7.64
	3	0.208	6.30	-21.64

Maximum +Moment : 7.75 k-ft
Corresponding Moment at End : -3.32 k-ft
Coincident Bottom Slab Load : 0.06 k/ft

Maximum -Moment in Top Slab

Vehicle	Axle No.	Weight (klf)	Length (ft)	Dist. From Left End (ft)
Truck	1	0.832	6.30	20.36
	2	0.832	6.30	6.36
	3	0.208	6.30	-7.64

Maximum -Moment : -9.48 k-ft
Corresponding Moment at Mid : 6.61 k-ft
Coincident Bottom Slab Load : 0.12 k/ft

Maximum +Shear in Top Slab

Truck	1	0.832	6.30	15.98
	2	0.832	6.30	1.98
	3	0.208	6.30	-12.02

Maximum +Shear : 4.23 k
Corresponding Shear at Mid : -1.19 k
Coincident Bottom Slab Load : 0.11 k/ft

Maximum -Shear in Top Slab

Truck	1	0.832	6.30	23.69
	2	0.832	6.30	9.69
	3	0.208	6.30	-4.31

Maximum -Shear : -4.35 k
Corresponding Shear at Mid : 0.89 k
Coincident Bottom Slab Load : 0.12 k/ft

Maximum +Moment in Top Slab
Tandem 1 0.795 10.30 6.40
Maximum +Moment : 9.15 k-ft
Corresponding Moment at End : -4.39 k-ft
Coincident Bottom Slab Load : 0.09 k/ft

Maximum -Moment in Top Slab
Tandem 1 0.795 10.30 7.04
Maximum -Moment : -8.83 k-ft
Corresponding Moment at Mid : 9.05 k-ft
Coincident Bottom Slab Load : 0.09 k/ft

Maximum +Shear in Top Slab
Tandem 1 0.795 10.30 17.98
Maximum +Shear : 4.96 k
Corresponding Shear at Mid : -0.43 k
Coincident Bottom Slab Load : 0.09 k/ft

Maximum -Shear in Top Slab
Tandem 1 0.795 10.30 7.69
Maximum -Shear : -5.27 k
Corresponding Shear at Mid : -0.16 k
Coincident Bottom Slab Load : 0.09 k/ft

Unfactored Moments and Shears due to Truck Loads: (k-ft, k)

	Truck				Tandem				Lane			
M-PT	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-	Mll+	Mll-	Vll+	Vll-
Member 1: (Exterior Wall)												
Bottom												
1- 0	0.35	-0.85	0.19	-0.48	0.19	-0.70	0.22	-0.57	0.00	0.00	0.00	0.00
1- 1	0.00	-0.71	0.19	-0.48	0.00	-0.53	0.22	-0.57	0.00	0.00	0.00	0.00
1- 2	0.00	-0.61	0.19	-0.48	0.00	-0.43	0.22	-0.57	0.00	0.00	0.00	0.00
1- 3	0.00	-0.82	0.19	-0.48	0.00	-0.93	0.22	-0.57	0.00	0.00	0.00	0.00
1- 4	0.00	-1.08	0.19	-0.48	0.00	-1.43	0.22	-0.57	0.00	0.00	0.00	0.00
1- 5	0.00	-1.47	0.19	-0.48	0.06	-1.93	0.22	-0.57	0.00	0.00	0.00	0.00
1- 6	0.06	-1.86	0.19	-0.48	0.30	-2.43	0.22	-0.57	0.00	0.00	0.00	0.00
1- 7	0.27	-2.26	0.19	-0.48	0.54	-2.93	0.22	-0.57	0.00	0.00	0.00	0.00
1- 8	0.42	-2.65	0.19	-0.48	0.71	-3.43	0.22	-0.57	0.00	0.00	0.00	0.00
1- 9	0.57	-3.04	0.19	-0.48	0.88	-3.93	0.22	-0.57	0.00	0.00	0.00	0.00
1-10	0.72	-3.44	0.19	-0.48	1.06	-4.43	0.22	-0.57	0.00	0.00	0.00	0.00
Top												
Member 2: (Top Slab)												
Left												
2- 0	0.72	-3.44	3.87	-0.26	1.06	-4.43	4.61	-0.43	0.00	0.00	0.00	0.00
2- 1	1.90	-0.63	3.28	-0.26	1.44	-0.54	3.74	-0.43	0.00	0.00	0.00	0.00
2- 2	4.49	-0.09	2.69	-0.26	4.88	-0.02	2.90	-0.43	0.00	0.00	0.00	0.00
2- 3	6.55	-0.37	2.10	-0.68	7.56	-0.55	2.13	-0.47	0.00	0.00	0.00	0.00
2- 4	7.63	-0.70	1.55	-1.19	8.98	-1.15	1.44	-0.86	0.00	0.00	0.00	0.00
2- 5	7.75	-1.03	1.05	-1.77	9.15	-1.73	0.86	-1.37	0.00	0.00	0.00	0.00
2- 6	6.89	-1.36	0.61	-2.35	8.06	-2.28	0.39	-1.99	0.00	0.00	0.00	0.00
2- 7	5.15	-1.70	0.25	-2.91	5.76	-2.84	0.11	-2.72	0.00	0.00	0.00	0.00
2- 8	2.66	-3.07	0.08	-3.43	2.31	-3.40	0.11	-3.56	0.00	0.00	0.00	0.00
2- 9	0.74	-5.89	0.08	-3.91	0.98	-3.95	0.10	-4.43	0.00	0.00	0.00	0.00
2-10	0.84	-9.48	0.08	-4.35	1.11	-8.83	0.10	-5.27	0.00	0.00	0.00	0.00
Right												
Member 3: (Interior Wall)												
Bottom												
3- 0	1.24	-0.99	0.47	-0.43	1.20	-1.22	0.61	-0.54	0.00	0.00	0.00	0.00
3- 1	0.89	-0.61	0.47	-0.43	0.76	-0.73	0.61	-0.54	0.00	0.00	0.00	0.00
3- 2	0.55	-0.25	0.47	-0.43	0.35	-0.25	0.61	-0.54	0.00	0.00	0.00	0.00
3- 3	0.27	-0.09	0.47	-0.43	0.33	-0.10	0.61	-0.54	0.00	0.00	0.00	0.00
3- 4	0.56	-0.24	0.47	-0.43	0.72	-0.55	0.61	-0.54	0.00	0.00	0.00	0.00
3- 5	0.93	-0.56	0.47	-0.43	1.22	-1.01	0.61	-0.54	0.00	0.00	0.00	0.00
3- 6	1.30	-0.90	0.47	-0.43	1.72	-1.45	0.61	-0.54	0.00	0.00	0.00	0.00
3- 7	1.68	-1.25	0.47	-0.43	2.22	-1.89	0.61	-0.54	0.00	0.00	0.00	0.00
3- 8	2.06	-1.60	0.47	-0.43	2.72	-2.33	0.61	-0.54	0.00	0.00	0.00	0.00
3- 9	2.44	-1.95	0.47	-0.43	3.23	-2.77	0.61	-0.54	0.00	0.00	0.00	0.00
3-10	2.82	-2.30	0.47	-0.43	3.73	-3.21	0.61	-0.54	0.00	0.00	0.00	0.00
Top												
Member 4: (Bottom Slab)												
Left												
4- 0	0.35	-0.85	0.74	0.00	0.19	-0.70	0.53	0.00	0.00	0.00	0.00	0.00
4- 1	0.85	-0.08	0.57	0.00	1.10	-0.14	0.41	0.00	0.00	0.00	0.00	0.00
4- 2	1.38	0.00	0.40	0.00	1.46	0.00	0.29	0.00	0.00	0.00	0.00	0.00
4- 3	1.69	0.00	0.23	0.00	1.68	0.00	0.17	0.00	0.00	0.00	0.00	0.00
4- 4	1.78	0.00	0.07	0.00	1.73	0.00	0.05	0.00	0.00	0.00	0.00	0.00
4- 5	1.64	0.00	0.00	-0.19	1.64	0.00	0.00	-0.14	0.00	0.00	0.00	0.00
4- 6	1.29	0.00	0.00	-0.37	1.39	0.00	0.00	-0.26	0.00	0.00	0.00	0.00
4- 7	0.71	0.00	0.00	-0.54	0.98	0.00	0.00	-0.38	0.00	0.00	0.00	0.00
4- 8	0.33	-0.46	0.00	-0.71	0.37	-0.60	0.00	-0.50	0.00	0.00	0.00	0.00
4- 9	0.00	-1.38	0.00	-0.89	0.00	-1.29	0.00	-0.62	0.00	0.00	0.00	0.00
4-10	0.00	-2.61	0.00	-1.06	0.00	-2.13	0.00	-0.74	0.00	0.00	0.00	0.00
Right												
Member 5: (Top Slab - Interior Cell)												
Bottom												
5- 0	1.15	-9.07	4.23	-0.40	1.43	-7.72	4.96	-0.51	0.00	0.00	0.00	0.00
5- 1	0.64	-5.70	3.76	-0.40	0.77	-4.46	4.08	-0.51	0.00	0.00	0.00	0.00

5- 2	2.90	-3.14	3.25	-0.40	2.53	-3.80	3.21	-0.51	0.00	0.00	0.00	0.00
5- 3	4.66	-2.43	2.70	-0.52	5.60	-3.15	2.39	-0.51	0.00	0.00	0.00	0.00
5- 4	5.63	-1.92	2.14	-1.04	7.48	-2.50	1.64	-0.51	0.00	0.00	0.00	0.00
5- 5	5.77	-1.41	1.58	-1.58	8.10	-1.84	0.99	-0.99	0.00	0.00	0.00	0.00
5- 6	5.63	-1.92	1.04	-2.14	7.48	-2.50	0.51	-1.64	0.00	0.00	0.00	0.00
5- 7	4.66	-2.43	0.52	-2.70	5.60	-3.15	0.51	-2.39	0.00	0.00	0.00	0.00
5- 8	2.90	-3.14	0.40	-3.25	2.53	-3.80	0.51	-3.21	0.00	0.00	0.00	0.00
5- 9	0.64	-5.70	0.40	-3.76	0.77	-4.46	0.51	-4.08	0.00	0.00	0.00	0.00
5-10	1.15	-9.07	0.40	-4.23	1.43	-7.72	0.51	-4.96	0.00	0.00	0.00	0.00

Top

Member 7: (Bottom Slab - Interior Cell)

Left

7- 0	0.00	-2.44	0.93	0.00	0.00	-2.46	0.71	0.00	0.00	0.00	0.00	0.00
7- 1	0.00	-1.36	0.76	0.00	0.00	-1.62	0.59	0.00	0.00	0.00	0.00	0.00
7- 2	0.11	-0.69	0.59	0.00	0.20	-0.94	0.47	0.00	0.00	0.00	0.00	0.00
7- 3	0.59	-0.29	0.41	0.00	0.69	-0.25	0.35	0.00	0.00	0.00	0.00	0.00
7- 4	0.79	0.00	0.24	0.00	0.92	0.00	0.23	0.00	0.00	0.00	0.00	0.00
7- 5	0.83	0.00	0.09	-0.09	1.00	0.00	0.11	-0.11	0.00	0.00	0.00	0.00
7- 6	0.79	0.00	0.00	-0.24	0.92	0.00	0.00	-0.23	0.00	0.00	0.00	0.00
7- 7	0.59	-0.29	0.00	-0.41	0.69	-0.25	0.00	-0.35	0.00	0.00	0.00	0.00
7- 8	0.11	-0.69	0.00	-0.59	0.20	-0.94	0.00	-0.47	0.00	0.00	0.00	0.00
7- 9	0.00	-1.36	0.00	-0.76	0.00	-1.62	0.00	-0.59	0.00	0.00	0.00	0.00
7-10	0.00	-2.44	0.00	-0.93	0.00	-2.46	0.00	-0.71	0.00	0.00	0.00	0.00

Right

Note: Unfactored live load results computed at 4.75 ft and 0 ft fill depths, per LRFD 3.6.1.2.6

Serviceability Check: Crack Control

Bar Mark	Location	Moment (k-ft)	Thrust (k)	Fss (ksi)	Spacing (in)	Allow (in)
A1	Top Corner Bar	-8.3	9.17	14.72	6.00	28.65
A2	Bot Corner Bar	-5.8	9.17	8.01	6.00	56.49
A100	Top Slab (int)	12.7	2.37	21.63	6.00	20.36
A300	Top Slab (ext)	-18.0	1.19	32.58	6.00	11.96
A200	Bot Slab (int)	6.3	3.03	9.73	6.00	50.33
A400	Bot Slab (ext)	-13.4	1.51	27.55	6.00	14.78
B2	Ext Wall (ext)	-4.0	9.00	3.57	6.00	99.99

Strength Limit State at Critical Sections: Flexure

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
BOT	6.50	-8.28	14.25	22.58	7.69	22.58	1.00	0.62	10.18	8.83	11.44
MID	48.63	1.77	4.08	22.58	7.69	22.58	1.00	0.62	10.18	16.84	21.82
MID-	48.63	-6.24	13.98	22.58	7.69	22.58	1.00	0.62	10.18	5.79	7.51
TOP	6.75	-13.09	14.25	22.58	7.69	22.58	1.00	0.62	10.18	2.24	2.90

Member 2: (Top Slab), Thickness = 13.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-11.18	4.69	33.43	11.19	33.43	1.00	0.62	18.56	4.35	5.64
MID	61.60	26.91	0.69	33.43	11.19	33.43	1.00	0.62	18.56	1.39	1.80
RT	5.00	-28.53	2.07	33.43	11.19	33.43	1.00	0.62	18.56	1.34	1.73

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
BOT	6.50	-2.19	26.25	22.58	7.69	22.58	1.00	0.62	10.18	12.85	16.66
MID	48.63	3.15	13.50	22.58	7.69	22.58	1.00	0.62	10.18	10.06	13.05
TOP	6.75	-4.50	26.25	22.58	7.69	22.58	1.00	0.62	10.18	4.22	5.47

Member 4: (Bottom Slab), Thickness = 13.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-8.04	5.36	28.78	9.69	28.78	1.00	0.62	17.21	11.05	14.32
MID	61.60	15.15	0.85	31.88	10.69	31.88	1.00	0.62	17.21	6.38	8.27
RT	5.00	-19.68	2.24	28.78	9.69	28.78	1.00	0.62	17.21	3.35	4.34

Member 5: (Top Slab - Interior Cell), Thickness = 13.50 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-27.49	1.68	33.43	11.19	33.43	1.00	0.62	18.56	1.43	1.85
MID	77.00	20.43	3.56	33.43	11.19	33.43	1.00	0.62	18.56	1.91	2.47
RT	5.00	-27.49	1.68	33.43	11.19	33.43	1.00	0.62	18.56	1.43	1.85

Member 7: (Bottom Slab - Interior Cell), Thickness = 13.00 in

Loc	Dist. (in)	Design Moment (k-ft)	Corr. A. F. (k)	Mu (k-ft)	ds (in)	Ma (k-ft)	phi	As (in2)	Mcr (k-ft)	Load Ratings IR	OR
LT	5.00	-18.84	1.98	28.78	9.69	28.78	1.00	0.62	17.21	3.60	4.67
MID	77.00	8.89	4.38	31.88	10.69	31.88	1.00	0.62	17.21	13.04	16.91
RT	5.00	-18.84	1.98	28.78	9.69	28.78	1.00	0.62	17.21	3.60	4.67

Notes: Mu - Resisting moment under pure flexure, Ma - Allowable moment under applied axial load

Strength Limit State at Critical Sections: Vertical Shear

Member 1: (Exterior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
BOT	13.70	3.81	-8.3	14.25	7.28	16.09	3.051	33.53	17.87a	0.00	0.00	0.00	11.53	14.95
MID	48.63	0.45	1.8	4.08	7.28	24.14	4.579	28.73	26.82a	0.00	0.00	0.00	64.38	83.46
MID-	48.63	0.45	-6.2	13.98	7.28	20.66	3.919	30.45	22.96a	0.00	0.00	0.00	20.50	26.57
TOP	13.95	-3.79	-13.1	14.25	7.28	13.07	2.479	36.30	14.52a	0.00	0.00	0.00	6.00	7.78

Member 2: (Top Slab), Thickness = 13.50 in

Loc	Dist.	Design Shear	Corr. Moment	Corr. A. F.	Dv	phi*Vn	Beta	Theta	Vc	Vs	Av	Max. Spac	Load Ratings IR	OR

	(in)	(k)	(k-ft)	(k)	(in)	(k)			(k)	(k)	(in2)	(in)		
LT	14.90	11.45	-11.2	4.69	11.19	19.78	n/a	n/a	21.97c	0.00	0.00	0.00	2.24	2.91
MID	77.00	1.19	26.9	0.69	11.19	17.43	n/a	n/a	19.37c	0.00	0.00	0.00	8.59	11.13
RT	14.90	14.22	-28.5	2.07	11.19	18.52	n/a	n/a	20.58c	0.00	0.00	0.00	1.55	2.01

Member 3: (Interior Wall), Thickness = 10.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
BOT	13.70	1.03	-2.2	26.25	7.28	27.23	5.165	27.51	30.26a	0.00	0.00	0.00	25.27	32.75
MID	48.63	1.03	3.2	13.50	7.28	26.57	5.040	27.71	29.53a	0.00	0.00	0.00	24.65	31.96
TOP	13.95	1.00	-4.5	26.25	7.28	26.92	5.106	27.60	29.91a	0.00	0.00	0.00	28.29	36.67

Member 4: (Bottom Slab), Thickness = 13.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	14.36	6.55	-8.0	5.36	9.69	18.80	2.681	37.17	20.89a	0.00	0.00	0.00	11.99	15.54
MID	77.00	0.30	15.1	0.85	10.69	17.58	2.272	40.22	19.54a	0.00	0.00	0.00	NC	NC
RT	14.36	8.78	-19.7	2.24	9.69	15.93	n/a	n/a	17.70c	0.00	0.00	0.00	5.55	7.19

Member 5: (Top Slab - Interior Cell), Thickness = 13.50 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	14.90	12.70	-27.5	1.68	11.19	18.43	n/a	n/a	20.48c	0.00	0.00	0.00	1.80	2.33
MID	77.00	2.77	20.4	3.56	11.19	17.65	n/a	n/a	19.61c	0.00	0.00	0.00	6.37	8.25
RT	14.90	12.70	-27.5	1.68	11.19	18.43	n/a	n/a	20.48c	0.00	0.00	0.00	1.80	2.33

Member 7: (Bottom Slab - Interior Cell), Thickness = 13.00 in

Loc	Dist. (in)	Design Shear (k)	Corr. Moment (k-ft)	Corr. A. F. (k)	Dv (in)	phi*Vn (k)	Beta	Theta	Vc (k)	Vs (k)	Av (in2)	Max. Spac (in)	Load Ratings IR	OR
LT	14.36	7.59	-18.8	1.98	9.69	15.84	n/a	n/a	17.60c	0.00	0.00	0.00	7.12	9.23
MID	77.00	0.19	8.9	4.38	10.69	23.20	2.999	36.11	25.78a	0.00	0.00	0.00	99.99	99.99
RT	14.36	7.59	-18.8	1.98	9.69	15.84	n/a	n/a	17.60c	0.00	0.00	0.00	7.12	9.23

Vc Calculation By: a - Iterative Beta, b - Constant Beta, c - Box Culvert, d - Standard/Arema

Load Combination Results at Tenth Points: (k-ft, k)

M-PT	+Moment	-Moment	+Axial	-Axial	+Shear	-Shear
Member 1: (Exterior Wall)						
Bottom						
1- 0	-5.971	-10.841	5.144	14.249	5.360	0.853
1- 1	-4.006	-7.010	4.076	14.249	4.242	0.446
1- 2	-1.350	-5.289	4.076	13.976	3.179	0.065
1- 3	0.469	-5.119	4.076	13.976	2.172	-0.291
1- 4	1.494	-5.550	4.076	13.976	1.221	-0.622
1- 5	1.771	-6.239	4.076	13.976	0.455	-1.056
1- 6	1.345	-7.165	4.076	13.976	0.175	-1.895
1- 7	0.262	-8.308	4.076	13.976	-0.080	-2.678
1- 8	-1.433	-9.647	4.076	13.976	-0.309	-3.405
1- 9	-2.744	-11.979	5.144	14.249	-0.513	-4.077
1-10	-3.235	-15.594	5.144	14.249	-0.692	-4.693
Top						
Member 2: (Top Slab)						
Left						
2- 0	-3.252	-15.632	0.692	4.693	14.249	4.076
2- 1	4.927	-1.929	0.692	4.693	11.359	3.208
2- 2	15.093	1.717	0.692	3.743	8.529	2.339
2- 3	22.968	4.162	0.692	3.743	5.811	0.611
2- 4	26.908	5.493	0.692	3.743	3.429	-1.647
2- 5	26.895	5.710	0.692	3.743	1.185	-4.014
2- 6	22.928	4.145	0.692	4.693	-0.939	-6.402
2- 7	15.100	-0.289	0.692	4.693	-2.001	-8.742
2- 8	4.125	-6.492	3.311	2.074	-2.870	-11.238
2- 9	-4.564	-18.166	3.743	2.074	-3.738	-14.129
2-10	-9.918	-33.508	3.743	2.074	-4.606	-16.961
Right						
Member 3: (Interior Wall)						
Bottom						
3- 0	3.367	-1.256	13.503	26.252	1.035	-0.995
3- 1	2.721	-0.428	13.503	26.252	1.035	-0.995
3- 2	2.085	0.360	13.503	8.947	1.035	-0.995
3- 3	1.660	0.340	13.503	8.947	1.035	-0.995
3- 4	2.317	-0.214	13.503	26.252	1.035	-0.995
3- 5	3.154	-1.042	13.503	26.252	1.035	-0.995
3- 6	3.992	-1.844	13.503	26.252	1.035	-0.995
3- 7	4.829	-2.647	13.503	26.252	1.035	-0.995
3- 8	5.672	-3.449	13.503	26.252	1.035	-0.995
3- 9	6.515	-4.252	13.503	26.252	1.035	-0.995
3-10	7.358	-5.054	13.503	26.252	1.035	-0.995
Top						
Member 4: (Bottom Slab)						
Left						
4- 0	-5.971	-10.841	0.853	5.360	8.257	4.646
4- 1	2.943	-2.220	0.853	4.928	6.427	3.656
4- 2	9.225	1.837	0.853	4.928	4.599	2.666
4- 3	13.292	4.624	0.853	4.928	2.774	1.677
4- 4	15.148	6.141	0.853	4.928	0.951	0.553
4- 5	14.647	6.387	0.853	4.928	-0.303	-1.312
4- 6	11.967	5.364	0.853	4.928	-1.293	-3.149
4- 7	7.055	3.070	0.853	4.928	-2.282	-4.986
4- 8	-0.151	-1.894	3.978	2.235	-3.272	-6.823
4- 9	-5.328	-11.398	4.928	2.235	-4.262	-8.660
4-10	-11.432	-23.656	4.928	2.235	-5.251	-10.497
Right						
Member 5: (Top Slab - Interior Cell)						
Bottom						
5- 0	-9.717	-31.960	3.767	1.678	15.497	4.341
5- 1	-4.703	-18.182	3.767	1.678	12.607	3.473
5- 2	3.444	-8.733	3.557	1.678	9.777	2.605
5- 3	12.550	-3.210	3.557	1.678	7.459	1.736
5- 4	18.453	0.562	3.557	1.678	5.115	-0.456
5- 5	20.429	2.581	3.557	1.678	2.772	-2.772
5- 6	18.453	0.562	3.557	1.678	0.456	-5.115
5- 7	12.550	-3.210	3.557	1.678	-1.736	-7.459
5- 8	3.444	-8.733	3.557	1.678	-2.605	-9.777
5- 9	-4.703	-18.182	3.767	1.678	-3.473	-12.607
5-10	-9.717	-31.960	3.767	1.678	-4.341	-15.497
Top						
Member 7: (Bottom Slab - Interior Cell)						
Left						

7- 0	-11.032	-22.184	4.903	1.984	9.300	4.949
7- 1	-5.316	-11.869	4.903	1.984	7.463	3.959
7- 2	-0.871	-3.791	4.903	1.984	5.626	2.969
7- 3	4.415	2.280	4.379	1.984	3.789	1.979
7- 4	7.773	4.210	4.379	4.903	1.953	0.990
7- 5	8.892	4.845	4.379	4.903	0.190	-0.190
7- 6	7.773	4.210	4.379	4.903	-0.990	-1.953
7- 7	4.415	2.280	4.379	1.984	-1.979	-3.789
7- 8	-0.871	-3.791	4.903	1.984	-2.969	-5.626
7- 9	-5.316	-11.869	4.903	1.984	-3.959	-7.463
7-10	-11.032	-22.184	4.903	1.984	-4.949	-9.300

Right

Appendix D

LON Calculations

Edition: June 26, 2018

US CUSTOMARY Hints

Givens	
Design Speed (mph)	30
ADT (<=)	1000

LookUps		
Ls	4	Shy Distance
Lr	70	Runout Length
Lc	10	Clear Zone

Approaching Traffic LON *(measured from the right side of vehicle, or ETW)*

Fill Slope	1V:5H to 1V:4H
La (ft)	32
L2 (from ETW right, ft)	2

Lh	10

Lh is the smaller of La or Lc

System Flare?	Yes	On Outside Curve?	No
L1, start system flare	0		
a	13		
of a/b system flare, b=1			

Connect to Structure?	Yes	Use Terminal	TL-2	***OK for <=45 mph***
Length (ft)	0	Length (ft)	37.5	

LON for Parallel Run (no system flare)

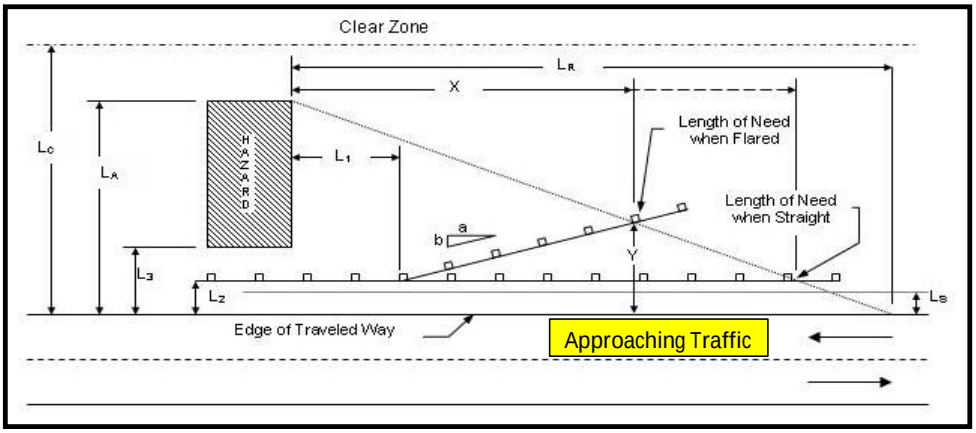
$$X = \frac{Lh - L2}{(Lh/Lr)} = \frac{\quad}{\quad} =$$

LON for Flared Run

$$X = \frac{Lh + (b/a)L1 - L2}{(b/a) + (Lh/Lr)} = \frac{8.00}{0.22} = 36.4$$

$$Y = Lh - X(Lh/Lr) = 4.8$$

See Definitions for more information.



Contract Amount for Approach Guardrail

Transition Length	Terminal Length	Guardrail Length	
0	37.5	Parallel	
		Flared	12.50

Contract Amount for In-between Guardrail

Include length connecting the approach and opposing guardrail installations

Opposing Traffic LON *(measured from the left side of vehicle, or centerline)*

Fill Slope	1V:5H to 1V:4H
La (ft)	46
L2 (from ETW left, ft)	16

Lh	10

Lh is the smaller of La or Lc

System Flare?	Yes	On Outside Curve?	No
L1, start system flare	16		
a	7		
of a/b system flare, b=1			

Connect to Structure?	Yes	Use Terminal	TL-2	***OK for <=45 mph***
Length (ft)	0	Length (ft)	37.5	

LON for Parallel Run (no system flare)

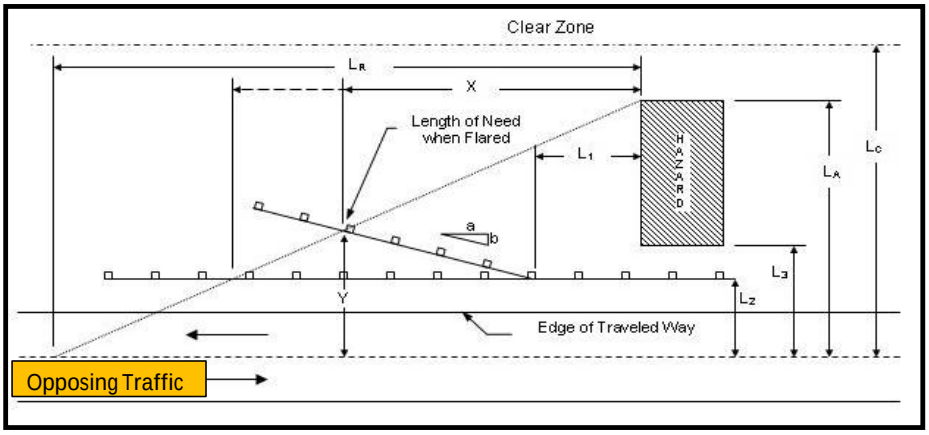
$$X = \frac{Lh - L2}{(Lh/Lr)} = \frac{\quad}{\quad} =$$

LON for Flared Run

$$X = \frac{Lh + (b/a)L1 - L2}{(b/a) + (Lh/Lr)} = \frac{-3.71}{0.29} = -13.0$$

$$Y = Lh - X(Lh/Lr) = 11.9$$

See Definitions for more information.



Contract Amount for Opposing Guardrail

Transition Length	Terminal Length	Guardrail Length	
0	37.5	Parallel	
		Flared	-50.00

Contract Amount for In-between Guardrail

Include length connecting the approach and opposing guardrail installations