# BEAR CANYON MINE

## RECLAMATION CHANNEL DESIGN

### Method

The reclamation channel designs are based on the SCS curve number technology (U.S. SCS, 1972), the flow model of the "PEAK" hydrograph software program, and the Flow Master I (Haestad Methods, 1991) channel design software program. The channel designs have been summarized in three sections: Reclaimed channel designs, post-mining ditch designs, and post-mining culvert designs.

### Flow Calculations

Watershed characteristics are shown in Table 7H-1. The areas were determined from plate 7-7 and 7-7A for local watersheds and 7-4 for the Bear Canyon watershed. Curve numbers are Based on Pinyon-Juniper-Grass reference area measurements (Chapter 9, Appendix A of permit application):

The curve number was selected from the nomograph in Figure 7H-1 (Soil Group = C). Since the cover for the Wild Horse Ridge watersheds have similar soils and a slightly larger cover value (Appendix 3-F), the same curve number was used for these watersheds, providing a conservative flow for the watersheds. The hydraulic lengths were also measured from plates 7-7 and 7-4. The average slopes were determined using the equation:

For the design storm, the 100-yr, 6-hr storm was used for Bear Canyon and Right Fork drainages (perennial and intermittent streams - see R645-301-742.323) and the 10-yr, 6-hr storm was used for ephemeral side drainages (see R645-301-742.333) and for road drainage diversions (see R645-301-742.423.1).

The "Peak" computer hydrology software was used to determine the hydrograph and peak flows. An SCS Type II distribution was used. The calculations are shown in Table 7H-2. The results are shown on pages 5-16 of this Appendix.

**Table 7H-1 Watershed Slope characteris**

| Watershed | EM | EN | $LC_{25}$ | $LC_{50}$ | $LC_{75}$ | Area ($ft^2$) | Slope (%) |
|---|---|---|---|---|---|---|---|
| WS-1 | 8425 | 7090 | 710 | 870 | 705 | $1.09x10^6$ | 69.9 |
| WS-1A | 7200 | 7105 | 240 | 220 | 75 | $4.88x10^4$ | 26.0 |
| WS-2 | 8705 | 7140 | 825 | 880 | 910 | $1.66x10^6$ | 61.7 |
| WS-3 | 8285 | 7140 | 470 | 360 | 220 | $4.84x10^5$ | 62.1 |
| WS-3A | 7250 | 7135 | 190 | 80 | 55 | $4.79x10^4$ | 19.5 |
| WS-4 | 8720 | 7220 | 275 | 525 | 320 | $6.34x10^5$ | 66.3 |
| WS-5 | 8275 | 7260 | 140 | 200 | 170 | $2.14x10^5$ | 60.6 |
| WS-6 | 8815 | 7300 | 650 | 855 | 740 | $1.33x10^6$ | 64.0 |
| WS-7 | 8110 | 6965 | 1090 | 1335 | 905 | $1.55x10^6$ | 61.5 |
| WS-8 | 8135 | 7020 | 850 | 775 | 725 | $1.22x10^6$ | 53.5 |
| WS-9 | 8240 | 7070 | 225 | 400 | 495 | $5.62x10^5$ | 58.3 |
| WS-10 | 8425 | 7080 | 850 | 810 | 740 | $1.30x10^6$ | 62.0 |
| WS-11 | 8020 | 7175 | 840 | 705 | 465 | $5.97x10^5$ | 71.2 |
| WS-12 | 8585 | 7245 | 745 | 1095 | 1000 | $1.57x10^6$ | 60.6 |
| WS-13 | 7963 | 7509 | 220 | 110 | 70 | $9.89x10^4$ | 45.9 |
| WS-14 | 7476 | 7321 | 570 | 580 | 320 | $8.02x10^4$ | 71.1 |
| WS-15 | 7480 | 7310 | 155 | 145 | 130 | $3.27x10^4$ | 55.9 |
| WS-16 | 8595 | 7540 | 720 | 700 | 540 | $8.95x10^5$ | 57.8 |
| WS-17 | 7556 | 7463 | 290 | 435 | 130 | $3.09x10^4$ | 64.3 |
| WS-18 | 7480 | 7306 | 165 | 155 | 145 | $3.57x10^4$ | 56.6 |
| WS-19 | 8650 | 7725 | 255 | 315 | 295 | $4.12x10^5$ | 48.6 |
| WS-20 | 7695 | 7625 | 115 | 210 | 275 | $2.13x10^4$ | 49.2 |
| WS-21 | 7770 | 7680 | 420 | 375 | 210 | $5.62x10^4$ | 40.0 |
| WS-22 | 8717 | 7864 | 500 | 500 | 485 | $5.25x10^5$ | 60.3 |
| WS-23 | 7875 | 7795 | 295 | 295 | 100 | $2.79x10^4$ | 49.5 |
| WS-24 | 7805 | 7700 | 95 | 175 | 215 | $2.40x10^4$ | 53.1 |
| WS-25 | 9185 | 7675 | 2345 | 3335 | 4040 | $6.09x10^6$ | 60.3 |
| WS-26 | 9360 | 7320 | 3345 | 3860 | 3380 | $8.60x10^6$ | 62.8 |
| WS-27 | 8925 | 7615 | 480 | 605 | 770 | $9.31x10^5$ | 65.3 |

**Table7H-2**

**Watershed Flow Characteristics**

| Watershed | CN | Area (acres) | Slope y (%) | Hyd. Length l (ft) | $S = \frac{1000}{CN} - 10$ | $L = \frac{l^{0.8}(s+1)^{0.7}}{1900Y^{0.5}}$ | Time of Conc. $T_c = 1.67\ L$ (Hr) | Peak Flow (cfs) |
|---|---|---|---|---|---|---|---|---|
| WS-1 | 76 | 25.1 | 69.9 | 2300 | 3.158 | 0.083 | 0.139 | 8.03 |
| WS-1A | 76 | 1.1 | 26.0 | 510 | 3.158 | 0.041 | 0.068 | 0.56 |
| WS-2 | 76 | 38.1 | 61.7 | 2860 | 3.158 | 0.106 | 0.177 | 10.51 |
| WS-3 | 76 | 11.1 | 62.1 | 2200 | 3.158 | 0.085 | 0.143 | 3.51 |
| WS-3A | 76 | 1.1 | 19.5 | 660 | 3.158 | 0.058 | 0.097 | 0.44 |
| WS-4 | 76 | 14.5 | 66.3 | 2400 | 3.158 | 0.089 | 0.148 | 4.46 |
| WS-5 | 76 | 4.90 | 60.6 | 1620 | 3.158 | 0.068 | 0.113 | 1.78 |
| WS-6 | 76 | 30.5 | 64.0 | 2400 | 3.158 | 0.090 | 0.151 | 9.21 |
| WS-7 | 76 | 35.6 | 61.5 | 2530 | 3.158 | 0.096 | 0.160 | 10.45 |
| WS-8 | 76 | 28.1 | 53.5 | 2410 | 3.158 | 0.090 | 0.150 | 8.53 |
| WS-9 | 76 | 12.9 | 58.3 | 1960 | 3.158 | 0.080 | 0.134 | 4.26 |
| WS-10 | 76 | 29.9 | 62.0 | 2380 | 3.158 | 0.091 | 0.152 | 8.99 |
| WS-11 | 76 | 13.7 | 71.2 | 1440 | 3.158 | 0.057 | 0.095 | 5.55 |
| WS-12 | 76 | 36.0 | 60.6 | 2190 | 3.158 | 0.086 | 0.144 | 11.33 |
| WS-13 | 76 | 2.3 | 45.9 | 980 | 3.158 | 0.052 | 0.087 | 0.98 |
| WS-14 | 76 | 1.8 | 71.1 | 560 | 3.158 | 0.027 | 0.045 | 1.12 |
| WS-15 | 76 | 0.8 | 55.9 | 310 | 3.158 | 0.019 | 0.031 | 0.51 |
| WS-16 | 76 | 20.6 | 57.8 | 1880 | 3.158 | 0.078 | 0.131 | 6.88 |
| WS-17 | 76 | 0.7 | 64.3 | 460 | 3.158 | 0.024 | 0.040 | 0.12 |
| WS-18 | 76 | 0.8 | 56.6 | 320 | 3.158 | 0.019 | 0.032 | 0.56 |
| WS-19 | 76 | 9.5 | 48.6 | 1360 | 3.158 | 0.066 | 0.110 | 3.54 |
| WS-20 | 76 | 0.5 | 49.2 | 270 | 3.158 | 0.018 | 0.030 | 0.34 |
| WS-21 | 76 | 1.3 | 40.0 | 190 | 3.158 | 0.015 | 0.025 | 0.93 |
| WS-22 | 76 | 12.1 | 60.3 | 1120 | 3.158 | 0.051 | 0.084 | 5.30 |
| WS-23 | 76 | 0.6 | 49.5 | 310 | 3.158 | 0.020 | 0.033 | 0.43 |
| WS-24 | 76 | 0.6 | 53.1 | 200 | 3.158 | 0.014 | 0.023 | 0.41 |
| WS-25 | 76 | 139.8 | 60.3 | 3250 | 3.158 | 0.119 | 0.198 | 136.41 |
| WS-26 | 76 | 197.5 | 62.8 | 5210 | 3.158 | 0.169 | 0.283 | 153.36 |
| WS-27 | 76 | 21.4 | 65.3 | 2370 | 3.158 | 0.088 | 0.148 | 6.55 |

Figure 7H-1 Curve Number Nomograph

Source: U.S. SCS (1972)

**PEAK**

HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-1

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.139 hr |
| Duration = 6.00 hr | Area =25.05 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 8.03 cfs (0.3181 iph)
At T = 3.22 hrs

INPUT SUMMARY FOR WATERSHED: WS-1A

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = hr |
| Duration = 6.00 hr | Area = |

OUTPUT SUMMARY

Runoff depth =0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.56 cfs (0.4933 iph)
At T =3.16 hrs

INPUT SUMMARY FOR WATERSHED: WS-2

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.177 hr |
| Duration = 6.00 hr | Area =38.08 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 10.51 cfs (0.2737 iph)
At T = 3.26 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-3

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.143 hr |
| Duration = 6.00 hr | Area =11.11 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 3.51 cfs (0.3137 iph)
At T = 3.22 hrs

INPUT SUMMARY FOR WATERSHED: WS-3A

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = hr |
| Duration = 6.00 hr | Area = acres |

OUTPUT SUMMARY

Runoff depth =0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.44 cfs (0.3970 iph)
At T =3.18 hrs

INPUT SUMMARY FOR WATERSHED: WS-4

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.148 hr |
| Duration = 6.00 hr | Area =14.54 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 4.46 cfs (0.3043 iph)
At T = 3.24 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-5

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.113 hr |
| Duration = 6.00 hr | Area =4.90 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 1.78 cfs (0.3600 iph)
At T = 3.19 hrs

INPUT SUMMARY FOR WATERSHED: WS-6

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.151 hr |
| Duration = 6.00 hr | Area =30.49 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 9.21 cfs (0.2994 iph)
At T = 3.24 hrs

INPUT SUMMARY FOR WATERSHED: WS-7

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.160 hr |
| Duration = 6.00 hr | Area =35.60 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 10.45 cfs (0.2912 iph)
At T = 3.24 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-8

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.150 hr |
| Duration = 6.00 hr | Area =28.10 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 8.53 cfs (0.3009 iph)
At T = 3.24 hrs

INPUT SUMMARY FOR WATERSHED: WS-9

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.134 hr |
| Duration = 6.00 hr | Area =12.90 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 4.26 cfs (0.3272 iph)
At T = 3.22 hrs

INPUT SUMMARY FOR WATERSHED: WS-10

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.152 hr |
| Duration = 6.00 hr | Area =29.90 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 8.99 cfs (0.2981 iph)
At T = 3.24 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-11

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.095 hr |
| Duration = 6.00 hr | Area =13.70 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 5.55 cfs (0.4018 iph)
At T = 3.18 hrs

INPUT SUMMARY FOR WATERSHED: WS-12

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.144 hr |
| Duration = 6.00 hr | Area =36.03 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 11.33 cfs (0.3119 iph)
At T = 3.23 hrs

INPUT SUMMARY FOR WATERSHED: WS-13

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.087 hr |
| Duration = 6.00 hr | Area =2.27 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.98 cfs (0.4275 iph)
At T = 3.18 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-14

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.045 hr |
| Duration = 6.00 hr | Area =1.84 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 1.12 cfs (0.6010 iph)
At T = 3.14 hrs

INPUT SUMMARY FOR WATERSHED: WS-15

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.031 hr |
| Duration = 6.00 hr | Area =0.75 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.51 cfs (0.6784 iph)
At T = 3.13 hrs

INPUT SUMMARY FOR WATERSHED: WS-16

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.144 hr |
| Duration = 6.00 hr | Area =36.0 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 11.32 cfs (0.3110 iph)
At T = 3.23 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-17

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.040 hr |
| Duration = 6.00 hr | Area =0.71 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.12 cfs (0.1689 iph)
At T = 3.52 hrs

INPUT SUMMARY FOR WATERSHED: WS-18

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.032 hr |
| Duration = 6.00 hr | Area =0.82 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.56 cfs (0.6721 iph)
At T = 3.14 hrs

INPUT SUMMARY FOR WATERSHED: WS-19

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.110 hr |
| Duration = 6.00 hr | Area =9.45 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 3.54 cfs (0.3711 iph)
At T = 3.20 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-19A

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.033 hr |
| Duration = 6.00 hr | Area = 0.63 |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.42 cfs (0.6661 iph)
At T = 3.14 hrs

INPUT SUMMARY FOR WATERSHED: WS-20

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.030 hr |
| Duration = 6.00 hr | Area =0.49 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.34 cfs (0.6826 iph)
At T = 3.14 hrs

INPUT SUMMARY FOR WATERSHED: WS-21

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.025 hr |
| Duration = 6.00 hr | Area =1.29 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.93 cfs (0.7127 iph)
At T = 3.13 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-21A

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.027 hr |
| Duration = 6.00 hr | Area = 0.2 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.14 cfs (0.7045 iph)
At T = 3.13 hrs

INPUT SUMMARY FOR WATERSHED: WS-22

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.084 hr |
| Duration = 6.00 hr | Area =12.05 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 5.30 cfs (0.4360 iph)
At T = 3.18 hrs

INPUT SUMMARY FOR WATERSHED: WS-22A

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.122 hr |
| Duration = 6.00 hr | Area = 6.59 acres |

OUTPUT SUMMARY

Runoff depth =0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 2.3 cfs (0.3464 iph)
At T =3.20 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-23

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.033 hr |
| Duration = 6.00 hr | Area =0.64 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.43 cfs (0.6661 iph)
At T = 3.14 hrs

INPUT SUMMARY FOR WATERSHED: WS-24

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.023 hr |
| Duration = 6.00 hr | Area =0.55 acres |

OUTPUT SUMMARY

Runoff depth = 0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 0.41 cfs (0.7309 iph)
At T = 3.13 hrs

INPUT SUMMARY FOR WATERSHED: WS-25

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 2.20 in | Time of Conc. = 0.198 hr |
| Duration = 6.00 hr | Area =139.82 |

OUTPUT SUMMARY

Runoff depth = 0.5205 in
Initial Abstraction = 0.6316 in
Peak Flow = 136.41 cfs (0.9676 iph)
At T = 3.25 hrs

**PEAK**
HYDROGRAPH GENERATION PROGRAM

INPUT SUMMARY FOR WATERSHED: WS-26

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 2.20 in | Time of Conc. = 0.283 hr |
| Duration = 6.00 hr | Area = 197.50 acres |

OUTPUT SUMMARY

Runoff depth = 0.5205 in
Initial Abstraction = 0.6316 in
Peak Flow = 153.36 cfs ( 0.7701 iph)
At T = 3.32 hrs

INPUT SUMMARY FOR WATERSHED: WS-27

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 1.50 in | Time of Conc. = 0.119hr |
| Duration = 6.00 hr | Area = 13.9 acres |

OUTPUT SUMMARY

Runoff depth =0.1873 in
Initial Abstraction = 0.6316 in
Peak Flow = 4.95 cfs (0.3534 iph)
At T =3.21 hrs

INPUT SUMMARY FOR WATERSHED: BEAR CANYON*

| STORM: | WATERSHED: |
|---|---|
| Distribution = SCS Type II | Curve Number = 76 |
| Precip. Depth = 2.20 in | Time of Conc. = 0.604 hr |
| Duration = 6.00 hr | Area = 1,728.00 acres |

OUTPUT SUMMARY

Runoff depth = 0.5205 in
Initial Abstraction = 0.6316 in
Peak Flow = 776.76 cfs ( 0.4458 iph)
At T = 3.62 hrs

*Watershed Characteristics for Bear Creek taken from Appendix 7-G.
Reclaimed Channel Designs

The following table summarizes the channel slopes (from Plates 7-7 and 7-7A):

| Channel | Watershed | Peak Flow (cfs) | Minimum Slope (ft/ft) | Maximum Slope (ft/ft) | Manning's coefficient * |
|---|---|---|---|---|---|
| RC-1 | WS-1 | 8.03 | 0.08 | 0.31 | 0.035 |
| RC-2 | WS-2 | 10.51 | 0.09 | 0.29 | 0.038 |
| RC-3 | WS-3 | 3.51 | 0.08 | 0.67 | 0.038 |
| RC-4 | WS-4 | 4.46 | 0.05 | 0.40 | 0.035 |
| RC-5 | WS-5 | 1.78 | 0.05 | 0.50 | 0.035 |
| RC-6 | WS-6 | 9.21 | 0.10 | 0.10 | 0.035 |
| RC-7 | Right Fork Lower | 317.39 | 0.10 | 0.10 | 0.044 |
| RC-8 | WS-17, RC-9 | 154.03 | 0.13 | 0.26 | 0.044 |
| RC-9 | Right Fork Right | 153.91 | 0.04 | 0.25 | 0.044 |
| RC-10 | Bear Canyon | 776.76 | 0.06 | 0.06 | 0.044 |
| RC-11 | WS-22, WS-23, WS-24 | 6.14 | 0.12 | 0.12 | 0.035 |
| RC-12 | WS-27 | 6.55 | 0.08 | 0.68 | 0.038 |
| RC-TS1 | WS-1 partial | 4.53 | 0.03 | 0.40 | 0.035 |
| RC-TS2 | WS-1 partial | 2.42 | 0.20 | 0.75 | 0.035 |
| RC-TS3 | WS-1 partial | 2.18 | 0.30 | 0.50 | 0.035 |
| RC-TS4 | WS-1 partial | 0.43 | 0.35 | 0.70 | 0.035 |
| RC-TS5 | WS-1 partial | 0.31 | 0.30 | 0.60 | 0.035 |
| RC-TS6 | WS-1 partial | 0.60 | 0.16 | 0.65 | 0.035 |

*Manning's coefficient based on riprap sizes shown on the following page.

The reclaimed channel designs for RC-1 through RC-12 are shown on the following pages. Plates 7-8A and 7-8B show the profiles for these channels. See pages 7H-~~52~~ 50 thru 7H-~~77~~ 74 for RC-TS channel designs, associated with the reclaimed Tank Seam Access Road. Plate 7-8C shows the profiles for these channels. Channels RC-7, RC-8, RC-9, RC-11 and RC-12 are associated with the Right Fork drainage of Bear Creek (Wild Horse Ridge disturbance).

The minimum channel slope was used to calculate the channel depth. The maximum slope was used to determine riprap requirements. Riprap sizing is based on the curves provided on the following page and on the equation:

$$n = 0.0395(d_{50})^{1/6} \qquad \text{(Barfield et al., 1981)}$$

where: $n$ = Manning's roughness coefficient
$d_{50}$ = median diameter (ft)

Following are the maximum permissible velocities for given riprap sizes (based on 2:1 side slope limitations):

$d_{50}$ = 3" Y $V_{max}$ = 5.6 ft/s
$d_{50}$ = 6" Y $V_{max}$ = 7.2 ft/s
$d_{50}$ = 9" Y $V_{max}$ = 8.9 ft/s
$d_{50}$ = 24" Y $V_{max}$ = 15.2 ft/s

Based on the Flowmaster printouts on the following pages, the velocities and riprap requirements are as follows:

| Channel | Velocity (ft/s) | Riprap (in) | Channel | Velocity (ft/s) | Riprap (in) |
|---|---|---|---|---|---|
| RC-1 | 7.16 | $D_{50}$ = 6" | RC-7 | 9.81 | $D_{50}$ = 24" |
| RC-2 | 8.76 | $D_{50}$ = 9" | RC-8 | 15.03 | $D_{50}$ = 24" |
| RC-3 | 7.92 | $D_{50}$ = 9" | RC-9 | 15.16 | $D_{50}$ = 24" |
| RC-4 | 7.08 | $D_{50}$ = 6" | RC-10 | 15.01 | $D_{50}$ = 24" |
| RC-5 | 7.17 | $D_{50}$ = 6" | RC-11 | 6.20 | $D_{50}$ = 6" |
| RC-6 | 6.55 | $D_{50}$ = 6" | RC-12 | 5.75 | $D_{50}$ = 6" |

**Figure 7H-2 Size of Stone that will Resist Displacement for Various Velocities and Slide Slopes**

Source: Searcy (1967), HEC No. 11

# Worksheet
## Worksheet for Trapezoidal Channel

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

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.310000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.67 | V : H |
| Bottom Width | 6.00 | ft |
| Discharge | 8.03 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.18 | ft |
| Flow Area | 1.1 | ft² |
| Wetted Perimeter | 6.72 | ft |
| Top Width | 6.62 | ft |
| Critical Depth | 0.37 | ft |
| Critical Slope | 0.026628 | ft/ft |
| Velocity | 7.16 | ft/s |
| Velocity Head | 0.80 | ft |
| Specific Energy | 0.98 | ft |
| Froude Number | 3.07 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-1 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.080000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.67 | V : H |
| Bottom Width | 6.00 | ft |
| Discharge | 8.03 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.27 | ft |
| Flow Area | 1.7 | ft² |
| Wetted Perimeter | 7.07 | ft |
| Top Width | 6.93 | ft |
| Critical Depth | 0.37 | ft |
| Critical Slope | 0.026628 | ft/ft |
| Velocity | 4.67 | ft/s |
| Velocity Head | 0.34 | ft |
| Specific Energy | 0.61 | ft |
| Froude Number | 1.66 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-2 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.038 | |
| Slope | 0.290000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 3.00 | ft |
| Discharge | 10.51 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.33 | ft |
| Flow Area | 1.2 | ft² |
| Wetted Perimeter | 4.47 | ft |
| Top Width | 4.31 | ft |
| Critical Depth | 0.63 | ft |
| Critical Slope | 0.028739 | ft/ft |
| Velocity | 8.76 | ft/s |
| Velocity Head | 1.19 | ft |
| Specific Energy | 1.52 | ft |
| Froude Number | 2.93 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-2 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.038 | |
| Slope | 0.090000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 3.00 | ft |
| Discharge | 10.51 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.46 | ft |
| Flow Area | 1.8 | ft² |
| Wetted Perimeter | 5.04 | ft |
| Top Width | 4.83 | ft |
| Critical Depth | 0.63 | ft |
| Critical Slope | 0.028739 | ft/ft |
| Velocity | 5.88 | ft/s |
| Velocity Head | 0.54 | ft |
| Specific Energy | 0.99 | ft |
| Froude Number | 1.70 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-3 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.038 | |
| Slope | 0.670000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 3.00 | ft |
| Discharge | 3.51 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.14 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 3.61 | ft |
| Top Width | 3.54 | ft |
| Critical Depth | 0.32 | ft |
| Critical Slope | 0.033907 | ft/ft |
| Velocity | 7.91 | ft/s |
| Velocity Head | 0.97 | ft |
| Specific Energy | 1.11 | ft |
| Froude Number | 3.94 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-3 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.038 | |
| Slope | 0.080000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 3.00 | ft |
| Discharge | 3.51 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.25 | ft |
| Flow Area | 0.9 | ft² |
| Wetted Perimeter | 4.13 | ft |
| Top Width | 4.01 | ft |
| Critical Depth | 0.32 | ft |
| Critical Slope | 0.033907 | ft/ft |
| Velocity | 3.96 | ft/s |
| Velocity Head | 0.24 | ft |
| Specific Energy | 0.50 | ft |
| Froude Number | 1.49 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-4 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.400000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 4.00 | ft |
| Discharge | 4.46 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.15 | ft |
| Flow Area | 0.6 | ft² |
| Wetted Perimeter | 4.66 | ft |
| Top Width | 4.59 | ft |
| Critical Depth | 0.32 | ft |
| Critical Slope | 0.028297 | ft/ft |
| Velocity | 7.08 | ft/s |
| Velocity Head | 0.78 | ft |
| Specific Energy | 0.93 | ft |
| Froude Number | 3.37 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-4 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.050000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 4.00 | ft |
| Discharge | 4.46 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.27 | ft |
| Flow Area | 1.2 | ft² |
| Wetted Perimeter | 5.21 | ft |
| Top Width | 5.08 | ft |
| Critical Depth | 0.32 | ft |
| Critical Slope | 0.028297 | ft/ft |
| Velocity | 3.63 | ft/s |
| Velocity Head | 0.20 | ft |
| Specific Energy | 0.48 | ft |
| Froude Number | 1.30 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-5 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.500000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 1.50 | ft |
| Discharge | 1.78 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.14 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 2.12 | ft |
| Top Width | 2.06 | ft |
| Critical Depth | 0.31 | ft |
| Critical Slope | 0.030905 | ft/ft |
| Velocity | 7.17 | ft/s |
| Velocity Head | 0.80 | ft |
| Specific Energy | 0.94 | ft |
| Froude Number | 3.64 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-5 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.050000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 1.50 | ft |
| Discharge | 1.78 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.27 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 2.70 | ft |
| Top Width | 2.57 | ft |
| Critical Depth | 0.31 | ft |
| Critical Slope | 0.030905 | ft/ft |
| Velocity | 3.27 | ft/s |
| Velocity Head | 0.17 | ft |
| Specific Energy | 0.43 | ft |
| Froude Number | 1.25 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-6 (Min & Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.100000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 2.00 | ft |
| Discharge | 9.21 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.48 | ft |
| Flow Area | 1.4 | ft² |
| Wetted Perimeter | 4.13 | ft |
| Top Width | 3.91 | ft |
| Critical Depth | 0.69 | ft |
| Critical Slope | 0.024750 | ft/ft |
| Velocity | 6.55 | ft/s |
| Velocity Head | 0.67 | ft |
| Specific Energy | 1.14 | ft |
| Froude Number | 1.92 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-7 (Min & Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.044 | |
| Slope | 0.040000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 6.00 | ft |
| Discharge | 317.39 | cfs |

| Results | | |
|---|---|---|
| Depth | 2.79 | ft |
| Flow Area | 32.4 | ft² |
| Wetted Perimeter | 18.49 | ft |
| Top Width | 17.17 | ft |
| Critical Depth | 3.15 | ft |
| Critical Slope | 0.024473 | ft/ft |
| Velocity | 9.81 | ft/s |
| Velocity Head | 1.50 | ft |
| Specific Energy | 4.29 | ft |
| Froude Number | 1.26 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-8 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.044 | |
| Slope | 0.260000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 8.00 | ft |
| Discharge | 154.03 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.02 | ft |
| Flow Area | 10.2 | ft² |
| Wetted Perimeter | 12.56 | ft |
| Top Width | 12.08 | ft |
| Critical Depth | 1.91 | ft |
| Critical Slope | 0.026895 | ft/ft |
| Velocity | 15.03 | ft/s |
| Velocity Head | 3.51 | ft |
| Specific Energy | 4.53 | ft |
| Froude Number | 2.88 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-8 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.044 | |
| Slope | 0.130000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 8.00 | ft |
| Discharge | 154.03 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.24 | ft |
| Flow Area | 13.0 | ft² |
| Wetted Perimeter | 13.55 | ft |
| Top Width | 12.96 | ft |
| Critical Depth | 1.91 | ft |
| Critical Slope | 0.026895 | ft/ft |
| Velocity | 11.85 | ft/s |
| Velocity Head | 2.18 | ft |
| Specific Energy | 3.42 | ft |
| Froude Number | 2.09 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-9 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.044 | |
| Slope | 0.250000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 7.00 | ft |
| Discharge | 153.91 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.10 | ft |
| Flow Area | 10.2 | ft² |
| Wetted Perimeter | 11.93 | ft |
| Top Width | 11.41 | ft |
| Critical Depth | 2.02 | ft |
| Critical Slope | 0.026869 | ft/ft |
| Velocity | 15.16 | ft/s |
| Velocity Head | 3.57 | ft |
| Specific Energy | 4.67 | ft |
| Froude Number | 2.83 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-9 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.044 | |
| Slope | 0.040000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 7.00 | ft |
| Discharge | 153.91 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.82 | ft |
| Flow Area | 19.3 | ft² |
| Wetted Perimeter | 15.13 | ft |
| Top Width | 14.27 | ft |
| Critical Depth | 2.02 | ft |
| Critical Slope | 0.026869 | ft/ft |
| Velocity | 7.96 | ft/s |
| Velocity Head | 0.98 | ft |
| Specific Energy | 2.80 | ft |
| Froude Number | 1.20 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-10 (Min & Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.044 | |
| Slope | 0.060000 | ft/ft |
| Left Side Slope | 0.67 | V : H |
| Right Side Slope | 0.67 | V : H |
| Bottom Width | 6.00 | ft |
| Discharge | 776.76 | cfs |

| Results | | |
|---|---|---|
| Depth | 4.20 | ft |
| Flow Area | 51.7 | ft² |
| Wetted Perimeter | 21.15 | ft |
| Top Width | 18.61 | ft |
| Critical Depth | 5.32 | ft |
| Critical Slope | 0.022548 | ft/ft |
| Velocity | 15.01 | ft/s |
| Velocity Head | 3.50 | ft |
| Specific Energy | 7.71 | ft |
| Froude Number | 1.59 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-11 (Min & Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.120000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 2.00 | ft |
| Discharge | 6.14 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.36 | ft |
| Flow Area | 1.0 | ft² |
| Wetted Perimeter | 3.63 | ft |
| Top Width | 3.45 | ft |
| Critical Depth | 0.55 | ft |
| Critical Slope | 0.026128 | ft/ft |
| Velocity | 6.19 | ft/s |
| Velocity Head | 0.60 | ft |
| Specific Energy | 0.96 | ft |
| Froude Number | 2.04 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-12 (Min & Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.080000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 1.00 | ft |
| Discharge | 6.55 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.55 | ft |
| Flow Area | 1.1 | ft² |
| Wetted Perimeter | 3.44 | ft |
| Top Width | 3.18 | ft |
| Critical Depth | 0.71 | ft |
| Critical Slope | 0.026078 | ft/ft |
| Velocity | 5.75 | ft/s |
| Velocity Head | 0.51 | ft |
| Specific Energy | 1.06 | ft |
| Froude Number | 1.69 | |
| Flow Type | Supercritical | |

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## Typical Riprap Gradations for Erosion Control

| Dimensionless Gradation | Percent Passing[a] | Rip-rap Gradation (in) | | | |
|---|---|---|---|---|---|
| | | $D_{50}$ = 3" | $D_{50}$ = 6" | $D_{50}$ = 9" | $D_{50}$ = 24" |
| 0.2 $D_{50}$ | 0 | 0.6 | 1.2 | 1.8 | 4.8 |
| 0.5 $D_{50}$ | 20 | 1.5 | 3.0 | 4.5 | 12.0 |
| $D_{50}$ | 50 | 3.0 | 6.0 | 9.0 | 24.0 |
| 2 $D_{50}$ | 100 | 6.0 | 12.0 | 18.0 | 48.0 |

[a] From Barfield et. al. (1981)

See rip-rap gradations plotted on pg. 7H-39.

## Typical Soil Gradations for Bear Canyon

| Particle Size (in) | Percent Passing [a] | | |
|---|---|---|---|
| | North-Facing Slopes | South-Facing Slopes | Alluvial Soils |
| 3.0 | 70 | 95 | 70 |
| 0.187 (No. 4) | 65 | 90 | 60 |
| 0.0787 (No. 10) | 60 | 80 | 50 |
| 0.0165 (No. 40) | 55 | 70 | 45 |
| 0.0029 (No. 200) | 35 | 55 | 30 |

[a] Soil type based on aspect or location.

See Soil Section of PAP.

See soil gradations plotted on pg. 7H-40. Use "Average Slope Soil" gradation for all reclamation channels except RC-7, RC-8, RC-9, RC-10, RC-11 and RC-12. Use "alluvial" gradation for these channels. Justification for using average gradation is that these soils were mixed to construct the pad areas.

The channel cross-sections are shown on pp. 7H-48 through 7H-51. A minimum freeboard of 1.0 ft or 20% of the flow depth was provided, whichever is greater (Barfield et. al., 1981).

The cross-sections shown represent the minimum channel dimensions. Upon reclamation, actual dimensions may vary somewhat.

A minimum of 6" will be maintained for each filter blanket thickness (Barfield et. al., 1981). As discussed in the previous calculations, the filter blanket will be increased to account for filters of marginal adequacy.

Typically, a riprap thickness equal to 2 * $D_{50}$ has been used for the designs. This thickness was increased for the 9" riprapped channels as discussed on page 7H-45.

References

Barfield, B.J., R.C. Warner, and C.T. Haan. 1981. Applied Hydrology and Sedimentology for Disturbed Areas. Oklahoma Technical Press. Stillwater, Oklahoma.

Haested Methods, Inc. 1990. "FlowMaster I - User's Mannual. Waterbury, Connecticut.

Hawkings, R.H. and K. A. Marshall. 1979. Storm Hydrograph Program. Final Report to the Utah Division of Oil, Gas and Mining. Utah State University Foundation. Logan, Utah.

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation - Frequency Atlas of the Western United States. NOAA Atlas 2 - Volume VI: Utah. National Weather Service. Silver Spring, Maryland.

Searcy, J.K. 1967, Use of Riprap for Bank Protection. Hydraulic Engineering Circular No. 11. U.S. Department of Transportation. Washington, D.C.

U.S. Soil Conservation Service. 1972. National Engineering Handbook - Section 4: Hydrology. Washington, D.C.

Hwang, Ned H.C., and Hita, Carlos E. 1987. Hydraulic Engineering Systems - Second Edition. Englewood Cliffs, New Jersey.

**Reclaimed Tank Seam Access Road Channel Designs**

Construction of the Tank Seam Access Road will require the disturbance of six channels, shown on Plate 7-7 as RC-TS1 through RC-TS6. All six channels exist as naturally eroding channels. Due to the steep maximum slopes, as shown on page 7H-16, riprap designs will not be proposed for these channels. This sections characterizes and documents the premining channels which exist prior to disturbance. Reclamation will consist of restoring these channels to this configuration and mimmicking the premining conditions, in order to obtain a naturally stable drainage and restore the approximate original configuration to the channels.

Disturbance of the channels will consist primarily of placing fill in the channels to provide access across the channels for the road. This will allow the channels to essential remain intact beneath the fill. Upon reclamation, the fill material will be excavated from the channels and fill areas, and the channels will be restored, with many of the large boulders shown in the photographs of each channel remaining in place for the post-mining channel. Profiles of the pre-mining, and subsequently the proposed post-mining, channels are shown on Plate 7-8C. A description of each channel follows. As the channels are reclaimed, the reclaimed channel will be blended in with the natural channels above and below the reclaimed channel by attempting to duplicate the appearance of the natural channels as they appear in the following photographs.

RC-TS1

Rc-TS1 is located between station 9+00 and 10+00 (See page 5G-11). The channel has an average bottom width of 11' and an average depth of 8'. The slope of the channel varies from 3% to 40%, with an average slope of 20%. The channel consists primarily of large boulders embedded into the soil. The rock size generally varies from 12"-72" m.d., with some boulders exceeding 72". These boulders (Photos TS1-1 and TS1-2) create near vertical drops in the channel, but also act naturally as energy dissipaters in the channel. Photo TS1-1 shows the top portion of the channel which will be disturbed, and photo TS1-3 shows the bottom of the channel, where the outlet of C-16U will be located during operation.

Photo TS-1: Top portion of Pre-mining channel RC-TS1. Top of channel located below large boulders shown in top center of photo.

Photo TS-2: An 11' vertical drop caused by large boulders (120-144" m.d.) embedded into the bottom of RC-TS1.

Photo TS1-3: Lower portion of RC-TS1, where the reclaimed channel will merge into the natural channel (Adjacent to leaning tree, top center). Slope at this location is approximately 3%.

RC-TS2

RC-TS2 is located between station 10+00 and 11+00 (See page 3H-11). The channel has an average bottom width of 12' and an average depth of 4', varying from 2 to 8 ft. The slope of the channel varies from 20% to 75%. The channel, as shown on Plate 7-8C, consists of a steep profile directly on bedrock with 20% to 30% grade "terraces" containing large boulders embedded into the surface. The rock size varies from 12"-72" m.d., with some boulders exceeding 72". These boulders primarily project from the side slope of the channel. The North side slope and the bottom of the channel consist primarily of bedrock outcrop, as shown in Photo TS2-3.

Photo TS2-1: Top portion of RC-TS2, where the reclaimed channel will join to the natural channel. Bedrock outcrop can be seen as red color in sides of channel.

Photo TS2-2: Lower portion of the channel, where the reclaimed channel will join the natural channel (center of photo).

Photo TS2-3: A horizontal view of the channel showing the outcropping of bedrock in the channel.

RC-TS3

RC-TS3 is located between station 21+00 and 22+00 (See page 3H-11). The channel has and average depth of 4', carrying from 2 to 7 ft. The slope of the channel varies form 30% to 50%, with the majority of the slope around 35%. This channel will see a minimal amount of disturbance (about 40 ft). The channel consists of boulders 18" to 60" embedded into the soil, with some larger boulders projecting out of the side slope of the channel. Photos TS3-1 through TS3-3 show the natural channel configuration.

Photo TS3-1: Upper portion of the channel shown, where natural channel will join the reclaimed channel.

Photo TS3-2: Typical channel configurations for RC-TS3.

Photo TS3-3: Bottom of channel RC-TS3, where reclaimed channel will join natural channel (adjacent to large boulder shown in top right corner).

RC-TS4

RC-TS4 is located between station 24+00 and 25+00 (See page 3H-11). The channel has an average bottom width of 15' and an average depth of 4', with runoff coming into the channel as sheet flow. The slope of the channel varies form 35% to 70%. The dominant presence of vegetation in the channel indicates minimal flows through the channel, primarily as sheet flow. The top portion of the channel is dominated by rock averaging 8"-36" m.d. The lower portion of the channel (Photo TS3-3) contains a great deal of "litter" scattered through the vegetation cover in the channel.

Photo TS4-1: Upper portion of RC-TS4 where the natural channel will join the reclaimed channel (lower center of photo).

Photo TS4-2: Profile of channel RC-TS4, showing the South side slope and the channel bottom configuration.

Photo TS4-3: Lower portion of RC-TS4. Reclaimed channel joins natural channel at the location of the large boulder shown just left of center in the photo.

RC-TS5

RC-TS5 is located at station 25+00 (See page 3H-11), adjacent to RC-TS4. The channel has a bottom width of 4' to 6' and a depth of 2' to 6'. The slope of the channel is 60%, with some portions varying down to 30%. The channel is the same configuration as RC-TS4, except much narrower and with a greater presence of 18" to 48" m.d. rocks. At the location of photo TS5-3, RC-TS5 terminated and runoff enters channel RC-TS6.

Photo TS5-1: Upper portion of channel RC-TS5, where the natural channel joins the reclaimed channel (center of photo).

Photo TS5-2: Profile of channel RC-TS5 showing North side slope and vegetation and rock cover in bottom of channel.

Photo TS5-3: Outlet of channel RC-TS5 where it drains into channel RC-TS6. Location of culvert C-23U outlet.

RC-TS6

RC-TS6 is located at station 25+00 (See page 3H-11) adjacent to RC-TS5. The channel has an average bottom width of 20' and a depth of 2 to 5 ft. Runoff through the channel occurs primarily as sheet flow, with the channel originating immediately above the disturbed area. The slope of the channel varies form 16% to 65%, with a 7' vertical drop occurring due to a ledge outcrop of bedrock. The channel is dominated by rock fragments 18" to 48" m.d. with some larger rocks present. The channel contains a series of terraces where bedrock is present at or near the surface.

Photo TS6-1: Upper portion of channel RC-TS6, where the natural channel joins the reclaimed channel (center of photo).

Photo TS6-2: Typical cross section of channel RC-TS6, showing a dominating presence of rock fragments with some outcropping bedrock.

Photo TS6-3: Lower portion of Channel RC-TS6, where reclaimed channel drains into natural channel (also location of culvert C-24U outlet).

## Tank Seam Access Road Channel Characteristics

| Channel | Peak Flow* (cfs) | Maximum Velocity** (ft/s) | Maximum Flow Depth** (ft) |
|---|---|---|---|
| RC-TS1 | 4.53 | 5.01 | 0.18 |
| RC-TS2 | 2.42 | 4.56 | 0.07 |
| RC-TS3 | 2.18 | 5.06 | 0.08 |
| RC-TS4 | 0.43 | 2.06 | 0.02 |
| RC-TS5 | 0.31 | 2.90 | 0.03 |
| RC-TS6 | 0.60 | 2.05 | 0.02 |

* Peak flows based on 10-Year, 24-Hour event using SCS Type II distribution.

** Maximum velocities and flow depths determined using FlowMaster Open Channel Flow Module, Version 3.3, Haestad Methods, Inc.

Flow depths in channels RC-TS4, RC-TS5 and RC-TS6 indicate the presence of sheet flow. Natural channel conditions in all channels provide a stable channel for the maximum velocities. The FlowMaster calculations are included, and are based on minimum and maximum channel slopes.

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS1 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 11.00 | ft |
| Discharge | 4.53 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.18 | ft |
| Flow Area | 2.0 | ft² |
| Wetted Perimeter | 11.50 | ft |
| Top Width | 11.36 | ft |
| Critical Depth | 0.17 | ft |
| Critical Slope | 0.032737 | ft/ft |
| Velocity | 2.28 | ft/s |
| Velocity Head | 0.08 | ft |
| Specific Energy | 0.26 | ft |
| Froude Number | 0.96 | |
| Flow Type | Subcritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS1 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.400000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 11.00 | ft |
| Discharge | 4.53 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.08 | ft |
| Flow Area | 0.9 | ft² |
| Wetted Perimeter | 11.23 | ft |
| Top Width | 11.16 | ft |
| Critical Depth | 0.17 | ft |
| Critical Slope | 0.032736 | ft/ft |
| Velocity | 5.01 | ft/s |
| Velocity Head | 0.39 | ft |
| Specific Energy | 0.47 | ft |
| Froude Number | 3.10 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS2 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.200000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 12.00 | ft |
| Discharge | 2.42 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.07 | ft |
| Flow Area | 0.8 | ft² |
| Wetted Perimeter | 12.19 | ft |
| Top Width | 12.13 | ft |
| Critical Depth | 0.11 | ft |
| Critical Slope | 0.037985 | ft/ft |
| Velocity | 3.06 | ft/s |
| Velocity Head | 0.15 | ft |
| Specific Energy | 0.21 | ft |
| Froude Number | 2.12 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS2 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.750000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 12.00 | ft |
| Discharge | 2.42 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.04 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 12.12 | ft |
| Top Width | 12.09 | ft |
| Critical Depth | 0.11 | ft |
| Critical Slope | 0.037983 | ft/ft |
| Velocity | 4.56 | ft/s |
| Velocity Head | 0.32 | ft |
| Specific Energy | 0.37 | ft |
| Froude Number | 3.84 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS3 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.300000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 0.67 | V : H |
| Bottom Width | 6.00 | ft |
| Discharge | 2.18 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.08 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 6.27 | ft |
| Top Width | 6.21 | ft |
| Critical Depth | 0.16 | ft |
| Critical Slope | 0.034136 | ft/ft |
| Velocity | 4.33 | ft/s |
| Velocity Head | 0.29 | ft |
| Specific Energy | 0.37 | ft |
| Froude Number | 2.68 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS3 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.500000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 0.67 | V : H |
| Bottom Width | 6.00 | ft |
| Discharge | 2.18 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.07 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 6.23 | ft |
| Top Width | 6.18 | ft |
| Critical Depth | 0.16 | ft |
| Critical Slope | 0.034136 | ft/ft |
| Velocity | 5.06 | ft/s |
| Velocity Head | 0.40 | ft |
| Specific Energy | 0.47 | ft |
| Froude Number | 3.38 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS4 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.350000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 0.67 | V : H |
| Bottom Width | 15.00 | ft |
| Discharge | 0.43 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.02 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 15.06 | ft |
| Top Width | 15.04 | ft |
| Critical Depth | 0.03 | ft |
| Critical Slope | 0.057962 | ft/ft |
| Velocity | 1.67 | ft/s |
| Velocity Head | 0.04 | ft |
| Specific Energy | 0.06 | ft |
| Froude Number | 2.25 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS4 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.700000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 2.00 | V : H |
| Bottom Width | 15.00 | ft |
| Discharge | 0.43 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.01 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 15.04 | ft |
| Top Width | 15.02 | ft |
| Critical Depth | 0.03 | ft |
| Critical Slope | 0.058002 | ft/ft |
| Velocity | 2.06 | ft/s |
| Velocity Head | 0.07 | ft |
| Specific Energy | 0.08 | ft |
| Froude Number | 3.07 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS5 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.300000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 4.00 | ft |
| Discharge | 0.31 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.03 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 4.09 | ft |
| Top Width | 4.07 | ft |
| Critical Depth | 0.06 | ft |
| Critical Slope | 0.047345 | ft/ft |
| Velocity | 2.35 | ft/s |
| Velocity Head | 0.09 | ft |
| Specific Energy | 0.12 | ft |
| Froude Number | 2.30 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS5 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.600000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 4.00 | ft |
| Discharge | 0.31 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.03 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 4.08 | ft |
| Top Width | 4.05 | ft |
| Critical Depth | 0.06 | ft |
| Critical Slope | 0.047349 | ft/ft |
| Velocity | 2.90 | ft/s |
| Velocity Head | 0.13 | ft |
| Specific Energy | 0.16 | ft |
| Froude Number | 3.15 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS6 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.160000 | ft/ft |
| Left Side Slope | 2.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 20.00 | ft |
| Discharge | 0.60 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.02 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 20.06 | ft |
| Top Width | 20.03 | ft |
| Critical Depth | 0.03 | ft |
| Critical Slope | 0.057383 | ft/ft |
| Velocity | 1.34 | ft/s |
| Velocity Head | 0.03 | ft |
| Specific Energy | 0.05 | ft |
| Froude Number | 1.59 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-TS6 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.650000 | ft/ft |
| Left Side Slope | 2.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 20.00 | ft |
| Discharge | 0.60 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.01 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 20.04 | ft |
| Top Width | 20.02 | ft |
| Critical Depth | 0.03 | ft |
| Critical Slope | 0.057376 | ft/ft |
| Velocity | 2.05 | ft/s |
| Velocity Head | 0.07 | ft |
| Specific Energy | 0.08 | ft |
| Froude Number | 2.98 | |
| Flow Type | Supercritical | |

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**Bear Canyon Haul Road and No. 3 Mine Access Road Post-Mining Diversion Designs**

As described in Appendix 3-D, the Bear Canyon Haul Road and the No. 3 Mine Access Road will remain in place for post-mining access to the Wild Horse Ridge hunting cabin. Following are the post-mining designs for the diversions located along these roads.

The watershed characteristics and peak flow calculations are shown on pages 7H-2 through 7H-15. In accordance with R645-301-742.423.1, the 10-year, 6-hour storm event was used to determine the peak flows. The flows are based on the SCS curve number technology using a Type II storm distribution. The table on the following page summarizes the post-mining road diversion design characteristics.

The designs were evaluated using Flowmaster software program. The Flowmaster printouts are shown beginning on page 7H-~~81~~ 78. Riprap sizes were selected from figure 7H-2 (page 7H-18).

## Post-Mining Ditch Characteristics

| Ditch | Contributing Watershed | Peak Flow (cfs) | Slope (%) | Bank and Bottom Description | Manning's Coefficient [1] | Ditch cross section[2] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Bottom Width (ft) | depth (ft)[2] |
| RC-RD1 | road drainage | 1.0[2] | 2 min, 10 max | Soil | 0.030 | 0.0 | 1.5 |
| RC-RD2 | WS-7 | 10.45 | 3 min, 9 max | $D_{50}$ = 6" | 0.035 | 0.0 | 2.0 |
| RC-RD3 | road drainage | 1.0[2] | 3 min, 8 max | Soil | 0.030 | 0.0 | 1.5 |
| RC-RD4 | WS-8 | 8.53 | 3 min, 10 max | $D_{50}$ = 6" | 0.035 | 0.0 | 2.0 |
| RC-RD5 | WS-10 | 8.99 | 1 min, 6 max | Soil | 0.030 | 5.0 | 1.5 |
| RC-RD6 | WS-1A | 0.56 | 3 min, 10 max | Soil | 0.030 | 0.0 | 1.5 |
| RC-RD7 | WS-3A | 0.44 | 2 min, 3 max | Soil | 0.030 | 0.0 | 1.5 |
| RC-RD8 | WS-11 | 5.55 | 6 min, 13 max | $D_{50}$ = 6" | 0.035 | 0.0 | 1.75 |
| RC-RD9 | WS-12, WS-13 | 12.31 | 9 min, 12 max | $D_{50}$ = 6" | 0.035 | 0.0 | 2.0 |
| RC-RD10 | WS-18 | 0.56 | 9 min, 14 max | Soil | 0.030 | 0.0 | 1.5 |
| RC-RD11 | WS-17 | 0.12 | 12 min, 14 max | Soil | 0.030 | 0.0 | 1.25 |
| RC-RD12 | WS-14 | 1.12 | 6 min, 14 max | $D_{50}$ = 3" | 0.031 | 0.0 | 1.5 |
| RC-RD13 | WS-13 | 0.98 | 6 min, 17 max | $D_{50}$ = 3" | 0.031 | 0.0 | 1.5 |
| RC-RD14 | WS-16 | 6.88 | 7 min, 18 max | Bedrock | 0.038 | 0.0 | 2.0 |
| RC-RD15 | WS-20 | 0.34 | 14 min, 22 max | Soil | 0.030 | 0.0 | 1.25 |
| RC-RD16 | WS-21 | 0.93 | 4 min, 22 max | Soil | 0.030 | 2.0 | 1.25 |
| RC-RD17 | WS-21A | 0.14 | 3 min. 13 max | Soil | 0.030 | 0.0 | 1.0 |
| RC-RD 18 | WS19A | 0.42 | 12 min, 14 max | Soil | 0.030 | 0.0 | 1.0 |
| RC-RD19 | WS-19 | 3.54 | 8 min,30 max | $D_{50}$ = 3" | 0.031 | 0.25 | 1.5 |
| RC-RD20 | WS-27 | 4.95 | 6 min, 27 max | $D_{50}$ = 3" | 0.031 | 0.25 | 1.5 |
| RC-RD21 | WS-22A | 2.30 | 7 min, 26 max | $D_{50}$ = 3" | 0.031 | 0.25 | 1.0 |

[1]Manning's coefficient is based on Figure 7H-2 and the equation:

$$n = 0.0395\,(d_{50})^{1/6} \qquad \text{(Barfield et. al., 1981)}$$

where:

n = Manning's roughness coefficient
$d_{50}$ = meidan stone diameter (ft)

[2]Design depth allows an approximate minimum freeboard of 1 ft.

## Post-Mining Culvert Characteristics

| Culvert | Contributing Watershed | Peak Flow (cfs) | Dia. (in) | Culvert Type | Slope (ft/ft) | Outlet Conditions | Manning's Coefficient [1] |
|---|---|---|---|---|---|---|---|
| RCC-1[2] | Road Drainage | 1.0[3] | 15 | CMP | 0.06 | Soil | 0.024 |
| RCC-2 | WS-8 | 8.53 | 24 | CMP | 0.04 | $D_{50}$ = 6" | 0.024 |
| RCC-3 | WS-9, WS-10 | 13.25 | 18 | CMP | 0.10 | $D_{50}$ = 12" | 0.024 |
| RCC-4 | Bear Canyon | 776.76 | 84 | CMP | 0.06 | $D_{50}$ = 48" | 0.024 |
| RCC-5 | WS-2, WS-3 WS-3A | 14.46 | 30 | CMP | 0.10 | $D_{50}$ = 6" | 0.024 |
| RCC-6 | WS-12, WS-13 | 12.31 | 20 | CMP | 0.06 | $D_{50}$ = 6" | 0.024 |
| RCC-7 | Right Fork Lower | 317.39 | 36 | CMP | 0.06 | $D_{50}$ = 36" | 0.024 |
| RCC-8 | WS-14, WS-16 | 8.0 | 15 | CMP | 0.06 | $D_{50}$ = 6" | 0.024 |
| RCC-9 | WS-16 | 6.88 | 15 | CMP | 0.06 | $D_{50}$ = 6" | 0.024 |
| RCC-10 | Right Fork Right | 153.91 | 30 | CMP | 0.06 | $D_{50}$ = 24" | 0.024 |
| RCC-11 | WS-19, WS-20 | 3.88 | 15 | CMP | 0.06 | $D_{50}$ = 6" | 0.024 |
| RCC-12 | WS-21, RCC-15 | 4.47 | 15 | CMP | 0.10 | $D_{50}$ = 6" | 0.024 |
| RCC-13 | WS-19 | 3.54 | 15 | CMP | 0.06 | $D_{50}$ = 3" | 0.024 |
| RCC-14 | WS-27,RCC-15 | 10.25 | 15 | CMP | 0.10 | $D_{50}$ = 8" | 0.024 |
| RCC-15 | WS-22 | 5.30 | 15 | CMP | 0.06 | $D_{50}$ = 6" | 0.024 |

[1]Manning's coefficient based on corrugated metal pipe (Hwang, et. al., 1987).

[2]RCC-1a, Plate 3-2A, receives the same flow and will also meet these design requirements.

[3]Due to small area, peak flow assumed for miscellaneous road drainage to obtain a conservative estimate.

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD1 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.100000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 1.00 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.34 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.50 | ft |
| Top Width | 1.34 | ft |
| Critical Depth | 0.43 | ft |
| Critical Slope | 0.025309 | ft/ft |
| Velocity | 4.43 | ft/s |
| Velocity Head | 0.30 | ft |
| Specific Energy | 0.64 | ft |
| Froude Number | 1.90 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD1 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.020000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 1.00 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.45 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 2.03 | ft |
| Top Width | 1.82 | ft |
| Critical Depth | 0.43 | ft |
| Critical Slope | 0.025309 | ft/ft |
| Velocity | 2.42 | ft/s |
| Velocity Head | 0.09 | ft |
| Specific Energy | 0.55 | ft |
| Froude Number | 0.90 | |
| Flow Type | Subcritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD2 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.090000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 10.45 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.88 | ft |
| Flow Area | 1.5 | ft² |
| Wetted Perimeter | 3.92 | ft |
| Top Width | 3.50 | ft |
| Critical Depth | 1.11 | ft |
| Critical Slope | 0.025193 | ft/ft |
| Velocity | 6.82 | ft/s |
| Velocity Head | 0.72 | ft |
| Specific Energy | 1.60 | ft |
| Froude Number | 1.82 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD2 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 10.45 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.08 | ft |
| Flow Area | 2.3 | ft² |
| Wetted Perimeter | 4.81 | ft |
| Top Width | 4.30 | ft |
| Critical Depth | 1.11 | ft |
| Critical Slope | 0.025194 | ft/ft |
| Velocity | 4.51 | ft/s |
| Velocity Head | 0.32 | ft |
| Specific Energy | 1.39 | ft |
| Froude Number | 1.09 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD3 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.080000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 1.00 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.35 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.57 | ft |
| Top Width | 1.40 | ft |
| Critical Depth | 0.43 | ft |
| Critical Slope | 0.025309 | ft/ft |
| Velocity | 4.07 | ft/s |
| Velocity Head | 0.26 | ft |
| Specific Energy | 0.61 | ft |
| Froude Number | 1.72 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD3 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 1.00 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.42 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 1.88 | ft |
| Top Width | 1.68 | ft |
| Critical Depth | 0.43 | ft |
| Critical Slope | 0.025309 | ft/ft |
| Velocity | 2.82 | ft/s |
| Velocity Head | 0.12 | ft |
| Specific Energy | 0.54 | ft |
| Froude Number | 1.08 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD4 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.100000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 8.53 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.80 | ft |
| Flow Area | 1.3 | ft² |
| Wetted Perimeter | 3.56 | ft |
| Top Width | 3.18 | ft |
| Critical Depth | 1.02 | ft |
| Critical Slope | 0.025885 | ft/ft |
| Velocity | 6.74 | ft/s |
| Velocity Head | 0.71 | ft |
| Specific Energy | 1.50 | ft |
| Froude Number | 1.88 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD4 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 8.53 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.00 | ft |
| Flow Area | 2.0 | ft² |
| Wetted Perimeter | 4.46 | ft |
| Top Width | 3.99 | ft |
| Critical Depth | 1.02 | ft |
| Critical Slope | 0.025885 | ft/ft |
| Velocity | 4.29 | ft/s |
| Velocity Head | 0.29 | ft |
| Specific Energy | 1.28 | ft |
| Froude Number | 1.07 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD5 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.060000 | ft/ft |
| Left Side Slope | 0.33 | V : H |
| Right Side Slope | 0.33 | V : H |
| Bottom Width | 5.00 | ft |
| Discharge | 8.99 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.31 | ft |
| Flow Area | 1.8 | ft² |
| Wetted Perimeter | 6.94 | ft |
| Top Width | 6.84 | ft |
| Critical Depth | 0.42 | ft |
| Critical Slope | 0.019007 | ft/ft |
| Velocity | 4.96 | ft/s |
| Velocity Head | 0.38 | ft |
| Specific Energy | 0.69 | ft |
| Froude Number | 1.70 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD5 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.010000 | ft/ft |
| Left Side Slope | 0.33 | V : H |
| Right Side Slope | 0.33 | V : H |
| Bottom Width | 5.00 | ft |
| Discharge | 8.99 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.51 | ft |
| Flow Area | 3.3 | ft² |
| Wetted Perimeter | 8.22 | ft |
| Top Width | 8.06 | ft |
| Critical Depth | 0.42 | ft |
| Critical Slope | 0.019006 | ft/ft |
| Velocity | 2.71 | ft/s |
| Velocity Head | 0.11 | ft |
| Specific Energy | 0.62 | ft |
| Froude Number | 0.74 | |
| Flow Type | Subcritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD6 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.100000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.56 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.27 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 1.21 | ft |
| Top Width | 1.08 | ft |
| Critical Depth | 0.34 | ft |
| Critical Slope | 0.027343 | ft/ft |
| Velocity | 3.83 | ft/s |
| Velocity Head | 0.23 | ft |
| Specific Energy | 0.50 | ft |
| Froude Number | 1.84 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD6 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.56 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.34 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.52 | ft |
| Top Width | 1.36 | ft |
| Critical Depth | 0.34 | ft |
| Critical Slope | 0.027343 | ft/ft |
| Velocity | 2.44 | ft/s |
| Velocity Head | 0.09 | ft |
| Specific Energy | 0.43 | ft |
| Froude Number | 1.04 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD7 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.44 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.31 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.38 | ft |
| Top Width | 1.24 | ft |
| Critical Depth | 0.31 | ft |
| Critical Slope | 0.028237 | ft/ft |
| Velocity | 2.30 | ft/s |
| Velocity Head | 0.08 | ft |
| Specific Energy | 0.39 | ft |
| Froude Number | 1.03 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD7 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.020000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.44 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.33 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.49 | ft |
| Top Width | 1.34 | ft |
| Critical Depth | 0.31 | ft |
| Critical Slope | 0.028236 | ft/ft |
| Velocity | 1.97 | ft/s |
| Velocity Head | 0.06 | ft |
| Specific Energy | 0.39 | ft |
| Froude Number | 0.85 | |
| Flow Type | Subcritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD8 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.130000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 5.55 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.64 | ft |
| Flow Area | 0.8 | ft² |
| Wetted Perimeter | 2.88 | ft |
| Top Width | 2.58 | ft |
| Critical Depth | 0.86 | ft |
| Critical Slope | 0.027412 | ft/ft |
| Velocity | 6.68 | ft/s |
| Velocity Head | 0.69 | ft |
| Specific Energy | 1.34 | ft |
| Froude Number | 2.07 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD8 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.060000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 5.55 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.75 | ft |
| Flow Area | 1.1 | ft² |
| Wetted Perimeter | 3.33 | ft |
| Top Width | 2.98 | ft |
| Critical Depth | 0.86 | ft |
| Critical Slope | 0.027411 | ft/ft |
| Velocity | 5.00 | ft/s |
| Velocity Head | 0.39 | ft |
| Specific Energy | 1.13 | ft |
| Froude Number | 1.44 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD9 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.120000 | ft/ft |
| Left Side Slope | 0.33 | V : H |
| Right Side Slope | 0.33 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 12.31 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.75 | ft |
| Flow Area | 1.7 | ft² |
| Wetted Perimeter | 4.72 | ft |
| Top Width | 4.48 | ft |
| Critical Depth | 1.01 | ft |
| Critical Slope | 0.024054 | ft/ft |
| Velocity | 7.36 | ft/s |
| Velocity Head | 0.84 | ft |
| Specific Energy | 1.59 | ft |
| Froude Number | 2.12 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD9 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.090000 | ft/ft |
| Left Side Slope | 0.33 | V : H |
| Right Side Slope | 0.33 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 12.31 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.79 | ft |
| Flow Area | 1.9 | ft² |
| Wetted Perimeter | 4.99 | ft |
| Top Width | 4.73 | ft |
| Critical Depth | 1.01 | ft |
| Critical Slope | 0.024053 | ft/ft |
| Velocity | 6.61 | ft/s |
| Velocity Head | 0.68 | ft |
| Specific Energy | 1.47 | ft |
| Froude Number | 1.86 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD10 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.140000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.56 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.25 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 1.14 | ft |
| Top Width | 1.02 | ft |
| Critical Depth | 0.34 | ft |
| Critical Slope | 0.027344 | ft/ft |
| Velocity | 4.35 | ft/s |
| Velocity Head | 0.29 | ft |
| Specific Energy | 0.55 | ft |
| Froude Number | 2.15 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD10 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.090000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.56 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.28 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.23 | ft |
| Top Width | 1.10 | ft |
| Critical Depth | 0.34 | ft |
| Critical Slope | 0.027343 | ft/ft |
| Velocity | 3.68 | ft/s |
| Velocity Head | 0.21 | ft |
| Specific Energy | 0.49 | ft |
| Froude Number | 1.75 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD11 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.140000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.12 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.14 | ft |
| Flow Area | 4.1e-2 | ft² |
| Wetted Perimeter | 0.64 | ft |
| Top Width | 0.57 | ft |
| Critical Depth | 0.19 | ft |
| Critical Slope | 0.033578 | ft/ft |
| Velocity | 2.96 | ft/s |
| Velocity Head | 0.14 | ft |
| Specific Energy | 0.28 | ft |
| Froude Number | 1.95 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD11 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.120000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.12 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.15 | ft |
| Flow Area | 4.3e-2 | ft² |
| Wetted Perimeter | 0.66 | ft |
| Top Width | 0.59 | ft |
| Critical Depth | 0.19 | ft |
| Critical Slope | 0.033577 | ft/ft |
| Velocity | 2.79 | ft/s |
| Velocity Head | 0.12 | ft |
| Specific Energy | 0.27 | ft |
| Froude Number | 1.82 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD12 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.031 | |
| Slope | 0.140000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 1.12 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.33 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.49 | ft |
| Top Width | 1.33 | ft |
| Critical Depth | 0.45 | ft |
| Critical Slope | 0.026619 | ft/ft |
| Velocity | 5.04 | ft/s |
| Velocity Head | 0.40 | ft |
| Specific Energy | 0.73 | ft |
| Froude Number | 2.18 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD 12 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.031 | |
| Slope | 0.060000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 1.12 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.39 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 1.75 | ft |
| Top Width | 1.56 | ft |
| Critical Depth | 0.45 | ft |
| Critical Slope | 0.026619 | ft/ft |
| Velocity | 3.67 | ft/s |
| Velocity Head | 0.21 | ft |
| Specific Energy | 0.60 | ft |
| Froude Number | 1.46 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD13 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.031 | |
| Slope | 0.170000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.98 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.31 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.37 | ft |
| Top Width | 1.22 | ft |
| Critical Depth | 0.43 | ft |
| Critical Slope | 0.027097 | ft/ft |
| Velocity | 5.24 | ft/s |
| Velocity Head | 0.43 | ft |
| Specific Energy | 0.73 | ft |
| Froude Number | 2.37 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD13 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.031 | |
| Slope | 0.060000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.98 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.37 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 1.66 | ft |
| Top Width | 1.49 | ft |
| Critical Depth | 0.43 | ft |
| Critical Slope | 0.027097 | ft/ft |
| Velocity | 3.55 | ft/s |
| Velocity Head | 0.20 | ft |
| Specific Energy | 0.57 | ft |
| Froude Number | 1.45 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD14 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.038 | |
| Slope | 0.180000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 6.88 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.68 | ft |
| Flow Area | 0.9 | ft² |
| Wetted Perimeter | 3.03 | ft |
| Top Width | 2.71 | ft |
| Critical Depth | 0.94 | ft |
| Critical Slope | 0.031399 | ft/ft |
| Velocity | 7.49 | ft/s |
| Velocity Head | 0.87 | ft |
| Specific Energy | 1.55 | ft |
| Froude Number | 2.27 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD14 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.038 | |
| Slope | 0.070000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 6.88 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.81 | ft |
| Flow Area | 1.3 | ft² |
| Wetted Perimeter | 3.62 | ft |
| Top Width | 3.24 | ft |
| Critical Depth | 0.94 | ft |
| Critical Slope | 0.031399 | ft/ft |
| Velocity | 5.25 | ft/s |
| Velocity Head | 0.43 | ft |
| Specific Energy | 1.24 | ft |
| Froude Number | 1.46 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD15 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.220000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.34 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.19 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 0.87 | ft |
| Top Width | 0.77 | ft |
| Critical Depth | 0.28 | ft |
| Critical Slope | 0.029224 | ft/ft |
| Velocity | 4.54 | ft/s |
| Velocity Head | 0.32 | ft |
| Specific Energy | 0.51 | ft |
| Froude Number | 2.58 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD15 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.140000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.34 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.21 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 0.94 | ft |
| Top Width | 0.84 | ft |
| Critical Depth | 0.28 | ft |
| Critical Slope | 0.029224 | ft/ft |
| Velocity | 3.84 | ft/s |
| Velocity Head | 0.23 | ft |
| Specific Energy | 0.44 | ft |
| Froude Number | 2.08 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD16 (Max Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.220000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 2.00 | ft |
| Discharge | 0.93 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.09 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 2.42 | ft |
| Top Width | 2.38 | ft |
| Critical Depth | 0.18 | ft |
| Critical Slope | 0.025473 | ft/ft |
| Velocity | 4.50 | ft/s |
| Velocity Head | 0.31 | ft |
| Specific Energy | 0.41 | ft |
| Froude Number | 2.69 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD16 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.040000 | ft/ft |
| Left Side Slope | 0.50 | V : H |
| Right Side Slope | 0.50 | V : H |
| Bottom Width | 2.00 | ft |
| Discharge | 0.93 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.16 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 2.70 | ft |
| Top Width | 2.62 | ft |
| Critical Depth | 0.18 | ft |
| Critical Slope | 0.025473 | ft/ft |
| Velocity | 2.59 | ft/s |
| Velocity Head | 0.10 | ft |
| Specific Energy | 0.26 | ft |
| Froude Number | 1.23 | |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD17(max) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.130000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.14 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.21 | ft |
| Flow Area | 4.4e-2 | ft² |
| Wetted Perimeter | 0.60 | ft |
| Top Width | 0.42 | ft |
| Critical Depth | 0.26 | ft |
| Critical Slope | 0.041027 | ft/ft |
| Velocity | 3.16 | ft/s |
| Velocity Head | 0.16 | ft |
| Specific Energy | 0.37 | ft |
| Froude Number | 1.72 | |
| Flow Type | Supercritical | |

| Project Description | |
|---|---|
| Worksheet | RC-RD17 (min) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.030000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.14 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.28 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 0.78 | ft |
| Top Width | 0.55 | ft |
| Critical Depth | 0.26 | ft |
| Critical Slope | 0.041028 | ft/ft |
| Velocity | 1.82 | ft/s |
| Velocity Head | 0.05 | ft |
| Specific Energy | 0.33 | ft |
| Froude Number | 0.86 | |
| Flow Type | Subcritical | |

| | |
|---|---|
| Use Minimum Depth = 1 ft<br>Velocity < 5 fps | Minimum Freeboard = 0.74 ft<br>No rip-rap required typically |

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD18 (max) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.140000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.42 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.31 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 0.89 | ft |
| Top Width | 0.63 | ft |
| Critical Depth | 0.41 | ft |
| Critical Slope | 0.035437 | ft/ft |
| Velocity | 4.28 | ft/s |
| Velocity Head | 0.28 | ft |
| Specific Energy | 0.60 | ft |
| Froude Number | 1.90 | |
| Flow Type | Supercritical | |

| Project Description | |
|---|---|
| Worksheet | RC-RD18 (min) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.120000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.42 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.32 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 0.91 | ft |
| Top Width | 0.65 | ft |
| Critical Depth | 0.41 | ft |
| Critical Slope | 0.035437 | ft/ft |
| Velocity | 4.04 | ft/s |
| Velocity Head | 0.25 | ft |
| Specific Energy | 0.58 | ft |
| Froude Number | 1.77 | |
| Flow Type | Supercritical | |

| | |
|---|---|
| Use Minimum Depth = 1 ft<br>Velocity < 5 fps | Minimum Freeboard = 0.59 ft<br>No rip-rap required typically |

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD19 (max) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.300000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.75 | ft |
| Discharge | 3.54 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.37 | ft |
| Flow Area | 0.4 | ft² |
| Wetted Perimeter | 1.78 | ft |
| Top Width | 1.48 | ft |
| Critical Depth | 0.66 | ft |
| Critical Slope | 0.031850 | ft/ft |
| Velocity | 8.69 | ft/s |
| Velocity Head | 1.17 | ft |
| Specific Energy | 1.54 | ft |
| Froude Number | 2.92 | |
| Flow Type | Supercritical | |

| Project Description | |
|---|---|
| Worksheet | RC-RD19 (min) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.031 | |
| Slope | 3.080000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.25 | ft |
| Discharge | 3.54 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.29 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.06 | ft |
| Top Width | 0.82 | ft |
| Critical Depth | 0.84 | ft |
| Critical Slope | 0.027102 | ft/ft |
| Velocity | 23.17 | ft/s |
| Velocity Head | 8.34 | ft |
| Specific Energy | 8.63 | ft |
| Froude Number | 9.47 | |
| Flow Type | Supercritical | |

| | |
|---|---|
| Use Minimum Depth = 1.5 ft<br>Velocity < 6 fps<br>At Steep Slope 30% | Minimum Freeboard = 0.55 ft<br>Use $D_{50}$ = 3”<br>Use $D_{50}$ = 9” |

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD20 (max) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.270000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.75 | ft |
| Discharge | 4.95 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.45 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 2.02 | ft |
| Top Width | 1.65 | ft |
| Critical Depth | 0.79 | ft |
| Critical Slope | 0.030858 | ft/ft |
| Velocity | 9.15 | ft/s |
| Velocity Head | 1.30 | ft |
| Specific Energy | 1.75 | ft |
| Froude Number | 2.82 | |
| Flow Type | Supercritical | |

| Project Description | |
|---|---|
| Worksheet | RC-RD20 (min) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.031 | |
| Slope | 1.060000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.25 | ft |
| Discharge | 4.95 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.43 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 1.47 | ft |
| Top Width | 1.11 | ft |
| Critical Depth | 0.97 | ft |
| Critical Slope | 0.026072 | ft/ft |
| Velocity | 16.87 | ft/s |
| Velocity Head | 4.42 | ft |
| Specific Energy | 4.85 | ft |
| Froude Number | 5.79 | |
| Flow Type | Supercritical | |

| | |
|---|---|
| Use Minimum Depth = 1.5 ft | Minimum Freeboard = 0.41 ft |
| Velocity < 6 fps | Use $D_{50}$ = 3” |
| At Steep Slope 27% | Use $D_{50}$ = 9” |

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-RD21 (max) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.035 | |
| Slope | 0.260000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.50 | ft |
| Discharge | 2.30 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.36 | ft |
| Flow Area | 0.3 | ft² |
| Wetted Perimeter | 1.51 | ft |
| Top Width | 1.22 | ft |
| Critical Depth | 0.60 | ft |
| Critical Slope | 0.034493 | ft/ft |
| Velocity | 7.48 | ft/s |
| Velocity Head | 0.87 | ft |
| Specific Energy | 1.23 | ft |
| Froude Number | 2.62 | |
| Flow Type | Supercritical | |

| Project Description | |
|---|---|
| Worksheet | RC-RD21 (min) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.070000 | ft/ft |
| Left Side Slope | 1.00 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 2.30 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.68 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 1.91 | ft |
| Top Width | 1.35 | ft |
| Critical Depth | 0.80 | ft |
| Critical Slope | 0.028248 | ft/ft |
| Velocity | 5.04 | ft/s |
| Velocity Head | 0.40 | ft |
| Specific Energy | 1.07 | ft |
| Froude Number | 1.53 | |
| Flow Type | Supercritical | |

| | |
|---|---|
| Use Minimum Depth = 1.0 ft<br>Velocity < 5 fps<br>At Steep Slope 26% | Minimum Freeboard = 0.40 ft<br>Use $D_{50}$ = 3”<br>Use $D_{50}$ = 5” |

# Worksheet
## Worksheet for Circular Channel

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

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 1.00 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.29 | ft |
| Flow Area | 0.2 | ft² |
| Wetted Perimeter | 1.25 | ft |
| Top Width | 1.05 | ft |
| Critical Depth | 0.39 | ft |
| Percent Full | 23.1 | % |
| Critical Slope | 0.017755 | ft/ft |
| Velocity | 4.67 | ft/s |
| Velocity Head | 0.34 | ft |
| Specific Energy | 0.63 | ft |
| Froude Number | 1.83 | |
| Maximum Discharge | 9.22 | cfs |
| Discharge Full | 8.57 | cfs |
| Slope Full | 0.000817 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-2 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.040000 | ft/ft |
| Diameter | 24 | in |
| Discharge | 8.53 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.81 | ft |
| Flow Area | 1.2 | ft² |
| Wetted Perimeter | 2.77 | ft |
| Top Width | 1.97 | ft |
| Critical Depth | 1.04 | ft |
| Percent Full | 40.7 | % |
| Critical Slope | 0.016910 | ft/ft |
| Velocity | 7.10 | ft/s |
| Velocity Head | 0.78 | ft |
| Specific Energy | 1.60 | ft |
| Froude Number | 1.60 | |
| Maximum Discharge | 26.36 | cfs |
| Discharge Full | 24.51 | cfs |
| Slope Full | 0.004846 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-3 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.100000 | ft/ft |
| Diameter | 18 | in |
| Discharge | 13.25 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.96 | ft |
| Flow Area | 1.2 | ft² |
| Wetted Perimeter | 2.78 | ft |
| Top Width | 1.44 | ft |
| Critical Depth | 1.36 | ft |
| Percent Full | 63.8 | % |
| Critical Slope | 0.047490 | ft/ft |
| Velocity | 11.13 | ft/s |
| Velocity Head | 1.93 | ft |
| Specific Energy | 2.88 | ft |
| Froude Number | 2.16 | |
| Maximum Discharge | 19.35 | cfs |
| Discharge Full | 17.99 | cfs |
| Slope Full | 0.054235 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-4 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 84 | in |
| Discharge | 776.76 | cfs |

| Results | | |
|---|---|---|
| Depth | 5.27 | ft |
| Flow Area | 31.1 | ft² |
| Wetted Perimeter | 14.71 | ft |
| Top Width | 6.04 | ft |
| Critical Depth | 6.69 | ft |
| Percent Full | 75.3 | % |
| Critical Slope | 0.043758 | ft/ft |
| Velocity | 24.98 | ft/s |
| Velocity Head | 9.70 | ft |
| Specific Energy | 14.97 | ft |
| Froude Number | 1.94 | |
| Maximum Discharge | 911.73 | cfs |
| Discharge Full | 847.56 | cfs |
| Slope Full | 0.050395 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-5 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.100000 | ft/ft |
| Diameter | 432 | in |
| Discharge | 14.46 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.38 | ft |
| Flow Area | 1.9 | ft² |
| Wetted Perimeter | 7.39 | ft |
| Top Width | 7.34 | ft |
| Critical Depth | 0.63 | ft |
| Percent Full | 1.1 | % |
| Critical Slope | 0.011399 | ft/ft |
| Velocity | 7.79 | ft/s |
| Velocity Head | 0.94 | ft |
| Specific Energy | 1.32 | ft |
| Froude Number | 2.73 | |
| Maximum Discharge | 92,754.31 | cfs |
| Discharge Full | 86,226.44 | cfs |
| Slope Full | 2.812261e-9 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-6 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.040 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 20 | in |
| Discharge | 12.31 | cfs |

| Results | | |
|---|---|---|
| Depth | 1.50 | ft |
| Flow Area | 2.1 | ft² |
| Wetted Perimeter | 4.14 | ft |
| Top Width | 1.10 | ft |
| Critical Depth | 1.32 | ft |
| Percent Full | 88.0 | % |
| Critical Slope | 0.074750 | ft/ft |
| Velocity | 5.82 | ft/s |
| Velocity Head | 0.53 | ft |
| Specific Energy | 2.02 | ft |
| Froude Number | 0.74 | |
| Maximum Discharge | 12.56 | cfs |
| Discharge Full | 11.68 | cfs |
| Slope Full | 0.066704 | ft/ft |
| Flow Type | Subcritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-7 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 60 | in |
| Discharge | 317.39 | cfs |

| Results | | |
|---|---|---|
| Depth | 3.77 | ft |
| Flow Area | 15.9 | ft² |
| Wetted Perimeter | 10.53 | ft |
| Top Width | 4.30 | ft |
| Critical Depth | 4.73 | ft |
| Percent Full | 75.5 | % |
| Critical Slope | 0.043786 | ft/ft |
| Velocity | 19.96 | ft/s |
| Velocity Head | 6.19 | ft |
| Specific Energy | 9.97 | ft |
| Froude Number | 1.83 | |
| Maximum Discharge | 371.70 | cfs |
| Discharge Full | 345.54 | cfs |
| Slope Full | 0.050623 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-8 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 8.00 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.96 | ft |
| Flow Area | 1.0 | ft² |
| Wetted Perimeter | 2.66 | ft |
| Top Width | 1.06 | ft |
| Critical Depth | 1.12 | ft |
| Percent Full | 76.6 | % |
| Critical Slope | 0.046387 | ft/ft |
| Velocity | 7.94 | ft/s |
| Velocity Head | 0.98 | ft |
| Specific Energy | 1.94 | ft |
| Froude Number | 1.43 | |
| Maximum Discharge | 9.22 | cfs |
| Discharge Full | 8.57 | cfs |
| Slope Full | 0.052279 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-9 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 6.88 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.85 | ft |
| Flow Area | 0.9 | ft² |
| Wetted Perimeter | 2.42 | ft |
| Top Width | 1.17 | ft |
| Critical Depth | 1.05 | ft |
| Percent Full | 67.8 | % |
| Critical Slope | 0.036933 | ft/ft |
| Velocity | 7.76 | ft/s |
| Velocity Head | 0.94 | ft |
| Specific Energy | 1.78 | ft |
| Froude Number | 1.57 | |
| Maximum Discharge | 9.22 | cfs |
| Discharge Full | 8.57 | cfs |
| Slope Full | 0.038665 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-10 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 48 | in |
| Discharge | 153.91 | cfs |

| Results | | |
|---|---|---|
| Depth | 2.73 | ft |
| Flow Area | 9.1 | ft² |
| Wetted Perimeter | 7.77 | ft |
| Top Width | 3.73 | ft |
| Critical Depth | 3.63 | ft |
| Percent Full | 68.1 | % |
| Critical Slope | 0.034267 | ft/ft |
| Velocity | 16.88 | ft/s |
| Velocity Head | 4.43 | ft |
| Specific Energy | 7.15 | ft |
| Froude Number | 1.90 | |
| Maximum Discharge | 205.00 | cfs |
| Discharge Full | 190.58 | cfs |
| Slope Full | 0.039133 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-11 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 3.88 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.59 | ft |
| Flow Area | 0.6 | ft² |
| Wetted Perimeter | 1.89 | ft |
| Top Width | 1.25 | ft |
| Critical Depth | 0.80 | ft |
| Percent Full | 47.2 | % |
| Critical Slope | 0.022735 | ft/ft |
| Velocity | 6.81 | ft/s |
| Velocity Head | 0.72 | ft |
| Specific Energy | 1.31 | ft |
| Froude Number | 1.78 | |
| Maximum Discharge | 9.22 | cfs |
| Discharge Full | 8.57 | cfs |
| Slope Full | 0.012297 | ft/ft |
| Flow Type | Supercritical | |

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-12 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.100000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 4.47 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.55 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 1.82 | ft |
| Top Width | 1.24 | ft |
| Critical Depth | 0.86 | ft |
| Percent Full | 44.2 | % |
| Critical Slope | 0.024608 | ft/ft |
| Velocity | 8.54 | ft/s |
| Velocity Head | 1.13 | ft |
| Specific Energy | 1.69 | ft |
| Froude Number | 2.32 | |
| Maximum Discharge | 11.90 | cfs |
| Discharge Full | 11.06 | cfs |
| Slope Full | 0.016322 | ft/ft |
| Flow Type | Supercritical | |

Minimum required riprap conditions = 6” m.d. riprap outlet.

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-13 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 3.54 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.56 | ft |
| Flow Area | 0.5 | ft² |
| Wetted Perimeter | 1.83 | ft |
| Top Width | 1.24 | ft |
| Critical Depth | 0.76 | ft |
| Percent Full | 44.8 | % |
| Critical Slope | 0.021826 | ft/ft |
| Velocity | 6.65 | ft/s |
| Velocity Head | 0.69 | ft |
| Specific Energy | 1.25 | ft |
| Froude Number | 1.79 | |
| Maximum Discharge | 9.22 | cfs |
| Discharge Full | 8.57 | cfs |
| Slope Full | 0.010237 | ft/ft |
| Flow Type | Supercritical | |

Minimum required riprap conditions = 3” m.d. riprap outlet.

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-14 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.100000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 10.25 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.95 | ft |
| Flow Area | 1.0 | ft² |
| Wetted Perimeter | 2.65 | ft |
| Top Width | 1.07 | ft |
| Critical Depth | 1.19 | ft |
| Percent Full | 76.0 | % |
| Critical Slope | 0.074378 | ft/ft |
| Velocity | 10.24 | ft/s |
| Velocity Head | 1.63 | ft |
| Specific Energy | 2.58 | ft |
| Froude Number | 1.86 | |
| Maximum Discharge | 11.90 | cfs |
| Discharge Full | 11.06 | cfs |
| Slope Full | 0.085821 | ft/ft |
| Flow Type | Supercritical | |

Minimum required riprap conditions = 8" m.d. riprap outlet.

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# Worksheet
## Worksheet for Circular Channel

| Project Description | |
|---|---|
| Worksheet | RCC-15 |
| Flow Element | Circular Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.024 | |
| Slope | 0.060000 | ft/ft |
| Diameter | 15 | in |
| Discharge | 5.30 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.71 | ft |
| Flow Area | 0.7 | ft² |
| Wetted Perimeter | 2.14 | ft |
| Top Width | 1.24 | ft |
| Critical Depth | 0.93 | ft |
| Percent Full | 56.9 | % |
| Critical Slope | 0.027878 | ft/ft |
| Velocity | 7.35 | ft/s |
| Velocity Head | 0.84 | ft |
| Specific Energy | 1.55 | ft |
| Froude Number | 1.70 | |
| Maximum Discharge | 9.22 | cfs |
| Discharge Full | 8.57 | cfs |
| Slope Full | 0.022945 | ft/ft |
| Flow Type | Supercritical | |

Minimum required riprap conditions = 6" m.d. riprap outlet.

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# Ball Park Channel

## RC-BP1

This channel is proposed as a post-mining channel to divert water away from the reclaimed ballpark area.

During the year 2000, increased flows have been observed coming from springs located upslope from the ballpark. These increased flows have resulted in water flowing from offsite onto the ballpark and through the silt fences and straw bales currently treating the area. In an effort to provide permanent protection for the reclaimed area, Co-Op proposes to construct this channel along the upslope side of the ballpark to divert flows around the ballpark.

The current flows which have been observed from the spring average 15 - 20 gpm, or 0.044 cfs. To provide added safety, a flow three times that of the observed flow was used in the design, or 0.13 cfs. The channel flow and cross section was analyzed using "Flowmaster" channel design software. This program uses Manning's formula to determine the required flow and depth. The results of the evaluation are shown on the following pages.

A maximum flow velocity of 2.03 fps was determined as shown on page 7H-~~125~~ 131. This flow indicates that no riprap will be required (see riprap designs on page 7H-18). A maximum flow depth of 0.24 feet was determined (page 7H-~~126~~ 132). A freeboard of 1 foot has been added to allow for additional capacity.

The proposed channel designs are as follows:

| Channel | Q max | Max. Vel. | Left Side | Rt Side | Depth | Max Slope |
|---|---|---|---|---|---|---|
| RC-BP1 | 0.13 cfs | 2.03 fps | 3H:1V | 1H:1V | 1.24' | 0.05 ft/ft |

A cross section of the channel is shown on page 7H-~~127~~ 133.

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-BP1 |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.050000 | ft/ft |
| Left Side Slope | 0.33 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.13 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.18 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 0.82 | ft |
| Top Width | 0.72 | ft |
| Critical Depth | 0.19 | ft |
| Critical Slope | 0.034256 | ft/ft |
| Velocity | 2.03 | ft/s |
| Velocity Head | 0.06 | ft |
| Specific Energy | 0.24 | ft |
| Froude Number | 1.19 | |
| Flow Type | Supercritical | |

Notes: Maximum Slope

# Worksheet
## Worksheet for Trapezoidal Channel

| Project Description | |
|---|---|
| Worksheet | RC-BP1 (Min Slope) |
| Flow Element | Trapezoidal Channel |
| Method | Manning's Formula |
| Solve For | Channel Depth |

| Input Data | | |
|---|---|---|
| Mannings Coefficient | 0.030 | |
| Slope | 0.010000 | ft/ft |
| Left Side Slope | 0.33 | V : H |
| Right Side Slope | 1.00 | V : H |
| Bottom Width | 0.00 | ft |
| Discharge | 0.13 | cfs |

| Results | | |
|---|---|---|
| Depth | 0.24 | ft |
| Flow Area | 0.1 | ft² |
| Wetted Perimeter | 1.11 | ft |
| Top Width | 0.97 | ft |
| Critical Depth | 0.19 | ft |
| Critical Slope | 0.034236 | ft/ft |
| Velocity | 1.11 | ft/s |
| Velocity Head | 0.02 | ft |
| Specific Energy | 0.26 | ft |
| Froude Number | 0.56 | |
| Flow Type | Subcritical | |

Notes: Minimum Slope

# Channel RC-BP1

Typical cross-section

Note: No riprap required - Max. Velocity = 2.03 ft/s