4. Embankment Protection

a. The maximum levee slope land side is: _____

b. The maximum levee slope flood side is: _____

c. The range of velocities along the levee during the base flood is: _____ (min.) to _____ (max.)

d. Embankment material is protected by (describe what kind): _____

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:
_____

☐ Overall height: Sta.: _____, height _____ ft.

☐ Limiting foundation soil strength:

Strength ϕ = _____ degrees, c = _____ psf

Slope: SS = _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):
_____

c. Summary of stability analysis results:

E. LEVEE/FLOODWALL (CONTINUED)

5. Embankment And Foundation Stability (continued)

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is _____ hours.

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one): ☐ UBC (1988) ☐ Other (specify): _____

b. Stability analysis submitted provides for: ☐ Overturning ☐ Sliding If not, explain: _____

c. Loading included in the analyses were: ☐ Lateral earth @ P_A = _____ psf; P_p = _____ psf

☐ Surcharge-Slope @ _____, ☐ surface _____ psf

☐ Wind @ P_w = _____ psf

☐ Seepage (Uplift); _____ ☐ Earthquake @ P_{eq} = _____ %g

☐ 1%-annual-chance significant wave height: _____ ft.

☐ 1%-annual-chance significant wave period: _____ sec.

d. Summary of Stability Analysis Results: Factors of Safety.
Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)
Note: (Extend table on an added sheet as needed and reference)

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability (continued)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is _____ ft. to _____ ft.

c. Settlement of the levee crest is determined to be primarily from : ☐ Foundation consolidation ☐ Embankment compression ☐ Other (Describe): _____

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: _____ acres
Draining to ponding area: _____ acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: _____ cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

e. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is _____ cfs

h. The length of levee system used to drive this seepage rate in item g: _____ ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants: _____ For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem

Hydrocompaction ☐ is ☐ is not a problem

Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No

If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why sediment transport was not considered.

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No If the answer is No to any of the above, please attach supporting documentation.

E. LEVEE/FLOODWALL (CONTINUED)

11. Maintenance Plan

Please attach a copy of the fomal maintenance plan for the levee/floodwall

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

CERTIFICATION OF THE LEVEE DOCUMENTION

This certification is to be signed and sealed by a licensed registered professional engineer authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.10(e) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: _____ License No.: _____ Expiration Date: _____

Company Name: _____ Telephone No.: _____ Fax No.: _____

Signature: _____ Date: _____ E-Mail Address: _____

F. SEDIMENT TRANSPORT

Flooding Source: _____

Name of Structure: _____

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume _____ acre-feet

Debris load associated with the base flood discharge: Volume _____ acre-feet

Sediment transport rate _____ (percent concentration by volume)

Method used to estimate sediment transport: _____

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition: _____

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport: _____

Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B. NO. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20598-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program; Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Happy Canyon Creek

Note**:** Fill out one form for each flooding source studied.

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization.....complete Section B
Bridge/Culvert.....complete Section C
Dam.....complete Section D
Levee/Floodwall.....complete Section E
Sediment Transport.....complete Section F (if required)

Description Of Modeled Structure

1. Name of Structure: Belford Avenue Bridge

   Type (check one): ☒ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: _____

   Downstream Limit/Cross Section: 11100

   Upstream Limit/Cross Section: 11180

2. Name of Structure: E-470 Pedestrian Train Crossing

   Type (check one): ☒ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: _____

   Downstream Limit/Cross Section: 10750

   Upstream Limit/Cross Section: 10810

3. Name of Structure: _____

   Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: _____

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

NOTE: FOR MORE STRUCTURES, ATTACH ADDITIONAL PAGES AS NEEDED.

B. CHANNELIZATION

Flooding Source: Happy Canyon Creek

Name of Structure: E-470 Pedestrian Trail Crossing

1. Hydraulic Considerations

The channel was designed to carry _____ (cfs) and/or the _____-year flood.

The design elevation in the channel is based on (check one):

☒ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☒ At Drop Structures ☐ At Transitions

☐ Other locations (specify): _____

2. Channel Design Plans

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Accessory Structures

The channelization includes (check one):

☐ Levees [Attach Section E (Levee/Floodwall)] ☒ Drop structures ☐ Superelevated sections

☒ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator

☐ Weir ☐ Other (Describe):

4. Sediment Transport Considerations

Are the hydraulics of the channel affected by sediment transport? ☐ Yes ☒ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: Happy Canyon Creek

Name of Structure: E-470 Pedestrian Trail Crossing

1. This revision reflects (check one):

☒ Bridge/culvert not modeled in the FIS

☐ Modified bridge/culvert previously modeled in the FIS

☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): HEC-RAS 4.1.0
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

☒ Dimensions (height, width, span, radius, length)
☒ Shape (culverts only)
☒ Material
☐ Beveling or Rounding
☒ Wing Wall Angle
☒ Skew Angle
☐ Distances Between Cross Sections
☐ Erosion Protection
☒ Low Chord Elevations – Upstream and Downstream
☒ Top of Road Elevations – Upstream and Downstream
☒ Structure Invert Elevations – Upstream and Downstream
☒ Stream Invert Elevations – Upstream and Downstream
☐ Cross-Section Locations

4. Sediment Transport Considerations

Are the hydraulics of the structure affected by sediment transport? ☐ Yes ☒ No

If Yes, then fill out Section F (Sediment Transport) of Form 3. If no, then attach an explanation.

D. DAM/BASIN

Flooding Source: _____
Name of Structure: _____

1. This request is for (check one): ☐ Existing dam/basin ☐ New dam/basin ☐ Modification of existing dam/basin

2. The dam/basin was designed by (check one): ☐ Federal agency ☐ State agency ☐ Private organization ☐ Local government agency

   Name of the agency or organization: _____

3. The Dam was permitted as (check one): ☐ Federal Dam ☐ State Dam

   Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

   Permit or ID number _____ Permitting Agency or Organization _____

   a. ☐ Local Government Dam ☐ Private Dam

   Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm? (must account for the maximum volume of runoff)

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why debris/sediment analysis was not considered?

6. Does the Base Flood Elevation behind the dam/basin or downstream of the dam/basin change? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

FREQUENCY (% annual chance)	Stillwater Elevation Behind the Dam/Basin FIS	REVISED
10-year (10%)	_____	_____
50-year (2%)	_____	_____
100-year (1%)	_____	_____
500-year (0.2%)	_____	_____
Normal Pool Elevation	_____	_____

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one): ☐ upgrading of an existing levee/floodwall system ☐ a newly constructed levee/floodwall system ☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc. Station _____ to _____
☐ structural floodwall Station _____ to _____
☐ Other (describe): Station _____ to _____

c. Structural Type (check one): ☐ monolithic cast-in place reinforced concrete ☐ reinforced concrete masonry block ☐ sheet piling ☐ Other (describe): _____

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency? _____

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers: _____
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers: _____
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers: _____
4. A layout detail for the embankment protection measures. Sheet Numbers: _____
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, Floodwall structure, closure structures, and pump stations. Sheet Numbers: _____

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope land side is: _____

b. The maximum levee slope flood side is: _____

c. The range of velocities along the levee during the base flood is: _____ (min.) to _____ (max.)

d. Embankment material is protected by (describe what kind): _____

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:
_____

☐ Overall height: Sta.: _____, height _____ ft.

☐ Limiting foundation soil strength:

Strength ϕ = _____ degrees, c = _____ psf

Slope: SS = _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):
_____

c. Summary of stability analysis results:

E. LEVEE/FLOODWALL (CONTINUED)

5. Embankment And Foundation Stability (continued)

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is _____ hours.

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one): ☐ UBC (1988) ☐ Other (specify): _____

b. Stability analysis submitted provides for: ☐ Overturning ☐ Sliding If not, explain: _____

c. Loading included in the analyses were: ☐ Lateral earth @ P_A = _____ psf; P_p = _____ psf

☐ Surcharge-Slope @ _____, ☐ surface _____ psf

☐ Wind @ P_w = _____ psf

☐ Seepage (Uplift); _____ ☐ Earthquake @ P_{eq} = _____ %g

☐ 1%-annual-chance significant wave height: _____ ft.

☐ 1%-annual-chance significant wave period: _____ sec.

d. Summary of Stability Analysis Results: Factors of Safety.
Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)
Note: (Extend table on an added sheet as needed and reference)

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability (continued)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is _____ ft. to _____ ft.

c. Settlement of the levee crest is determined to be primarily from : ☐ Foundation consolidation ☐ Embankment compression ☐ Other (Describe): _____

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: _____ acres
Draining to ponding area: _____ acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: _____ cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

e. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is _____ cfs

h. The length of levee system used to drive this seepage rate in item g: _____ ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants: _____ For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem

Hydrocompaction ☐ is ☐ is not a problem

Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No

If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why sediment transport was not considered.

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No If the answer is No to any of the above, please attach supporting documentation.

E. LEVEE/FLOODWALL (CONTINUED)

11. Maintenance Plan

Please attach a copy of the fomal maintenance plan for the levee/floodwall

12. Operations and Maintenance Plan

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

CERTIFICATION OF THE LEVEE DOCUMENTION

This certification is to be signed and sealed by a licensed registered professional engineer authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.10(e) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: _____ License No.: _____ Expiration Date: _____

Company Name: _____ Telephone No.: _____ Fax No.: _____

Signature: _____ Date: _____ E-Mail Address: _____

F. SEDIMENT TRANSPORT

Flooding Source: _____

Name of Structure: _____

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume _____ acre-feet

Debris load associated with the base flood discharge: Volume _____ acre-feet

Sediment transport rate _____ (percent concentration by volume)

Method used to estimate sediment transport: _____

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition: _____

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport: _____

Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

SMITH ENVIRONMENTAL & ENGINEERING
Delivering Sustainable Environmental Solutions

RECEIVED
APR 14 2016

U.S. FISH AND WILDLIFE SERVICE
☒ NO CONCERNS
☐ CONCUR NOT LIKELY TO ADVERSELY AFFECT
☐ NO COMMENT
5/9/16
DRUE L. DEBERRY — DATE
ACTING COLORADO FIELD SUPERVISOR

MAIL TRANSMITTAL SHEET

TO: US Fish and Wildlife Service, Colorado Field Office

ATTN: Drue DeBerry

FROM: Darrin Masters, Smith Environmental and Engineering

DATE: April 11, 2016

RE: Happy Canyon Creek Project

Attached please find one copy of the following:

- Habitat Suitability Assessment for the Happy Canyon Creek Improvement Project, Douglas County, Colorado

WWW.SMITHDELIVERS.COM
1490 W. 121ST AVENUE SUITE 101 WESTMINSTER, CO 80234 PHONE: 720.887.4928 FAX: 720.887.4680

SMITH ENVIRONMENTAL AND ENGINEERING
Delivering Smart Solutions for Planning, Permitting, & Design

January 5, 2016

Mr. Drue DeBerry
Colorado State Supervisor
U.S. Fish and Wildlife Service
Colorado Field Office
P.O. Box 25486, DFC (MS65412)
Denver, CO 80225-0486

Re: Habitat Suitability Assessment for Federally Threatened and Endangered Species for the Happy Canyon Creek Improvement Project.

Dear Mr. DeBerry:

This letter presents the results of a habitat suitability assessment (HSA) for federally listed threatened and endangered species (TES) completed by Smith Environmental and Engineering (SMITH) for the Compark development's proposed improvements to Happy Canyon Creek. The purpose of this HSA is to: 1) determine whether the selected species' habitat is currently in the Study Area, and 2) the likelihood of the selected species occurring in the Study Area.

STUDY AREA AND PROJECT DESCRIPTION

The Study Area consists of approximately 7.3 ac located along Happy Canyon Creek in unincorporated Douglas County, Colorado (see Figure 1). The Study Area is located south of E-470 and west of S Chambers Road. The Study Area is located in Sections 6 and 7 of Township 6 South, Range 66 West of the 6th Principal Meridian on the Parker, Colorado, U.S. Geological Survey (USGS) quadrangle. The center of the Study Area is located at 39.553 degrees north, 104.817 degrees west at an elevation of approximately 5,800 ft.

Compark proposes to construct a new bridge and roadway approaches over Happy Canyon Creek as a part of an access road that will connect S. Chambers Road with a future development area to the west. These improvements will also include permanent bank stabilization in and adjacent to Happy Canyon Creek.

EXISTING HABITAT

Happy Canyon Creek is identified on the USGS topographic map as a sand wash within the Study Area, though it is marked as an intermittent stream farther downstream. Historically, the natural course of Happy Canyon Creek led to a confluence with Cherry Creek, but development along the Front Range altered this hydrology. Happy Canyon Creek is a tributary to Cherry Creek, but the connection is now facilitated by means of pipes and culverts. Within the Study Area, the Happy Canyon Creek floodplain is broad, flat and sandy, and some water was flowing at the time of the investigation (see photos in Appendix A).



SMITH ENVIRONMENTAL AND ENGINEERING
1490 W 121st Avenue, Suite 101
Westminster, Colorado 80234
(720) 887-4928, (720) 887-4680 (fax)

HAPPY CANYON CREEK IMPROVEMENTS

0 300 600 Feet

Figure 1
Study Area

Douglas County, Colorado
January 2016

Vegetation along the creek corridor varied significantly in the Study Area. The sharpest contrast occurred between the upstream segment, located near the private residences, and the downstream segment near E-470. The downstream banks were very steep and eroded, and upland grasses were growing up to the edge of the cut. Species observed included smooth brome (*Bromus inermis)*, field brome (*Bromus arvensis)*, sideoats grama (*Bouteloua curtipendula)*, yucca (*Yucca* spp.), common mullein (*Verbascum thapsus)*, sweetclover (*Melilotus officinalis)* and horseweed (*Conyza canadensis).*

Farther upstream, the erosion was less extreme and wetland vegetation was able to establish along the edge of the banks. Species observed in these areas included plains cottonwood (*Populus deltoides)*, sandbar willow (*Salix exigua)*, redtop (*Agrostis gigantea),* common threesquare (*Schoenoplectus pungens)*, arctic rush (*Juncus arcticus)* and Torrey's rush (*Juncus torreyi)*. Species observed on the fringes included Canada thistle (*Cirsium arvense)*, Wood's rose (*Rosa woodsii)*, wild licorice (*Glycyrrhiza lepidota)* and curly dock (*Rumex crispus)*. In one area, the wetland extended inland nearly 50 ft from the edge of the bank. Portions of this area were so wet that cattails (*Typha* spp.) and Nebraska sedge (*Carex nebrascensis)* were thriving.

Soils in the Study Area have been mapped by the Natural Resource Conservation Service (NRCS). The creek drainage consists primarily of loamy alluvial land which is a well-drained soil found in floodplains. The NRCS also maps smaller areas of Newlin gravelly sandy loam and Santana loam. Newlin soils are well drained soils that occur on plateaus, terraces and mesas. Santana loams occur terraces and ridges and are also well drained (NRCS 2015).

HABITAT SUITABILITY ASSESSMENT

Ten TES were investigated for this HSA, because the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) lists them as potentially being impacted by projects occurring the Study Area (USFWS 2015). These species are listed in Table 1 with an explanation of their potential to occur in the Study Area and their potential to be affected by the Project.

Table 1. Habitat Suitability Assessment for Federally Listed Species

Species	Listing Status	Potential for Species to Occur in the Study Area
BIRDS		
Least Tern (*Sterna antillarum)*	FE	Habitat for the tern does not occur in the Study Area., and this Project does not propose to deplete water from the South Platte River or its alluvium. Therefore SMITH believes the proposed Project will have no effect on this species.
Mexican Spotted Owl (*Strix occidentalis lucida)*	FT	The owl is known to occur in Douglas County, and critical habitat has been established approximately 17 miles southwest of the Study Area. However, the Study Area does not provide suitable habitat of old growth forests and rock outcrops in steep canyon areas. SMITH believes there is no potential for the owl to occur in the Study Area, and the proposed Project will have no effect on this species.
Piping Plover (*Charadrius melodus)*	FT	Habitat for the plover does not occur in the Study Area., and this Project does not propose to deplete water from the South Platte River or its alluvium. Therefore SMITH believes the proposed Project will have no effect on this species.

Whooping Crane (*Grus americana*)	FE	Habitat for the crane does not occur in the Study Area., and this Project does not propose to deplete water from the South Platte River or its alluvium. Therefore SMITH believes the proposed Project will have no effect on this species.
FISH		
Greenback cutthroat trout (*Oncorhynchus clarki stomias*)	FT	Happy Canyon Creek is an intermittent stream with a sandy bed that was very shallow at the time of the investigation. It does not provide the necessary habitat conditions to support trout. Also, recent genetic analysis has shown that the only true population of the trout currently survives in Bear Creek west of Colorado Springs (Metcalf et al. 2012). SMITH believes there is no potential for the trout to occur in the Study Area, and the proposed Project will have no effect on this species.
Pallid sturgeon (*Scaphirhynchus albus*)	FE	Habitat for the sturgeon does not occur in the Study Area., and this Project does not propose to deplete water from the South Platte River or its alluvium. Therefore SMITH believes the proposed Project will have no effect on this species.
MAMMALS		
Preble's meadow jumping mouse (*Zapus hudsonius preblei*)	FT	Typical habitat for the Preble's meadow jumping mouse includes well-developed plains riparian vegetation with adjacent, undisturbed grasslands and a nearby water source. The Study Area occurs within the Denver Metropolitan Block Clearance Area for the Preble's meadow jumping mouse (*Zapus hudsonius preblei*) (Urban Drainage and Flood Control District 2010). Therefore SMITH believes the proposed Project will have no effect on this species.
PLANTS		
Colorado butterfly plant (*Gaura neomexicana* var. *coloradensis*)	FT	The Colorado butterfly plant is known to occur in subirrigated, alluvial soils with mesic moisture regimes in early- to mid-successional plant communities. The Study Area does provide these habitat conditions along Happy Canyon Creek; the banks are not steeply eroded in most areas and there are areas where the canopy is open. Although the plant has been historically documented in Douglas County, it is now believed that those occurrences have been extirpated (Colorado Natural Heritage Program 1997+). Although the plant could potentially thrive in the Study Area, the proposed Project will not alter the character of the existing habitat. Furthermore, SMITH believes that this species does not occur in Douglas County, and therefore the proposed Project will have no effect on this species.
Ute ladies'-tresses orchid (*Spiranthes diluvialis*)	FT	The Ute ladies'-tresses orchid (ULTO) is known to occur in seasonally moist soils and wet meadows between 4,500 and 6,500 ft. The orchid thrives in areas that do not experience high flow events, and Happy Canyon Creek is subject to seasonal flooding. Furthermore, there are currently no known current or historically documented populations in Douglas County (Colorado Natural Heritage Program 1997+). SMITH believes that there is no potential for the orchid to occur in the Study Area, and the proposed Project will have no effect on this species.
Western prairie fringed orchid	FT	Habitat for the orchid does not occur in the Study Area., and this Project does not propose to deplete water from the South Platte River or

(*Platanthera praeclara*)		its alluvium. Therefore SMITH believes the proposed Project will have no effect on this species.

FT = Federally Threatened; FE = Federally Endangered

CONCLUSIONS

SMITH concludes that the proposed Project should have no effect on any federally listed threatened or endangered species. SMITH requests concurrence on these opinions from the USFWS on behalf of the Project sponsor.

REFERENCES

Colorado Natural Heritage Program. 1997+. Colorado Rare Plant Guide. Available at: www.cnhp.colostate.edu. Latest update: June 30, 2014.

Metcalf, J. L., Love Stowell, S., Kennedy, C. M., Rogers, K. B., McDonald, D., Epp, J., Keepers, K., Cooper, A., Austin, J. J. and Martin, A. P. 2012. Historical stocking data and 19th century DNA reveal human-induced changes to native diversity and distribution of cutthroat trout. Molecular Ecology 21:21, pp. 5194-5207.

NRCS. 2015. United States Department of Agriculture, Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed November 17, 2015.

Urban Drainage and Flood Control District. 2010. Preble's Meadow Jumping Mouse, Ute-ladies' Tresses Orchid and Colorado Butterfly Plant Block Clearances for the Denver Metropolitan Area – Revised 2010. Denver, Colorado.

USFWS. 2015. IPaC - Information, Planning and Conservation System. Available online at: http://ecos.fws.gov/ipac/. Accessed November 17, 2015.

PERSONNEL

Rebecca Hannon, Environmental Scientist II of SMITH investigated this site.

SMITH requests concurrence on the opinions in this assessment from USFWS on behalf of the project sponsor. If you have any questions about this assessment, please call me at (303) 551-7980.

Sincerely,
Smith Environmental and Engineering



Darrin Masters, Certified Wildlife Biologist®
Senior Environmental Scientist

cc: Russell Burrows, Manhard Consulting, Ltd.

APPENDIX A - PHOTOS OF THE STUDY AREA



Photo1. A portion of Happy Canyon Creek where wetlands are supported, especially on the far bank. The shallow water that was flowing is also visible.



Photo 2. View of wetland vegetation that has established in the floodplain bench along Happy Canyon Creek. Willows occur above an understory of common threesquare, rushes and wetland grasses.



Photo 3. View looking south at wet area that extends inland from Happy Canyon Creek. Cattails and sedges are growing in the wettest areas.



Photo4. View of the upstream segment of Happy Canyon Creek near the private residences. The cut bank and the sandy soils are precluding the establishment of wetland vegetation.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 SOUTH WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

November 13, 2017

SUBJECT: Nationwide Permit Verification – Corps File No. NWO-2017-01897-DEN, Compark South Project, Douglas County, Colorado

Michael Vickers
Belford South Metropolitan District
8390 East Crescent Parkway, Suite 500
Greenwood Village, CO 80111

Dear Mr. Vickers:

This letter is in reference to the proposed project located at approximately 39.553041°N, -104.821996°W, in Douglas County, Colorado. The work as described in your submittal will consist of constructing a road bridge crossing over Happy Canyon Creek, replacing an existing pedestrian bridge over Happy Canyon Creek, and installing three buried channel stabilization structures in Happy Canyon Creek, all in direct support of a residential development. This project will cause temporary impacts to 0.486 acre of Happy Canyon Creek and to 0.1657 acre of adjacent wetlands, and will cause permanent impacts to 0.049 acre of Happy Canyon Creek.

Based on the information provided, this office has determined that the work is authorized by the **Department of the Army Nationwide Permit (NWP) 29, Residential Developments**, found in the January 6, 2017, Federal Register. Enclosed is a fact sheet, which fully describes this Nationwide Permit and lists the General Conditions, and Colorado Regional Conditions, which must be adhered to for this authorization to remain valid. In addition, the following Special Conditions must be followed:

1. In order for this Nationwide Permit verification to be valid, 0.1657 acre of wetland shall be restored where impacted.
2. The created wetlands will be considered successful and self-sustaining when the following conditions have been met without intervention in the form of irrigation, removal of undesirable vegetation or replanting of desirable vegetation for a period of two consecutive years, as determined by the Corps of Engineers:
    a) At least 80 % (determined by ocular estimate of herbaceous and shrub foliar cover) of the mitigation site is vegetated, with at least 50% of the total number of dominant species present will consist of species rated as facultative or wetter.
    b) Those species shown on the Colorado Noxious Weed Inventory list-A shall be 100% eradicated. Those species shown on list-B shall be no more than 5% or less of the total cover in the mitigation area. The lists can be found at http://www.colorado.gov/cs/Satellite/ag_Conservation/CBON/1251618874438

3. A mitigation monitoring report documenting growing season conditions shall be sent to the Denver Regulatory Office prior to December 31st of each year, for a period of at least three years, or until the Corps of Engineers determines that the 0.1657 acre of wetlands has successfully developed.

4. Annual reports shall be formatted per the attached Annual Mitigation Monitoring Report Formatting Requirements. If the authorized work has not yet started, please state so in the annual mitigation monitoring report.

Although an Individual Department of the Army permit will not be required for this work, this does not eliminate the requirement that any other applicable federal, state, tribal or local permits be obtained as required. Please be advised that deviations from the original plans and specifications of this project could require additional authorization from this office.

The applicant is responsible for all work accomplished in accordance with the terms and conditions of the nationwide permit. If a contractor or other authorized representative will be accomplishing the work authorized by the nationwide permit on behalf of the applicant, it is strongly recommended that they be provided a copy of this letter and the enclosed conditions so that they are aware of the limitations of the applicable nationwide permit. Any activity which fails to comply with all the terms and conditions of the nationwide permit will be considered unauthorized and subject to appropriate enforcement action.

This verification will be valid until March 18, 2022. In compliance with General Condition 30, the enclosed "Certification of Completed Work" form (blue) must be signed and returned to this office upon completion of the authorized work and any required mitigation.

If there are any questions please feel free to contact Angelle Greer at (303) 979-4120 or by e-mail at Angelle.V.Greer@usace.army.mil, and reference **Corps File No. NWO-2017-01897-DEN**.

Sincerely,

Aaron Eilers
Chief, Denver Regulatory Office

Enclosure(s)
Nationwide Permit 29, Residential Developments
Certification of Completed Work
Annual Mitigation Monitoring Report Format Requirements

Copies Furnished:
Esa Crumb, ERO Resources Corporation, 1842 Clarkson Street, Denver, CO/80218

November 30, 2017

470 Compark LLC
C/O MPV Compark Management LLC 290
Fillmore St. STE 2
Denver, CO. 80206

Re: Notification of proposed changes to the FEMA Flood Insurance Rate Map (FIRM) and proposed changes to the floodway for Happy Canyon Creek associated with the Belford Avenue Bridge and Happy Canyon Creek Project.

Notice for Property: No Address, Parcel #: 2233-064-00-012

To Whom It May Concern,

The Flood Insurance Rate Map (FIRM) for a community depicts the Special Flood Hazard Area (SFHA), the area which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The floodway is the portion of the floodplain that includes the channel of a river or other watercourse and the adjacent land area that must be reserved in order to discharge the 1% annual chance (base) flood without cumulatively increasing the water-surface elevation by more than a designated height. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

Belford South Metropolitan District is applying for a Conditional Letter of Map Revision (CLOMR) from the Federal Emergency Management Agency (FEMA) to revise FIRM's 08035C0062G and 08035C0066G for the Town of Parker, Douglas County, Colorado. Manhard Consulting Ltd is proposing a new bridge structure over Happy Canyon Creek that will connect Belford Avenue from S. Peoria St. to the west to S. Chambers Road to the east. The Belford Ave. bridge structure will be built in phases. The first phase includes the eastbound roadway lanes, sidewalk and southern half of the bridge structure. A future phase will include the westbound lanes, sidewalk and remaining north half of the bridge structure.

The proposed project will result in increases in the 1% annual chance (base) water-surface elevations for a portion of Happy Canyon Creek, when comparing existing conditions to proposed conditions. A rise does occur on your property.

Once the project has been completed, a Letter of Map Revision (LOMR) request should be submitted that will, in part, revise the following flood hazards along Happy Canyon Creek.

1. The floodway will be revised from downstream (north) of E-470 to north of Filbert Avenue along Happy Canyon Creek.
2. Base Flood Elevations (BFEs) will both increase and decrease along Happy Canyon Creek. On your property, the BFEs will both increase and decrease.
3. The SFHA will both increase and decrease along Happy Canyon Creek. On your property, the SFHA will both increase about 0.8 feet and decrease about 1.4 feet.

This letter is to inform you of the proposed project that may affect flood elevations on your property at Parcel #: 2233-064-00-012 located in Douglas County, Colorado. This letter is also to inform you of the potential changes to the effective flood hazard information that would result after the project is completed and a LOMR request is submitted to FEMA.

Maps and detailed analysis of the proposed flood hazard revisions can be reviewed at the Town of Parker at 20120 E. Mainstreet, Parker, CO 80138. If you have any questions or concerns about the proposed project or its effect on your property, you may contact Mr. Rick Moore at either 303-708-

0500 or by email at rick.moore@manhard.com or Mr. Jacob James at the Town of Parker at 303-840-9546.

Sincerely,

Michael Vickers
Belford South Metropolitan District
8390 East Crescent Parkway, Suite 500
Greenwood Village, CO 80111

November 30, 2017

Compark 190 LLC
Attn: Steve Gruenler
4600 S. Ulster St. STE 1400
Denver, CO. 80237

Re: Notification of proposed changes to the FEMA Flood Insurance Rate Map (FIRM) and proposed changes to the floodway for Happy Canyon Creek associated with the Belford Avenue Bridge and Happy Canyon Creek Project.

Notice for Property: No Address, Parcel #: 2233-053-00-001

To Whom It May Concern,

The Flood Insurance Rate Map (FIRM) for a community depicts the Special Flood Hazard Area (SFHA), the area which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The floodway is the portion of the floodplain that includes the channel of a river or other watercourse and the adjacent land area that must be reserved in order to discharge the 1% annual chance (base) flood without cumulatively increasing the water-surface elevation by more than a designated height. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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0500 or by email at rick.moore@manhard.com or Mr. Jacob James at the Town of Parker at 303-840-9546.

Sincerely,

Michael Vickers
Belford South Metropolitan District
8390 East Crescent Parkway, Suite 500
Greenwood Village, CO 80111

November 30, 2017

E470 Public Highway Authority
22470 E. 6th Pkwy STE 100
Aurora, CO. 80018

Re: Notification of proposed changes to the FEMA Flood Insurance Rate Map (FIRM) and proposed changes to the floodway for Happy Canyon Creek associated with the Belford Avenue Bridge and Happy Canyon Creek Project.

Notice for Property: No Address, Parcel #: 2233-064-99-002

To Whom It May Concern,

The Flood Insurance Rate Map (FIRM) for a community depicts the Special Flood Hazard Area (SFHA), the area which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The floodway is the portion of the floodplain that includes the channel of a river or other watercourse and the adjacent land area that must be reserved in order to discharge the 1% annual chance (base) flood without cumulatively increasing the water-surface elevation by more than a designated height. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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3. The SFHA will both increase and decrease along Happy Canyon Creek. On your property, the SFHA will increase about 0.5 feet.

This letter is to inform you of the proposed project that may affect flood elevations on your property at Parcel #: 2233-064-99-002 located in Douglas County, Colorado. This letter is also to inform you of the potential changes to the effective flood hazard information that would result after the project is completed and a LOMR request is submitted to FEMA.

Maps and detailed analysis of the proposed flood hazard revisions can be reviewed at the Town of Parker at 20120 E. Mainstreet, Parker, CO 80138. If you have any questions or concerns about the proposed project or its effect on your property, you may contact Mr. Rick Moore at either 303-708-

0500 or by email at rick.moore@manhard.com or Mr. Jacob James at the Town of Parker at 303-840-9546.

Sincerely,

Michael Vickers
Belford South Metropolitan District
8390 East Crescent Parkway, Suite 500
Greenwood Village, CO 80111

November 30, 2017

Platte Valley Commercial Corp.
4900 Main St.
Kansas City, MO. 64112

Re: Notification of proposed changes to the FEMA Flood Insurance Rate Map (FIRM) and proposed changes to the floodway for Happy Canyon Creek associated with the Belford Avenue Bridge and Happy Canyon Creek Project.

Notice for Property: No Address, Parcel #: 2233-050-00-009

To Whom It May Concern,

The Flood Insurance Rate Map (FIRM) for a community depicts the Special Flood Hazard Area (SFHA), the area which has been determined to be subject to a 1% (100-year) or greater chance of flooding in any given year. The floodway is the portion of the floodplain that includes the channel of a river or other watercourse and the adjacent land area that must be reserved in order to discharge the 1% annual chance (base) flood without cumulatively increasing the water-surface elevation by more than a designated height. The FIRM is used to determine flood insurance rates and to help the community with floodplain management.

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This letter is to inform you of the proposed project that may affect flood elevations on your property at Parcel #: 2233-050-00-009 located in Douglas County, Colorado. This letter is also to inform you of the potential changes to the effective flood hazard information that would result after the project is completed and a LOMR request is submitted to FEMA.

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0500 or by email at rick.moore@manhard.com or Mr. Jacob James at the Town of Parker at 303-840-9546.

Sincerely,

Michael Vickers
Belford South Metropolitan District
8390 East Crescent Parkway, Suite 500
Greenwood Village, CO 80111

UDFCD DLOMC Submittal - BFE Comparison Table

Project Name :	**115360-01 Compark/Belford Avenue**
Flooding Source:	**Happy Canyon Creek**
Company:	**Felsburg Holt & Ullevig**
Completed By:	**ZJG**

SOURCE DATA											COMPARISONS				
HYDRAULIC CROSS-SECTION INFO.						BASE FLOOD ELEVATIONS (NAVD)									
Effective Cross-Section ID (Letter)	Corrected Effective Cross-Section ID	Corrected Effective Stream Station	Existing Cross-Section ID	Proposed Cross-Section ID	Proposed Stream Station	EFFECTIVE	DUP. EFF.	COR. EFF.	EXISTING	PROPOSED	DUP. EFF vs. EFF.	COR. EFF. vs. EFF.	EX. vs. COR. EFF.	PP. vs. COR. EFF.	PP. vs. EFF.
						BFE	BFE	BFE	BFE	BFE	BFE	BFE	BFE	BFE	BFE
10111	10111	10111	-	10111	10111	5767.4	5767.4	5767.4	-	5767.4	0.0	0.0	-	0.0	0.0
10157	10157	10157	-	10157	10157	5767.9	5767.9	5767.7	-	5767.7	0.0	-0.2	-	0.0	-0.2
10326	10326	10326	-	10326	10326	5768.5	5768.5	5769.3	-	5769.3	0.0	0.8	-	0.0	0.8
10548	10548	10548	-	10548	10548	5770.5	5770.5	5772.5	-	5772.5	0.0	2.0	-	0.0	2.0
10595	10595	10597	-	10595	10597	5771.3	5771.3	5772.1	-	5772.1	0.0	0.8	-	0.0	0.8
10679	10679	10691	-	10679	10691	5772.1	5772.1	5772.5	-	5772.5	0.0	0.4	-	0.0	0.4
-	10725	10735	-	10725	10735	-	-	5775.0	-	5775.5	-	-	-	0.5	-
10749	-	-	-	-	-	5774.9	5774.9	-	-	-	0.0	-	-	-	-
-	-	-	-	10750	10764	-	-	-	-	5775.9	-	-	-	-	-
-	10775	10786	-	-	-	-	-	5775.7	-	-	-	-	-	-	-
-	-	-	-	10810	10823	-	-	-	-	5776.1	-	-	-	-	-
-	-	-	-	10819	10833	-	-	-	-	5776.1	-	-	-	-	-
-	-	-	-	10825	10838	-	-	-	-	5776.1	-	-	-	-	-
10842	10842	10856	-	-	-	5775.0	5775.0	5775.4	-	-	0.0	0.5	-	-	-
-	10900	10922	-	10900	10915	-	-	5775.7	-	5776.0	-	-	-	0.3	-
10974	10974	10995	-	10974	10989	5774.9	5774.9	5775.5	-	5775.9	0.0	0.6	-	0.5	1.0
-	11100	11050	-	11100	11043	-	-	5775.4	-	5776.1	-	-	-	0.7	-
11153	11153	11187	-	-	-	5774.8	5774.8	5775.7	-	-	0.0	0.9	-	-	-
-	11180	11230	-	11180	11215	-	-	5775.5	-	5776.4	-	-	-	0.8	-
-	11280	11321	-	11280	11312	-	-	5776.1	-	5776.4	-	-	-	0.4	-
-	11370	11424	-	11370	11411	-	-	5776.7	-	5776.4	-	-	-	-0.3	-
-	11385	11440	-	11385	11426	-	-	5776.8	-	5776.4	-	-	-	-0.4	-
-	11400	11458	-	11400	11441	-	-	5777.0	-	5776.5	-	-	-	-0.5	-
-	11410	11465	-	11410	11447	-	-	5777.0	-	5776.5	-	-	-	-0.5	-
11494	11494	11544	-	11494	11526	5776.8	5776.8	5778.6	-	5777.1	0.0	1.7	-	-1.4	0.3
11620	11620	11680	-	11620	11662	5779.4	5779.4	5779.9	-	5779.7	0.0	0.6	-	-0.3	0.3
11772	11772	11836	-	-	-	5779.4	5779.4	5779.9	-	-	0.0	0.5	-	-	-
-	-	-	-	11800	11818	-	-	-	-	5779.8	-	-	-	-	-
-	-	-	-	11830	11979	-	-	-	-	5779.7	-	-	-	-	-
-	-	-	-	11835	12011	-	-	-	-	5779.7	-	-	-	-	-
11959	11959	12030	-	11959	12017	5780.1	5780.1	5781.0	-	5781.0	0.0	0.9	-	0.0	0.9
12129	12129	12213	-	12129	12194	5781.6	5781.6	5782.9	-	5782.9	0.0	1.3	-	0.0	1.3
12388	12388	12478	-	12388	12460	5782.8	5782.8	5783.4	-	5783.4	0.0	0.6	-	0.0	0.5
-	12400	12490	-	12400	12471	-	-	5784.0	-	5784.1	-	-	-	0.0	-
-	12430	12520	-	12430	12501	-	-	5784.8	-	5784.8	-	-	-	0.0	-
-	12436	12526	-	12436	12507	-	-	5784.8	-	5784.8	-	-	-	0.0	-
12541	12541	12631	-	12541	12613	5784.7	5784.7	5785.4	-	5785.4	0.0	0.7	-	0.0	0.7
12694	12694	12777	-	12694	12759	5784.6	5784.6	5785.3	-	5785.3	0.0	0.6	-	0.0	0.6

-- = Not applicable or no direct comparison available

In anticipation, the FHAD Model was taken to be Effective in this comparison. Flows used were the 100-yr Future Flows (Q=8355 cfs @ E-470)

UDFCD LOMC AGREEMENT TABLE

PROJECT NAME: 115360-01 Compark/Belford Avenue

COMPANY: Felsburg Holt & Ullevig

COMPLETED BY: ZJG

Community(ies): Town of Parker & Douglas County, CO

Flooding Source(s): Happy Canyon Creek

Date: 11/30/2017

Reference Location	Stream Station	Cross Section #	Channel Distance (ft)			Cumulative Channel Distance (ft)			Base Floodplain Width (ft)			Floodway Width (ft)			Comments
			Model	Map	% Difference	Model	Map	% Difference	Model	Map	Difference (ft)	Model	Map	Difference (ft)	
		10111	0	0	#DIV/0!	0	0	#DIV/0!	444	448	4	399	397	2	*
		10157	45	45	0%	45	45	0%	239	241	2	186	182	4	*
D/S XS - E-470 Bridge		10326	169	169	0%	214	214	0%	94	94	0	94	94	0	*
U/S XS - E-470 Bridge		10548	223	223	0%	437	437	0%	129	129	0	129	129	0	*
		10595	46	48	4%	484	486	0%	121	140	19	121	140	19	*
		10679	94	94	0%	578	580	0%	104	110	6	104	110	6	*
		10725	43	44	2%	620	623	1%	185	185	0	185	185	0	*
D/S XS - E-470 Trail Crossing		10750	29	29	0%	650	653	1%	219	221	1	219	221	1	*
U/S XS - E-470 Trail Crossing		10810	59	59	0%	708	711	0%	285	284	1	285	284	1	*
		10819	9	10	*14%*	717	722	1%	292	291	0	292	291	0	*
		10825	6	5	*11%*	723	727	1%	295	291	4	295	291	4	*
		10900	77	76	1%	800	803	0%	245	250	5	245	250	5	*
		10974	74	74	0%	874	877	0%	205	211	7	205	211	7	*
D/S XS - Belford Avenue		11100	54	54	0%	928	931	0%	168	168	0	168	168	0	*
U/S XS - Belford Avenue		11180	168	169	0%	1097	1100	0%	179	183	4	179	183	4	*
		11280	87	86	1%	1183	1186	0%	186	187	1	186	187	1	*
		11370	66	66	0%	1249	1252	0%	184	192	8	184	192	8	*
		11385	15	15	0%	1264	1267	0%	171	172	1	171	172	1	*
		11400	15	15	0%	1279	1282	0%	163	162	2	163	162	2	*
		11410	6	6	0%	1285	1288	0%	159	159	0	159	159	0	*
		11494	128	129	0%	1414	1417	0%	128	124	3	128	124	3	*
		11620	136	136	0%	1550	1552	0%	236	240	4	236	240	4	*
		11800	179	179	0%	1729	1732	0%	200	200	0	200	200	0	*
		11830	30	35	*14%*	1759	1767	0%	203	207	4	203	207	4	*
		11835	6	6	0%	1765	1773	0%	202	210	7	202	210	7	*
		11959	130	130	0%	1895	1903	0%	209	209	0	209	209	0	*
		12129	182	182	0%	2077	2085	0%	294	298	4	294	298	4	*
		12388	264	266	1%	2341	2351	0%	245	244	1	245	244	1	*
		12400	11	11	0%	2352	2362	0%	263	261	1	263	261	1	*
		12430	30	30	0%	2382	2392	0%	299	298	1	299	298	1	*
		12436	6	6	0%	2388	2398	0%	308	307	1	308	307	1	*
		12541	105	105	0%	2493	2504	0%	498	498	1	498	498	1	*
		12694	153	146	4%	2646	2650	0%	424	424	0	424	424	0	*
ACCEPTABLE TOLERANCES =			**+/- 5% of Model**			**+/- 5% of Model**			**+/- 25 Feet**						

* - Floodway = Floodplain

FELSBURG HOLT & ULLEVIG

Job Title Happy Canyon Creek By ZJG Date 6/13/17 Job No. 115360-01

Subject Bridge Scour Checked Sheet 1 of

Vratio

$V_{shear} / V_{fall} = V_* / w$

$V_{shear} = V_* = (g\, y_1\, S_1)^{1/2}$ (32.16 = g; y_1 = upstream depth (ft); S_1 = E.G.L. slope (ft/ft))

$V_{*100} = (32.16 * 8.49 * 0.002589)^{1/2} = 0.84$

$V_{*500} = (32.16 * 11.45 * 0.00166)^{1/2} = 0.78$

d50 size = 0.005 ft (1.5 mm)

$V_{fall} = w = 0.7$

$V_{ratio_{100}} = V_{*100} / w = 0.84 / 0.7 = 1.2$

$V_{ratio_{500}} = V_{*500} / w = 0.78 / 0.7 = 1.11$

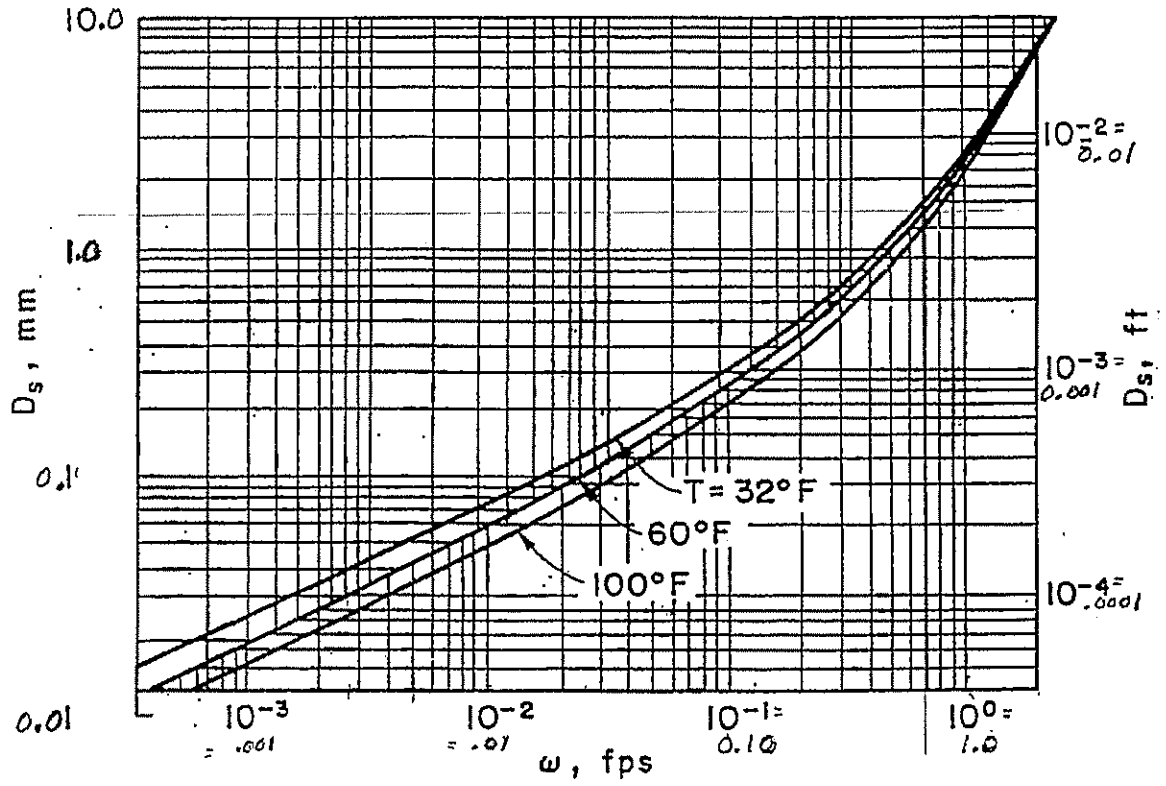


Figure 3. Fall Velocity of Sand-Sized Particles.

REV. 7-26-00

FELSBURG HOLT & ULLEVIG

Job Title | By | Date | Job No.

Subject Bridge Scour | Checked | Sheet 2 of

Determine if Contraction Scour is live bed or clear water

V_c = Critical Velocity, y_1 = Upstream flow depth

$$V_c = 11.17\ y_1^{1/6} D_{50}^{1/3}$$

$$V_{c100} = 11.17 \times \underline{8.49}^{1/6} \times \underline{0.005}^{1/3} = \underline{2.73}$$

V_{100} main channel = 8.21 ∴ Live Bed Scour

If $V_{c100} \leq V_{100\,MC}$ then Live Bed Scour
If $V_{c100} > V_{100\,MC}$ then Clear Water

$$V_{c500} = 11.17 \times \underline{11.45}^{1/6} \times \underline{0.005}^{1/3} = \underline{2.87}$$

$V_{500\,MC}$ = 8.24 ∴ Live Bed Scour

REV 7-26-00

FELSBURG HOLT & ULLEVIG

Job Title | By | Date | Job No.

Subject *Bridge Scour* | Checked | Sheet 3 of

CLEAR WATER SCOUR

$$Y_s = \left[\frac{Q^2}{120\, D_M^{2/3} W^2}\right]^{3/7} - Y_1$$

Y_s = Avg. Scour Depth

Q = Q bridge

Y_1 = depth of flow in channel

D_M = 1.25 D_{50} = 1.25 * ____ = ____

W = bottom width of bridge less piers (low chord)

DOES NOT APPLY

$$Y_{s_{100}} = \left[\frac{\quad^2}{120 * __^{2/3} * __^2}\right]^{3/7} - ____ = ____ \text{ ft}$$

$$Y_{s_{500}} = \left[\frac{\quad^2}{120 * __^{2/3} * __^2}\right]^{3/7} - ____ = ____ \text{ ft.}$$

LIVE BED SCOUR

$$Y_2 = \left(\frac{Q_2}{Q_1}\right)^{6/7} * \left(\frac{W_1}{W_2}\right)^{K_1} * (Y_1)$$

Q_2 = Flow in cont. main channel which is often Q_{Total}

Q_1 = Flow in approach main channel that transports sediment

W_1 = Avg. bottom width of the main channel at approach cross section

W_2 = Avg. bottom width of the contracted section.

Y_1 = Avg. depth in upstream main channel

V^*/w	K_1
< 0.5	0.59
0.5 - 2.0	0.64
> 2.0	0.69

$$Y_{2(100)} = \left(\frac{8303}{8027}\right)^{0.857} * \left(\frac{160}{145}\right)^{0.64} * 8.49 = 9.31 \qquad Y_s = Y_2 - Y_1 = 9.31 - 8.49 = 0.82'$$

$$Y_{2(500)} = \left(\frac{12024}{10913}\right)^{0.857} * \left(\frac{160}{145}\right)^{0.64} * 11.45 = 13.25 \qquad Y_s = Y_2 - Y_1 = 13.25 - 11.45 = 1.8'$$

Contraction Scour

100 YR = 0.82'

500 YR = 1.8'

REV 7-26-00

FELSBURG HOLT & ULLEVIG

Job Title | By | Date | Job No.

Subject *Bridge Scour* | Checked | Sheet 4 of

Clear Water OR Live-Bed Scour at Abutments

$$y_s = y_a \left[2.27\, K_1\, K_2 \left(\frac{a'}{y_a} \right)^{0.43} Fr^{0.61} + 1 \right]$$

- y_a: Avg depth in floodplain
- a': (To ineffective flow boundary) length of Abutment projected normal to flow
- Fr: #approach Froude No.
- K_1: Abutment coefficient
- K_2: Coefficient of abutment angle, $K_2 = (\theta/90)^{0.13}$

Vert. wall abut.	$K = 1.00$
" " " with wing walls	$K = 0.82$
Spill through abut.	$K = 0.55$

$K_2 = (\theta/90)^{0.13}$

$K_2 = (90/90)^{0.13} = 1.0$

LEFT ABUTMENT

$$y_{s\,100} = 4.91 \left[2.27 * \frac{1.0}{} * 1.0 * \left(\frac{14}{4.91} \right)^{0.43} * \frac{0.7}{}^{0.61} + 1 \right]$$

$= 18.98$

$$y_{s\,500} = 6.79 \left[2.27 * \frac{1.0}{} * 1.0 * \left(\frac{14}{6.79} \right)^{0.43} * \frac{0.49}{}^{0.61} + 1 \right]$$

$= 20.41$

RIGHT ABUTMENT

$$y_{s\,100} = 4.91 \left[2.27 * \frac{1.0}{} * 1.0 * \left(\frac{12}{4.91} \right)^{0.43} * \frac{0.7}{}^{0.61} + 1 \right]$$

$= 18.08$

$$y_{s\,500} = 6.79 \left[2.27 * \frac{1.0}{} * 1.0 * \left(\frac{12}{6.79} \right)^{0.43} * \frac{0.49}{}^{0.61} + 1 \right]$$

$= 19.53$

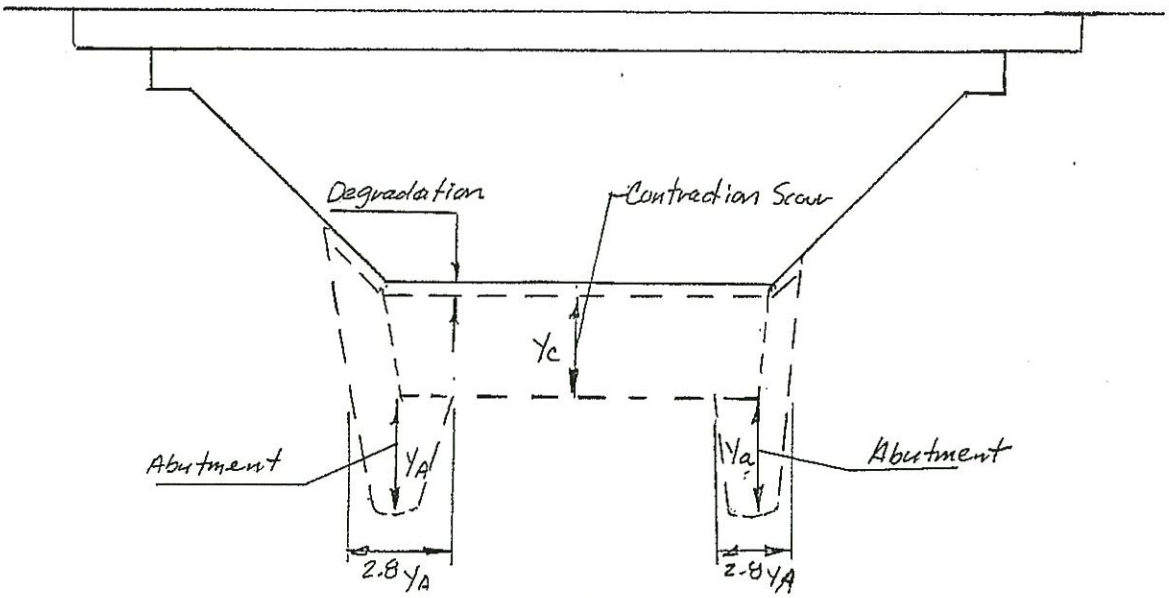
Note:

Per HEC-18, Section 3.3.3, since abutment scour lacks field verification, riprap protection at the abutments makes it unnecessary to design abutments to resist the computed abutment scour depth. Also per HEC-18 Section 4.5.9 "Discussion of Abutment Scour Computations", it is stated that if properly vegetated in the overbanks, channel banks and areas adjacent to the abutment, scour depths as predicted with the Froehlich equation will probably not occur.

FELSBURG HOLT & ULLEVIG

Job Title | By | Date | Job No.

Subject *Bridge Scour* | Checked | Sheet 5 of



	100-YEAR			500-YEAR		
	LEFT	CHAN.	RT.	LEFT	CH.	RT.
Degradation	0	2.0	0	0	2.0	0
Contraction	0.82	0.82	0.82	1.8	1.8	1.8
Abutment	18.98	—	18.08	20.41	—	19.53
Total	19.8	2.82	18.9	22.21	3.8	21.33
Pier						

Local Scour at Pier

	100 YR	500-yr	
V =	10.3 fps	10.1 fps	= Velocity upstream of the pier
Y_1 =	8.1 ft	11.25 ft.	= Depth of flow upstream of pier

0	= Angle of attack of the flow
3.5 ft	= Pier width
21 ft	= Pier Length (3.5 x6)
1.0	= k_1 Circular
1.0	= k_2
1.1	= k_3

F_{100} = 0.63 F_{500} = 0.53 = Froude

$$Y_s = \alpha \; 2.0 \; K_1 \; K_2 \; K_3 \left(\frac{Y_1}{\alpha}\right)^{0.35} Fr^{0.43}$$

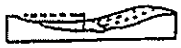
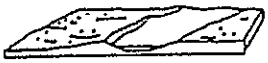
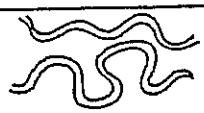
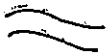
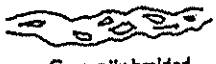
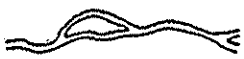
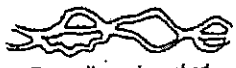
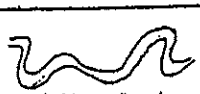
(α: Pier width; K_1: Pier Shape; K_2: Angle of Attack; K_3: Bed Condition; Y_1: Flow depth at pier; α: Pier width; Fr: Froude No. $V_1 / (gY_1)^{0.5}$)

$$Ys_{100} = 3.5 * 2.0 * 1.0 * 1.0 * 1.1 * \left(\frac{8.1}{3.5}\right)^{0.35} * 0.63^{0.43}$$

$$= 8.47 \text{ ft.}$$

$$Ys_{500} = 3.5 * 2.0 * 1.0 * 1.0 * 1.1 * \left(\frac{11.25}{3.5}\right)^{0.35} * 0.53^{0.43}$$

$$= 8.82 \text{ ft.}$$

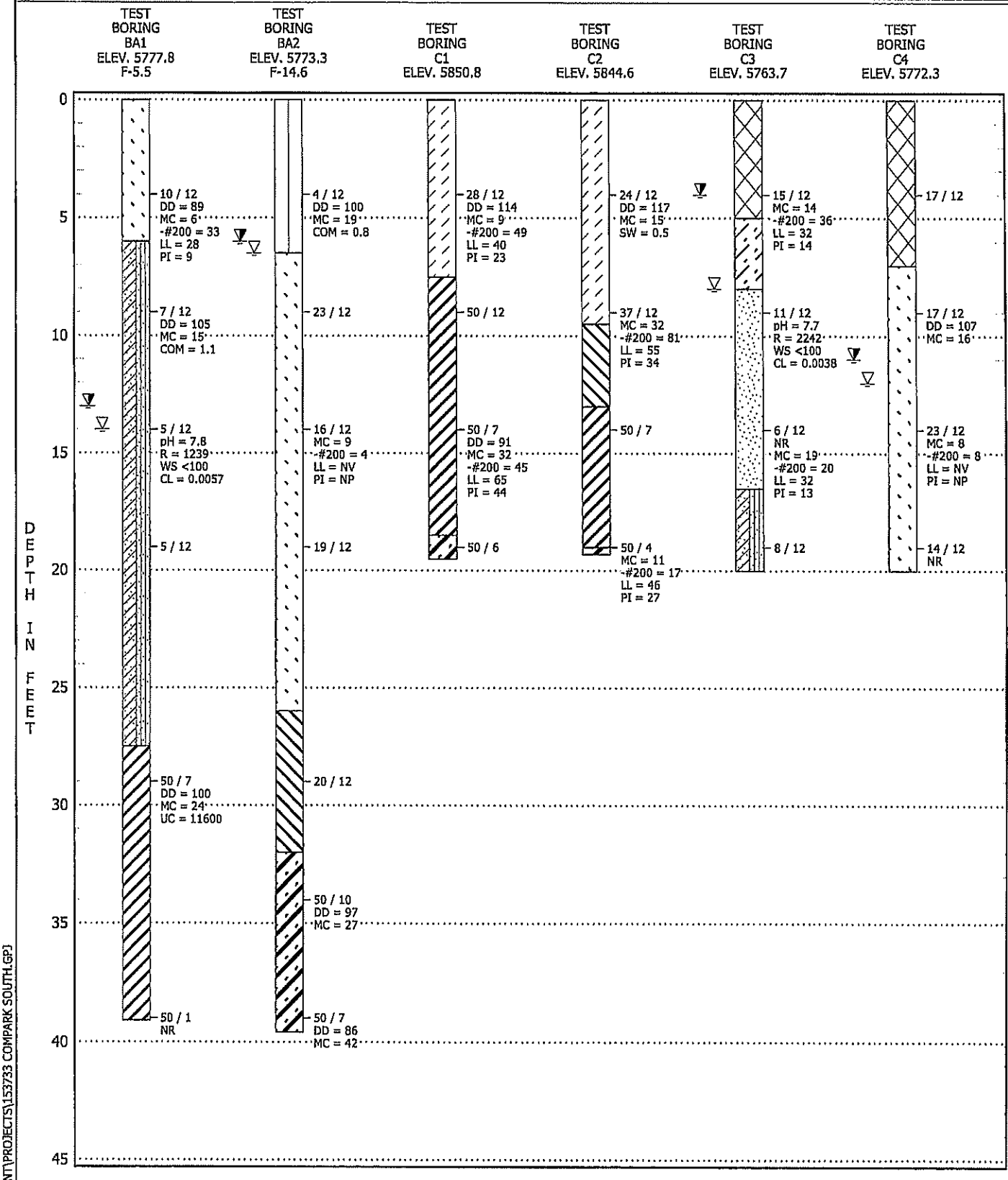
STREAM SIZE (SECT. 2.2.1)	Small (<100 ft. or 30 m wide)		Medium (100-500 ft. or 30- 150 m)		Wide (>500 ft. or 150 m)
FLOW HABIT (SECT. 2.2.2)	Ephemeral	(Intermittent)	Perennial but flashy		Perennial
BED MATERIAL (SECT. 2.2.3)	Silt-clay	Silt	Sand	Gravel	Cobble or boulder
VALLEY SETTING (SECT. 2.2.4)	 No valley; alluvial fan		 Low relief valley (<100 ft. or 30 m deep)	 Moderate relief (100-1000 ft. or 30-300 m)	 High relief (>1000 ft. or 300 m)
FLOOD PLAINS (SECT. 2.2.5)	 Little or none (<2X channel width)		 Narrow (2-10 channel width)		 Wide (>10X channel width)
NATURAL LEVEES (SECT. 2.2.6)	 Little or None		 Mainly on Concave		 Well Developed on Both Banks
APPARENT INCISION (SECT. 2.2.7)	 Not Incised			 Probably Incised	
CHANNEL BOUNDARIES (SECT.. 2.2.8)	 Alluvial		 Semi-alluvial		 Non-alluvial
TREE COVER ON BANKS (SECT. 2.2.8)	<50 percent of bankline		50-90 percent		>90 percent
SINUOSITY (SECT. 2.2.9)	 Straight Sinuosity 1-1.05)	 Sinuous (1.06-1.25)	 Meandering (1.25-2.0)		 Highly meandering (>2)
BRAIDED STREAMS (SECT. 2.2.10)	 Not braided (<5 percent)		 Locally braided (5-35 percent)		 Generally braided (>35 percent)
ANABRANCHED STREAMS (SECT. 2.2.11)	 Not anabranched (<5 percent)		 Locally anabranched (5-35 percent)		 Generally anabranched (>35 percent)
VARIABILITY OF WIDTH AND DEVELOPMENT OF BARS (SECT. 2.2.12)	 Equal width		 Wider at bends		 Random variation
	 Narrow point bars		 Wide point bars		 Irregular point and lateral bars

GEOMORPHIC FACTORS THAT AFFECT STREAM STABILITY

A.G. Wassenaar, Inc.
Geotechnical and Environmental Consultants

CLIENT 470 Compark, LLC c/o MPV Compark Management, LLC **PROJECT NAME** Compark Village South

PROJECT NUMBER 153733 **PROJECT LOCATION** Parker, Douglas County, Colorado



SEE FIGURE 7 FOR LEGEND AND NOTES TO TEST BORINGS

TEST BORING LOGS

FIGURE 2

3/16/16 - U:\GINT\PROJECTS\153733 COMPARK SOUTH.GPJ

Job Title	Compark South	By	CDT	Date	24-Jul-17	Job No.	115360-01
	Belford Ave. @ Happy Canyon Creek						
Subject	GSB Calculations		Checked		Sheet 1 of 2		

1. Estimate Mannings n For Flows over GSB

When upper **1/2** (+/- 1") of the rock depth (height) is left ungrouted: *UDFCD Volume 2 Equation 9-1*

$$n_{18"\text{-}42"(1/2)} = \frac{0.097 * (y/D)^{0.16}}{ln(2.55\ Y/D)}$$

Upper limit: n <= 0.15 for above equation

$$n_{18"\text{-}42"(1/2)} = \frac{0.097 * \quad ^{0.16}}{ln(2.55\ \quad)} = \frac{0.000}{\#NUM!} = \#NUM!$$

When upper **1/3** (+/- 1") of the rock depth (height) is left ungrouted: *UDFCD Volume 2 Equation 9-2*

$$n_{18"\text{-}42"(2/3)} = \frac{0.086 * (y/D)^{0.16}}{ln(2.55\ y/D)}$$

Low-flow n

y= 3
d= 1.5
2

$$n_{18"\text{-}42"(2/3)} = \frac{0.086 * 2.0^{0.16}}{ln(2.55 * 3.0 / 1.5)} = \frac{0.096}{1.629} = 0.059$$

High-flow n

y= 7.76
d= 1.5
5.1733

$$n_{18"\text{-}42"(2/3)} = \frac{0.086 * 5.2^{0.16}}{ln(2.55 * 7.8 / 1.5)} = \frac{0.114}{2.985} = 0.038$$

Upper limit: n <= 0.12 for above equation

y = depth of flow above top of rock, in feet

D = diameter of the boulder, in feet

Outside the low-flow section

UDFCD Volume 2 Equation 9-7

$$R_p = \frac{V_c * S^{0.17}}{(S_s - 1)^{0.66}}$$

$$R_p = \frac{14.00 * 0.0075^{0.17}}{(2.55 - 1)^{0.66}} = \frac{6.09}{1.34} = 4.56$$

See Table 9-4 below

Use 18" (B18) grouted boulders for protection outside of the low-flow section.

Within the low-flow section

UDFCD Volume 2 Equation 9-7

$$R_p = \frac{V_c * S^{0.17}}{(S_s - 1)^{0.66}}$$

$$R_p = \frac{9.03 * 0.100^{0.17}}{(2.55 - 1)^{0.66}} = \frac{6.11}{1.34} = 4.57$$

See Table 9-4 below

Use 18" (B18) grouted boulders for protection within the low-flow section.

V_c = Critical Velocity

S = longitudinal slope along direction of flow in ft/ft

S_s = Specific gravity of rock - assume 2.55

(For drops of 6-feet or less in height, use UD-Channels Spreadsheet to find the 100-year critical velocities in the low-flow and the main channels to size boulders for each section)

Note: This project will use B24 boulders grouted 2/3 of the height. UDFCD recommends a minimum of B24 size due to maintenance concerns.

Table 9-4. Boulder sizes for various rock sizing parameters

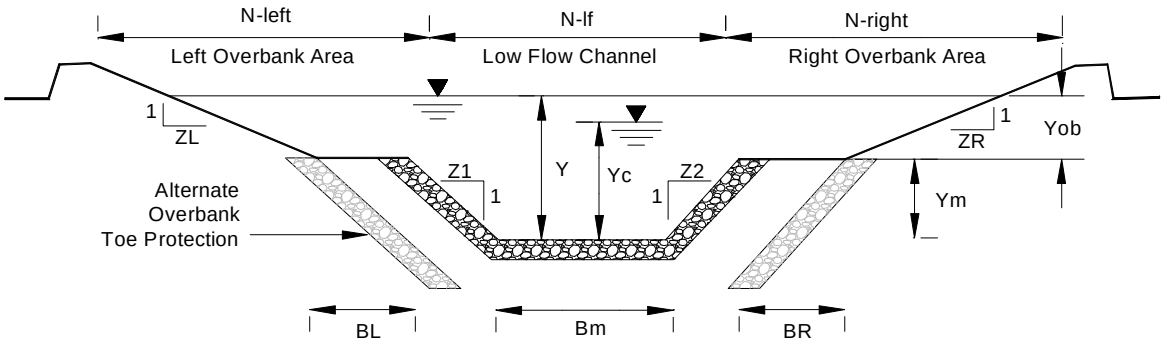
Rock Sizing Parameter, R_p	Grouted Boulders [1]
	Boulder Classification [2]
Less than 4.50	B18
4.50 to 4.99	B18
5.00 to 5.59	B24
5.60 to 6.99	B36
7.00 to 8.00	B48

[1] Grouted to no less than 1/3 the height (+1"/- 0"), no more than 1/2 (+0"/- 1") of boulder height.
[2] See *Open Channels* chapter.

Capacity Analysis of Composite Channel

Project: Happy Canyon Creek @ Belford Avenue - Drops

Channel ID: High & Low-Flow at 0.75% Slope



Design Information (Input)

Channel Invert Slope	So =	0.00750 ft/ft	Left Overbank Bottom Width	BL =	75.00 ft
			Left Overbank Side Slope	ZL =	0.03 ft/ft
Low Flow Channel Bottom Width	Bm =	15.00 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	20.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	2.50 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0590	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0380			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**3.00 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**4.85 ft**

Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	39.0 ft	Top width	Tm =	39.0 ft
Flow area	Alf =	81.0 sq ft	Flow area	Am =	270.2 sq ft
Wetted perimeter	Plf =	39.7 ft	Wetted perimeter	Pm =	39.7 ft
Discharge (Calculated)	**Qlf =**	**284.8 cfs**	**Discharge**	**Qm =**	**3,292.1 cfs**
Velocity	**Vlf=**	**3.5 fps**	**Velocity**	**Vm =**	**12.2 fps**
Froude number	**Fr-lf =**	**0.43**	**Froude number**	**Frm =**	**0.82**
Qd Critical Velocity	Vlfc =	6.74 fps	100-Yr. Critical Velocity	Vmc =	14.0 fps
Qd Critical Depth	Ylfc =	1.88 ft	100-Yr. Critical Depth	Ymc =	7.0 ft

Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	75.1 ft	Top width	TR =	32.1 ft
Flow area	AL =	364.0600 sq ft	Flow area	AR =	126.4000 sq ft
Wetted perimeter	PL =	79.8500 ft	Wetted perimeter	PR =	33.0600 ft
Discharge	**QL =**	**3,690.5 cfs**	**Discharge**	**QR =**	**1,139.5 cfs**
Velocity	**VL =**	**10.1 fps**	**Velocity**	**VR =**	**9.0 fps**
Froude number	**FrL =**	**0.81**	**Froude number**	**FrR =**	**0.80**
100-Yr. Critical Velocity	VLc =	11.7 fps	100-Yr. Critical Velocity	VRc =	10.6 fps
100-Yr. Critical Depth in Overbanks	YLc =	4.2 ft	100-Yr. Critical Depth in Overbanks	YRc =	4.2 ft

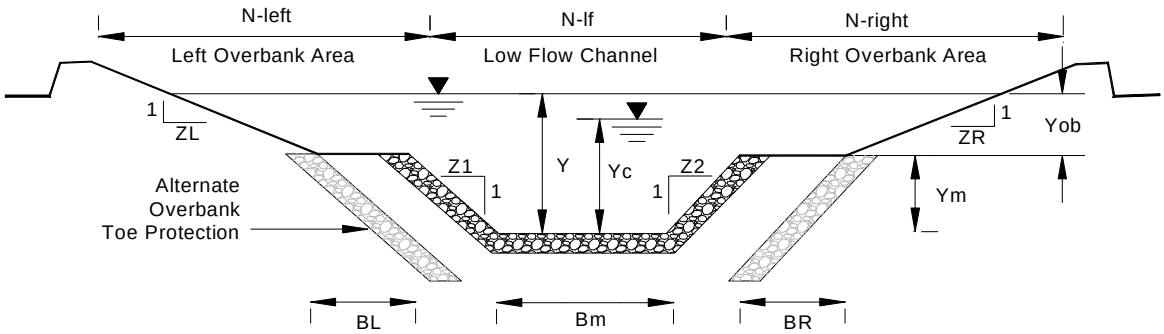
Composite Cross-Section Flow Condition for Q100

Top width	**T =**	**146.3 ft**	**Discharge**	**Q =**	**8,122.1 cfs**
Channel Depth Y	**Y =**	**7.85 ft**	**Velocity**	**V =**	**10.7 fps**
Flow area	A =	760.6 sq ft	**Froude number**	**Fr =**	**0.83**
Wetted perimeter	P =	152.7 ft	100-Yr. Critical Velocity	Vc =	12.2 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0353	100-Yr. Critical Depth in Overbanks	Yc =	4.20 ft

Capacity Analysis of Composite Channel

Project: Happy Canyon Creek @ Belford Avenue Drops

Channel ID: Low-Flow at 10:1



Design Information (Input)					
Channel Invert Slope	So =	0.10000 ft/ft	Left Overbank Bottom Width	BL =	75.00 ft
			Left Overbank Side Slope	ZL =	0.03 ft/ft
Low Flow Channel Bottom Width	Bm =	15.00 ft	Left Overbank Manning's n	n-left =	0.0350
Low Flow Channel Left Side Slope	Z1 =	4.00 ft/ft	Right Overbank Bottom Width	BR =	20.00 ft
Low Flow Channel Right Side Slope	Z2 =	4.00 ft/ft	Right Overbank Side Slope	ZR =	2.50 ft/ft
Low Flow Channel Manning's Nn for Qd	n-lf =	0.0590	Right Overbank Manning's n	n-right =	0.0350
Low Flow Channel Manning's Nn for Q100	n-m-Q100 =	0.0380			
(See USDCM Vol. II, n vs. Depth Graph)					
Low Flow Channel Bank-full depth	**Ym =**	**3.00 ft**	**Overbank Flow Depth Yob (Y - Ym)**	**Yob =**	**4.85 ft**

Low Flow Channel Condition for Qd			**Low Flow Channel Flow Condition for Q100**		
Top width	Tlf =	39.0 ft	Top width	Tm =	39.0 ft
Flow area	Alf =	81.0 sq ft	Flow area	Am =	270.2 sq ft
Wetted perimeter	Plf =	39.7 ft	Wetted perimeter	Pm =	39.7 ft
Discharge (Calculated)	**Qlf =**	**1,039.9 cfs**	**Discharge**	**Qm =**	**12,020.9 cfs**
Velocity	**Vlf=**	**12.8 fps**	**Velocity**	**Vm =**	**44.5 fps**
Froude number	**Fr-lf =**	**1.57**	**Froude number**	**Frm =**	**2.98**
Qd Critical Velocity	Vlfc =	9.03 fps	100-Yr. Critical Velocity	Vmc =	16.2 fps
Qd Critical Depth	Ylfc =	3.81 ft	100-Yr. Critical Depth	Ymc =	7.9 ft
Left Overbank Flow Condition for Q100			**Right Overbank Flow Condition for Q100**		
Top width	TL =	75.2 ft	Top width	TR =	32.1 ft
Flow area	AL =	364.1000 sq ft	Flow area	AR =	126.4000 sq ft
Wetted perimeter	PL =	79.8500 ft	Wetted perimeter	PR =	33.0600 ft
Discharge	**QL =**	**13,478.3 cfs**	**Discharge**	**QR =**	**4,160.9 cfs**
Velocity	**VL =**	**37.0 fps**	**Velocity**	**VR =**	**32.9 fps**
Froude number	**FrL =**	**2.96**	**Froude number**	**FrR =**	**2.92**
100-Yr. Critical Velocity	VLc =	17.9 fps	100-Yr. Critical Velocity	VRc =	14.6 fps
100-Yr. Critical Depth in Overbanks	YLc =	10.0 ft	100-Yr. Critical Depth in Overbanks	YRc =	9.1 ft

Composite Cross-Section Flow Condition for Q100

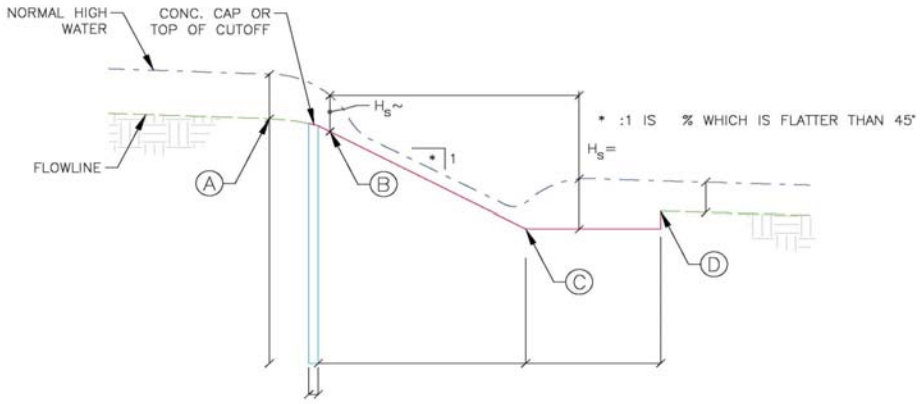
Top width	**T =**	**146.3 ft**	**Discharge**	**Q =**	**29,660.0 cfs**
Channel Depth Y	**Y =**	**7.85 ft**	**Velocity**	**V =**	**39.0 fps**
Flow area	A =	760.7 sq ft	**Froude number**	**Fr =**	**3.01**
Wetted perimeter	P =	152.7 ft	100-Yr. Critical Velocity	Vc =	18.4 fps
Cross-Sectional Manning's n (Calculated)	n =	0.0353	100-Yr. Critical Depth in Overbanks	Yc =	8.07 ft

Job Title	Compark South	By	CDT	Date	24-Jul-17	Job No.	115360-01
	Belford Ave. @ Happy Canyon Creek						
Subject	Seepage Control		Checked		Sheet	1 of	1

1. Lane's Weighed Creep Method

$$Cw = \frac{\left(\frac{L_H}{3} + L_v\right)}{Hs}$$

UDFCD Volume 2 Equation 9-5



From (A) to (B) L_H = 8.0 L_v = 0 + 0.25 = 0.25 '

Hs ~ 0.25 (Change in water surface elevation between A & B)

$$Cw = \frac{\left(\frac{8.0}{3} + 0.3\right)}{0.3} = 11.7$$ 11.7 > 6.0 OK

From (A) to (C) L_H = 38.0 L_v = 3 + 0.25 = 3.25 '

Hs = 1.06 (Change in water surface elevation between A & C)

$$Cw = \frac{\left(\frac{38.0}{3} + 3.3\right)}{1.1} = 15.0$$ 15.0 > 6.0 OK

L_H = *Horizontal creep distance*
Lv = Vertical creep distance
C_w = *Creep ratio*
H_s = *Differential head between analysis points (ft)*

Table 9-3. Lane's weighted creep: Recommended minimum ratios

Material	Ratio
Very fine sand or silt	8.5
Fine sand	7.0
Medium sand	6.0
Coarse sand	5.0
Fine gravel	4.0
Medium gravel	3.0
Coarse gravel including cobbles	3.0
Boulders with some cobbles and gravel	3.0
Soft clay	3.0
Medium clay	2.0
Hard clay	1.8
Very hard clay or hardpan	1.6

Notes: Soil samples at the site located along Happy Canyon Creek provided by A.G. Wassenaar Inc. indicates coarse to mediam lenses of clay/sand interbedded poorly graded sand with gravel, well-graded sand with silt and gravel material. Free groundwater was encountered at the time of drilling (March 2016) ranging in depths of 2 feet near the proposed ped. box culvert and 4 feet to 8 feet along the channel.

Average LWC Ratio per UDFCD Table 9-3 to the right is: 6.0

REVETMENT RIPRAP DESIGN
SIZING

Project: Belford @ HCC | By: CDT | I:\115360-01 - Compark at Belford\CADD\Hydraulics\Calculations\
Project No. 115360-01 | Date: 7/24/2017 | Happy Canyon Creek\Bridge Hydraulics

$d_{30} = y(s_f*C_s*C_v*C_t)[(V_{des}/(K_1(S_g-1)*g*y]^{2.5}$

d_{30}=Riprap particle size for which 30% is finer by weight , ft (adapted from USACE Engineering Manual No. 1110-2-1601, 1991)

y=	8.4	Local depth of flow above particle, ft
S_f=	1.2	Safety factor
C_s=	0.3	Stability coefficient (for blanket thickness=d100 or 1.5d50 whichever is greater, and uniformity ratio
		Stability coefficient (for blanket thickness=d100 or 1.5d50 whichever is greater, and uniformity ratio d85/d15 = 1.7 to 5.2) Use 0.30 for angular rock and 0.375 for rounded rock
C_v=	1.35	Velocity distribution coefficient
		use 1.0 for straight channels or the inside of bends
		use 1.283-0.2log(Rc/W) for the outside of bends (1 for Rc/W>26)= 1.35
		Rc= 130 Centerline radius of curvature of Channel bend, ft
		W= 294 Width of water surface at upstream end of channel bend, ft
		Rc/W= 0.442177
		use 1.25 downstream from concrete channels
		use 1.25 at the end of dikes
C_t=	1	Blanket thickness coefficient given as a function of the uniformity ratio d85/d15
		use 1.0 recommended because it is based on very limited data
V_{des}=	10.26	Characteristic velocity for design, defined as the depth-averaged velocity at a point
		20% upslope from the toe of the revetment, ft/s
	V_{des}= 10.26	For natural channels use $V_{des}=V_{avg}(1.74-0.52 \log(Rc/W)$
	V_{des}= 10.59	For trapezoidal channels use $V_{des}=V_{avg}(1.71-0.78 \log(Rc/W)$
V_{avg}=	5.33	Channel cross sectional average velocity, ft/s
K_1=	1.00	Side slope correctional factor
		$k_1=(1-((\sin 14°)$ H:1= 4
		θ= 14.0 0.24 = radians
		K_1= 1.00
S_g=	2.65	Specific gravity of riprap (usually taken at 2.65)
g=	32.2	Acceleration of gravity, 32.2 ft/s

d_{30}=	**0.67**	**Particle size for which 30% is finer by weight , ft**
d_{50}=	**0.81**	**$d_{50}=1.2d_{30}$, ft**
RIPRAP d_{50} SIZE=	**9.7**	**inches**
$t=1.5d_{50}$=	**14.5**	**Riprap Thickness, inches**

Use Soil Riprap (12 inch) (2'-0" thick)
@ 120+25 to 122+25 RT.

Reference: Lagasse, et. al., NCHRP Report 568, Riprap Design Criteria, Recommended Specifications, and Quality Control, 2006

REVETMENT RIPRAP DESIGN
SIZING

Project: Belford @ HCC | By: CDT | I:\115360-01 - Compark at Belford\CADD\Hydraulics\Calculations\
Project No. 115360-01 | Date: 7/24/2017 | Happy Canyon Creek\Bridge Hydraulics

$d_{30} = y(s_f*C_s*C_v*C_t)[(V_{des}/(K_1(S_g-1)*g*y]^{2.5}$

d_{30}=Riprap particle size for which 30% is finer by weight , ft (adapted from USACE Engineering Manual No. 1110-2-1601, 1991)

y=	7.35	Local depth of flow above particle, ft
S_f=	1.2	Safety factor
C_s=	0.3	Stability coefficient (for blanket thickness=d100 or 1.5d50 whichever is greater, and uniformity ratio
		Stability coefficient (for blanket thickness=d100 or 1.5d50 whichever is greater, and uniformity ratio d85/d15 = 1.7 to 5.2) Use 0.30 for angular rock and 0.375 for rounded rock
C_v=	1.24	Velocity distribution coefficient
		use 1.0 for straight channels or the inside of bends
		use 1.283-0.2log(Rc/W) for the outside of bends (1 for Rc/W>26)= 1.26
		Rc= 308 Centerline radius of curvature of Channel bend, ft
		W= 236 Width of water surface at upstream end of channel bend, ft
		Rc/W= 1.305085
		use 1.25 downstream from concrete channels
		use 1.25 at the end of dikes
C_t=	1	Blanket thickness coefficient given as a function of the uniformity ratio d85/d15
		use 1.0 recommended because it is based on very limited data
V_{des}=	10.80	Characteristic velocity for design, defined as the depth-averaged velocity at a point
		20% upslope from the toe of the revetment, ft/s
	V_{des}= 10.80	For natural channels use $V_{des}=V_{avg}(1.74-0.52 \log(Rc/W)$
	V_{des}= 10.42	For trapezoidal channels use $V_{des}=V_{avg}(1.71-0.78 \log(Rc/W)$
V_{avg}=	6.43	Channel cross sectional average velocity, ft/s
K_1=	1.00	Side slope correctional factor; H:1= 4
		$k_1=(1-((\sin 14°)$; θ= 14.0 0.24 = radians
		K_1= 1.00
S_g=	2.65	Specific gravity of riprap (usually taken at 2.65)
g=	32.2	Acceleration of gravity, 32.2 ft/s

d_{30}=	**0.72**	**Particle size for which 30% is finer by weight , ft**
d_{50}=	**0.87**	**$d_{50}=1.2d_{30}$, ft**
RIPRAP d_{50} SIZE=	**10.4**	**inches**
$t=1.5d_{50}$=	**15.6**	**Riprap Thickness, inches**

Use Soil Riprap (12 inch) (2'-0" thick)
@ 116+25 to 118+75 RT.

Reference: Lagasse, et. al., NCHRP Report 568, Riprap Design Criteria, Recommended Specifications, and Quality Control, 2006

REVETMENT RIPRAP DESIGN
SIZING USING UDFCD CRITERIA

Project:	Belford @ HCC	By: CDT	I:\115360-01 - Compark at Belford\CADD\Hydraulics\Calculations\
Project No.	115360-01	Date: 7/24/2017	Happy Canyon Creek\Bridge Hydraulics

d_{50} >/= ((V*S^0.17)/(4.5)*(Gs-1)^0.66)^2

V=	14.58	Velocity, ft/s	*(Worst case velocity at Drop 2.)*
S=	0.0075	Longitudinal Slope, ft/ft	
G_s=	2.65	Specific gravity of riprap (usually taken at 2.65)	
d_{50}=	**1.03**	**ft**	
RIPRAP d_{50} SIZE=	**12.3**	**inches**	
t=1.75d50=	**21.6**	**Riprap Thickness, inches**	

Riprap for Approach to Drop Structres
Soil Riprap (12 Inch) (2'-0" thick)

Reference: UDFCD Manual, Volume 1, Section 8.1.1 Equation 8-11

RIPRAP AT BRIDGE ABUTMENTS AND GUIDE BANKS
SIZING

Project: Belford @ HCC By: CDT I:\115360-01 - Compark at Belford\CADD\Hydraulics\Calculations\
Project No. 115360-01 Date: 7/24/2017 Happy Canyon Creek\Bridge Hydraulics

$d_{50} = Y*K/(S_g-1)*(V^2/gy)$ for Froude numbers less than 0.80

$d_{50} = Y*K/(S_g-1)*(V^2/gy)^{0.14}$ for Froude numbers greater than 0.80

d_{50}=Median stone diamenter, ft (adapted from FHWA's HEC23, Legasse et al, 2001)

SBR= Set Back Ratio = Dist. From main channel/Flow depth in main channel

	Left Abutment	Right Abutment	
D=	114	37	Distance from main channel
Y_{ch}=	8.33	8.33	Flow depth in main channel
SBR=	13.7	4.4	Set Back Ratio
Q=	5317	1203	If SBR is >5, then $V=Q_{overbank}/A_{overbank}$ (Overbank flow only)
A=	762	198	If SBR is <5, then $V=Q_{total}/A_{total}$ (Entire bridge opening)
$V_{char.}$=	7.0	7.2	

Q_{total}=8303 cfs

A_{total}=1150 (sq ft)

V=	7.56	7.66	Characteristic average velocity in the contracted section, ft/s
S_g=	2.65	2.65	Specific gravity of riprap (usually taken at 2.65)
g=	32.2	32.2	Acceleration of gravity, 32.2 ft/s
y=	8.24	8.24	Depth of flow in the contracted bridge opening, ft
K=	1.02	1.02	For Froude <0.80 use K=0.89 for spill through and 1.02 for vertical wall abutments
			For Froude >0.80 use K=0.61 for spill through and 0.69 for vertical wall abutments
F=	0.46	0.47	Froude number, $(V/(gy)^{0.5}$

d_{50}=	1.10	1.13	Median stone diamenter, ft for Froude number less than 0.80
d_{50}=	4.11	4.12	Median stone diamenter, ft for Froude number greater than 0.80

	Left Abutment	Right Abutment	
d_{50}=	**1.10**	**1.13**	Median stone diamenter, ft
RIPRAP d_{50} SIZE=	**13.2**	**13.5**	**inches**
$t=1.5d_{50}$	**19.8**	**20.3**	**Riprap Thickness, inches**

Riprap for Bridge Abutments
Soil Riprap (18 Inch) (3'-0" thick)
& Riprap (18 Inch) (3'-0" thick)

Reference: Lagasse, et. al., NCHRP Report 568, Riprap Design Criteria, Recommended Specifications, and Quality Control, 2006

RIPRAP AT BRIDGE PIERS
SIZING

Project: Belford @ HCC By: CDT I:\115360-01 - Compark at Belford\CADD\Hydraulics\Calculations\
Project No. 115360-01 Date: 7/24/2017 Happy Canyon Creek\Bridge Hydraulics

$d_{50} = 0.692(V_{des})^2/(S_g-1)*2*g$

d_{50}=Riprap particle size for which 50% is finer by weight, ft (adapted from FHWA's HEC23, Legasse et al, 2001)

K_1=	1.5	Shape factor equal to 1.5 for round-nose pier, 1.7 for square-faced piers, ft/s
K_2=	0.9	Velocity adjustment factor or location in the channel
		0.9 for a pier near a bank in a straight reach
		1.7 for a pier located in the main current of flow around a sharp bend
S_g=	2.65	Specific gravity of riprap (usually taken as 2.65)
g=	32.2	Acceleration of gravity, 32.2 ft/s

If only the average channel velocity is known, then $V_{des}=K_1*K_2*V_{avg}$:

V_{avg}=	8.21	Channel average velocity, fps		From bridge hyd. sheet
V_{des}=	11.0835	Design velocity for local conditions at the pier, ft/s	$V_{des}=K_1*K_2*V_{avg}$	

If the local velocity at the pier is known (a 2-D model stream tube), then $Vdes=K_1*V_{local}$:

V_{local}=	9.79	Local velocity in the vicinity of the pier, ft/s		From bridge hyd. sheet
V_{des}=	14.685	Design velocity for local conditions at the pier, ft/s	$V_{des}=K_1*V_{local}$	

V_{des}=	14.685	Design velocity in the vicinity of the pier to be used, ft/s

d_{50}=	1.40	Particle size for which 50% is finer by weight , ft			
d_{50} =	16.9	Riprap size in inches	Use standard size d_{50}= (6", 9", 12" 18", 24")=	18	inches
$t=3d_{50}$=	50.6	Minimum riprap thickness, inches	$t=3d_{50}$=	54.0	

Conclusion

Use 4.50 ft thick layer of
Riprap d50= 18 inches

Reference: Lagasse, et. al., NCHRP Report 568, Riprap Design Criteria, Recommended Specifications, and Quality Control, 2006

RIPRAP FOR OVERTOPPING FLOW
FOR SLOPES 4:1 AND FLATTER

Project: Belford @ HCC | By: CDT | I:\115360-01 - Compark at Belford\CADD\Hydraulics\Calculations\
Proj. No. 115360-01 | Date: 7/24/2017 | Happy Canyon Creek\Bridge Hydraulics

Weir formula H=(Q/C*L)^.67

Q=	2691	Discharge, cfs (FHAD Future 10yr c.f.s)
C=	2.6	Weir coefficient
L=	310	Length of broad crested weir, ft
H=	2.24	Overtopping depth, ft

Median Rock Size d50=ku*qf^0.52/Cu^0.25*S^0.75*(sin a/Sg cos a-1)(cos a tan p-sin a))^1.11

Ku=	0.525	Constant for English units				
qf=	8.7	Unit discharge at failure, ft/s/ft				
Cu=	4.5	Coefficient of uniformity of the riprap, d60/d10				
S=	0.25	Slope of the embankment. ft/ft				
Sg	2.65	Specific gravity of the riprap				
ά=	4	Slope of the embankment, H:1	H:1=	4.0	θ= 14.0	0.24 = radians
φ=	1	Angle of repose for riprap, H:1	H:1=	1.0	θ= 45.0	0.79 = radians
d50=	0.56	Smallest possible median rock size, d50, ft				
d50=	6.7	Smallest possible median rock size, d50, in				
Use a d50 of	18	inches (from Table C8.1)				

Interstitial Velocity Vi=(2.48(g*d50)^0.5)*(S^0.58/Cu^2.22)

g=	32.2	Acceleration due to gravity, ft/sec
d50=	1.5	Particle size for which 50% is finer by weight, ft
S=	0.25	Slope, ft/ft
Cu=	4.5	Coefficient of uniformity of the riprap, d60/d10
Vi=	0.27	ft/sec
ŋ=	0.45	porosity
Vavg=	0.12	ft/sec

Thickness of riprap as if all of the flow were through the riprap t=qf/Vavg, ft

t=	70.5	thickness of riprap layer, ft	
2*d50=	3.0	ft	**FALSE If "t" is < than 2*d50, then design is complete and a 2d50 thickness is ok**
Use a d50 of	18	in.	**0 If "t" is > than 2*d50, then continue**

Allowable flow depth over riprap h=(0.06(Sg-1)d50tanφ)/(0.97S)

h=	0.61	ft depth

Calculate Manning roughness coefficient, n n=.034(d50)^.1667

n=	0.04	

Calculate Unit Discharge, q q=1.489/n*y^1.67*S^0.5

q1=	9.02	ft3/s/ft

Calculate the Required Interstitial Flow through the riprap and the flow provided by a riprap thickness of 2d50

q2=	-0.34	ft3/s/ft	q2=qf-q1
q=	0.37	ft3/s/ft	q=2d50*Vavg

t=2d50=	36	in	**If q is > than or equal to q2, then the design is complete with a 2d50**
t=	18	in	**If not, then increase riprap size to next higher gradation (C8.1)**

Reference: Lagasse, et. al., NCHRP Report 568, Riprap Design Criteria, Recommended Specifications, and Quality Control, 2006

Table C8.1. Minimum and maximum allowable particle size in inches.

Nominal Riprap Class by Median Particle Diameter		d_{15}		d_{50}		d_{85}		d_{100}	Cu, Coef. Of Uniform. (d60/d10)
Class	Size	Min	Max	Min	Max	Min	Max	Max	
I	6 in	3.7	5.2	5.7	6.9	7.8	9.2	12.0	4.5
II	9 in	5.5	7.8	8.5	10.5	11.5	14.0	18.0	4
III	12 in	7.3	10.5	11.5	14.0	15.5	18.5	24.0	4.5
IV	15 in	9.2	13.0	14.5	17.5	19.5	23.0	30.0	
V	18 in	11.0	15.5	17.0	20.5	23.5	27.5	36.0	4
VI	21 in	13.0	18.5	20.0	24.0	27.5	32.5	42.0	
VII	24 in	14.5	21.0	23.0	27.5	31.0	37.0	48.0	3.7
VIII	30 in	18.5	26.0	28.5	34.5	39.0	46.0	60.0	
IX	36 in	22.0	31.5	34.0	41.5	47.0	55.5	72.0	
X	42 in	25.5	36.5	40.0	48.5	54.5	64.5	84.0	

Note: Particle size d corresponds to the intermediate (B) axis of the particle.

(CDOT)

FREEBOARD REQUIREMENTS

Project: Belford Avenue @ Happy Canyon Creek File Name: Freeboard.xlsx
Date: 24-Jul-17 FHU Project #: 115360-01

Fb = 0.1 * Q^0.3 + 0.008 * V^2 (English Units)
RE: UDFCD defers to CDOT Roadway Design Manual

REQUIRED FREEBOARD

Q_{100} =	8303	cfs	(Design Q)
V_{100} =	8.21	fps	(Average Velocity)
Fb=	2.04	ft.	(Required Freeboard)

AVAILABLE FREEBOARD

Low chord elevation =	5780.07	
Design W.S. elevation =	5776.33	
Available freeboard =	3.74	ft.

STORM DRAINAGE INFRASTRUCTURE NOTES

1. ALL STORM DRAINAGE IMPROVEMENTS ARE SUBJECT TO COMPLIANCE WITH THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) CURRENT EDITION OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, M & S STANDARDS, AND ALL STANDARD SPECIAL PROVISIONS CURRENTLY USED BY CDOT, WITH THE MODIFICATIONS SET FORTH IN THE TOWN OF PARKER'S STORM DRAINAGE AND ENVIRONMENTAL CRITERIA MANUAL (SDECM), AS AMENDED.

2. THE CONTRACTOR SHALL COMPLY WITH THE "COLORADO WATER QUALITY CONTROL ACT" (TITLE 25, ARTICLE 8 CRS), THE "PROTECTION OF FISHING STREAMS" TITLE 33, ARTICLE 5, CRS), THE "CLEAN WATER ACT" (33 USC 1344), "CHERRY CREEK RESERVOIR CONTROL REGULATION NO. 72" (5 CCR 1002–72), THE REGULATION PROMULGATED, CERTIFICATION OR PERMITS ISSUES, AND THE REQUIREMENTS PRESENTED IN THE SDECM REVISION TO SECTION 107 AND THE CONSTRUCTION BMP PLAN. IN THE EVENT OF CONFLICTS BETWEEN THESE REQUIREMENTS AND WATER QUALITY CONTROL LAWS, RULES, OR REGULATIONS OF OTHER FEDERAL, OR STATE AGENCIES, THE MORE RESTRICTIVE LAWS, RULES, OR REGULATIONS SHALL APPLY.

3. INSPECTIONS: CONSTRUCTION SHALL NOT BEGIN UNTIL A GRADING PERMIT HAS BEEN ISSUED FOR THE PROJECT. THE CONTRACTOR SHALL NOTIFY THE TOWN OF PARKER ENGINEERING DEPARTMENT (PUBLIC WORKS) TO SCHEDULE INSPECTIONS A MINIMUM OF 48 HOURS PRIOR THE CONSTRUCTION OF ALL DRAINAGE INFRASTRUCTURE (STORM SEWERS, INLETS, MANHOLES, ENERGY DISSIPATERS, RIPRAP, GROUTED BOULDERS, DETENTION POND OUTLET STRUCTURES, FOREBAYS, TRICKLE CHANNELS, ETC). FAILURE TO NOTIFY THE ENGINEERING DEPARTMENT FOR INSPECTIONS MAY RESULT IN NON–ACCEPTANCE OF THE INFRASTRUCTURE BY THE TOWN. URBAN DRAINAGE AND FLOOD CONTROL DISTRICT MUST ALSO BE NOTIFIED IN A SIMILAR MANNER FOR ALL MAINTENANCE ELIGIBLE DRAINAGE INFRASTRUCTURES (CONSULT WITH STORMWATER ENGINEERING DIVISION).

4. STRUCTURAL BACKFILL (CDOT CLASS 1) SHALL BE COMPACTED TO CONFORM TO CDOT STANDARD SPECIFICATION 203.03. STRUCTURAL BACKFILL (CDOT CLASS 2) SHALL CONFORM TO CDOT STANDARD SPECIFICATION 203.07. AT THE CONTRACTOR'S OPTION, STRUCTURAL BACKFILL (SQUEEGEE) MEETING THE GRADATION REQUIREMENTS CONTAINED IN REVISION OF SECTION 206 OF THE CDOT STANDARD SPECIFICATIONS AS PRESENTED IN THE SDECM, MAY BE SUBSTITUTED FOR STRUCTURE BACKFILL (CLASS 1) OR CLASS 2) FOR BACKFILLING OF CULVERT PIPES, STORM SEWER PIPES, MANHOLES AND INLET STRUCTURES; HOWEVER, THE TOP 2 FEET BELOW SUBGRADE ELEVATION SHALL BE THE REQUIRED EMBANKMENT MATERIAL.

5. ALL EXCAVATIONS SHALL MEET OSHA REQUIREMENTS.

6. TESTING: PROBATIONARY ACCEPTANCE OF STORM DRAINAGE IMPROVEMENTS WILL BE CONTINGENT UPON SATISFACTORY TESTING RESULTS. IN ALL CASES WHERE TESTS INDICATE COMPACTION LESS THAN THAT REQUIRED BY TOWN SPECIFICATIONS, ADDITIONAL COMPACTION AND TESTS WILL BE REQUIRED UNTIL THE SPECIFICATIONS ARE MET. FREQUENCY OF TESTING WILL BE AS FOLLOWS:
1 TEST FOR SUBGRADE AND 1 TEST FOR BACKFILL AT EVERY ABOVE GROUND APPURTENANCE (MANHOLES, INLETS, ETC)
1 TEST EVERY 200 LF OF MAINLINE TRENCH EVERY 1 FOOT OF BACKFILL LIFT AND WITHIN 1 FOOT FROM ALL STRUCTURES.

7. ALLOWABLE STORM SEWER CONDUIT MATERIAL WITHIN THE TOWN OF PARKER SHALL BE LIMITED TO REINFORCED CONCRETE PIPE (RCP) CONFORMING TO CDOT STANDARD SPECIFICATION 706.02.

8. ALL RCP JOINTS SHALL BE MANUFACTURED IN ACCORDANCE WITH ASTM C443. RUBBER GASKETS SHALL BE USED ON ALL PIPE JOINTS CONFORMING TO ASTM C443. ALL RCP SECTIONS SHALL BE JOINED IN SUCH A MANNER THAT THE ENDS ARE FULLY ENTERED AND THE INNER SURFACES ARE REASONABLE FLUSH. AVERAGE JOINT GAP THAT EXCEEDS ½ INCH SHALL BE FILLED WITH AN APPROVED FLEXIBLE PLASTIC SEALANT.

9. JOINT RESTRAINTS AND TOE–WALLS, CONFORMING TO CDOT M&S STANDARD PLAN NO. M–601–11 SHALL BE USED ON ALL RCP FLARED END SECTION OUTFALLS.

10. EPOXY COATED REBAR SHALL BE USED AS REINFORCING STEEL ON ALL STORM INLETS AND STRUCTURES. REFERENCE CDOT M&S STANDARD PLAN NO. M–604–10, 11, 12, AND 13.

11. CDOT CLASS D CONCRETE SHALL BE USED FOR ALL CONCRETE DRAINAGE STRUCTURES.

12. PRE–CAST INLETS AND MANHOLE BASES SHALL NOT BE USED WITHIN THE TOWN OF PARKER RIGHT–OF–WAY, WITH THE EXCEPTION OF CDOT TYPE C AND D INLETS.

13. TWO– (2) MANHOLE ACCESS POINTS ARE REQUIRED ON ALL TYPE "R" CURB INLETS GREATER THAN OR EQUAL TO TEN (10) FEET IN LENGTH AS PRESENTED IN CDOT M&S STANDARD PLAN NO. M–604–12.

14. ALL GROUTING (BOULDERS, RIPRAP) SHALL BE IN ACCORDANCE WITH THE REVISION OF SECTION 506 OF THE CDOT STANDARD SPECIFICATIONS AS PRESENTED IN THE SDECM.

15. ALL BOULDERS AND RIPRAP SHALL BE SELECTED AND PLACED IN ACCORDANCE WITH THE REVISION OF SECTION 506 OF THE CDOT STANDARD SPECIFICATIONS AS PRESENTED IN THE SDECM.

16. CONTRACTOR SHALL REFER TO THE TOWN OF PARKER'S CONSTRUCTION BEST MANAGEMENT PRACTICES DETAILS AND NOTES FOR ALL REQUIREMENTS RELATING TO RE–VEGETATION, SEDIMENT AND EROSION CONTROL REQUIREMENTS FOR CONSTRUCTION ACTIVITIES.

17. PIPE BELLS SHALL NOT BE CAST INTO MANHOLE BASES OR INLETS.

DROP STRUCTURE TABULATION

INDEX BOOK	INDEX PAGE	INDEX SHEET	ITEM NO.	CONTRACT ITEM	UNIT	GSB PLAN	GSB AS CONST.
			206	FILTER MATERIAL (CLASS A)	CY	2019	
			206	FILTER MATERIAL (CLASS C)	CY	37	
			206	STRUCTURE EXCAVATION	CY	130	
			206	STRUCTURE BACKFILL (CLASS 1)	CY	118	
			207	TOPSOIL	CY	739	
			501	STEEL SHEET PILING (TYPE II)	SF	8770	
			506	RIPRAP (12 INCH)	CY	76	
			506	SOIL RIPRAP (12 INCH)	CY	2769	
			506	SOIL RIPRAP (18 INCH)	CY	652	
			506	24 INCH GROUTED BOULDERS	CY	434	
			601	CONCRETE CLASS D (BOX CULVERT)	CY	47	
			602	REINFORCING STEEL	LB	2352	
			602	REINFORCING STEEL (EPOXY COATED)	LB	740	
			603	48 INCH REINFORCED CONCRETE PIPE (CIP)	LF	187	
			603	48 INCH REINFORCED CONCRETE END SECTION	EA	1	
			603	10X3 FOOT CONCRETE BOX CULVERT (PRECAST)	LF	90	
			604	INLET TYPE D (10 FOOT)	EA	1	
			604	INLET SPECIAL	EA	1	
			619	8 INCH PLASTIC PIPE	LF	266	

NOTES:

1. 24 INCH GROUTED BOULDERS SHALL BE PAID FOR AS GROUTED RIPRAP (24 INCH).
2. SEE CBMP PLANS FOR TABULATION OF EROSION CONTROL ITEMS.
3. FOR UNCLASSIFIED EXCAVATION SEE EARTHWORK SUMMARY. COST OF EXCAVATION FOR ALL GROUTED RIPRAP AND SOIL RIPRAP IS INCLUDED IN THE COST OF THE BID ITEM.
4. DROP STRUCTURE TABULATION QUANTITIES HAVE BEEN CARRIED FORWARD TO THE SUMMARY OF APPROXIMATE QUANTITIES SHEETS.
5. 10X3 FOOT CONCRETE BOX CULVERT (PRECAST) QUANTITY SHOW IS FOR DUAL BOX CULVERTS AT CHEROKEE TRAIL.
6. THE PRESENCE OF GROUNDWATER IS ANTICIPATED AND THE CONTRACTOR SHALL BE RESPONSIBLE FOR DEWATERING DURING CONSTRUCTION FOR ALL STORM SEWER AND DROP STRUCTURE INFRASTRUCTURE. DEWATERING SHALL BE INCLUDED IN THE COST OF THE WORK AND NOT PAID FOR SEPARATELY.
7. THE SUGGESTED SEQUENCING FOR DEWATERING WHEN CONSTRUCTING THE DROP STRUCTURES INCLUDES CONSTRUCTING THE SHEET PILE CUTOFF WALLS FIRST, THEN INSTALLING DEWATERING WELLS OR TRENCHES TO DEWATER BELOW THE PROPOSED LOWEST EXCAVATION LIMITS.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL APPLICABLE DEWATERING PERMITS AND TREATMENT (AS REQUIRED) OF DISCHARGE FROM DEWATERING OPERATIONS.

I:\115360-01 – Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\, Zach.Grady

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Sheet Revisions		
Date	Comments	Initials

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No Revisions:
Revised:
Void:

BELFORD–HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE TABULATION

Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD–01 of 19

Project No./Code

Sheet Number 65

HAPPY CANYON CREEK CHEROKEE TRAIL CROSSING STEEL SHEET PILE CUTOFF WALL POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
W1	27979.00	94785.96	5774.83	SHEET PILE CUTOFF WALL – FINISHED GRADE EL.
W2	27816.64	94898.82	5777.00	SHEET PILE CUTOFF WALL – FINISHED GRADE EL.

HAPPY CANYON CREEK DROP STRUCTURE NO. 1 STEEL SHEET PILE CUTOFF WALL POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
W1	27675.42	94283.50	5777.39	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W2	27745.88	94255.72	5769.99	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W3	27770.71	94252.88	5769.21	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W4	27834.84	94262.40	5776.14	CONCRETE CUTOFF WALL – FINISHED GRADE EL.

HAPPY CANYON CREEK DROP STRUCTURE NO. 2 STEEL SHEET PILE CUTOFF WALL POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
W1	27522.92	93938.45	5781.00	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W2	27627.16	93827.68	5772.57	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W3	27648.54	93814.47	5772.41	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W4	27680.82	93804.64	5781.00	CONCRETE CUTOFF WALL – FINISHED GRADE EL.

HAPPY CANYON CREEK DROP STRUCTURE NO. 3 STEEL SHEET PILE CUTOFF WALL POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
W1	27224.37	93849.23	5785.98	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W2	27201.63	93834.88	5777.63	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W3	27174.38	93805.42	5777.06	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W4	27143.34	93746.45	5778.26	CONCRETE CUTOFF WALL – FINISHED GRADE EL.
W5	27143.34	93579.99	5784.32	CONCRETE CUTOFF WALL – FINISHED GRADE EL.

HAPPY CANYON CREEK DROP STRUCTURE CHANNEL REVETMENT SOIL RIPRAP (12 INCH) POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
CR1	27384.46	93620.98	5776.96	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR2	27409.72	93613.85	5776.89	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR3	27455.43	93616.23	5776.93	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR4	27504.52	93635.29	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR5	27521.43	93646.91	5777.11	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR6	27547.94	93676.17	5776.07	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR7	27561.71	93693.16	5776.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR8	27566.68	93697.18	5776.04	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR9	27669.93	93800.97	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR10	27681.39	93814.88	5776.99	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR11	27699.52	93838.94	5776.86	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR12	27713.46	93854.66	5777.09	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR13	27724.95	93872.92	5776.90	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR14	27732.94	93886.34	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR15	27743.41	93902.84	5777.05	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR16	27754.96	93929.13	5776.62	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR17	27765.52	93944.63	5775.94	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR18	27769.88	93961.99	5775.77	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR19	27781.73	93978.73	5775.97	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR20	27782.09	94006.03	5775.95	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
CR21	27787.18	94029.84	5776.06	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.

HAPPY CANYON CREEK DROP STRUCTURE GRADING POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
G1	27872.10	94962.88	5779.00	FINISHED GRADE
G2	27823.77	94932.12	5779.00	FINISHED GRADE
G3	27808.04	94890.63	5779.00	FINISHED GRADE
G4	27766.29	94809.24	5779.00	FINISHED GRADE
G5	27745.18	94744.70	5779.00	FINISHED GRADE

HAPPY CANYON CREEK DROP STRUCTURE SOIL RIPRAP (12 INCH & 18 INCH) POINT DATA

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
SR1	27769.57	94610.15	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR2	27835.00	94932.41	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR3	27801.00	94604.71	5765.86	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR4	27800.34	94633.29	5767.10	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR5	27797.05	94661.68	5769.72	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR6	27804.21	94763.47	5770.47	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR7	27862.90	94848.01	5766.25	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR8	27885.85	94800.95	5767.60	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR9	27876.75	94787.62	5765.88	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR10	27853.55	94783.45	5766.72	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR11	27913.61	94738.94	5766.30	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR12	27871.26	94540.03	5768.10	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR13	27892.28	94575.67	5770.18	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR14	27920.57	94605.87	5772.85	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR15	27943.91	94626.32	5774.60	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR16	27967.25	94646.78	5775.74	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR17	27912.28	94510.88	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR18	27925.40	94519.82	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR19	27937.08	94566.65	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR20	27941.85	94573.12	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR21	27962.56	94597.66	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR22	27970.79	94607.21	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR23	27995.66	94624.88	5777.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR24	27980.34	94661.67	5776.11	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR25	27988.53	94666.66	5776.90	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR26	27956.85	94747.12	5773.49	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR27	27965.72	94770.00	5773.56	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR28	27950.72	94782.27	5766.42	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR29	27953.26	94821.86	5765.14	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR30	27913.37	94849.59	5764.89	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR31	27904.16	94855.99	5765.02	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR32	27881.83	94903.47	5766.84	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR33	27890.55	94916.56	5771.36	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR34	27878.94	94919.88	5772.38	LIMITS OF SOIL RIPRAP (18 INCH) – FINISHED GRADE EL.
SR35	27821.75	94260.96	5774.00	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR36	27816.88	94288.38	5772.05	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR37	27814.22	94331.33	5770.01	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR38	27821.34	94373.78	5769.37	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.
SR39	27831.26	94408.21	5769.24	LIMITS OF SOIL RIPRAP (12 INCH) – FINISHED GRADE EL.

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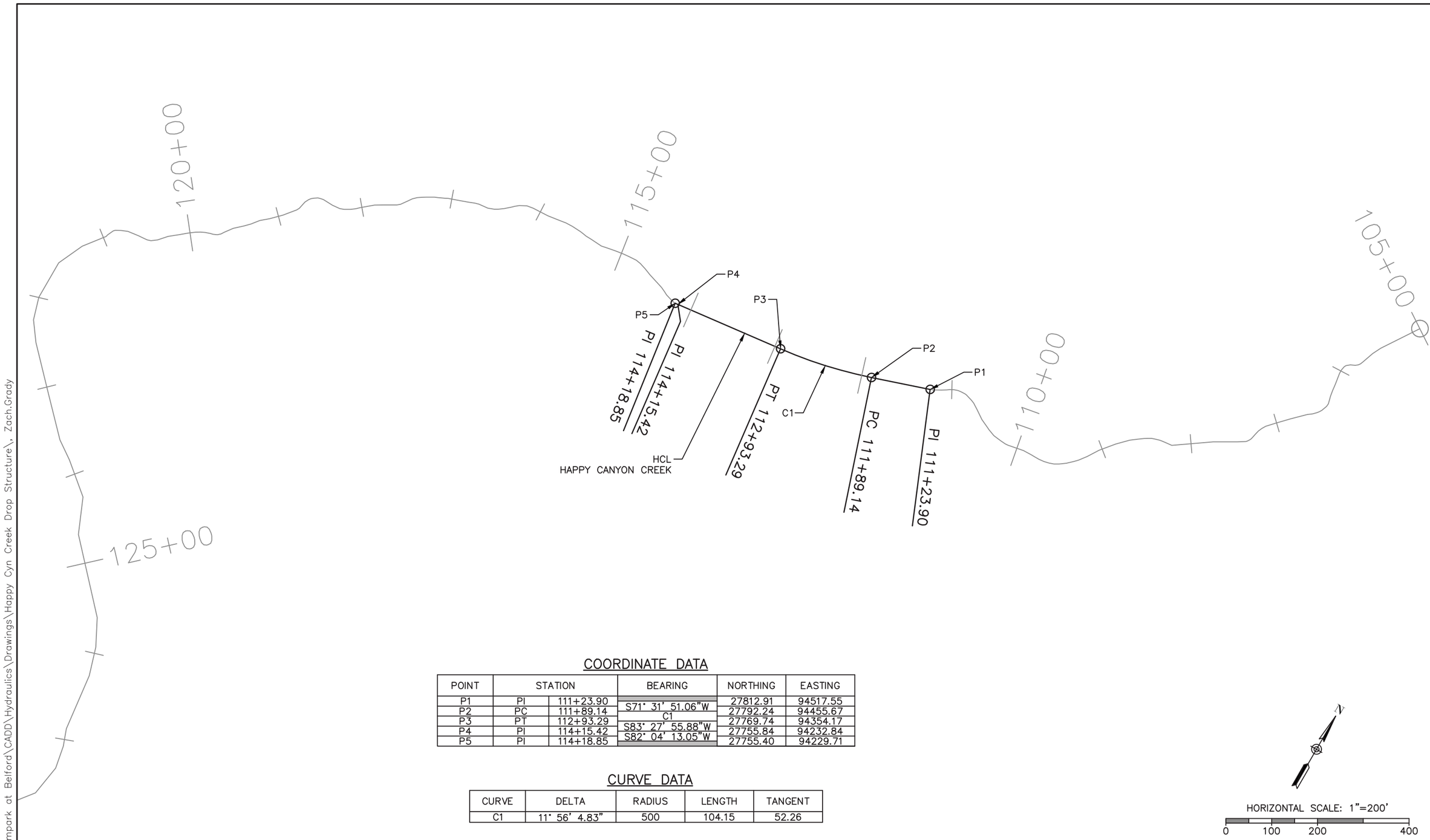
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Revised:
Void:

BELFORD–HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
POINT DATA DETAIL

Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD–02 of 19

Project No./Code:

Sheet Number 66



COORDINATE DATA

POINT	STATION		BEARING	NORTHING	EASTING
P1	PI	111+23.90		27812.91	94517.55
P2	PC	111+89.14	S71° 31' 51.06"W	27792.24	94455.67
P3	PT	112+93.29	C1	27769.74	94354.17
P4	PI	114+15.42	S83° 27' 55.88"W	27755.84	94232.84
P5	PI	114+18.85	S82° 04' 13.05"W	27755.40	94229.71

CURVE DATA

CURVE	DELTA	RADIUS	LENGTH	TANGENT
C1	11° 56' 4.83"	500	104.15	52.26

HORIZONTAL SCALE: 1"=200'

0 100 200 400

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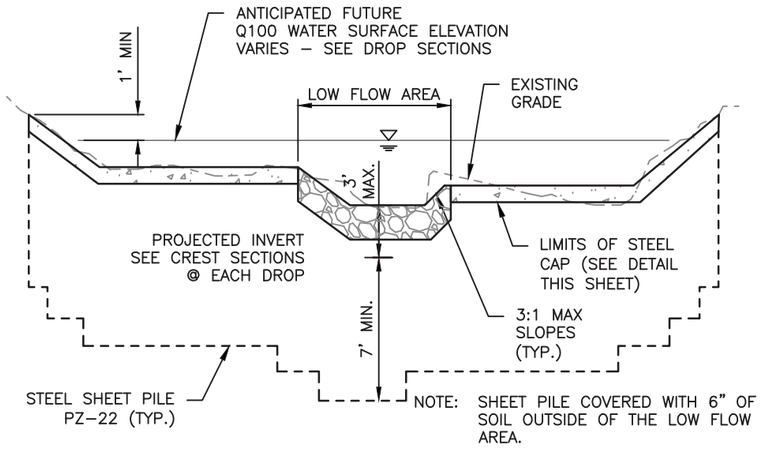
BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
HCL GEOMETRY LAYOUT

Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	Drainage	Sheets:	DD-03 of 19

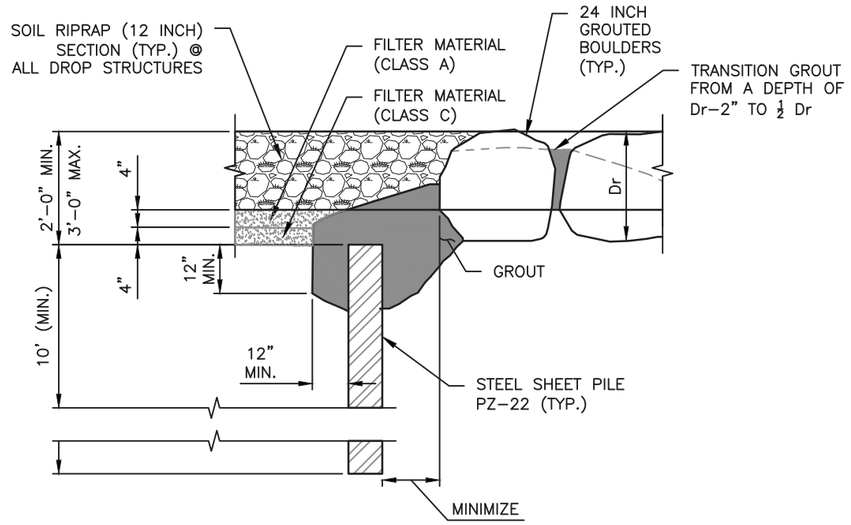
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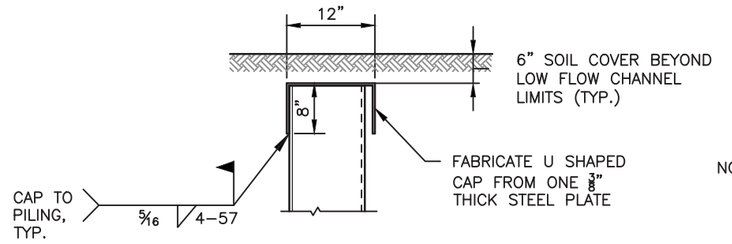
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SHEET PILE TYPICAL SECTION
N.T.S.



SHEET PILE CUTOFF CONNECTION
(GROUTED BOULDER)
N.T.S.



STEEL SHEET PILE CAP DETAIL
N.T.S.

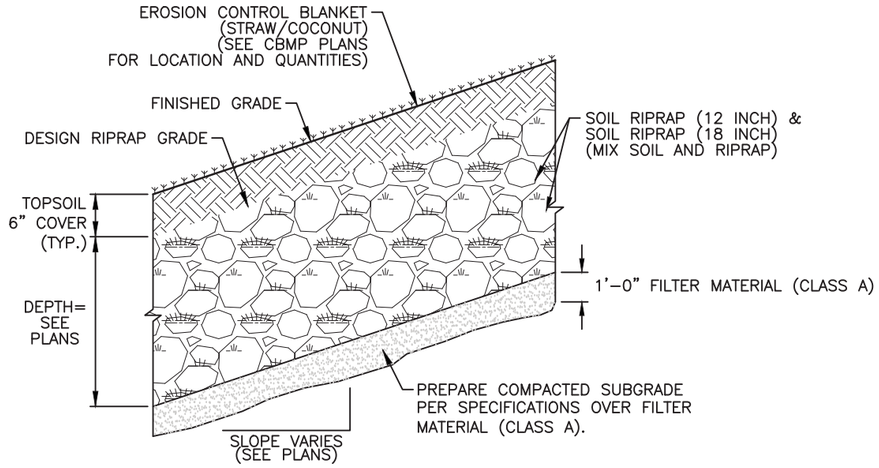
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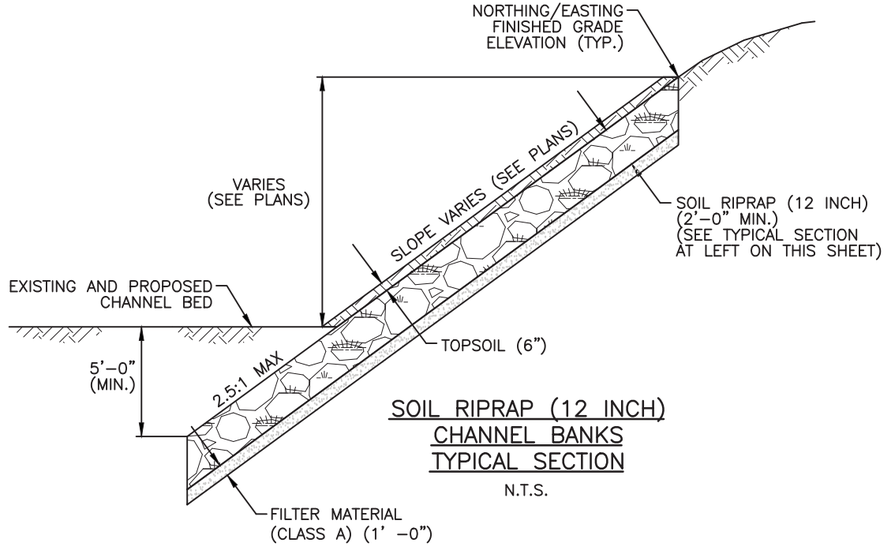
As Constructed	BELFORD–HAPPY CANYON CREEK HAPPY CANYON CREEK DROP STRUCTURE SHEET PILE DETAILS			Project No./Code
No Revisions:				
Revised:	Designer: CDT	Structure Numbers		
Void:	Detailer: KLT			
	Subset: Drainage	Sheets: DD–04 of 19		Sheet Number 68

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SOIL RIPRAP (12 INCH) & SOIL RIPRAP (18 INCH)
TYPICAL SECTION
N.T.S.

RIPRAP AND SOIL RIPRAP GRADATION				
UDFCD RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)	BID ITEM DESCRIPTION
TYPE M	70 – 100	21	12	RIPRAP (12 INCH)
	50 – 70	18		
	35 – 50	12		SOIL RIPRAP (12 INCH)
	2 – 10	4		
TYPE H	70 – 100	30	18	RIPRAP (18 INCH)
	50 – 70	24		
	35 – 50	18		SOIL RIPRAP (18 INCH)
	2 – 10	6		
TYPE VH	70 – 100	42	24	GROUTED RIPRAP (24 INCH)
	50 – 70	33		
	35 – 50	24		
	2 – 10	9		



SOIL RIPRAP (12 INCH)
CHANNEL BANKS
TYPICAL SECTION
N.T.S.

SOIL RIPRAP (12 INCH) & SOIL RIPRAP (18 INCH) NOTES:

1. ELEVATION TOLERANCES FOR THE SOIL RIPRAP SHALL BE 0.10 FEET. THICKNESS OF SOIL RIPRAP SHALL BE NO LESS THAN THICKNESS SHOWN AND NO MORE THAN 2–INCHES GREATER THAN THE THICKNESS SHOWN.

2. WHERE "SOIL RIPRAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP VOIDS ARE TO BE FILLED WITH NATIVE SOIL. THE RIPRAP SHALL BE PRE–MIXED WITH THE NATIVE SOIL AT THE FOLLOWING PROPORTIONS BY VOLUME: 65% RIPRAP AND 35% SOIL. THE SOIL USED FOR MIXING SHALL BE NATIVE TOPSOIL AND BE INSTALLED IN A MANNER THAT RESULTS IN A DENSE, INTERLOCKED LAYER OF RIPRAP WITH RIPRAP VOIDS FILLED COMPLETELY WITH SOIL. SEGREGATION OF MATERIALS SHALL BE AVOIDED AND IN NO CASE SHALL THE COMBINED MATERKAL CONSIST PRIMARILY OF SOIL; THE DENSITY AND INTERLOCKING NATURE OF RIPRAP IN THE MIXED MATERIAL SHALL ESSENTIALLY BE THE SAME AS IF THE RIPRAP WAS PLACED WITHOUT SOIL.

3. WHERE SPECIFIED (TYPICALLY AS "BURIED SOIL RIPRAP"), A SURFACE LAYER OF TOPSOIL SHALL BE PLACED OVER THE SOIL RIPRAP ACCORDING TO THE THICKNESS SPECIFIED ON THE CONTRACT DRAWINGS. THE TOPSOIL SURFACE LAYER SHALL BE COMPACTED TO APPROXIMATELY 85% OF THE MAXIMUM DENSITY AND WITHIN TWO PERCENTAGE POINTS OF OPTIMUM MOISTURE IN ACCORDANCE WITH ASTM D698. TOPSOIL SHALL BE ADDED TO ANY AREAS THAT SETTLE.

4. ALL SOIL RIPRAP THAT IS BURIED WITH THE TOPSOIL SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO ANY TOPSOIL PLACEMENT.

2. CRIMP MULCH AS CALLED FOR IN THE CBMP PLANS AND SPECIFICATIONS.

3. SEE DD–04 FOR SOIL RIPRAP AT DROP STRUCTURES.

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BELFORD–HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DETAILS

Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD–05 of 19

Project No./Code:
Sheet Number 69

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GROUT NOTES

BOULDER PLACEMENT NOTES:

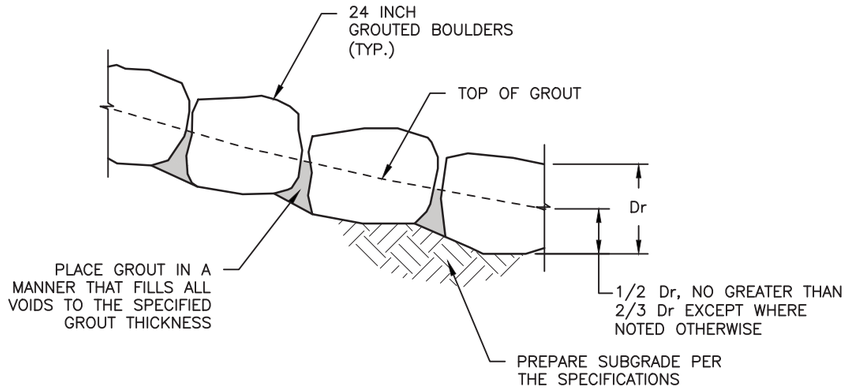
1. PLACE BOULDERS WITH THE REQUIRED BOULDER HEIGHT VERTICAL. PLACE BOULDERS AS TIGHTLY TOGETHER AS POSSIBLE (WITHOUT TOUCHING) WHILE PROVIDING ENOUGH ROOM BETWEEN THEM TO THOROUGHLY VIBRATE THE GROUT AND TO ENSURE NO GAPS IN THE GROUT. THE SMALL DIMENSION OF A 2X4 CAN BE USED AS A GUIDE TO CHECK MINIMUM SPACING.
2. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIAL FROM ROCK THAT COULD PREVENT THE GROUT FROM BINDING TO THE ROCK. KEEP BOULDERS FROM TOUCHING. AVOID SLIDING BOULDERS AGAINST SUBGRADE TO PROPERLY POSITION.

MATERIAL SPECIFICATIONS:

1. ALL GROUT SHALL HAVE A MINIMUM 28–DAY COMPRESSIVE STRENGTH EQUAL TO 3200 PSI.
2. ONE CUBIC YARD OF GROUT SHALL HAVE A MINIMUM OF SIX (6) SACKS OF TYPE II PORTLAND CEMENT.
3. A MAXIMUM OF 25% TYPE F FLY ASH MAY BE SUBSTITUTED FOR THE PORTLAND CEMENT.
4. THE AGGREGATE SHALL BE COMPRISED OF 70% NATURAL SAND (FINES) AND 30% 3/8–INCH ROCK (COARSE).
5. THE GROUT SLUMP SHALL BE BETWEEN 4–INCHES TO 6–INCHES.
6. AIR ENTRAINMENT SHALL BE BETWEEN 5.5% AND 7.5%.
7. TO CONTROL SHRINKAGE AND CRACKING, 1.5 POUNDS OF FIBERMESH, OR EQUIVALENT, SHALL BE USED PER CUBIC YARD OF GROUT.
8. COLOR ADDITIVE IN REQUIRED AMOUNTS SHALL BE USED WHEN SO SPECIFIED BY CONTRACT.

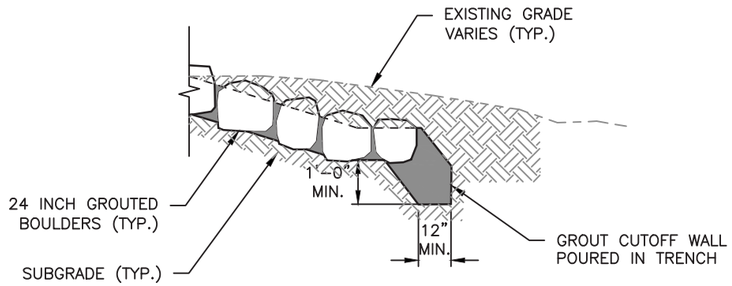
GROUT PLACEMENT SPECIFICATIONS:

1. SPECIAL PROCEDURES SHALL BE REQUIRED FOR GROUT PLACEMENT WHEN THE AIR TEMPERATURES ARE LESS THAN 40°F OR GREATER THAN 90°F. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE DESIGN ENGINEER OF THE PROCEDURES TO BE USED FOR PROTECTING THE GROUT.
2. GROUT SHALL BE DELIVERED BY MEANS OF A LOW PRESSURE (LESS THAN 10 PSI) GROUT PUMP USING A 2–INCH DIAMETER (MAXIMUM) NOZZLE.
3. FULL DEPTH PENETRATION OF THE GROUT INTO THE BOULDER VOIDS SHALL BE ACHIEVED BY INJECTING GROUT STARTING WITH THE NOZZLE NEAR THE BOTTOM AND RAISING IT AS THE GROUT FILLS, WHILE VIBRATING GROUT INTO PLACE USING A PENCIL VIBRATOR.
4. ALL GROUT BETWEEN BOULDERS SHALL BE TREATED WITH A BROOM FINISH.
5. AFTER GROUT PLACEMENT, EXPOSED BOULDER FACES SHALL BE CLEANED AND FREE OF GROUT.
6. ALL FINISHED GROUT SURFACES SHALL BE SPRAYED WITH A CLEAR LIQUID MEMBRANE CURING COMPOUND AS SPECIFIED IN ASTM C309.



GROUTED BOULDER PLACEMENT DETAIL

N.T.S.



STRUCTURE EDGE WALL DETAIL

N.T.S.

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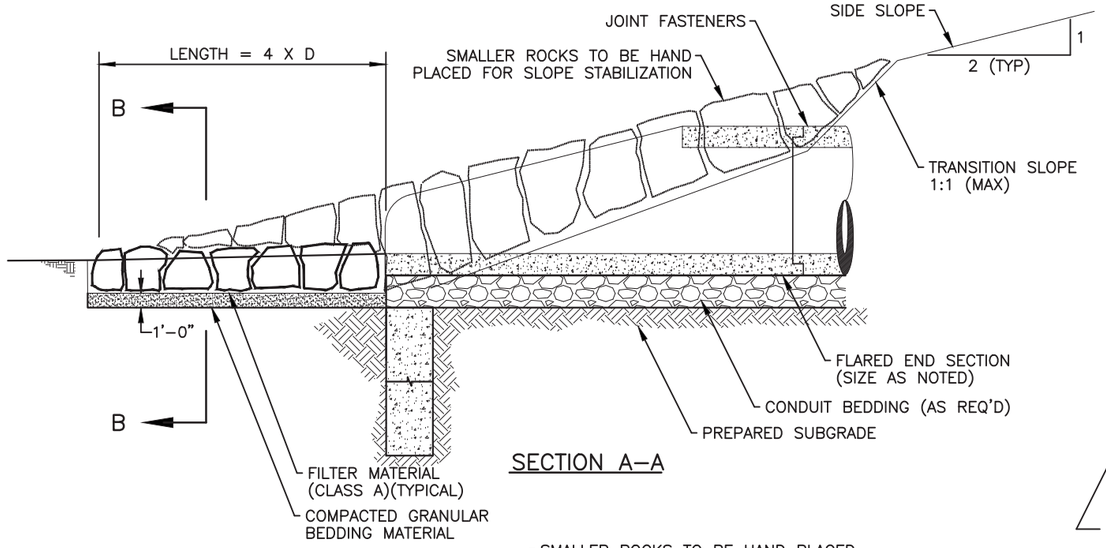
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BELFORD–HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DETAIL

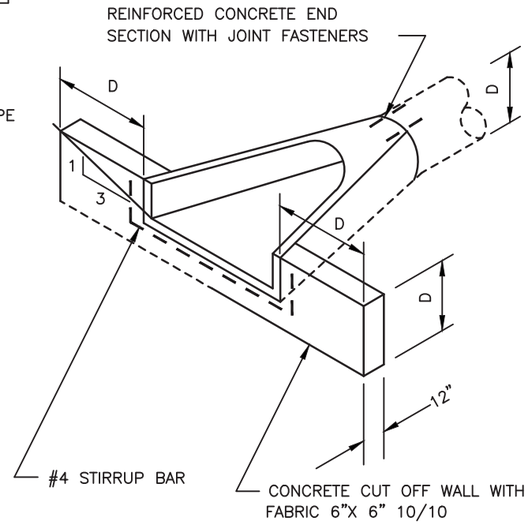
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Detailer:	KLT		
Subset:	Drainage	Sheets:	DD–06 of 19

Project No./Code

Sheet Number 70



SECTION A–A

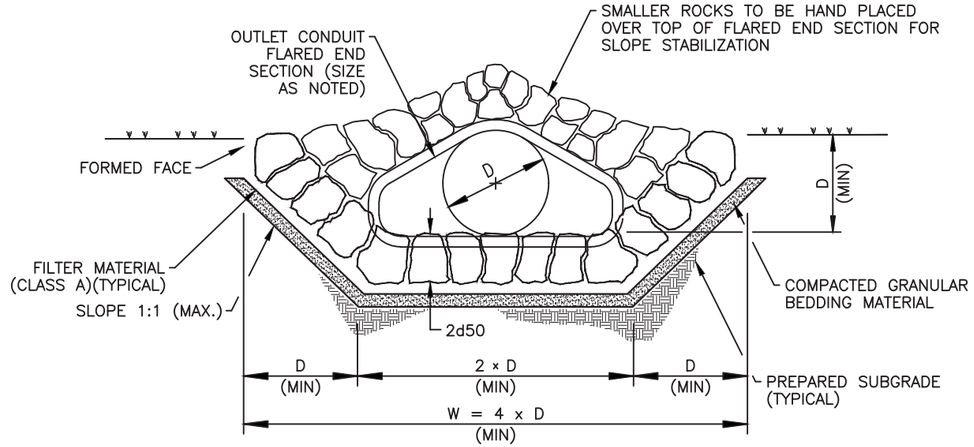


ID NO.	DIMENSIONS					QUANTITIES	
	D (in)	W (ft)	L (ft)	RIPRAP TYPE	d50 (in)	RIPRAP (12 INCH) (CY)	FILTER MATERIAL (CLASS A) (CY)
A1	48	16	16	M	12	19	9

TABULATION OF RIPRAP AND GEOTEXTILE MATERIAL AT CULVERT INLETS & OUTLETS

NOTES:

1. THESE QUANTITIES HAVE BEEN CARRIED FORWARD TO THE DROP STRUCTURE TABULATION.



SECTION B–B

CONCRETE TOEWALL AND END SECTION FOR REINFORCED CONCRETE PIPE

NOTES:

1. D= INSIDE DIAMETER OF REINFORCED CONCRETE PIPE.
2. CONCRETE FOR THE TOEWALL SHALL BE CONCRETE CLASS D (WALL)
3. EACH REINFORCED CONCRETE END SECTION SHALL BE CONNECTED TO THE REINFORCED CONCRETE PIPE WITH CONCRETE PIPE JOINT FASTENERS (2–EACH). CONCRETE PIPE JOINT FASTENERS SHALL BE INCLUDED IN THE COST OF THE REINFORCED CONCRETE END SECTION.
4. ALL CONCRETE, REINFORCING, CONNECTIONS, STRUCTURE EXCAVATION, AND EXTRA WORK REQUIRED TO CONSTRUCT THE CONCRETE TOEWALL SHALL BE INCLUDED IN THE COST OF 48 INCH RCES.
5. ALL REINFORCED CONCRETE PIPE EXTENSIONS SHALL HAVE A CONCRETE COLLAR AND SHALL BE INCLUDED IN THE COST OF THE REINFORCED CONCRETE PIPE.
6. REMOVED RIPRAP MAY BE UTILIZED FOR RIPRAP (12 INCH) UNLESS DIRECTED OTHERWISE BY THE ENGINEER.

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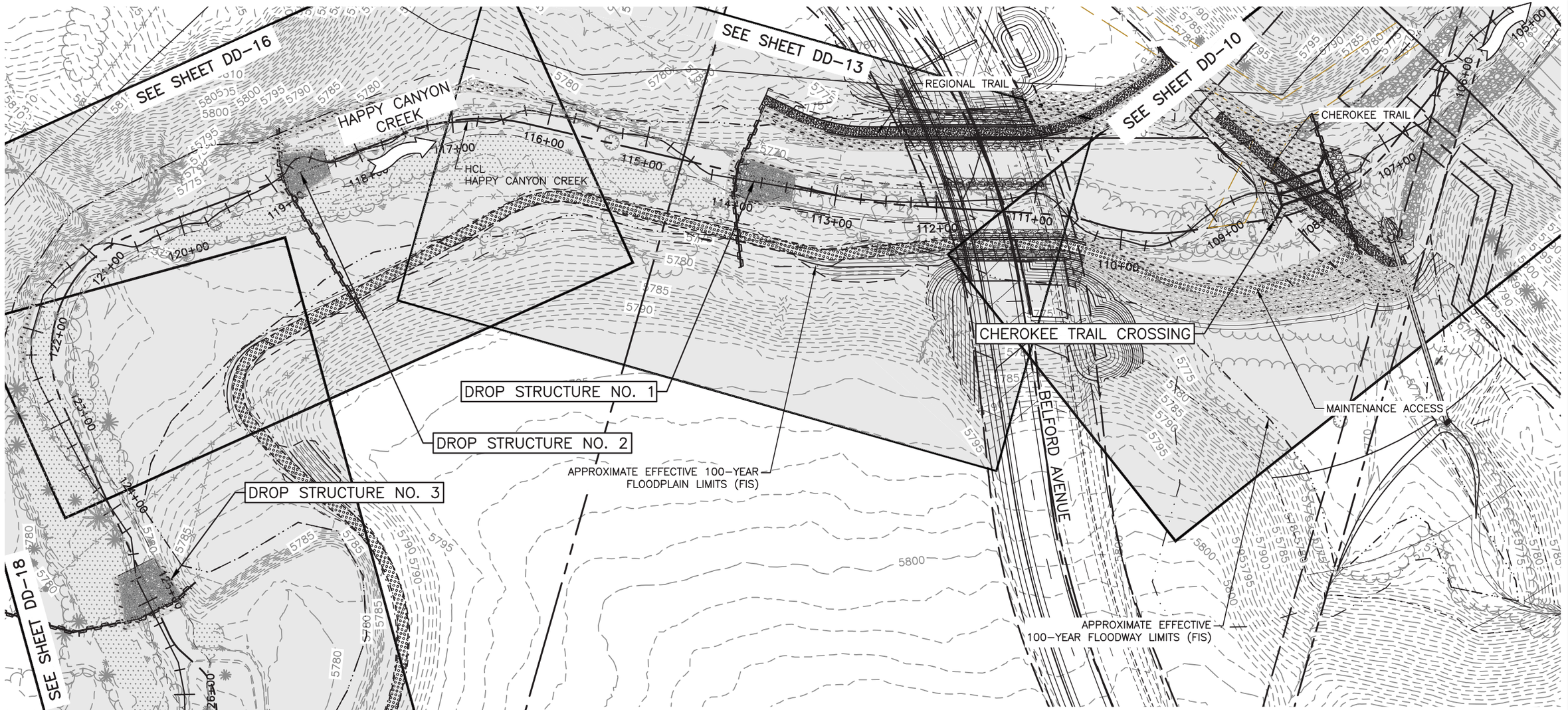
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BELFORD–HAPPY CANYON CREEK DRAINAGE
OUTLET PROTECTION DETAILS

Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD–07 of 19

Project No./Code:

Sheet Number 71



NOTES:

1. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION
2. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.

LEGEND

- TOP OF CUT
- TOE OF FILL
- WETLANDS
- SOIL RIPRAP (12 INCH)
- RIPRAP (12 INCH)
- RIPRAP (18 INCH)
- 24" GROUTED BOULDERS

N

HORIZONTAL SCALE: 1"=100'

0 50 100 200

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BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE PLAN

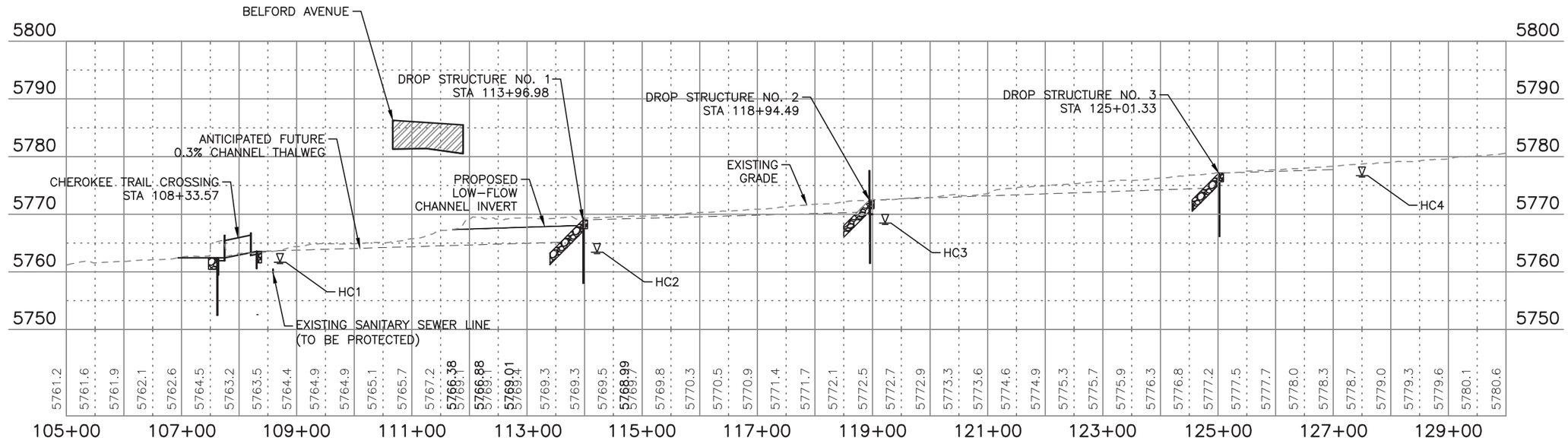
Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD-08 of 19

Project No./Code:

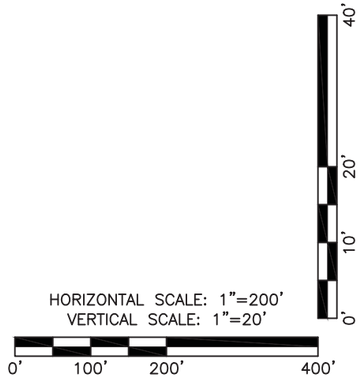
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NOTES

1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION.



HAPPY CANYON CREEK PROFILE



▽ APPROX. GROUNDWATER ELEVATION

GROUNDWATER ELEVATIONS	
TEST BORING ID	APPROX. DEPTH BELOW SURFACE (FT.)
HC1	−2.0
HC2	−6.0
HC3	−4.0
HC3	−2.0

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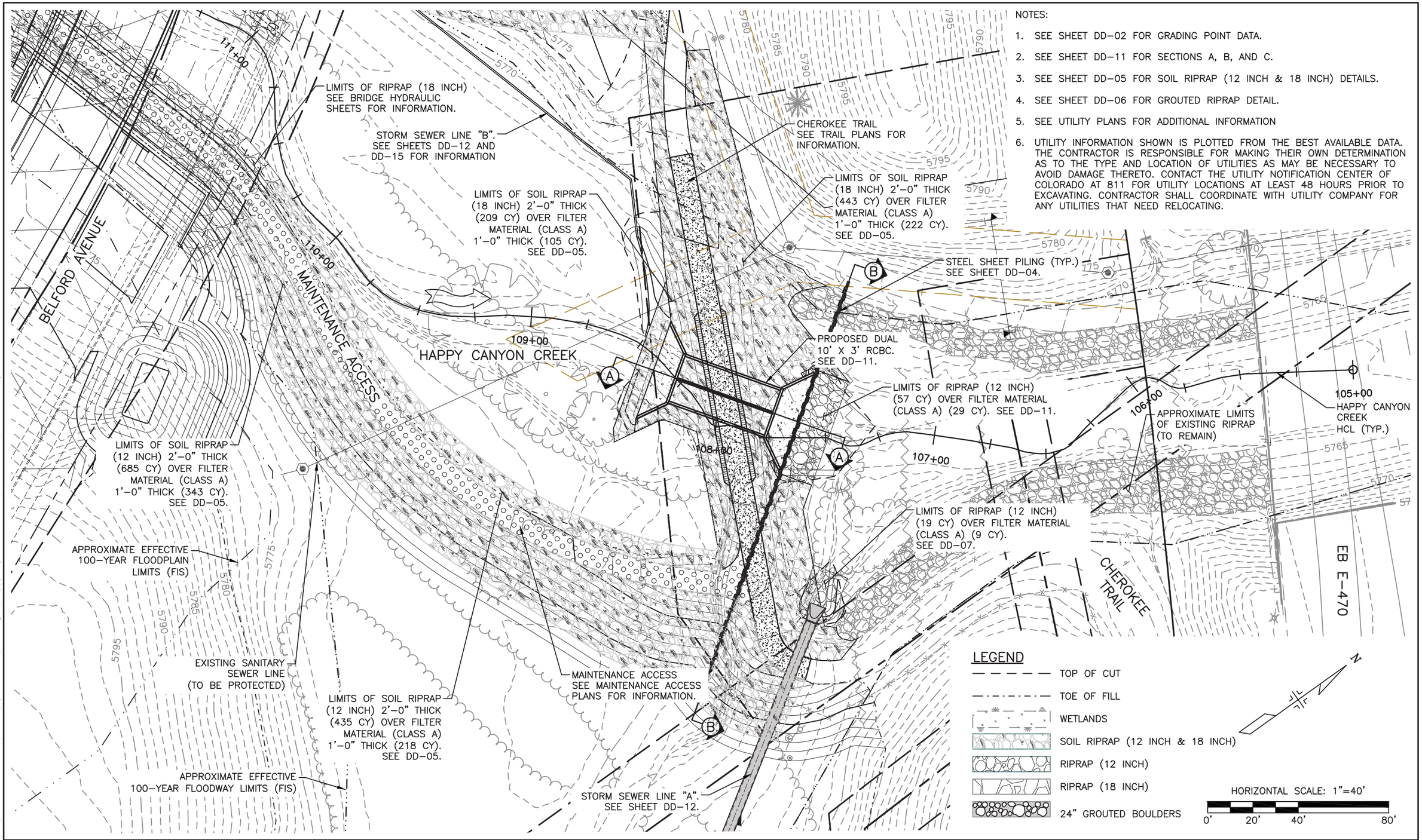
BELFORD−HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE PROFILE

Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	Drainage	Sheets:	DD−09 of 19

Project No./Code

Sheet Number 73

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NOTES:

1. SEE SHEET DD-02 FOR GRADING POINT DATA.
2. SEE SHEET DD-11 FOR SECTIONS A, B, AND C.
3. SEE SHEET DD-05 FOR SOIL RIPRAP (12 INCH & 18 INCH) DETAILS.
4. SEE SHEET DD-06 FOR GROUTED RIPRAP DETAIL.
5. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION
6. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.

I:\115360-01 - Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\, Zach.Grady

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Horizontal Scale: 1"=20' Vertical Scale: N.T.S.

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As Constructed
No Revisions:
Revised:
Void:

BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
CHEROKEE TRAIL PLAN

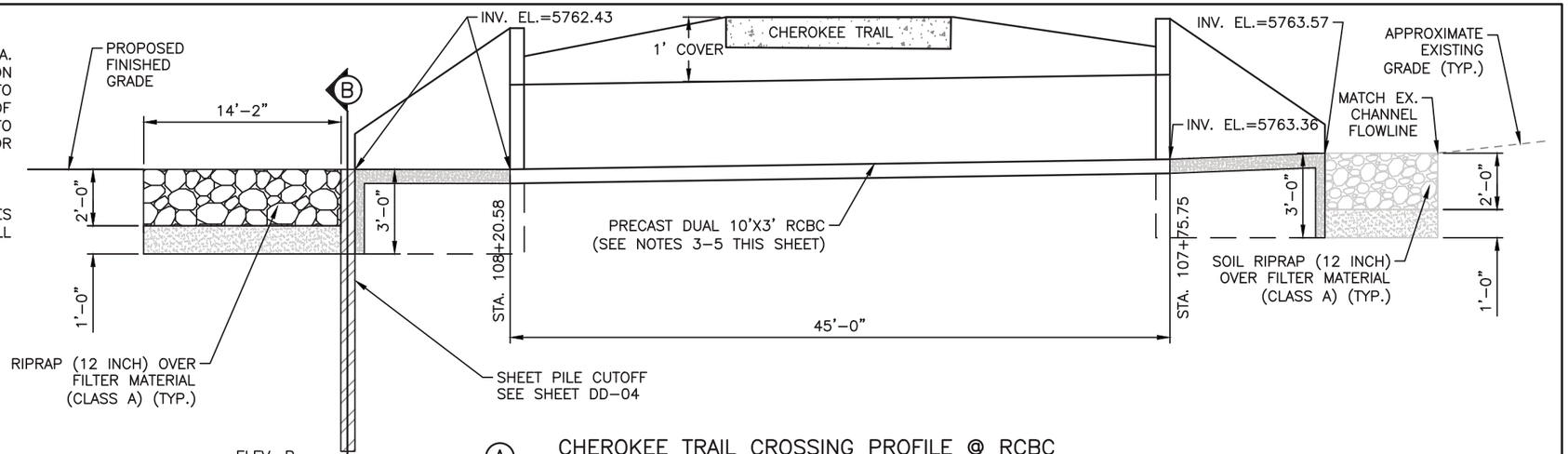
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Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD-10 of 19

Project No./Code:

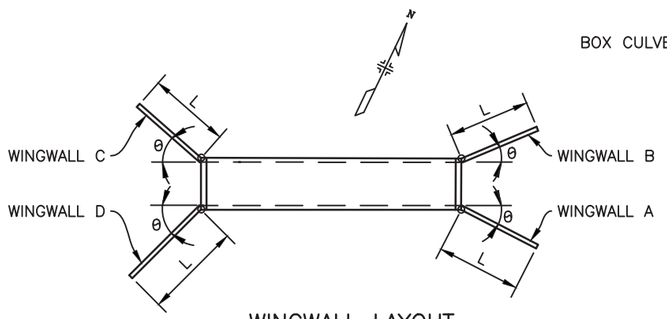
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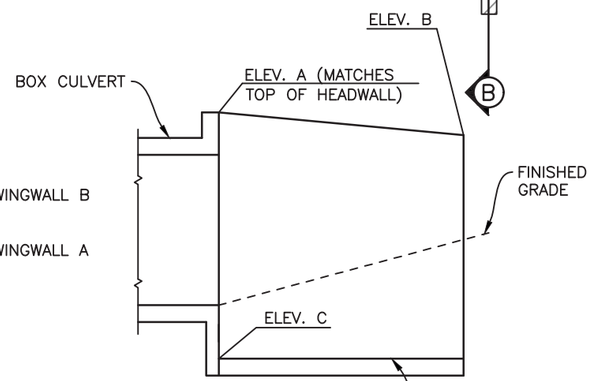
1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION.
3. PRECAST BOX CULVERT MUST CONFORM TO CDOT M-STANDARDS M-603-2.
4. FOR CAST-IN-PLACE END SECTIONS, USE M-601-2 FOR WALL THICKNESSES AND REINFORCEMENT SIZE AND SPACINGS WITH S=10 FT, R=6 FT, AND FILL HEIGHT = 0-5 FT.
5. FOR WINGWALLS AND CONCRETE APRON, USE M-601-20.



Ⓐ CHEROKEE TRAIL CROSSING PROFILE @ RCBC
STA 107+48.70 TO 108+41.52
N.T.S.

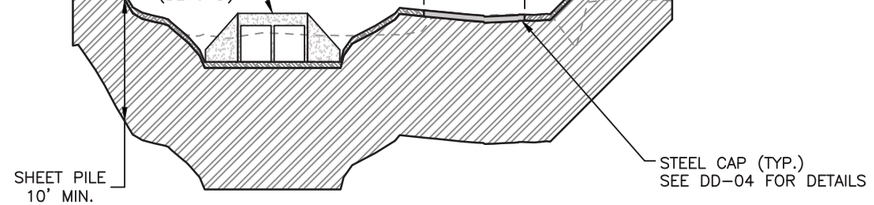


WINGWALL LAYOUT AT BOX CULVERT

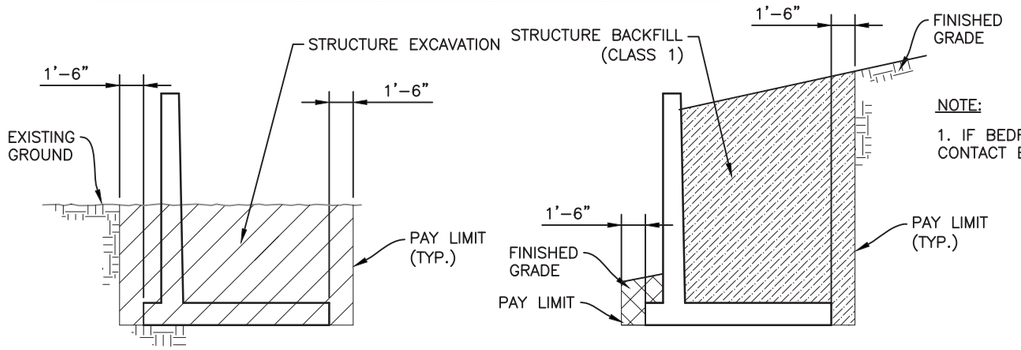


ELEVATION WINGWALLS

WINGWALL	θ	L	ELEV. A	ELEV. B	ELEV. C
A	45°0'0"	15'-6"	5767.18	5763.43	5760.43
B	45°0'0"	15'-6"	5767.18	5763.43	5760.43
C	45°0'0"	15'-6"	5768.11	5764.57	5761.36
D	45°0'0"	15'-6"	5768.11	5764.57	5761.36



Ⓑ CREST SECTION
STA 107+63.54

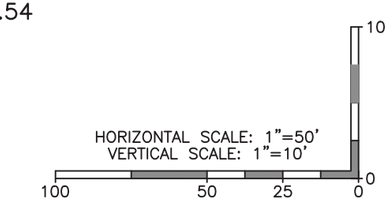


WINGWALLS EXCAVATION

WINGWALLS BACKFILL

NOTE:

1. IF BEDROCK IS ENCOUNTERED, CONTACT ENGINEER PRIOR TO PROCEEDING.



HAPPY CANYON CREEK HYDRAULICS

Q100= 8,303 C.F.S
Q100 VELOCITY = 6.11 F.P.S
FROUDE No.=0.31
FOR INFO ONLY

CHEROKEE TRAIL CROSSING

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File Name: H115360-01DROP10Δrop1 Prof Sect.dwg
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Void:

BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
CHEROKEE TRAIL PROFILE/DETAILS

Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD-11 of 19

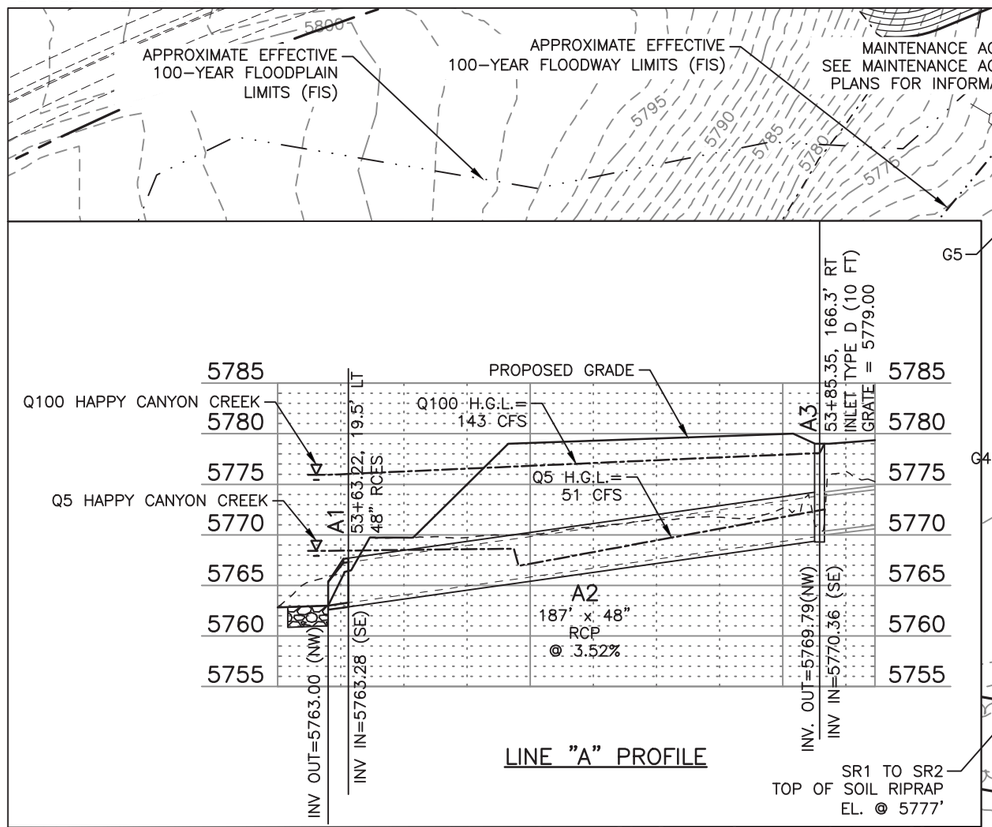
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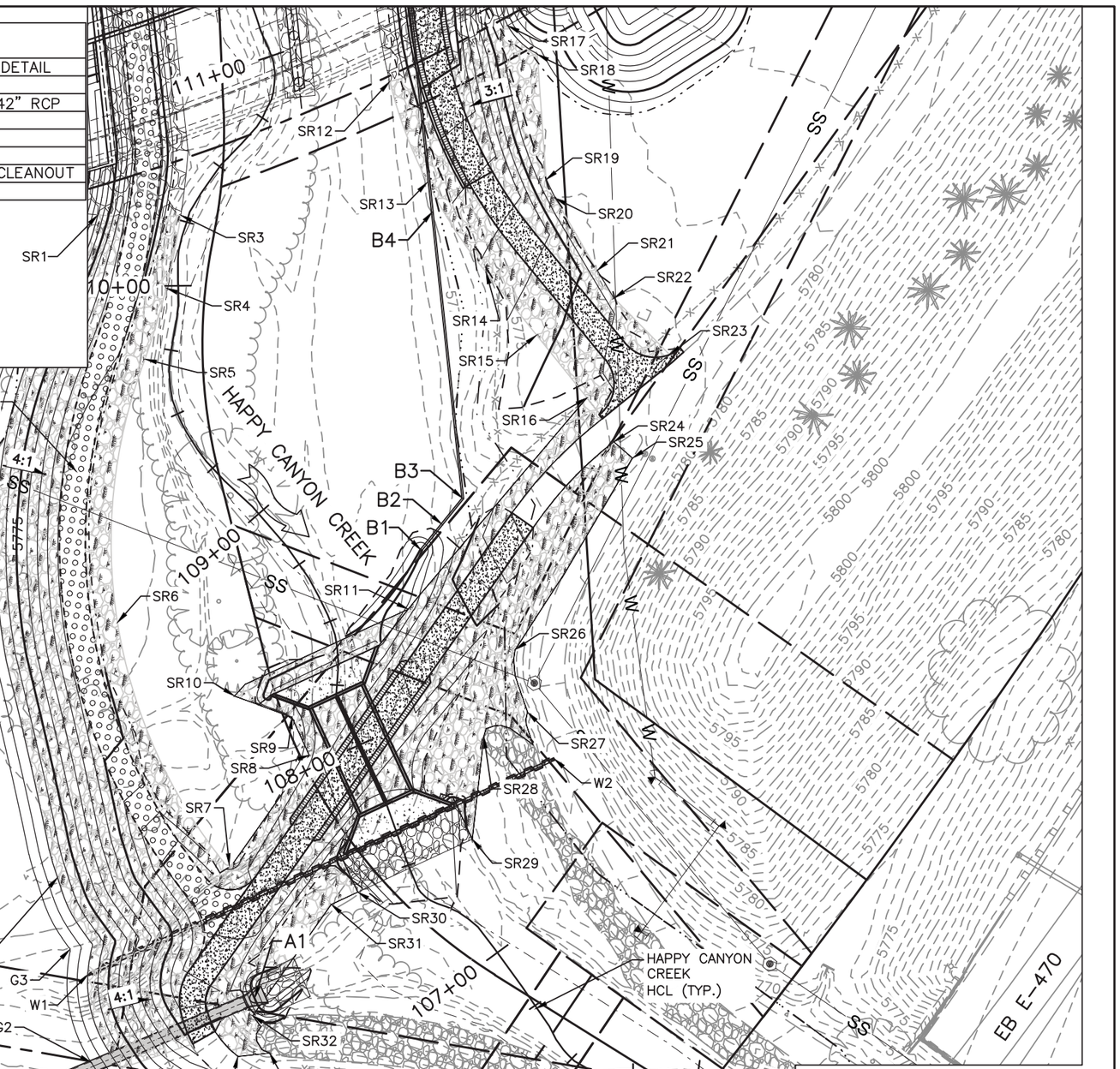
Sheet Number 75

I.D.	NORTHING & EASTING	ITEM	LENGTH	PAY DEPTH	INV. IN	INV. OUT	NOTES
A1	N: 27899.87, E: 94884.63	48" RCES, RIPRAP			5763.28	5763.00	SEE DD-07 FOR DETAIL
A2		48" RCP	187'				
A3	N: 27721.77, E: 95000.49	TYPE D INLET		10'	5770.36	5769.79	CONNECT TO EX. 42" RCP
B1	N: 27914.54, E: 94715.62					5765.00	
B2		8" PLASTIC PIPE	27'				
B3	N: 27926.90, E: 94693.26					5765.13	45 DEGREE ELBOW/CLEANOUT
B4		8" PLASTIC PIPE	241'	10'			

NOTES:

1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE SHEET DD-02 FOR POINT DATA.





Print Date: 12/1/2017 8:35:04 AM	Sheet Revisions			As Constructed
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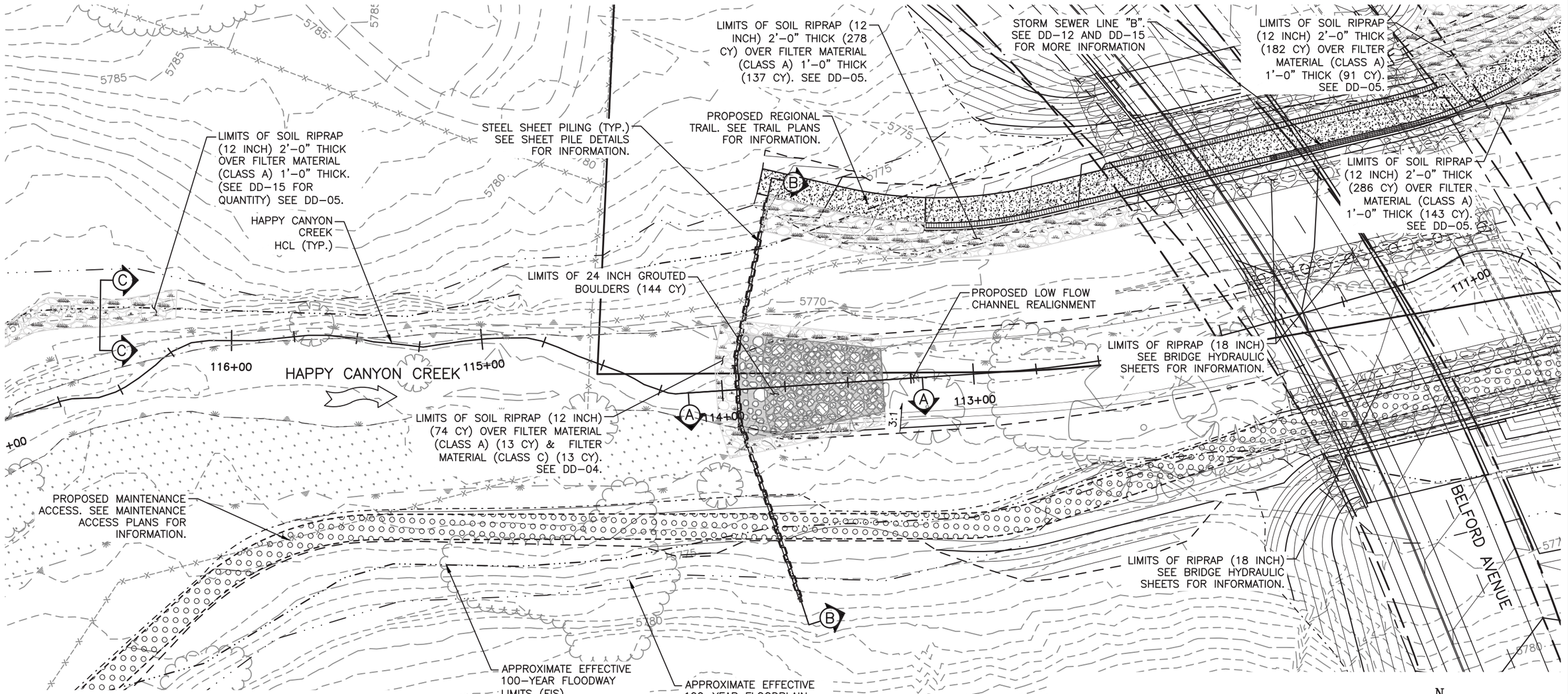
BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
CHEROKEE TRAIL GRADING DETAIL

Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	Drainage	Sheets:	DD-12 of 19

Project No./Code

Sheet Number 76

I:\115360-01 - Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\, Zach.Grady



NOTES:

1. SEE SHEET DD–02 FOR GRADING POINT DATA.
2. SEE SHEET DD–14 FOR SECTIONS A, AND B.
3. SEE SHEET DD–05 FOR SOIL RIPRAP (12 INCH) DETAILS.
4. SEE SHEET DD–06 FOR GROUTED RIPRAP DETAIL.
5. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION
6. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.

Ⓒ SOIL RIPRAP SECTION

N.T.S

STA 116+16.00 TO STA 118+80.00

LEGEND

- TOP OF CUT
- TOE OF FILL
- WETLANDS
- SOIL RIPRAP (12 INCH)
- RIPRAP (18 INCH)
- 24" GROUTED BOULDERS

N

HORIZONTAL SCALE: 1"=40'

0' 20' 40' 80'

I:\115360-01 – Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\

Print Date: 12/1/2017 8:37:14 AM
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Horizontal Scale: 1"=20' Vertical Scale: N.T.S.

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No Revisions:
Revised:
Void:

BELFORD–HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DROP NO. 1 PLAN

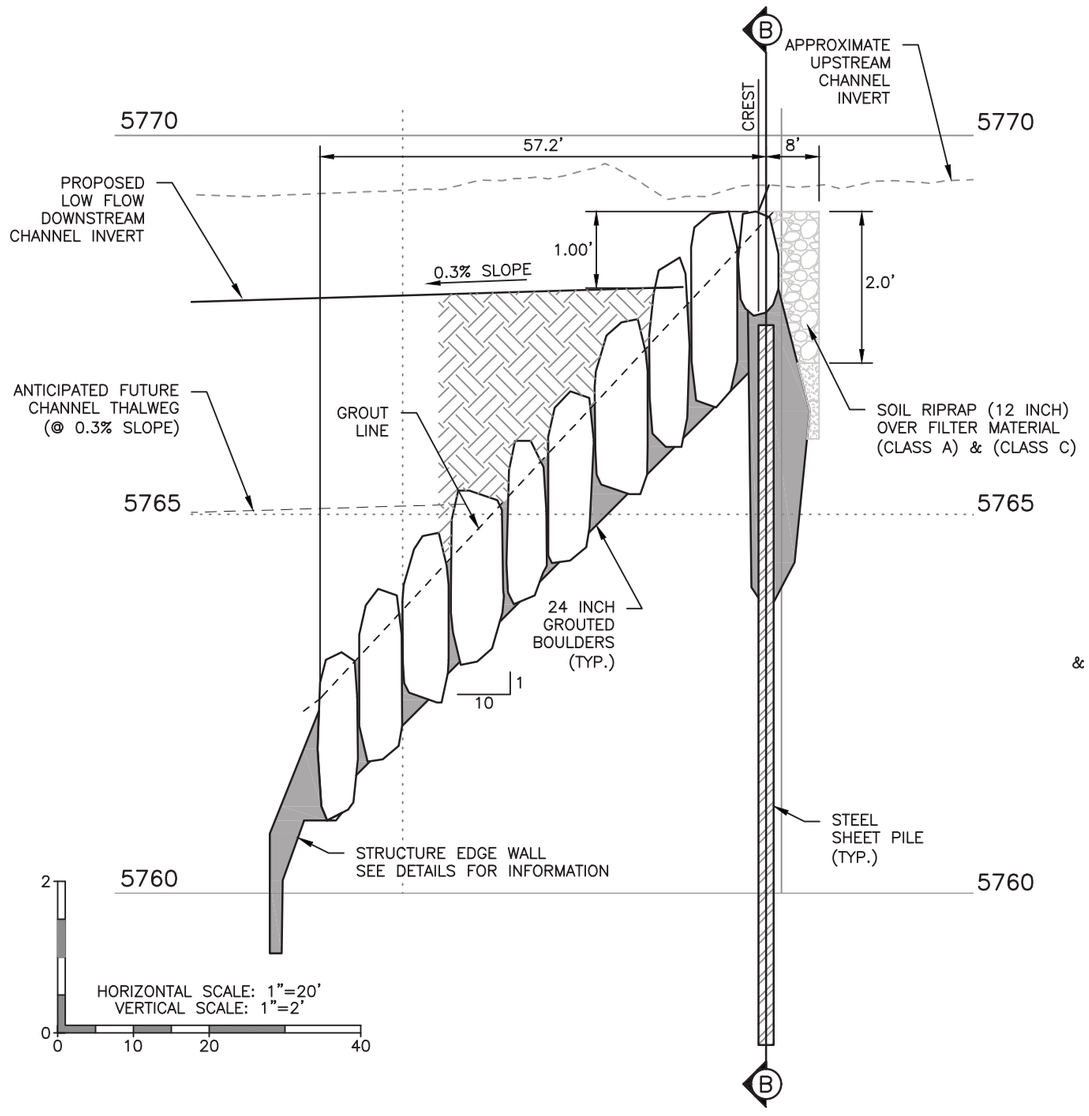
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Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD–13 of 19

Project No./Code:

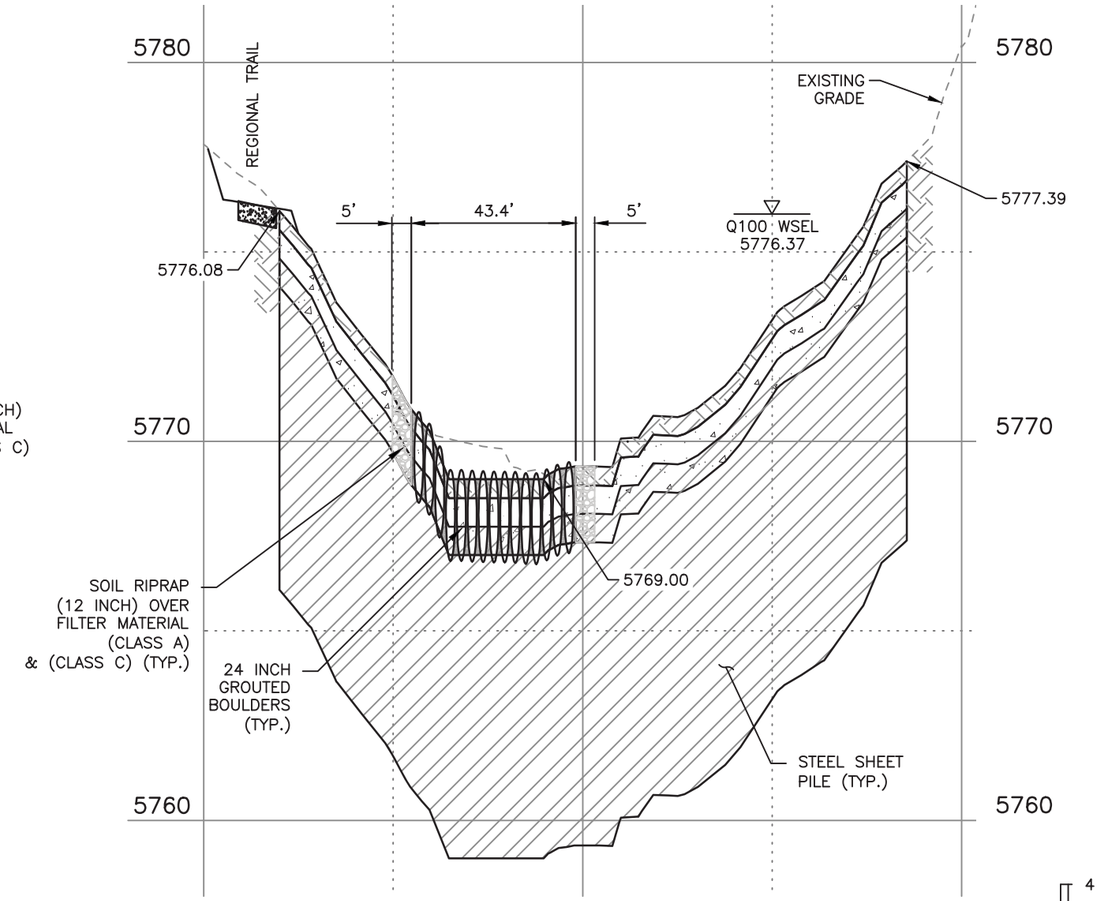
Sheet Number 77

NOTES

1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION.



Ⓐ GROUTED BOULDER DROP NO. 1 PROFILE
STA 113+39.80 TO 114+04.98



Ⓑ CREST SECTION
STATION 113+96.98

HAPPY CANYON CREEK HYDRAULICS

Q100= 8,303 C.F.S
Q100 VELOCITY = 14.17 F.P.S
FROUDE No.=0.93
FOR INFO ONLY

DROP STRUCTURE NO. 1

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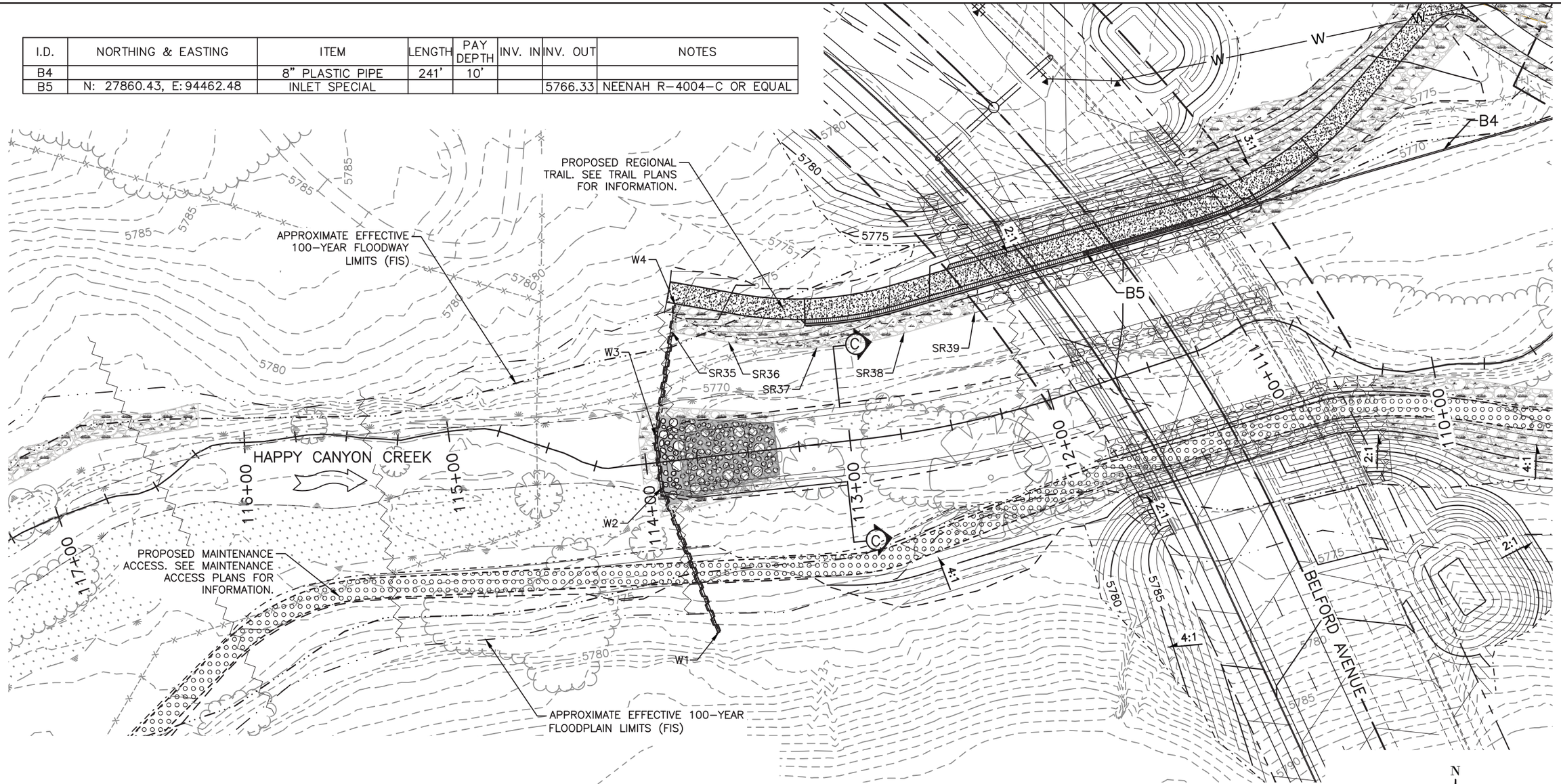
BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DROP NO. 1 PROFILE/DETAILS

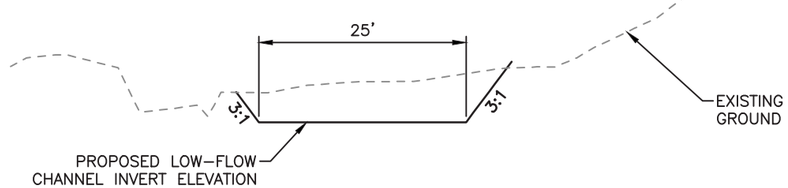
Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	Drainage	Sheets:	DD-14 of 19

Project No./Code

Sheet Number 78

I.D.	NORTHING & EASTING	ITEM	LENGTH	PAY DEPTH	INV. IN	INV. OUT	NOTES
B4		8" PLASTIC PIPE	241'	10'			
B5	N: 27860.43, E: 94462.48	INLET SPECIAL				5766.33	NEENAH R-4004-C OR EQUAL





© TYPICAL CHANNEL SECTION
N.T.S.

NOTES:

1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE SHEET DD-02 FOR POINT DATA.

N

HORIZONTAL SCALE: 1"=20'
0 10 20 40

I:\115360-01 - Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\, Zach.Grady

Print Date: 12/1/2017 8:39:53 AM
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Horizontal Scale: 1"=10' Vertical Scale: N.T.S.

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No Revisions:
Revised:
Void:

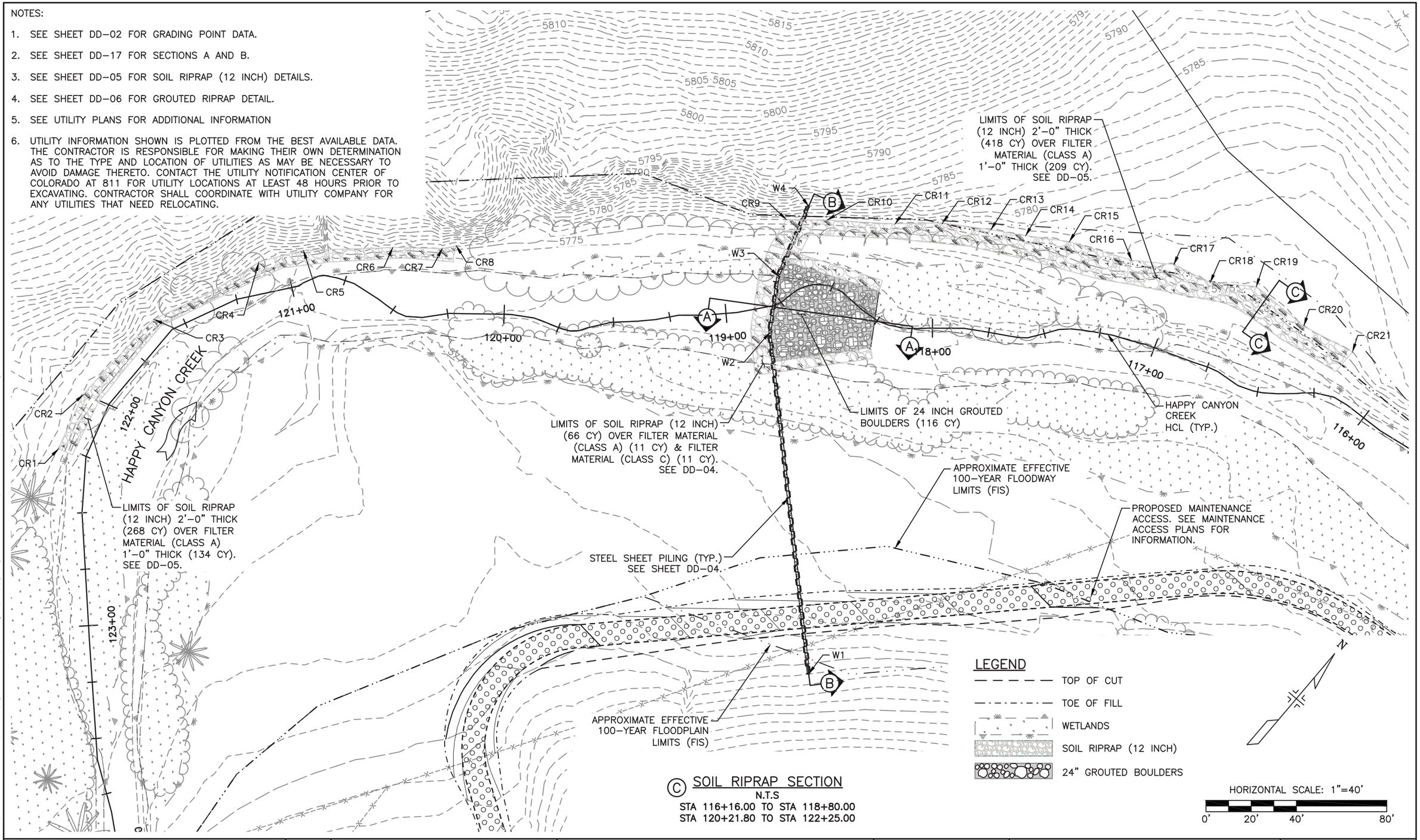
BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DROP NO. 1 GRADING DETAIL

Designer: CDT
Detailer: KLT
Subset: Drainage
Structure Numbers:
Sheets: DD-15 of 19

Project No./Code:
Sheet Number 79

NOTES:

1. SEE SHEET DD-02 FOR GRADING POINT DATA.
2. SEE SHEET DD-17 FOR SECTIONS A AND B.
3. SEE SHEET DD-05 FOR SOIL RIPRAP (12 INCH) DETAILS.
4. SEE SHEET DD-06 FOR GROUTED RIPRAP DETAIL.
5. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION
6. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.



© SOIL RIPRAP SECTION

N.T.S

STA 116+16.00 TO STA 118+80.00
STA 120+21.80 TO STA 122+25.00

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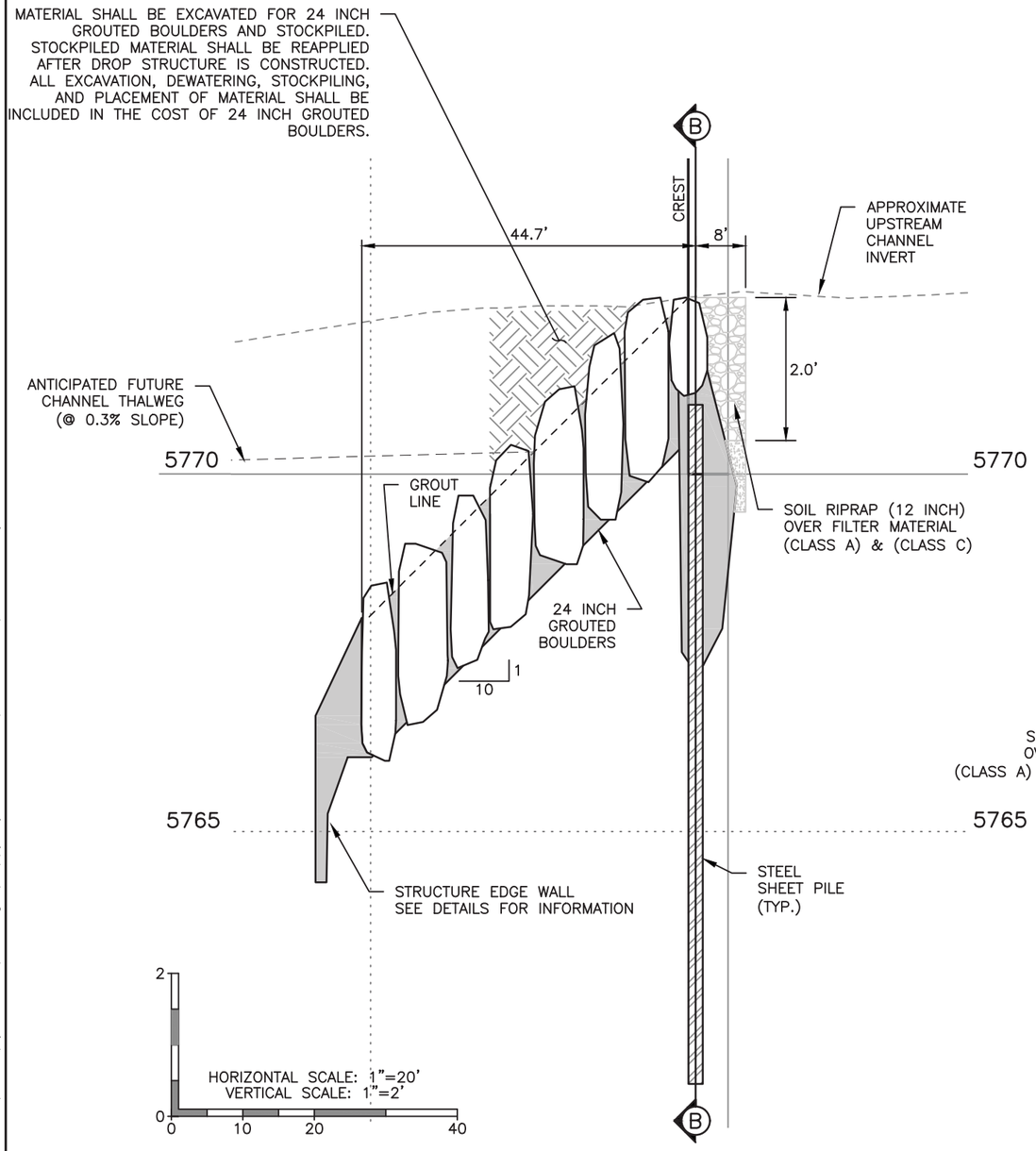
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BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DROP NO. 2 PLAN

Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	Drainage	Sheets:	DD-16 of 19

Project No./Code

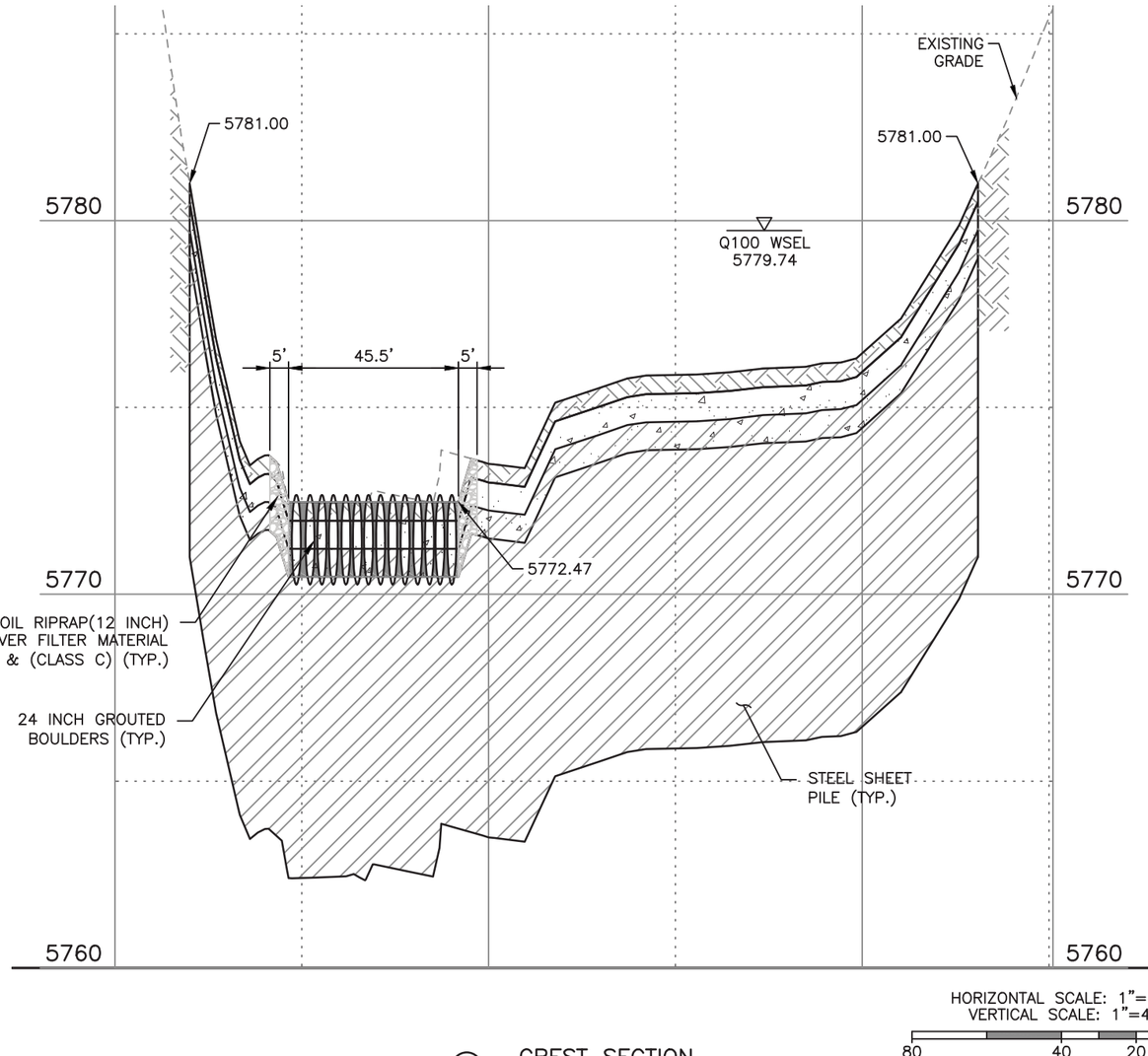
Sheet Number 80



Ⓐ GROUTED BOULDER DROP NO. 2 PROFILE
STA 118+49.81 TO 119+02.49

NOTES

1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION.



Ⓑ CREST SECTION
STATION 118+94.49

HAPPY CANYON CREEK HYDRAULICS

Q100= 8,303 C.F.S
Q100 VELOCITY = 11.93 F.P.S
FROUDE No.=0.79
FOR INFO ONLY

DROP STRUCTURE NO. 2

Print Date: 12/1/2017 8:42:47 AM		Sheet Revisions	
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No Revisions:			
Revised:	Designer: CDT	Structure Numbers	
Void:	Detailer: KLT		
	Subset: Drainage	Sheets: DD–17 of 19	Sheet Number 81

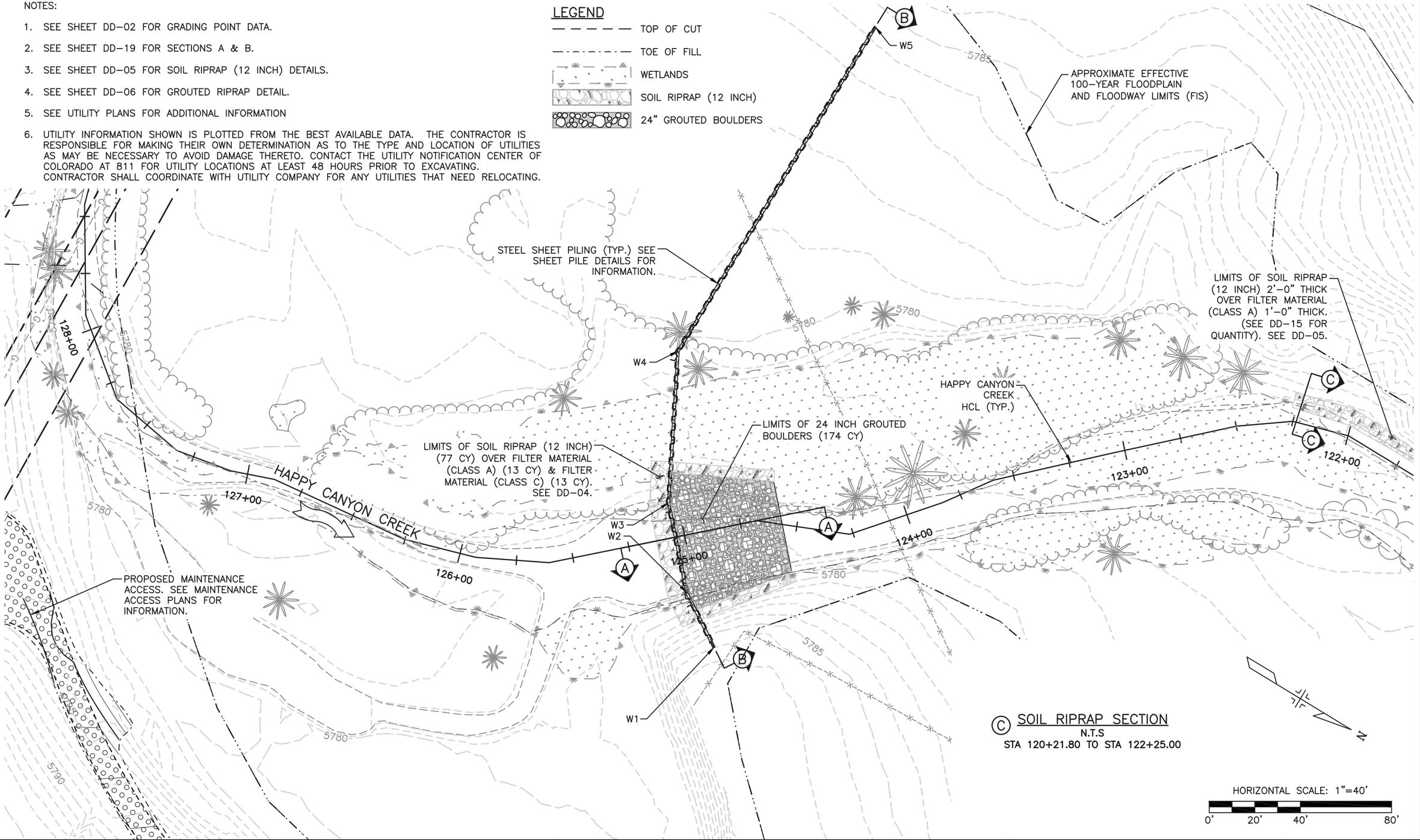
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NOTES:

1. SEE SHEET DD-02 FOR GRADING POINT DATA.
2. SEE SHEET DD-19 FOR SECTIONS A & B.
3. SEE SHEET DD-05 FOR SOIL RIPRAP (12 INCH) DETAILS.
4. SEE SHEET DD-06 FOR GROUTED RIPRAP DETAIL.
5. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION
6. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.

LEGEND

- TOP OF CUT
- TOE OF FILL
- WETLANDS
- SOIL RIPRAP (12 INCH)
- 24" GROUTED BOULDERS



Ⓒ SOIL RIPRAP SECTION
N.T.S
STA 120+21.80 TO STA 122+25.00

HORIZONTAL SCALE: 1"=40'
0' 20' 40' 80'

I:\115360-01 - Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\, Zach.Grady

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No Revisions:
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Void:

BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
DROP NO. 3 PLAN

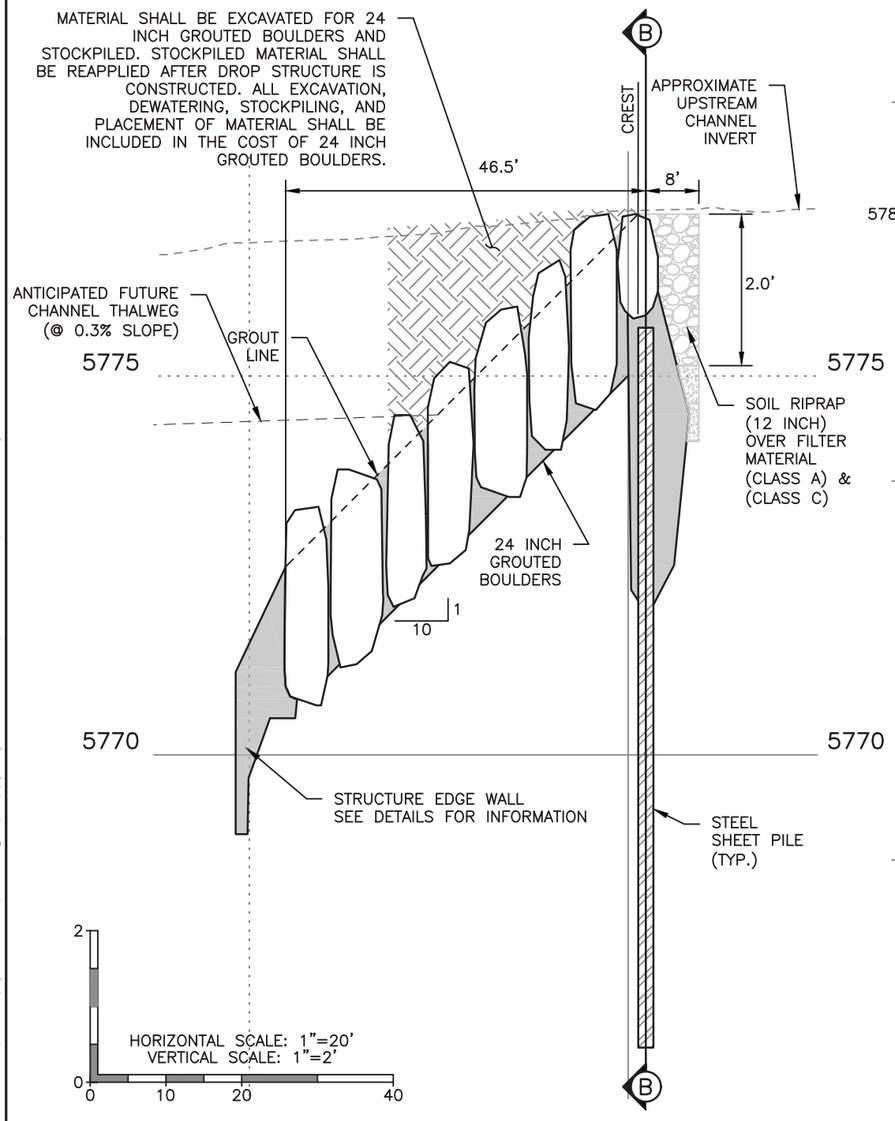
Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	Drainage	Sheets:	DD-18 of 19

Project No./Code

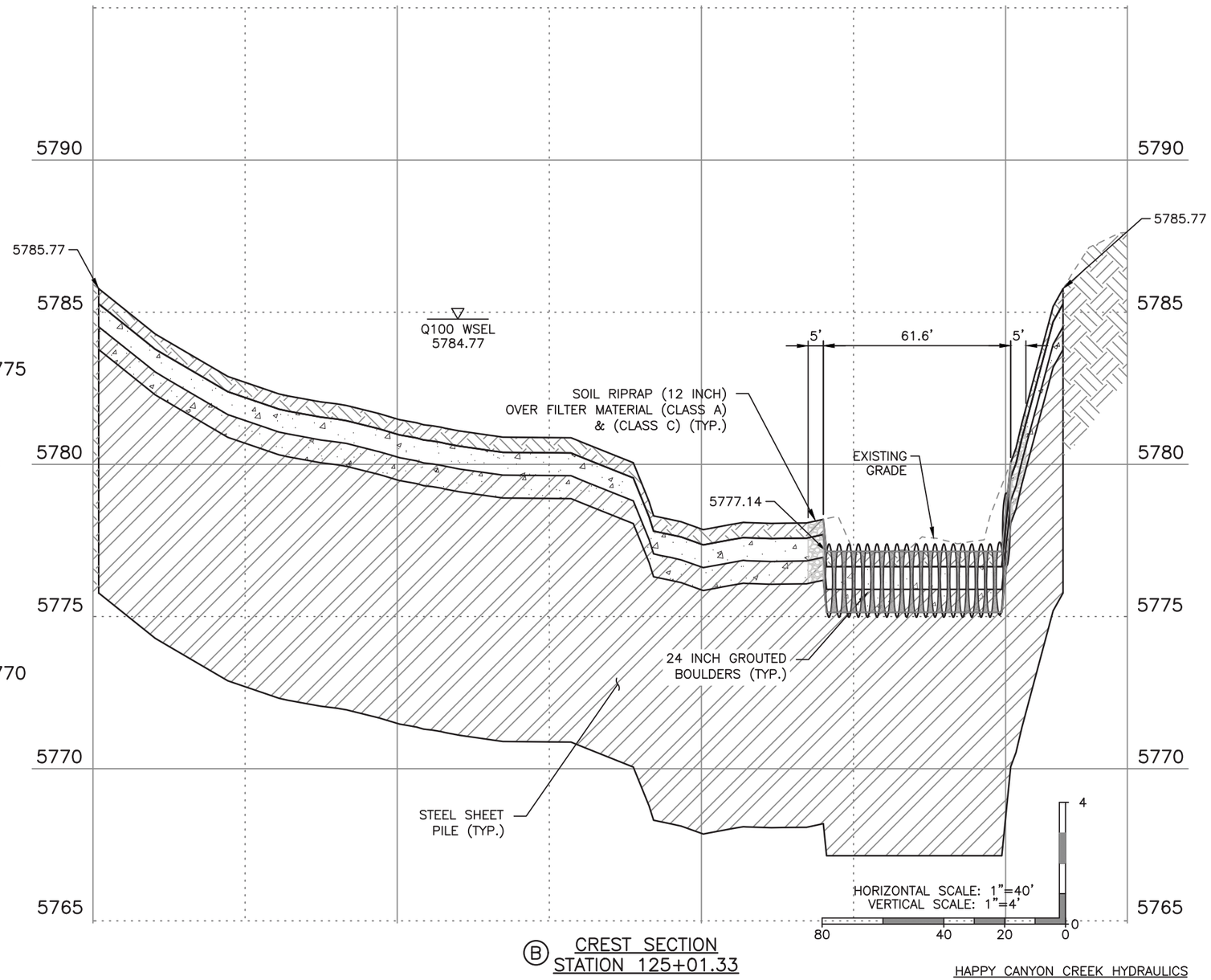
Sheet Number 82

NOTES

1. UTILITY INFORMATION SHOWN IS PLOTTED FROM THE BEST AVAILABLE DATA. THE CONTRACTOR IS RESPONSIBLE FOR MAKING THEIR OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 811 FOR UTILITY LOCATIONS AT LEAST 48 HOURS PRIOR TO EXCAVATING. CONTRACTOR SHALL COORDINATE WITH UTILITY COMPANY FOR ANY UTILITIES THAT NEED RELOCATING.
2. SEE UTILITY PLANS FOR ADDITIONAL INFORMATION.



Ⓐ GROUTED BOULDER DROP NO. 3 PROFILE
STA 124+54.81 TO 125+09.33



Ⓑ CREST SECTION
STATION 125+01.33

HAPPY CANYON CREEK HYDRAULICS

Q100= 8,303 C.F.S
Q100 VELOCITY = 8.97 F.P.S
FROUDE No.=0.58
FOR INFO ONLY

DROP STRUCTURE NO. 3

I:\115360-01 - Compark at Belford\CADD\Hydraulics\Drawings\Happy Cyn Creek Drop Structure\, Zach.Grady

Print Date: 12/1/2017 8:45:51 AM	Sheet Revisions	As Constructed	BELFORD–HAPPY CANYON CREEK HAPPY CANYON CREEK DROP STRUCTURE DROP NO. 3 PROFILE/DETAILS	Project No./Code
File Name: H115360–01DROP19Δrop3 Prof Sect.dwg	(R–X) Date / Comments / Initials	No Revisions:	Designer: CDT	Structure Numbers
Horizontal Scale: As Noted Vertical Scale: As Noted		Revised:	Detailer: KLT	
FELSBURG HOLT & ULLEVIG 6300 South Syracuse Way, Suite 600 Centennial, CO 80111 tel 303.721.1440 fax 303.721.0832		Void:	Subset: Drainage	Sheets: DD–19 of 19	Sheet Number 83

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PARKER
COLORADO

CONSTRUCTION PLANS

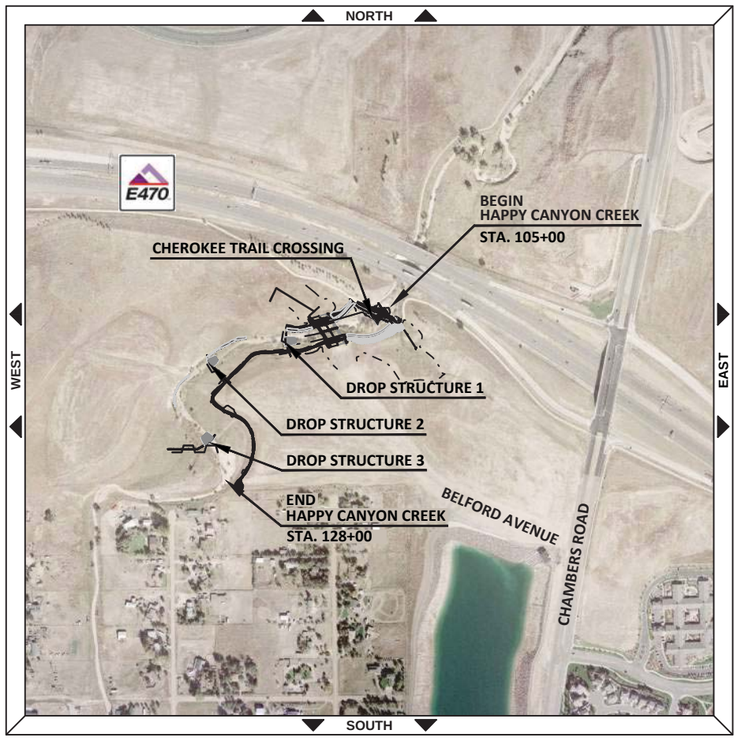
CONSTRUCTION BEST MANAGEMENT PRACTICES

BELFORD AVENUE BRIDGE AND HAPPY CANYON CREEK

TOWN OF PARKER, COUNTY OF DOUGLAS, STATE OF COLORADO

SCALE OF ORIGINAL DRAWINGS

ON PLAN 1" = 80'



INDEX OF SHEETS

SHEET NO.	SUBSET SHEETS	DESCRIPTION
83	EL–1	CBMP TITLE SHEET
84	ET–1	TABULATION OF EROSION CONTROL QUANTITIES
85–86	EI–1 TO EI–2	INITIAL CBMP PLAN
87–88	EN–1 TO EN–2	INTERIM CBMP PLAN
89–90	EF–1 TO EN–2	FINAL CBMP PLAN
91–125	ED–1 TO ED–35	CBMP STANDARD NOTES AND DETAILS

TOWN OF PARKER APPROVALS

THE TOWN OF PARKER REVIEW CONSTITUTES GENERAL COMPLIANCE WITH THE TOWNS STANDARDS AND APPROVED VARIANCES, SUBJECT TO THESE PLANS BEING STAMPED, SIGNED, AND DATED BY THE PROFESSIONAL ENGINEER OF RECORD. REVIEW BY THE TOWN DOES NOT CONSTITUTE APPROVAL OF THE PLAN DESIGN OR ACCURACY AND CORRECTNESS OF ENGINEERING CALCULATION. ERRORS IN THE DESIGN OR CALCULATIONS REMAIN THE RESPONSIBILITY OF THE REGISTERED PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE ARE AFFIXED TO THIS DOCUMENT.

THIS REVIEW DOES NOT CONSTITUTE APPROVAL OF ANY PRIVATE ON–SITE IMPROVEMENTS WHICH MAY BE SHOWN. CONSTRUCTION CANNOT COMMENCE UNTIL ALL REQUIRED DRAINAGE/TRAFFIC REPORT(S), FINAL DEVELOPMENT PLAN(S), SPECIAL REVIEW(S), GRADING PERMIT, AND/OR OTHER PERMITS ARE COMPLETE, APPROVED AND ON FILE WITH THE TOWN OF PARKER.

TOWN OF PARKER, PUBLIC WORKS DIRECTOR DATE

TOWN OF PARKER, PUBLIC WORKS MANAGER – STORMWATER DATE

TOWN OF PARKER, PUBLIC WORKS MANAGER – TRANSPORTATION DATE

BASIS OF BEARING:

THE WEST LINE OF THE SOUTHWEST QUARTER OF SECTION 6, TOWNSHIP 6 SOUTH, RANGE 66 WEST OF THE SIXTH PRINCIPAL MERIDIAN BEING MONUMENTED AS SHOWN HEREON HAVING A BEARING OF NORTH 00°29'49" WEST, AS DETERMINED BY GPS OBSERVATION FROM NGS CONTROL POINTS IN THE COLORADO CENTRAL ZONE, STATE PLAN COORDINATE SYSTEM, TOWN OF PARKER, COUNTY OF DOUGLAS, STATE OF COLORADO.

BENCHMARKS: (COMPARK SOUTH)

SOURCE BENCHMARKS:

DOUGLAS COUNTY BM 1.115010
A DOUGLAS COUNTY GIS MONUMENT SET IN CONCRETE LOCATED APPROXIMATELY 130 FEET SOUTHWESTERLY OF THE CENTERLINE OF CHAMBERS ROAD AND 95 FEET NORTHWESTERLY OF THE CENTERLINE OF COMPARK BOULEVARD.

ELEVATION = 5752.84 (NAVD 88)

SITE BENCHMARKS:

A NO. 5 REBAR WITH 2" ALUMINUM CAP STAMPED "LS 28286, 2001" FOUND AT THE SOUTHWEST CORNER OF SECTION 6, T6S, R66W LOCATED ON THE WEST LINE OF FIRST STREET APPROXIMATELY 1000 FEET NORTH OF ELM AVENUE.

ELEVATION = 5845.51

A 2.5" IRON PIPE WITH 3.25" ALUMINUM CAP STAMPED "PLS 12405, 1997" FOUND AT THE SOUTHEAST CORNER OF SECTION 6, T6S, R66W LOCATED APPROXIMATELY 960 FEET NORTH OF THE CENTERLINE OF AVENTERRA PARKWAY AND APPROXIMATELY 1050 FEET WEST OF THE CENTERLINE OF CHAMBERS ROAD.

ELEVATION = 5808.06

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BELFORD–HAPPY CANYON CREEK CBMP TITLE SHEET

Designer:	CDT	Structure Numbers	
Detailer:	KLT		
Subset:	EROSION	Sheets:	EL–1 of 1

Project No./Code

Sheet Number 84

TABULATION OF EROSION CONTROL QUANTITIES

DRAWING NUMBER	CHECK DAM (CD)	*CONCRETE WASHOUT STRUCTURE (CWA)	*VEHICLE TRACKING CONTROL (VTC)	*STABILIZED STAGING AREA (SSA)	SEEDING (NATIVE) (SMC)	MULCHING (WEED FREE STRAW) (SMC)	*CULVERT PROTECTION (CP)	DEWATERING (D)	*SEDIMENT CONTROL LOG (12 INCH) (SCL)	EROSION CONTROL BLANKET (STRAW/COCONUT) (ECB)	DIVERSION DITCH (DD)	CONSTRUCTION FENCE (CF)	SILT FENCE (SF)	#INLET PROTECTION AREA INLETS NOT IN PAVEMENT (IPAN)	##ROUGH CUT STREET CONTROL (RCSC)	TEMPORARY SEDIMENT BASIN (TSB)	TEMPORARY STREAM CONTROL (TSC)	PORTABLE TOILET PROTECTION (PTP)
	LF	EACH	EACH	SY	ACRE	ACRE	LF	LS	LF	SY	LF	LF	LF	EA	LF	EA	EA	EA
INITIAL (EI–1)	275	2	2	2300			40		1798		312	8650	883				4	1
INTERIM (EN–1)							60	1	1760					1	480	2		
FINAL (EF–1)					5.8	5.8				6180								
PROJECT TOTALS	275	2	2	2300	5.8	5.8	100	1	3558	6180	312	8650	883	1	480	2	4	1

1. THESE QUANTITIES HAVE BEEN TAKEN FORWARD TO THE SUMMARY OF APPROXIMATE QUANTITIES.
2. FOR DETAILS, SEE CBMP STANDARD NOTES AND DETAILS.
3. CHECK DAMS ARE NOT TO BE REMOVED UNLESS DIRECTED BY THE PROJECT ENGINEER.
4. MULCH TACKIFIER IS REQUIRED AND IS INCLUDED IN THE COST OF MULCHING.
5. SEE CBMP SHEETS FOR ADDITIONAL PLACEMENT INFORMATION.
6. LOCATION OF STOCKPILES, INCLUDING TOPSOIL, IMPORTED AGGREGATES, EXCESS MATERIALS, STORAGE AND STAGING AREAS FOR EQUIPMENT FUEL, LUBRICANT, CHEMICAL (AND OTHER MATERIALS), WASTE STORAGE, BORROW AND DISPOSAL AREAS SHALL BE LOCATED PRIOR TO CONSTRUCTION WITH IN THE DEFINED LIMITS OF CONSTRUCTION BY THE PROJECT ENGINEER.

* THESE ITEMS SHALL BE PAID FOR AS PLACE AND REMOVE.
\# THESE ITEMS SHALL BE PAID FOR AS INLET PROTECTION (EACH).
\## ROUGH CUT STREET CONTROL SHALL BE PAID FOR AS AGGREGATE BAG (LF)

ADDITIONAL SEDIMENT/EROSION CONTROL:
IT IS ESTIMATED THAT BLADING (120 HORSEPOWER), DOZING (100 HORSEPOWER), COMBINATION LOADER (125 HORSEPOWER) AND/OR BACKHOE (75 HORSEPOWER) AND/OR LABORER MAY BE REQUIRED FOR MISCELLANEOUS EROSION CONTROL WORK AS DIRECTED BY THE ENGINEER. WORK SHALL BE PAID FOR AS 208 SEDIMENT REMOVAL AND DISPOSAL (40 HRS). EROSION CONTROL MANAGEMENT WILL BE REQUIRED FOR THIS PROJECT AND SHALL BE PAID FOR AS 208 EROSION CONTROL MANAGEMENT (30 DAYS).

WATER CONTROL NOTES – TEMPORARY STREAM CONTROL

1. THE CONTRACTOR SHALL DEVELOP AND SUBMIT A WATER CONTROL PLAN TO THE TOWN OF PARKER FOR REVIEW AND APPROVAL TWO WEEKS PRIOR TO BEGINNING CONSTRUCTION. WATER CONTROL INCLUDES CHANNEL BASE FLOW, STORMWATER RUNOFF, AND GROUNDWATER. THE CONTRACTOR'S WATER CONTROL PLAN SHALL INCLUDE ALL MEANS AND METHODS NECESSARY IN CONVEYING A CLEAN WATER DIVERSION FOR WATER THROUGH AND FROM THE PROJECT SITE SO THAT THE WATER QUALITY OR PROPERTY DOWNSTREAM OF THE PROJECT LIMITS ARE NOT IMPACTED NEGATIVELY FROM THE PROJECT'S CONSTRUCTION ACTIVITIES.

2. THE CONTRACTOR'S MEANS AND METHODS INCLUDED IN THE CONTRACTOR'S APPROVED WATER CONTROL PLAN MAY INCLUDE, BUT ARE NOT LIMITED TO THE FOLLOWING: PLASTIC LINED DIVERSION DITCHES, TEMPORARY PIPING, HOSES, CUTOFF WALLS, CHECK DAMS, PUMPS, GENERATORS, SOUND PROOFING, TEMPORARY POWER, SHEET PILE, SHORING, SEDIMENT TRAPS, SEDIMENT BASINS, FILTER BAGS, REINFORCED ROCK BERMS, STREAM CROSSINGS, RIPRAP PADS, RIPRAP, CRUSHED ROCK AND ANY OTHER WATER CONTROL MEASURES NECESSARY AND APPROVED BY THE TOWN OF PARKER.

3. GIVEN THE NATURE OF THE PROJECT SITE'S TERRAIN AND SCOPE OF WORK, THE CONTRACTOR'S WATER CONTROL PLAN AND PROPOSAL SHALL ACCOUNT FOR THE NEED TO RELOCATE WATER CONTROL MEASURES AS NEEDED BASED ON THE CONTRACTOR'S ACTUAL CONSTRUCTION SEQUENCE AND SELECTED MEANS AND METHODS.

4. WATER QUALITY SHALL BE ONE OF THE CONTRACTOR'S PRIMARY CONCERNS. THE CONTRACTOR'S IMPLEMENTED WATER CONTROL PLAN WILL BE INSPECTED DAILY. IF FOR ANY REASON THE CONTRACTOR'S IMPLEMENTED WATER CONTROL PLAN NEEDS CORRECTIVE ACTION OR IF THE CONTRACTOR IS DIRECTED BY THE TOWN OF PARKER OR THE OWNER'S REPRESENTATIVE TO MAKE REPAIRS, THE CONTRACTOR SHALL MAKE SUCH CORRECTIONS IMMEDIATELY.

5. THE APPROXIMATE 2–YR DISCHARGE FOR HAPPY CANYON CREEK IS 309 CFS. THE AVERAGE BASE FLOW RATE IS UNKNOWN. THE ESTIMATED AVERAGE BASE FLOW RATE IS APPROXIMATELY 1 CFS.

6. ALL STREAM DIVERSION DITCHES NEED TO BE PLASTIC LINED AT A MINIMUM AS DIRECTED BY THE TOWN OF PARKER.

7. ALL TEMPORARY STREAM CROSSINGS SHALL BE COMPLETELY RIPRAP REINFORCED AND HAVE PLASTIC LINING UNDER THE RIPRAP. THE CONTRACTOR'S SELECTED STREAM CROSSING SHALL ACCOMMODATE PASSAGE FOR BASE FLOWS AND AT NO TIME SHALL CONTRACTORS' EQUIPMENT HAVE DIRECT CONTACT WITH ANY STREAM FLOW.

8. ALL INCIDENTAL WATER CONTROL ITEMS SHALL BE PAID FOR AS TEMPORARY STREAM CROSSING (EA).

CBMP LEGEND

- CD — CHECK DAM
- CF — CONSTRUCTION FENCE
- CP — CULVERT PROTECTION
- CWA — CONCRETE WASHOUT AREA
- D — DEWATERING
- DD — DIVERSION DITCH
- ECB — EROSION CONTROL BLANKET (STRAW/COCONUT)
- IPAN — INLET PROTECTION FOR AREA INLETS NOT IN PAVEMENT
- LOC — LIMITS OF CONSTRUCTION
- PTP — PORTABLE TOILET PROTECTION
- RCSC — ROUGH CUT STREET CONTROL
- SCL — SEDIMENT CONTROL LOG (12 INCH)
- SF — SILT FENCE
- SMC — SEEDING MULCHING AND CRIMPING
- SSA — STABILIZED STAGING AREA
- TSB — TEMPORARY SEDIMENT BASIN
- TSC — TEMPORARY STREAM CONTROL
- VTC — VEHICLE TRACKING CONTROL

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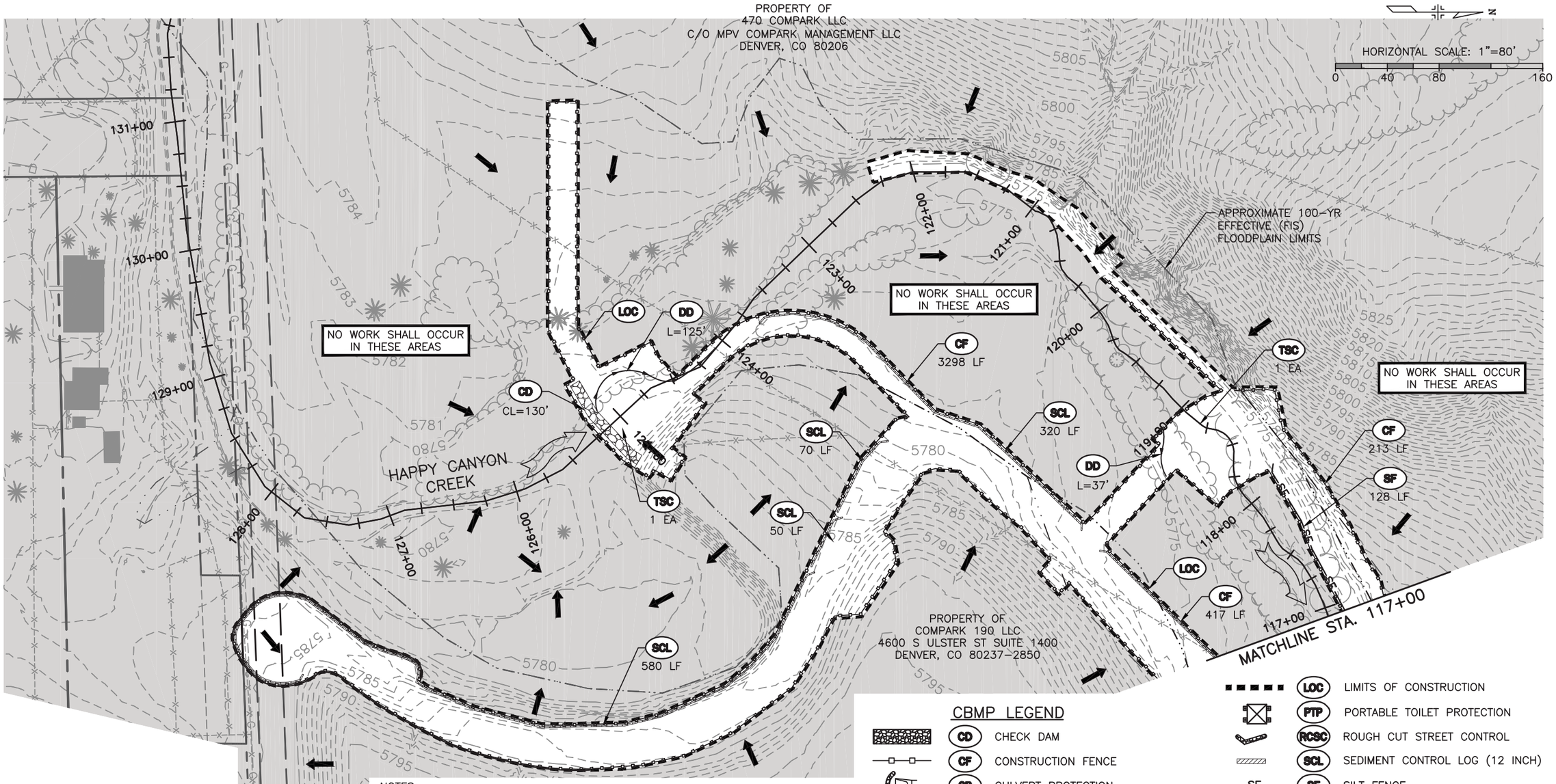
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BELFORD–HAPPY CANYON CREEK
TABULATION OF
EROSION CONTROL QUANTITIES

Designer: CDT
Detailer: KLT
Subset: EROSION
Structure Numbers:
Sheets: ET–1 of 1

Project No./Code:

Sheet Number 85



LEGEND

- TOP OF CUT
- TOE OF FILL
- LIMITS OF CONSTRUCTION
- GENERAL FLOW DIRECTION
- WETLANDS

CBMP LEGEND

CD	CHECK DAM	
CF	CONSTRUCTION FENCE	
CP	CULVERT PROTECTION	
CWA	CONCRETE WASHOUT AREA	
D	DEWATERING	
DD	DIVERSION DITCH	
ECB	EROSION CONTROL BLANKET (STRAW/COCONUT)	
IPAN	INLET PROTECTION FOR AREA INLETS NOT IN PAVEMENT	
LOC	LIMITS OF CONSTRUCTION	
PTP	PORTABLE TOILET PROTECTION	
RCSC	ROUGH CUT STREET CONTROL	
SCL	SEDIMENT CONTROL LOG (12 INCH)	
SF	SILT FENCE	
SMC	SEEDING MULCHING AND CRIMPING	
SSA	STABILIZED STAGING AREA	
TSB	TEMPORARY SEDIMENT BASIN	
TSC	TEMPORARY STREAM CONTROL (SEE WATER CONTROL NOTES ON ET-1)	
VTC	VEHICLE TRACKING CONTROL	

NOTES:

1. TEMPORARY CONSTRUCTION EASEMENTS SHALL NOT BE CLEARED AND GRUBBED UNLESS IT IS REQUIRED IN ORDER TO CONSTRUCT THE ROADWAY SECTION. THE CONTRACTOR SHALL USE PARTICULAR CARE TO MINIMIZE DAMAGE TO PLANTINGS WITHIN THE PROPERTY.
2. ALL DIRTY STREETS, CURBS, GUTTER, SIDEWALKS, LITTER AND OTHER CONSTRUCTION TRASH/DEBRIS, ETC. MUST BE THOROUGHLY CLEANED THROUGHOUT THE DAY AS THESE AREAS BECOME SOILED. NO EXCEPTIONS WILL BE MADE.
3. NO WORK SHALL OCCUR ON ANY AREA ADJACENT TO THE PROJECT OUTSIDE THE LIMITS OF CONSTRUCTION.

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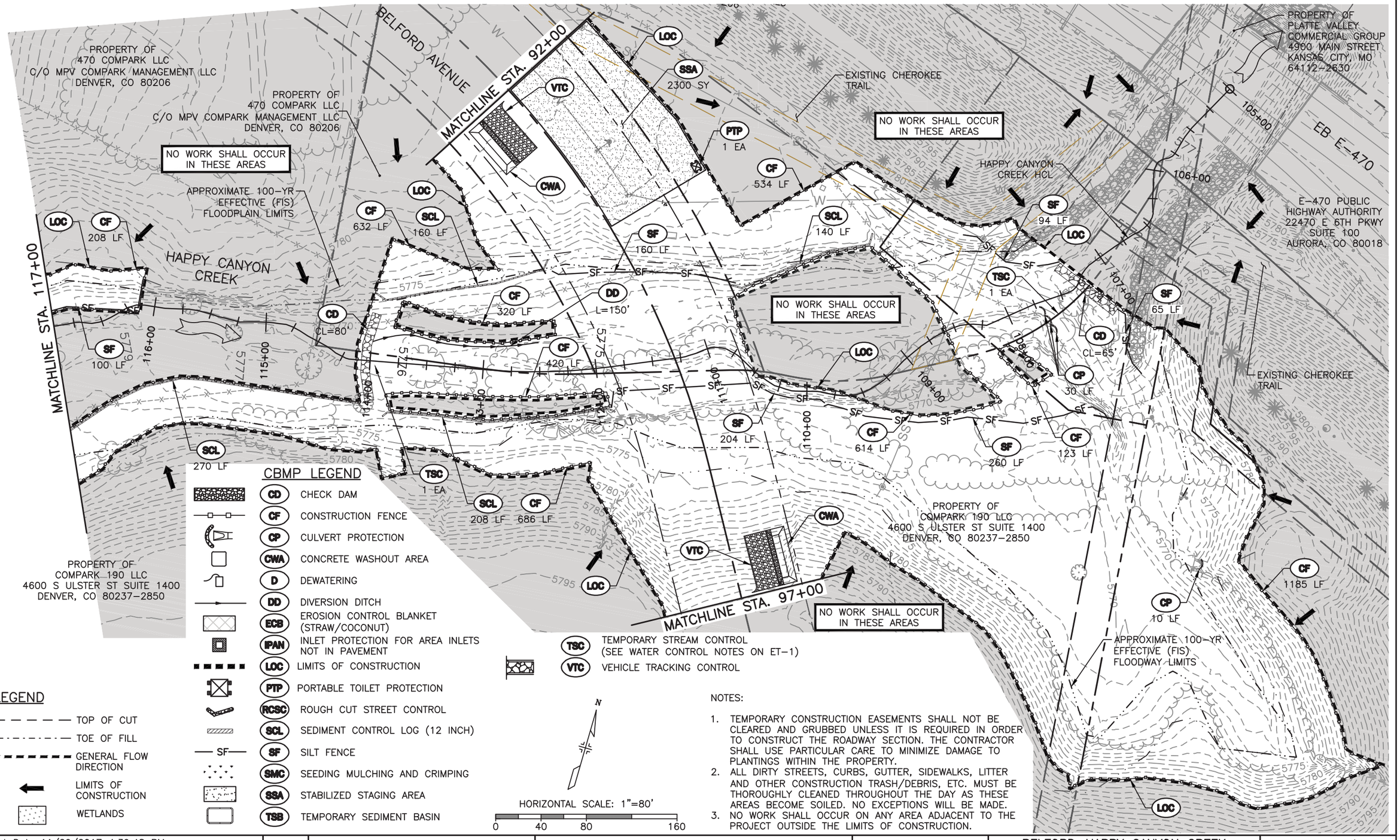
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No Revisions:
Revised:
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PEORIA & BELFORD INTERSECTION
HAPPY CANYON CREEK DROP STRUCTURE
INITIAL CBMP PLAN

Designer: CDT
Detailer: KLT
Subset: Erosion
Structure Numbers:
Sheets: EI-1 of 2

Project No./Code:
Sheet Number 86

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CBMP LEGEND

CD	CHECK DAM	
CF	CONSTRUCTION FENCE	
CP	CULVERT PROTECTION	
CWA	CONCRETE WASHOUT AREA	
D	DEWATERING	
DD	DIVERSION DITCH	
ECB	EROSION CONTROL BLANKET (STRAW/COCONUT)	
IPAN	INLET PROTECTION FOR AREA INLETS NOT IN PAVEMENT	
LOC	LIMITS OF CONSTRUCTION	
PTP	PORTABLE TOILET PROTECTION	
RCSC	ROUGH CUT STREET CONTROL	
SCL	SEDIMENT CONTROL LOG (12 INCH)	
SF	SILT FENCE	
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SSA	STABILIZED STAGING AREA	
TSB	TEMPORARY SEDIMENT BASIN	
TSC	TEMPORARY STREAM CONTROL (SEE WATER CONTROL NOTES ON ET-1)	
VTC	VEHICLE TRACKING CONTROL	

LEGEND

- TOP OF CUT
- TOE OF FILL
- GENERAL FLOW DIRECTION
- LIMITS OF CONSTRUCTION
- WETLANDS

HORIZONTAL SCALE: 1"=80'
0 40 80 160

NOTES:

1. TEMPORARY CONSTRUCTION EASEMENTS SHALL NOT BE CLEARED AND GRUBBED UNLESS IT IS REQUIRED IN ORDER TO CONSTRUCT THE ROADWAY SECTION. THE CONTRACTOR SHALL USE PARTICULAR CARE TO MINIMIZE DAMAGE TO PLANTINGS WITHIN THE PROPERTY.
2. ALL DIRTY STREETS, CURBS, GUTTER, SIDEWALKS, LITTER AND OTHER CONSTRUCTION TRASH/DEBRIS, ETC. MUST BE THOROUGHLY CLEANED THROUGHOUT THE DAY AS THESE AREAS BECOME SOILED. NO EXCEPTIONS WILL BE MADE.
3. NO WORK SHALL OCCUR ON ANY AREA ADJACENT TO THE PROJECT OUTSIDE THE LIMITS OF CONSTRUCTION.

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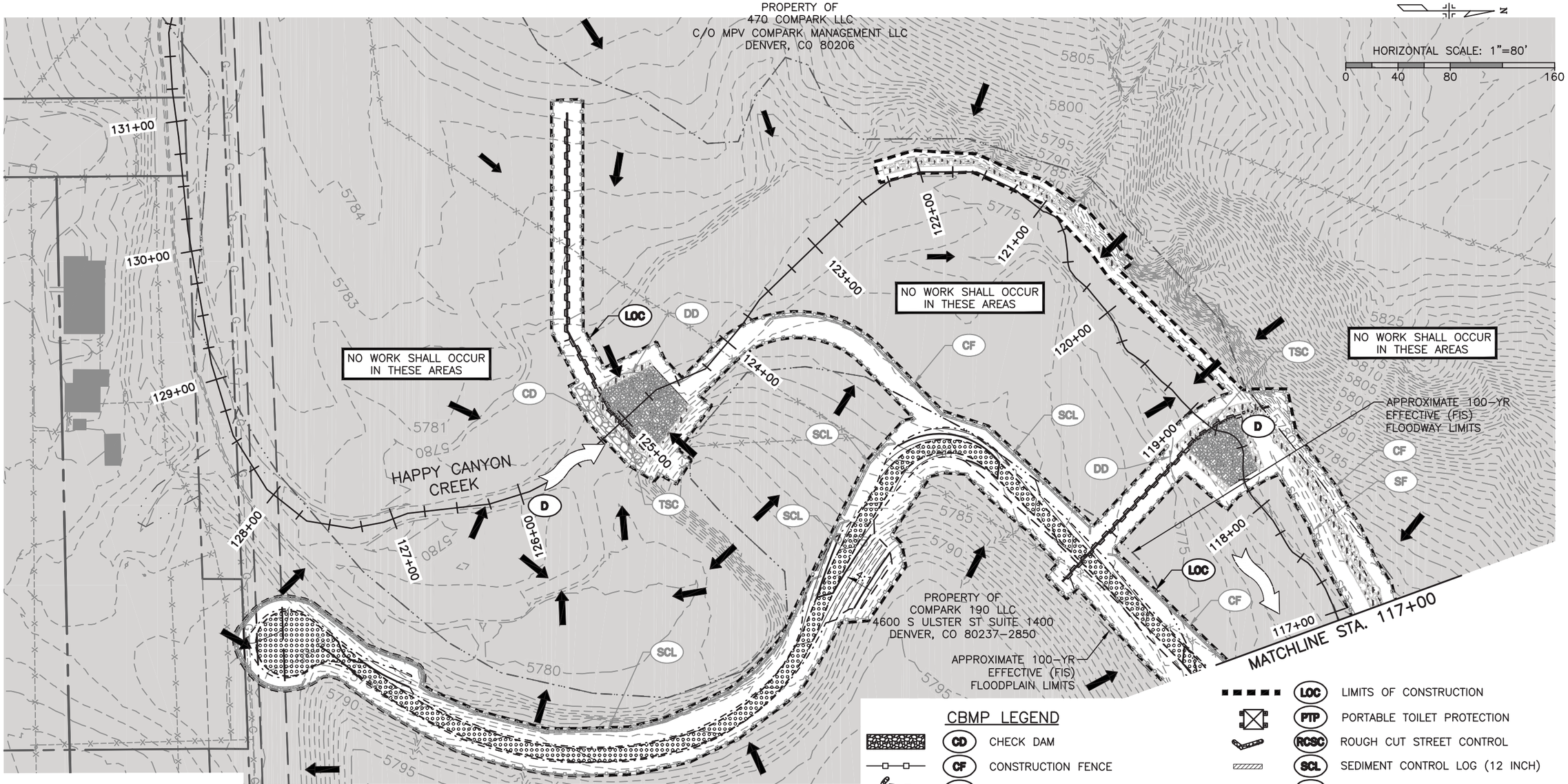
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BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
INITIAL CBMP PLAN

Designer: CDT
Detailer: KLT
Subset: Erosion
Structure Numbers:
Sheets: EI-2 of 2

Project No./Code

Sheet Number 87



LEGEND

- TOP OF CUT
- TOE OF FILL
- LIMITS OF CONSTRUCTION
- GENERAL FLOW DIRECTION
- WETLANDS

NOTES:

1. TEMPORARY CONSTRUCTION EASEMENTS SHALL NOT BE CLEARED AND GRUBBED UNLESS IT IS REQUIRED IN ORDER TO CONSTRUCT THE ROADWAY SECTION. THE CONTRACTOR SHALL USE PARTICULAR CARE TO MINIMIZE DAMAGE TO PLANTINGS WITHIN THE PROPERTY.
2. * EROSION CONTROL ITEMS INSTALLED IN THE INITIAL EROSION CONTROL PLAN SHALL REMAIN IN PLACE FOR INTERIM PHASES OF CONSTRUCTION AND SHALL BE REMOVED, MODIFIED OR REPLACED AT THE DIRECTION OF THE PROJECT ENGINEER. THESE ITEMS SHALL BE PAID FOR AS PLACE AND REMOVE.
3. NO WORK SHALL OCCUR ON ANY AREA ADJACENT TO THE PROJECT OUTSIDE THE LIMITS OF CONSTRUCTION.

CBMP LEGEND

CD	CHECK DAM	LOC	LIMITS OF CONSTRUCTION
CF	CONSTRUCTION FENCE	PTP	PORTABLE TOILET PROTECTION
CP	CULVERT PROTECTION	RCSC	ROUGH CUT STREET CONTROL
CWA	CONCRETE WASHOUT AREA	SCL	SEDIMENT CONTROL LOG (12 INCH)
D	DEWATERING	SF	SILT FENCE
DD	DIVERSION DITCH	SMC	SEEDING MULCHING AND CRIMPING
ECB	EROSION CONTROL BLANKET (STRAW/COCONUT)	SSA	STABILIZED STAGING AREA
IPAN	INLET PROTECTION FOR AREA INLETS NOT IN PAVEMENT	TSB	TEMPORARY SEDIMENT BASIN
		TSC	TEMPORARY STREAM CONTROL (SEE WATER CONTROL NOTES SHEET ET-1)
		VTC	VEHICLE TRACKING CONTROL

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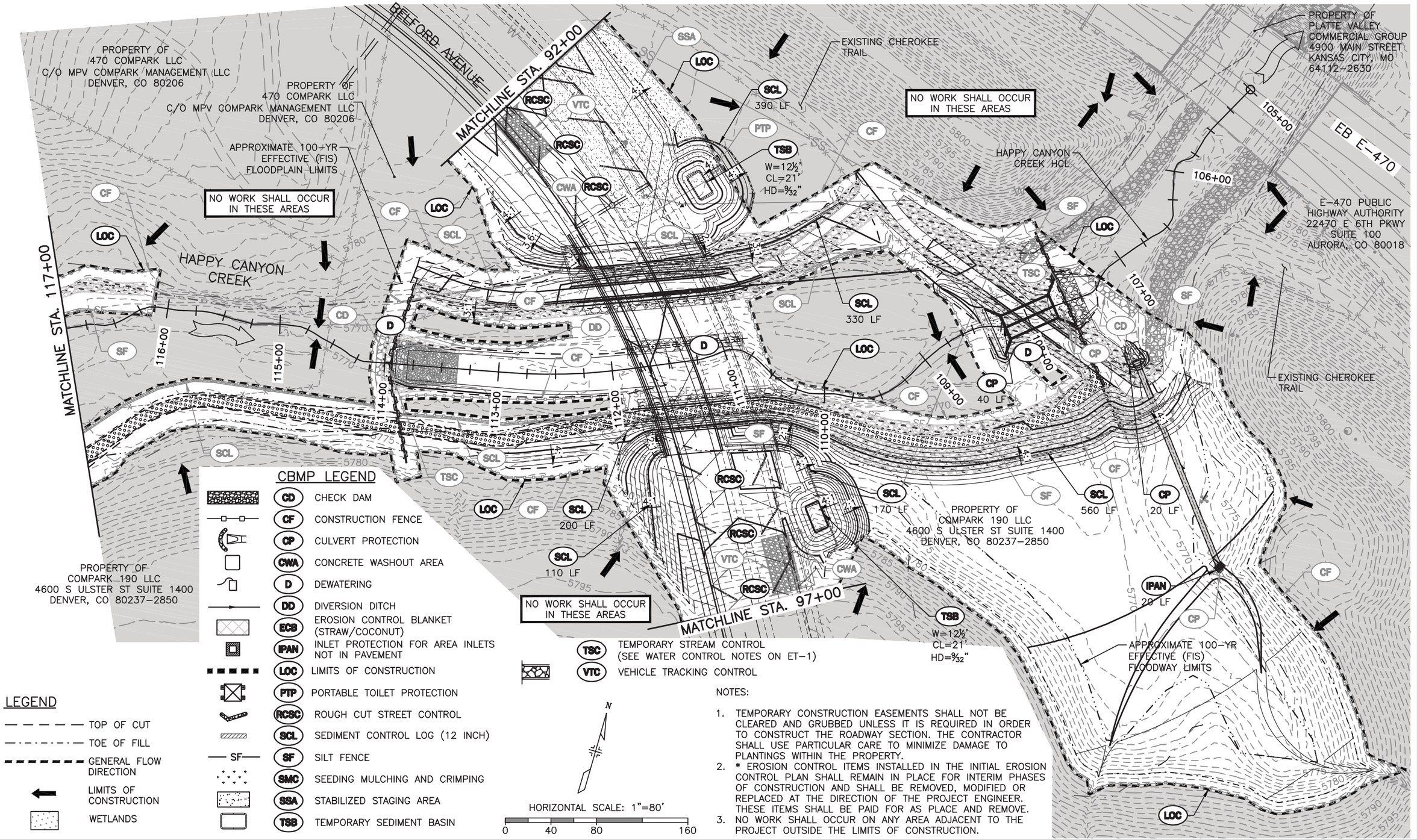
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Revised:
Void:

BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
INTERIM CBMP PLAN

Designer: CDT
Detailer: KLT
Subset: Erosion
Structure Numbers:
Sheets: EN-1 of 2

Project No./Code:
Sheet Number 88



CBMP LEGEND

CD	CHECK DAM	
CF	CONSTRUCTION FENCE	
CP	CULVERT PROTECTION	
CWA	CONCRETE WASHOUT AREA	
D	DEWATERING	
DD	DIVERSION DITCH	
ECB	EROSION CONTROL BLANKET (STRAW/COCONUT)	
IPAN	INLET PROTECTION FOR AREA INLETS NOT IN PAVEMENT	
LOC	LIMITS OF CONSTRUCTION	
PTP	PORTABLE TOILET PROTECTION	
RCSC	ROUGH CUT STREET CONTROL	
SCL	SEDIMENT CONTROL LOG (12 INCH)	
SF	SILT FENCE	
SMC	SEEDING MULCHING AND CRIMPING	
SSA	STABILIZED STAGING AREA	
TSB	TEMPORARY SEDIMENT BASIN	
TSC	TEMPORARY STREAM CONTROL (SEE WATER CONTROL NOTES ON ET-1)	
VTC	VEHICLE TRACKING CONTROL	

LEGEND

- TOP OF CUT
- TOE OF FILL
- GENERAL FLOW DIRECTION
- LIMITS OF CONSTRUCTION
- WETLANDS

HORIZONTAL SCALE: 1"=80'

0 40 80 160

NOTES:

1. TEMPORARY CONSTRUCTION EASEMENTS SHALL NOT BE CLEARED AND GRUBBED UNLESS IT IS REQUIRED IN ORDER TO CONSTRUCT THE ROADWAY SECTION. THE CONTRACTOR SHALL USE PARTICULAR CARE TO MINIMIZE DAMAGE TO PLANTINGS WITHIN THE PROPERTY.
2. * EROSION CONTROL ITEMS INSTALLED IN THE INITIAL EROSION CONTROL PLAN SHALL REMAIN IN PLACE FOR INTERIM PHASES OF CONSTRUCTION AND SHALL BE REMOVED, MODIFIED OR REPLACED AT THE DIRECTION OF THE PROJECT ENGINEER. THESE ITEMS SHALL BE PAID FOR AS PLACE AND REMOVE.
3. NO WORK SHALL OCCUR ON ANY AREA ADJACENT TO THE PROJECT OUTSIDE THE LIMITS OF CONSTRUCTION.

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FELSBURG HOLT & ULLEVIG
6300 South Syracuse Way, Suite 600
Centennial, CO 80111
tel 303.721.1440
fax 303.721.0832

Sheet Revisions

R-X	Date	Comments	Initials

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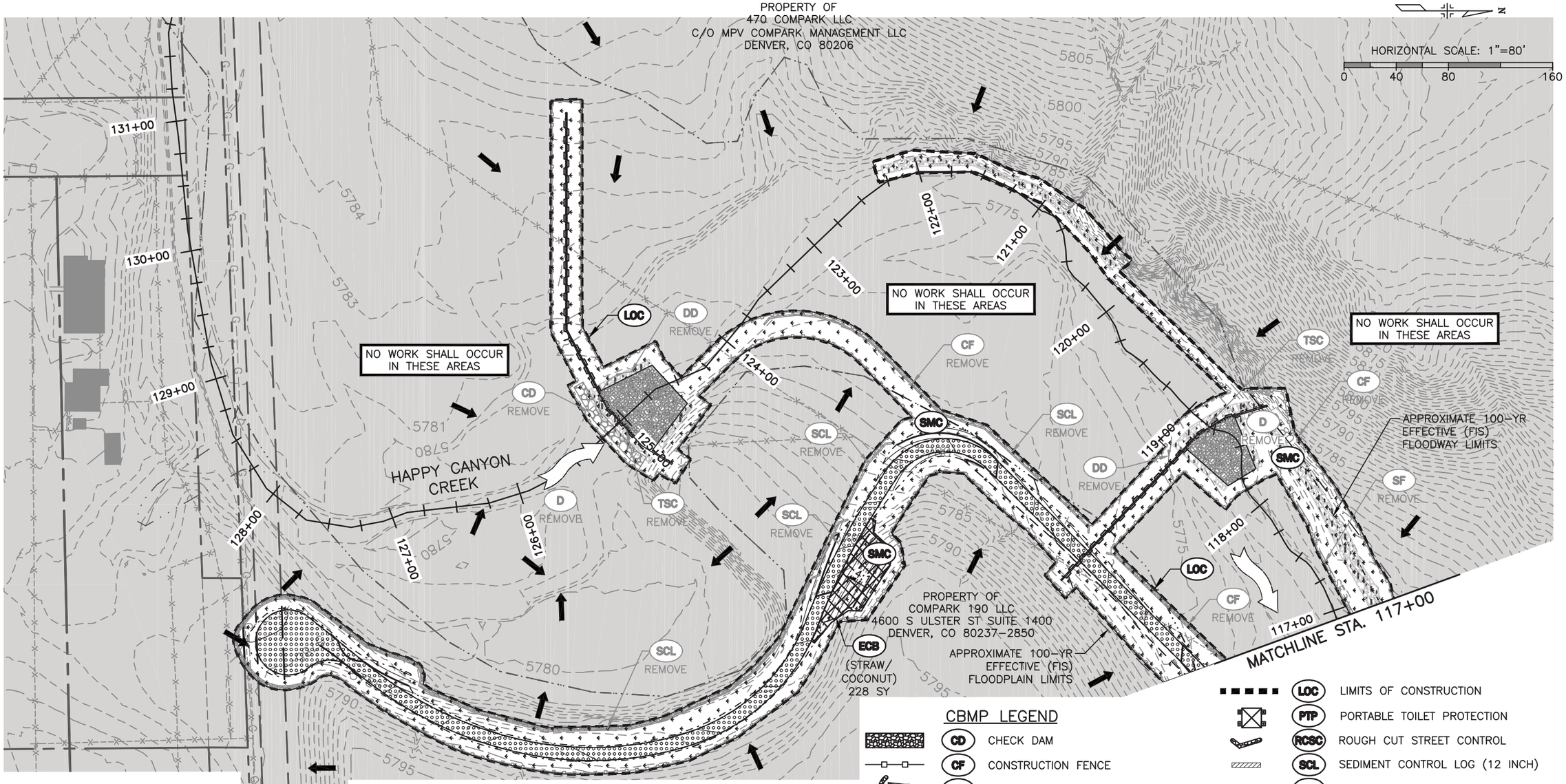
As Constructed
No Revisions:
Revised:
Void:

BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
INTERIM CBMP PLAN

Designer: CDT
Detailer: KLT
Subset: Erosion
Structure Numbers:
Sheets: EN-2 of 2

Project No./Code:
Sheet Number 89

I:\115360-01 - Compark at Belford\CADD\Erosion\Drawings\Happy Cyn Creek Drop Structure\, Kelly.Turner



LEGEND

- TOP OF CUT
- TOE OF FILL
- LIMITS OF CONSTRUCTION
- GENERAL FLOW DIRECTION
- WETLANDS

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CBMP LEGEND

CD	CHECK DAM	LOC	LIMITS OF CONSTRUCTION
CF	CONSTRUCTION FENCE	PTP	PORTABLE TOILET PROTECTION
CP	CULVERT PROTECTION	RCSC	ROUGH CUT STREET CONTROL
CWA	CONCRETE WASHOUT AREA	SCL	SEDIMENT CONTROL LOG (12 INCH)
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IPAN	INLET PROTECTION FOR AREA INLETS NOT IN PAVEMENT	TSB	TEMPORARY SEDIMENT BASIN
		TSC	TEMPORARY STREAM CONTROL (SEE WATER CONTROL NOTES SHEET ET-1)
		VTC	VEHICLE TRACKING CONTROL

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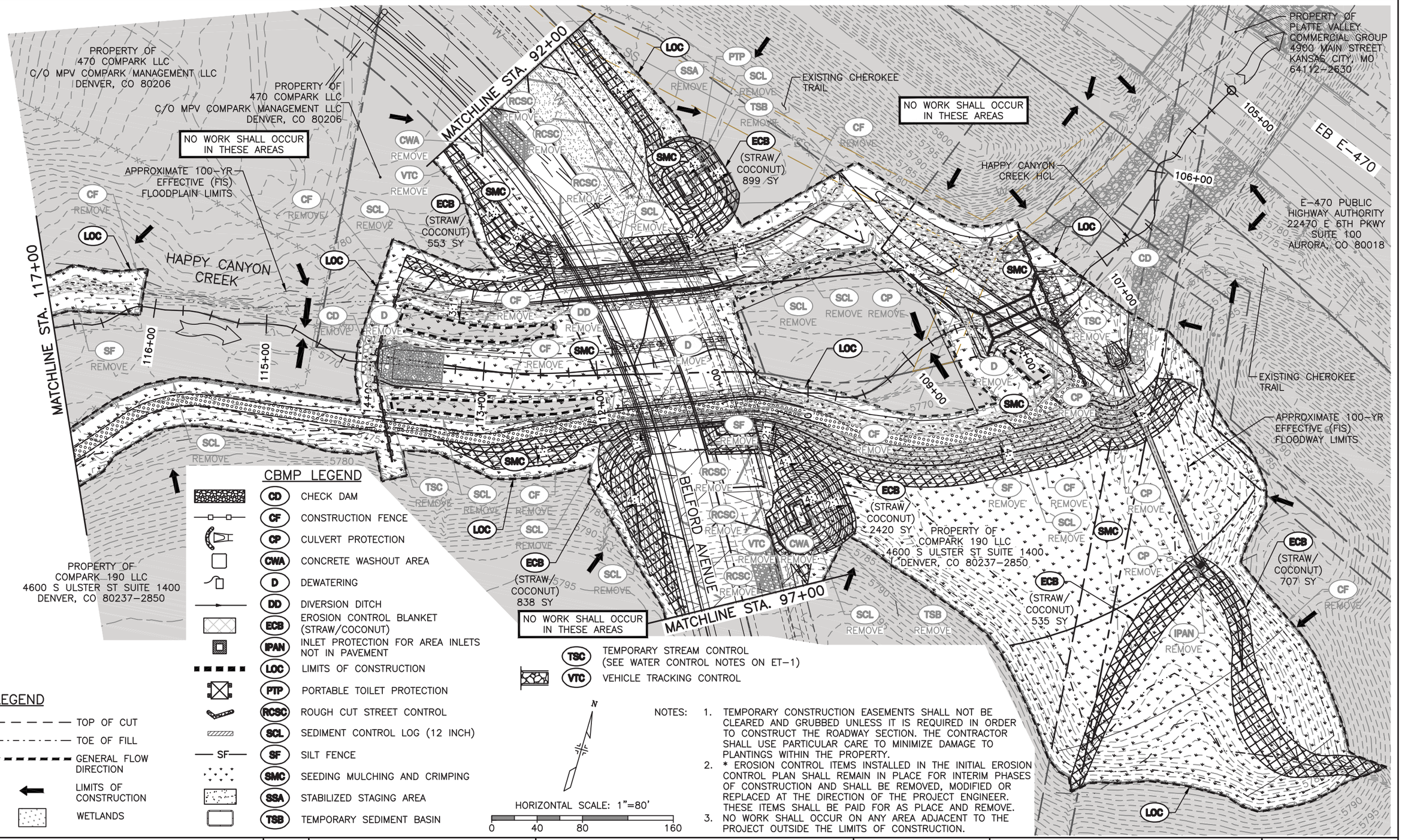
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BELFORD-HAPPY CANYON CREEK
HAPPY CANYON CREEK DROP STRUCTURE
FINAL CBMP PLAN

Designer: CDT
Detailer: KLT
Subset: Erosion
Structure Numbers:
Sheets: EF-1 of 2

Project No./Code:

Sheet Number 90



NOTES:

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FINAL CBMP PLAN

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Sheet Number 91

APPENDIX G. PHOTOGRAPHS



Photo #1.
Looking north towards the E-470 crossing. Photo taken from existing CherokeeTrail looking downstream.



Photo #2.
Photo taken from existing CherokeeTrail looking upstream to the south.



Photo #3.
Looking upstream towards the south. Photo taken from center of channel with Grandview Estates in the background. This location is approximately 500 feet upstream of the proposed Belford Avenue bridge crossing.



Photo #4.
Looking downstream to the north. Photo taken from center of channel with E-470 in the background. This photo was taken from the same location as Photo #3.