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FILE: ACT/015/009

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October 9, 1981

Mr. Wayne Hedberg
Division of Oil, Gas, & Mining
1588 W. North Temple
Salt Lake City, Utah 84110

RE: Justification of culvert size used to pass 510 cfs flood on Cottonwood Creek

Dear Mr. Hedberg:

Andy King has asked that we submit our calculations showing that the culvert we designed for Cottonwood Creek has the capacity to pass the 50-year flood event. The U.S. Forest Service estimated the design flood to be 450 cfs. We have estimated it to be about 510 cfs and have designed the culvert with a capacity of about 535 cfs.

We have used the Darcy-Weisbach equation for estimating headloss in the culvert. This is considered as the most accurate headloss equation. As you may be aware, headloss through a culvert and entrance capacity of a culvert both need to be checked to determine actual capacity. When culverts are installed on fairly steep slopes (such as in the Natomas Trail Mountain case) the inlet capacity is much less than the capacity of the rest of the culvert. Consequently, in large, expensive installations on relatively steep slopes it is cost-effective to use a larger inlet than the main portion of the culvert. That is why we recommend using a 96-inch inlet which goes into a transition down to the 66-inch main culvert.

If you have any questions please feel free to call me.

Sincerely,

D. George Chadwick Jr.

D. George Chadwick, Jr., P.E.

DGC/das

Enclosure

cc: Andy King

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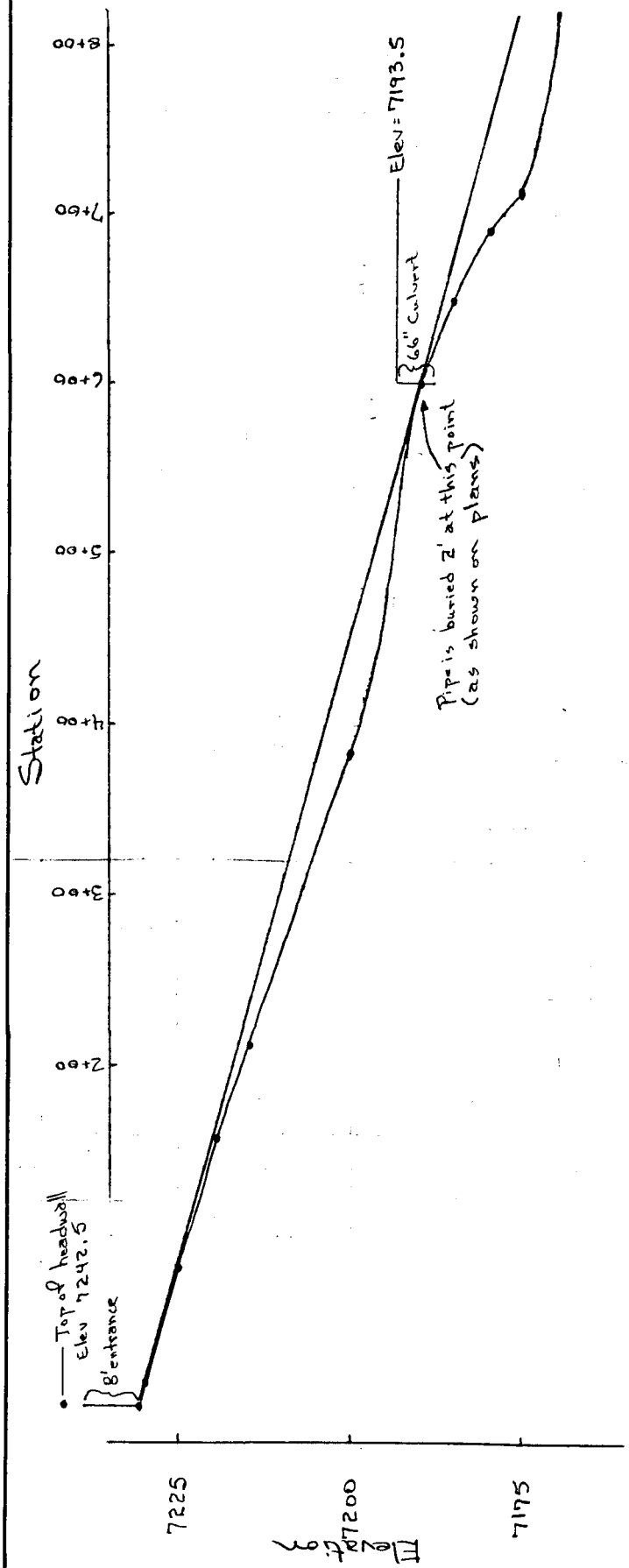
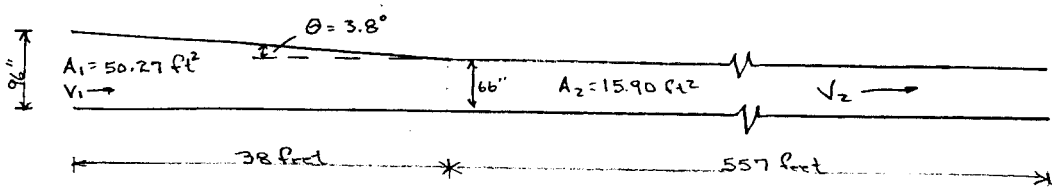
OCT 13 1981
DIVISION OF
OIL, GAS & MINING

Determination of Culvert Size needed to pass 510 cfs Flood on Cottonwood Creek



Governing section of pipe is from Sta 0+00 to 5+95
The allowable headloss through this section is 7242.5 − 7193.5 = 49 feet



Using Darcy-Weisbach Equation

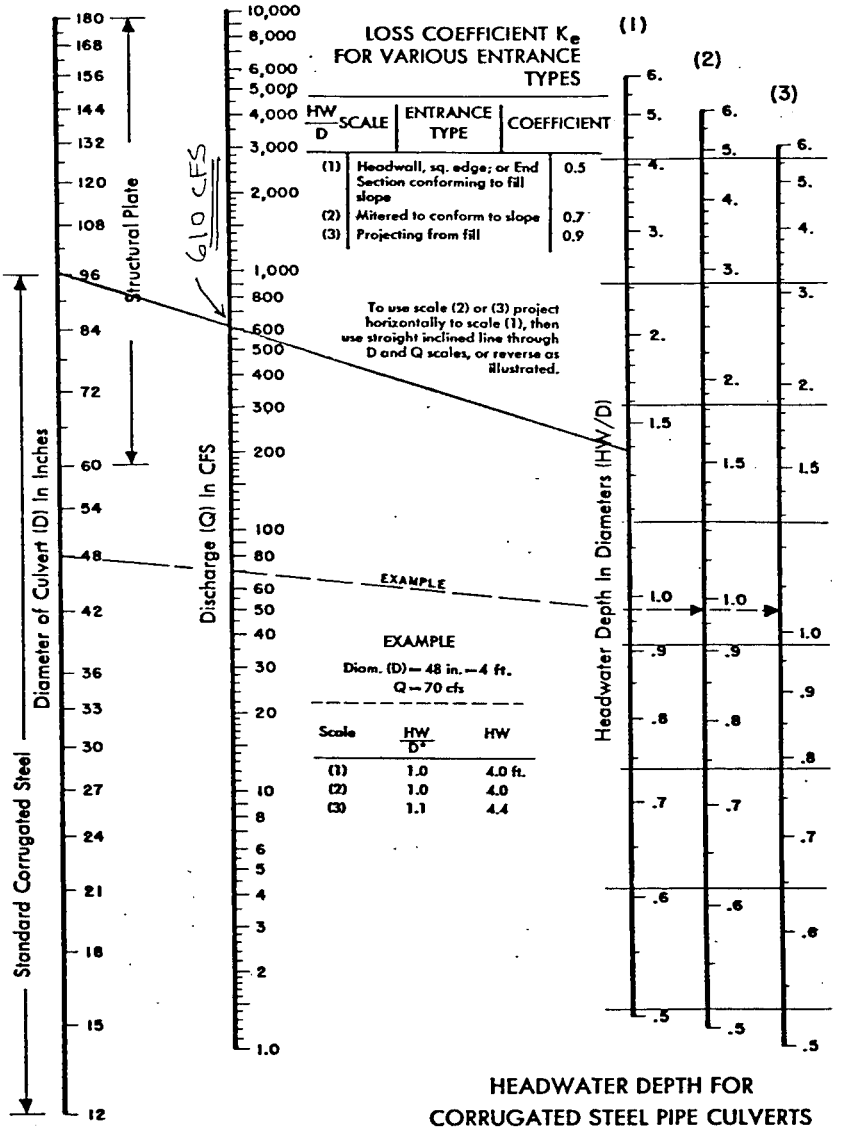
Minor Losses

	K	~~Headloss (H_L)~~
Entrance loss	0.25	$H_L = 0.25 \frac{V_1^2}{2g}$
Contraction	0.11	
Bends (2 @ 0.08 ea.)	0.16	
Exit	1.0	
	$\Sigma = 1.27$	$H_L = 1.27 \frac{V_2^2}{2g}$

Friction Loss

Headloss in a pipe is $\frac{fL}{D} \frac{V^2}{2g}$

The headloss in the 38 ft transition is approximated by the above formula when D = 6.5 ft



HEADWATER DEPTH FOR CORRUGATED STEEL PIPE CULVERTS WITH INLET CONTROL

Trial #1 $Q = 450$ cfs

$V_1 = \frac{450}{50.27} = 8.95$ fps

$V_2 = \frac{450}{23.76} = 18.94$ fps

V in 6.5' average transitional section is $\frac{450}{33.18} = 13.56$ fps

Minor losses $= .25\frac{(8.95)^2}{64.4} + 1.27\frac{(18.94)^2}{64.4} = \underline{7.1 \text{ ft}}$

Major losses

— 557 ft of 5.5' pipe

$e = .1$ $e/D = .1/5.5 = .018$ so $f = .047$

$H_L = (.047)\frac{(557)}{5.5}\frac{(18.94)^2}{64.4} = \underline{26.5 \text{ feet}}$

— 38 ft of 6.5' ave. dia. transition

$H_L = (.044)\frac{(38)}{6.5}\frac{(13.56)^2}{64.4} = \underline{.7 \text{ ft}}$

Total Loss $= 7.1 + 26.5 + .7 = \underline{\underline{34.3 \text{ feet}}}$

Trial #2 $Q = 535$ CFS

$V_1 = \frac{535}{50.27} = 10.64$ fps V in 6.5' ave. trans. section is $\frac{535}{33.18} = 16.12$ fps

$V_2 = \frac{535}{23.76} = 22.52$ fps

Minor losses $= .25\frac{(10.64)^2}{64.4} + 1.27\frac{(22.52)^2}{64.4} = \underline{10.4 \text{ ft}}$

Major losses

-557 ft of pipe $H_L = (.047)\frac{(557)}{5.5}\frac{(22.52)^2}{64.4} = \underline{37.5 \text{ ft}}$

- 38 ft of ave. diam. 6.5' transition

$H_L = .044\frac{(38)}{6.5}\frac{(16.12)^2}{64.4} = \underline{1.0 \text{ ft}}$

Total losses $= 10.4 + 37.5 + 1.0 = \underline{48.9 \text{ ft}}$ OK (because it is ≈49 ft available)

therefore $\boxed{\text{Capacity is 535 CFS}}$

Check inlet control of 96" Culvert $\frac{Hw}{D} = 11/8 = 1.38$

From Nomograph. Capacity is 610 CFS so 535 cfs governs.

535 cfs is greater than the 510 cfs required.