CANYON FUEL COMPANY, LLC

DUGOUT CANYON MINE

C/007/039

AS-BUILTS OF AMV ROAD, DEGAS PAD G-18 & G-31

AUGUST 2008

File in:
☐ Confidential
☐ Shelf
☒ Expandable
Refer to Record No 0021 Date 08062008
In C/0070039, 2008, Incoming
For additional information

CHAPTER 2

SOILS

230 OPERATION PLAN

231 General Requirements

231.100 Removing and Storing Topsoil Methods

The topsoil will be removed, stockpiled and protected with a berm and/or silt fence. A qualified person will be on site during soil salvage to monitor and supervise the operation for the purpose of maximizing salvage volumes. Prior to topsoil salvage shrubs/vegetation will be removed and placed/wind rowed along the inside perimeter of the disturbed area.

After the topsoil is removed, the mud pit will be excavated and the soils from the mud pit excavation will be stored immediately adjacent to the mud pit. Mud pit excavation of subsoil will be approximately 110 CY at each well site (G-2 thru G-6).

The subsoil excavation for the mud pits at G-7 thru G-19 and G-31 was approximately 430 CY. A portable container for drilling fluids will be used if necessary, should there not be sufficient subsoil depth to excavate a mud pit.

Topsoil beneath the topsoil stockpiles will not be removed. Ribbon or a marking fabric will be placed on top of the topsoil prior to placement of the topsoil from the well pad area.

The approximate volume of subsoil to be salvaged and used to create berms around the perimeter of the well site including the topsoil stockpile perimeter is: G-1 - 161 CY; G-2 - 254 CY, G-3 - 208 CY, G-4-165 CY, G-5 - 191 CY, G-6 - 156 CY, G-7 - 107 CY, G-8 - 143 CY, G-9 - 182 CY, G-10 - 137 CY, G-11 - 185 CY, G-12 - 260 CY, G-13 - 142 CY, G-14A - 123 CY, G-15 - 101 CY, G-16 - 98 CY, G-18 - 39 CY excludes topsoil pile, G-19 - 48 CY, G-31 - 62 CY excludes topsoil pile, Topsoil Stockpiles T-2 thru T10 - ~~309~~ 300 CY and Access Road - ~~265~~ 248 CY.

TABLE 2-2 (Continued)

Topsoil Stockpile Dimensions*

Well No.	Description	Length (ft)	Width (ft)	Height (ft)
G-18	T-10	118	80	20
G-19	Lower Road	235	8	5
	Pad	140	52	35
G-31	T-8	85	67	7
	T-9	128	100	13
Access Road	T-2	40	90	8
	T-3	108	95	11
	T-4	12	45	5
	T-5	95	110	13
	T-6	95	138	14
	T-7	110	150	21

* These are approximate dimensions of the topsoil stockpile and construction dimensions may vary. The height represents the elevation difference between the lowest point and highest point of the topsoil stockpile. The topsoil thickness will vary with the slope of the native ground surface. When stored on steep slopes the topsoil thickness will be much less than the estimated height of the stockpile.

See Section 234.200 for detailed information on the topsoil stockpile(s).

232.300 Thin Topsoil

Not applicable see Attachment 2-1.

232.400 Minor Disturbances Not Requiring Topsoil Removal

Topsoil will not be removed along the fence line at the wells sites.

The topsoil stockpile will be constructed in such a manner as to allow access for repair of the pile surfaces and diversion structures.

Wind and Water Erosion Protection - The topsoil stockpile will be protected from water erosion by berms, which trap sediment runoff from the stockpile. The berms have been designed to completely contain the 10-year 24-hour storm event (see Attachment 7-1). The stockpile will be surface pitted, gouged and/or roughened and revegetated using the grass seeds listed in Table 3-2 to prevent wind erosion.

Topsoil Redistribution - Stockpile soil will not be moved until redistribution during contemporaneous or final reclamation operations unless approved by the Division.

At well pad G-19 a portion of the salvaged topsoil will be stored on a fork of the existing road. There is no topsoil remaining on the road and the road will remain following reclamation of the G-19 pad site. Wide flagging will be used as a marker to identify the separate between the road surface and the stored topsoil. Landowner correspondence pertaining to topsoil storage on the existing road is contained in Attachment 2-3.

Cross-sections of topsoil piles T-2 thru T-10 are shown on Plate ~~2 and~~ 3, in Attachment 5-4. As-built cross sections with horizontal and vertical scales equal with two perpendicular cross sections provided for each of the topsoil stockpiles will be submitted within 30 days following the completion of the construction of topsoil stockpiles T-2 thru T-10 (Attachment 5-4, Plate 3). The perpendicular cross sections will extend through the area where the stockpiles join the road, except T-8, T-9 and T-10 which do not join a road but are on degas well pads.

234.300 Topsoil Stockpile Relocation

Stockpiled soil in jeopardy of being detrimentally affected in terms of its quantity and quality by drilling operations may be temporarily redistributed or relocated on approval by the Division and modification of this M&RP.

240 RECLAMATION PLAN

As-built cross section where both horizontal and vertical scales are equal will be provided within 30 days of completion of the AMV road construction. The as-built road cross sections are provided ~~would be drawn at stations are 0+15, 15+35, 33+81, 39+62, 45+49 and 51+07~~ on Plates 2 and 3 in Attachment 5-4. ~~the section of the road leading to G-31. On the section of the road leading to G-18 the proposed cross sections will be at station 0+44, 5+22, 10+05 and 12+40.~~ In addition, an as-built road profile will be provided within 30 days of completion of the AMV road construction

241 General Information

Reclamation of the degassification sites (topsoil redistribution, amendments, and stabilization) is discussed in Sections 242, 243, and 244 respectively.

242 Soil Redistribution

242.100 Soil Redistribution Practices

The topsoil will be placed after recontouring of the site has occurred. Topsoil will be handled when they are loose or in a friable condition. The moisture content will be visually monitored and water will be added as needed to enhance the soil's condition for handling. The approximate amount of topsoil available for each site is shown in Table 2-1. The reclamation time line can be found on Figure 5-15 for sites G-2 and G-3 and on Figure 5-26 for sites G-4 thru G-19 and G-31. Figure 5-26 has been revised to include the access road (AMV).

The topsoil will be distributed in two phases at well site G-2, the first phase will be the contemporaneous reclamation of a portion of the pad area used during well construction (see Figures 5-4, 5-8 and 5-12). During contemporaneous reclamation topsoil from the stockpile will be distributed in the depths shown in Table 2-3.

ATTACHMENT 2-4

RECLAMATION INFORMATION

CHAPTER 5

ENGINEERING

542.100 Reclamation Timetable

A timetable for the completion of each major step in the reclamation plan is presented in Figure 5-15 (G-2 and G-5) and 5-26 (G-3, G-4, G-6 thru G-19, G-31 and the AMV access road). Per Task ID #2408, "the Division requires notification and a reasonably specific time to initiate the reclamation activities associated with degassification well sites." In addition to the two figures referenced above, information pertaining to reclamation timing for methane degas wells is provided in Attachment 5-2 of this amendment.

542.200 Plan for Backfilling, Soil Stabilization, Compacting, and Grading

Following completion of the venting activities, the well site will be prepared for contouring and soil distribution. Details regarding topsoil placement and revegetation are provided in Section 242 and Section 353, respectively.

Sedimentation Pond Removal and Interim Sediment Control - See Section 542.500 of this submittal.

542.300 Final Surface Configuration Maps and Cross Sections

The sites will be regraded to the approximate original contour, the contours representing the pre-disturbance topography also represent the reclamation topography. Refer to Figures 5-2, 5-6, 5-10, 5-18, 5-21, 5-24, 5-28 and Attachment 5-1 (G-8 thru G-19 and G-31) to see cross sections representing the final surface configuration. Refer to Attachment 5-4, Plates 1 thru 3 for the surface configuration of the road and cross sections showing pre-mining, operational and post-mining contours. ~~Selected as-built cross sections are shown on Plate 4, Attachment 5-4.~~

ATTACHMENT 5-4

Degas Wells Access Road

ATTACHMENT 5-4
DEGAS WELLS ACCESS ROAD
AS-BUILT DESIGN CALCULATIONS

REGISTERED PROFESSIONAL ENGINEER
No. 168246
RICHARD B. WHITE
5 Aug 2008
STATE OF UTAH

ATTACHMENT 5-4
G31/G18 ACCESS ROAD AS-BUILT HYDROLOGY CALCULATIONS

As-Built Areas and Cut/Fill Volumetrics

Area	Road	Pad 31	Pad 18	TOTAL
Disturbed Acreage	5.68	2.87	1.36	9.91
Disturbed Area Acreage	14.23	3.18	1.88	19.29
Topsoil Volume (cyd)	9,167	4,624	2,195	15,986
Subsoil Cut Volume (cyd)	15,207	8,470	6,962	30,639
Cut Volume Total (cyd)	24,374	13,094	9,157	46,625
Fill Volume Required (cyd)	11,954	11,781	5,938	29,673
Net Cut(+)/Fill(-) Subsoil Only (cyd)	3,253	-3,311	1,024	966

Notes

Constructed road is 6,705 feet long.

Topsoil Volume assumes that the Disturbed Area contained 1 foot (avg) thickness topsoil that was stockpiled.

The Subsoil Cut Volume is the Cut Volume Total minus the Topsoil Volume.

The Net Cut Volume (966 cyd) does not include the volume of subsoil required to construct berms along the road (248 cyd), around the topsoil stockpiles (300 cyd), or around the degas well pads G-31 (62 cyd) and G-18 (39 cyd). The net cut is thus 966-300-248-62-39= 317 cyd. The road and pad berm volumes were calculated assuming that they were 1 ft tall with 1H:1V side slopes. The lengths of the berms for the road, G-31, and G-18 were taken as 6705, 1670, and 1023 feet long, respectively.

All acreages and cut/fill volumes were calculated with AutoCAD software.

As-Built Stockpile Runoff Volume Calculations

Stockpile	Watershed Area (sq. ft.)	Watershed Area (acres)	Precip. - ***P*** (in)	Curve Number (***CN***)	Potential Max. Retention - ***S*** (in.)	Runoff - ***Q*** (in)	Runoff Volume - ***V*** (ft3)
T-2	2,955	0.07	2.05	82	2.20	0.68	168
T-3	4,384	0.10	2.05	82	2.20	0.68	249
T-4	1,516	0.03	2.05	89	1.24	1.07	135
T-5	4,363	0.10	2.05	89	1.24	1.07	389
T-6	8,934	0.21	2.05	89	1.24	1.07	796
T-7	9,824	0.23	2.05	82	2.20	0.68	558
T-8	1,866	0.04	2.05	82	2.20	0.68	106
T-9	10,028	0.23	2.05	82	2.20	0.68	570
T-10	9,936	0.23	2.05	82	2.20	0.68	565

Notes

T-1 does not exist

Calculations have been performed for the 10-year, 24-hour design storm event.

Topsoil is derived from the Midfork Family - Comodore Complex, the Rabbitex Family - Datino Complex, and the Rock-outcrop Rubbleland - Travesilla Complex, as described in the NRCS Soil Survey for Carbon Area, Parts of Carbon and Emery Counties.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

Precipitation for 10-year, 24-hour event taken from National Weather Service web site (http://hdsc.nws.noaa.gov/hdsc/pfds /sa/ut_pfds.html)

CN = 82 and 89, based on Table 9.1, NEH s4 ch9. Assume Hyd. Soil Gp. B for T-2, 3, 7, 8, 9, 10 (as given for Midfork and Rabbitex soils in NRCS survey) and Hyd. Soil Gp. D for T-4, 5, 6 (as given for Rock-outcrop Complex soils in NRCS survey). Assume road, dirt surface (non-vegetated, conservative case).

$S = (1000/CN) - 10$

$L = [(I^{0.8} (S+1)^{0.7}]/(1900Y^{0.5})$

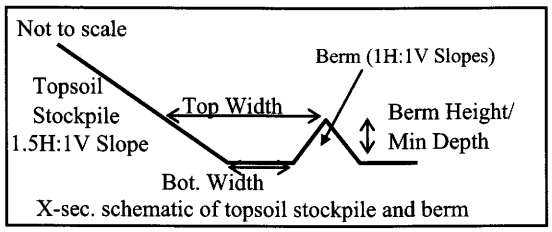
$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Stockpile Runoff Containment Volume Calculations

Stockpile	Bottom Width (ft)	Top Width (ft)	Min Depth (ft)	Impounding Length of Berm (ft)	Cntnmt Vol. (ft3)	Contain Vol > Runoff Vol ?
T-2	0	5	2	112	560	Yes
T-3	0	7.5	3	115	1,294	Yes
T-4	1	3.5	1	66	149	Yes
T-5	1.5	21.5	8	158	14,536	Yes
T-6	9	14	2	203	4,669	Yes
T-7	3	13	4	194	6,208	Yes
T-8	1.5	11.5	4	88	2,288	Yes
T-9	3	15.5	5	213	9,851	Yes
T-10	3	14.25	4.5	239	9,276	Yes



X-sec. schematic of topsoil stockpile and berm

Notes

T-1 does not exist.

The bottom width is the distance between the toe of the topsoil stockpile and the base of the berm. (see schematic)

The top width is the horizontal distance between the crest of the berm and the topsoil stockpile. (see schematic)

The max depth is the height of the berm.

The Impounding Length of the berm accounts for the slope of the ground, and is the portion of the berm that will impound runoff.

The Containment Volume = Length * Cross sectional area of the space between the topsoil stockpile and the inby side of the berm.

As-Built Watershed Hydrology

Watershed	Watershed Area (acres)	Precip. *P* (in)	Hydraulic Length - *l* (ft)	Avg Watershed Slope - *Y* (%)	Duration of Storm (hr)	Curve Number (*CN*)	Potential Max. Retention *S* (in.)	Lag - *L* (hr)	Time of Concentration - *Tc* (hr)	Runoff - *Q* (in)	Runoff Volume - *V* (ft^3)
WSBottom	0.2	1.38	193	62.9	6	74	3.51	0.01	0.02	0.11	65
WSC1	5.3	2.05	783	51.0	24	74	3.51	0.04	0.07	0.37	7,124
WSC2	3.0	2.05	475	59.4	24	74	3.51	0.03	0.05	0.37	4,107
WSC3	2.8	2.05	398	67.9	24	74	3.51	0.02	0.04	0.37	3,742
WSWB1	0.4	1.38	291	55.4	6	74	3.51	0.02	0.03	0.11	168
WSWB2	0.2	1.38	280	71.6	6	74	3.51	0.02	0.03	0.11	78
WSWB3	0.5	1.38	469	44.3	6	74	3.51	0.03	0.05	0.11	191
WSWB4	2.9	1.38	1,103	52.2	6	74	3.51	0.06	0.09	0.11	1,165
WSWB5	4.9	1.38	703	58.8	6	74	3.51	0.04	0.06	0.11	1,945
WSC4	3.2	1.38	752	52.6	24	74	3.51	0.04	0.07	0.11	1,277
WSC5	1.3	2.05	1,146	13.2	24	74	3.51	0.12	0.19	0.37	1,786
WSWB6	3.2	1.38	777	57.5	6	74	3.51	0.04	0.07	0.11	1,279
WSWB7	2.4	1.38	548	52.5	6	74	3.51	0.03	0.05	0.11	940
WSWB8	0.6	1.38	416	45.8	6	74	3.51	0.03	0.05	0.11	220
WSWB9	1.0	1.38	560	25.0	6	74	3.51	0.05	0.08	0.11	381
WSC6	1.2	1.38	481	41.5	6	74	3.51	0.03	0.05	0.11	468
WSWB10	1.2	1.38	506	66.4	6	74	3.51	0.03	0.05	0.11	477
WSWB11	2.8	1.38	701	43.2	6	74	3.51	0.04	0.07	0.11	1,107
WSWB12	2.2	1.38	499	31.3	6	74	3.51	0.04	0.06	0.11	879
WSWB13	0.11	1.38	127	14.0	6	74	3.51	0.02	0.03	0.11	43

Notes

Watersheds are labeled "WS" followed by the abbreviations for their respective outlets to which they report. i.e. "WSWB1" refers to the watershed reporting to water bar WB1.

WSBottom discharges to the road ditch below the road.

Calculations have been performed for the 10-year, 24-hour storm event for ephemeral drainage channel culverts (C1 - C3, C5) and the 10-year, 6-hour design storm event for road runoff water bars.

Refer to Figure 1 for locations of watersheds. NRCS soils units are shown on the attached NRCS Web Soil Survey Maps.

Calculations based on Soil Conservation Service (SCS) Method, National Engineering Handbook Section 4, Chapters 9 & 10 by Victor Mockus, 1972

CN determined based on NRCS soils map, which shows that each watershed contains soils of which half are in Hydrologic Soils Group B and half are in Group D According to the UDOT Manual of Instruction, Table 7-14, woods-grass combination, fair condition has a CN of 65 for Group B and 82 for Group D. The weighted average CN is thus 74.

$S = (1000/CN) - 10$

$L = [(l^{0.8} (S+1)^{0.7}]/(1900Y^{0.5})$

$T_c = 1.67L$

$Q = (P - 0.2*S)^2 / (P + 0.8*S)$

$V = Area * Q$

Average Watershed Slope Calculation (Sum of lengths of contour lines X contour interval / Area)

WSWB1

Contour (ft)	Length (ft)
7,790	5
7,760	33
7,730	63
7,700	49
TOTAL	**149**
AvgSlope	**62.9%**

WSC1

Contour (ft)	Length (ft)
8,040	94
7,970	515
7,900	425
7,830	366
7,760	268
TOTAL	**1,668**
AvgSlope	**51.0%**

WSC2

Contour (ft)	Length (ft)
8,000	58
7,950	273
7,900	307
7,850	327
7,800	387
7,750	216
TOTAL	**1,568**
AvgSlope	**59.4%**

WSC3

Contour (ft)	Length (ft)
7,950	297
7,900	534
7,850	504
7,800	297
TOTAL	**1,632**
AvgSlope	**67.9%**

WSWB2

Contour (ft)	Length (ft)
7,900	26
7,880	148
7,860	218
7,840	117
TOTAL	**509**
AvgSlope	**55.4%**

WSWB3

Contour (ft)	Length (ft)
7,890	25
7,880	395
7,870	142
7,860	51
TOTAL	**613**
AvgSlope	**71.6%**

WSWB4

Contour (ft)	Length (ft)
8,030	1
7,990	23
7,950	75
7,910	133
TOTAL	**232**
AvgSlope	**44.3%**

WSWB5

Contour (ft)	Length (ft)
8,330	4
8,230	30
8,130	145
8,030	316
7,930	172
TOTAL	**667**
AvgSlope	**52.2%**

WSWB6

Contour (ft)	Length (ft)
8,340	72
8,240	349
8,140	419
8,040	415
TOTAL	**1,255**
AvgSlope	**58.8%**

WSC4

Contour (ft)	Length (ft)
8,340	10
8,240	103
8,140	209
8,040	415
TOTAL	**737**
AvgSlope	**52.6%**

WSC5

Contour (ft)	Length (ft)
8,330	2
8,280	28
8,130	121
TOTAL	**151**
AvgSlope	**13.2%**

WSWB7

Contour (ft)	Length (ft)
8,340	29
8,290	351
8,240	399
8,190	433
8,140	401
TOTAL	**1,613**
AvgSlope	**57.5%**

WSWB8

Contour (ft)	Length (ft)
8,300	17
8,250	391
8,200	536
8,150	138
TOTAL	**1,082**
AvgSlope	**52.5%**

WSWB9

Contour (ft)	Length (ft)
8,220	128
8,210	276
8,200	359
8,190	243
8,180	97
TOTAL	**1,103**
AvgSlope	**45.8%**

WSWB10

Contour (ft)	Length (ft)
8,240	34
8,230	116
8,220	192
8,210	242
8,200	296
8,190	115
8,180	46
TOTAL	**1,041**
AvgSlope	**25.0%**

WSC6

Contour (ft)	Length (ft)
8,340	9
8,320	39
8,300	102
8,280	146
8,260	193
8,240	270
8,220	306
TOTAL	**1,065**
AvgSlope	**41.5%**

WSWB11

Contour (ft)	Length (ft)
8,380	49
8,360	168
8,340	210
8,320	235
8,300	249
8,280	267
8,260	270
8,240	286
TOTAL	**1,734**
AvgSlope	**66.4%**

WSWB12

Contour (ft)	Length (ft)
8,420	24
8,390	166
8,360	465
8,330	432
8,300	402
8,270	254
8,240	4
TOTAL	**1,747**
AvgSlope	**43.2%**

WSWB13

Contour (ft)	Length (ft)
8,430	88
8,400	238
8,370	264
8,340	204
8,310	212
TOTAL	**1,006**
AvgSlope	**31.3%**

WSWB14

Contour (ft)	Length (ft)
8,352	12
8,348	35
8,344	58
8,340	35
8,336	25
TOTAL	**165**
AvgSlope	**14.0%**

As-Built Culvert and Water Bar Sizing

Structure	Depth of Road Ditch Above Structure (ft)	Peak Stage in Road Ditch (ft)	Peak Velocity in Road Ditch (fps)	Depth of Water Bar (ft)	Peak Stage in Water Bar (ft)	Peak Flow Velocity in Water Bar (fps)	Culvert Peak Inlet Stage (ft)	Culvert Peak Inside Stage (ft)	Peak Flow Velocity from Culvert (fps)	Peak Culvert/Water Bar Discharge (cfs)
Bottom	0.67	0.15	1.90	NA	NA	NA	NA	NA	NA	0.04
C1	0.67	0.47	4.66	NA	NA	NA	0.45	0.45	18.32	5.20
C2	0.67	0.40	3.72	NA	NA	NA	0.22	0.22	13.56	1.93
C3	0.67	0.45	4.85	NA	NA	NA	0.34	0.34	17.91	4.82
WB1	0.67	0.38	3.64	1	0.14	2.28	NA	NA	NA	0.51
WB2	0.67	0.16	1.89	1	0.02	0.95	NA	NA	NA	0.04
WB3	1.00	0.10	2.45	3	0.08	2.07	NA	NA	NA	0.10
WB4	1.00	0.22	3.69	1	0.14	1.81	NA	NA	NA	0.42
WB5	1.00	0.35	3.76	1	0.20	2.17	NA	NA	NA	0.82
C4	0.83	0.33	2.55	NA	NA	NA		0.15	3.93	0.50
C5	0.67	0.13	1.73	NA	NA	NA		0.06	2.16	0.07
WB6	0.67	0.27	2.60	1	0.15	1.85	NA	NA	NA	0.46
WB7	0.67	0.39	3.37	1	0.24	2.38	NA	NA	NA	1.16
WB8	0.67	0.22	2.33	1	0.11	1.58	NA	NA	NA	0.27
C6	0.67	0.30	2.21	NA	NA	NA		0.09	2.98	0.19
WB9	0.67	0.26	1.87	1	0.07	1.29	NA	NA	NA	0.12
WB10	0.67	0.36	2.16	1	0.08	1.87	NA	NA	NA	0.21
WB11	0.67	0.31	3.22	1	0.12	2.34	NA	NA	NA	0.44
WB12	0.67	0.34	3.37	1	0.11	2.24	NA	NA	NA	0.38
WB13	0.50	0.1	1.72	1	0.02	0.94	NA	NA	NA	0.55

Notes

Culvert and Water Bar No. corresponds to Watershed No. on As-Built Watershed Hydrology - Culvert and Water Bar Design Table. i.e. Culvert C1 is located where watershed WSC1 crosses the road, and water bar WB1 is where watershed WSWB1 crosses the road.

All culverts are 36-inch diameter corrugated metal pipe (Manning's No., n = 0.025).

Water bars and culverts are sloped at approximately 8% and 10%, respectively. Note that culverts C1, C2, and C3 discharge via downspouts sloped at approximately 100%.

The peak flows and stages in each culvert, water bar, and ditch were calculated using HydroCad 8.00 software using the Soil Conservation Service (SCS) method, as shown in the As-Built Watershed Hydrology Table. The design storm was the 10-year, 24-hour precipitation event for culverts discharging to ephemeral drainages (C1, C2, C3, and C5) and the the 10-year, 6-hour precipitation event for the road runoff ditches, the water bars, and the culverts that do not discharge to ephermal drainages (C4 and C6).

The only peak discharge velocities considered to be erosive (> 5 fps) are from culverts C1, C2, and C3. All other culverts, road ditches, and water bars discharge at nonerosive velocities during their respective design events.

The peak inlet depths are measured from the bottom of the culvert and were determined to be neglibly greater than the inside depth using Hydraulic Engineering Circular No. 5 Chart 5 (U.S. Department of Transportation, 1977). See the attached nomograph for additional information.

The peak inside depths are measured from the bottom of the culvert and were calculated using HydroCad 8.00 software. See attached output sheets for additional information.

The peak flow velocity from culvert considers the exit velocity from culvert downspouts, if present. See attached Flowmaster output sheets.

As-Built Culvert and Water Bar Outlet Protection

Water Bar/ Culvert Outlet	Rip Rap Outlet Protection D_{50} (in)	Length of Slope Protected Below Culvert Outlet (ft)	Slope at Water Bar/ Culvert Outlet (ft/ft)	Manning's Roughness (n)	Design Event Peak Flow (cfs)	Peak Culvert/Water Bar Flow Velocity (fps)	Steady State Flow Velocity in Rip Rap Structure (fps)
C1	40	25	0.10	0.057	5.20	18.3	3.7
C2	36	20	0.20	0.062	1.93	13.6	3.2
C3	36	25	0.20	0.062	4.82	17.9	4.3
WB1	18	16	0.67	0.068	0.51	2.3	2.7
WB2	36	25	0.63	0.075	0.04	1.0	0.9
WB3	18	25	0.04	0.043	0.10	2.1	0.8
WB4	18	16	0.56	0.066	0.42	1.8	2.4
WB5	24	15	0.71	0.072	0.82	2.2	3.2
C4	36	25	0.63	0.075	0.50	1.2	2.5
C5	48	15	1.00	0.084	0.07	2.3	1.2
WB6	22	16	0.42	0.065	0.46	1.9	2.3
WB7	24	16	0.67	0.071	1.16	2.4	3.6
WB8	24	24	0.59	0.069	0.27	1.6	2.0
C6	40	20	0.57	0.075	0.19	1.4	1.6
WB9	4	15	0.25	0.046	0.12	1.3	1.4
WB10	9	4	0.71	0.061	0.21	1.9	2.1
WB11	12	12	0.83	0.066	0.44	2.3	2.8
WB12	18	11	0.83	0.070	0.38	2.2	2.5
WB13	10	9	0.71	0.062	0.55	0.9	3.0

Notes

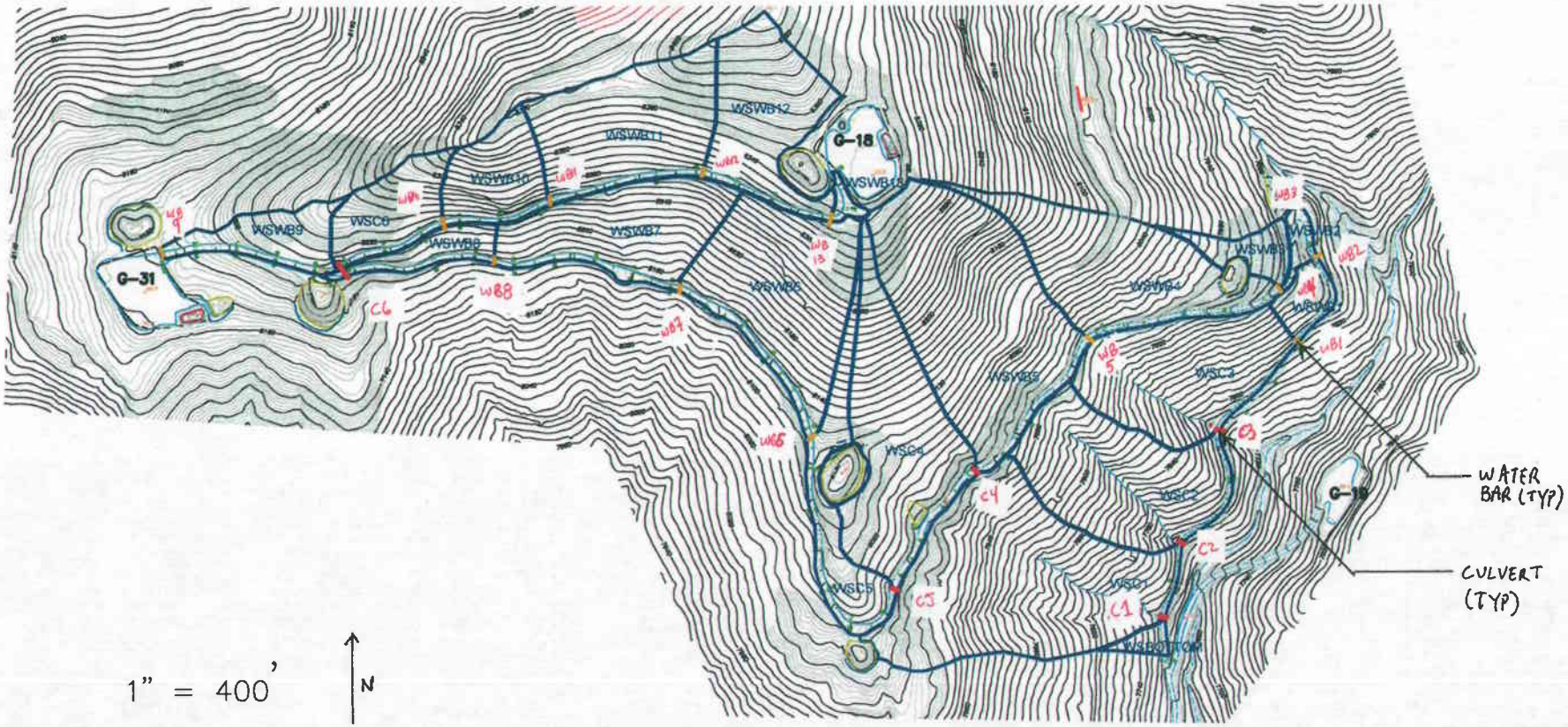
Refer to Figure 2 for a typical drawing of road culverts and outlet protection

Rip rap has been placed to armor outlets of water bars and culverts. Culverts C1, C2, and C3 are the only structures calculated to discharge at erosive velocities during the design event (see As-Built Culvert and Water Bar Sizing Table). For these three culverts, appropriately sized rip rap has been placed based on recommendations in USDOT FHWA HEC 11 (1978) Fig. 2.

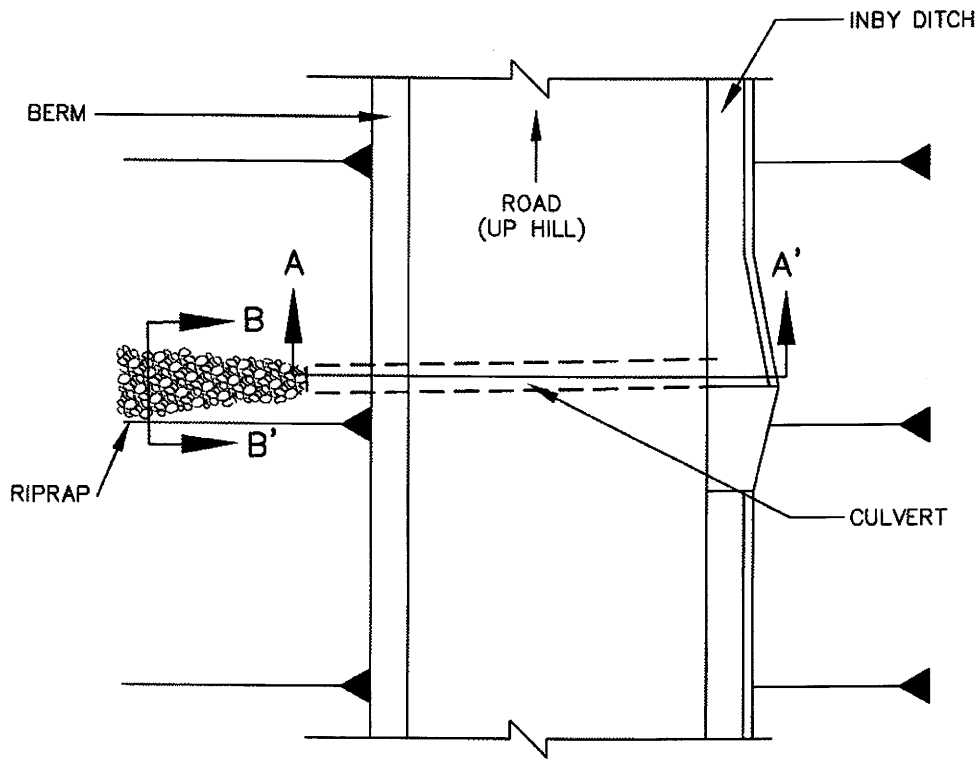
Manning's Roughness calculated as $n = 0.0456(D_{50} \times S)^{0.159}$, where D_{50} is the median rip rap diameter in inches and S is the channel slope (Abt et al, 1987).

Peak culvert/water bar flows and velocities were calculated for the 10-year, 24-hour event for culverts that drain into ephemeral drainages (C1 - C3, and C5), and the 10-year, 6-hour event for road runoff culverts (C4, C6) and water bars using HydroCAD 8.00.

Steady state flow velocities calculated using Flowmaster 6.0 (Haestad Methods, Inc.) They have been calculated to show that the rip rap protection will sufficiently reduce flow velocities so that the design discharge is non-erosive. Velocities less than 5.0 fps are considered nonerosive.

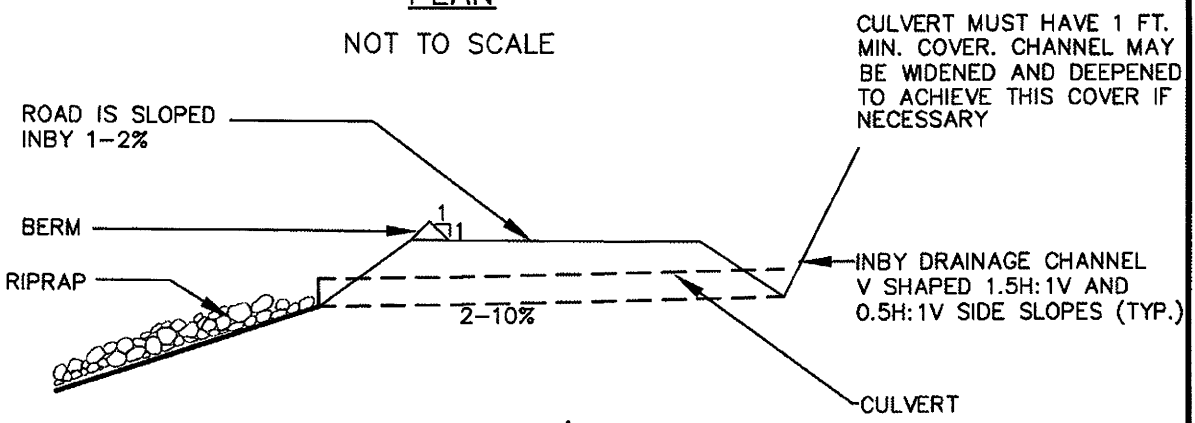


ATTACHMENT 5-4 FIGURE 1. ROAD WATERSHED, CULVERT, AND WATER BAR MAP



PLAN

NOT TO SCALE



SECTION A–A'

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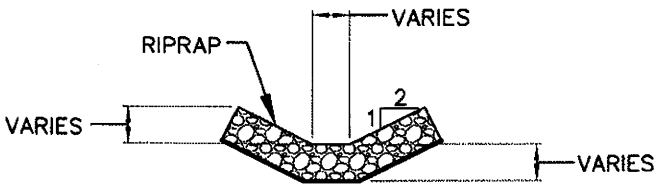

SECTION B–B'

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FIGURE 2. TYPICAL CULVERT DESIGN

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HYDROCAD 8.00 AND FLOWMASTER MODEL OUTPUT

Description of Model Output

Watershed hydrology and runoff control hydraulics were modeled with HydroCAD 8.00 and Flowmaster computer programs. Because HydroCAD models were limited to 20 nodes, the road was broken down into four segments. These segments include the following:

(1) The bottom of the road up to water bar WB1
(2) Water Bar WB2 up to culvert C5
(3) Water bar WB6 up to culvert C6
(4) Water bar WB10 up to water bar WB13

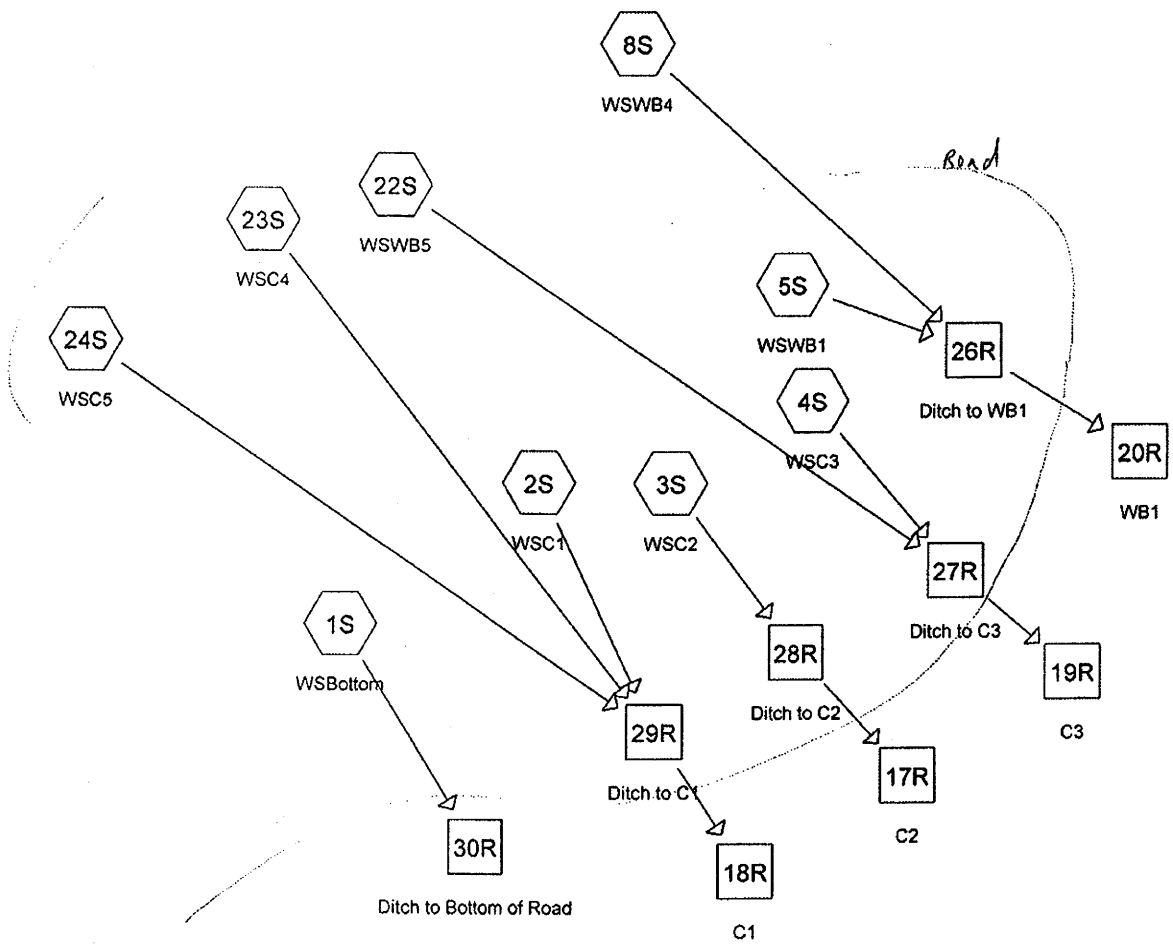
Thus, the HydroCAD 8.00 output is included in four files. Each of the four files consider the 10-year, 6-hour precipitation event. Additional output sheets are attached showing model results of the 10-year, 24-hour precipitation event for culverts C1, C2, C3, and C5, all of which discharge to ephemeral stream channels. Culvert inlet conditions were determined using HEC No. 5, Chart 5 (attached).

Flowmaster output files are included to show design discharge velocities from culverts C1,C2, and C3, which have been constructed with downspouts. Additional Flowmaster output sheets are included to show the results of calculating the steady-state flow velocities in the armored water bar and culvert outlets. The rip rap armor was sufficient to reduce velocities to less than 5 fps (non-erosive) for all discharge structures except C1, C2, and C3 during their respective design events. For these three culverts, HEC No. 11, Fig. 2 (attached) shows that the rip rap has been sufficiently sized.

10-YR, 6-HR PRECIP EVENT

BOTTOM PORTION OF ROAD UP TO WB1

CALCS FOR ROAD DITCHES, WB1



Subcat Reach Pond Link

Drainage Diagram for 10-6 Bottom - WB1

Prepared by {enter your company name here}, Printed 8/1/2008

HydroCAD® 8.50 s/n 003900 © 2007 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.03 hrs, 801 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: WSBottom Runoff Area=7,128 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=193' Slope=0.6290 '/' Tc=1.3 min CN=74 Runoff=0.05 cfs 0.001 af

Subcatchment 2S: WSC1 Runoff Area=228,916 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=783' Slope=0.5100 '/' Tc=4.4 min CN=74 Runoff=0.99 cfs 0.048 af

Subcatchment 3S: WSC2 Runoff Area=131,963 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=475' Slope=0.5940 '/' Tc=2.7 min CN=74 Runoff=0.74 cfs 0.028 af

Subcatchment 4S: WSC3 Runoff Area=120,249 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=398' Slope=0.6790 '/' Tc=2.2 min CN=74 Runoff=0.65 cfs 0.025 af

Subcatchment 5S: WSWB1 Runoff Area=18,370 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=291' Slope=0.5540 '/' Tc=1.9 min CN=74 Runoff=0.11 cfs 0.004 af

Subcatchment 8S: WSWB4 Runoff Area=127,724 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=1,103' Slope=0.5220 '/' Tc=5.7 min CN=74 Runoff=0.50 cfs 0.027 af

Subcatchment 22S: WSWB5 Runoff Area=213,234 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=703' Slope=0.5880 '/' Tc=3.7 min CN=74 Runoff=1.07 cfs 0.045 af

Subcatchment 23S: WSC4 Runoff Area=140,003 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=752' Slope=0.5260 '/' Tc=4.2 min CN=74 Runoff=0.61 cfs 0.029 af

Subcatchment 24S: WSC5 Runoff Area=57,396 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=57,396' Slope=0.1320 '/' Tc=266.8 min CN=74 Runoff=0.03 cfs 0.012 af

Reach 17R: C2 Avg. Depth=0.13' Max Vel=5.63 fps Inflow=0.56 cfs 0.028 af
D=36.0" n=0.025 L=50.0' S=0.2500 '/' Capacity=173.42 cfs Outflow=0.56 cfs 0.028 af

Reach 18R: C1 Avg. Depth=0.24' Max Vel=5.44 fps Inflow=1.47 cfs 0.089 af
D=36.0" n=0.025 L=50.0' S=0.1000 '/' Capacity=109.68 cfs Outflow=1.46 cfs 0.089 af

Reach 19R: C3 Avg. Depth=0.19' Max Vel=7.35 fps Inflow=1.43 cfs 0.070 af
D=36.0" n=0.025 L=50.0' S=0.2500 '/' Capacity=173.42 cfs Outflow=1.40 cfs 0.070 af

Reach 20R: WB1 Avg. Depth=0.14' Max Vel=2.28 fps Inflow=0.51 cfs 0.031 af
n=0.040 L=20.0' S=0.0830 '/' Capacity=38.88 cfs Outflow=0.51 cfs 0.031 af

Reach 26R: Ditch to WB1 Avg. Depth=0.38' Max Vel=3.64 fps Inflow=0.55 cfs 0.031 af
n=0.040 L=244.0' S=0.1393 '/' Capacity=2.38 cfs Outflow=0.51 cfs 0.031 af

Reach 27R: Ditch to C3 Avg. Depth=0.45' Max Vel=4.85 fps Inflow=1.68 cfs 0.070 af
n=0.040 L=277.0' S=0.1588 '/' Capacity=4.25 cfs Outflow=1.43 cfs 0.070 af

Reach 28R: Ditch to C2 Avg. Depth=0.40' Max Vel=3.72 fps Inflow=0.74 cfs 0.028 af
n=0.040 L=320.0' S=0.1375 '/' Capacity=2.37 cfs Outflow=0.56 cfs 0.028 af

Reach 29R: Ditch to C1 Avg. Depth=0.47' Max Vel=4.66 fps Inflow=1.59 cfs 0.089 af
n=0.040 L=185.0' S=0.1189 '/' Capacity=3.70 cfs Outflow=1.47 cfs 0.089 af

Reach 30R: Ditch to Bottom of Road Avg. Depth=0.15' Max Vel=1.90 fps Inflow=0.05 cfs 0.001 af
n=0.040 L=90.0' S=0.1333 '/' Capacity=2.33 cfs Outflow=0.04 cfs 0.001 af

Total Runoff Area = **23.990 ac** **Runoff Volume = 0.219 af** **Average Runoff Depth = 0.11"**
100.00% Pervious = 23.990 ac **0.00% Impervious = 0.000 ac**

Summary for Subcatchment 1S: WSBottom

Runoff = 0.05 cfs @ 3.00 hrs, Volume= 0.001 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	7,128	74	
	7,128		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.3	193	0.6290	2.51		**Lag/CN Method,**

Summary for Subcatchment 2S: WSC1

Runoff = 0.99 cfs @ 3.05 hrs, Volume= 0.048 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	228,916	74	
	228,916		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.4	783	0.5100	2.99		**Lag/CN Method,**

Summary for Subcatchment 3S: WSC2

Runoff = 0.74 cfs @ 3.03 hrs, Volume= 0.028 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	131,963	74	
	131,963		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	475	0.5940	2.92		**Lag/CN Method,**

Summary for Subcatchment 4S: WSC3

Runoff = 0.65 cfs @ 3.02 hrs, Volume= 0.025 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	120,249	74	
	120,249		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	398	0.6790	3.01		**Lag/CN Method,**

Summary for Subcatchment 5S: WSWB1

Runoff = 0.11 cfs @ 3.01 hrs, Volume= 0.004 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	18,370	74	
	18,370		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.9	291	0.5540	2.55		**Lag/CN Method,**

Summary for Subcatchment 8S: WSWB4

Runoff = 0.50 cfs @ 3.07 hrs, Volume= 0.027 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	127,724	74	
	127,724		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	1,103	0.5220	3.23		**Lag/CN Method,**

Summary for Subcatchment 22S: WSWB5

Runoff = 1.07 cfs @ 3.04 hrs, Volume= 0.045 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	213,234	74	
	213,234		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	703	0.5880	3.14		**Lag/CN Method,**

Summary for Subcatchment 23S: WSC4

Runoff = 0.61 cfs @ 3.05 hrs, Volume= 0.029 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	140,003	74	
	140,003		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	752	0.5260	3.01		**Lag/CN Method,**

Summary for Subcatchment 24S: WSC5

Runoff = 0.03 cfs @ 7.41 hrs, Volume= 0.012 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	57,396	74	
	57,396		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
266.8	57,396	0.1320	3.59		**Lag/CN Method,**

Summary for Reach 17R: C2

Inflow Area =	3.029 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.56 cfs @	3.08 hrs,	Volume=	0.028 af	
Outflow =	0.56 cfs @	3.09 hrs,	Volume=	0.028 af,	Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 5.63 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.22 fps, Avg. Travel Time= 0.3 min

Peak Storage= 5 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 173.42 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.2500 '/'
Inlet Invert= 7,728.00', Outlet Invert= 7,715.50'

Summary for Reach 18R: C1

Inflow Area =	9.787 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	1.47 cfs @	3.08 hrs,	Volume=	0.089 af	
Outflow =	1.46 cfs @	3.09 hrs,	Volume=	0.089 af,	Atten= 1%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 5.44 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.84 fps, Avg. Travel Time= 0.5 min

Peak Storage= 14 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 109.68 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.1000 '/'
Inlet Invert= 7,708.00', Outlet Invert= 7,703.00'

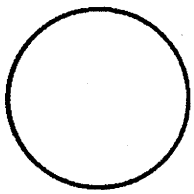
Summary for Reach 19R: C3

Inflow Area = 7.656 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 1.43 cfs @ 3.07 hrs, Volume= 0.070 af
Outflow = 1.40 cfs @ 3.07 hrs, Volume= 0.070 af, Atten= 2%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 7.35 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.12 fps, Avg. Travel Time= 0.2 min

Peak Storage= 10 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 173.42 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.2500 '/'
Inlet Invert= 7,770.00', Outlet Invert= 7,757.50'



Summary for Reach 20R: WB1

Inflow Area = 3.354 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 0.51 cfs @ 3.11 hrs, Volume= 0.031 af
Outflow = 0.51 cfs @ 3.12 hrs, Volume= 0.031 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 2.28 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 0.3 min

Peak Storage= 4 cf @ 3.11 hrs, Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 38.88 cfs

1.00' x 1.00' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0830 '/'
Inlet Invert= 7,822.00', Outlet Invert= 7,820.34'

‡

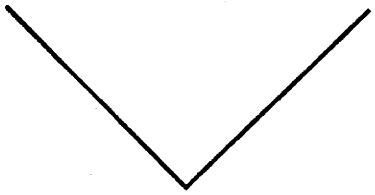
Summary for Reach 26R: Ditch to WB1

Inflow Area =	3.354 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.55 cfs @	3.07 hrs,	Volume=	0.031 af	
Outflow =	0.51 cfs @	3.11 hrs,	Volume=	0.031 af,	Atten= 8%, Lag= 2.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.64 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 2.16 fps, Avg. Travel Time= 1.9 min

Peak Storage= 35 cf @ 3.09 hrs, Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.38 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 244.0' Slope= 0.1393 '/'
Inlet Invert= 7,856.00', Outlet Invert= 7,822.00'



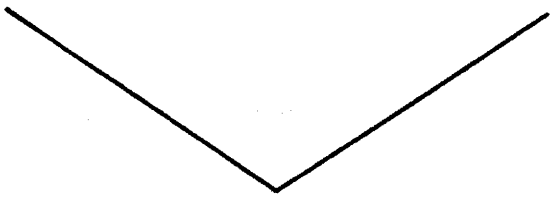
Summary for Reach 27R: Ditch to C3

Inflow Area =	7.656 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	1.68 cfs @	3.03 hrs,	Volume=	0.070 af	
Outflow =	1.43 cfs @	3.07 hrs,	Volume=	0.070 af,	Atten= 15%, Lag= 2.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 4.85 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 2.70 fps, Avg. Travel Time= 1.7 min

Peak Storage= 85 cf @ 3.05 hrs, Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 4.25 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.5 '/' Top Width= 2.01'
Length= 277.0' Slope= 0.1588 '/'
Inlet Invert= 7,822.00', Outlet Invert= 7,778.00'



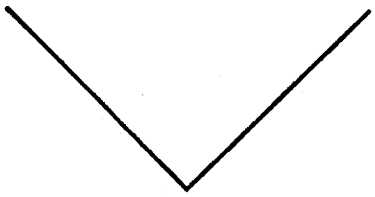
Summary for Reach 28R: Ditch to C2

Inflow Area =	3.029 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.74 cfs @	3.03 hrs,	Volume=	0.028 af	
Outflow =	0.56 cfs @	3.08 hrs,	Volume=	0.028 af,	Atten= 24%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 3.72 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 2.05 fps, Avg. Travel Time= 2.6 min

Peak Storage= 51 cf @ 3.06 hrs, Average Depth at Peak Storage= 0.40'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.37 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 320.0' Slope= 0.1375 '/'
Inlet Invert= 7,772.00', Outlet Invert= 7,728.00'



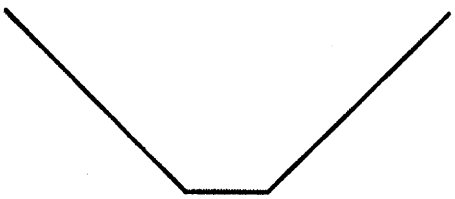
Summary for Reach 29R: Ditch to C1

Inflow Area =	9.787 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	1.59 cfs @	3.05 hrs,	Volume=	0.089 af	
Outflow =	1.47 cfs @	3.08 hrs,	Volume=	0.089 af,	Atten= 8%, Lag= 1.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 4.66 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 2.4 min

Peak Storage= 66 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.47'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 3.70 cfs

0.30' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.64'
Length= 185.0' Slope= 0.1189 '/'
Inlet Invert= 7,730.00', Outlet Invert= 7,708.00'



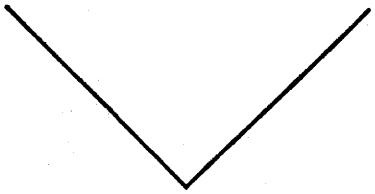
Summary for Reach 30R: Ditch to Bottom of Road

Inflow Area =	0.164 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.05 cfs @	3.00 hrs,	Volume=	0.001 af	
Outflow =	0.04 cfs @	3.04 hrs,	Volume=	0.001 af,	Atten= 31%, Lag= 2.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 1.90 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 1.4 min

Peak Storage= 2 cf @ 3.03 hrs, Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.33 cfs

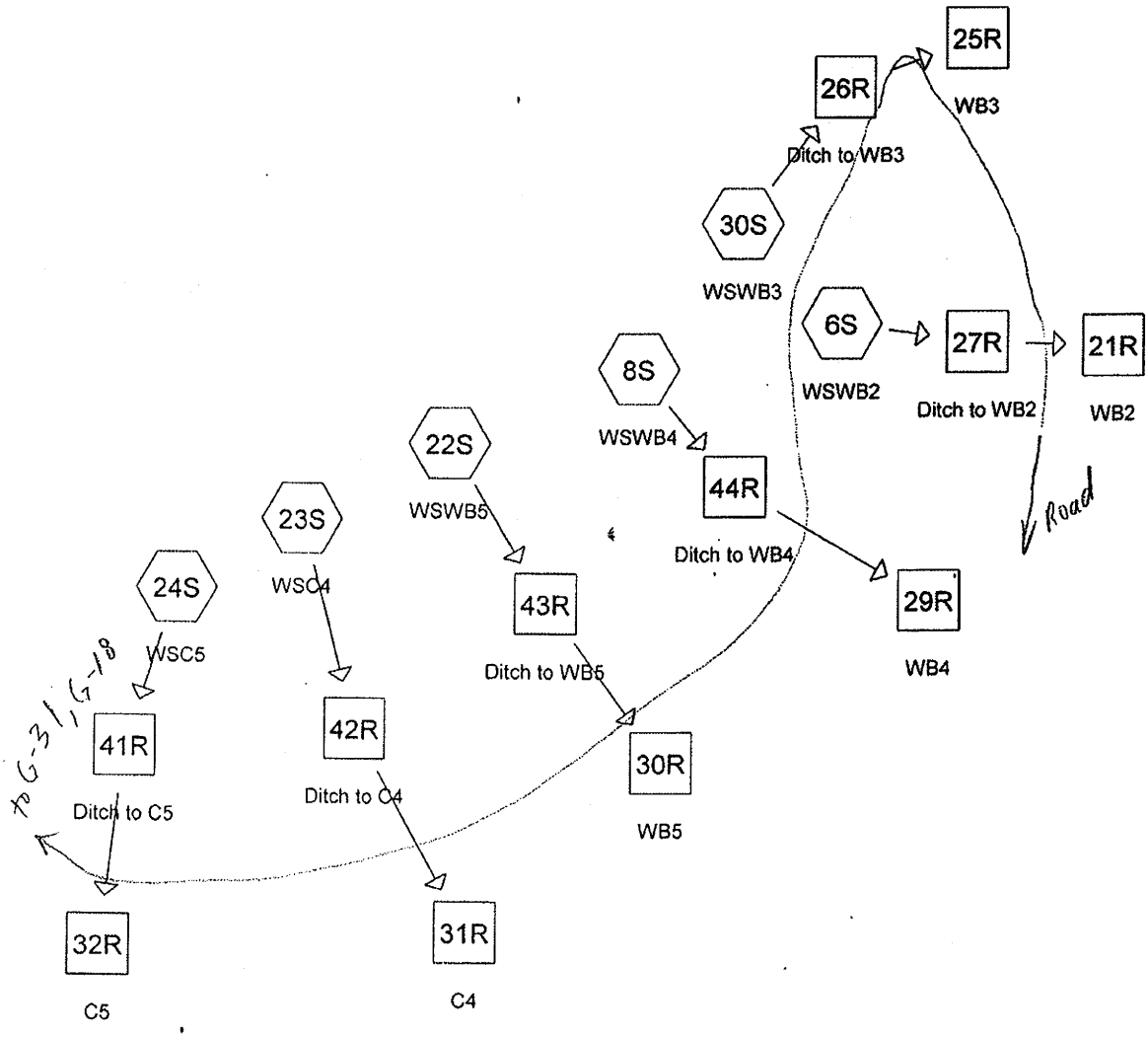
0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 90.0' Slope= 0.1333 '/'
Inlet Invert= 7,708.00', Outlet Invert= 7,696.00'



10 YR/6HR PRECIP EVENT

WB2 UP TO C5

CALCS FOR ROAD DITCHES, WB2, WB3, WB4, WB5



Subcat Reach Pond Link

Drainage Diagram for 10-6 WB2 - C5

Prepared by {enter your company name here}, Printed 8/1/2008

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
13.037	74	(6S,8S,22S,23S,24S,30S)
13.037		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.02 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 6S: WSWB2 Runoff Area=8,566 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=280' Slope=0.7160 '/' Tc=1.6 min CN=74 Runoff=0.07 cfs 0.002 af

Subcatchment 8S: WSWB4 Runoff Area=127,724 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=1,103' Slope=0.5220 '/' Tc=5.7 min CN=74 Runoff=0.50 cfs 0.027 af

Subcatchment 22S: WSWB5 Runoff Area=213,234 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=703' Slope=0.5880 '/' Tc=3.7 min CN=74 Runoff=1.07 cfs 0.045 af

Subcatchment 23S: WSC4 Runoff Area=140,003 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=752' Slope=0.5260 '/' Tc=4.2 min CN=74 Runoff=0.66 cfs 0.029 af

Subcatchment 24S: WSC5 Runoff Area=57,396 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=57,396' Slope=0.1320 '/' Tc=266.8 min CN=74 Runoff=0.03 cfs 0.012 af

Subcatchment 30S: WSWB3 Runoff Area=20,955 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=469' Slope=0.4430 '/' Tc=3.1 min CN=74 Runoff=0.12 cfs 0.004 af

Reach 21R: WB2 Avg. Depth=0.02' Max Vel=0.95 fps Inflow=0.05 cfs 0.002 af
n=0.040 L=20.0' S=0.1000 '/' Capacity=52.99 cfs Outflow=0.04 cfs 0.002 af

Reach 25R: WB3 Avg. Depth=0.08' Max Vel=2.07 fps Inflow=0.10 cfs 0.004 af
n=0.050 L=52.0' S=0.1827 '/' Capacity=147.98 cfs Outflow=0.10 cfs 0.004 af

Reach 26R: Ditch to WB3 Avg. Depth=0.10' Max Vel=2.45 fps Inflow=0.12 cfs 0.004 af
n=0.040 L=165.0' S=0.1515 '/' Capacity=10.47 cfs Outflow=0.10 cfs 0.004 af

Reach 27R: Ditch to WB2 Avg. Depth=0.16' Max Vel=1.89 fps Inflow=0.07 cfs 0.002 af
n=0.040 L=120.0' S=0.1167 '/' Capacity=2.18 cfs Outflow=0.05 cfs 0.002 af

Reach 29R: WB4 Avg. Depth=0.14' Max Vel=1.81 fps Inflow=0.43 cfs 0.027 af
n=0.040 L=20.0' S=0.0500 '/' Capacity=30.18 cfs Outflow=0.42 cfs 0.027 af

Reach 30R: WB5 Avg. Depth=0.20' Max Vel=2.17 fps Inflow=0.83 cfs 0.045 af
n=0.040 L=20.0' S=0.0500 '/' Capacity=30.18 cfs Outflow=0.82 cfs 0.045 af

Reach 31R: C4 Avg. Depth=0.15' Max Vel=3.93 fps Inflow=0.50 cfs 0.029 af
D=36.0" n=0.025 L=50.0' S=0.1000 '/' Capacity=109.68 cfs Outflow=0.50 cfs 0.029 af

Reach 32R: C5 Avg. Depth=0.04' Max Vel=1.78 fps Inflow=0.03 cfs 0.012 af
D=36.0" n=0.025 L=50.0' S=0.1000 '/' Capacity=109.68 cfs Outflow=0.03 cfs 0.012 af

Reach 41R: Ditch to C5 Avg. Depth=0.13' Max Vel=1.73 fps Inflow=0.03 cfs 0.012 af
n=0.040 L=652.0' S=0.1258 '/' Capacity=2.26 cfs Outflow=0.03 cfs 0.012 af

Reach 42R: Ditch to C4 Avg. Depth=0.33' Max Vel=2.55 fps Inflow=0.66 cfs 0.029 af
n=0.040 L=355.0' S=0.0620 '/' Capacity=5.83 cfs Outflow=0.50 cfs 0.029 af

Reach 43R: Ditch to WB5 Avg. Depth=0.35' Max Vel=3.76 fps Inflow=1.07 cfs 0.045 af
n=0.040 L=435.0' S=0.1057 '/' Capacity=8.75 cfs Outflow=0.83 cfs 0.045 af

Reach 44R: Ditch to WB4 Avg. Depth=0.22' Max Vel=3.69 fps Inflow=0.50 cfs 0.027 af
n=0.040 L=487.0' S=0.1581 '/' Capacity=10.69 cfs Outflow=0.43 cfs 0.027 af

Total Runoff Area = 13.037 ac Runoff Volume = 0.119 af Average Runoff Depth = 0.11"
100.00% Pervious = 13.037 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 6S: WSWB2

Runoff = 0.07 cfs @ 3.01 hrs, Volume= 0.002 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6,00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	8,566	74	
	8,566		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	280	0.7160	2.88		**Lag/CN Method,**

Summary for Subcatchment 8S: WSWB4

Runoff = 0.50 cfs @ 3.07 hrs, Volume= 0.027 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	127,724	74	
	127,724		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	1,103	0.5220	3.23		**Lag/CN Method,**

Summary for Subcatchment 22S: WSWB5

Runoff = 1.07 cfs @ 3.04 hrs, Volume= 0.045 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	213,234	74	
	213,234		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	703	0.5880	3.14		**Lag/CN Method,**

Summary for Subcatchment 23S: WSC4

Runoff = 0.66 cfs @ 3.05 hrs, Volume= 0.029 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	140,003	74	
	140,003		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.2	752	0.5260	3.01		**Lag/CN Method,**

Summary for Subcatchment 24S: WSC5

Runoff = 0.03 cfs @ 7.41 hrs, Volume= 0.012 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	57,396	74	
	57,396		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
266.8	57,396	0.1320	3.59		**Lag/CN Method,**

Summary for Subcatchment 30S: WSWB3

Runoff = 0.12 cfs @ 3.03 hrs, Volume= 0.004 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	20,955	74	
	20,955		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	469	0.4430	2.51		**Lag/CN Method,**

Summary for Reach 21R: WB2

Inflow Area =	0.197 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.05 cfs @	3.04 hrs,	Volume=	0.002 af	
Outflow =	0.04 cfs @	3.06 hrs,	Volume=	0.002 af,	Atten= 11%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.95 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 0.6 min

Peak Storage= 1 cf @ 3.05 hrs, Average Depth at Peak Storage= 0.02'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 52.99 cfs

2.00' x 1.00' deep channel, n= 0.040 Earth, cobble bottom, clean sides
Side Slope Z-value= 3.0 6.0 '/' Top Width= 11.00'
Length= 20.0' Slope= 0.1000 '/'
Inlet Invert= 5.00', Outlet Invert= 3.00'

‡

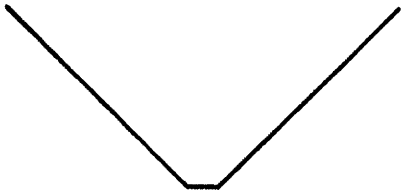
Summary for Reach 25R: WB3

Inflow Area =	0.481 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.10 cfs @	3.07 hrs,	Volume=	0.004 af	
Outflow =	0.10 cfs @	3.08 hrs,	Volume=	0.004 af,	Atten= 6%, Lag= 1.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.07 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.21 fps, Avg. Travel Time= 0.7 min

Peak Storage= 2 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 147.98 cfs

0.50' x 3.00' deep channel, n= 0.050 Earth, cobble bottom, clean sides
Side Slope Z-value= 1.0 '/' Top Width= 6.50'
Length= 52.0' Slope= 0.1827 '/'
Inlet Invert= 7,869.50', Outlet Invert= 7,860.00'



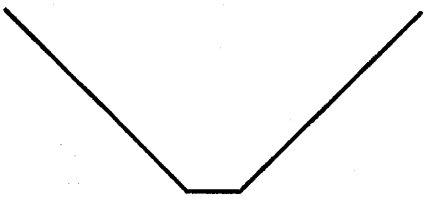
Summary for Reach 26R: Ditch to WB3

Inflow Area =	0.481 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.12 cfs @	3.03 hrs,	Volume=	0.004 af	
Outflow =	0.10 cfs @	3.07 hrs,	Volume=	0.004 af,	Atten= 14%, Lag= 2.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.45 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.29 fps, Avg. Travel Time= 2.1 min

Peak Storage= 7 cf @ 3.05 hrs, Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 10.47 cfs

0.30' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 2.30'
Length= 165.0' Slope= 0.1515 '/'
Inlet Invert= 7,895.00', Outlet Invert= 7,870.00'



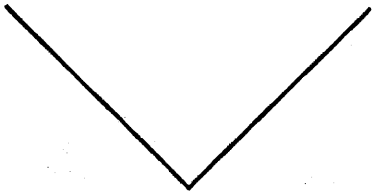
Summary for Reach 27R: Ditch to WB2

Inflow Area =	0.197 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.07 cfs @	3.01 hrs,	Volume=	0.002 af	
Outflow =	0.05 cfs @	3.04 hrs,	Volume=	0.002 af,	Atten= 23%, Lag= 2.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.89 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 1.9 min

Peak Storage= 3 cf @ 3.02 hrs, Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.18 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 120.0' Slope= 0.1167 '/'
Inlet Invert= 7,870.00', Outlet Invert= 7,856.00'



Summary for Reach 29R: WB4

Inflow Area =	2.932 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.43 cfs @	3.14 hrs,	Volume=	0.027 af	
Outflow =	0.42 cfs @	3.15 hrs,	Volume=	0.027 af,	Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.81 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 0.4 min

Peak Storage= 5 cf @ 3.15 hrs, Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 30.18 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 7,895.00', Outlet Invert= 7,894.00'

‡

Summary for Reach 30R: WB5

Inflow Area =	4.895 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.83 cfs @	3.10 hrs,	Volume=	0.045 af	
Outflow =	0.82 cfs @	3.11 hrs,	Volume=	0.045 af,	Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.17 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 0.3 min

Peak Storage= 8 cf @ 3.11 hrs, Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 30.18 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 7,972.00', Outlet Invert= 7,971.00'

‡

Summary for Reach 31R: C4

Inflow Area =	3.214 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.50 cfs @	3.12 hrs,	Volume=	0.029 af	
Outflow =	0.50 cfs @	3.13 hrs,	Volume=	0.029 af,	Atten= 1%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 3.93 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 0.4 min

Peak Storage= 6 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 109.68 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.1000 '/'
Inlet Invert= 8,014.00', Outlet Invert= 8,009.00'

Summary for Reach 32R: C5

Inflow Area =	1.318 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.03 cfs @	7.56 hrs,	Volume=	0.012 af	
Outflow =	0.03 cfs @	7.58 hrs,	Volume=	0.012 af,	Atten= 0%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.78 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.46 fps, Avg. Travel Time= 0.6 min

Peak Storage= 1 cf @ 7.57 hrs, Average Depth at Peak Storage= 0.04'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 109.68 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.1000 '/'
Inlet Invert= 8,032.00', Outlet Invert= 8,027.00'

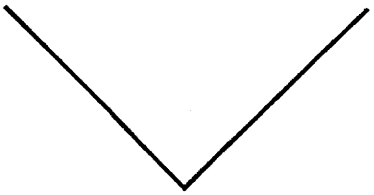
Summary for Reach 41R: Ditch to C5

Inflow Area =	1.318 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.03 cfs @	7.41 hrs,	Volume=	0.012 af	
Outflow =	0.03 cfs @	7.56 hrs,	Volume=	0.012 af,	Atten= 0%, Lag= 9.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.73 fps, Min. Travel Time= 6.3 min
Avg. Velocity = 1.04 fps, Avg. Travel Time= 10.5 min

Peak Storage= 12 cf @ 7.46 hrs, Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.26 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 652.0' Slope= 0.1258 '/'
Inlet Invert= 8,114.00', Outlet Invert= 8,032.00'



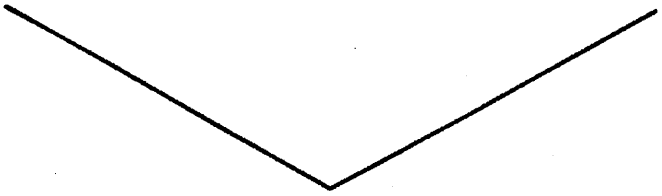
Summary for Reach 42R: Ditch to C4

Inflow Area =	3.214 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.66 cfs @	3.05 hrs,	Volume=	0.029 af	
Outflow =	0.50 cfs @	3.12 hrs,	Volume=	0.029 af,	Atten= 25%, Lag= 4.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.55 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.35 fps, Avg. Travel Time= 4.4 min

Peak Storage= 70 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 0.83', Capacity at Bank-Full= 5.83 cfs

0.00' x 0.83' deep channel, n= 0.040
Side Slope Z-value= 1.8 '/' Top Width= 2.99'
Length= 355.0' Slope= 0.0620 '/'
Inlet Invert= 8,036.00', Outlet Invert= 8,014.00'



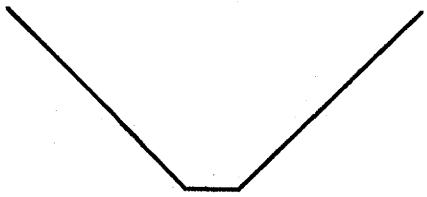
Summary for Reach 43R: Ditch to WB5

Inflow Area =	4.895 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	1.07 cfs @	3.04 hrs,	Volume=	0.045 af	
Outflow =	0.83 cfs @	3.10 hrs,	Volume=	0.045 af,	Atten= 23%, Lag= 3.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 3.76 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.96 fps, Avg. Travel Time= 3.7 min

Peak Storage= 98 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 8.75 cfs

0.30' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 2.30'
Length= 435.0' Slope= 0.1057 '/'
Inlet Invert= 8,018.00', Outlet Invert= 7,972.00'



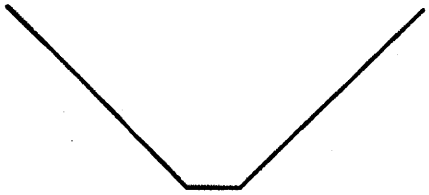
Summary for Reach 44R: Ditch to WB4

Inflow Area =	2.932 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.50 cfs @	3.07 hrs,	Volume=	0.027 af	
Outflow =	0.43 cfs @	3.14 hrs,	Volume=	0.027 af,	Atten= 15%, Lag= 4.5 min

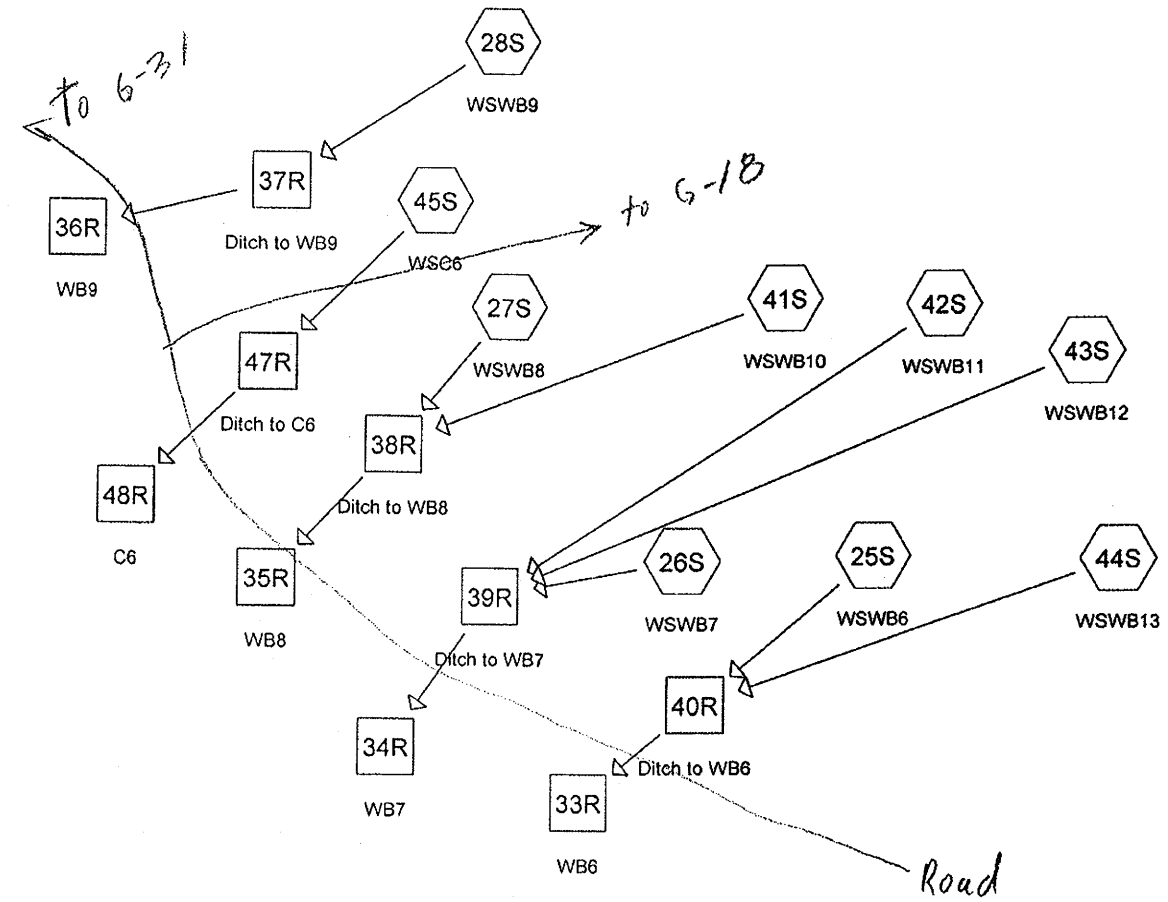
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 3.69 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 2.01 fps, Avg. Travel Time= 4.0 min

Peak Storage= 57 cf @ 3.11 hrs, Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 10.69 cfs

0.30' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 2.30'
Length= 487.0' Slope= 0.1581 '/'
Inlet Invert= 7,972.00', Outlet Invert= 7,895.00'



10-YR, 6-HR PRECIP EVENT
WB6 UP TO C6
CALCS FOR ROAD DITCHES, WB6, WB7, WB8



Subcat Reach Pond Link

Drainage Diagram for 10-6 WB6 - C6
Prepared by {enter your company name here}, Printed 8/1/2008
HydroCAD® 8.50 s/n 003900 © 2007 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
14.578	74	(25S,26S,27S,28S,41S,42S,43S,44S,45S)
14.578		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.02 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25S: WSWB6 Runoff Area=140,195 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=777' Slope=0.5750 '/' Tc=4.1 min CN=74 Runoff=0.67 cfs 0.029 af

Subcatchment 26S: WSWB7 Runoff Area=103,030 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=548' Slope=0.5250 '/' Tc=3.2 min CN=74 Runoff=0.57 cfs 0.022 af

Subcatchment 27S: WSWB8 Runoff Area=24,084 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=416' Slope=0.4580 '/' Tc=2.8 min CN=74 Runoff=0.15 cfs 0.005 af

Subcatchment 28S: WSWB9 Runoff Area=41,732 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=560' Slope=0.2500 '/' Tc=4.8 min CN=74 Runoff=0.18 cfs 0.009 af

Subcatchment 41S: WSWB10 Runoff Area=52,267 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=506' Slope=0.6640 '/' Tc=2.7 min CN=74 Runoff=0.32 cfs 0.011 af

Subcatchment 42S: WSWB11 Runoff Area=121,347 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=701' Slope=0.4320 '/' Tc=4.3 min CN=74 Runoff=0.57 cfs 0.025 af

Subcatchment 43S: WSWB12 Runoff Area=96,368 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=499' Slope=0.3130 '/' Tc=3.9 min CN=74 Runoff=0.48 cfs 0.020 af

Subcatchment 44S: WSWB13 Runoff Area=4,727 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=127' Slope=0.1400 '/' Tc=1.9 min CN=74 Runoff=0.03 cfs 0.001 af

Subcatchment 45S: WSC6 Runoff Area=51,273 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=481' Slope=0.4150 '/' Tc=3.3 min CN=74 Runoff=0.27 cfs 0.011 af

Reach 33R: WB6 Avg. Depth=0.15' Max Vel=1.85 fps Inflow=0.47 cfs 0.030 af
n=0.040 L=20.0' S=0.0500 '/' Capacity=30.18 cfs Outflow=0.46 cfs 0.030 af

Reach 34R: WB7 Avg. Depth=0.24' Max Vel=2.38 fps Inflow=1.16 cfs 0.067 af
n=0.040 L=20.0' S=0.0500 '/' Capacity=30.18 cfs Outflow=1.16 cfs 0.067 af

Reach 35R: WB8 Avg. Depth=0.11' Max Vel=1.58 fps Inflow=0.27 cfs 0.016 af
n=0.040 L=20.0' S=0.0500 '/' Capacity=30.18 cfs Outflow=0.27 cfs 0.016 af

Reach 36R: WB9 Avg. Depth=0.07' Max Vel=1.26 fps Inflow=0.12 cfs 0.009 af
n=0.040 L=20.0' S=0.0500 '/' Capacity=30.18 cfs Outflow=0.12 cfs 0.009 af

Reach 37R: Ditch to WB9 Avg. Depth=0.26' Max Vel=1.87 fps Inflow=0.18 cfs 0.009 af
n=0.040 L=420.0' S=0.0619 '/' Capacity=1.59 cfs Outflow=0.12 cfs 0.009 af

Reach 38R: Ditch to WB8 Avg. Depth=0.22' Max Vel=2.33 fps Inflow=0.47 cfs 0.016 af
n=0.040 L=412.0' S=0.0631 '/' Capacity=2.81 cfs Outflow=0.27 cfs 0.016 af

Reach 39R: Ditch to WB7 Avg. Depth=0.39' Max Vel=3.37 fps Inflow=1.55 cfs 0.067 af
n=0.040 L=471.0' S=0.0637 '/' Capacity=3.49 cfs Outflow=1.16 cfs 0.067 af

Reach 40R: Ditch to WB6 Avg. Depth=0.27' Max Vel=2.60 fps Inflow=0.69 cfs 0.030 af
n=0.040 L=496.0' S=0.0605 '/' Capacity=3.20 cfs Outflow=0.47 cfs 0.030 af

Reach 47R: Ditch to C6 Avg. Depth=0.30' Max Vel=2.21 fps Inflow=0.27 cfs 0.011 af
n=0.040 L=285.0' S=0.0702 '/' Capacity=1.69 cfs Outflow=0.20 cfs 0.011 af

Reach 48R: C6 Avg. Depth=0.09' Max Vel=2.98 fps Inflow=0.20 cfs 0.011 af
D=36.0" n=0.025 L=50.0' S=0.1000 '/' Capacity=109.68 cfs Outflow=0.19 cfs 0.011 af

Total Runoff Area = 14.578 ac Runoff Volume = 0.133 af Average Runoff Depth = 0.11"
100.00% Pervious = 14.578 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 25S: WSWB6

Runoff = 0.67 cfs @ 3.04 hrs, Volume= 0.029 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	140,195	74	
	140,195		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	777	0.5750	3.16		**Lag/CN Method,**

Summary for Subcatchment 26S: WSWB7

Runoff = 0.57 cfs @ 3.03 hrs, Volume= 0.022 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	103,030	74	
	103,030		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	548	0.5250	2.82		**Lag/CN Method,**

Summary for Subcatchment 27S: WSWB8

Runoff = 0.15 cfs @ 3.02 hrs, Volume= 0.005 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	24,084	74	
	24,084		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	416	0.4580	2.49		**Lag/CN Method,**

Summary for Subcatchment 28S: WSWB9

Runoff = 0.18 cfs @ 3.06 hrs, Volume= 0.009 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	41,732	74	
	41,732		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	560	0.2500	1.95		**Lag/CN Method,**

Summary for Subcatchment 41S: WSWB10

Runoff = 0.32 cfs @ 3.02 hrs, Volume= 0.011 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	52,267	74	
	52,267		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	506	0.6640	3.12		**Lag/CN Method,**

Summary for Subcatchment 42S: WSWB11

Runoff = 0.57 cfs @ 3.05 hrs, Volume= 0.025 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	121,347	74	
	121,347		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	701	0.4320	2.69		**Lag/CN Method,**

Summary for Subcatchment 43S: WSWB12

Runoff = 0.48 cfs @ 3.04 hrs, Volume= 0.020 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	96,368	74	
	96,368		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	499	0.3130	2.14		**Lag/CN Method,**

Summary for Subcatchment 44S: WSWB13

Runoff = 0.03 cfs @ 3.01 hrs, Volume= 0.001 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	4,727	74	
	4,727		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.9	127	0.1400	1.09		**Lag/CN Method,**

Summary for Subcatchment 45S: WSC6

Runoff = 0.27 cfs @ 3.03 hrs, Volume= 0.011 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	51,273	74	
	51,273		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	481	0.4150	2.44		**Lag/CN Method,**

Summary for Reach 33R: WB6

Inflow Area =	3.327 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.47 cfs @	3.15 hrs,	Volume=	0.030 af	
Outflow =	0.46 cfs @	3.15 hrs,	Volume=	0.030 af,	Atten= 1%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.85 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 0.4 min

Peak Storage= 5 cf @ 3.15 hrs, Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 30.18 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 8,114.00', Outlet Invert= 8,113.00'

‡

Summary for Reach 34R: WB7

Inflow Area =	7.363 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	1.16 cfs @	3.12 hrs,	Volume=	0.067 af	
Outflow =	1.16 cfs @	3.12 hrs,	Volume=	0.067 af,	Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.38 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 0.3 min

Peak Storage= 10 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.24'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 30.18 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 8,144.00', Outlet Invert= 8,143.00'

‡

Summary for Reach 35R: WB8

Inflow Area =	1.753 ac,	0.00% Impervious,	Inflow Depth =	0.11"
Inflow =	0.27 cfs @	3.12 hrs, Volume=	0.016 af	
Outflow =	0.27 cfs @	3.12 hrs, Volume=	0.016 af, Atten= 0%, Lag= 0.5 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.58 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 0.4 min

Peak Storage= 3 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 30.18 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 8,174.00', Outlet Invert= 8,173.00'

‡

Summary for Reach 36R: WB9

Inflow Area =	0.958 ac,	0.00% Impervious,	Inflow Depth =	0.11"
Inflow =	0.12 cfs @	3.18 hrs, Volume=	0.009 af	
Outflow =	0.12 cfs @	3.19 hrs, Volume=	0.009 af, Atten= 0%, Lag= 0.5 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.26 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 0.68 fps, Avg. Travel Time= 0.5 min

Peak Storage= 2 cf @ 3.18 hrs, Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 30.18 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.0500 '/'
Inlet Invert= 8,174.00', Outlet Invert= 8,173.00'

‡

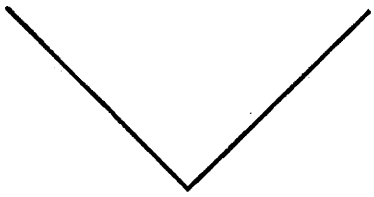
Summary for Reach 37R: Ditch to WB9

Inflow Area =	0.958 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.18 cfs @	3.06 hrs,	Volume=	0.009 af	
Outflow =	0.12 cfs @	3.18 hrs,	Volume=	0.009 af,	Atten= 31%, Lag= 7.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.87 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 6.7 min

Peak Storage= 28 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.59 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 420.0' Slope= 0.0619 '/'
Inlet Invert= 8,200.00', Outlet Invert= 8,174.00'



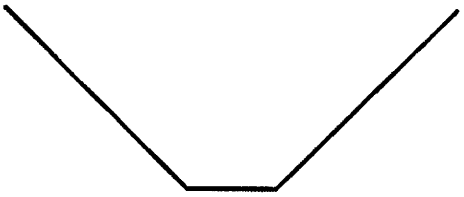
Summary for Reach 38R: Ditch to WB8

Inflow Area =	1.753 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.47 cfs @	3.02 hrs,	Volume=	0.016 af	
Outflow =	0.27 cfs @	3.12 hrs,	Volume=	0.016 af,	Atten= 43%, Lag= 5.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.33 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 6.1 min

Peak Storage= 49 cf @ 3.06 hrs, Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.81 cfs

0.33' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.67'
Length= 412.0' Slope= 0.0631 '/'
Inlet Invert= 8,200.00', Outlet Invert= 8,174.00'



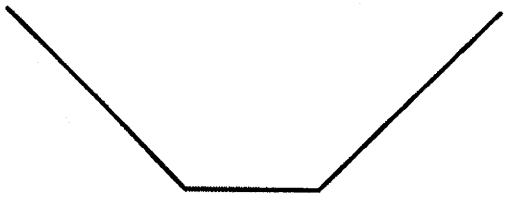
Summary for Reach 39R: Ditch to WB7

Inflow Area =	7.363 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	1.55 cfs @	3.04 hrs,	Volume=	0.067 af	
Outflow =	1.16 cfs @	3.12 hrs,	Volume=	0.067 af,	Atten= 25%, Lag= 4.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 3.37 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 5.3 min

Peak Storage= 162 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 3.49 cfs

0.50' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.84'
Length= 471.0' Slope= 0.0637 '/'
Inlet Invert= 8,174.00', Outlet Invert= 8,144.00'



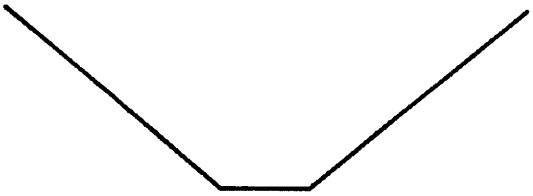
Summary for Reach 40R: Ditch to WB6

Inflow Area =	3.327 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.69 cfs @	3.04 hrs,	Volume=	0.030 af	
Outflow =	0.47 cfs @	3.15 hrs,	Volume=	0.030 af,	Atten= 32%, Lag= 6.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.60 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 6.8 min

Peak Storage= 89 cf @ 3.09 hrs, Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 3.20 cfs

0.33' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.2 '/' Top Width= 1.94'
Length= 496.0' Slope= 0.0605 '/'
Inlet Invert= 8,144.00', Outlet Invert= 8,114.00'



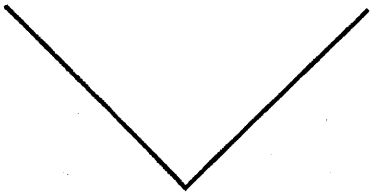
Summary for Reach 47R: Ditch to C6

Inflow Area =	1.177 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.27 cfs @	3.03 hrs,	Volume=	0.011 af	
Outflow =	0.20 cfs @	3.10 hrs,	Volume=	0.011 af,	Atten= 26%, Lag= 4.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.21 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 3.8 min

Peak Storage= 26 cf @ 3.06 hrs, Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.69 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 285.0' Slope= 0.0702 '/'
Inlet Invert= 8,220.00', Outlet Invert= 8,200.00'



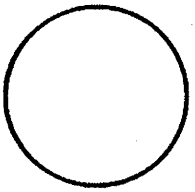
Summary for Reach 48R: C6

Inflow Area =	1.177 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.20 cfs @	3.10 hrs,	Volume=	0.011 af	
Outflow =	0.19 cfs @	3.11 hrs,	Volume=	0.011 af,	Atten= 3%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.98 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 0.5 min

Peak Storage= 3 cf @ 3.11 hrs, Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 109.68 cfs

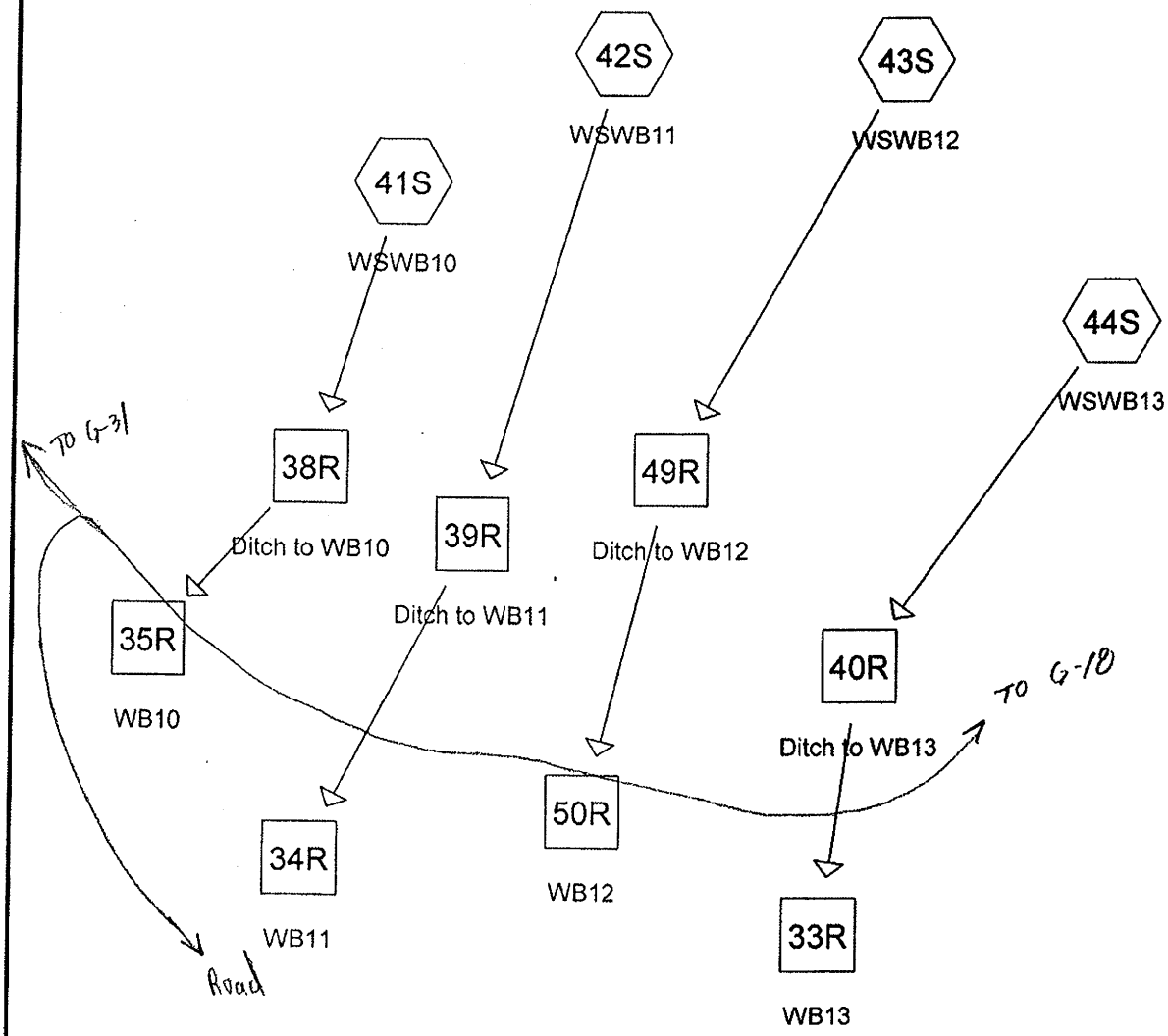
36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.1000 '/'
Inlet Invert= 8,200.00', Outlet Invert= 8,195.00'



10-YR, 6HR PRECIP EVENT

WB10 UP TO WB13

CALCS FOR ROAD DITCHES, WB10, WB11, WB12, WB13



Subcat Reach Pond Link

Drainage Diagram for 10-6 WB10 - WB13

Prepared by {enter your company name here}, Printed 8/1/2008

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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.306	74	(41S,42S,43S,44S)
6.306		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.02 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 41S: WSWB10 Runoff Area=52,267 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=506' Slope=0.6640 '/' Tc=2.7 min CN=74 Runoff=0.32 cfs 0.011 af

Subcatchment 42S: WSWB11 Runoff Area=121,347 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=701' Slope=0.4320 '/' Tc=4.3 min CN=74 Runoff=0.57 cfs 0.025 af

Subcatchment 43S: WSWB12 Runoff Area=96,368 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=499' Slope=0.3130 '/' Tc=3.9 min CN=74 Runoff=0.48 cfs 0.020 af

Subcatchment 44S: WSWB13 Runoff Area=4,727 sf 0.00% Impervious Runoff Depth=0.11"
Flow Length=127' Slope=0.1400 '/' Tc=1.9 min CN=74 Runoff=0.03 cfs 0.001 af

Reach 33R: WB13 Avg. Depth=0.02' Max Vel=0.94 fps Inflow=0.02 cfs 0.001 af
n=0.040 L=20.0' S=0.1000 '/' Capacity=42.68 cfs Outflow=0.02 cfs 0.001 af

Reach 34R: WB11 Avg. Depth=0.12' Max Vel=2.34 fps Inflow=0.44 cfs 0.025 af
n=0.040 L=20.0' S=0.1000 '/' Capacity=42.68 cfs Outflow=0.44 cfs 0.025 af

Reach 35R: WB10 Avg. Depth=0.08' Max Vel=1.87 fps Inflow=0.22 cfs 0.011 af
n=0.040 L=20.0' S=0.1000 '/' Capacity=42.68 cfs Outflow=0.21 cfs 0.011 af

Reach 38R: Ditch to WB10 Avg. Depth=0.36' Max Vel=2.16 fps Inflow=0.32 cfs 0.011 af
n=0.040 L=270.0' S=0.0667 '/' Capacity=1.10 cfs Outflow=0.22 cfs 0.011 af

Reach 39R: Ditch to WB11 Avg. Depth=0.31' Max Vel=3.22 fps Inflow=0.57 cfs 0.025 af
n=0.040 L=390.0' S=0.1179 '/' Capacity=3.67 cfs Outflow=0.44 cfs 0.025 af

Reach 40R: Ditch to WB13 Avg. Depth=0.10' Max Vel=1.72 fps Inflow=0.03 cfs 0.001 af
n=0.040 L=127.0' S=0.1575 '/' Capacity=1.94 cfs Outflow=0.02 cfs 0.001 af

Reach 49R: Ditch to WB12 Avg. Depth=0.34' Max Vel=3.37 fps Inflow=0.48 cfs 0.020 af
n=0.040 L=330.0' S=0.1394 '/' Capacity=2.38 cfs Outflow=0.38 cfs 0.020 af

Reach 50R: WB12 Avg. Depth=0.11' Max Vel=2.24 fps Inflow=0.38 cfs 0.020 af
n=0.040 L=20.0' S=0.1000 '/' Capacity=16.40 cfs Outflow=0.38 cfs 0.020 af

Total Runoff Area = 6.306 ac Runoff Volume = 0.058 af Average Runoff Depth = 0.11"
100.00% Pervious = 6.306 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 41S: WSWB10

Runoff = 0.32 cfs @ 3.02 hrs, Volume= 0.011 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	52,267	74	
	52,267		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.7	506	0.6640	3.12		**Lag/CN Method,**

Summary for Subcatchment 42S: WSWB11

Runoff = 0.57 cfs @ 3.05 hrs, Volume= 0.025 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	121,347	74	
	121,347		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	701	0.4320	2.69		**Lag/CN Method,**

Summary for Subcatchment 43S: WSWB12

Runoff = 0.48 cfs @ 3.04 hrs, Volume= 0.020 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	96,368	74	
	96,368		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	499	0.3130	2.14		**Lag/CN Method,**

Summary for Subcatchment 44S: WSWB13

Runoff = 0.03 cfs @ 3.01 hrs, Volume= 0.001 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type II 24-hr 6.00 hrs Rainfall=1.38"

	Area (sf)	CN	Description
*	4,727	74	
	4,727		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.9	127	0.1400	1.09		**Lag/CN Method,**

Summary for Reach 33R: WB13

Inflow Area = 0.109 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 0.02 cfs @ 3.05 hrs, Volume= 0.001 af
Outflow = 0.02 cfs @ 3.06 hrs, Volume= 0.001 af, Atten= 2%, Lag= 0.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.94 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 0.55 fps, Avg. Travel Time= 0.6 min

Peak Storage= 1 cf @ 3.06 hrs, Average Depth at Peak Storage= 0.02'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 42.68 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.1000 '/'
Inlet Invert= 8,334.00', Outlet Invert= 8,332.00'

‡

Summary for Reach 34R: WB11

Inflow Area = 2.786 ac, 0.00% Impervious, Inflow Depth = 0.11"
Inflow = 0.44 cfs @ 3.12 hrs, Volume= 0.025 af
Outflow = 0.44 cfs @ 3.12 hrs, Volume= 0.025 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.34 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.24 fps, Avg. Travel Time= 0.3 min

Peak Storage= 4 cf @ 3.12 hrs, Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 42.68 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.1000 '/'
Inlet Invert= 8,242.00', Outlet Invert= 8,240.00'

‡

Summary for Reach 35R: WB10

Inflow Area =	1.200 ac,	0.00% Impervious,	Inflow Depth =	0.11"
Inflow =	0.22 cfs @	3.09 hrs, Volume=	0.011 af	
Outflow =	0.21 cfs @	3.10 hrs, Volume=	0.011 af, Atten= 4%, Lag= 0.5 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.87 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 0.3 min

Peak Storage= 2 cf @ 3.09 hrs, Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00', Capacity at Bank-Full= 42.68 cfs

1.00' x 1.00' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 10.00'
Length= 20.0' Slope= 0.1000 '/'
Inlet Invert= 8,222.00', Outlet Invert= 8,220.00'

‡

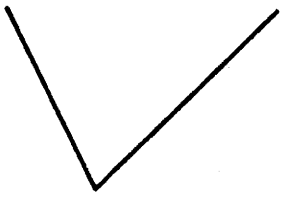
Summary for Reach 38R: Ditch to WB10

Inflow Area =	1.200 ac,	0.00% Impervious,	Inflow Depth =	0.11"
Inflow =	0.32 cfs @	3.02 hrs, Volume=	0.011 af	
Outflow =	0.22 cfs @	3.09 hrs, Volume=	0.011 af, Atten= 33%, Lag= 3.9 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.16 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.20 fps, Avg. Travel Time= 3.8 min

Peak Storage= 27 cf @ 3.05 hrs, Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 1.10 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 0.5 1.0 '/' Top Width= 1.01'
Length= 270.0' Slope= 0.0667 '/'
Inlet Invert= 8,240.00', Outlet Invert= 8,222.00'



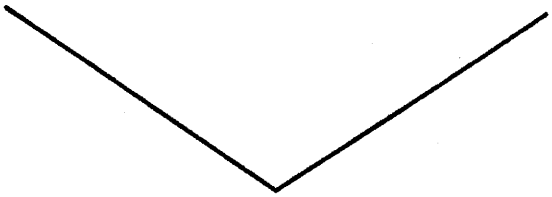
Summary for Reach 39R: Ditch to WB11

Inflow Area =	2.786 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.57 cfs @	3.05 hrs,	Volume=	0.025 af	
Outflow =	0.44 cfs @	3.12 hrs,	Volume=	0.025 af,	Atten= 22%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 3.22 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 1.78 fps, Avg. Travel Time= 3.6 min

Peak Storage= 55 cf @ 3.08 hrs, Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 3.67 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.5 '/' Top Width= 2.01'
Length= 390.0' Slope= 0.1179 '/'
Inlet Invert= 8,288.00', Outlet Invert= 8,242.00'



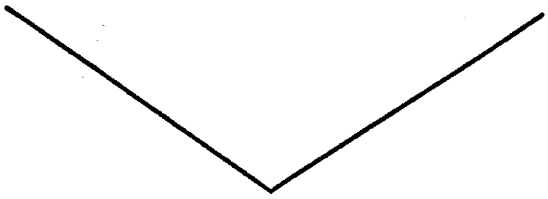
Summary for Reach 40R: Ditch to WB13

Inflow Area =	0.109 ac,	0.00% Impervious,	Inflow Depth =	0.11"	
Inflow =	0.03 cfs @	3.01 hrs,	Volume=	0.001 af	
Outflow =	0.02 cfs @	3.05 hrs,	Volume=	0.001 af,	Atten= 21%, Lag= 2.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.72 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 2.1 min

Peak Storage= 2 cf @ 3.03 hrs, Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 1.94 cfs

0.00' x 0.50' deep channel, n= 0.040
Side Slope Z-value= 1.5 '/' Top Width= 1.50'
Length= 127.0' Slope= 0.1575 '/'
Inlet Invert= 8,354.00', Outlet Invert= 8,334.00'



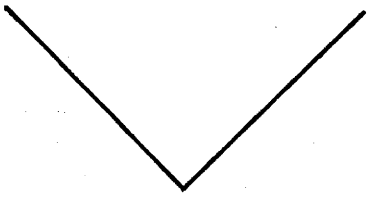
Summary for Reach 49R: Ditch to WB12

Inflow Area =	2.212 ac,	0.00% Impervious,	Inflow Depth =	0.11"
Inflow =	0.48 cfs @	3.04 hrs, Volume=	0.020 af	
Outflow =	0.38 cfs @	3.10 hrs, Volume=	0.020 af, Atten= 20%, Lag= 3.4 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 3.37 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.91 fps, Avg. Travel Time= 2.9 min

Peak Storage= 39 cf @ 3.07 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 2.38 cfs

0.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 1.34'
Length= 330.0' Slope= 0.1394 '/'
Inlet Invert= 8,334.00', Outlet Invert= 8,288.00'



Summary for Reach 50R: WB12

Inflow Area =	2.212 ac,	0.00% Impervious,	Inflow Depth =	0.11"
Inflow =	0.38 cfs @	3.10 hrs, Volume=	0.020 af	
Outflow =	0.38 cfs @	3.10 hrs, Volume=	0.020 af, Atten= 0%, Lag= 0.3 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.24 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 0.3 min

Peak Storage= 3 cf @ 3.10 hrs, Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 0.67', Capacity at Bank-Full= 16.40 cfs

1.00' x 0.67' deep channel, n= 0.040
Side Slope Z-value= 3.0 6.0 '/' Top Width= 7.03'
Length= 20.0' Slope= 0.1000 '/'
Inlet Invert= 8,288.00', Outlet Invert= 8,286.00'

‡

Summary for Reach 17R: C2

Inflow Area = 3.029 ac, 0.00% Impervious, Inflow Depth > 0.37"
Inflow = 1.94 cfs @ 11.98 hrs, Volume= 0.094 af
Outflow = 1.93 cfs @ 11.98 hrs, Volume= 0.094 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 8.14 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.01 fps, Avg. Travel Time= 0.3 min

Peak Storage= 12 cf @ 11.98 hrs, Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 173.42 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.2500 '/'
Inlet Invert= 7,728.00', Outlet Invert= 7,715.50'

Summary for Reach 18R: C1

Inflow Area = 9.787 ac, 0.00% Impervious, Inflow Depth > 0.37"
Inflow = 5.23 cfs @ 11.98 hrs, Volume= 0.298 af
Outflow = 5.20 cfs @ 11.99 hrs, Volume= 0.298 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 7.92 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.10 fps, Avg. Travel Time= 0.3 min

Peak Storage= 33 cf @ 11.99 hrs, Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 109.68 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.1000 '/'
Inlet Invert= 7,708.00', Outlet Invert= 7,703.00'

10yr, 24hr design event

Summary for Reach 19R: C3

Inflow Area =	7.656 ac,	0.00% Impervious,	Inflow Depth >	0.37"
Inflow =	4.84 cfs @	11.97 hrs, Volume=		0.238 af
Outflow =	4.82 cfs @	11.98 hrs, Volume=		0.238 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.03 hrs
Max. Velocity= 10.74 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.92 fps, Avg. Travel Time= 0.2 min

Peak Storage= 23 cf @ 11.97 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 173.42 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.2500 '/'
Inlet Invert= 7,770.00', Outlet Invert= 7,757.50'

10 yr, 24 hr design event

Summary for Reach 32R: C5

[52] Hint: Inlet/Outlet conditions not evaluated
[61] Hint: Exceeded Reach 41R outlet invert by 0.06' @ 16.08 hrs

Inflow Area =	1.318 ac,	0.00% Impervious,	Inflow Depth >	0.32"
Inflow =	0.07 cfs @	16.08 hrs, Volume=	0.035 af	
Outflow =	0.07 cfs @	16.09 hrs, Volume=	0.035 af, Atten= 0%, Lag= 0.6 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Max. Velocity= 2.16 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.80 fps, Avg. Travel Time= 0.5 min

Peak Storage= 2 cf @ 16.08 hrs, Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 3.00', Capacity at Bank-Full= 109.68 cfs

36.0" Diameter Pipe, n= 0.025 Corrugated metal
Length= 50.0' Slope= 0.1000 '/'
Inlet Invert= 8,032.00', Outlet Invert= 8,027.00'

10yr, 24 hr design event

Culvert C1 Downspout Discharge (10 yr, 24 hr event)
Worksheet for Circular Channel

Project Description	
Worksheet	C1 Discharge
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Slope	1.000000	ft/ft
Diameter	36	in
Discharge	5.20	cfs

Results		
Depth	0.25	ft
Flow Area	0.3	ft²
Wetted Perimeter	1.76	ft
Top Width	1.66	ft
Critical Depth	0.71	ft
Percent Full	8.4	%
Critical Slope	0.013376	ft/ft
Velocity	18.32	ft/s
Velocity Head	5.22	ft
Specific Energy	5.47	ft
Froude Number	7.82	
Maximum Discharge	388.61	cfs
Discharge Full	361.26	cfs
Slope Full	0.000207	ft/ft
Flow Type	Supercritical	

Culvert C2 Downspout Discharge (10 yr, 24 hr event)
Worksheet for Circular Channel

Project Description	
Worksheet	C2 Discharge
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Slope	1.000000	ft/ft
Diameter	36	in
Discharge	1.93	cfs

Results		
Depth	0.16	ft
Flow Area	0.1	ft²
Wetted Perimeter	1.39	ft
Top Width	1.34	ft
Critical Depth	0.43	ft
Percent Full	5.3	%
Critical Slope	0.014426	ft/ft
Velocity	13.56	ft/s
Velocity Head	2.86	ft
Specific Energy	3.02	ft
Froude Number	7.33	
Maximum Discharge	388.61	cfs
Discharge Full	361.26	cfs
Slope Full	0.000029	ft/ft
Flow Type	Supercritical	

Culvert C3 Downspout Discharge (10 yr, 24 hr event)
Worksheet for Circular Channel

Project Description	
Worksheet	C3 Discharge
Flow Element	Circular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.024	
Slope	1.000000	ft/ft
Diameter	36	in
Discharge	4.82	cfs

Results		
Depth	0.24	ft
Flow Area	0.3	ft²
Wetted Perimeter	1.73	ft
Top Width	1.64	ft
Critical Depth	0.69	ft
Percent Full	8.1	%
Critical Slope	0.013436	ft/ft
Velocity	17.91	ft/s
Velocity Head	4.98	ft
Specific Energy	5.23	ft
Froude Number	7.78	
Maximum Discharge	388.61	cfs
Discharge Full	361.26	cfs
Slope Full	0.000178	ft/ft
Flow Type	Supercritical	

C1 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.057
Slope	0.100000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	5.20 cfs

Results	
Depth	0.37 ft
Flow Area	1.4 ft²
Wetted Perimeter	4.68 ft
Top Width	4.50 ft
Critical Depth	0.41 ft
Critical Slope	0.071723 ft/ft
Velocity	3.70 ft/s
Velocity Head	0.21 ft
Specific Energy	0.59 ft
Froude Number	1.17
Flow Type	Supercritical

C2 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.062	
Slope	0.200000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	1.93	cfs

Results		
Depth	0.18	ft
Flow Area	0.6	ft²
Wetted Perimeter	3.81	ft
Top Width	3.73	ft
Critical Depth	0.22	ft
Critical Slope	0.099740	ft/ft
Velocity	3.16	ft/s
Velocity Head	0.16	ft
Specific Energy	0.34	ft
Froude Number	1.38	
Flow Type	Supercritical	

C3 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.062	
Slope	0.200000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	4.82	cfs

Results		
Depth	0.31	ft
Flow Area	1.1	ft^2
Wetted Perimeter	4.38	ft
Top Width	4.24	ft
Critical Depth	0.39	ft
Critical Slope	0.085856	ft/ft
Velocity	4.31	ft/s
Velocity Head	0.29	ft
Specific Energy	0.60	ft
Froude Number	1.48	
Flow Type	Supercritical	

WB1 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.068
Slope	0.670000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.51 cfs

Results	
Depth	0.06 ft
Flow Area	0.2 ft²
Wetted Perimeter	3.27 ft
Top Width	3.24 ft
Critical Depth	0.09 ft
Critical Slope	0.153491 ft/ft
Velocity	2.68 ft/s
Velocity Head	0.11 ft
Specific Energy	0.17 ft
Froude Number	1.95
Flow Type	Supercritical

WB2 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.075	
Slope	0.630000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	0.04	cfs

Results		
Depth	0.01	ft
Flow Area	4.3e-2	ft²
Wetted Perimeter	3.06	ft
Top Width	3.06	ft
Critical Depth	0.02	ft
Critical Slope	0.317481	ft/ft
Velocity	0.92	ft/s
Velocity Head	0.01	ft
Specific Energy	0.03	ft
Froude Number	1.36	
Flow Type	Supercritical	

WB3 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.043	
Slope	0.040000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	0.10	cfs

Results		
Depth	0.04	ft
Flow Area	0.1	ft^2
Wetted Perimeter	3.18	ft
Top Width	3.16	ft
Critical Depth	0.03	ft
Critical Slope	0.085722	ft/ft
Velocity	0.80	ft/s
Velocity Head	0.01	ft
Specific Energy	0.05	ft
Froude Number	0.71	
Flow Type	Subcritical	

WB4 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.066
Slope	0.560000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.42 cfs

Results	
Depth	0.06 ft
Flow Area	0.2 ft²
Welted Perimeter	3.25 ft
Top Width	3.22 ft
Critical Depth	0.08 ft
Critical Slope	0.150240 ft/ft
Velocity	2.40 ft/s
Velocity Head	0.09 ft
Specific Energy	0.15 ft
Froude Number	1.82
Flow Type	Supercritical

WB5 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.072	
Slope	0.710000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	0.82	cfs

Results		
Depth	0.08	ft
Flow Area	0.3	ft^2
Wetted Perimeter	3.37	ft
Top Width	3.33	ft
Critical Depth	0.13	ft
Critical Slope	0.157053	ft/ft
Velocity	3.15	ft/s
Velocity Head	0.15	ft
Specific Energy	0.24	ft
Froude Number	1.99	
Flow Type	Supercritical	

C4 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.075	
Slope	0.630000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	0.50	cfs

Results		
Depth	0.06	ft
Flow Area	0.2	ft²
Wetted Perimeter	3.29	ft
Top Width	3.26	ft
Critical Depth	0.09	ft
Critical Slope	0.187444	ft/ft
Velocity	2.46	ft/s
Velocity Head	0.09	ft
Specific Energy	0.16	ft
Froude Number	1.74	
Flow Type	Supercritical	

C5 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.084
Slope	1.000000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.07 cfs

Results	
Depth	0.02 ft
Flow Area	0.1 ft²
Wetted Perimeter	3.08 ft
Top Width	3.07 ft
Critical Depth	0.03 ft
Critical Slope	0.353042 ft/ft
Velocity	1.23 ft/s
Velocity Head	0.02 ft
Specific Energy	0.04 ft
Froude Number	1.60
Flow Type	Supercritical

WB6 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.065
Slope	0.420000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.46 cfs

Results	
Depth	0.06 ft
Flow Area	0.2 ft²
Wetted Perimeter	3.29 ft
Top Width	3.26 ft
Critical Depth	0.09 ft
Critical Slope	0.143121 ft/ft
Velocity	2.30 ft/s
Velocity Head	0.08 ft
Specific Energy	0.15 ft
Froude Number	1.63
Flow Type	Supercritical

WB7 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.071	
Slope	0.670000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	1.16	cfs

Results		
Depth	0.10	ft
Flow Area	0.3	ft^2
Wetted Perimeter	3.46	ft
Top Width	3.41	ft
Critical Depth	0.16	ft
Critical Slope	0.143194	ft/ft
Velocity	3.55	ft/s
Velocity Head	0.20	ft
Specific Energy	0.30	ft
Froude Number	2.02	
Flow Type	Supercritical	

WB8 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.069
Slope	0.590000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.27 cfs

Results	
Depth	0.04 ft
Flow Area	0.1 ft²
Wetted Perimeter	3.20 ft
Top Width	3.17 ft
Critical Depth	0.06 ft
Critical Slope	0.179479 ft/ft
Velocity	2.00 ft/s
Velocity Head	0.06 ft
Specific Energy	0.11 ft
Froude Number	1.71
Flow Type	Supercritical

C6 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.075	
Slope	0.570000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	0.19	cfs

Results		
Depth	0.04	ft
Flow Area	0.1	ft²
Wetted Perimeter	3.17	ft
Top Width	3.15	ft
Critical Depth	0.05	ft
Critical Slope	0.227940	ft/ft
Velocity	1.64	ft/s
Velocity Head	0.04	ft
Specific Energy	0.08	ft
Froude Number	1.51	
Flow Type	Supercritical	

WB9 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.046	
Slope	0.250000	ft/ft
Left Side Slope	2.00	H : V
Right Side Slope	2.00	H : V
Bottom Width	3.00	ft
Discharge	0.12	cfs

Results		
Depth	0.03	ft
Flow Area	0.1	ft^2
Wetted Perimeter	3.12	ft
Top Width	3.11	ft
Critical Depth	0.04	ft
Critical Slope	0.094400	ft/ft
Velocity	1.44	ft/s
Velocity Head	0.03	ft
Specific Energy	0.06	ft
Froude Number	1.55	
Flow Type	Supercritical	

WB10 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.061
Slope	0.710000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.21 cfs

Results	
Depth	0.03 ft
Flow Area	0.1 ft²
Wetted Perimeter	3.15 ft
Top Width	3.13 ft
Critical Depth	0.05 ft
Critical Slope	0.147685 ft/ft
Velocity	2.08 ft/s
Velocity Head	0.07 ft
Specific Energy	0.10 ft
Froude Number	2.04
Flow Type	Supercritical

WB11 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.066
Slope	0.830000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.44 cfs

Results	
Depth	0.05 ft
Flow Area	0.2 ft²
Wetted Perimeter	3.23 ft
Top Width	3.21 ft
Critical Depth	0.09 ft
Critical Slope	0.148865 ft/ft
Velocity	2.76 ft/s
Velocity Head	0.12 ft
Specific Energy	0.17 ft
Froude Number	2.18
Flow Type	Supercritical

WB12 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.070
Slope	0.830000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.38 cfs

Results	
Depth	0.05 ft
Flow Area	0.2 ft²
Wetted Perimeter	3.22 ft
Top Width	3.20 ft
Critical Depth	0.08 ft
Critical Slope	0.172397 ft/ft
Velocity	2.52 ft/s
Velocity Head	0.10 ft
Specific Energy	0.15 ft
Froude Number	2.04
Flow Type	Supercritical

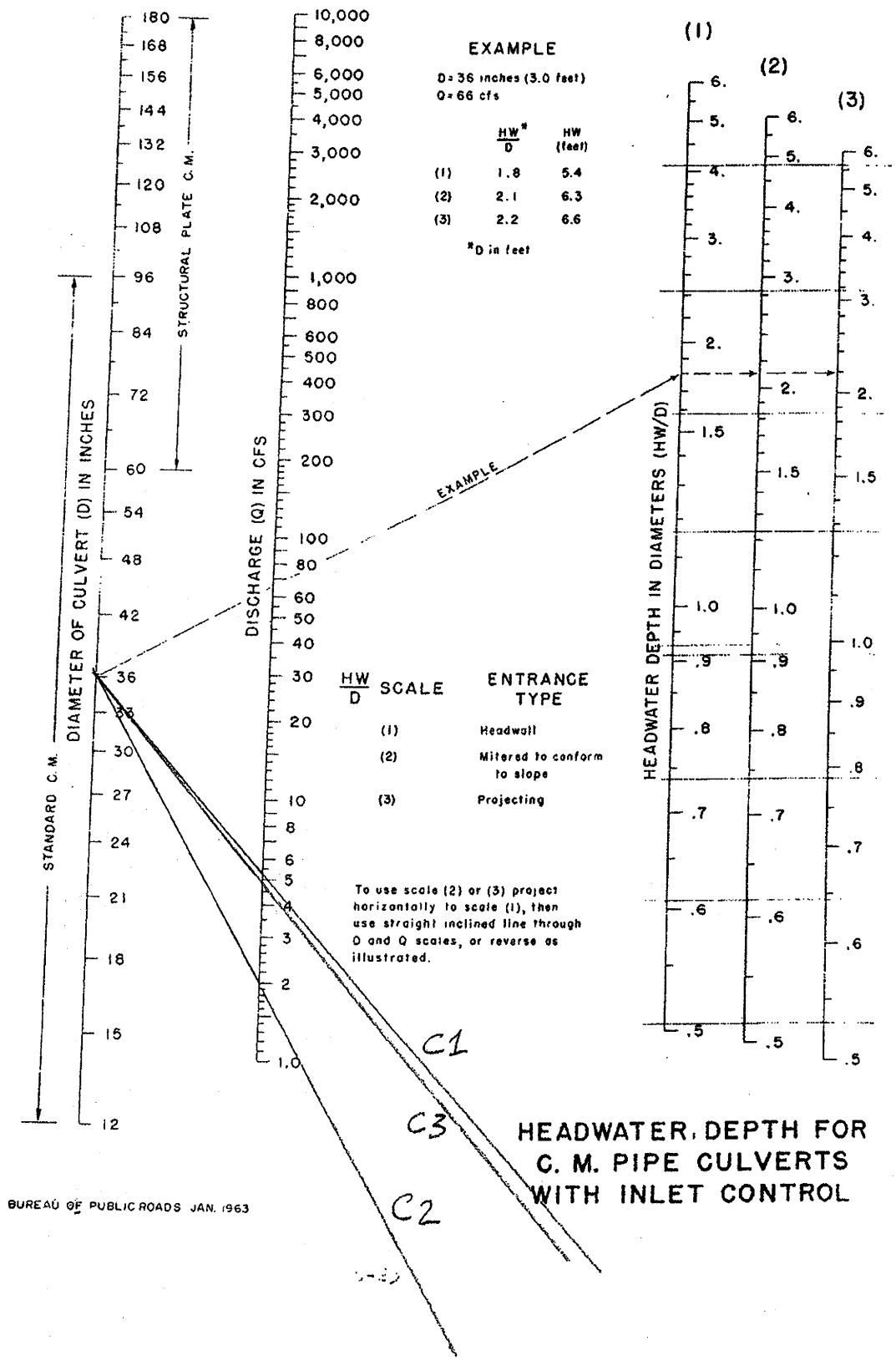
WB13 Armored Outlet
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - 1
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data	
Mannings Coefficient	0.062
Slope	0.710000 ft/ft
Left Side Slope	2.00 H : V
Right Side Slope	2.00 H : V
Bottom Width	3.00 ft
Discharge	0.55 cfs

Results	
Depth	0.06 ft
Flow Area	0.2 ft²
Wetted Perimeter	3.26 ft
Top Width	3.24 ft
Critical Depth	0.10 ft
Critical Slope	0.125731 ft/ft
Velocity	2.98 ft/s
Velocity Head	0.14 ft
Specific Energy	0.20 ft
Froude Number	2.20
Flow Type	Supercritical

CHART 5



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Reference: Use of Riprap for Bank Protection
Hydraulic Engineering Circular No. 11
USDOT Federal Highway Admin 1978

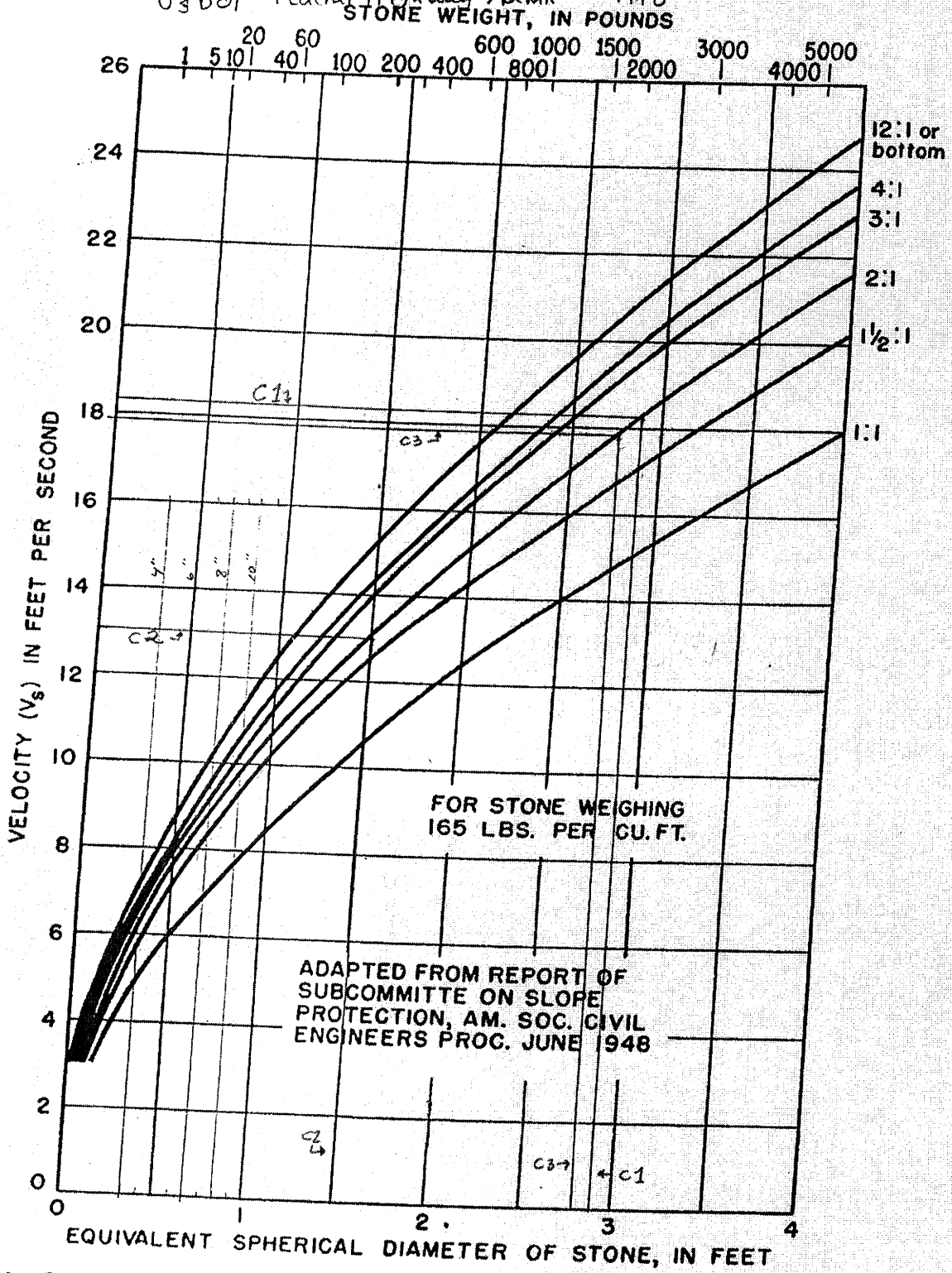


FIG. 2 - SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

BACKUP INFORMATION

Hydrologic Soil Group–Carbon Area, Utah, Parts of Carbon and Emery Counties

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

Municipalities

- Cities
- Urban Areas

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails

Roads

- Interstate Highways
- US Routes
- State Highways
- Local Roads
- Other Roads

MAP INFORMATION

Original soil survey map sheets were prepared at publication scale. Viewing scale and printing scale, however, may vary from the original. Please rely on the bar scale on each map sheet for proper map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 12N

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

Soil Survey Area: Carbon Area, Utah, Parts of Carbon and Emery Counties
Survey Area Data: Version 4, Jul 2, 2008

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Carbon Area, Utah, Parts of Carbon and Emery Counties				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
7	Beje-Trag complex	D	287.3	18.7%
21	Croydon loam, 8 to 30 percent slopes	B	160.8	10.5%
62	Midfork family-Comodore complex	B	190.7	12.4%
75	Perma family, 15 to 40 percent slopes	B	20.3	1.3%
84	Podo-Rock outcrop complex	D	50.1	3.3%
88	Rabbitex family-Datino variant complex	B	116.5	7.6%
96	Rock outcrop-Rubbleland-Travessilla complex	D	275.2	17.9%
97	Rottulee family-Trag complex	C	351.9	22.9%
100	Senchert loam, 3 to 15 percent slopes	C	60.3	3.9%
101	Senchert loam, 30 to 50 percent slopes	C	25.5	1.7%
Totals for Area of Interest (AOI)			1,538.6	100.0%

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower

TABLE 7-14 — Other Agricultural Lands[1]

Cover Description	Hydrologic Condition	Curve Numbers for Hydrologic Soil Group			
Cover Type		A	B	C	D
Pasture, grassland, or range — continuous forage for graving [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow — continuous grass — protected from grazing and generally mowed for hay		30	58	71	78
Brush — brush-weed-grass mixture with brush the major element [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods — grass combination (orchard or tree farm) [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30[4]	55	70	77
Farmsteads — buildings, land, driveways and surrounding lots	—	59	74	82	86

1 Average runoff condition and $I_a = 0.2S$.

2 Poor: < 50% ground cover or heavily grazed with no mulch
Fair: 50% to 75% ground cover and not heavily grazed
Good: > 75% ground cover and lightly or only occasionally grazed

3 Poor: < 50% ground cover
Fair: 50% to 75% ground cover
Good: > 75% ground cover

4 Actual Curve Number is less than 30; use CN = 30 for runoff computations.

5 CNs shown were computed for areas with 50% grass (pasture) cover. Other combinations of conditions may be computed from CNs for woods and pasture.

6 Poor: Forest litter, small trees and brush are destroyed by heavy grazing or regular burning.
Fair: Woods grazed but not burned, and some forest litter covers the soil.
Good: Woods protected from grazing; litter and brush adequately cover soil.

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

Utah 39.68175 N 110.48129 W 7946 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M. Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Tue Jun 26 2007

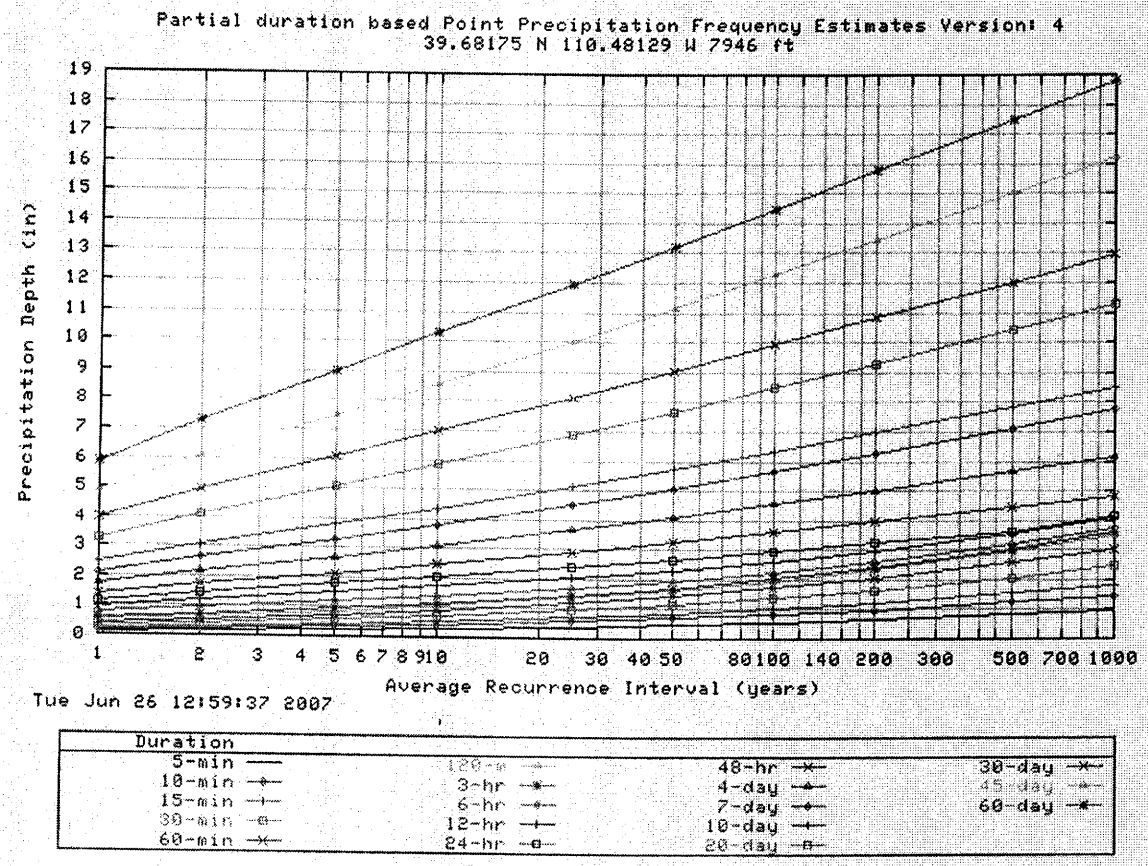
Confidence Limits | Seasonality | Location Maps | Other Info. | GIS data | Maps | Help | D

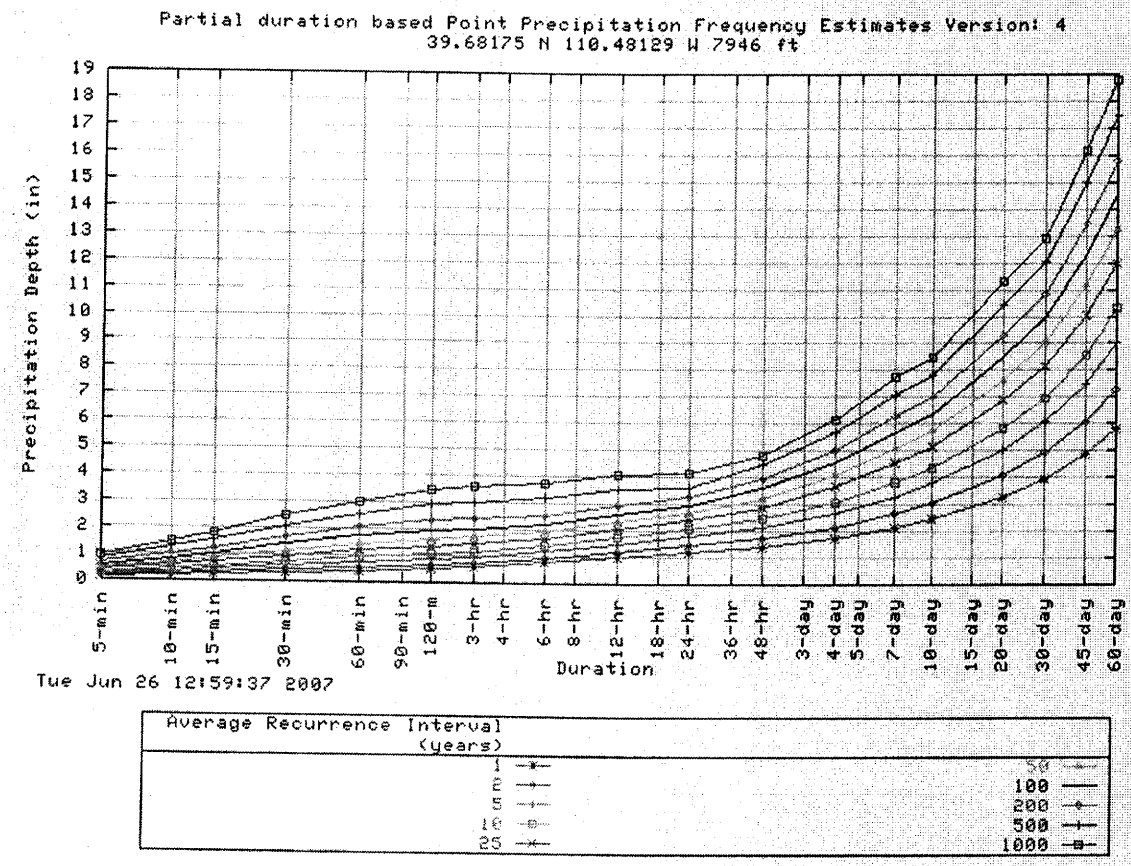
Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.14	0.20	0.25	0.34	0.42	0.52	0.59	0.77	0.99	1.18	1.40	1.74	2.12	2.44	3.26	3.97	4.88	5.83
2	0.17	0.26	0.33	0.44	0.55	0.65	0.74	0.96	1.23	1.46	1.74	2.16	2.65	3.06	4.08	4.95	6.10	7.31
5	0.24	0.36	0.45	0.60	0.74	0.86	0.95	1.19	1.50	1.78	2.13	2.67	3.29	3.78	5.05	6.09	7.50	9.00
10	0.29	0.45	0.55	0.74	0.92	1.06	1.15	1.38	1.73	2.05	2.46	3.08	3.80	4.36	5.82	6.98	8.59	10.29
25	0.38	0.58	0.72	0.97	1.20	1.36	1.45	1.67	2.05	2.40	2.89	3.65	4.52	5.14	6.86	8.15	10.04	11.96
50	0.46	0.70	0.86	1.16	1.44	1.64	1.72	1.92	2.32	2.68	3.24	4.09	5.08	5.74	7.66	9.04	11.15	13.22
100	0.55	0.83	1.03	1.39	1.72	1.96	2.04	2.22	2.60	2.96	3.60	4.55	5.67	6.36	8.48	9.94	12.29	14.50
200	0.65	0.99	1.23	1.66	2.05	2.33	2.41	2.57	2.94	3.25	3.96	5.03	6.28	7.00	9.31	10.84	13.44	15.78
500	0.82	1.24	1.54	2.08	2.57	2.93	3.03	3.18	3.53	3.64	4.45	5.67	7.11	7.86	10.44	12.03	14.99	17.48
1000	0.97	1.47	1.83	2.46	3.04	3.49	3.59	3.74	4.09	4.13	4.84	6.17	7.77	8.53	11.30	12.94	16.22	18.80

Text version of table

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval. Please refer to the documentation for more information. NOTE: Formatting forces estimates near zero to appear as zero.


Partial duration based Point Precipitation Frequency Estimates Version: 4
39.68175 N 110.48129 W 7946 ft
Precipitation Depth (in)
Average Recurrence Interval (years)
Tue Jun 26 12:59:37 2007
Duration
5-min
10-min
15-min
30-min
60-min
120-m
3-hr
6-hr
12-hr
24-hr
48-hr
4-day
7-day
10-day
20-day
30-day
45-day
60-day



Confidence Limits -

* Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)																		
ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.16	0.24	0.30	0.41	0.51	0.60	0.69	0.88	1.11	1.31	1.56	1.94	2.41	2.74	3.65	4.43	5.44	6.49
2	0.21	0.32	0.39	0.53	0.65	0.76	0.86	1.09	1.38	1.63	1.94	2.42	3.01	3.42	4.56	5.54	6.80	8.12
5	0.28	0.43	0.53	0.72	0.89	1.01	1.11	1.35	1.68	2.00	2.38	2.98	3.73	4.24	5.66	6.80	8.37	10.00
10	0.35	0.53	0.66	0.89	1.10	1.24	1.33	1.58	1.94	2.29	2.74	3.44	4.33	4.89	6.53	7.79	9.60	11.44
25	0.46	0.69	0.86	1.16	1.43	1.60	1.69	1.91	2.32	2.69	3.23	4.08	5.15	5.76	7.70	9.12	11.24	13.33
50	0.55	0.83	1.04	1.40	1.73	1.93	2.01	2.21	2.63	3.00	3.62	4.58	5.80	6.45	8.61	10.14	12.51	14.77
100	0.66	1.00	1.24	1.67	2.07	2.33	2.40	2.58	2.97	3.33	4.03	5.11	6.50	7.17	9.55	11.18	13.80	16.25
200	0.79	1.20	1.49	2.01	2.49	2.79	2.87	3.01	3.38	3.66	4.45	5.65	7.22	7.91	10.53	12.23	15.15	17.77
500	1.01	1.54	1.90	2.56	3.17	3.59	3.67	3.79	4.13	4.17	5.04	6.42	8.24	8.93	11.88	13.66	17.01	19.80
1000	1.22	1.85	2.30	3.09	3.83	4.35	4.43	4.52	4.85	4.90	5.51	7.04	9.06	9.75	12.94	14.77	18.49	21.43

* The upper bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are greater than.
** These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval**

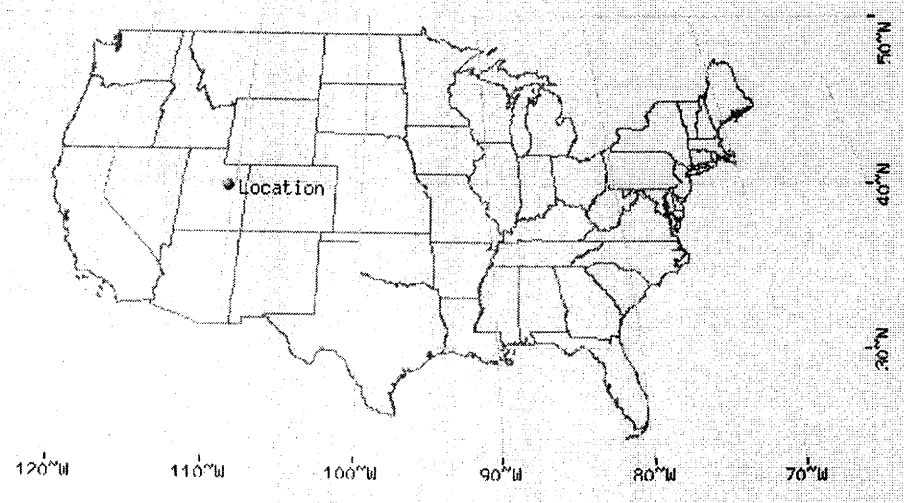
Precipitation Frequency Estimates (inches)

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.12	0.18	0.22	0.29	0.36	0.45	0.52	0.69	0.90	1.07	1.26	1.56	1.89	2.19	2.94	3.59	4.41	5.28
2	0.15	0.23	0.28	0.38	0.47	0.57	0.65	0.85	1.11	1.32	1.57	1.95	2.36	2.75	3.68	4.48	5.51	6.61
5	0.20	0.31	0.38	0.52	0.64	0.75	0.84	1.05	1.34	1.61	1.92	2.39	2.92	3.38	4.53	5.49	6.75	8.10
10	0.25	0.38	0.47	0.63	0.79	0.90	1.00	1.22	1.54	1.84	2.20	2.75	3.37	3.88	5.22	6.26	7.69	9.22
25	0.32	0.48	0.59	0.80	0.99	1.14	1.24	1.45	1.81	2.15	2.58	3.23	3.97	4.55	6.10	7.27	8.94	10.66
50	0.37	0.56	0.70	0.94	1.17	1.34	1.44	1.65	2.02	2.39	2.86	3.60	4.43	5.05	6.76	8.02	9.86	11.71
100	0.43	0.66	0.82	1.10	1.36	1.56	1.67	1.88	2.23	2.62	3.15	3.97	4.90	5.55	7.41	8.75	10.78	12.73
200	0.50	0.76	0.94	1.27	1.57	1.81	1.93	2.13	2.48	2.85	3.44	4.34	5.36	6.06	8.07	9.47	11.69	13.73
500	0.60	0.91	1.13	1.52	1.88	2.17	2.32	2.56	2.93	3.15	3.81	4.82	5.99	6.71	8.90	10.36	12.86	15.01
1000	0.68	1.04	1.29	1.73	2.15	2.48	2.65	2.94	3.34	3.38	4.10	5.18	6.46	7.19	9.53	11.03	13.76	15.97

* The lower bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are less than.
** These precipitation frequency estimates are based on a partial duration maxima series. ARI is the Average Recurrence Interval.

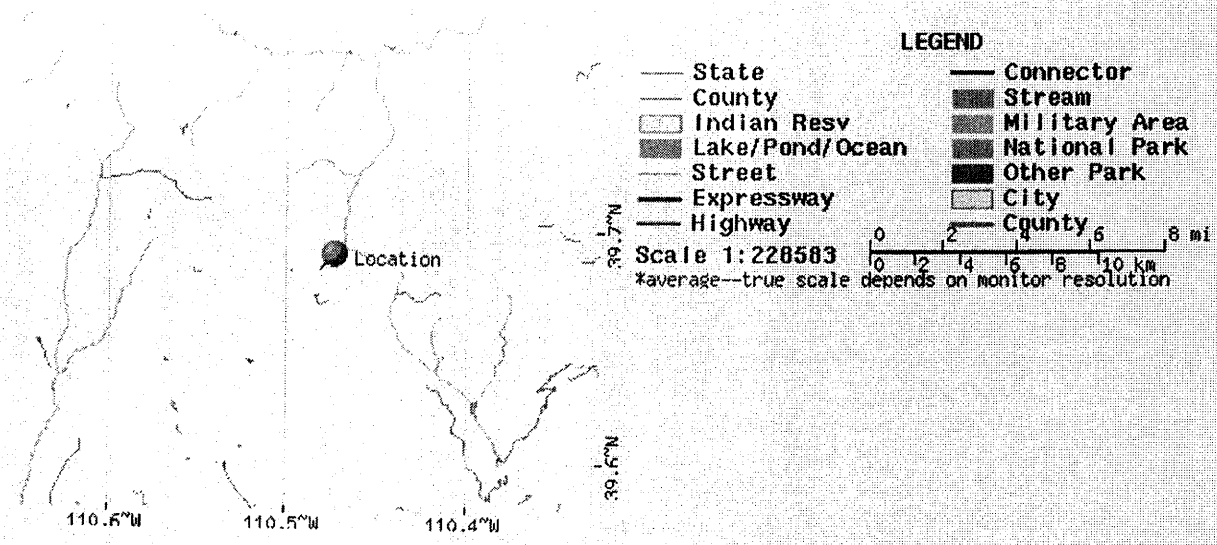
Please refer to the documentation for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

Maps -



These maps were produced using a direct map request from the U.S. Census Bureau Mapping and Cartographic Resources Tiger Map Server.

Please read disclaimer for more information.



Other Maps/Photographs -

View USGS digital orthophoto quadrangle (DOQ) covering this location from TerraServer; **USGS Aerial Photograph** may also be available
from this site. A DOQ is a computer-generated image of an aerial photograph in which image displacement caused by terrain relief and camera tilts has been removed. It combines the image characteristics of a photograph with the geometric qualities of a map. Visit the USGS for more information.

Watershed/Stream Flow Information -

Find the Watershed for this location using the U.S. Environmental Protection Agency's site.

Climate Data Sources -

Precipitation frequency results are based on data from a variety of sources, but largely NCDC. The following links provide general information
about observing sites in the area, regardless of if their data was used in this study. For detailed information about the stations used in this study,
please refer to our documentation.

Using the **National Climatic Data Center's (NCDC)** station search engine, locate other climate stations within:

+/-30 minutes ...OR... +/-1 degree of this location (39.68175/-110.48129). Digital ASCII data can be obtained directly from **NCDC**.

Find Natural Resources Conservation Service (NRCS) SNOTEL (SNOwpack TELemetry) stations by visiting the **Western Regional Climate Center's state-specific SNOTEL station maps.**

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