November 1, 2022

Department of Parks and Recreation
Town of Parker
20120 Mainstreet
Parker, CO 80138

RE: Harvie Open Space Park
Drainage Letter

To the Department of Parks and Recreation,

The Harvie Open Space Park project proposes to develop non-paved trails and several shelters on currently undeveloped land. The park is to be developed on a parcel of land, owned by the Town of Parker, just north of the intersection of Canterberry Parkway and East Mainstreet. The parcel of land is 71.459 acres and is subject to a conservation easement (No. 9608486). Other than an old farmstead with appurtenances, in disrepair, in the easterly portion of the site, the property is undeveloped. Said Parcel of land is bordered by Mainstreet to the south, Pope Road to the east, The Quail Creek Subdivision to the west and the Homestead Hills Subdivision and private agricultural lands to the north.

The proposed park disturbed area is approximately 4.0 acres of the 71.459 acre site. Historically stormwater runoff drains from north to south through the site, with the drainage basin extending north of the subject property down to East Mainstreet. The proposed developed trails and shelters were designed to minimize drainage basin impact and will not change the overall outfall locations of the site. Only minor drainage basin changes will occur within the main, historic, drainage basin A0. See drainage map for outfall location and details.

Soils Present within the boundaries of the park are identified by the United States Department of Agriculture Natural Resource Conservation Services to include Bresser-Truckton sandy loams and Stapleton-Bresser association

Bresser-Truckton sandy loams (BtE) covers 55.7% of the site. Classified as a hydrologic type B soil, Bresser-Truckton yields a medium runoff.

Soil Composition:

- Bresser, 50% of parent soil, is classified as hydrologic soil group B.
- Truckton, 35% of parent soil, is classified as hydrologic soil group A.
- 15% of the soil is made up of minor components. Soils less than 5%.

Stapleton-Bresser association (St) covers 44.3% of the site. Classified as a hydrologic type B soil, Stapleton-Bresser association yields a medium runoff.

Soil Composition:

- Stapleton, 60% of the parent soil, is classified as hydrologic soil group A.
- Bresser, 25% of the parent soil, is classified as hydrologic soil group B.
- 15% of the soil is made up of minor components.

See soils map and soils report documents for additional information.

The proposed site is covered by Statewide MS4 Permit C0R090000 Part 1.E.4, Post-Construction Stormwater Management in New Development & Redevelopment. All trails within the park are exempt

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per Part 1.E.4.a.i.(I) *Trials*. The non-trail, impervious areas, concrete pads, stairs and shelter areas fall under Part 1.E.4.a.i.(F), *Non-Residential and Non-Commercial Infiltration Conditions*.

Section 4.a.i.(F) requires that the completed project, impervious areas, do not produce concentrated stormwater flow nor produce discharge from the 80th percentile stormwater runoff. Per the Urban Drainage and Flood Control District's Urban Storm Drainage Criteria Manual, Volume 3, Table 3-1. Table 3-1, *Number of Rainfall Events in the Denver Area,* indicated that the 80th percentile of runoff producing storm, produces less than 0.6 inches (~5/8 of an inch) of rainfall. See attached USDCM Table 3-1.

There are three shelter areas proposed on site. These shelters utilize crusher fines as a surface and the roof is an open toped frame system with no proposed walls. These structures and associated areas were designed to minimize runoff impact and as such, no runoff calculations were performed regarding these areas (Assumed negligible drainage changes).

The proposed parking area located along the southern boundary of the site is primarily gravel with asphalt transitions to the existing Mainstreet road and concrete for ADA parking stall and loading area. The breakdown of the parking areas is as follows:

- Total Area: 13,010 S.F.
- Gravel: 10,857 S.F.
- Asphalt: 1,696 S.F.
- Concrete: 457 S.F.

Considering that the majority of the parking area is pervious and that the parking area includes less than 0.5% of the total property, no calculation were performed regarding the negligible change to runoff volume.

CCR 1002-72 conformance is satisfied by implementing a multi-teared approach when treating proposed disturbed area. This project proposes sediment control logs, silt fence, rock socks, and surface roughening with seeding mulching/crimping immediately within the disturbed area. A second line of treatment is located in the parking area near the existing inlet, this includes additional sediment control logs, and inlet protection. The existing inlet is also located in a grassy low point which acts like a grass swale to additionally filter storm runoff. Finally, a permanent treatment facility is currently being planned by the Town of Parker just downstream of the park site. A "Stormceptor" shall be constructed in-line within the existing storm line. This Stormceptor treats all flow upstream of this unit.

The parking area for the open space is proposed around the current, existing type c inlet, designated drainage basin A0 (Design Point 1). Per Stanley Consultants, Inc., Harvie Open Space Access Improvements DRAINAGE MEMORANDUM, (Dated March 16, 2018) the existing type c inlet and 24" conveyance pipe is capable of carrying 35.7 cfs. In order to maintain the existing drainage patterns and to reduce the amount of runoff crossing the parking lot area during storm events, this letter proposes to leave the existing system, type c inlet and 24" drainage pipe, in place and extend the line an additional 167 feet to a single new Type D inlet in sump located at Design Point 2 (Basin A1). This new Type D inlet was designed to intercept both the minor (5-yr) and major (100-yr) storm events. The proposed inlet is designed with to have 0.5 feet of depth to capture the 5-yr storm event, and 3.2 feet of depth in the 100-yr event. See SF-3 Standard Form for details.

Drainage Basin A1.1, outlets at Design Point 3, where a proposed pedestrian bridge is to be set. Given the 26.3 cfs required to pass under said bridge for the 100-yr storm, a trapezoidal cross section with a bottom width of 3 feet, side slopes of 4:1 and a depth of 1 foot is adequate to pass the required flow (See *Trapezoidal Channel Calculations – "Channel Report"* for details*).*

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Design Points 4 through 10 have a discharge of 3.1 cfs or less (see SF-3 100yr Form for details). An 18 inch HDPE culvert at each crossing is more than adequate to protect the trail from erosion during a 100-yr storm even. Each 18 inch culvert outlet is to be protected by UDFCD Riprap Type VL, utilizing a 3 foot wide by 5 foot long area (assumes elevation of culvert outlet at riprap grade). Trail crossings further upstream of these design points are proposed as sheet flow crossing (no culvert improvements are anticipated).

If there are any questions regarding this letter, please do not hesitate to contact me at 720.249.3575.

Sincerely,

Thomas J. Odle, PE
Sr. Project Manager

Attached:

Document Name	*(# of Pages)*
Table 3-1. Number of Rainfall Event in the Denver Area (USDCM)	*(1)*
Table 5.1 One-Hour Point Rainfall, Town of Parker Storm Drainage and Environmental Criterial Manual	*(1)*
USDA Soils Map and Soils Report	*(8)*
Sub-Basin Drainage Map	*(1)*
Standard Form SF-1	*(1)*
Standard Form SF-2	*(1)*
Standard Form SF-3 5-yr	*(1)*
Standard Form SF-3 100-yr	*(1)*
Culvert Stage-Discharge Sizing Worksheet	*(1)*
Culvert Headwater and Outlet Protection Worksheet	*(1)*
Trapezoidal Channel Calculations – "Channel Report"	*(2)*
Type C Inlet Calculations	*(2)*

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Table 3-1. Number of Rainfall Events in the Denver Area
(Adapted from Urbonas et al. 1989)

Total Rainfall Depth (inches)	Average Annual Number of Storm Events	Percent of Total Storm Events	Percentile of Runoff-producing Storms
0.0 to 0.1	46	61.07%	0.00%
0.1 to 0.5	22	29.21%	75.04%
≤ 0.6	**69**	**91.61%**	**80.00%**
0.5 to 1.0	4.7	6.24%	91.07%
1.0 to 1.5	1.5	1.99%	96.19%
1.5 to 2.0	0.6	0.80%	98.23%
2.0 to 3.0	0.3	0.40%	99.26%
3.0 to 4.0	0.19	0.25%	99.90%
4.0 to 5.0	0.028	0.04%	100.00%
> 5.0	0	0.00%	100.00%
TOTAL:	**75**	**100%**	**100%**

TABLE 5.1
ONE-HOUR POINT RAINFALL

Frequency of Design Event (yr)	One-hour Point Rainfall, P_1 (in)
2	0.99
5	1.39
10	1.64
25	1.98
50	2.31
100	2.60

Soil Map—Castle Rock Area, Colorado
(Harvie Park Open Space)

104° 43' 42" W
104° 43' 2" W
39° 31' 22" N
39° 31' 4" N

523380 523460 523540 523620 523700 523780 523860 523940 524020 524100 524180 524260

4374810 4374730 4374650 4374570 4374490 4374410 4374330

BtE
St
BtE
St
BtE
Pope Rd
E Parker Rd
Parker
Miller Rd
E Main St
Main

Soil Map may not be valid at this scale.

Map Scale: 1:2,580 if printed on B landscape (17" x 11") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 10, Oct 10, 2017

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

Date(s) aerial images were photographed: Mar 16, 2012—Aug 21, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BtE	Bresser-Truckton sandy loams, 5 to 25 percent slopes	40.2	55.7%
St	Stapleton-Bresser association	31.9	44.3%
Totals for Area of Interest		**72.1**	**100.0%**

Castle Rock Area, Colorado

BtE—Bresser-Truckton sandy loams, 5 to 25 percent slopes

Map Unit Setting

National map unit symbol: jqy9
Elevation: 5,500 to 6,600 feet
Mean annual precipitation: 15 to 19 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Bresser and similar soils: 50 percent
Truckton and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bresser

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy eolian deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy clay loam
H3 - 30 to 60 inches: loamy sand

Properties and qualities

Slope: 5 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Description of Truckton

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkosic sedimentary rock

Typical profile

H1 - 0 to 4 inches: sandy loam
H2 - 4 to 19 inches: sandy loam
H3 - 19 to 60 inches: sandy loam

Properties and qualities

Slope: 10 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Blakeland

Percent of map unit: 5 percent
Hydric soil rating: No

Newlin

Percent of map unit: 5 percent
Hydric soil rating: No

Stapleton

Percent of map unit: 4 percent
Hydric soil rating: No

Aquic haplustolls

Percent of map unit: 1 percent
Landform: Swales

Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 10, Oct 10, 2017

Castle Rock Area, Colorado

St—Stapleton-Bresser association

Map Unit Setting

National map unit symbol: jr09
Elevation: 5,500 to 6,600 feet
Mean annual precipitation: 15 to 19 inches
Mean annual air temperature: 49 to 51 degrees F
Frost-free period: 120 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Stapleton and similar soils: 60 percent
Bresser and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stapleton

Setting

Landform: Ridges, valley sides, knobs
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Weathered alluvium derived from arkose

Typical profile

H1 - 0 to 7 inches: sandy loam
H2 - 7 to 16 inches: sandy loam
H3 - 16 to 60 inches: gravelly sandy loam, gravelly coarse sandy loam
H3 - 16 to 60 inches:

Properties and qualities

Slope: 8 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: Sandy Foothill (R049BY210CO)
Hydric soil rating: No

Description of Bresser

Setting

Landform: Valley sides
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium and/or sandy eolian deposits

Typical profile

H1 - 0 to 8 inches: sandy loam
H2 - 8 to 30 inches: sandy clay loam
H3 - 30 to 60 inches: loamy sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat):
Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Loamy alluvial land

Percent of map unit: 14 percent
Hydric soil rating: No

Aquic haplustolls

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

Data Source Information

Soil Survey Area: Castle Rock Area, Colorado
Survey Area Data: Version 10, Oct 10, 2017

HARVIE OPEN SPACE
TOWN OF PARKER, COLORADO

THE TOWN OF PARKER REVIEW CONSTITUTES GENERAL COMPLIANCE WITH THE TOWN'S STANDARDS AND APPROVED VARIANCES, SUBJECT TO THESE PLANS BEING STAMPED, SIGN, 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 CALCULATIONS. 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, DIRECTOR OF ENGINEERING DATE

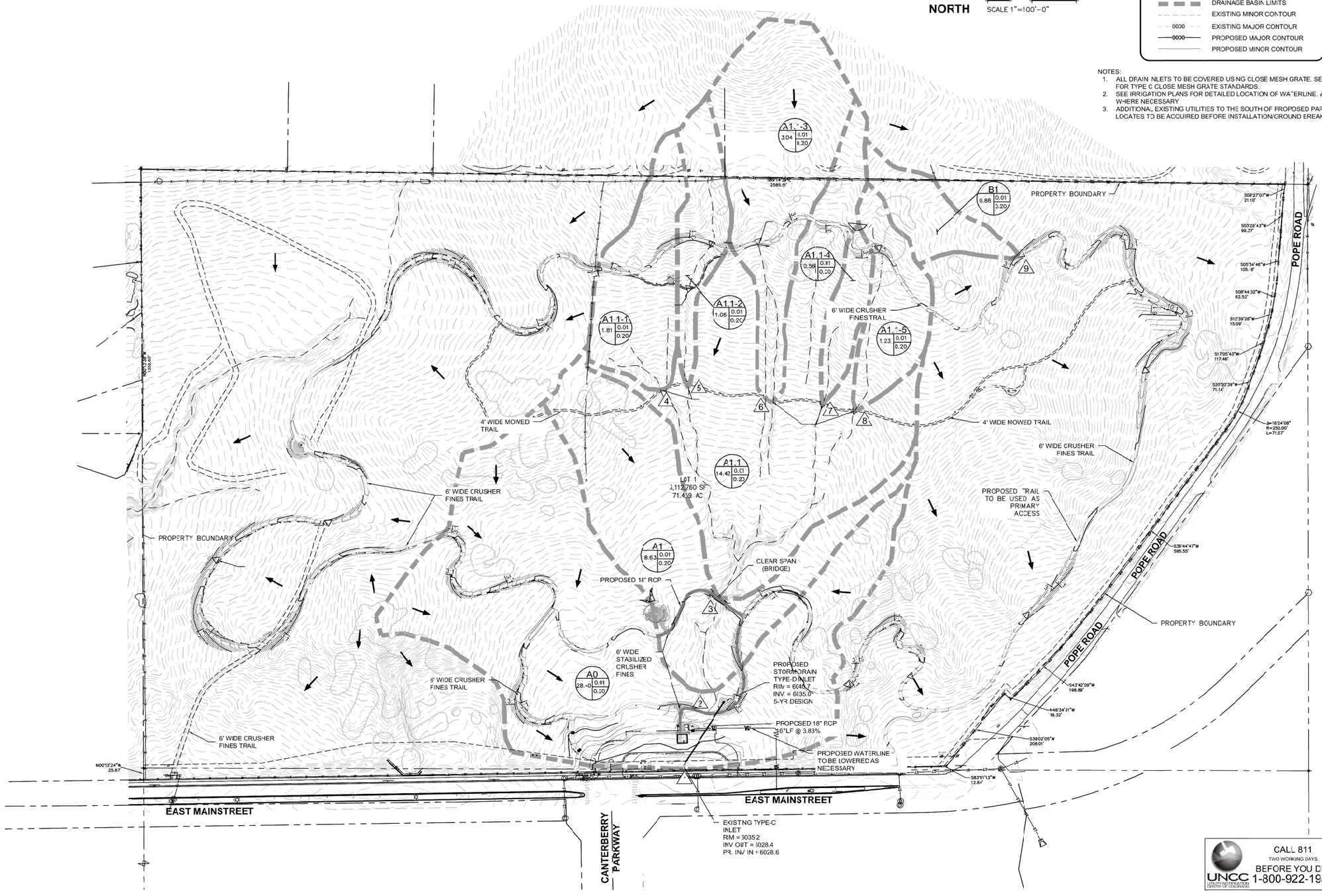
NORTH

0 50 100 200
SCALE 1"=100'-0"

LEGEND

- A = BASIN DESIGNATION
  B = AREA IN ACRES
  C = 5 YEAR RUNOFF COEFF.
  D = 100 YEAR RUNOFF COEFF.
- NC — PROPOSED NATURALIZED WATER CROSSING
- 0.44% — PROPOSED SLOPE
- FLOW ARROW
- PROPOSED CULVERT LOCATION
- DRAINAGE BASIN LIMITS
- EXISTING MINOR CONTOUR
- 0000 — EXISTING MAJOR CONTOUR
- 0000 — PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

NOTES:
1. ALL DRAIN NLETS TO BE COVERED US NG CLOSE MESH GRATE. SEE CDOT STANDARD M-604-10 FOR TYPE C CLOSE MESH GRATE STANDARDS.
2. SEE IRRIGATION PLANS FOR DETAILED LOCATION OF WA¯ERLINE. WATERLINE TO BE LOWERED WHERE NECESSARY
3. ADDITIONAL EXISTING UTILITIES TO THE SOUTH OF PROPOSED PARKING LOT MAY EXIST. UTIL TY LOCATES TO BE ACQUIRED BEFORE INSTALLATION/GROUND BREAKING MAY COMMENCE.



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Westwood Professional Services, Inc.

Harvie Open Space Park
100% CONSTRUCTION DRAWINGS
20120 East Main Street, Parker, CO 80138

PROJECT NUMBER: 17279.00
DATE: 01.15.2019
DESIGNED: CUB
DRAWN: CUB
CHECKED: TJO
REVISIONS:
JOB DESCRIPTION: 100% CONSTRUCTION DOCUMENTS
SHEET TITLE: DRAINAGE BASIN MAP
SCALE: 1" = 100'
SHEET NUMBER: D1.0

CALL 811
TWO WORKING DAYS
BEFORE YOU DIG
UNCC 1-800-922-1987
UTILITY NOTIFICATION CENTER OF COLORADO

PREPARED UNDER THE SUPERVISION OF
COLORADO LICENSED THOMAS J. ODLE 52802 PROFESSIONAL ENGINEER
THOMAS J. ODLE
COLORADO P.E. 52802

SF-1 SUB-BASIN SUMMARY

COMPOSITE C AND IMPERVIOUS VALUES

Harvie Park

Project Name: Harvie Park
Project No. 8.13.0308201
Calculated By: CUB

Land Use Assumptions,
Note: Per USDA Web Soil Survey, Hydrologic Soil Group B is conservative.
Note: Runoff Coefficients from UDFCD Vol. 1 Table 6-5, *Runoff Coefficients*

Land Use	Imp.	C_2	C_5	C_{100}
Openspace	2%	0.01	0.01	0.44

A1

Total Area **18.63** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	18.63	2.0
TOTAL					**18.63**	**2.0**

A1

A1.1

Total Area **14.42** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	14.42	2.0
TOTAL					**14.42**	**2.0**

A1.1

A1.1-1

Total Area **1.44** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	1.44	2.0
TOTAL					**1.44**	**2.0**

A1.1-1

A1.1-2

Total Area **0.37** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	0.37	2.0
TOTAL					**0.37**	**2.0**

A1.1-2

A1.1-3

Total Area **1.06** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	1.06	2.0
TOTAL					**1.06**	**2.0**

A1.1-3

A1.1-4

Total Area **3.04** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	3.04	2.0
TOTAL					**3.04**	**2.0**

A1.1-4

A1.1-5

Total Area **0.56** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	0.56	2.0
TOTAL					**0.56**	**2.0**

A1.1-5

A1.1-6

Total Area **1.23** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	1.23	2.0
TOTAL					**1.23**	**2.0**

A1.1-6

B1

Total Area **0.88** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	0.88	2.0
TOTAL					**0.88**	**2.0**

B1

A0

Total Area **28.40** **acres**

Land Use	Imp.	C_2	C_5	C_{100}	Area	Imp%
Openspace	2%	0.01	0.01	0.44	28.40	2.0
TOTAL					**28.40**	**2.0**

A0

SF-2 TIME OF CONCENTRATION FOR EACH SUB-BASIN

SUB-BASIN DATA			INITIAL/OVERLAND T_i			TRAVEL TIME Tt				Tc CHECK $T_I + T_T$	FIRST DESIGN POINT T_C				EFFECTIVE T_c
BASIN ID	D.A. (AC)	C_5	L FT	S FT/FT	T_i MIN	L FT	S FT/FT	VEL. FPS	T_t MIN	TOTAL Tc MIN	% IMP. DECIMAL	LENGTH FT	SLOPE FT/FT	MIN. T_c MIN. Tc	MIN
A1	18.63	0.01	500	0.08	22.2	1073	0.08	2.0	9.0	31.2	0.02	1573	0.080	35.6	31.2
A1.1	14.42	0.01	500	0.08	22.2	845	0.08	2.0	7.1	29.3	0.02	1345	0.080	34.2	29.3
A1.1-1	1.44	0.01	500	0.09	21.3	117	0.09	2.1	0.9	22.2	0.02	617	0.090	29.4	22.2
A1.1-2	0.37	0.01	433	0.09	19.8	0	0.09	2.1	0.0	19.8	0.02	433	0.090	28.3	19.8
A1.1-3	1.06	0.01	500	0.08	22.2	148	0.08	2.0	1.2	23.4	0.02	648	0.080	29.8	23.4
A1.1-4	3.04	0.01	500	0.08	22.2	371	0.08	2.0	3.1	25.3	0.02	871	0.080	31.2	25.3
A1.1-5	0.56	0.01	417	0.10	18.8	0	0.10	2.2	0.0	18.8	0.02	417	0.100	28.0	18.8
A1.1-6	1.23	0.01	500	0.08	22.2	38	0.08	2.0	0.3	22.5	0.02	538	0.080	29.1	22.5
B1	0.88	0.01	378	0.09	18.5	0	0.09	2.1	0.0	18.5	0.02	378	0.090	27.9	18.5
A0	28.40	0.01	500	0.08	22.2	1349	0.08	2.0	11.4	33.5	0.02	1849	0.080	37.4	33.5

SF-3 STANDARD FORM
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Project Name: Harvie Park
Project No. 8.13.0308201
Calculated By: CUB

Subdivision Harvie Park

Design Storm 5
100-Year P1 = 1.39 in. (Table 5.1, *One-Hour Point Rainfall* , Town of Parker Strom Drainage and Environmental Criterial Manual)

	DIRECT RUNOFF								TOTAL RUNOFF							STREET		PIPE			TRAVEL TIME			
COMBINED BASINS	Design Point	Area Design.	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Inlet Type	Q (Intercept)	Q (Carry-On)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Overland Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	REMARKS
A1	2	A1	18.63	0.01	31.2	0.19	2.1	0.4	TRAPAZOIDAL CHANNEL									0.4	8.00					CDOT Type C Area Inlet
A1.1	3	A1.1	14.42	0.01	29.3	0.14	2.2	0.3	CDOT TYPE-C INLET									0.3	8.00	18.0	30.0	8.15	0.061	Design point 3 is a point where the channel narrows to cross under a pedestrian bridge.
A1.1-1	4	A1.1-1	1.44	0.01	22.2	0.01	2.6	0.0	18" CMP									0.0	9.00	18.0	30.0	5.31	0.094	CMP trail crossing
A1.1-2	5	A1.1-2	0.37	0.01	19.8	0.00	2.7	0.0	18" CMP									0.0	9.00	18.0	30.0	7.08	0.071	CMP trail crossing
A1.1-3	6	A1.1-3	1.06	0.01	23.4	0.01	2.5	0.0	18" CMP									0.0	8.00	18.0	30.0	9.96	0.050	CMP trail crossing
A1.1-4	7	A1.1-4	3.04	0.01	25.3	0.03	2.4	0.1	18" CMP									0.1	8.00	18.0	30.0	6.48	0.077	CMP trail crossing
A1.1-5	8	A1.1-5	0.56	0.01	18.8	0.01	2.8	0.0	18" CMP									0.0	10.00	18.0	30.0	7.36	0.068	CMP trail crossing
A1.1-6	9	A1.1-6	1.23	0.01	22.5	0.01	2.6	0.0	18" CMP									0.0	8.00	18.0	30.0	7.42	0.067	CMP trail crossing
B1	10	B1	0.88	0.01	18.5	0.01	2.8	0.0	18" CMP									0.0	9.00	24.0	23.0	13.30	0.029	CMP trail crossing
AO - AI	1	A0	28.40	0.01	33.5	0.28	2.0	0.6	CDOT TYPE-C INLET						0.2			0.2	2.61	24.0	23.0	13.30	0.029	CDOT Type C Area Inlet to remain. New inlet to be installed to the northeast to eliminate additional crossings.

Note: Refer to SewerGEMS Conduit Table for slopes & pipe diameter.
Note: See design sheet for riprap & outlet protection details

SF-3 STANDARD FORM
STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Project Name: Harvie Park
Project No. 8.13.0308201
Calculated By: CUB

Subdivision Harvie Park

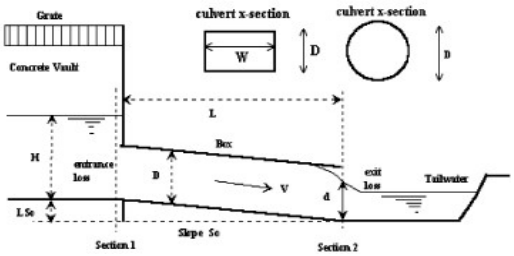
Design Storm 100
100-Year P1 = 2.6 in. (Table 5.1, *One-Hour Point Rainfall* , Town of Parker Strom Drainage and Environmental Criterial Manual)

	DIRECT RUNOFF								TOTAL RUNOFF							STREET		PIPE			TRAVEL TIME			
COMBINED BASINS	Design Point	Area Design.	Area (Ac)	Runoff Coeff.	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Inlet Type	Q (Intercept)	Q (Carry-On)	Tc (min)	C*A (Ac)	I (in/hr)	Q (cfs)	Slope (%)	Overland Flow (cfs)	Design Flow (cfs)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	Tt (min)	REMARKS
A1	2	A1	18.63	0.44	31.2	8.20	4.0	32.7	TRAPAZOIDAL CHANNEL									32.7	8.00					CDOT Type C Area Inlet
A1.1	3	A1.1	14.42	0.44	29.3	6.34	4.1	26.3	CDOT TYPE-C INLET									26.3	8.00	18.0	30.0	8.15	0.061	Design point 3 is a point where the channel narrows to cross under a pedestrian bridge.
A1.1-1	4	A1.1-1	1.44	0.44	22.2	0.63	4.8	3.1	18" CMP									3.1	9.00	18.0	30.0	5.31	0.094	CMP trail crossing
A1.1-2	5	A1.1-2	0.37	0.44	19.8	0.16	5.1	0.8	18" CMP									0.8	9.00	18.0	30.0	7.08	0.071	CMP trail crossing
A1.1-3	6	A1.1-3	1.06	0.44	23.4	0.47	4.7	2.2	18" CMP									2.2	8.00	18.0	30.0	9.96	0.050	CMP trail crossing
A1.1-4	7	A1.1-4	3.04	0.44	25.3	1.34	4.5	6.0	18" CMP									6.0	8.00	18.0	30.0	6.48	0.077	CMP trail crossing
A1.1-5	8	A1.1-5	0.56	0.44	18.8	0.25	5.3	1.3	18" CMP									1.3	10.00	18.0	30.0	7.36	0.068	CMP trail crossing
A1.1-6	9	A1.1-6	1.23	0.44	22.5	0.54	4.8	2.6	18" CMP									2.6	8.00	18.0	30.0	7.42	0.067	CMP trail crossing
B1	10	B1	0.88	0.44	18.5	0.39	5.3	2.1	18" CMP									2.1	9.00	24.0	23.0	13.30	0.029	CMP trail crossing
AO - AI	1	A0	28.40	0.44	33.5	12.50	3.8	47.7	CDOT TYPE-C INLET						15.0			15.0	2.61	24.0	23.0	13.30	0.029	CDOT Type C Area Inlet to remain. New inlet to be installed to the northeast to eliminate additional crossings.

Note: Refer to SewerGEMS Conduit Table for slopes & pipe diameter.
Note: See design sheet for riprap & outlet protection details

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

Project: Harvie Park Open Space
Basin ID: A1.1-1 thru A1.1-6 & B1
Status:



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = 18 inches
Inlet Edge Type (choose from pull-down list) — Square End Projection

OR:

Box Culvert: Barrel Height (Rise) in Feet — Height (Rise) = ft.
Barrel Width (Span) in Feet — Width (Span) = ft.
Inlet Edge Type (choose from pull-down list) — Square Edge w/ 30-78 deg. Flared Wingwall

Number of Barrels	No =	1	
Inlet Elevation at Culvert Invert	Inlet Elev =	10	ft. elev.
Outlet Elevation at Culvert Invert **OR** Slope of Culvert (ft v./ft h.)	Slope =	0.05	ft vert. / ft horiz.
Culvert Length in Feet	L =	30	ft.
Manning's Roughness	n =	0.014	
Bend Loss Coefficient	K_b =	0	
Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.50
Friction Loss Coefficient	K_f =	0.63
Sum of All Loss Coefficients	K_s =	2.13
Orifice Inlet Condition Coefficient	C_d =	0.85
Minimum Energy Condition Coefficient	KE_{low} =	-0.0860

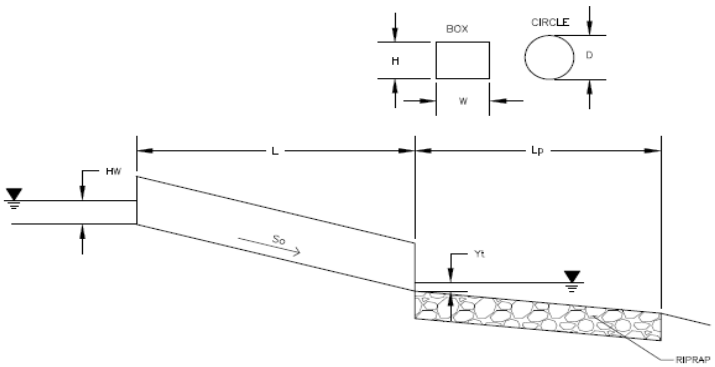
Calculations of Culvert Capacity (output):

Water Surface Elevation (ft., linked)	Tailwater Surface Elevation ft	Culvert Inlet-Control Flowrate cfs	Culvert Outlet-Control Flowrate cfs	Controlling Culvert Flowrate cfs (output)	Inlet Equation Used:	Flow Control Used
10.00		0.00	0.00	**0.00**	No Flow (WS < inlet)	N/A
10.10		0.10	8.69	**0.10**	Min. Energy. Eqn.	INLET
10.20		0.20	8.96	**0.20**	Min. Energy. Eqn.	INLET
10.30		0.40	9.23	**0.40**	Min. Energy. Eqn.	INLET
10.40		0.70	9.48	**0.70**	Min. Energy. Eqn.	INLET
10.50		1.10	9.72	**1.10**	Min. Energy. Eqn.	INLET
10.60		1.50	9.96	**1.50**	Min. Energy. Eqn.	INLET
10.70		2.00	10.20	**2.00**	Min. Energy. Eqn.	INLET
10.80		2.40	10.43	**2.40**	Regression Eqn.	INLET
10.90		3.00	10.64	**3.00**	Regression Eqn.	INLET
11.00		3.50	10.87	**3.50**	Regression Eqn.	INLET
11.10		4.10	11.08	**4.10**	Regression Eqn.	INLET
11.20		4.70	11.30	**4.70**	Regression Eqn.	INLET
11.30		5.30	11.51	**5.30**	Regression Eqn.	INLET
11.40		5.80	11.70	**5.80**	Regression Eqn.	INLET
11.50		6.40	11.91	**6.40**	Regression Eqn.	INLET
11.60		7.00	12.29	**7.00**	Regression Eqn.	INLET
11.70		7.50	12.67	**7.50**	Regression Eqn.	INLET
11.80		8.00	13.04	**8.00**	Regression Eqn.	INLET
11.90		8.50	13.40	**8.50**	Regression Eqn.	INLET
12.00		8.90	13.74	**8.90**	Regression Eqn.	INLET
12.10		9.40	14.09	**9.40**	Regression Eqn.	INLET
12.20		9.80	14.42	**9.80**	Regression Eqn.	INLET
12.30		10.20	14.74	**10.20**	Regression Eqn.	INLET
12.40		10.60	15.06	**10.60**	Regression Eqn.	INLET
12.50		10.90	15.37	**10.90**	Regression Eqn.	INLET
12.60		11.30	15.67	**11.30**	Regression Eqn.	INLET
12.70		11.60	15.97	**11.60**	Regression Eqn.	INLET
12.80		12.00	16.26	**12.00**	Regression Eqn.	INLET
12.90		12.30	16.55	**12.30**	Regression Eqn.	INLET

Processing Time: 00.70 Seconds

Determination of Culvert Headwater and Outlet Protection

Project: Harvie Park Open Space
Basin ID: A1.1-1 Thru A1.1-6 & B1



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

Supercritical Flow! Using Da to calculate protection type.

Design Information (Input):

	Design Discharge	Q =	3.1	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	18	inches
	Inlet Edge Type (Choose from pull-down list)		Square End Projection	
Box Culvert:			**OR**	
	Barrel Height (Rise) in Feet	Height (Rise) =		ft
	Barrel Width (Span) in Feet	Width (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	No =	1	
	Inlet Elevation	Elev IN =	10	ft
	Outlet Elevation **OR** Slope	So =	0.05	ft/ft
	Culvert Length	L =	30	ft
	Manning's Roughness	n =	0.014	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	Elev Y_t =		ft
	Max Allowable Channel Velocity	V =	5	ft/s

Required Protection (Output):

	Tailwater Surface Height	Y_t =	0.60	ft
	Flow Area at Max Channel Velocity	A_t =	0.62	ft^2
	Culvert Cross Sectional Area Available	A =	1.77	ft^2
	Entrance Loss Coefficient	k_e =	0.50	
	Friction Loss Coefficient	k_f =	0.63	
	Sum of All Losses Coefficients	k_s =	2.13	ft
	Culvert Normal Depth	Y_n =	0.38	ft
	Culvert Critical Depth	Y_c =	0.67	ft
	Tailwater Depth for Design	d =	1.09	ft
	Adjusted Diameter **OR** Adjusted Rise	D_a =	0.94	ft
	Expansion Factor	1/(2*tan(Θ)) =	6.70	
	Flow/Diameter$^{2.5}$ **OR** Flow/(Span * Rise$^{1.5}$)	Q/D^2.5 =	1.12	$ft^{0.5}/s$
	Froude Number	Fr =	2.96	**Supercritical!**
	Tailwater/Adjusted Diameter **OR** Tailwater/Adjusted Rise	Yt/D =	0.64	
	Inlet Control Headwater	HW_I =	0.93	ft
	Outlet Control Headwater	HW_O =	-0.31	
	Design Headwater Elevation	**HW =**	**10.93**	**ft**
	Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**0.62**	
	Minimum Theoretical Riprap Size	d_{50} =	2	in
	Nominal Riprap Size	d_{50} =	6	in
	UDFCD Riprap Type	**Type =**	**VL**	
	Length of Protection	**L_p =**	**5**	**ft**
	Width of Protection	**T =**	**3**	**ft**

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Apr 4 2018

Harvie Park Open Space

Trapezoidal

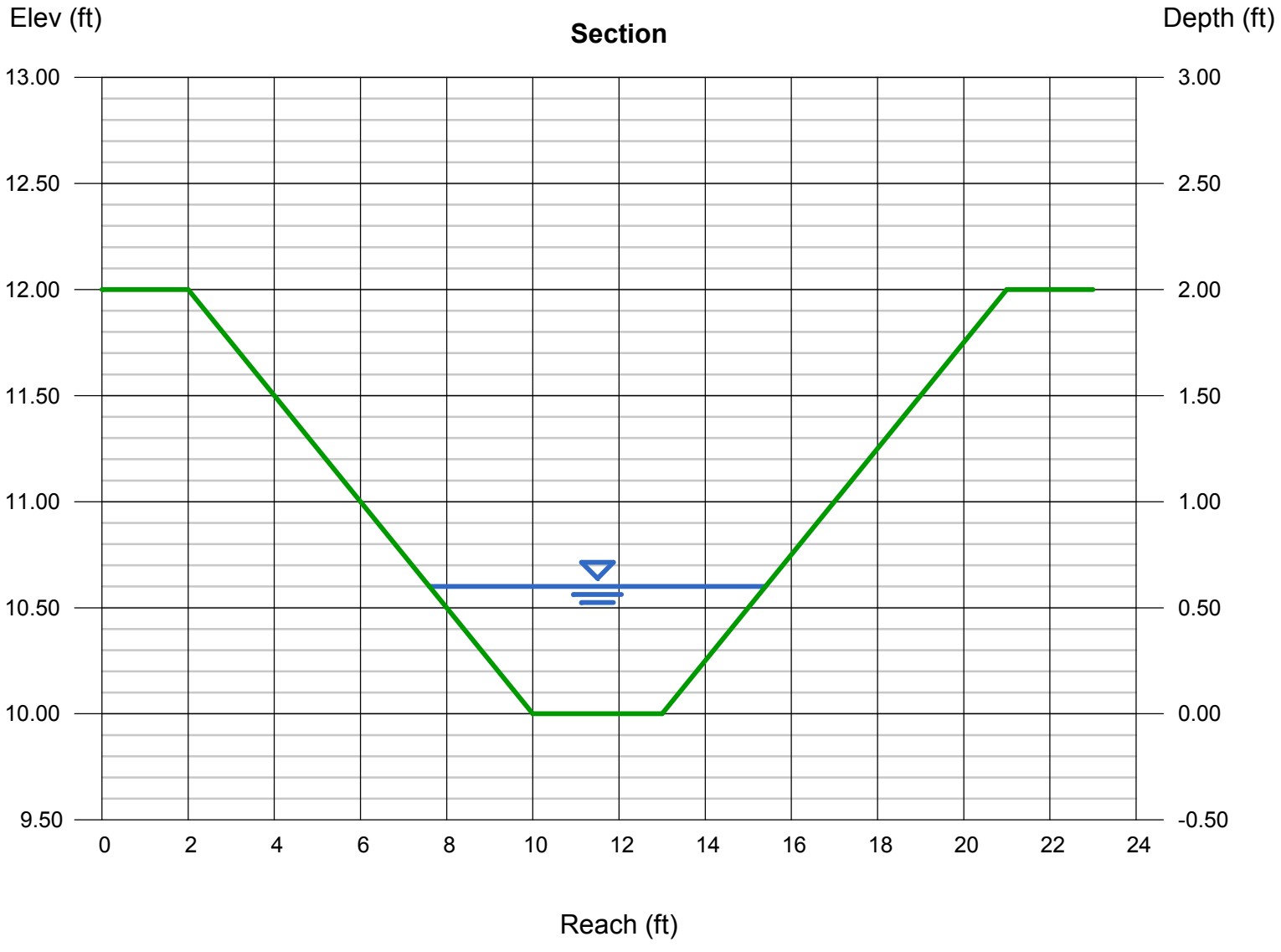
Bottom Width (ft)	= 3.00
Side Slopes (z:1)	= 4.00, 4.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 10.00
Slope (%)	= 3.00
N-Value	= 0.030

Calculations

Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

Depth (ft)	= 0.60
Q (cfs)	= 15.28
Area (sqft)	= 3.24
Velocity (ft/s)	= 4.72
Wetted Perim (ft)	= 7.95
Crit Depth, Yc (ft)	= 0.69
Top Width (ft)	= 7.80
EGL (ft)	= 0.95



Channel Report

Depth	Q	Area	Veloc	Wp	Yc	Top Width	Energy
(ft)	(cfs)	(sqft)	(ft/s)	(ft)	(ft)	(ft)	(ft)
0.20	1.95	0.76	2.56	4.65	0.22	4.60	0.30
0.40	6.95	1.84	3.78	6.30	0.45	6.20	0.62
0.60	15.28	324.00	4.72	7.95	0.69	7.80	0.95
0.80	27.40	4.96	5.52	9.60	0.93	9.40	1.27
1.00	43.77	7.00	6.25	11.25	1.18	11.00	1.61

Worksheet for Irregular Section - Span Bridge

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data		
Channel Slope	3.300	%
Discharge	26.30	cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	7.50
0+27	4.00
0+36	1.00
0+43	0.00
0+52	1.00
0+60	2.50
0+73	5.20
0+85	6.30
0+94	6.50

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 7.50)	(0+94, 6.50)	0.030

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results		
Normal Depth	9.9	in
Roughness Coefficient	0.030	
Elevation	0.83	ft
Elevation Range	0.0 to 7.5	ft
Flow Area	5.3	ft²
Wetted Perimeter	12.9	ft
Hydraulic Radius	4.9	in
Top Width	12.82	ft
Normal Depth	9.9	in
Critical Depth	11.2	in
Critical Slope	1.708	%
Velocity	4.96	ft/s
Velocity Head	0.38	ft

Worksheet for Irregular Section - Span Bridge

Results	
Specific Energy	1.21 ft
Froude Number	1.361
Flow Type	Supercritical

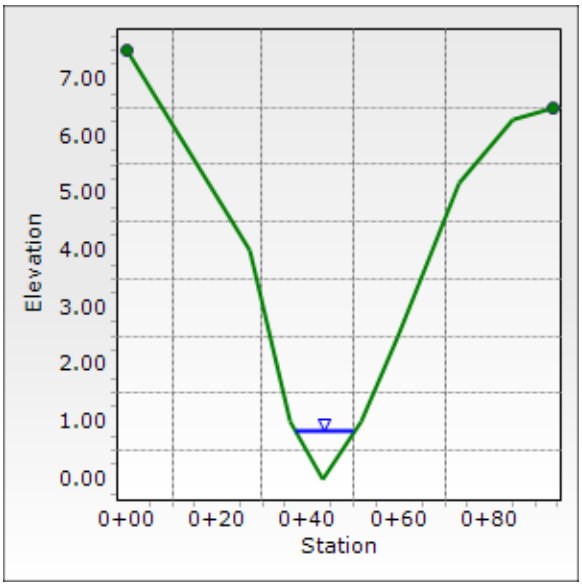
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.9 in
Critical Depth	11.2 in
Channel Slope	3.300 %
Critical Slope	1.708 %

Span Bridge 100-yr WSE

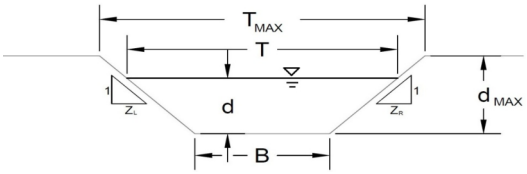
Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	3.300 %
Normal Depth	9.9 in
Discharge	26.30 cfs



AREA INLET IN A SWALE

TYPE D DP2



This worksheet uses the NRCS vegetal retardance method to determine Manning's n.

For more information see Section 7.2.3 of the USDCM.

Analysis of Trapezoidal Grass-Lined Channel Using SCS Method

NRCS Vegetal Retardance (A, B, C, D, or E)	A, B, C, D, or E =	A	
Manning's n (Leave cell D16 blank to manually enter an n value)	n =	see details below	
Channel Invert Slope	S_O =	0.0050	ft/ft
Bottom Width	B =	3.00	ft
Left Side Slope	Z1 =	6.00	ft/ft
Right Side Sloe	Z2 =	6.00	ft/ft

Check one of the following soil types:

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

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

		Minor Storm	Major Storm	
Maximum Allowable Top Width of Channel for Minor & Major Storm	T_{MAX} =	**20.00**	**35.00**	**ft**
Maximum Allowable Water Depth in Channel for Minor & Major Storm	d_{MAX} =	**0.50**	**3.20**	**ft**

Allowable Channel Capacity Based On Channel Geometry

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**0.5**	**18.7**	**cfs**
MAJOR STORM Allowable Capacity is based on Top Width Criterion	d_{allow} =	**0.50**	**2.67**	**ft**

Water Depth in Channel Based On Design Peak Flow

Design Peak Flow	Q_o =	**0.4**	**32.7**	**cfs**
Water Depth	**d** =	**0.43**	**3.18**	**ft**

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

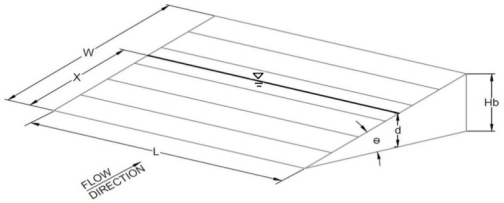
WARNING: MAJOR STORM max. allowable capacity is less than the design flow given on sheet 'Inlet Management'

AREA INLET IN A SWALE

TYPE D DP2

Inlet Design Information (Input)

Type of Inlet	CDOT Type C (Depressed)	Inlet Type =	CDOT Type C (Depressed)	
Angle of Inclined Grate (must be <= 30 degrees)		θ =	30.00	degrees
Width of Grate		W =	3.00	ft
Length of Grate		L =	3.00	ft
Open Area Ratio		A_{RATIO} =	0.70	
Height of Inclined Grate		H_B =	1.50	ft
Clogging Factor		C_f =	0.50	
Grate Discharge Coefficient		C_d =	0.77	
Orifice Coefficient		C_o =	0.52	
Weir Coefficient		C_w =	1.65	



		MINOR	MAJOR	
Water Depth at Inlet (for depressed inlets, 1 foot is added for depression)	d =	1.43	4.18	
Total Inlet Interception Capacity (assumes clogged condition)	**Q_a =**	**12.8**	**32.9**	**cfs**
Bypassed Flow	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Qa/Qo	**C% =**	**100**	**100**	**%**

Warning 06: Top Width (T) exceeds max allowable top width (Tmax).

Profile Report
Engineering Profile - 100-yr Proposed Storm Extension (SewerGems2022.stsw)