ANIMAS GLACIER GRAVEL PIT
DRAINAGE REPORT

Durango, CO
La Plata County

Date: August 21st, 2012

Prepared by
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I. Introduction

The following drainage study has been completed in order to determine the historic and developed flows for the drainage basin that drains much of the Animas Air Park, which flows to the southwest down a drainage that will be utilized by the Main Access Road to the proposed Animas Glacier Gravel Pit.

The drainage basin covers approximately 347 acres, therefore the TR-55 graphical peak method was used to determine the amount of run-off that the area would generate in a 2-year, 10-year, and 100-year storm events.

II. Drainage Basin Description

The project is located approximately 2 miles south of the intersection of US 160/550 and River Road in Durango, CO. Due to the large size of the basin (347 acres) and the minimal area of disturbance for the proposed access road (2.27 acres, which is less than 1% of the drainage basin area). The conclusion, that no consequential change in the TR-55 Curve Numbers (CN) would be realized due to the construction of the access road. Therefore, the post-development run-off would roughly equal the historic runoff and no detention is proposed for the proved.

The 347 acre drainage basin is a mix of native scrub brush lining the mesa and drainage along with the top of the mesa, which has been developed into an air park. Many of the lots have been commercially developed, which has meant that many have large areas of impervious area due to large buildings and parking lots. In the commercial areas, the CNs have been adjusted upward to reflect the conditions.

The soil types and condition of the drainage basin were used to approximate the appropriate Curve Numbers (CN) for the Graphical Peak Discharge Method, TR-55. The following is a summary of each soil type.

(26) Falfa Clay Loam, 1 to 3 percent slopes, is a deep well drained soil located on mesa tops. The unit is used mainly for irrigated crops, and development. The soil belongs to Hydrologic Group C, which will be used to determine the Curve Number for the TR-55 Graphical Peak Discharge Method.

(27) Falfa Clay Loam, 3 to 8 percent slopes, is a deep well drained soil located on mesa tops. The unit is used mainly for irrigated crops, and homesites. The soil belongs to Hydrologic Group C, which will be used to determine the Curve Number for the TR-55 Graphical Peak Discharge Method.

(60) Shalona Loam, is a deep well drained soil found on old high terraces. It formed in mixed alluvium derived from sandstone and shale. The unit is used mainly for irrigated field crops and pasture and as rangeland. It is also used for homesite and urban development. The soil belongs to Hydrologic Group B, which will be used to determine the Curve Number for the TR-55 Graphical Peak Discharge Method.

(70) Ustic Torriorthents-Ustollic Haplargids complex, 12 to 60 percent slopes, is located on terrace edges, mesa edges, and hillsides. The unit is deep and well to somewhat excessively well drained. This unit is used manily for wildlife habitat, as rangeland, and as a source of construction material. The soil belongs to Hydrologic Group B, which will be used to determine the Curve Number for the TR-55 Graphical Peak Discharge Method.

III. Hydrologic Data

The Contributing drainage basin was divided into 7 drainage basin that were used to calculate the 2, 10, and 100 year peak flows at various design points, which were chosen based on the proposed culvert locations. See Appendix A. The Graphical Peak Discharge Method TR-55 was used to determine the peak discharge of the inflow basins. Using the basin properties discussed in the previous section Curve Numbers were estimated. See Appendix B.

Tc (Time of Concentration) was calculated using the mannings coefficient, slopes, lengths, and estimated swale geometry of each drainage basin. See Appendix B.

Based on the Graphical Peak Discharge Method, the following flows were calculated for the individual drainage basins:

Basin #1 has a 2-year flow rate of 15.9cfs, 10-year flow rate of 47.9cfs, and a 100-year flow rate of 135.1cfs.

Basin #2 has a 2-year flow rate of 1.0cfs, 10-year flow rate of 3.3cfs, and a 100-year flow rate of 9.6cfs.

Basin #3 has a 2-year flow rate of 2.1cfs, 10-year flow rate of 7.4cfs, and a 100-year flow rate of 22.0cfs.

Basin #4 has a 2-year flow rate of 1.1cfs, 10-year flow rate of 4.0cfsnd a 100-year flow rate of 12.7cfs

Basin #5 has a 2-year flow rate of 1.2cfs, 10-year flow rate of 6.2cfs, and a 100-year flow rate of 26.4cfs.

Basin #6 has a 2-year flow rate of 0.4cs, 10-year flow rate of 2.0cfs, and a 100-year flow rate of 9.1cfs.

Basin #7 has a 2-year flow rate of 0.6cfs, 10-year flow rate of 3.1cfs, and a 100-year flow rate of 15.3cfs

Basin #8 has a 2-year flow rate of 0.2cfs, 10-year flow rate of 1.2cfs, and a 100-year flow rate of 11.7cfs

See Appendix B.

IV. Culvert Design

Based on the flow rates calculated using the TR-55 Graphical Peak Discharge Method, the flow rates for 7 design points were estimated. In order to conservatively estimate the flows at each design point the basins were not routed; rather peak flows were assumed to occur simultaneously, which will result in a conservative design. Storm Culverts were designed to accommodate the 10-year storm.

Design Point A occurs and the point were Basins #1, #2, and #3 meet to cross the Main Access Road. The design flow for this point is 58.6cfs. Two 30" Corrugated Metal Pipes (CMPs) have been designed with a maximum capacity of 58.6cfs at this point.

Design Point B occurs and the point were Basin #2 crosses the Main Access Road. The design flow for this point is 3.3cfs. A 15" Corrugated Metal Pipe (CMP) was designed with a maximum capacity of 6.1cfs at this point.

Design Point C occurs and the point were Basin #3 crosses the Main Access Road. The design flow for this point is 7.4cfs. A 15" Corrugated Metal Pipe (CMP) was designed with a maximum capacity of 7.4cfs at this point.

Design Point D occurs and the point were Basins #1, #2, #3, and #4 meet and cross the Main Access Road. The design flow for this point is 62.6cfs. A 36" Corrugated Metal Pipe (CMP) was designed with a maximum capacity of 80.0cfs at this point.

Design Point E occurs and the point were Basins #1, #2, #3, #4, and #6 meet and cross the Main Access Road. The design flow for this point is 64.6cfs. A 36" Corrugated Metal Pipe (CMP) was designed with a maximum capacity of 80.0cfs at this point.

Design Point F occurs and the point were Basins #7 crosses the Main Access Road along CR 213. The design flow for this point is 3.1cfs. An 18" Corrugated Metal Pipe (CMP) was designed with a maximum capacity of 11.1cfs at this point.

Design Point G occurs and the point were Basins #1 - #7 crosses CR 213. The design flow for this point is 75.1cfs. An existing 24" Corrugated Metal Pipe (CMP) will remain in place to convey the flows across the highway. Its flow capacity was not checked.

V. Basin Creek - Zero Discharge Retention Pond

In order to satisfy the requirements of the project's Storm Water Discharge Associated with Sand and Gravel Mining and Processing Permit along with their Colorado Division of Reclamation, Mining and Safety Permit the proposed gravel pit will not allow storm water to discharge from the mining site into the Basin Creek Drainage. To ensure that there won't be any discharge from the area of mining activities the owner of the pit will only "open" a limited amount of land at a time, with this limit being capped at 10 acres of disturbance. The "open" mining area will be routed to a retention pond, which will be sized to contain a 100-year storm event. Reclaimed and native area flows on the property will be routed around the open mining areas, in order to avoid co-mingling of the two types of storm water, and allowed to travel to its natural receiving water (The Animas River via Basin Creek).

During a 100 year storm event a 20 acre site (assumed 10 acres of active mine and 10 acres of reclamation area) will generate up to 480,200 cubic feet of runoff, which is equal to roughly 11 acre-feet of water. Therefore, it is recommended that the gravel pit constructs a detention pond and maintains no less than 12 acre-feet of available volume to ensure that a 100-year storm will produce zero runoff from the "open" portion of the gravel pit. Based on the project's anticipated water usage it will be able to dispose of storm water to suppress dust, wash gravel, mix concrete, irrigate newly seeded native area, etc.

Should, during the operation of the Gravel Pit, the site have less than 20 acres of contributing area routed to the detention pond the size of the pond volume may be reduced as follows:

Total Acreage of Open and in process Reclamation Area Routed to Retention Pond	**Required Storage Volume**
5 Acres	3 Acre-ft
10 Acres	6 Acre-ft
15 Acres	9 Acre-ft
20 Acres	12 Acre-ft

In the event that a 100 year storm occurs during the life of the project, which is likely based on the project life of the pit, it is important to consider the potential for another large storm to occur prior to the gravel pit operator being able to empty the pond to provide adequate storage. Three scenarios were studied to determine their probability of occurrence: 100 year storm followed by a 100 year storm, 100 year storm followed by a 10 year storm, and a 100 year storm followed by a 2 year storm.

Per Four Corner's Materials, their normal daily dust mitigation water use will be 30,000 gallons/day (0.092 acre-feet/day). It is assumed that with a full pond the operator will utilize their water trucks to reduce the amount of water within the retention pond at this normal rate. [1] The retention pond will be assume to be full and the only way to empty the pond is via dust mitigation, infiltration and evaporation are not considered and no other storage is available within the pit boundary.

Based on these criteria Table – 1 was created to show the probability that a 2, 10, and 100 year storm event would occur prior to the operator being able to remove water from the retention pond and provide adequate storage volume for each storm event.

[1] 30,000 gallons/day should be considered an extremely conservative number, as the operator will have the ability to increase the amount via additional water trucks. Other water uses on the project that have not been considered for this analysis include an aggregate wash plant that will average 60,000 gallons/day and a redi-mix concrete plant with a capacity of 72,000 gallons/day.

Table -1. Probability of Storm Event Occurance within Drainage Time

Event	Volume of Water (acre-ft)	Time to Drain (Days)	Probability of Storm Event Occurance[1]
2-Year Storm	1.99	22	3.01%
10-Year Storm	5.10	55	1.51%
100-Year Storm	11.06	120	0.36%

[1] The probablity of a 2 year storm on any given day = 0.137%, 5 year storm on any given day = 0.055%, and 100 year storm on any given day = 0.0027%. Probability given is for each storm occurring with the window of time that it takes

Based on this analysis smaller, more frequent, storm events will have the highest likelihood of occurring while the pond is full or nearly full. To reduce the chance of a discharge from the site, the operator should take the following steps:

1. Maintain 12 acre-ft of free board whenever possible. This will allow the operator to detain slightly more water than a 100-year storm generates and keep the pond from filling completely with lesser storms. This extra freeboard will reduce the chances of smaller storms (following larger storm) causing the retention pond to discharge.
2. Increase their efforts to drainage the pond (increase storage) when it has less than the required storage volume available based on the contribution area. Additional ways to drain the pond included wash plant water, redi-mix concrete water, additional dust mitigation, construct additional retention ponds.
3. Follow the 10-day weather forecast.

Three individual swales are proposed to convey the in Disturbed and Undisturbed Flows in the Gravel Pit area (Basin Creek Drainage Basin). Swale "A" will convey the Undisturbed Area (Basin 8) and Swales "B" and "C" will convey the Disturbed Basin flows. For simplicity all three swales will have the same geometric properties: 24" depth 12' width, 4:1 side slopes, and a 0.50% to 1.00% transverse slope. Table 2 shows a summary of the swales design flows and velocities for a slope of 0.50% and 1.00%.

Table -2. Summary of Swales

Disturbed Area	**2 year storm**	**10 year storm**	**100 year storm**
Swale Slope (%)	**32.28cfs[2]**	**80.38cfs[2]**	**167.13cfs[2]**
0.50	3.48fps	4.65fps	5.78fps
1.00	4.38fps	5.90fps	7.39fps
Undisturbed Area	**2 year storm**	**10 year storm**	**100 year storm**
Swale Slope (%)	**NA**	**NA**	**11.70cfs[3]**

[2] See Appendix D for Hydraflow runoff calculations
[3] See Appendix B for Drainage Basin 8 runoff calculations.

0.50	NA	NA	2.58fps
1.00	NA	NA	3.23fps

Based on this analysis, the maximum velocity of the proposed swales would be 7.39fps during a 100-year storm in swales "B" and "C". Velocities for the 2 and 10 year storm within the same swales would be a maximum of 4.38fps and 5.90fps respectively.

Analysis was also completed on the retention ponds potential overflow weir (only necessary for and embankment retention pond), and the existing grouted rip rap run down.

Overflow Weir Requirements: 3' High, 20' feet wide, and armored with D9-50 rip rap. See Engineering Plans for Details.

Grouted Rip Rap Run Down Characteristics: 10' Bottom Width, 3' Depth, 2:1 side slopes, 36.8% transverse slope.

Grouted Rip Rap Run Down Flow Capacity (167.13cfs):
Depth of Flow = 8.65 inches
Velocity = 22.39 fps

No consideration was given to the structural design or adequacy of the rundown within this report.

See Appendix D for all calculations concerning the retention pond, swales, run down, and weir.

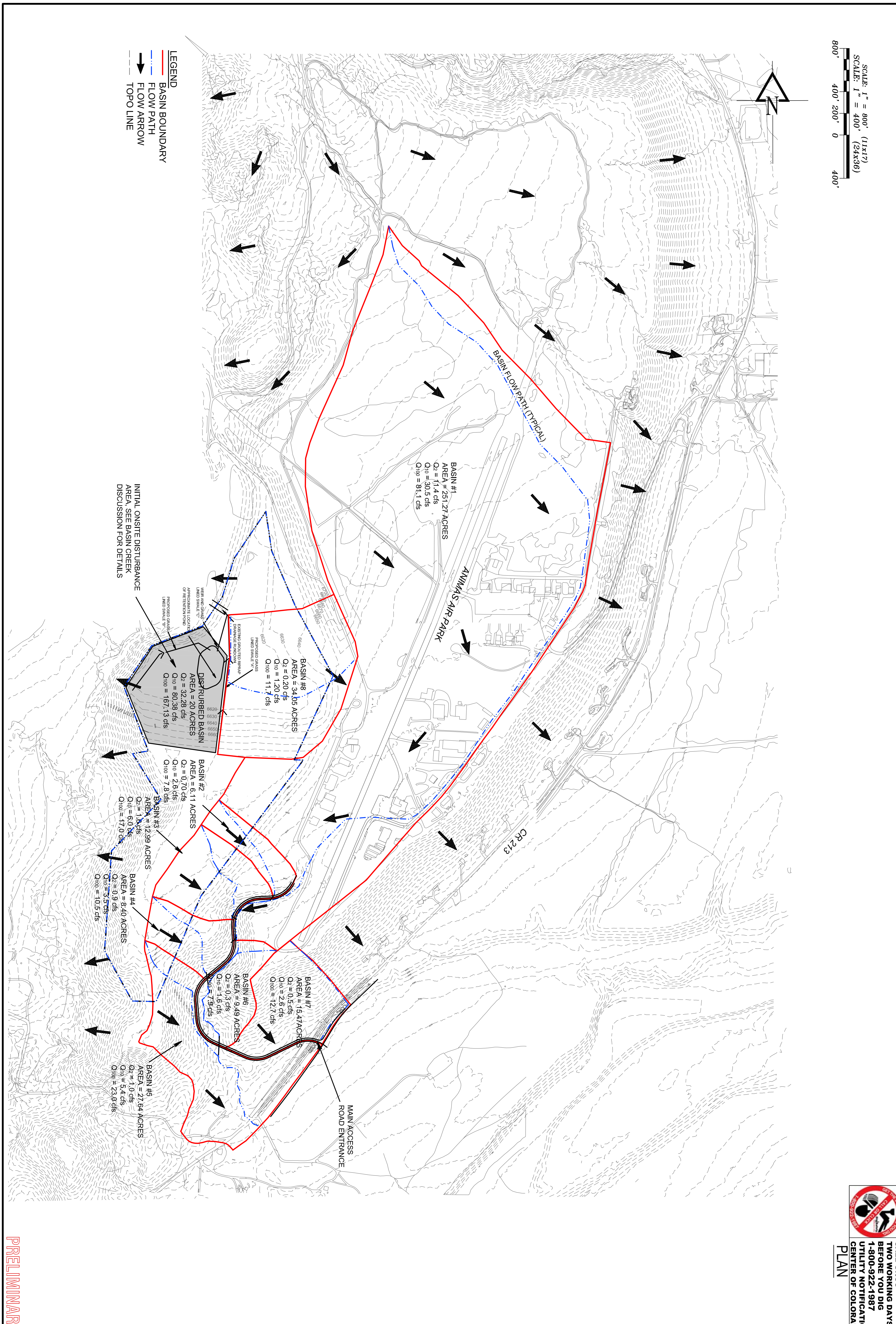
See Engineering Plans for Construction Design and Details.

VI. Stormwater Management Plan (SWMP)

"Precautions shall be taken to prevent any new erosion on-site and on all adjacent areas. Because the proposed disturbance area is greater than 0.50 acres Construction Stormwater Discharge permit is required by the State of Colorado. Stormwater Best Management Practices (BMP's) shall be included on the plan to mitigate the impacts of the proposed construction

Appendix A

Figure 1. – Drainage Basin Map #1
Figure 2. – Drainage Basin Map #2



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Drawn/Checked:

Drafted by:

DATE: 05/10/2010

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ANIMAS GLACIER GRAVEL PIT
DRAINAGE BASIN MAP #1

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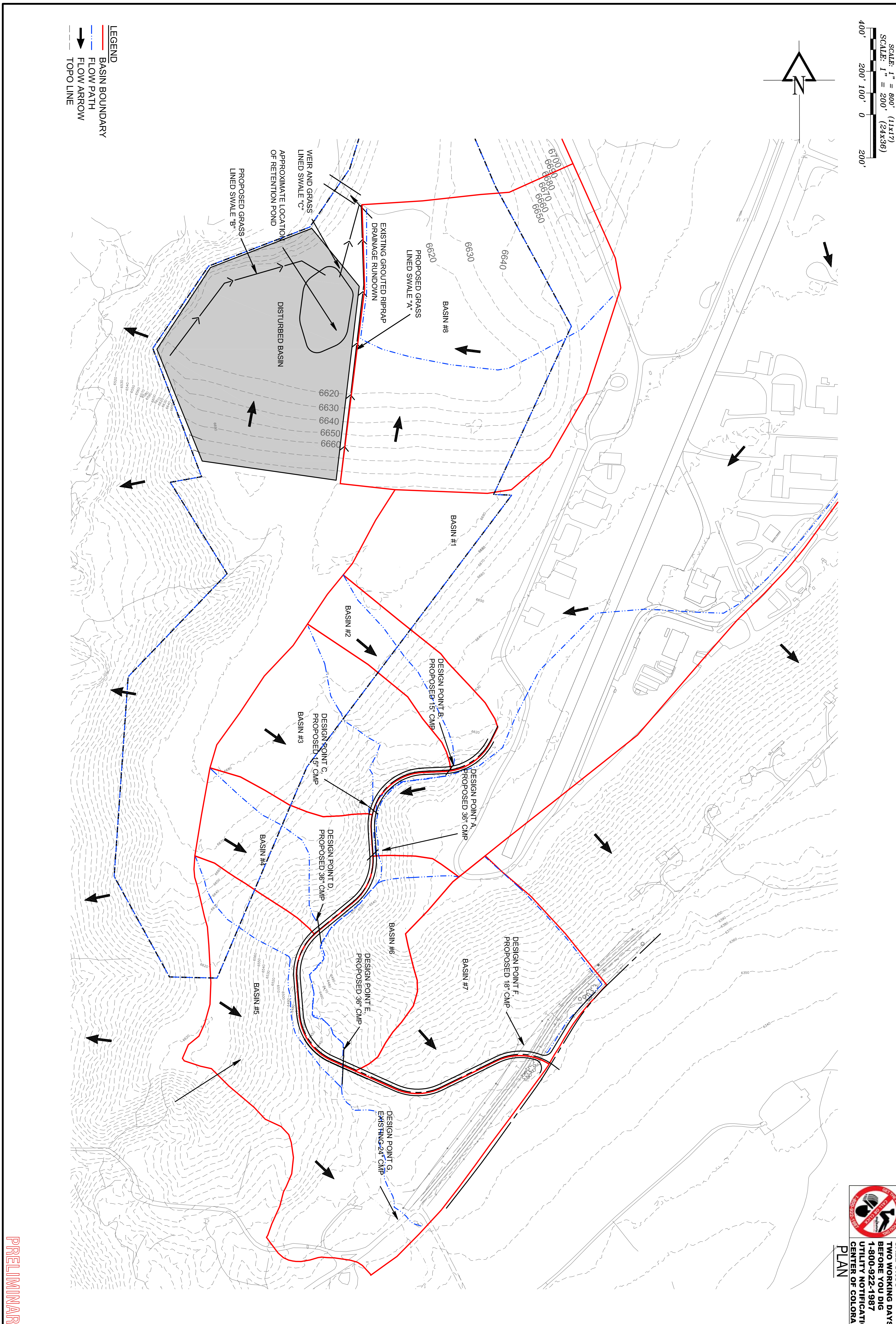

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REVISIONS: ⚠ XX

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ANIMAS GLACIER GRAVEL PIT
DRAINAGE BASIN MAP #2

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Appendix B

Figure 1. – Curve Number Calculations
Figure 2. – Tc (Time of Concentration) Calculations
Figure 3. - Graphical Peak Method TR-55

Major Basin #1

Soil Type	Area (SF)	Acres	CN		
27	3524170	80.90	73		5905.98
26	1501568	34.47	91		3136.88
26	1501568	34.47	73		2516.40
27	1002231	23.01	91		2093.73
27	1002231	23.01	73		1679.59
26	1207474	27.72	77		2134.42
70	1052710	24.17	66		1595.02
27	353666	8.12	66		535.86
70	175708	4.03	66		266.22
70	171344	3.93	66		259.61
70	120475	2.77	66		182.54
27	21163	0.49	77		37.41
27	4461	0.10	77		7.89
27	3236	0.07	77		5.72
	11642004	267.26			20357.27
				Average CN	**76.17**

Major Basin #2

Soil Type	Area (SF)	Acres	CN		
27	101590	2.33	77		179.58
27	97976	2.25	77		173.19
70	63756	1.46	66		96.60
70	2908	0.07	66		4.41
	266230	6.11			453.77
				Average CN	**74.25**

Major Basin #3

Soil Type	Area (SF)	Acres	CN		
27	360626	8.28	77		637.47
27	47538	1.09	77		84.03
70	154917	3.56	66		234.72
	563081	12.93			956.22
				Average CN	**73.97**

Major Basin #4

Soil Type	Area (SF)	Acres	CN		
27	230434	5.29	77		407.33
70	135491	3.11	66		205.29
	365925	8.40			612.62
				Average CN	**72.93**

Major Basin #5

Soil Type	Area (SF)	Acres	CN		
27	225245	5.17	77		398.16
60	180582	4.15	66		273.61
70	6655	0.15	66		10.08
70	791675	18.17	66		1199.51
	1204157	27.64			1881.36
				Average CN	**68.06**

Major Basin #6

Soil Type	Area (SF)	Acres	CN		
27	37331	0.86	77		65.99
70	376015	8.63	66		569.72
	413346	9.49			635.71
				Average CN	**66.99**

Major Basin #7

Soil Type	Area (SF)	Acres	CN		
27	51629	1.19	77		91.26
60	44254.64	1.02	66		67.05
70	578135	13.27	66		875.96
	674018.6	15.47			1034.28
				Average CN	**66.84**

Major Basin #8

Soil Type	Area (SF)	Acres	CN		
26	51629	7.64	73		557.72
70	44254.64	26.41	66		1743.06
	95883.64	34.05			2300.78
				Average CN	**67.57**

Time of Concentration							Overland Flow (T_i)					Shallow Concentrated Flow (T_1)				Open Channel Flow (T_2)						Open Channel Flow (T_3)					
Basin	T_i (min)	T_1 (min)	T_2 (min)	T_3 (min)	T_c (min)	T_c (hours)	Fall (ft)	Distance (ft)	Slope (ft/ft)	Mannings (n)	P_2	Fall (ft)	Distance (ft)	Slope (ft/ft)	Velocity (ft/s)	Fall (ft)	Distance (ft)	Slope (ft/ft)	Mannings, n	Hydraulic Radius, r	Velocity, V	Fall (ft)	Distance (ft)	Slope (ft/ft)	Mannings, n	Hydraulic Radius, r	Velocity, V
Historic Basin	12.47	38.13	58.25	10.91	119.75	2.00	10.00	200.00	0.05	0.40	1.60	95.00	3660.00	0.026	1.60	35.00	3890.00	0.009	0.08	0.50	1.11	300.00	2720.00	0.110	0.08	0.50	4.16
Basin #1	12.47	23.46	58.25	5.57	99.75	1.66	10.00	200.00	0.05	0.40	1.60	95.00	3660.00	0.026	2.60	35.00	3890.00	0.009	0.08	0.50	1.11	95.00	1185.00	0.080	0.08	0.50	3.54
Basin #2	7.16	1.28	2.57	0.00	11.01	0.18	5.00	100.00	0.05	0.40	1.60	5.00	200.00	0.025	2.60	70.00	639.00	0.110	0.08	0.50	4.14	NA	NA	NA	NA	NA	NA
Basin #3	7.16	0.99	1.72	0.00	9.86	0.16	5.00	100.00	0.05	0.40	1.60	15.00	237.00	0.063	4.00	120.00	584.00	0.205	0.08	0.50	5.67	NA	NA	NA	NA	NA	NA
Basin #4	6.96	0.53	2.22	0.00	9.71	0.16	10.00	100.00	0.10	0.40	1.60	25.00	189.00	0.132	6.00	60.00	550.00	0.109	0.08	0.50	4.13	NA	NA	NA	NA	NA	NA
Basin #5	6.71	0.86	6.54	0.00	14.11	0.24	25.00	100.00	0.25	0.40	1.60	140.00	465.00	0.301	9.00	150.00	1535.00	0.098	0.08	0.50	3.91	NA	NA	NA	NA	NA	NA
Basin #6	6.85	0.29	3.64	0.00	10.79	0.18	15.00	100.00	0.15	0.40	1.60	80.00	175.00	0.457	10.00	120.00	965.00	0.124	0.08	0.50	4.41	NA	NA	NA	NA	NA	NA
Basin #7	6.77	1.32	3.50	0.00	11.59	0.19	20.00	100.00	0.20	0.40	1.60	125.00	596.00	0.210	7.50	10.00	410.00	0.024	0.08	0.50	1.95	NA	NA	NA	NA	NA	NA
Basin #8	9.79	1.11	9.42	0.00	20.32	0.34	10.00	150.00	0.07	0.40	1.60	50.00	500.00	0.100	7.50	20.00	1000.00	0.020	0.08	0.50	1.77	NA	NA	NA	NA	NA	NA

Graphical Peak Discharge Method TR-55

		Historic Basin				Basin #1			Basin #2			Basin #3			Basin #4			Basin #5			Basin #6			Basin #7			Basin #8		
1	Drainage Area (Acres)	331.37	331.37	331.37	331.37	251.27	251.27	251.27	6.11	6.11	6.11	12.99	12.99	12.99	8.40	8.40	8.40	27.64	27.64	27.64	9.49	9.49	9.49	15.47	15.47	15.47	34.05	34.05	34.05
	Drainage Area (sq. mi.)	0.52	0.52	0.52	0.52	0.39	0.39	0.39	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.04	0.04	0.04	0.01	0.01	0.01	0.02	0.02	0.02	0.05	0.05	0.05
	Curve Number (Avg.)	74.66	74.66	74.66	74.66	76.17	76.17	76.17	74.25	74.25	74.25	73.97	73.97	73.97	72.93	72.93	72.93	68.06	68.06	68.06	66.99	66.99	66.99	66.84	66.84	66.84	67.57	67.57	67.57
	Time of Concentration (hr.)	2.00	2.00	2.00	2.00	1.66	1.66	1.66	0.18	0.18	0.18	0.16	0.16	0.16	0.16	0.16	0.16	0.24	0.24	0.24	0.18	0.18	0.18	0.19	0.19	0.19	0.34	0.34	0.34
	Rainfall Distribution	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II	Type II
	Pond/Swamp Area	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Frequency (Years)	**2**	**5**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**	**2**	**10**	**100**
3	Rainfall, P (24-hour)	1.60	1.90	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50	1.60	2.25	3.50
4	Maximum Retention, S	3.39	3.39	3.39	3.39	3.13	3.13	3.13	3.47	3.47	3.47	3.52	3.52	3.52	3.71	3.71	3.71	4.69	4.69	4.69	4.93	4.93	4.93	4.96	4.96	4.96	4.80	4.80	4.80
	Initial abstraction, Ia (Inches) from Table 4-I	0.68	0.68	0.68	0.68	0.63	0.63	0.63	0.69	0.69	0.69	0.70	0.70	0.70	0.74	0.74	0.74	0.94	0.94	0.94	0.99	0.99	0.99	0.99	0.99	0.99	0.96	0.96	0.96
5	Cumpute Ia/P	0.42	0.36	0.30	0.19	0.39	0.28	0.18	0.43	0.31	0.20	0.44	0.31	0.20	0.46	0.33	0.21	0.59	0.42	0.27	0.62	0.44	0.28	0.62	0.44	0.28	0.60	0.43	0.27
6	Unit Peak Discharge, Qu (csm/in) from Exhibit 4-II	145	165	185	210	175	220	250	550	725	800	570	775	875	525	700	825	350	500	675	400	525	725	375	500	750	50	85	250
7	Runoff, Q (inches)	0.20	0.32	0.50	1.28	0.23	0.56	1.38	0.19	0.48	1.26	0.18	0.47	1.24	0.16	0.44	1.18	0.08	0.29	0.90	0.07	0.26	0.85	0.07	0.25	0.84	0.08	0.27	0.88
8	Pond and Swamp Adjustment, Fp	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	Peak Discharge, Qp	**14.8**	**27.6**	**47.6**	**139.2**	**15.9**	**47.9**	**135.1**	**1.0**	**3.3**	**9.6**	**2.1**	**7.4**	**22.0**	**1.1**	**4.0**	**12.7**	**1.2**	**6.2**	**26.4**	**0.4**	**2.0**	**9.1**	**0.6**	**3.1**	**15.3**	**0.2**	**1.2**	**11.7**

Appendix C

Design Point	#	SIZE	TYPE	Notes	Inlet Elev	Outlet Elev	Length	Slope	Approximate Road Elev	Contributing Basins	Design Storm	Design Flow	Capacity	Water Elev	Freeboard	HW/D
A	2	30	CMP	Proposed	6530.75	6525.75	70.00	7.14%	6534.50	#1, #2, #3	10-year	58.6	58.6	6533.63	0.87	1.15
B	1	15	CMP	Proposed	6580.30	6579.70	60.00	1.00%	6584.00	#2	10-year	3.3	6.1	6582.78	1.22	1.98
C	1	18	CMP	Proposed	6546.00	6544.00	58.00	3.45%	6548.00	#3	10-year	7.4	7.4	6547.62	0.38	1.08
D	1	36	CMP	Proposed	6489.00	6479.70	120.00	7.75%	6498.00	#1, #2, #3, #4	10-year	62.6	80.0	6494.99	3.01	2.00
E	1	36	CMP	Proposed	6418.00	6406.00	170.00	7.06%	6440.00	#1, #2, #3, #4, #6	10-year	64.6	80.0	6424.00	16.00	2.00
F	1	18	CMP	Proposed	6364.21	6362.06	94.00	2.29%	6368.50	#7	10-year	3.1	11.1	6367.14	1.36	1.95
G	1	24	CMP	Existing	Existing	Existing	Existing	Existing	Existing	#1-#7	10-year	75.1	Existing	Existing	Existing	Existing

Culvert Report

Design Point A

Invert Elev Dn (ft)	= 6525.75
Pipe Length (ft)	= 70.00
Slope (%)	= 7.14
Invert Elev Up (ft)	= 6530.75
Rise (in)	= 30.0
Shape	= Cir
Span (in)	= 30.0
No. Barrels	= 2
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

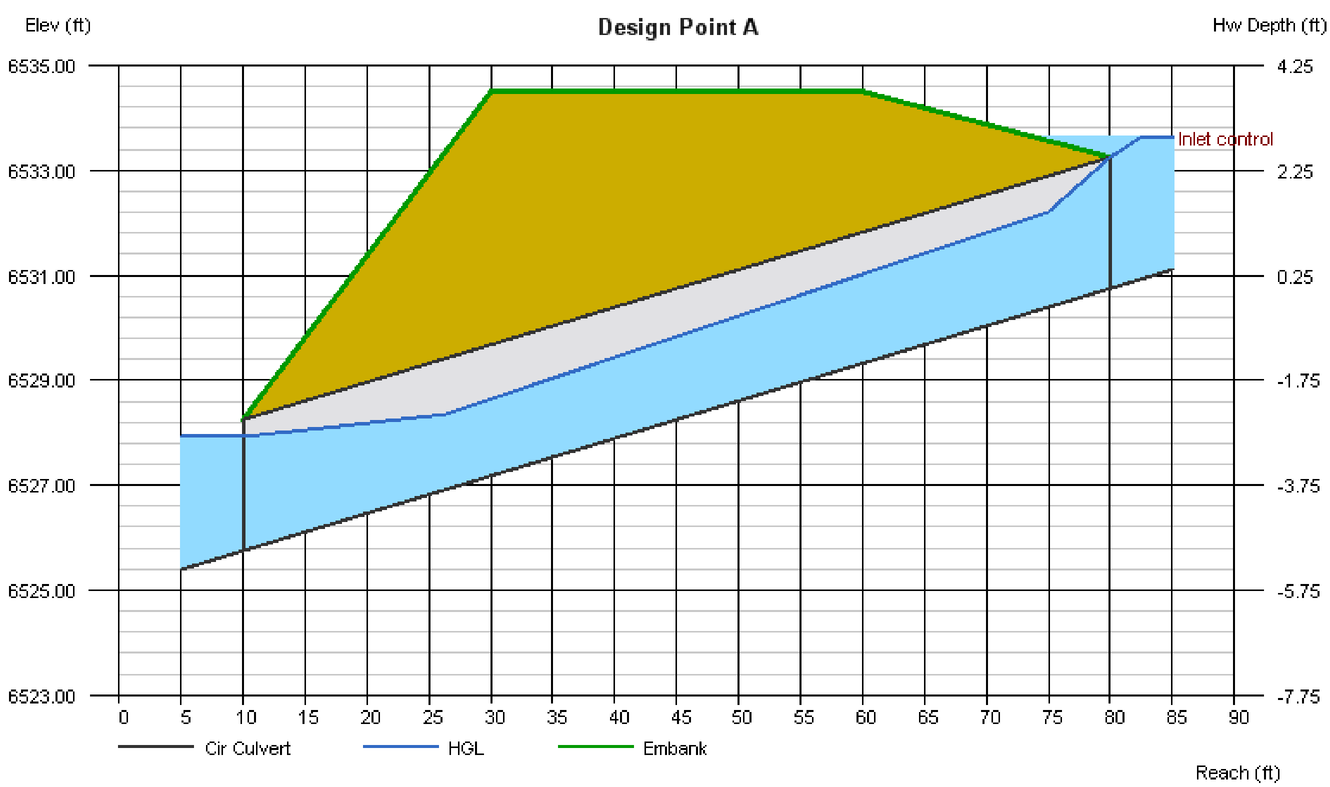
Top Elevation (ft)	= 6534.50
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 58.60
Qmax (cfs)	= 58.60
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 58.60
Qpipe (cfs)	= 58.60
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.46
Veloc Up (ft/s)	= 7.51
HGL Dn (ft)	= 6527.93
HGL Up (ft)	= 6532.60
Hw Elev (ft)	= 6533.63
Hw/D (ft)	= 1.15
Flow Regime	= Inlet Control



Culvert Report

Design Point B

Invert Elev Dn (ft)	= 6579.70
Pipe Length (ft)	= 60.00
Slope (%)	= 1.00
Invert Elev Up (ft)	= 6580.30
Rise (in)	= 15.0
Shape	= Cir
Span (in)	= 15.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

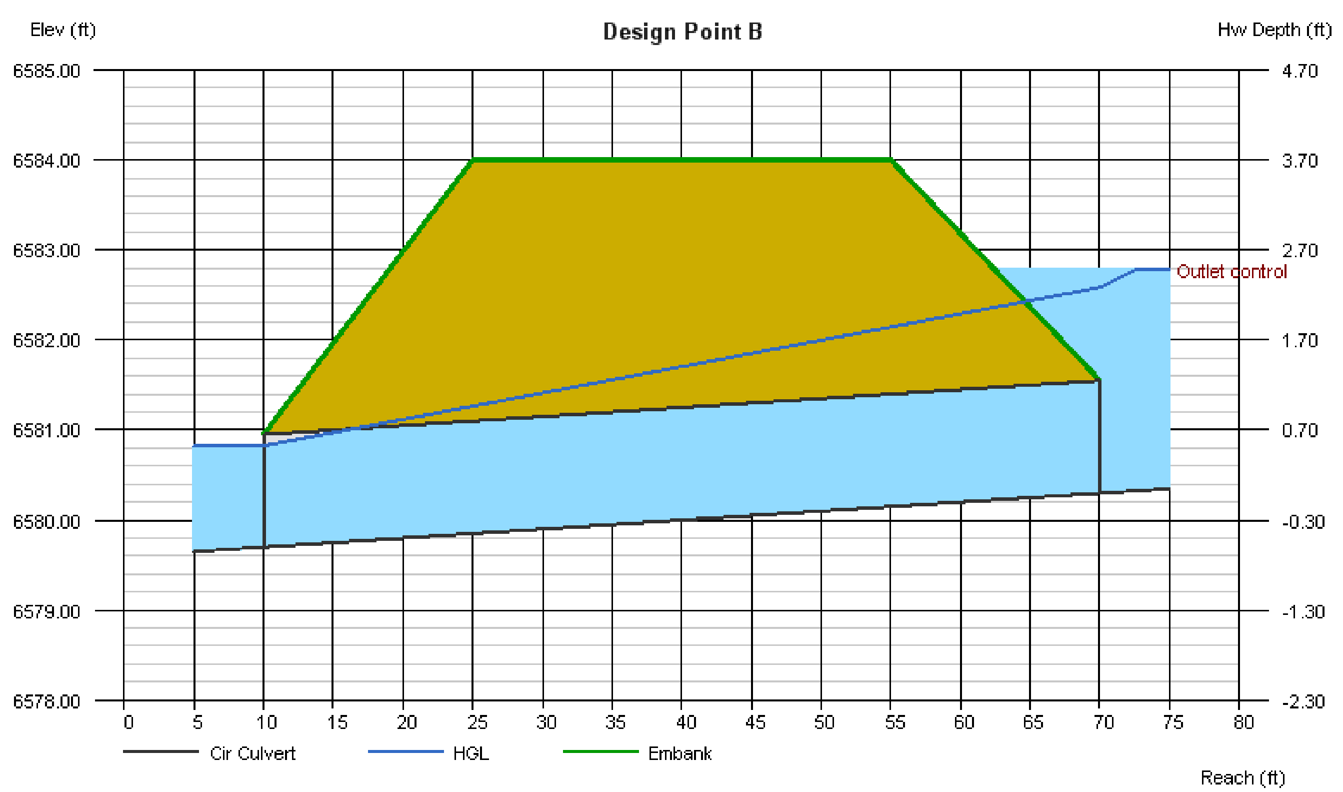
Top Elevation (ft)	= 6584.00
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 3.30
Qmax (cfs)	= 6.10
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 6.10
Qpipe (cfs)	= 6.10
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 5.24
Veloc Up (ft/s)	= 4.97
HGL Dn (ft)	= 6580.83
HGL Up (ft)	= 6582.58
Hw Elev (ft)	= 6582.78
Hw/D (ft)	= 1.98
Flow Regime	= Outlet Control



Culvert Report

Design Point C

Invert Elev Dn (ft)	= 6544.00
Pipe Length (ft)	= 58.00
Slope (%)	= 3.45
Invert Elev Up (ft)	= 6546.00
Rise (in)	= 18.0
Shape	= Cir
Span (in)	= 18.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

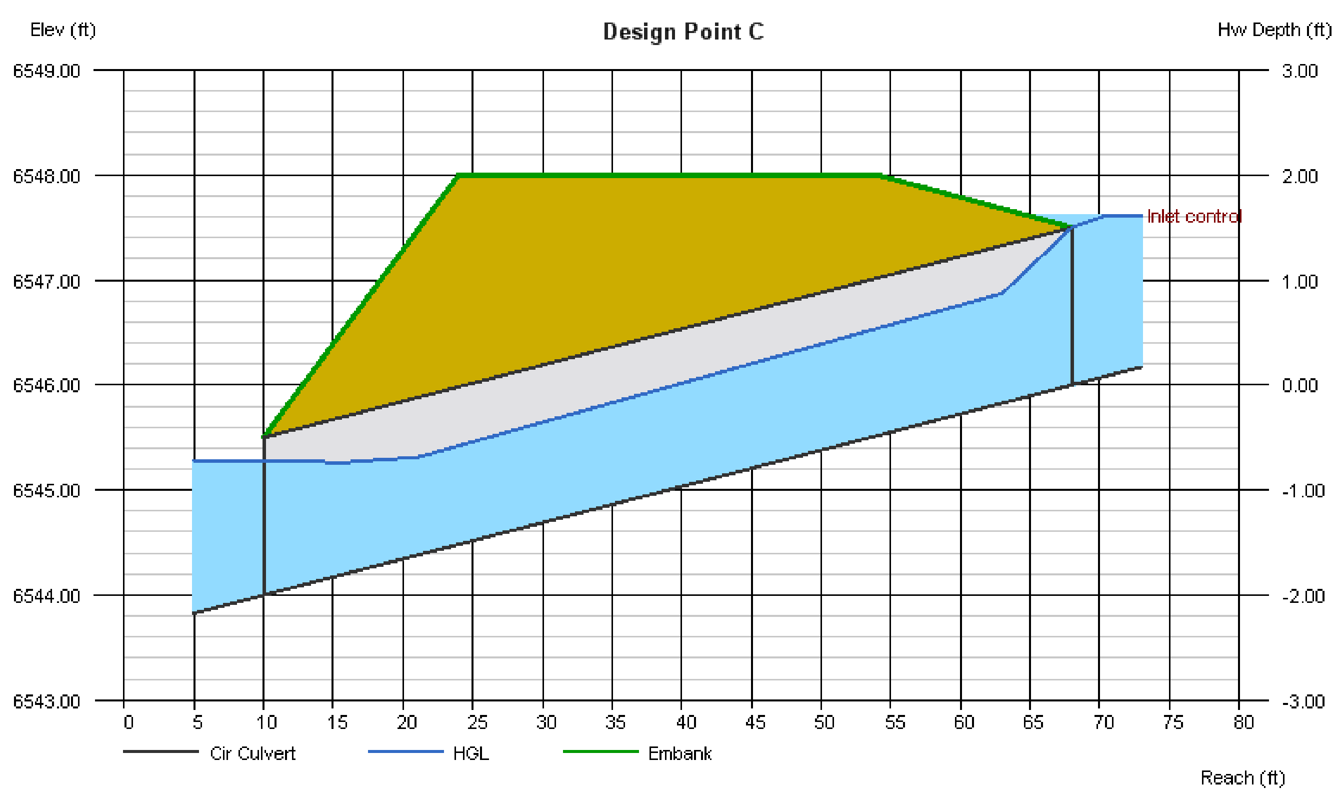
Top Elevation (ft)	= 6548.00
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 7.40
Qmax (cfs)	= 7.40
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 7.40
Qpipe (cfs)	= 7.40
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 4.61
Veloc Up (ft/s)	= 5.55
HGL Dn (ft)	= 6545.28
HGL Up (ft)	= 6547.06
Hw Elev (ft)	= 6547.62
Hw/D (ft)	= 1.08
Flow Regime	= Inlet Control



Culvert Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. Tuesday, Aug 21 2012

Design Point D

Invert Elev Dn (ft)	= 6479.70
Pipe Length (ft)	= 120.00
Slope (%)	= 7.75
Invert Elev Up (ft)	= 6489.00
Rise (in)	= 36.0
Shape	= Cir
Span (in)	= 36.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

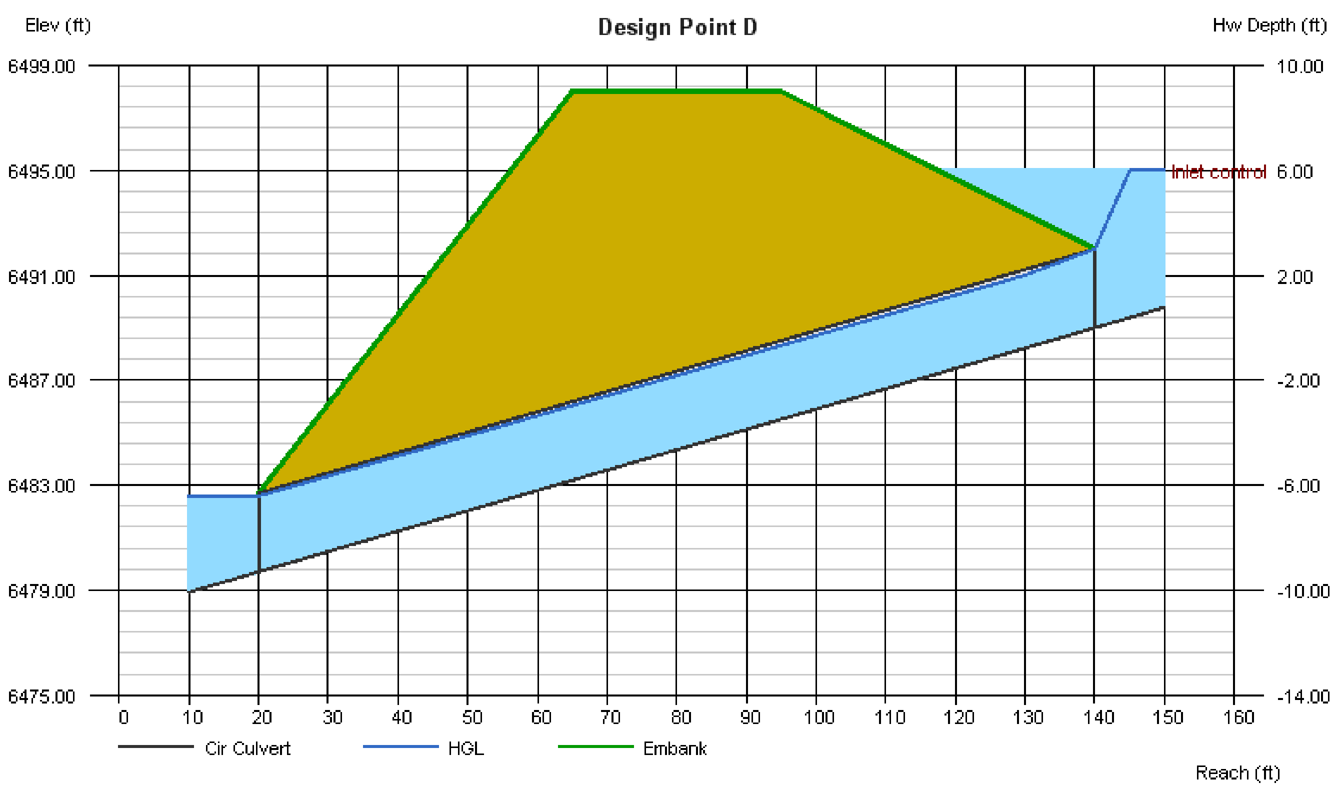
Top Elevation (ft)	= 6498.00
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 62.60
Qmax (cfs)	= 80.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 79.80
Qpipe (cfs)	= 79.80
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 11.43
Veloc Up (ft/s)	= 11.69
HGL Dn (ft)	= 6482.59
HGL Up (ft)	= 6491.77
Hw Elev (ft)	= 6494.99
Hw/D (ft)	= 2.00
Flow Regime	= Inlet Control



Culvert Report

Design Point E

Invert Elev Dn (ft)	= 6406.00
Pipe Length (ft)	= 170.00
Slope (%)	= 7.06
Invert Elev Up (ft)	= 6418.00
Rise (in)	= 36.0
Shape	= Cir
Span (in)	= 36.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

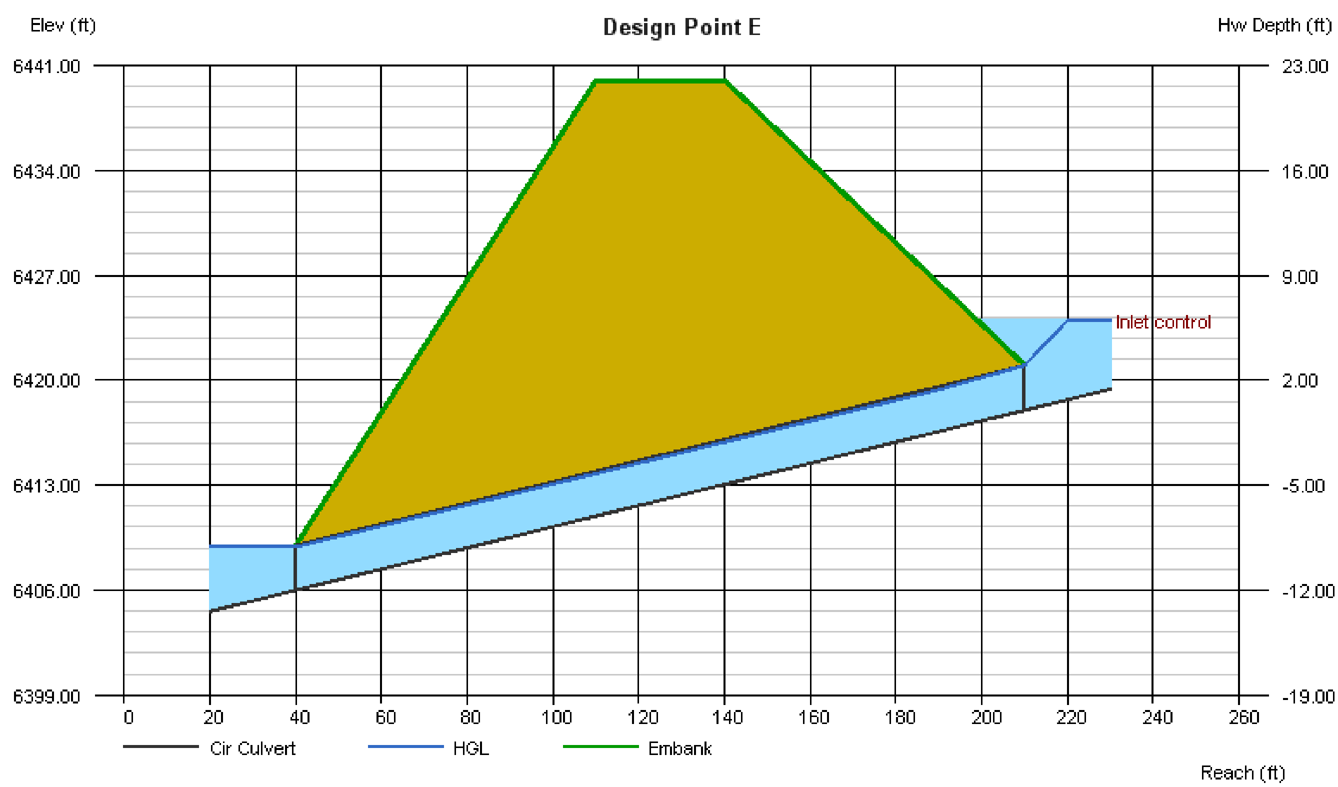
Top Elevation (ft)	= 6440.00
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 64.60
Qmax (cfs)	= 80.00
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 79.80
Qpipe (cfs)	= 79.80
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 11.43
Veloc Up (ft/s)	= 11.69
HGL Dn (ft)	= 6408.89
HGL Up (ft)	= 6420.77
Hw Elev (ft)	= 6424.00
Hw/D (ft)	= 2.00
Flow Regime	= Inlet Control



Culvert Report

Design Point F

Invert Elev Dn (ft)	= 6362.06
Pipe Length (ft)	= 94.00
Slope (%)	= 2.29
Invert Elev Up (ft)	= 6364.21
Rise (in)	= 18.0
Shape	= Cir
Span (in)	= 18.0
No. Barrels	= 1
n-Value	= 0.024
Inlet Edge	= 0
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.5

Embankment

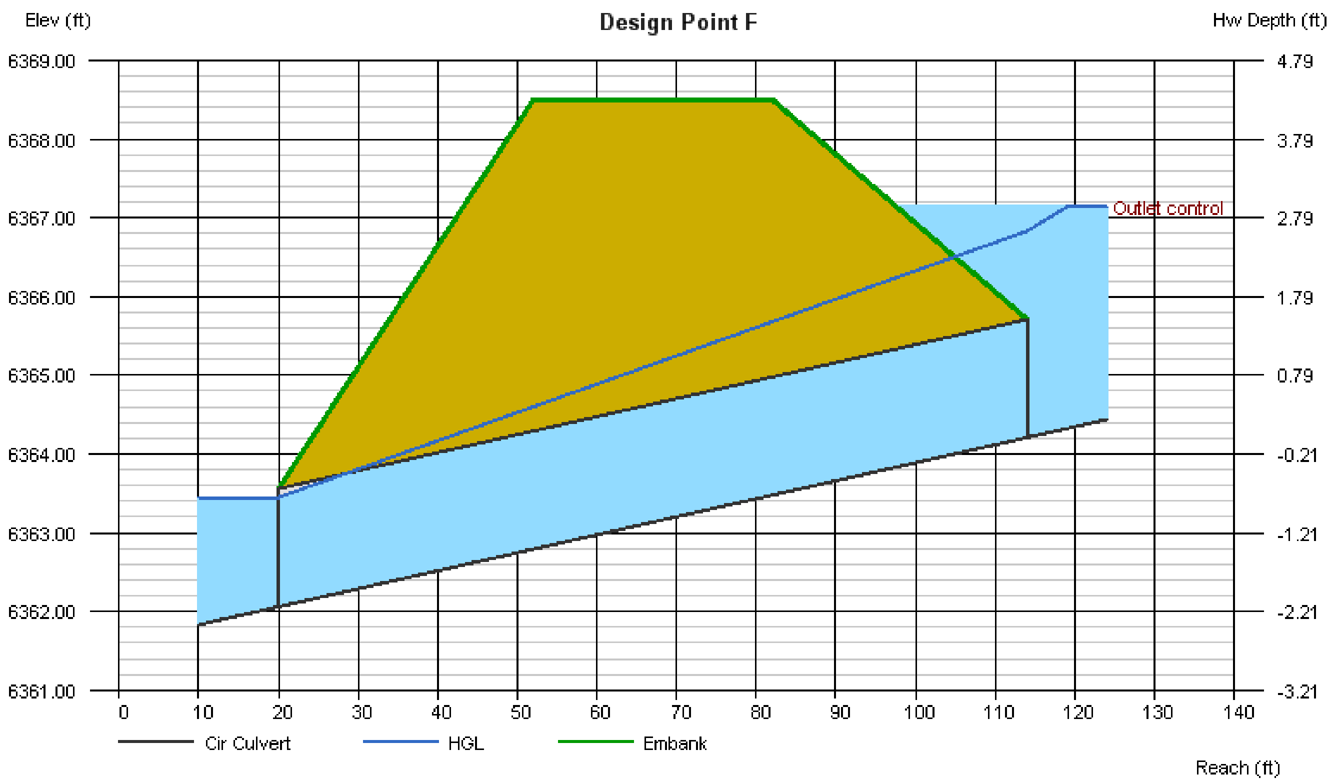
Top Elevation (ft)	= 6368.50
Top Width (ft)	= 30.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 3.10
Qmax (cfs)	= 11.10
Tailwater Elev (ft)	= (dc+D)/2

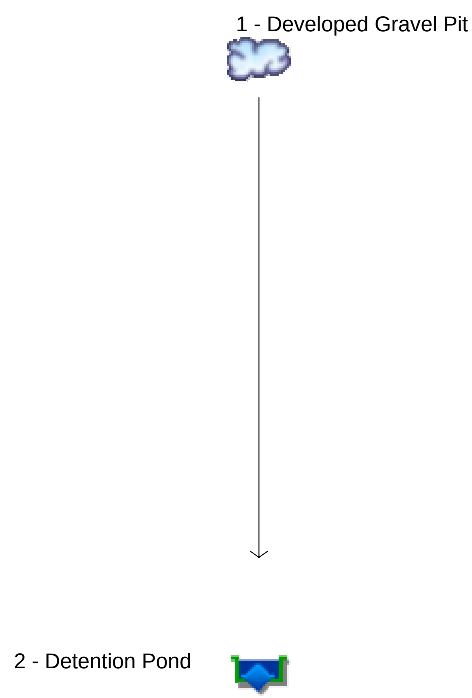
Highlighted

Qtotal (cfs)	= 11.10
Qpipe (cfs)	= 11.10
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 6.50
Veloc Up (ft/s)	= 6.28
HGL Dn (ft)	= 6363.45
HGL Up (ft)	= 6366.83
Hw Elev (ft)	= 6367.14
Hw/D (ft)	= 1.95
Flow Regime	= Outlet Control



Appendix D

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	SCS Runoff	Developed Gravel Pit
2	Reservoir	Detention Pond

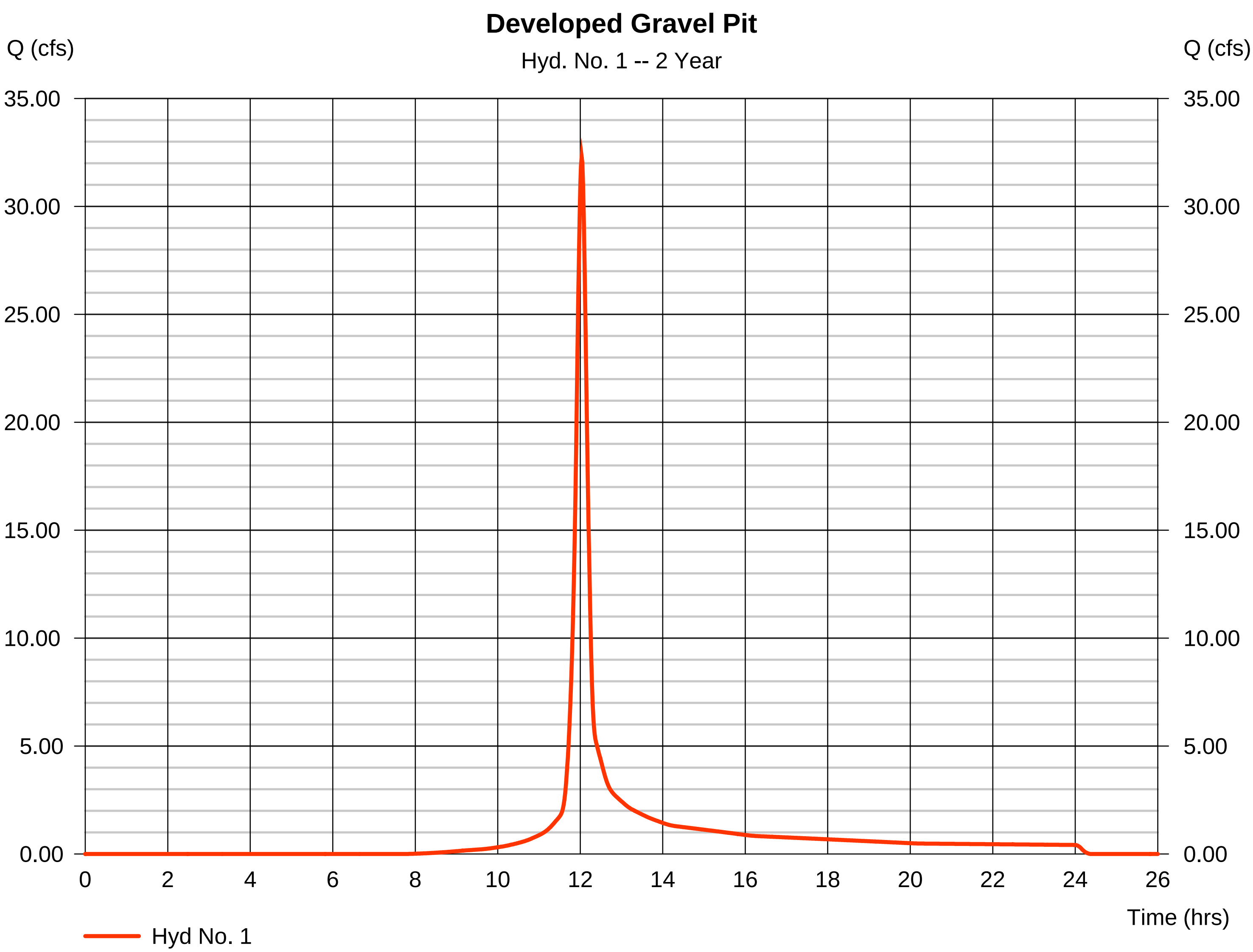
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 Tuesday, Apr 3, 2012

Hyd. No. 1

Developed Gravel Pit

Hydrograph type	= SCS Runoff	Peak discharge	= 32.28 cfs
Storm frequency	= 2 yrs	Time to peak	= 12.03 hrs
Time interval	= 1 min	Hyd. volume	= 86,823 cuft
Drainage area	= 20.000 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 2.20 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



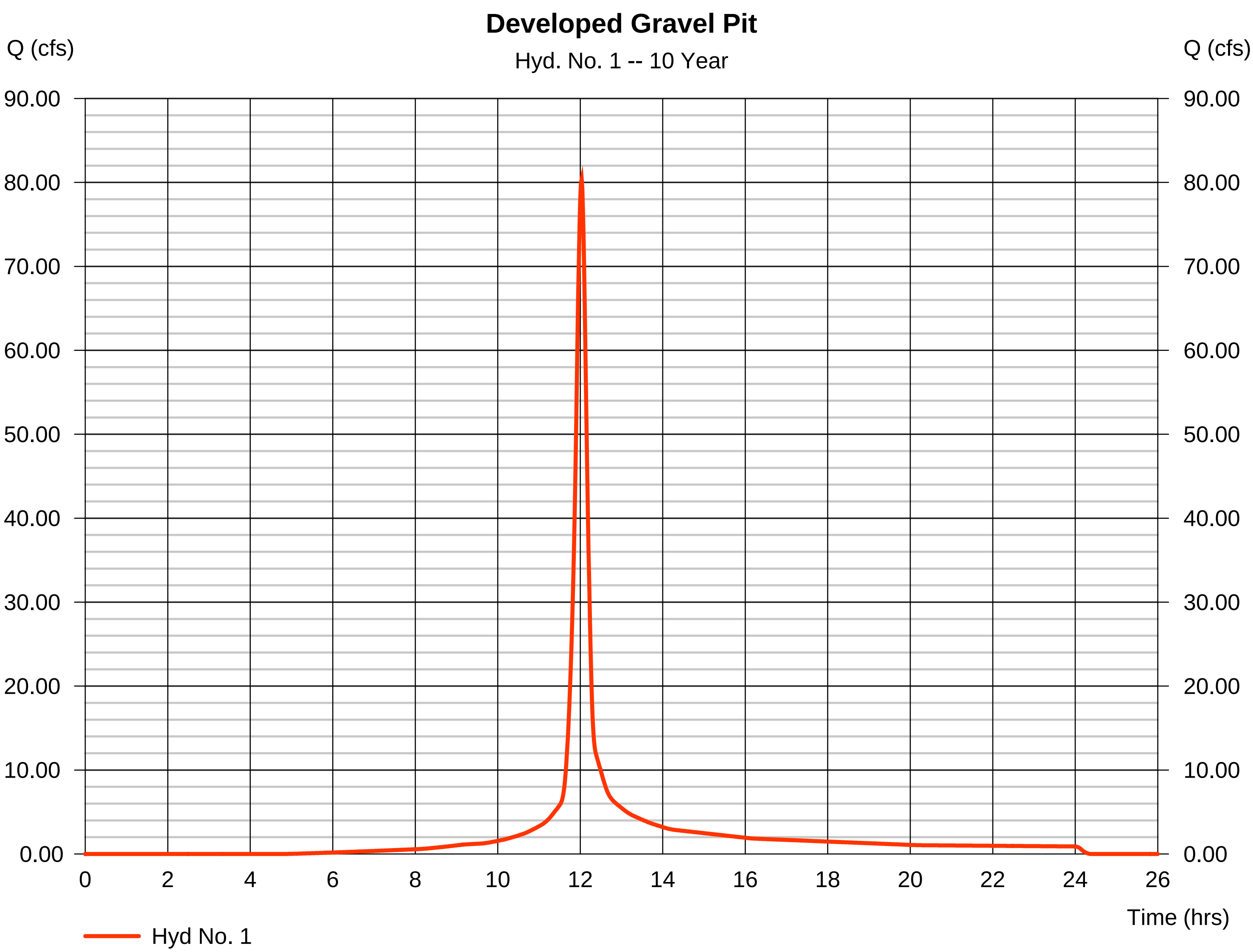
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 | Tuesday, Apr 3, 2012

Hyd. No. 1

Developed Gravel Pit

Hydrograph type	= SCS Runoff	Peak discharge	= 80.38 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.03 hrs
Time interval	= 1 min	Hyd. volume	= 222,043 cuft
Drainage area	= 20.000 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 4.25 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



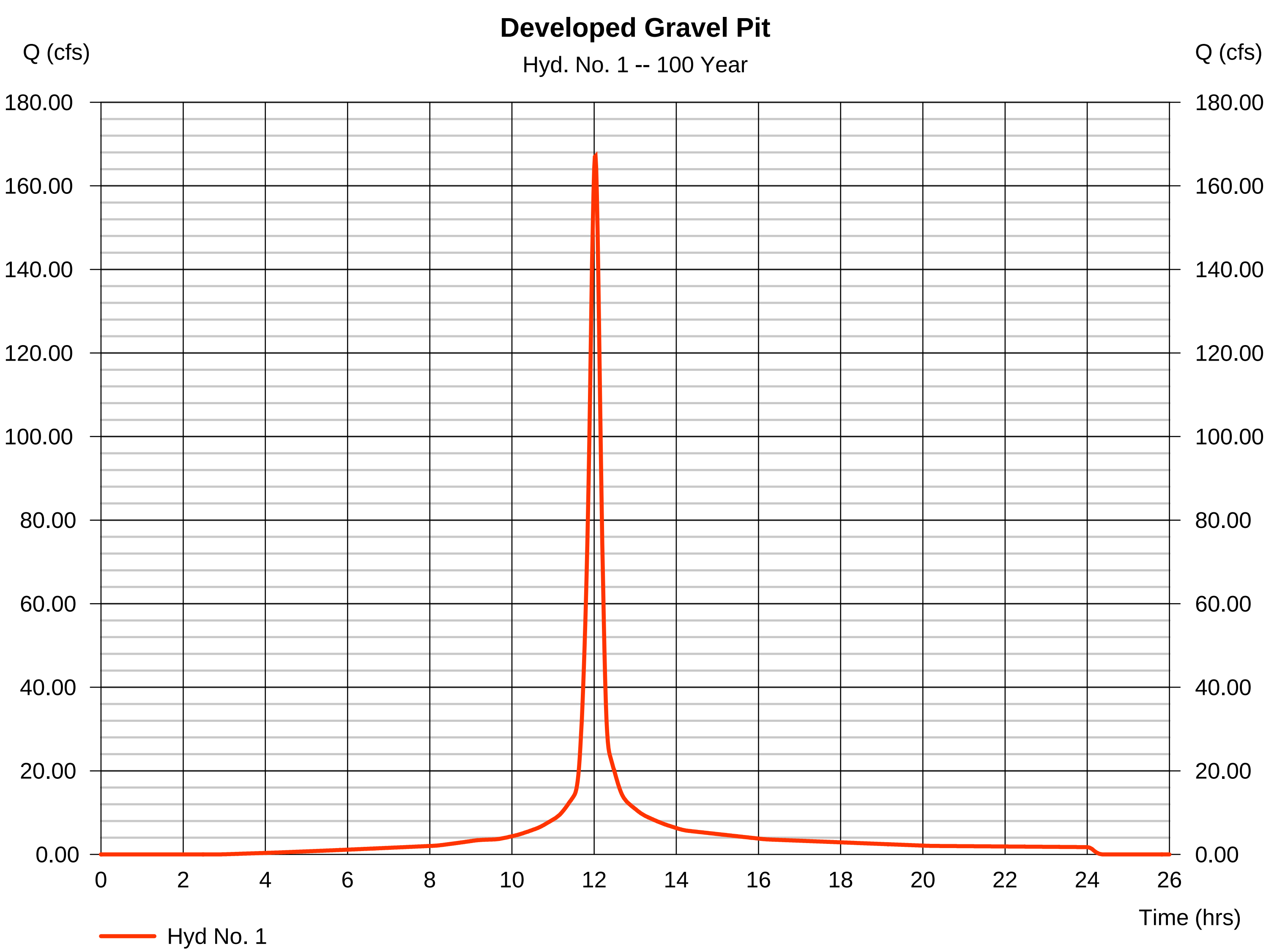
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2011 by Autodesk, Inc. v8 — Tuesday, Apr 3, 2012

Hyd. No. 1

Developed Gravel Pit

Hydrograph type	= SCS Runoff	Peak discharge	= 167.13 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.03 hrs
Time interval	= 1 min	Hyd. volume	= 481,900 cuft
Drainage area	= 20.000 ac	Curve number	= 89
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 15.00 min
Total precip.	= 7.95 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	32.2800 cfs
Slope	0.0050 ft/ft
Manning's n	0.0200
Height	36.0000 in
Bottom width	144.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	7.6587 in
Velocity	3.4755 fps
Full Flowrate	592.3967 cfs
Flow area	9.2880 ft2
Flow perimeter	207.1550 in
Hydraulic radius	6.4564 in
Top width	205.2694 in
Area	72.0000 ft2
Perimeter	440.8636 in
Percent full	21.2741 %

Critical Information

Critical depth	6.8283 in
Critical slope	0.0075 ft/ft
Critical velocity	3.9737 fps
Critical area	8.1234 ft2
Critical perimeter	200.3074 in
Critical hydraulic radius	5.8399 in
Critical top width	198.6262 in
Specific energy	0.8259 ft
Minimum energy	0.8535 ft
Froude number	0.8315
Flow condition	Subcritical

Channel Calculator

```
Given Input Data:
     Shape ...........................  Trapezoidal
     Solving for .....................  Depth of Flow
     Flowrate ........................  32.2800 cfs
     Slope ...........................  0.0100 ft/ft
     Manning's n .....................  0.0200
     Height ..........................  36.0000 in
     Bottom width ....................  144.0000 in
     Left slope ......................  0.2500 ft/ft (V/H)
     Right slope .....................  0.2500 ft/ft (V/H)

Computed Results:
     Depth ...........................  6.2802 in
     Velocity ........................  4.3765 fps
     Full Flowrate ...................  837.7755 cfs
     Flow area .......................  7.3758 ft2
     Flow perimeter ..................  195.7879 in
     Hydraulic radius ................  5.4248 in
     Top width .......................  194.2417 in
     Area ............................  72.0000 ft2
     Perimeter .......................  440.8636 in
     Percent full ....................  17.4450 %

                    Critical Information
     Critical depth ..................  6.8283 in
     Critical slope ..................  0.0075 ft/ft
     Critical velocity ...............  3.9737 fps
     Critical area ...................  8.1234 ft2
     Critical perimeter ..............  200.3074 in
     Critical hydraulic radius .......  5.8399 in
     Critical top width ..............  198.6262 in
     Specific energy .................  0.8210 ft
     Minimum energy ..................  0.8535 ft
     Froude number ...................  1.1430
     Flow condition ..................  Supercritical
```

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	80.3800 cfs
Slope	0.0050 ft/ft
Manning's n	0.0200
Height	36.0000 in
Bottom width	144.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	12.7642 in
Velocity	4.6490 fps
Full Flowrate	592.3967 cfs
Flow area	17.2898 ft2
Flow perimeter	249.2559 in
Hydraulic radius	9.9887 in
Top width	246.1132 in
Area	72.0000 ft2
Perimeter	440.8636 in
Percent full	35.4560 %

Critical Information

Critical depth	11.9298 in
Critical slope	0.0064 ft/ft
Critical velocity	5.0607 fps
Critical area	15.8831 ft2
Critical perimeter	242.3753 in
Critical hydraulic radius	9.4364 in
Critical top width	239.4380 in
Specific energy	1.3996 ft
Minimum energy	1.4912 ft
Froude number	0.8927
Flow condition	Subcritical

Channel Calculator

Given Input Data:

```
     Shape ..........................  Trapezoidal
     Solving for ....................  Depth of Flow
     Flowrate .......................  80.3800 cfs
     Slope ..........................  0.0100 ft/ft
     Manning's n ....................  0.0200
     Height .........................  36.0000 in
     Bottom width ...................  144.0000 in
     Left slope .....................  0.2500 ft/ft (V/H)
     Right slope ....................  0.2500 ft/ft (V/H)
```

Computed Results:

```
     Depth ..........................  10.5364 in
     Velocity .......................  5.9016 fps
     Full Flowrate ..................  837.7755 cfs
     Flow area ......................  13.6201 ft2
     Flow perimeter .................  230.8852 in
     Hydraulic radius ...............  8.4947 in
     Top width ......................  228.2910 in
     Area ...........................  72.0000 ft2
     Perimeter ......................  440.8636 in
     Percent full ...................  29.2677 %
```

Critical Information

```
     Critical depth .................  11.9298 in
     Critical slope .................  0.0064 ft/ft
     Critical velocity ..............  5.0607 fps
     Critical area ..................  15.8831 ft2
     Critical perimeter .............  242.3753 in
     Critical hydraulic radius ......  9.4364 in
     Critical top width .............  239.4380 in
     Specific energy ................  1.4193 ft
     Minimum energy .................  1.4912 ft
     Froude number ..................  1.2296
     Flow condition .................  Supercritical
```

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	167.1300 cfs
Slope	0.0050 ft/ft
Manning's n	0.0200
Height	36.0000 in
Bottom width	144.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	18.9348 in
Velocity	5.7843 fps
Full Flowrate	592.3967 cfs
Flow area	28.8939 ft2
Flow perimeter	300.1403 in
Hydraulic radius	13.8626 in
Top width	295.4784 in
Area	72.0000 ft2
Perimeter	440.8636 in
Percent full	52.5967 %

Critical Information

Critical depth	18.2949 in
Critical slope	0.0057 ft/ft
Critical velocity	6.0572 fps
Critical area	27.5922 ft2
Critical perimeter	294.8635 in
Critical hydraulic radius	13.4750 in
Critical top width	290.3590 in
Specific energy	2.0979 ft
Minimum energy	2.2869 ft
Froude number	0.9414
Flow condition	Subcritical

Channel Calculator

Given Input Data:

Shape	Trapezoidal
Solving for	Depth of Flow
Flowrate	167.1300 cfs
Slope	0.0100 ft/ft
Manning's n	0.0200
Height	36.0000 in
Bottom width	144.0000 in
Left slope	0.2500 ft/ft (V/H)
Right slope	0.2500 ft/ft (V/H)

Computed Results:

Depth	15.7403 in
Velocity	7.3878 fps
Full Flowrate	837.7755 cfs
Flow area	22.6224 ft2
Flow perimeter	273.7977 in
Hydraulic radius	11.8979 in
Top width	269.9222 in
Area	72.0000 ft2
Perimeter	440.8636 in
Percent full	43.7230 %

Critical Information

Critical depth	18.2949 in
Critical slope	0.0057 ft/ft
Critical velocity	6.0572 fps
Critical area	27.5922 ft2
Critical perimeter	294.8635 in
Critical hydraulic radius	13.4750 in
Critical top width	290.3590 in
Specific energy	2.1599 ft
Minimum energy	2.2869 ft
Froude number	1.2987
Flow condition	Supercritical

Channel Calculator

```
Given Input Data:
     Shape ...........................  Trapezoidal
     Solving for .....................  Depth of Flow
     Flowrate ........................  11.7000 cfs
     Slope ...........................  0.0050 ft/ft
     Manning's n .....................  0.0200
     Height ..........................  24.0000 in
     Bottom width ....................  120.0000 in
     Left slope ......................  0.2500 ft/ft (V/H)
     Right slope .....................  0.2500 ft/ft (V/H)

Computed Results:
     Depth ...........................  4.7117 in
     Velocity ........................  2.5753 fps
     Full Flowrate ...................  232.0404 cfs
     Flow area .......................  4.5431 ft2
     Flow perimeter ..................  158.8539 in
     Hydraulic radius ................  4.1183 in
     Top width .......................  157.6938 in
     Area ............................  36.0000 ft2
     Perimeter .......................  317.9091 in
     Percent full ....................  19.6322 %

                    Critical Information
     Critical depth ..................  3.9995 in
     Critical slope ..................  0.0088 ft/ft
     Critical velocity ...............  3.0975 fps
     Critical area ...................  3.7772 ft2
     Critical perimeter ..............  152.9805 in
     Critical hydraulic radius .......  3.5555 in
     Critical top width ..............  151.9958 in
     Specific energy .................  0.4957 ft
     Minimum energy ..................  0.4999 ft
     Froude number ...................  0.7722
     Flow condition ..................  Subcritical
```

Channel Calculator

```
Given Input Data:
     Shape ..........................  Trapezoidal
     Solving for ....................  Depth of Flow
     Flowrate .......................  11.7000 cfs
     Slope ..........................  0.0100 ft/ft
     Manning's n ....................  0.0200
     Height .........................  24.0000 in
     Bottom width ...................  120.0000 in
     Left slope .....................  0.2500 ft/ft (V/H)
     Right slope ....................  0.2500 ft/ft (V/H)

Computed Results:
     Depth ..........................  3.8533 in
     Velocity .......................  3.2289 fps
     Full Flowrate ..................  328.1546 cfs
     Flow area ......................  3.6235 ft2
     Flow perimeter .................  151.7747 in
     Hydraulic radius ...............  3.4379 in
     Top width ......................  150.8260 in
     Area ...........................  36.0000 ft2
     Perimeter ......................  317.9091 in
     Percent full ...................  16.0552 %

                    Critical Information
     Critical depth .................  3.9995 in
     Critical slope .................  0.0088 ft/ft
     Critical velocity ..............  3.0975 fps
     Critical area ..................  3.7772 ft2
     Critical perimeter .............  152.9805 in
     Critical hydraulic radius ......  3.5555 in
     Critical top width .............  151.9958 in
     Specific energy ................  0.4831 ft
     Minimum energy .................  0.4999 ft
     Froude number ..................  1.0602
     Flow condition .................  Supercritical
```

Weir Calculator

Given Input Data:

Weir Type	Rectangular
Equation	Suppressed
Solving for	Depth of Flow
Flowrate	167.1300 cfs
Coefficient	0.6500
Height	36.0000 in

Computed Results:

Depth of Flow	21.5346 in
Full Flow	361.2447 cfs
Velocity	4.6566 fps
Width	240.0000 in
Area	60.0000 ft2
Perimeter	312.0000 in
Wet Perimeter	283.0693 in
Wet Area	35.8911 ft2
Percent Full	59.8185 %

Channel Calculator

```
Given Input Data:
     Shape ...........................  Trapezoidal
     Solving for .....................  Depth of Flow
     Flowrate ........................  167.1300 cfs
     Slope ...........................  0.3680 ft/ft
     Manning's n .....................  0.0300
     Height ..........................  36.0000 in
     Bottom width ....................  120.0000 in
     Left slope ......................  2.0000 ft/ft (V/H)
     Right slope .....................  2.0000 ft/ft (V/H)

Computed Results:
     Depth ...........................  8.6477 in
     Velocity ........................  22.3852 fps
     Full Flowrate ...................  1680.9964 cfs
     Flow area .......................  7.4661 ft2
     Flow perimeter ..................  139.3369 in
     Hydraulic radius ................  7.7160 in
     Top width .......................  128.6477 in
     Area ............................  34.5000 ft2
     Perimeter .......................  200.4984 in
     Percent full ....................  24.0215 %

                    Critical Information
     Critical depth ..................  23.8319 in
     Critical slope ..................  0.0138 ft/ft
     Critical velocity ...............  7.6553 fps
     Critical area ...................  21.8320 ft2
     Critical perimeter ..............  173.2896 in
     Critical hydraulic radius .......  18.1419 in
     Critical top width ..............  143.8319 in
     Specific energy .................  8.5079 ft
     Minimum energy ..................  2.9790 ft
     Froude number ...................  4.7290
     Flow condition ..................  Supercritical
```

Appendix E

Figure 1. – USDA Soil Conservation, Soil Map
Figure 2. – USDA Soil Conservation, Soil Characteristic Tables
Figure 3. – USDA Soil Conservation, Soil Description (Falfa Clay Loam, 1 to 3 percent)
Figure 4. – USDA Soil Conservation, Soil Description (Falfa Clay Loam, 3 to 8 percent)
Figure 5. – USDA Soil Conservation, Soil Description (Shalona Loam)
Figure 6 – USDA Soil Conservation, Soil Description (Ustic Torriorthents-Ustollic Haplargids Complex


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TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
16------------------ Buckle	B	None---------	---	---	>6.0	---	---	>60	---	Low------	High-----	Low.
17------------------ Chris	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
18------------------ Clark Fork	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate	Moderate.
19, 20-------------- Clayburn	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
21*----------------- Coni	D	None---------	---	---	>6.0	---	---	10-20	Hard	Moderate	Moderate	Low.
22, 23-------------- Corta	D	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
24*:												
Dulce---------------	D	None---------	---	---	>6.0	---	---	8-20	Soft	Low------	Moderate	Low.
Travessilla---------	D	None---------	---	---	>6.0	---	---	6-20	Hard	Low------	Moderate	Low.
Rock outcrop.												
25------------------ Durango	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
26, 27-------------- Falfa	C	None---------	---	---	>6.0	---	---	>60	---	Low------	High-----	Low.
28------------------ Fluvaquents	D	Frequent----	Brief-----	May-Jun	1.0-3.5	Apparent	Jan-Dec	>60	---	Moderate	Moderate	Low.
29------------------ Fortwingate	C	None---------	---	---	>6.0	---	---	20-40	Hard	Low------	High-----	High.
30*:												
Fortwingate---------	C	None---------	---	---	>6.0	---	---	20-40	Hard	Low------	High-----	High.
Rock outcrop.												

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In				
60 Shalona	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
61 Shawa Variant	B	None	---	---	>6.0	---	---	>60	---	Low	High	Low.
62, 63 Sili	C	None	---	---	>6.0	---	---	>60	---	Low	High	Low.
64 Simpatico	B	Rare	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
65 Sycle	B	None	---	---	>6.0	---	---	>60	---	Low	High	Low.
66 Tefton	C	Rare	---	---	2.0-3.0	Apparent	Apr-Sep	>60	---	Low	Moderate	Low.
67, 68 Uinta	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
69 Umbarg	C	None	---	---	3.0-4.0	Apparent	May-Jun	>60	---	Low	High	Low.
70*:												
Ustic Torriorthents	B	None	---	---	>6.0	---	---	>60	---	Low	Moderate	Low.
Ustollic Haplargids	B	None	---	---	>6.0	---	---	>60	---	Low	High	Low.
71*:												
Valto	D	None	---	---	>6.0	---	---	6-20	Hard	Low	Moderate	Low.
Rock outcrop.												
72 Vernal	B	None	---	---	>6.0	---	---	>60	---	Low	High	Low.
73*:												
Vernal	B	None	---	---	>6.0	---	---	>60	---	Low	High	Low.
Sedillo	B	None	---	---	>6.0	---	---	>60	---	Low	High	Low.

See footnote at end of table.

producing about 15 cords of firewood per acre, and the Travessilla soil about 13 cords. Both production figures are for stands of trees that average 5 inches in diameter at a height of 1 foot and apply if all limbs larger than 2 inches in diameter are used.

The main limitations for woodland production are shallow depth to bedrock, low available water capacity, and steepness of slope. Limiting soil disturbance when harvesting trees helps to minimize erosion. Seeding to adapted grasses may be needed in some areas after harvesting. Low precipitation and the presence of brushy plants may influence seedling survival. Areas can be maintained in pinyon and juniper by selective cutting, leaving small trees and a few of the larger seed producing trees, and controlling livestock grazing so that seedlings can become established.

Wildlife such as mule deer, elk, jackrabbit, cottontail, coyote, eagles, and squirrel use this unit for food, shelter, and nesting areas. They also obtain food from nearby areas of rangeland and cropland. Suitable management for wildlife should include protecting the unit from overgrazing and maintaining the areas of pinyon and juniper woodland.

Depth to bedrock and slope are the main limitations for the construction of homesites and urban development. Proper design is needed to overcome these limitations. Shallow depth to bedrock and slope limit design and installation of septic tank absorption fields or sewage lagoons. Community sewage systems are more satisfactory.

This map unit is in capability subclass VIIs, nonirrigated.

25—Durango cobbly loam, 3 to 20 percent slopes. This deep, well drained soil is on mesa tops and ridgetops that are dissected by drainageways. It formed in glacial outwash. Elevation is 6,800 to 7,400 feet. The average annual precipitation is 15 to 18 inches. The average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 100 to 130 days.

Typically, the surface layer is brown cobbly loam about 3 inches thick. The upper part of the subsoil is brown clay loam about 5 inches thick, and the lower part is reddish brown and light reddish brown clay loam about 23 inches thick. The substratum is brown clay loam about 11 inches thick over light gray clay that extends to a depth of 60 inches or more.

Included in this unit are about 15 percent Witt loam and small areas of Nehar stony sandy loam, Ustic Torriorthents, and Ustollic Haplargids.

Permeability of this Durango soil is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Runoff is medium, and the hazard of erosion is slight.

The unit is used mainly as rangeland and wildlife habitat.

The native vegetation on this unit is mainly Indian ricegrass, needleandthread, junegrass, western wheatgrass, bluegrass, pinyon, juniper, oak brush, skunkbrush, snowberry, big sagebrush, bitterbrush, and mountainmahogany. Proper grazing use as part of a planned grazing system helps to maintain the quality and quantity of the preferred rangeland vegetation. Seeding and deferring grazing facilitate revegetation of areas depleted by heavy grazing, cultivation, and other disturbances. Seeding should be done by hand broadcasting or aerial methods because of the cobbly surface layer. Developing livestock watering facilities, fencing, and deferring grazing improve the distribution of grazing and help to maintain the condition of the rangeland.

This unit is suited to the production of pinyon and juniper. Woodland products such as firewood, fenceposts, Christmas trees, and pinyon nuts can be obtained from the unit. The unit is capable of producing about 18 cords of firewood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot, if all limbs larger than 2 inches in diameter are used.

The main limitation for the production of timber is stoniness. Limiting soil disturbance when harvesting trees helps to minimize erosion. Seeding to adapted grasses may be needed in some areas after harvesting. Low precipitation and the presence of brushy plants may influence seedling survival. Areas can be maintained in pinyon and juniper by selective cutting, leaving small trees and a few of the larger seed producing trees, and controlling livestock grazing so that seedlings can become established.

Wildlife such as mule deer, cottontail, squirrel, coyote, and mourning dove use this unit as a source of food, shelter, and nesting areas. Nearby areas of rangeland also provide food for some of the wildlife. Suitable management for wildlife should include protecting the unit from overgrazing and wildfire and maintaining areas in pinyon and juniper.

Low soil strength and high shrink-swell potential are the main limitations for homesite and urban development. The foundations of buildings should be designed to compensate for the high shrink-swell potential. Roads should be designed to overcome the limitations of low soil strength and high shrink-swell potential. Cobbles and stones limit the unit for lawns. The moderately slow permeability should be considered when designing septic tank absorption fields or sewage lagoons. Absorption fields may need to be made larger than normal. Sewage lagoons would work well if the limitation of slope were overcome.

This map unit is in capability subclass VIIs, nonirrigated.

26—Falfa clay loam, 1 to 3 percent slopes. This deep, well drained soil is on mesa tops. It formed in calcareous loess. Elevation is 6,500 to 7,000 feet. The average annual precipitation is 15 to 18 inches. The average annual air temperature is about 45 to 49 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is reddish brown clay loam about 9 inches thick. The upper part of the subsoil is reddish brown clay loam about 5 inches thick, the next part is reddish brown clay about 20 inches thick, and the lower part is reddish brown clay loam about 23 inches thick. The substratum to a depth of 60 inches or more is yellowish red clay loam.

Included in this unit are about 10 percent Corta loam, 5 percent soils that are similar to this Falfa soil but have a dark-colored surface layer, and small areas of Witt loam and Simpatico loam.

Permeability of this Falfa soil is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Runoff is medium, and the hazard of erosion is moderate.

This unit is used mainly for irrigated crops, nonirrigated crops, rangeland, and homesites. The main irrigated crops are corn for silage; small grain such as wheat, barley, and oats; pasture; and alfalfa hay. The main nonirrigated crops are wheat and pinto beans.

In areas used for irrigated crops, the main concerns of management are controlling water erosion, maintaining the organic matter content and fertility of the surface layer, and properly using irrigation water. Incorporating crop residue into the surface layer increases the water intake rate, improves tilth, reduces erosion, and helps to maintain adequate organic matter content. Land smoothing and irrigation structures are needed in some areas to achieve a more uniform distribution of irrigation water. Irrigation methods suited to this unit are furrow, corrugation, and sprinkler systems. Furrow irrigation is best suited to row crops. Sprinkler irrigation is well suited to most crops. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Corrugation systems are suited to alfalfa, pasture, and small grain. Regardless of the irrigation method used, water should be applied carefully to reduce runoff and control erosion. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain the fertility and tilth. The use of fertilizer helps to maintain the fertility of the soil. Grain and grasses respond to nitrogen, and legumes respond to phosphorus.

In areas used for nonirrigated crops, management is needed to conserve moisture, control erosion, and maintain the productivity of the soil. Using stubble mulch tillage and returning crop residue to the soil reduce runoff and erosion and conserve moisture. Chiseling or subsoiling can be used to break up the tillage pan and thus improve the water intake rate. Tillage should be kept to a minimum.

The native vegetation is mainly western wheatgrass, muttongrass, junegrass, Indian ricegrass, big sagebrush, Gambel oak, serviceberry, Rocky Mountain juniper, and pinyon. Proper grazing use as part of a planned grazing system helps to maintain the quality and quantity of the preferred rangeland vegetation. Seeding and deferring grazing facilitate revegetation of areas depleted by heavy grazing, cultivation, and other disturbances. Developing livestock watering facilities, fencing, and deferring grazing improve the distribution of grazing and help to maintain the condition of the rangeland. The production of forage is limited by low rainfall in summer. Contour furrowing and pitting increase the water intake rate and reduce runoff. These practices are especially effective on rangeland in poor or fair condition.

This unit generally is suited to windbreaks and environmental plantings. It is limited mainly by lack of sufficient rainfall in summer. Supplemental irrigation may be needed when planting and during the early stages of growth. Cultivation to reduce plant competition commonly is necessary, particularly while the plantings are young. Among the trees that are suitable for planting are ponderosa pine, Russian-olive, Colorado blue spruce, and eastern redcedar. Among the shrubs are caragana, lilac, honeysuckle, and sumac.

Some areas of this unit support stands of pinyon and juniper. Woodland products such as firewood, fenceposts, Christmas trees, and pinyon nuts can be obtained from these areas. The unit is capable of producing about 18 cords of firewood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot, if all limbs larger than 2 inches in diameter are used.

Limiting soil disturbance when harvesting trees helps to minimize erosion. Seeding to adapted grasses may be needed in some areas after harvesting. Low precipitation and the presence of brushy plants may influence seedling survival. Areas can be maintained in pinyon and juniper by selective cutting, leaving small trees and a few of the larger seed producing trees, and controlling livestock grazing so that seedlings can become established.

Wildlife such as cottontail, mule deer, coyote, squirrel, pheasant, and mourning dove use this unit. Irrigated cropland provides food and shelter for some wildlife. Native rangeland and nearby pinyon and juniper areas provide shelter and nesting areas. Suitable management for wildlife should include protecting the unit from overgrazing and wildfire and maintaining adequate plant cover, including areas of pinyon and juniper. In cropland areas, favorable habitat can be developed by maintaining plant cover along fences and ditches and in corners of fields.

Low soil strength and high shrink-swell potential are the main limitations for homesite and urban development. The foundations of buildings should be designed to compensate for the high shrink-swell potential. Roads should be designed to overcome the limitations of low soil strength and high shrink-swell potential. The slow permeability should be considered when planning septic tank absorption fields. Sewage lagoons work well.

This map unit is in capability subclasses IIIe, irrigated, and IIIc, nonirrigated.

27—Falfa clay loam, 3 to 8 percent slopes. This deep, well drained soil is on mesa tops. It formed in calcareous loess. Elevation is 6,500 to 7,000 feet. The average annual precipitation is 15 to 18 inches. The average annual air temperature is about 48 to 49 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is reddish brown clay loam about 9 inches thick. The upper part of the subsoil is reddish brown clay loam about 5 inches thick, the next part is reddish brown clay about 20 inches thick, and the lower part is reddish brown clay loam about 23 inches thick. The substratum is yellowish red clay loam that extends to a depth of 60 inches or more.

Included in this unit are about 10 percent Corta loam, 5 percent soils that are similar to this Falfa soil but have a dark-colored surface layer, and small areas of Witt loam and Simpatico loam.

Permeability of this Falfa soil is slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Runoff is medium, and the hazard of erosion is moderate.

This unit is used mainly for irrigated and nonirrigated crops and as rangeland and homesites. The main irrigated crops are corn for silage; small grain such as wheat, barley, and oats; pasture; and alfalfa hay. The main nonirrigated crops are wheat and pinto beans.

In irrigated areas, the main concerns of management are controlling water erosion, maintaining the organic matter content and fertility of the surface layer, and properly using irrigation water. Incorporating crop residue into the surface layer increases the water intake rate, improves tilth, reduces erosion, and helps to maintain adequate organic matter content. Realignment of ditches and irrigation structures is needed in some areas to achieve a more uniform distribution of irrigation water. Irrigation methods suited to this unit are furrow, corrugation, and sprinkler systems. Furrow irrigation is best suited to row crops. Furrows should run across the slope. Sprinkler irrigation is well suited to most crops. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Corrugation systems are suited to alfalfa, pasture, and small grain. Regardless of the irrigation method used, water should be applied carefully to reduce runoff and control erosion. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain the fertility and tilth. The use of fertilizer helps to maintain the fertility of the soil. Grain and grasses respond to nitrogen, and legumes respond to phosphorus.

In nonirrigated areas, management is needed to conserve moisture, control erosion, and maintain the productivity of the soil. Stubble mulch tillage and returning crop residue help to reduce runoff and erosion and to conserve moisture. Chiseling or subsoiling can be used to break up the tillage pan and thus improve the water intake rate. Tillage should be kept to a minimum. Diversions and grassed waterways may be needed to reduce gully erosion.

The native vegetation of the unit consists of western wheatgrass, muttongrass, junegrass, Indian ricegrass, big sagebrush, Gambel oak, serviceberry, Rocky Mountain juniper, and pinyon. Proper grazing use as part of a planned grazing system helps to maintain the quality and quantity of the preferred rangeland vegetation. Seeding and deferring grazing facilitate revegetation of areas depleted by heavy grazing, cultivation, and other disturbances. Developing livestock watering facilities, fencing, and deferring grazing improve the distribution of grazing and help to maintain the condition of the rangeland. The production of forage is limited by low rainfall in summer. Contour furrowing and pitting increase the water intake rate and reduce runoff. These practices are especially effective on rangeland in poor or fair condition.

This unit generally is suited to windbreaks and environmental plantings. It is limited mainly by lack of sufficient rainfall in summer. Supplemental irrigation may be needed when planting and during the early stages of growth. Cultivation to reduce plant competition commonly is necessary, particularly while the plantings are young.

Among the trees that are suitable for planting are ponderosa pine, Russian-olive, Colorado blue spruce, and eastern redcedar. Among the shrubs are caragana, lilac, honeysuckle, and sumac. Some areas support stands of pinyon and juniper. Woodland products such as firewood, fenceposts, Christmas trees, and pinyon nuts can be obtained from these areas. The unit is capable of producing about 18 cords of firewood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot, if all limbs larger than 2 inches in diameter are used.

Limiting soil disturbance when harvesting trees helps to minimize erosion. Seeding to adapted grasses may be needed in some areas after harvesting. Low precipitation and the presence of brushy plants may influence seedling survival. Areas can be maintained in pinyon and juniper by selective cutting, leaving small trees and a few of the larger seed producing trees, and controlling livestock grazing so that seedlings can become established.

Wildlife such as cottontail, mule deer, coyote, squirrel, pheasant, and mourning dove use this unit. Irrigated cropland provides food and shelter for some wildlife. Native rangeland and nearby areas of pinyon and juniper provide shelter and nesting areas. Suitable management for wildlife should include protecting the unit from overgrazing, providing protection from wildfire, and maintaining adequate plant cover, including areas of pinyon and juniper. In cropland areas, favorable habitat can be developed by maintaining plant cover along fences and ditches and in corners of fields.

Low soil strength and high shrink-swell potential are the main limitations for homesite and urban development. The foundations of buildings should be designed to compensate for the high shrink-swell potential of the soil. Roads should be designed to overcome the limitations of low soil strength and high shrink-swell potential. The slow permeability should be considered when planning septic tank absorption fields. Sewage lagoons work well if the limitation of slope is overcome.

This map unit is in capability subclass IVe, irrigated and nonirrigated.

28—Fluvaquents, sandy, frequently flooded. This unit consists of deep, somewhat poorly drained and poorly drained, nearly level soils that formed in recent alluvial deposits bordering major drainageways on alluvial valley floors. The areas are dissected by old river channels and by smaller streams. Elevation is 6,000 to 8,000 feet. The average annual precipitation is 15 to 20 inches. The average annual air temperature is 42 to 50 degrees F, and the frost-free period is 90 to 130 days.

The soils in this unit are extremely variable. The surface layer ranges from gravelly or cobbly loam to sandy loam. Stratified sandy loam, sand, and gravel are at a depth of 5 to 20 inches.

Permeability of these Fluvaquents is moderately rapid or rapid. Effective rooting depth is 12 to 40 inches or more because of the presence of a fluctuating water table. Available water capacity is very low to low. Runoff is slow, and the hazard of erosion is slight. The soils have a fluctuating water table between depths of 12 and 40 inches year round.

Included in this unit are small areas of Pescar fine sandy loam, Tefton loam, Riverwash, gravel, and sand bars.

This unit is used for livestock grazing and wildlife habitat.

The native vegetation is mainly cottonwood, willows, sedges, rushes, tufted hairgrass, yarrow, and iris. Proper grazing use as part of a planned grazing system helps to maintain the desired quality and quantity of the rangeland vegetation. Deferred grazing facilitates revegetation and improves areas of rangeland in poor condition. Brush control may be needed in some places.

Wildlife such as squirrel, mule deer, coyote, rabbit, and waterfowl use this unit. The unit is suited to the production of wetland plants that provide nesting areas, protective cover, and food for waterfowl. The location of this unit near areas of irrigated cropland makes it valuable to both wetland and rangeland wildlife. Suitable management for wildlife should include protecting the unit from overgrazing.

If this unit is used for homesite development, the main limitations are the fluctuating water table and hazard of flooding. Buildings and roads should be designed to overcome these limitations. These limitations restrict the construction of sewage systems and may contribute to the pollution of ground water. Drainage and protection from flooding should be established before construction is begun.

This map unit is in capability subclass VIIw, nonirrigated.

29—Fortwingate stony sandy loam, 3 to 12 percent slopes. This moderately deep, well drained soil is on mountainsides. It formed in material derived from sandstone and mixed with loess. Elevation is 7,600 to 8,800 feet. The average annual precipitation is 18 to 22 inches. The average annual air temperature 41 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typically, the surface is covered with a layer of organic material 1 inch thick. The surface layer is brown stony fine sandy loam about 1 inch thick. The next layer is pinkish gray stony fine sandy loam about 6 inches thick. The upper part of the subsoil is light brown loam about 5 inches thick, the next part is reddish brown clay loam about 13 inches thick, and the lower part is reddish yellow stony sandy clay loam about 7 inches thick over sandstone. Sandstone commonly is at a depth of 20 to 40 inches. In some places the surface layer is stony loam.

Included in this unit are about 15 percent Goldvale very stony fine sandy loam and small areas of Rock outcrop, Valto very stony fine sandy loam, Nordicol very stony sandy loam, and Anvik loam.

Permeability of this Fortwingate soil is moderately slow. Effective rooting depth is 20 to 40 inches because of the presence of hard bedrock. Available water capacity is low. Runoff is medium, and the hazard of erosion is slight.

This unit is used mainly as woodland and for livestock grazing and homesite development. It is also used for wildlife habitat.

This unit is well suited to the production of ponderosa pine. On the basis of a site index of 65, the potential production of marketable timber per acre is 4,025 cubic feet or 18,300 board feet (International rule) from an even-aged, fully stocked stand of trees 100 years old.

The main concerns in producing and harvesting timber are reforestation and providing protection from erosion along roads and in other areas where vegetation has been removed. Harvesting may be restricted during periods of heavy snowfall or rainfall or during snowmelt. Reforestation should be carefully managed to reduce

30 inches. The average annual air temperature ranges from 38 to 50 degrees F, and the frost-free period ranges from 60 to 130 days.

Included in this unit are small areas of soils that are shallow and very shallow over bedrock.

The native vegetation is sparse. It grows in the small areas of inclusions and in cracks and fissures in the Rock outcrop. It varies with elevation and consists of pinyon, Rocky Mountain juniper, ponderosa pine, spruce, fir, and various shrubs and grasses.

This unit is used as wildlife habitat and for limited amounts of construction material.

Wildlife such as marmots, eagles, hawks, squirrel, and bear use this unit for cover and nesting areas, and they obtain food from included areas and nearby soils.

This map unit is in capability subclass VIIIs, nonirrigated.

59—Sedillo gravelly loam, 0 to 3 percent slopes. This deep, well drained soil is old high terraces of major river valleys. It formed in cobbly glacial outwash. Elevation is 6,000 to 6,700 feet. The average annual precipitation is 13 to 16 inches. The average annual air temperature is about 50 to 52 degrees F, and the average frost-free period is 110 to 130 days.

Typically, the surface layer is brown gravelly loam about 6 inches thick. The upper part of the subsoil is reddish brown very gravelly clay loam about 15 inches thick, and the lower part is brown very gravelly sandy clay loam about 6 inches thick. The substratum is pinkish white very cobbly or very gravelly sandy clay loam that extends to a depth of 60 inches or more.

Included in this unit are about 15 percent Nehar stony sandy loam and small areas of Agua Fria loam.

Permeability of this Sedillo soil is moderately slow. Effective rooting depth is 60 inches or more. The available water capacity is moderate. Runoff is medium, and the hazard of erosion is slight.

This unit is used mainly as rangeland and for wildlife habitat.

The native vegetation on this unit is mainly Indian ricegrass, junegrass, western wheatgrass, blue grama, muttongrass, Fendler threeawn, big sagebrush, bitterbrush, serviceberry, pinyon, and Rocky Mountain juniper (fig. 9). Use of proper grazing and planned grazing systems are the most important practices that can be used to maintain the quality and quantity of grasses. Seeding speeds up revegetation of areas of rangeland that have deteriorated because of overgrazing, cultivation, and other disturbances. Developing livestock watering facilities, fencing, and deferring grazing improve the distribution of grazing and help to maintain the condition of the rangeland.

Some areas of the unit support stands of pinyon and juniper. This unit is suited to this production. Woodland products such as firewood, fenceposts, Christmas trees, and pinyon nuts can be obtained from the unit. It is capable of producing about 16 cords of firewood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot, if all limbs larger than 2 inches in diameter are used. Limiting soil disturbance when harvesting trees helps to minimize erosion. Seeding to adapted grasses may be needed in some areas after harvesting. Low precipitation and the presence of brushy plants may influence seedling survival. Areas can be maintained in pinyon and juniper by selective cutting, leaving small trees and a few of the larger seed producing trees, and controlling livestock grazing so that seedlings can become established.

Wildlife such as mule deer, cottontail, coyote, and various birds use this unit. They obtain their food from areas of rangeland and from nearby areas of cropland. Nearby areas of pinyon and juniper provide cover and nesting areas. Suitable management for wildlife includes protecting the unit from overgrazing and maintaining areas of pinyon and juniper. Areas of rangeland and tall grasses in fence rows and odd corners of fields can be managed as wildlife habitat.

This unit is suited to homesite and urban development. Cobbles and gravel make excavations for roads, utilities, and other development difficult. The moderately slow permeability of the soil should be considered when planning for septic tank absorption fields or lagoons. Sewage lagoons can be lined to reduce seepage. Absorption fields may need to be made larger than normal.

Gravel on the surface limits recreational development such as playgrounds, picnic areas, camp areas, and golf courses.

This map unit is in capability subclass VIs, nonirrigated.

60—Shalona loam. This deep, well drained soil is on old high terraces. It formed in mixed alluvium derived from sandstone and shale. Slope is 1 to 6 percent. Elevation is 6,000 to 7,000 feet. The average annual precipitation is 14 to 18 inches. The average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 110 to 130 days.

Typically, the upper part of the surface layer is pinkish gray loam about 2 inches thick and the lower part is brown clay loam about 5 inches thick. The upper part of the subsoil is dark grayish brown clay loam about 7 inches thick, and the lower part is brown clay loam about 29 inches thick. The substratum is pale brown loam that extends to a depth of 60 inches or more. In some places the surface layer is light clay loam.

Included in this unit are about 15 percent Agua Fria loam and small areas of Mikim loam and Harlan cobbly loam.

Permeability of this Shalona soil is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Runoff is slow, and the hazard of erosion is slight.

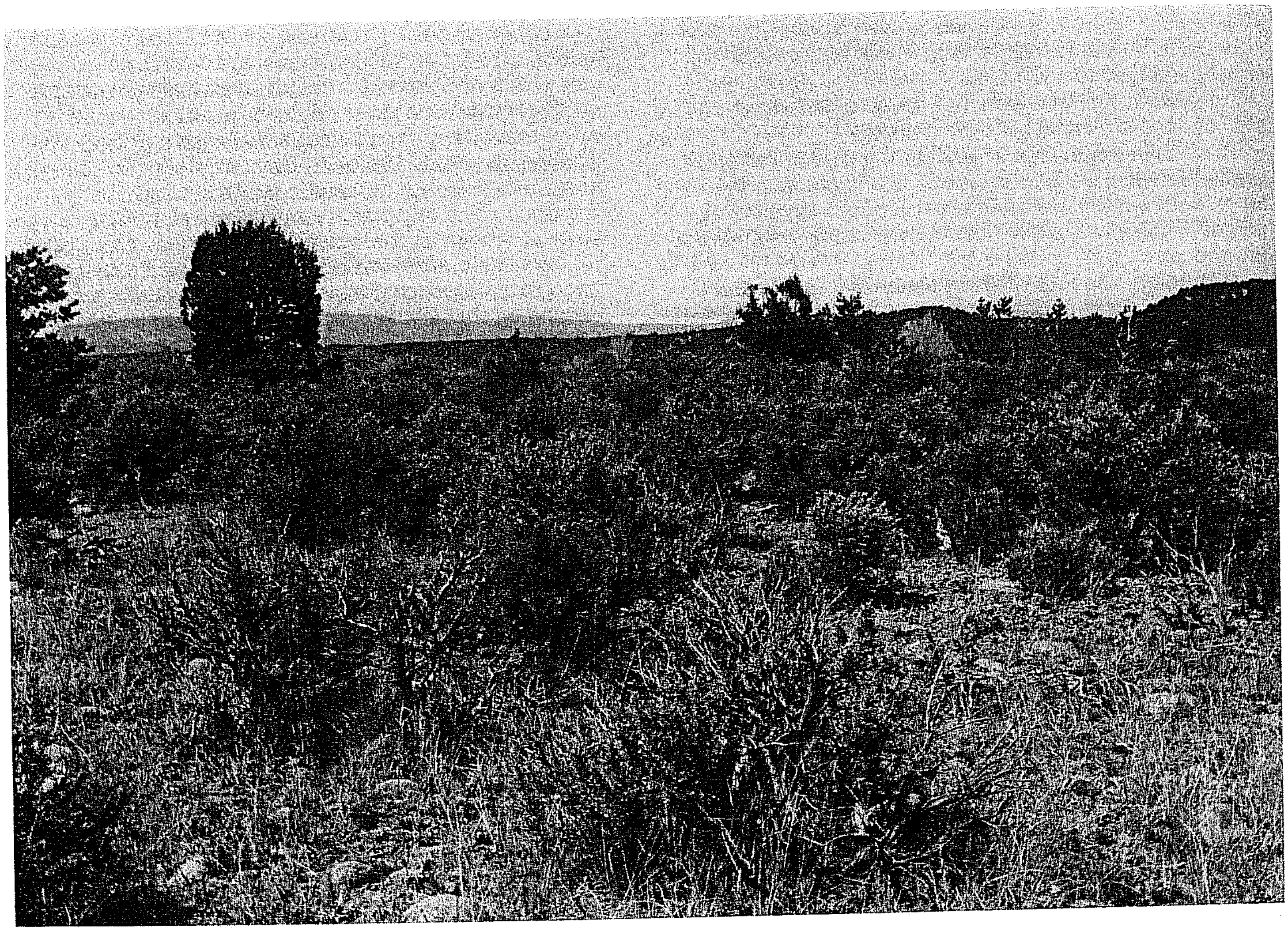

Figure 9.—Native vegetation in an area of Sedillo gravelly loam, 0 to 3 percent slopes.

This unit is used mainly for irrigated field crops and pasture and as rangeland. It is also used for homesite and urban development. Alfalfa, barley, and oats are the main irrigated crops.

The main management concerns in areas of irrigated cropland are controlling water erosion, maintaining the organic matter content and fertility of the surface layer, and properly using irrigation water. Land smoothing improves distribution of irrigation water. The incorporation of crop residue into the surface layer increases the water intake rate, improves tilth, helps to maintain the organic matter content of the surface layer, and reduces erosion. The use of fertilizer helps to maintain the productivity and fertility of the soil. Grain and grasses respond to nitrogen, and legumes respond to phosphorus. Irrigation methods suited to this unit are furrow, corrugation, and sprinkler systems. Sprinkler irrigation is well suited to most crops. Use of this method permits the even, controlled application of water, reduces runoff, and minimizes the risk of erosion. Furrow irrigation is suited to row crops. Corrugation irrigation is suited to alfalfa, small grain, and pasture. Regardless of the irrigation method used, water should be applied carefully to control erosion and ensure the most efficient use of water.

The native vegetation on this unit is mainly western wheatgrass, Indian ricegrass, junegrass, blue grama, slender wheatgrass, muttongrass, squirreltail, big sagebrush, pinyon, and Rocky Mountain juniper. Proper grazing use as part of a planned grazing system helps to maintain the quality and quantity of grasses. Mechanical or chemical brush control followed by seeding to adapted grasses improves areas that have dense stands of sagebrush. Seeding speeds up revegetation of areas underlying material is grayish brown loam, and the lower part to a depth of 60 inches or more is light brownish gray clay loam.

Included in this unit are about 10 percent Shalona loam and small areas of Mikim loam and Harlan cobbly loam.

Permeability of this Umbarg soil is moderately slow. Effective rooting depth is 60 inches or more. Available water capacity is high. Runoff is slow, and the hazard of erosion is slight. The soil has a fluctuating water table that rises to within about 3 feet of the surface in most places.

This unit is used mainly for irrigated field crops, irrigated pasture, and homesite development and as rangeland. It is also used for wildlife habitat.

In irrigated areas, the main concerns of management are controlling water erosion, maintaining the organic matter content and fertility of the surface layer, and properly using irrigation water. Returning crop residue to the soil increases the water intake rate, improves tilth, and helps to control erosion. The use of fertilizer helps to maintain the productivity and fertility of the soil. Grain and grasses respond to nitrogen, and legumes respond to phosphorus. Land smoothing is needed in some areas to achieve a more uniform distribution and more efficient use of irrigation water. Irrigation methods suited to this unit are furrow, corrugation, and sprinkler systems. Furrow irrigation is suited to row crops. Corrugation irrigation is well suited to small grain and pasture. Sprinkler irrigation is well suited to most crops. Regardless of the irrigation method used, water should be applied carefully to prevent runoff and erosion.

The native vegetation on this unit is mainly western wheatgrass, Indian ricegrass, needleandthread, mountain muhly, serviceberry, big sagebrush, and Gambel oak. Proper grazing use as part of a planned grazing system helps to maintain the quality and quantity of the rangeland vegetation. Seeding and deferring grazing facilitate revegetation of areas depleted by heavy grazing, cultivation, and other disturbances. Mechanical or chemical brush control followed by seeding to adapted grasses improves areas that have dense stands of sagebrush. Developing livestock watering facilities, fencing, and deferring grazing improve the distribution of grazing and help to maintain the condition of the rangeland.

Wildlife such as mule deer, pheasant, squirrel, cottontail, coyote, and mourning dove use this unit. Irrigated areas provide food, and the areas of rangeland provide shelter, nesting areas, and some food. Nearby wooded areas also provide shelter and nesting areas. Suitable management for wildlife should include protecting the rangeland from overgrazing and wildfire and maintaining adequate plant cover.

Wetness and shrink-swell potential are the main limitations for homesite and urban development. The foundations of buildings should be designed to compensate for the shrink-swell potential of the soil. Drainage may be needed to overcome the limitation of wetness. The construction of sanitary facilities on this unit poses a risk of polluting nearby water. The moderately slow permeability of the soil and the fluctuating water table should be considered when designing septic tank absorption fields or sewage lagoons. If drainage and protection from seepage are provided, septic tank absorption fields may be suitable if they are made larger than normal. Sewage lagoons can be sealed to reduce seepage.

This map unit is in capability subclass IIIe, irrigated and nonirrigated.

70—Ustic Torriorthents-Ustollic Haplargids complex, 12 to 60 percent slopes. This map unit is on terrace edges, mesa edges, and hillsides. Elevation is 6,000 to 8,500 feet. The average annual precipitation is about 14 to 19 inches. The average annual air temperature is 45 to 50 degrees F, and the average frost-free period is 100 to 130 days.

This unit is 50 percent Ustic Torriorthents and 30 percent Ustollic Haplargids. The Ustollic Haplargids are in the less sloping areas.

Included in this unit are about 15 percent soils that are underlain by bedrock at a depth of 40 inches or less and 5 percent shale and sandstone Rock outcrop.

Ustic Torriorthents are deep and somewhat excessively drained. These soils formed in outwash. No single profile of Ustic Torriorthents is typical, but one commonly observed in the survey area has a surface layer of gravelly or cobbly loam or fine sandy loam. The substratum is very gravelly or very cobbly outwash.

Ustollic Haplargids are deep and well drained. They formed in gravelly and cobbly alluvium. No single profile of Ustollic Haplargids is typical, but one commonly observed in the survey area has a surface layer of gravelly or cobbly loam or fine sandy loam. The subsoil is very cobbly or very gravelly loam, very gravelly or very cobbly sandy clay loam, or very gravelly or very cobbly fine sandy loam. The substratum is very gravelly or very cobbly outwash.

Permeability of these Ustic Torriorthents and Ustollic Haplargids varies depending on the texture of the parent material. Effective rooting depth is 40 inches or more. Available water capacity is low. Runoff is rapid, and the hazard of erosion is high.

This unit is used mainly for wildlife habitat, as rangeland, and as a source of construction material.

The native vegetation on this unit is mainly western wheatgrass, Indian ricegrass, needleandthread, blue grama, muttongrass, Fendler threeawn, junegrass, big sagebrush, rabbitbrush, pinyon, Rocky Mountain juniper, ponderosa pine, mountainmahogany, serviceberry, snowberry, and Gambel oak. Steepness of slope limits access by livestock and promotes overgrazing of the less sloping areas. Proper grazing use as part of a planned grazing system helps to maintain the desired quantity and quality of native vegetation. Deferred grazing speeds up revegetation of areas depleted by overgrazing and other disturbances and improves areas in poor condition. Developing livestock watering facilities and fencing improve the distribution of livestock and the production of understory plants.

This unit is suited to the production of pinyon and juniper. Woodland products such as firewood, fenceposts, Christmas trees, and pinyon nuts can be obtained from the unit. This unit is capable of producing about 14 cords of firewood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot, if all limbs larger than 2 inches in diameter are used.

The main limitations for the production of pinyon and juniper are low available water capacity, steepness of slope, stoniness, and the high hazard of erosion. Limiting soil disturbance when harvesting trees helps to minimize soil erosion. Seeding to adapted grasses may be needed in some areas after harvesting. Low precipitation and the presence of brushy plants may influence seedling survival. Areas can be maintained in pinyon and juniper by selective cutting, leaving small trees and a few of the larger seed producing trees, and controlling livestock grazing so that seedlings can become established.

Wildlife such as mule deer, cottontail, coyote, squirrel, and various birds use this unit. They obtain their food from nearby areas of cropland and rangeland and from areas of this unit. Wooded areas provide shelter and nesting areas. Suitable management for wildlife includes protecting the unit from overgrazing, providing protection from fire, and maintaining adequate plant cover, including pinyon and juniper.

Steepness of slope and gravel and cobbles are the main limitations for homesite and urban development. Gravel and cobbles affect excavation for foundations, utility lines, and roads. The construction of sanitary facilities is severely limited by steepness of slope and the presence of gravel and cobbles. Off-site sewage disposal systems are more satisfactory.

Areas of this unit are used as a source of gravel and roadfill. The soil material commonly requires screening or screening and crushing to eliminate large stones.

This map unit is in capability subclass VIIe, nonirrigated.

71—Valto-Rock outcrop complex, 12 to 65 percent slopes. This map unit is on mountainsides, ridges, and breaks. Elevation is 7,500 to 9,000 feet. The average annual precipitation is about 20 to 30 inches. The average annual air temperature is 39 to 43 degrees F, and the average frost-free period is 90 to 110 days.

This unit is about 45 percent Valto very stony fine sandy loam and 35 percent Rock outcrop.

Included in this unit are about 15 percent Fortwingate stony fine sandy loam and small areas of Goldvale very stony fine sandy loam.

The Valto soil is shallow and well drained. It formed material weathered mainly from sandstone. Typically, t surface is covered with a layer of organic material 2 inches thick. The surface layer is dark reddish gray ve stony fine sandy loam about 2 inches thick. The underlying material is light reddish brown very stony fir sandy loam about 10 inches thick over fractured sandstone. Depth to bedrock ranges from 10 to 20 inches.

Permeability of this Valto soil is moderately rapid. Effective rooting depth is 10 to 20 inches because of t presence of hard bedrock. Available water capacity is very low. Runoff is moderately rapid, and the hazard o erosion is slight.

Rock outcrop consists of barren exposures of sandstone. Nearly vertical cliffs are common.

This unit is used mainly as woodland. Some areas a used for homesite development and livestock grazing.

This unit is moderately suited to the production of ponderosa pine. On the basis of a site index of 59, the soil is capable of producing about 3,463 cubic feet or about 14,060 board feet (International rule) of marketable timber per acre from a fully stocked, even-aged stand of trees 100 years old. Other trees suited t this unit at the higher elevations are Douglas-fir, white and Engelmann spruce.

The main limitation for the production of timber is the shallow depth to hard bedrock, which affects construction of logging roads and establishment of seedlings. Harvesting may be restricted during periods when snow accumulates to a great depth and during snowmelt. Reforestation should be done when the soil moisture content is high, and it should be carefully managed to reduce competition from undesirable plant Hand planting of nursery stock commonly is necessary to establish a stand. Road systems should be designec to minimize cuts in this shallow soil.

The native vegetation on this unit is mainly ponderos pine, Gambel oak, mountainmahogany, snowberry, Arizona fescue, mountain muhly, junegrass, mountain brome, bluegrasses, elk sedge, and serviceberry. Douglas-fir, white fir, and Engelmann spruce grow at th higher elevations of this unit. Logged areas and some forested areas are used for livestock grazing. Proper grazing use as part of a planned grazing system helps t maintain the desired quality and quantity of the understory. Deferred grazing speeds up revegetation ar improves areas in poor condition.

Wildlife such as wild turkey, elk, mule deer, bear, squirrel, and cottontail use this unit. They obtain their food from areas of grasses, forbs, and shrubs on the ur and from adjacent areas. The forested areas provide cover and nesting areas. Suitable management for wildlife includes protecting the unit from overgrazing anc wildfire and controlling timber harvesting.

Stoniness, steepness of slope, and depth to bedrock are the main limitations for homesite and urban