SHOOKS RUN

DRAINAGE BASIN PLANNING STUDY

TECHNICAL APPENDIX VOLUME III - IMPROVEMENT ALTERNATIVES ANALYSIS

prepared for

City of Colorado Springs, Colorado
Department of Planning & Development
City Engineering Division

455 East Pikes Peak Avenue, Suite 200
Colorado Springs, Colorado 80903-3675
Project No. 90-809

WILSON &COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
TECHNICAL APPENDIX

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A. SOFT-LINED FULL IMPROVEMENT ALTERNATIVE HYDRAULIC CALCULATIONS

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PROJ. Shooks Run

SUBJ. Soft-Lined Alternative

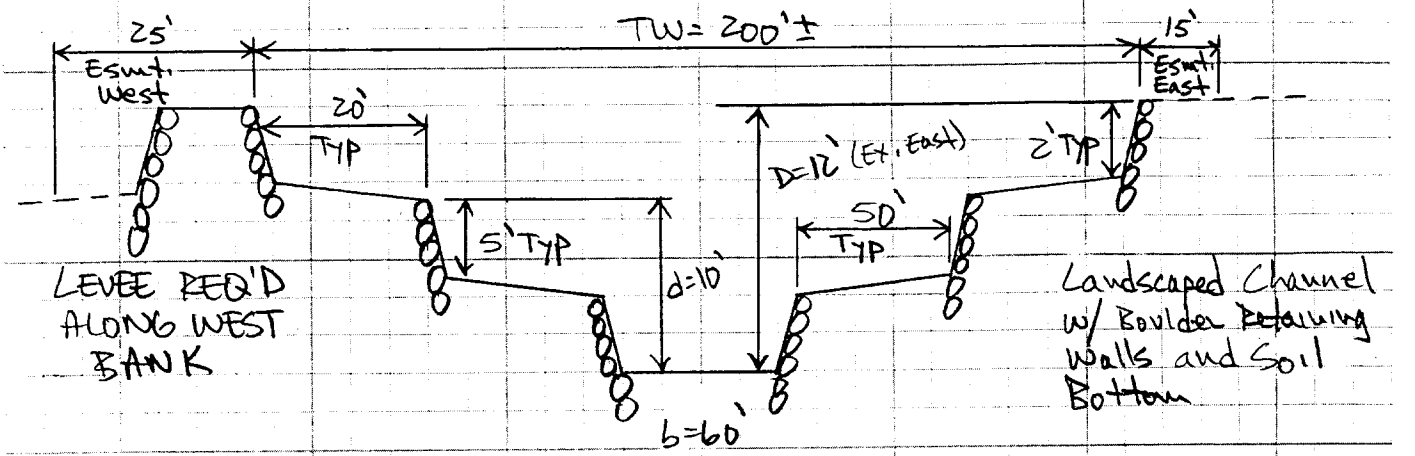
FILE 90-809

SHEET 1

OF

SOFT-LINED ALTERNATIVE

Sta. 0+25 to Sta. 9+75 - New open Channel between Fountain Creek confluence and Las Vegas Street



$Q_{100} = 6910$ cfs $\quad S_{EX} = 0.4\%$

$d = 10' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{1100}{180}\right)^{2/3}(0.004)^{1/2} = 6.3$ fps $\Rightarrow Q = (6.3)(1100) = 6925$ cfs

Freeboard $= 1.0 + (0.025)(6.3)(10)^{1/3} = 1.3' \Rightarrow$ Use 2' $\quad D_{min} = 10+2 = 12'$ (Meet exist. east bank)

$F = \frac{6.3}{\sqrt{(32.2)(10)}} = 0.35 \Rightarrow$ Subcritical

Sta. 9+75 to Sta. 10+80 - Replace bridge and dissipator at Las Vegas Street

5 - 12' x 10' RCB

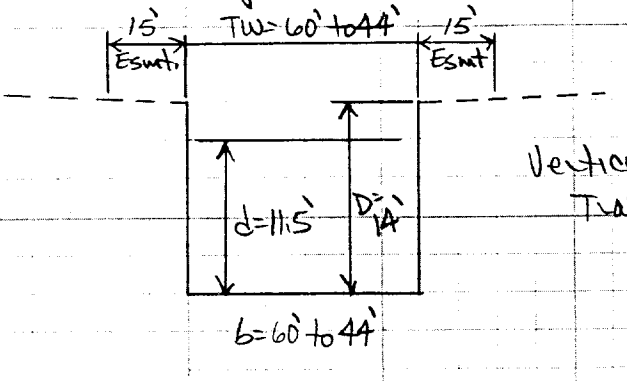
$Q_{100} = 6910$ cfs $\quad L = 70' \quad S_{EX} = 0.7\% \quad$ AHW = 111.6 - 97.7 = 13.9'

Inlet Control $\Rightarrow Q/b = \frac{6910}{60} = 115 \quad HW/D = 1.2 \quad HW = (1.2)(10) = 12'$

Outlet Control $\Rightarrow H = 3' \quad d_c = 7.5' \quad H_0 = \frac{10+7.5}{2} = 9'$

$LS_0 = (70)(0.007) = 0.5' \quad HW = 3 + 9 - 0.5 = 11.5'$

Sta. 10+80 to Sta. 11+20 - New Concrete transition channel between Las Vegas Street and A.T.S.F. & D.R.G.W. Railroad



Vertical Walled Concrete Transition Channel

$Q_{100} = 6910$ cfs $S_{EX} = 1.0\%$

$d = 5.5'$ and $b = 44' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{242}{55}\right)^{2/3}(0.010)^{1/2} = 30.8$ fps $\Rightarrow Q = (30.8)(242) = 7455$ cfs

Actual $d = 12.0'$ to $11.5' \pm$ (Est'd/Exist HEC2) $\Rightarrow d = 11.5'$ and $b = 44' \Rightarrow A = 506$ sf $V = \frac{6910}{506} = 13.7$ fps

Freeboard $= 1.0 + (0.025)(13.7)(11.5)^{1/3} = 1.8' \Rightarrow$ Use $2'$ $D_{min} = 11.5 + 2.0 = 13.5 \Rightarrow$ Use $14'$

$F = \frac{13.7}{\sqrt{(32.2)(11.5)}} = 0.71 \Rightarrow$ Subcritical

Sta. 11+20 to 11+65 - Existing Culvert for A.T.S.F. & D.R.G.W. Railroad

Double $20' \times 16.5'$ Conc. Arch ($18.7' \times 15.4'$ RCB Equiv)

$Q_{100} = 6910$ cfs $L = 45'$ $S_{EX} = 1.3\%$ $AHW = 23.2 - 98.7 = 24.5'$

Inlet Control $\Rightarrow Q/b = \frac{6910}{(2)(18.7)} = 185$ $HW/D = 1.1$ $HW = (1.1)(15.4) = 16.9'$

Outlet Control $\Rightarrow H = 3'$ $H_0 = 11.5'$ $LS_0 = (45)(0.013) = 0.6'$

$HW = 3 + 11.5 - 0.6 = 13.9'$

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PROJ. Shooks Run

SUBJ. Soft-Lined Alternative

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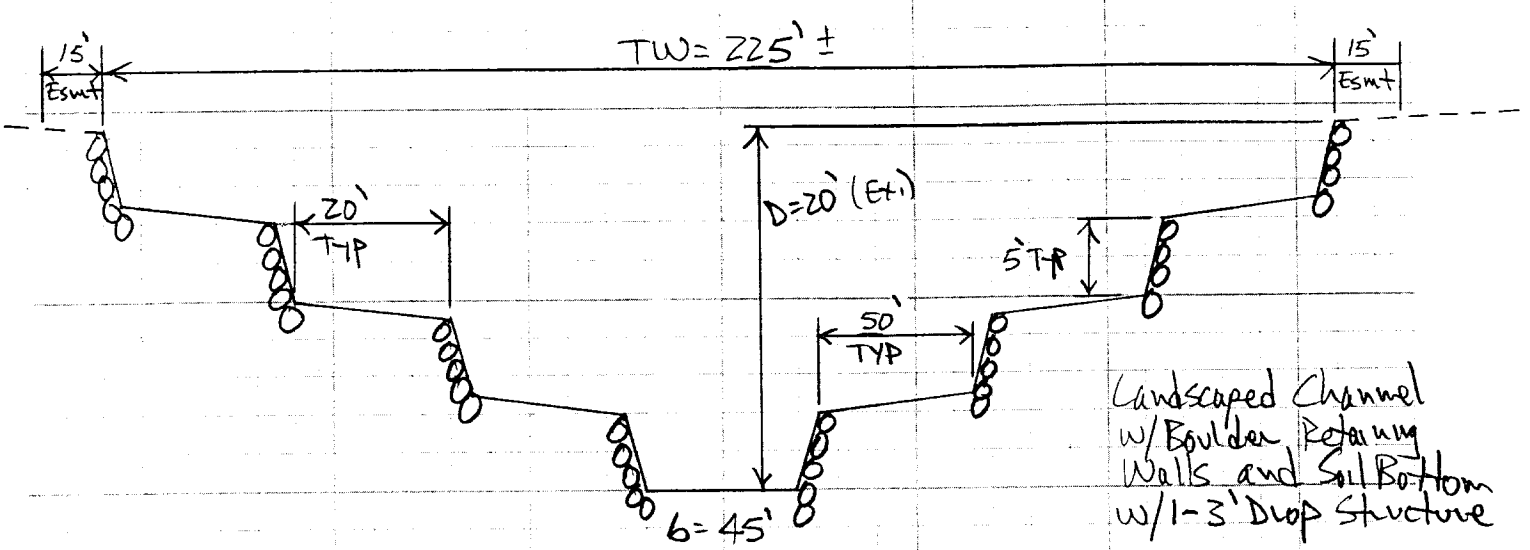
SHEET 3

OF

Sta. 11+65 to Sta. 15+60 - Newgen Channel between A.T.S.F. & D.R.G.W. Railroad and abandoned railroad



Landscaped Channel w/ Boulder Retaining Walls and Soil Bottom w/ 1-3' Drop Structure

Q_{100} = 6910 cfs S_{EX} = 1.2% S_{PRO} = 0.5% ±

$d = 11' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{1135}{207}\right)^{2/3}(0.005)^{1/2} = 6.6$ fps $\Rightarrow Q = (6.6)(1135) = 7490$ cfs

Actual d = 16.9' to 13.5' ± (Est'd / Exist HEC2) $\Rightarrow d = 13.5' \Rightarrow A = 1598$ sf $V = \frac{6910}{1598} = 4.3$ fps

Freeboard = $1.0 + 0.025(4.3)(13.5)^{1/3} = 1.3' \Rightarrow$ use 2.0' $D_{min} = 13.5 + 2.0 = 15.5'$

$F = \frac{4.3}{\sqrt{(32.2)(13.5)}} = 0.21 \Rightarrow$ Subcritical

Sta. 15+60 to 16+20 - Existing culvert for abandoned railroad

Double 20' x 17.9' Stone Masonry Arch (18.8' x 16.8' RCB Equiv)

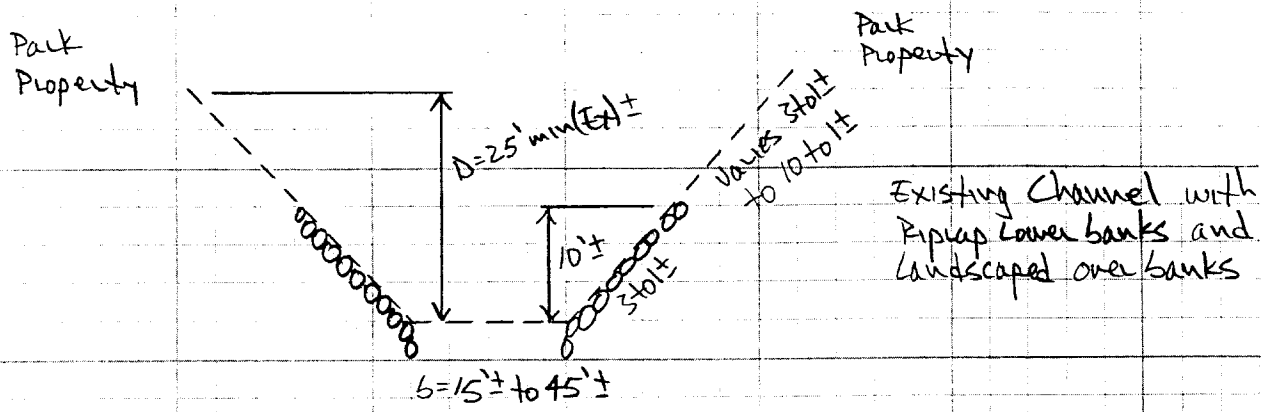
Q_{100} = 6910 cfs L = 60' S_{EX} = 0.7% AHW = 43.8 - 03.8 = 40.0'

Inlet Control $\Rightarrow Q/b = \frac{6910}{2(18.8)} = 184$ HW/D = 1.1 HW = (1.1)(16.8) = 18.5'

Outlet Control $\Rightarrow$ H = 2.3' H_0 = 13.5' $LS_0 = (60)(0.00) = 0.4'$

HW = 2.3 + 13.5 - 0.4 = 15.4'

Sta. 16+20 to Sta. 24+00 - Remove undesireable vegetation and debris from floodplain between abandoned railroad and Fountain Boulevard



Q_{100} = 6910 cfs to 6940 cfs S_{EX} = 0.17% ±

d = 11' and b = 30'± ⇒ $V = \left(\frac{1.49}{0.045}\right)\left(\frac{693}{100}\right)^{4/3}(0.001)^{1/2}$ = 10.1 fps ⇒ Q = (10.1)(693) = 7000 cfs

Actual d = 18.5' to 15'± (Est'd/ Exist HEC2) ⇒ d = 15' and b = 30' ⇒ A = 1125 sf $V = \frac{6940}{1125}$ = 6.2 fps

Freeboard = 1.0 + 0.025(6.2)(15.0)$^{1/3}$ = 1.4' ⇒ use 2.0' D_{min} = 15+2 = 17.0'

$F = \frac{6.2}{\sqrt{(32.2)(15.0)}} = 0.28$ ⇒ Subcritical

Sta. 24+00 to Sta. 25+50 - Replace culvert at Fountain Boulevard

4 - 12' x 10' RCB

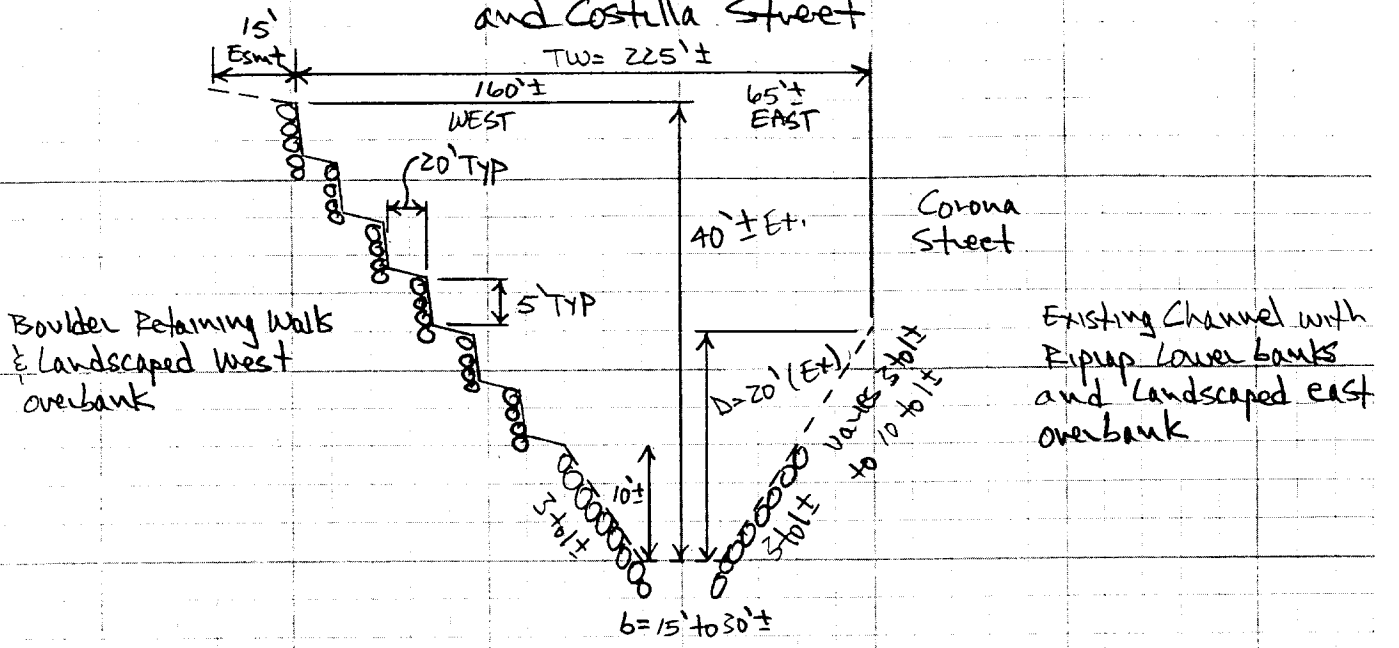
Q_{100} = 6940 cfs L = 150' S_{EX} = 0.17% AHW = 30.3 - 10.3 = 20.0'

Inlet Control ⇒ $Q/b = \frac{6940}{48} = 145$ HW/D = 1.5 HW = (1.5)(10) = 15.0'

Outlet Control ⇒ H = 4.6' H_0 = 15' LS_0 = (150)(0.007) = 1.1'

HW = 4.6 + 15 - 1.1 = 18.5'

Sta. 25+50 to Sta. 48+65 - Remove undesireable vegetation and debris from floodplain and reduce slope of West overbank between Fountain Boulevard and Costilla Street



Q_{100} = 6940 cfs to 6820 cfs S_{EX} = 0.18%

$d = 10.5'$ and $b = 30'\pm \Rightarrow V = \left(\frac{1.49}{0.045}\right)\left(\frac{646}{96}\right)^{2/3}(0.008)^{1/2} = 10.6 fps \Rightarrow Q = (10.6)(646) = 6850 cfs$

Actual $d = 18.5'$ to $12.5' \pm$ (Est'd/Exist HEC2) $\Rightarrow d = 12.5'$ and $b = 30' \Rightarrow A = 884 sf$ $V = \frac{6820}{884} = 7.7 fps$

Freeboard $= 1.0 + (0.025)(7.7)(12.5)^{1/3} = 1.4' \Rightarrow$ Use 2.0' $D_{min} = 12.5 + 2.0 = 14.5'$

$F = \frac{7.7}{\sqrt{(32.2)(12.5)}} = 0.38 \Rightarrow$ Subcritical

Sta. 48+65 to Sta. 50+65 - Replace culvert at Costilla Street

4 - 10' x 10' RCB

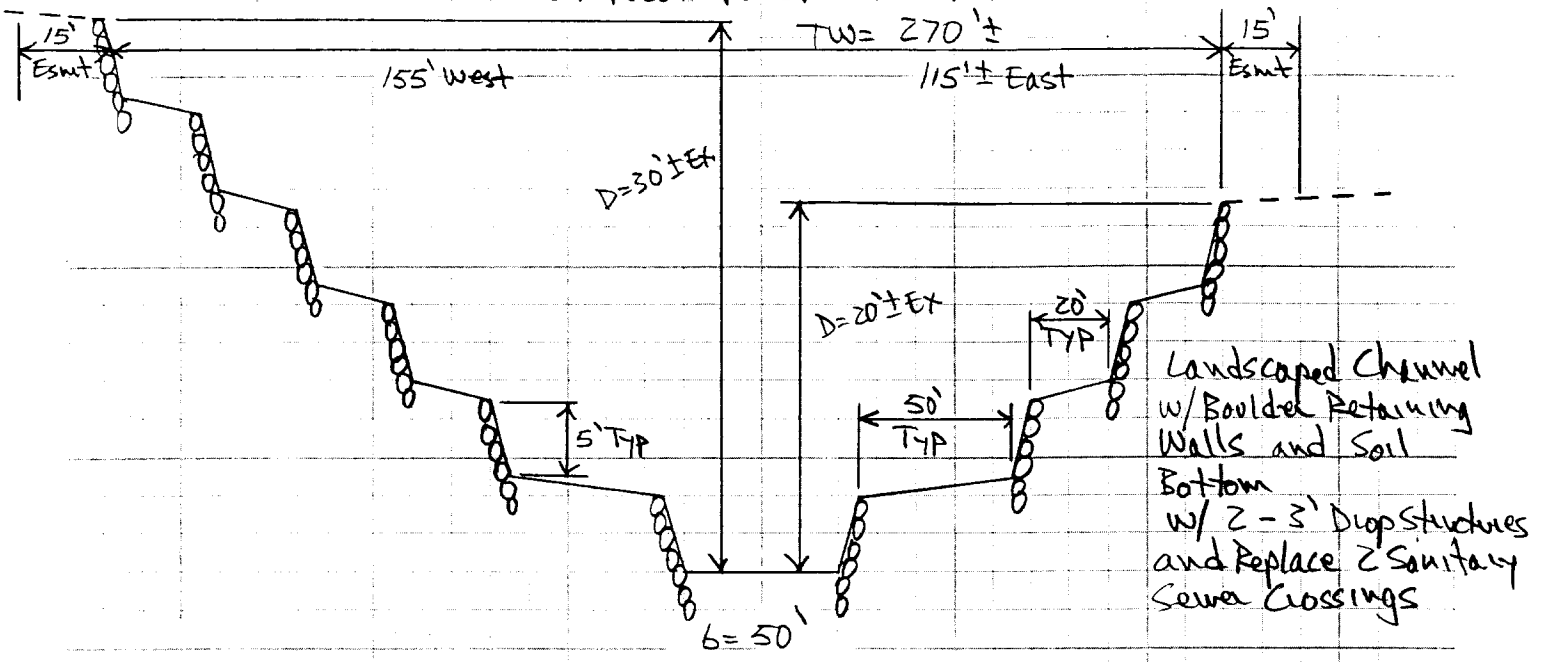
Q_{100} = 6820 cfs $L = 200'$ $S_{EX} = 0.6\%$ $HW = 50.1 - 29.9 = 20.2'$

Inlet Control $\Rightarrow Q/b = \frac{6820}{40} = 171$ $HW/D = 1.8$ $HW = (1.8)(10.0) = 18.0'$

Outlet Control $\Rightarrow H = 7.0'$ $H_0 = 12.5'$ $LS_0 = (200)(0.006) = 1.2'$

$HW = 7.0 + 12.5 - 1.2 = 18.3'$

Sta. 50+65 to Sta. 71+55 - New open channel between Costilla Street and El Paso Street



Q_{100} = 6820 cfs to 6705 cfs S_{EX} = 0.8% S_{PRO} = 0.5%±

$d = 10' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{1000}{170}\right)^{2/3}(0.005)^{1/2} = 6.9$ fps $\Rightarrow Q = (6.9)(1000) = 6900$ cfs

Freeboard = $1.0 + (0.025)(6.9)(10.0)^{1/3} = 1.4' \Rightarrow$ use 2.0' $\Rightarrow D_{min} = 10.0 + 2.0 = 12.0'$

$F = \frac{6.9}{\sqrt{(32.2)(10.0)}} = 0.38 \Rightarrow$ Subcritical

Sta. 71+55 to Sta. 72+80 - Replace culvert at El Paso Street

5-14'X10' RCB

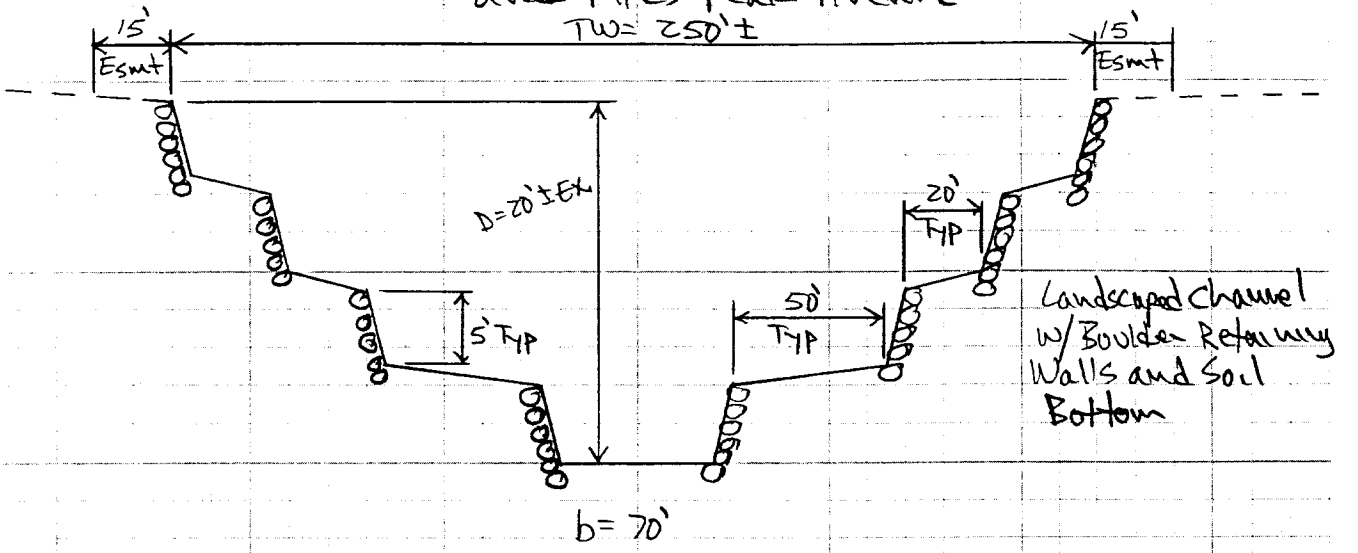
Q_{100} = 6705 cfs L = 125' S_{EX} = 1.0% AHW = 65 - 53.2 = 11.8'

Inlet Control $\Rightarrow Q/b = \frac{6705}{70} = 96$ HW/D = 1.05 HW = (1.05)(10.0) = 10.5'

Outlet Control $\Rightarrow H = 2.0'$ $H_0 = 10.0'$ $LS_0 = (125)(0.01) = 1.3'$

HW = 2.0 + 10.0 - 1.3 = 10.7'

Sta. 72+80 to Sta. 76+80 - New open channel between El Paso Street and Pikes Peak Avenue



Q_{100} = 6705 cfs S_{EX} = 0.4%±

$d = 9.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{1115}{189}\right)^{2/3}(0.004)^{1/2} = 6.2 fps \Rightarrow Q = (6.2)(1115) = 6915 cfs$

Actual d = 10.7'± (Est'd / Exist HEC 2) $\Rightarrow$ A = 1347 sf $V = \frac{6705}{1347} = 5.0 fps$

$Freeboard = 1.0 + (0.025)(5.0)(10.7)^{1/3} = 1.3' \Rightarrow$ Use 2.0' $D_{min} = 10.7 + 2.0 = 12.7'$

$F = \frac{5.0}{\sqrt{(32.2)(10.7)}} = 0.27 \Rightarrow$ Subcritical

Sta. 76+80 to Sta. 85+60 - Replace culverts at Pikes Peak Avenue / El Paso Street and at Kiowa Street

Pikes Peak Avenue / El Paso Avenue

5 - 14' X 10' RCB

Q_{100} = 6705 cfs L = 650' S_{EX} = 1.0% AHW = 76.0 - 61.2 = 14.8'

Inlet Control $\Rightarrow Q/b = \frac{6705}{70} = 96$ HW/D = 1.05 HW = (1.05)(10) = 10.5'

Outlet Control $\Rightarrow$ H = 2.7' H_0 = 10.7' $LS_0 = (650)(0.01) = 6.5'$

HW = 2.7 + 10.7 - 6.5 = 6.9'

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PROJ. Shooks Run

SUBJ. Soft-Lined Alternative

FILE 90-809

SHEET 8

OF

Kiowa Street

4 - 14'x10' RCB

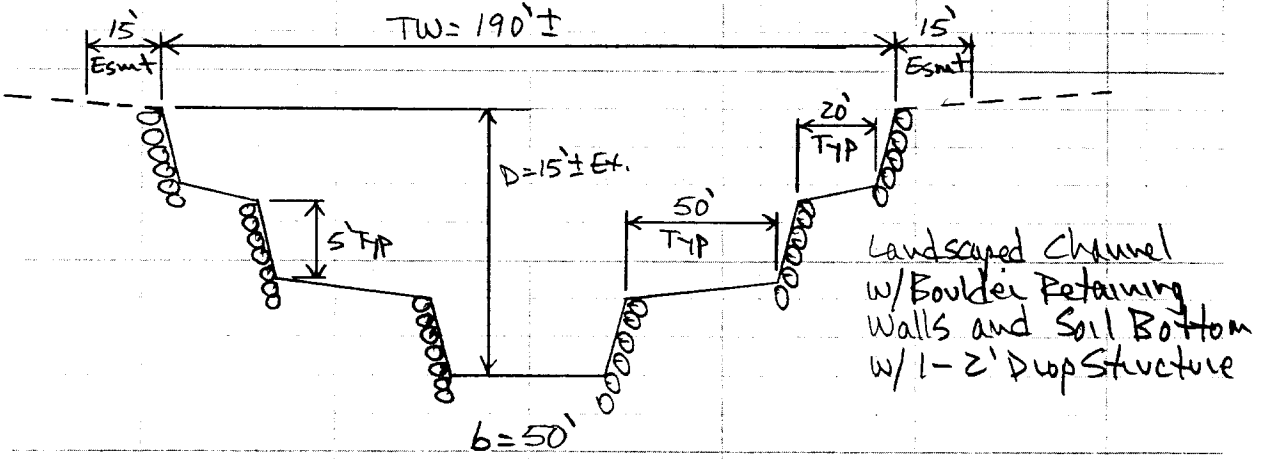
Q_{100} = 5060 cfs L = 150' S_{EX} = 0.3% AHW = 76.0 - 62.4 = 13.6'

Inlet Control ⇒ Q/b = $\frac{5060}{56}$ = 90 HW/D = 1.0 HW = (1.0)(10) = 10.0'

Outlet Control ⇒ H = 1.8' H_0 = 10.5' LS_0 = (150)(0.003) = 0.5'

HW = 1.8 + 10.5 - 0.5 = 11.8'

Sta. 85+60 to Sta. 89+95 - New open channel between Kiowa Street and Bijou Street



Q_{100} = 5060 cfs S_{EX} = 0.9% S_{PRO} = 0.5%±

d = 9.0' ⇒ $v = \left(\frac{1.49}{0.050}\right)\left(\frac{850}{168}\right)^{2/3}(0.005)^{1/2}$ = 6.2 fps ⇒ Q = (6.2)(850) = 5270 cfs

Freeboard = 1.0 + (0.025)(6.2)(9.0)$^{1/3}$ = 1.3 ⇒ Use 2.0' D_{min} = 9.0 + 2.0 = 11.0'

$F = \frac{6.2}{\sqrt{(32.2)(9.0)}}$ = 0.36 ⇒ Subcritical

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PROJ. Shooks Run

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SHEET 9

OF

Sta. 89+95 to Sta. 94+50 - Replace culvert at Bijou Street

4 - 14' X 10' RCB

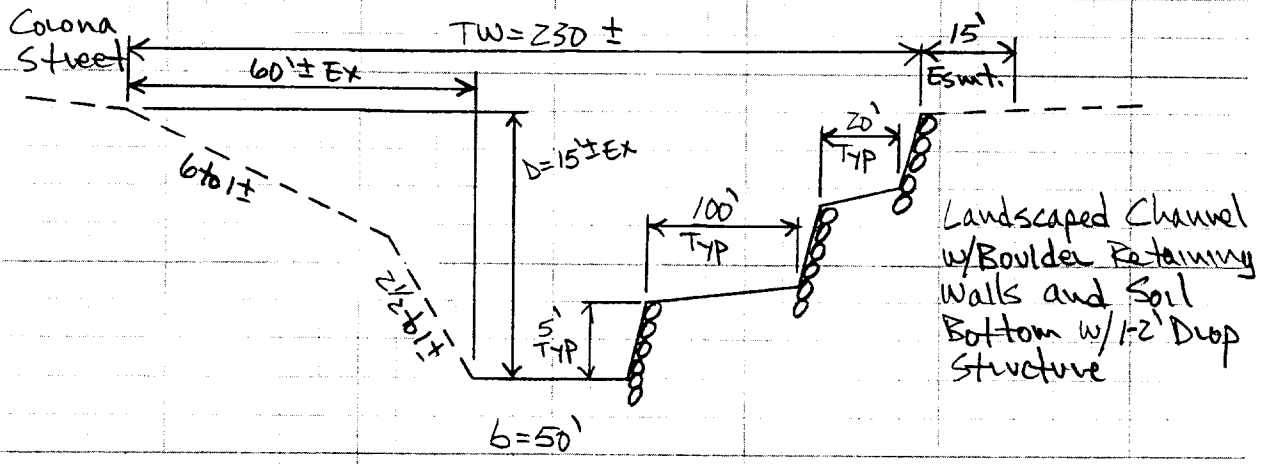
$Q_{100} = 5060$ cfs $L = 455'$ $S_{EX} = 0.6\%$ $AHW = 82.0 - 69.8 = 12.2'$

Inlet Control $\Rightarrow Q/b = \frac{5060}{56} = 90$ $HW/D = 1.0$ $HW = (1.0)(10.0) = 10.0'$

Outlet Control $\Rightarrow 2.1'$ $H_0 = 9.0'$ $LS_0 = (455)(0.006) = 2.7'$

$HW = 2.1 + 9.0 - 2.7 = 8.4'$

Sta. 94+50 to Sta. 98+10 - New open channel between Bijou Street and Platte Avenue



$Q_{100} = 5060$ cfs $S_{EX} = 0.9\%$ $S_{PRO} = 0.5\% \pm$

$d = 8.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{865}{181}\right)^{2/3}(0.005)^{1/2} = 6.0$ fps $Q = (6.0)(865) = 5190$ cfs

Freeboard $= 1.0 + (0.025)(6.0)(8.5)^{1/3} = 1.3 \Rightarrow$ Use 2.0' $D_{min} = 8.5 + 2.0 = 10.5'$

$F = \frac{6.0}{\sqrt{(32.2)(8.5)}} = 0.36 \Rightarrow$ Subcritical

Sta. 98+10 to Sta. 106+30 – Replace Culvert at Platte Avenue / School Athletic Field and Bridge at Boulder Street

4 - 12' x 10' RCB

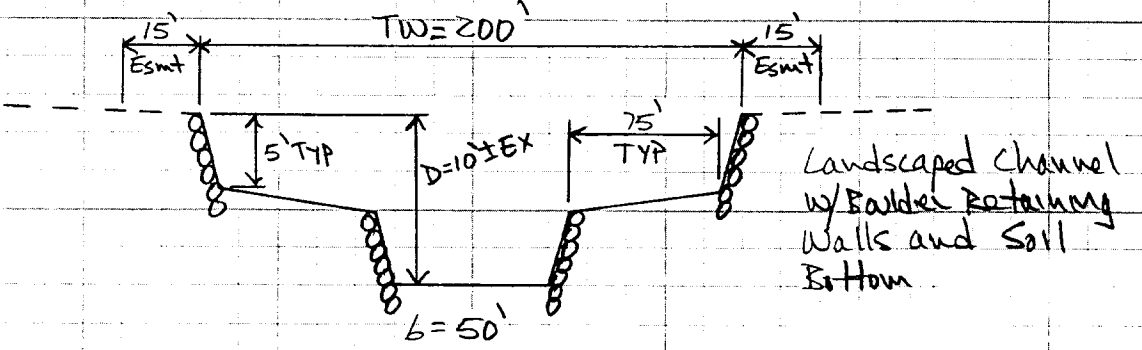
Q_{100} = 5020 cfs L = 695' S_{EX} = 0.15% AHW = 91.5 - 76.5 = 15.0'

Inlet Control ⇒ $Q/b = \frac{5020}{48} = 105$ HW/D = 1.1 HW = (1.1)(10.0) = 11.0'

Outlet Control ⇒ H = 3.4' H_0 = 8.5' LS_0 = (695)(0.005) = 3.5'

HW = 3.4 + 8.5 - 3.5 = 8.4'

Sta. 106+30 to Sta. 112+35 – New open channel between Boulder Street and St. Vrain Street



Q_{100} = 5020 cfs. S_{EX} = 0.19%

d = 8' ⇒ $V = \left(\frac{1.49}{0.050}\right)\left(\frac{850}{216}\right)^{2/3}(0.009)^{1/2} = 7.0$ fps Q = (7.0)(850) = 5950 cfs

Freeboard = 1.0 + (0.025)(7.0)(8.0)$^{1/3}$ = 1.4' ⇒ Use 2' D = 8.0 + 2.0 = 10.0'

$F = \frac{7.0}{\sqrt{(32.2)(8.0)}} = 0.44$ ⇒ Subcritical

Sta. 112+35 to Sta. 113+40 - Replace Culvert at St. Vrain Street

4 - 10' x 10' RCB

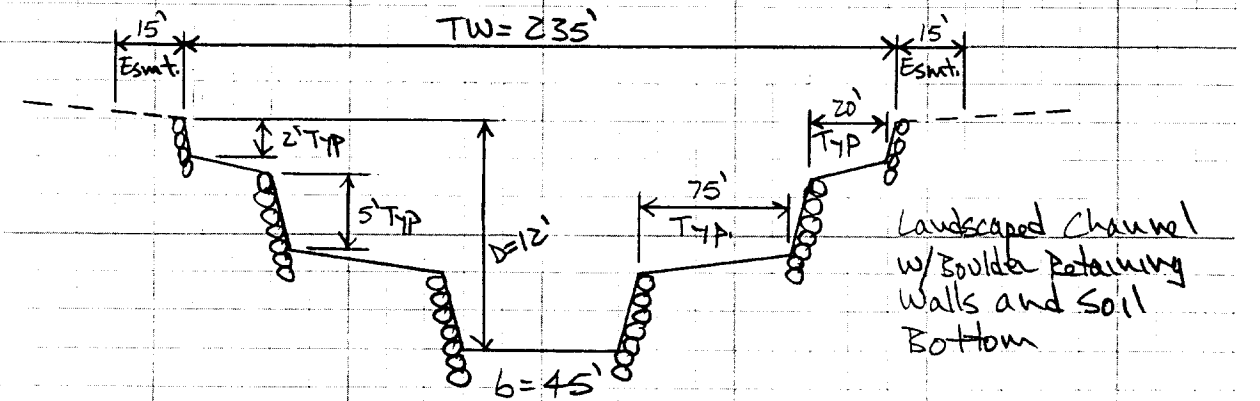
$Q_{100} = 4935$ cfs $L = 105'$ $S_{EX} = 0.14\%$ $\Delta HW = 00.0 - 85.0 = 15.0'$

Inlet Control $\Rightarrow Q/6 = \frac{4935}{40} = 123$ $HW/D = 1.3$ $HW = (1.3)(10.0) = 13.0'$

Outlet Control $\Rightarrow H = 3.3'$ $H_0 = 8'$ $LS_0 = (105)(0.004) = 0.4'$

$HW = 3.3 + 8.0 - 0.4 = 10.9'$

Sta. 113+40 to Sta. 117+75 - New open channel between St. Vrain Street and Willamette Street



$Q_{100} = 4935$ cfs $S_{EX} = 0.17\%$

$d = 8' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{810}{211}\right)^{2/3}(0.007)^{1/2} = 6.1$ fps $\Rightarrow Q = (6.1)(810) = 4940$ cfs

Actual $d = 13'$ to $10' \pm$ (Est'd/Exist HEC 2) $\Rightarrow d = 10' \Rightarrow A = 1200$ sf $V = \frac{4935}{1200} = 4.1$ fps

Freeboard $= 1.0 + (0.025)(4.1)(10)^{1/3} = 1.2 \Rightarrow$ Use 2' $D = 10 + 2 = 12'$

$F = \frac{4.1}{\sqrt{(32.2)(10)}} = 0.23 \Rightarrow$ Subcritical

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CK. | PROJ. Shooks Run | SHEET 12

DATE November 30, 1992 | SUBJ. Soft-Lined Alternative | OF

Sta. 117+75 to Sta 119+80 - Replace Culvert at Willamette Street

3-10' x 10' RCB

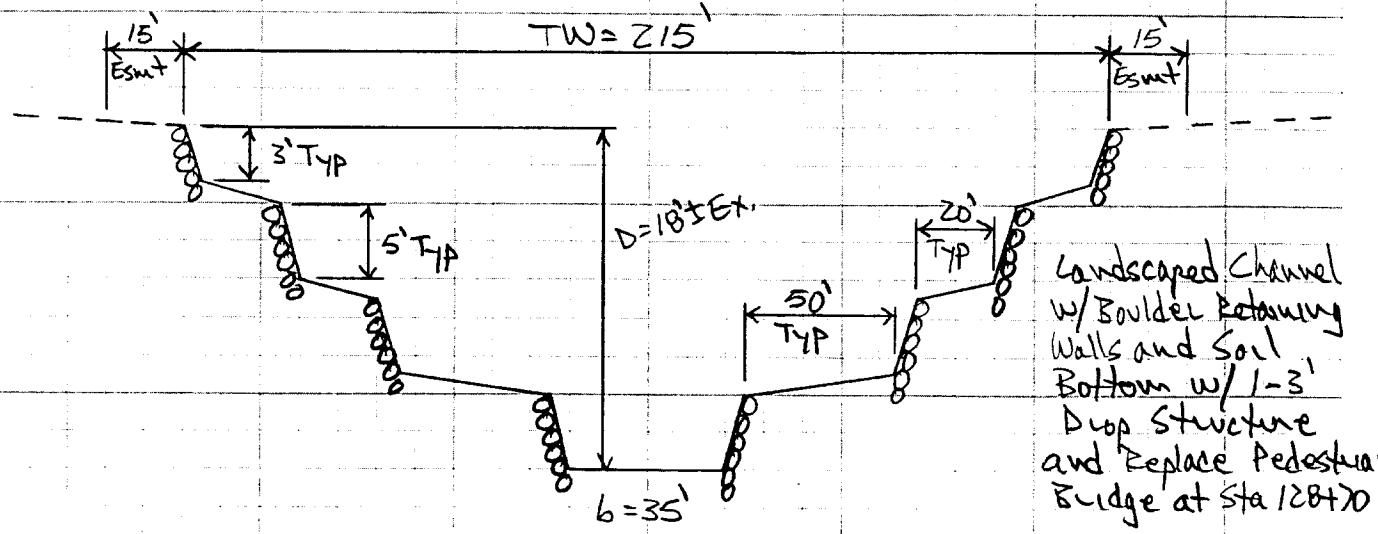
$Q_{100} = 4875$ cfs $L = 205'$ $S_{EX} = 0.1\%$ $AHW = 12.0 - 9.9 = 2.1'$

Inlet Control $\Rightarrow Q/b = \frac{4875}{30} = 163$ $HW/D = 1.7$ $HW = (1.7)(10) = 17.0'$

Outlet Control $\Rightarrow H = 6.3'$ $H_0 = 10'$ $LS_0 = (205)(0.001) = 0.3'$

$HW = 6.3 + 10 - 0.3 = 16.0'$

Sta. 119+80 to Sta. 135+15 - New open channel between Willamette Street and Cache La Poudre Street



$Q_{100} = 4875$ cfs $S_{EX} = 0.7\%$ $S_{PPD} = 0.5\% \pm$

$d = 10' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{850}{155}\right)^{2/3}(0.005)^{1/2} = 6.6$ fps $\Rightarrow Q = (6.6)(850) = 5610$ cfs

Freeboard $= 1.0 + (0.025)(6.6)(10)^{1/3} = 1.4 \Rightarrow$ Use 2' $D_{MIN} = 10 + 2 = 12'$

$F = \frac{6.6}{\sqrt{(32.2)(10)}} = 0.37 \Rightarrow$ Subcritical

Sta. 135+15 to Sta. 137+05 - Replace Culvert at Cache La Poudre Street

3 - 10' x 10' RCB

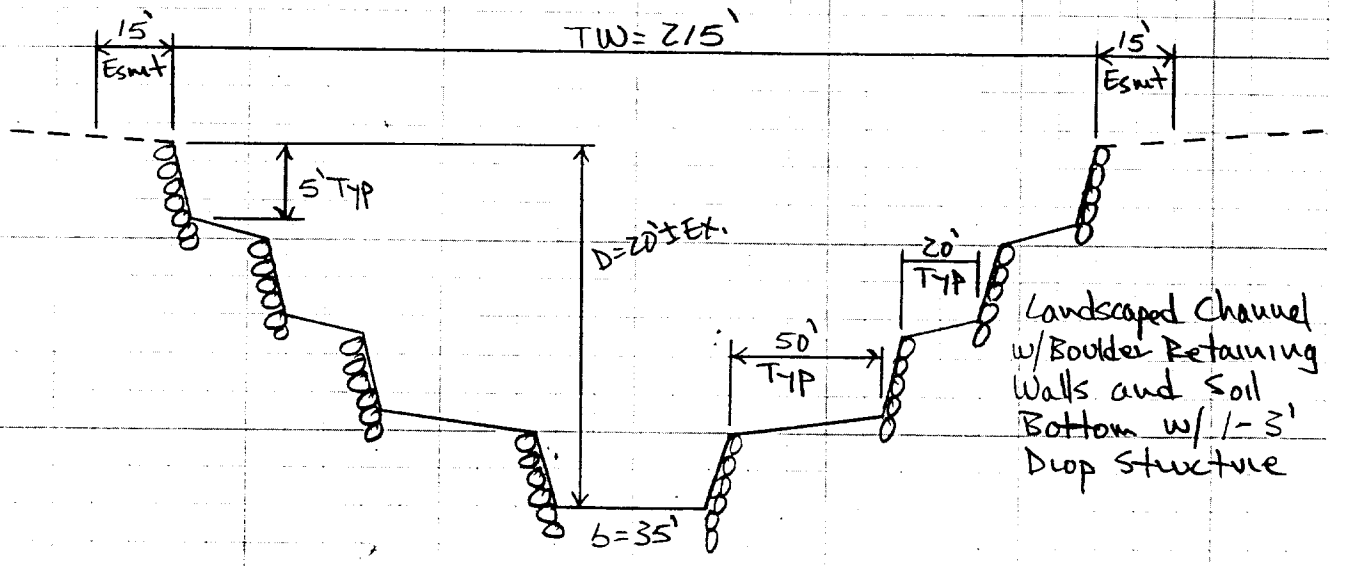
$Q_{100} = 4305$ cfs $L = 190'$ $S_{EX} = 0.2\%$ $AHW = 26.0 - 09.5 = 16.5'$

Inlet Control $\Rightarrow Q/b = \frac{4305}{30} = 144$ $HW/D = 1.5$ $HW = (1.5)(10) = 15.0'$

Outlet Control $\Rightarrow H = 5.0'$ $H_0 = 10'$ $LS_0 = (190)(0.002) = 0.4'$

$HW = 5.0 + 10 - 0.4 = 14.6'$

Sta. 137+05 to Sta 152+45 - New open channel between Cache La Poudre Street and Vintah Street



$Q_{100} = 4305$ cfs $S_{EX} = 0.7\%$ $S_{PRO} = 0.5\% \pm$

$d = 9.5' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{783}{154}\right)^{2/3}(0.005)^{1/2} = 6.2$ fps $\Rightarrow Q = (6.2)(783) = 4855$ cfs

Freeboard $= 1.0 + (0.025)(6.2)(9.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 9.5 + 2 = 11.5'$

$F = \frac{6.2}{\sqrt{(32.2)(9.5)}} = 0.35 \Rightarrow$ Subcritical

Sta. 152+45 to Sta. 153+55 - Replace Culvert at Uintah Street

2 - 14'x10' RCB

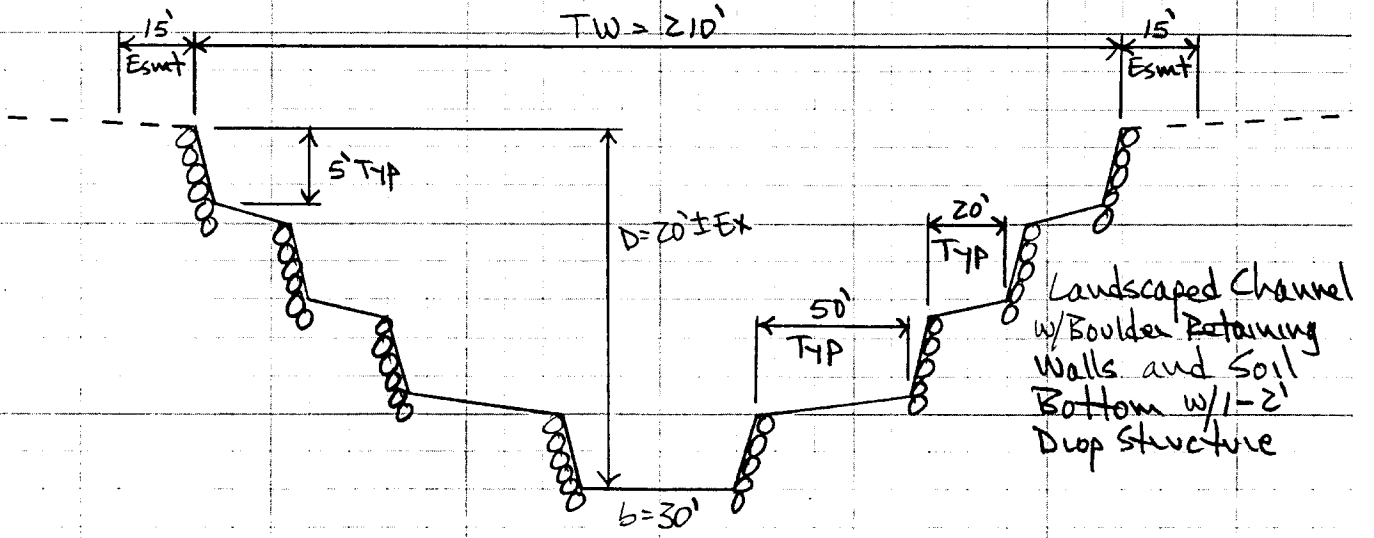
Q_{100} = 3940 cfs L = 110' S_{EX} = 1.2% AHW = 50.0 - 28.1 = 21.9'

Inlet Control ⇒ Q/b = $\frac{3940}{28}$ = 141 HW/D = 1.5 HW = (1.5)(10) = 15.0'

Outlet Control ⇒ H = 4.4' H_o = 9.5' LS_o = (110)(0.012) = 1.3'

HW = 4.4 + 9.5 - 1.3 = 12.6'

Sta. 153+55 to Sta. 157+55 - New open channel between Uintah Street and San Miguel Street



Q_{100} = 3940 cfs S_{EX} = 1.1% S_{PRO} = 0.5% ±

d = 9.5' ⇒ $V = \left(\frac{1.49}{0.050}\right)\left(\frac{735}{149}\right)^{2/3}(0.005)^{1/2}$ = 6.1 fps ⇒ Q = (6.1)(735) = 4485 cfs

Actual d = 15.0' to 11.5' ± (Est'd from Exist HEC 2) ⇒ d = 11.5' ⇒ A = 1055 sf ⇒ $V = \frac{3940}{1055}$ = 3.7 fps

Freeboard = 1.0 + (0.025)(3.7)$(11.5)^{1/3}$ = 1.2 ⇒ Use 2' D_{min} = 11.5 + 2 = 13.5'

$F = \frac{3.7}{\sqrt{(32.2)(11.5)}} = 0.19$ ⇒ Subcritical

Sta. 157+55 to Sta. 158+40 – Replace Culvert at San Miguel Street

2 - 14' X 10' RCB

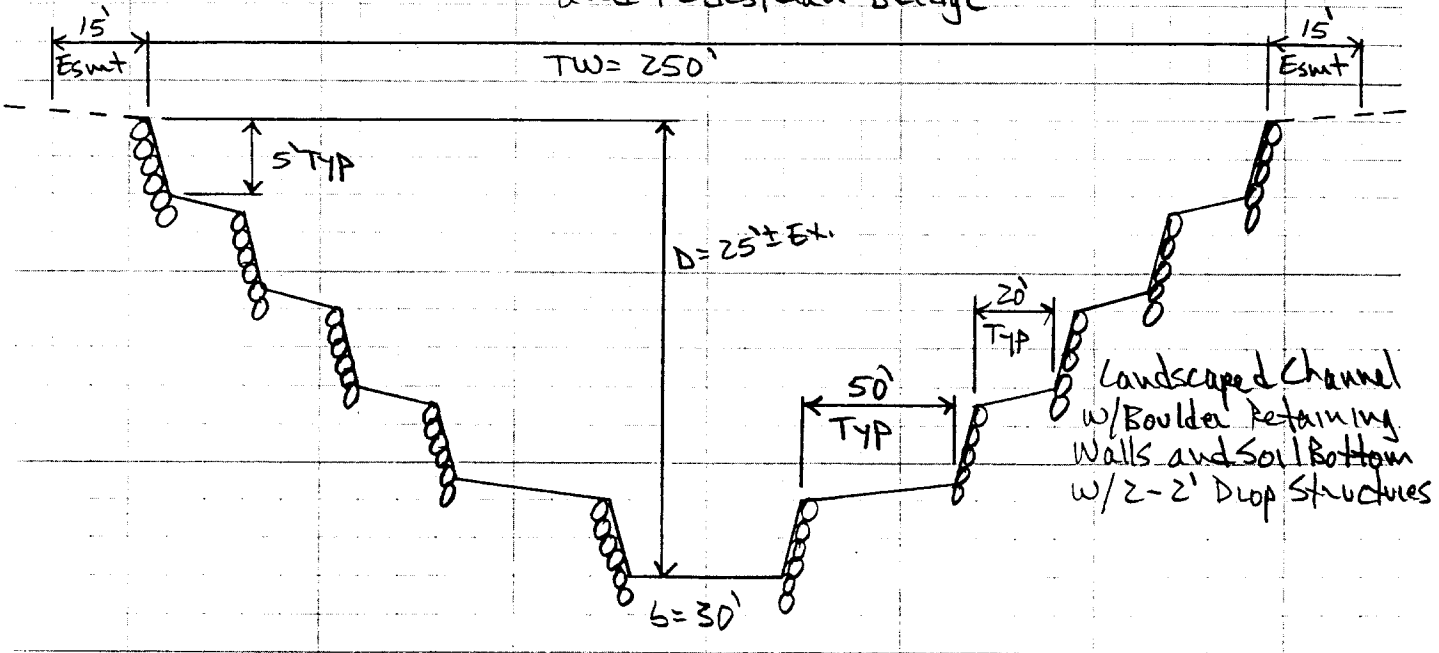
$Q_{100} = 3940$ $L = 85'$ $S_{EX} = 0.6\%$ $AHW = 52.5 - 33.1 = 19.4'$

Inlet Control $\Rightarrow Q/b = \frac{3940}{28} = 141$ $HW/D = 1.5$ $HW = (1.5)(10) = 15.0'$

Outlet Control $\Rightarrow H = 4.2'$ $H_0 = 11.5'$ $LS_0 = (85)(0.006) = 0.5'$

$HW = 4.2 + 11.5 - 0.5 = 15.2'$

Sta. 158+40 to Sta. 167+35 – New Open channel between San Miguel Street and Pedestrian Bridge



$Q_{100} = 3940$ cfs $S_{EX} = 1.0\%$ $S_{PRO} = 0.5\%\pm$

$d = 9.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{735}{149}\right)^{2/3}(0.005)^{1/2} = 6.1$ fps $\Rightarrow Q = (6.1)(735) = 4485$ cfs

Freeboard $= 1.0 + (0.025)(6.1)(9.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 9.5 + 2 = 11.5'$

$F = \frac{6.1}{\sqrt{(32.2)(9.5)}} = 0.35 \Rightarrow$ Subcritical

COMP. [illegible]

CK.

DATE November 30, 1992

WILSON &COMPANY

LOC.

FILE 90-809

PROJ. Shooks Run

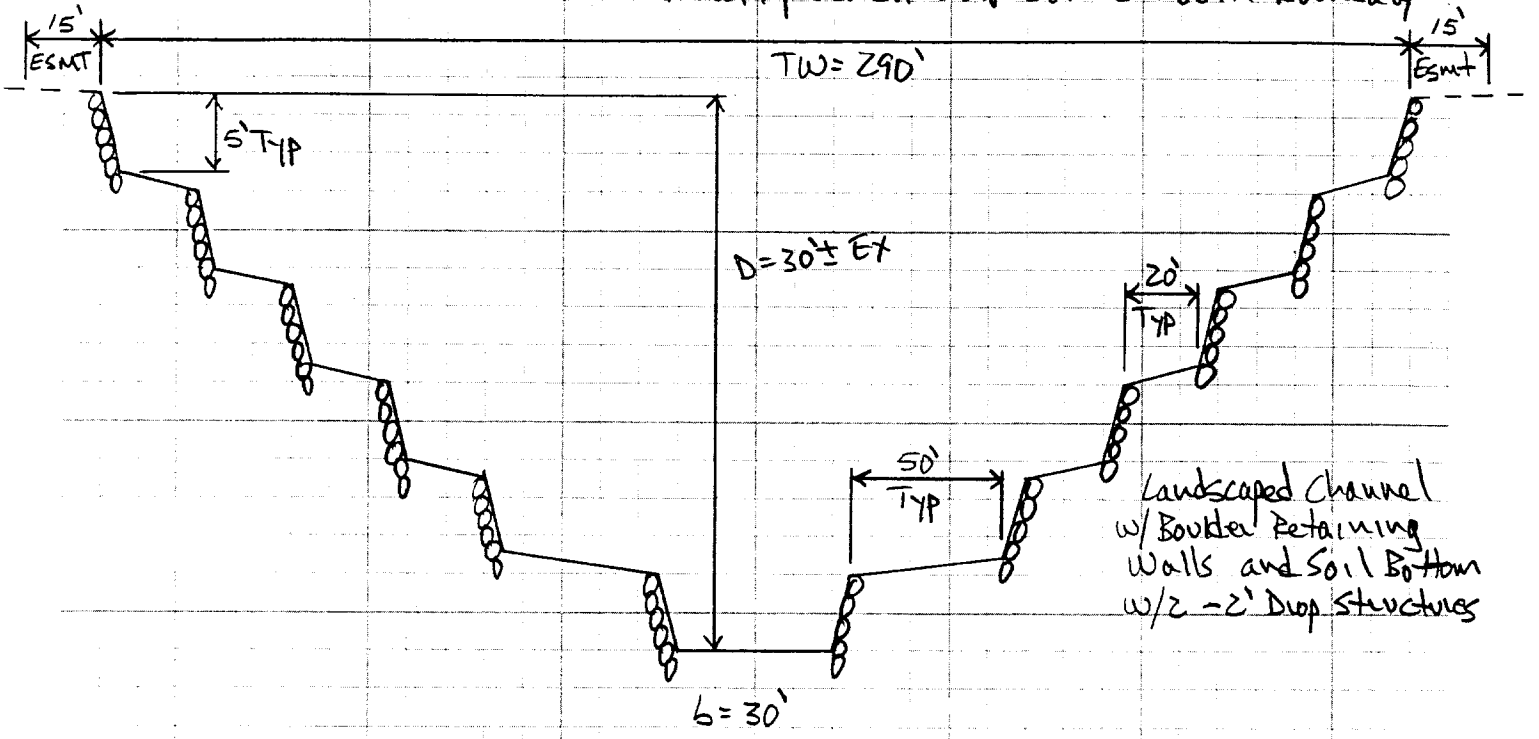
SHEET 16

SUBJ. Soft-Lined Alternative

OF

Sta. 167+35 - Replace Pedestrian Bridge

Sta. 167+35 to Sta 176+25 - New open channel between Pedestrian Bridge and Patty Jewett Golf Course South Boundary



$Q_{100} = 3665$ cfs $S_{EX} = 1.0\%$ $S_{PRO} = 0.5\% \pm$

$d = 9' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{670}{148}\right)^{2/3}(0.005)^{1/2} = 5.8$ fps $\Rightarrow Q = (5.8)(670) = 3885$ cfs

Freeboard $= 1.0 + (0.025)(5.8)(9)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 9 + 2 = 11'$

$F = \frac{5.8}{\sqrt{(32.2)(9)}} = 0.34 \Rightarrow$ Subcritical

COMP. [illegible]

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

FILE 90-809

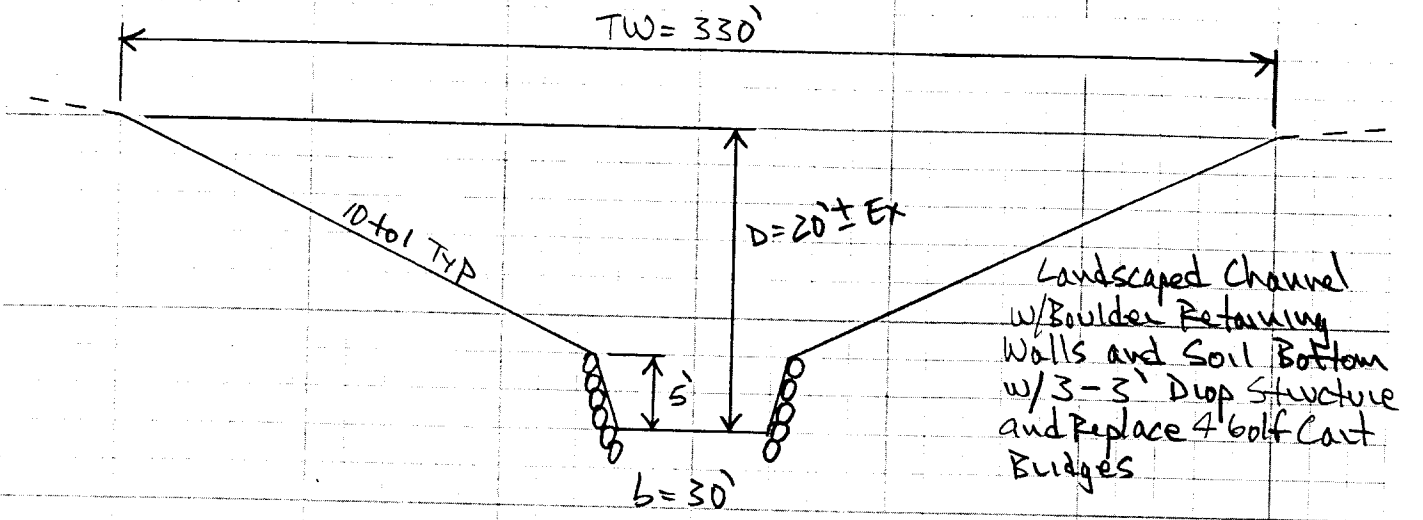
PROJ. Shooks Run

SHEET 17

SUBJ. Soft-Lined Alternative

OF

Sta. 176+25 to Sta. 189+05 - New Open Channel between Patty Jewett Golf Course South Boundary and Espanola Street



$Q_{100} = 3665$ cfs $S_{EX} = 1.0\% + 6'$ Ex Drop $S_{PRO} = 0.8\%$ ±

$d = 10' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{550}{140}\right)^{2/3}(0.008)^{1/2} = 6.6$ fps $\Rightarrow Q = (6.6)(550) = 3630$ cfs

Freeboard $= 1.0 + (0.025)(6.6)(10)^{1/3} = 1.4 \Rightarrow$ Use 2' $D_{min} = 10 + 2 = 12'$

$F = \frac{6.6}{\sqrt{(32.2)(10)}} = 0.37 \Rightarrow$ Subcritical

Sta. 189+05 to Sta 190+85 - Replace Culvert at Espanola Street

3 - 12' X 10' RCB

$Q_{100} = 3555$ cfs $L = 180'$ $S_{Et} = 1.3\%$ $AHW = 85.5 - 72.8 = 12.7'$

Inlet Control $\Rightarrow Q/b = \frac{3555}{36} = 99$ $HW/D = 1.05$ $HW = (1.05)(10) = 10.5'$

Outlet Control $\Rightarrow H = 2.0'$ $H_0 = 10'$ $LS_0 = (180)(0.013) = 2.3'$

$HW = 2.0 + 10 - 2.3 = 9.7'$

COMP. WWA

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

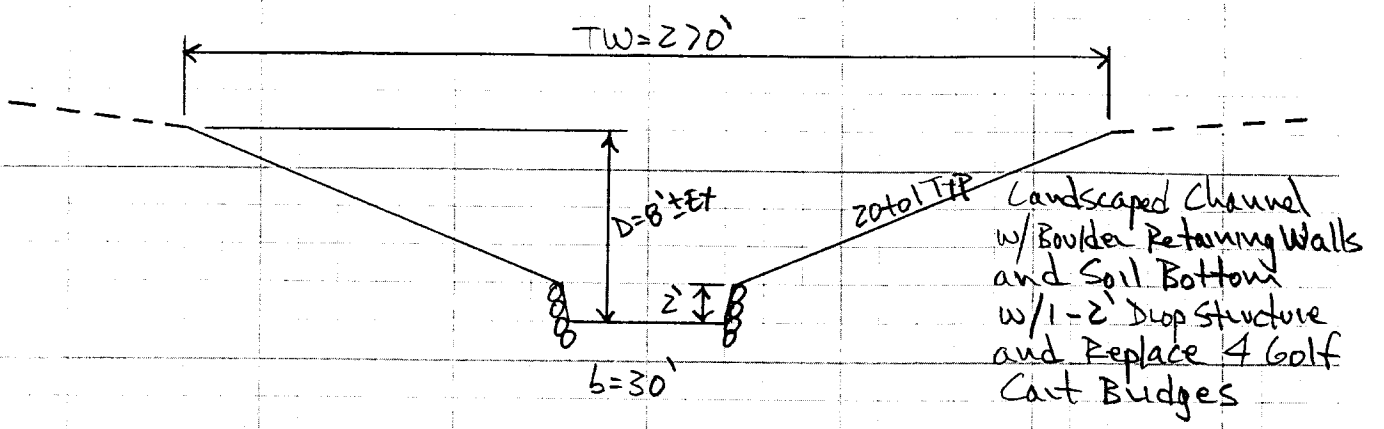
SUBJ Soft-Lined Alternative

FILE 90-809

SHEET 18

OF

Sta. 190+85 to Sta 198+45 - New Open Channel between Espanola Street and End of Existing Channel Lining



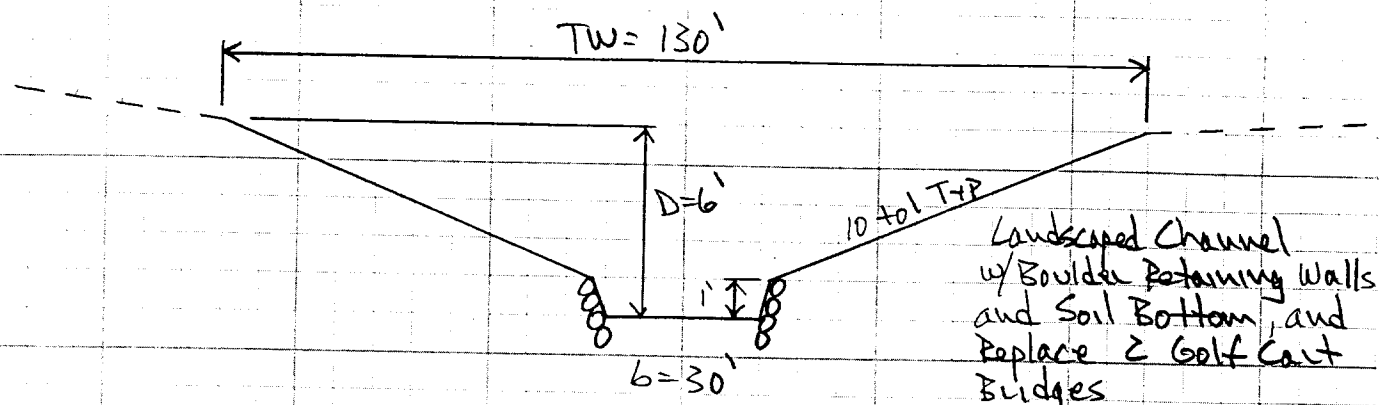
$Q_{100} = 3460$ cfs $\quad S_{EX} = 1.44\% + 3'$ Ex Drop $\quad S_{PRO} = 1.5\% \pm$

$d = 6' \Rightarrow V = \left(\frac{1.44}{.050}\right)\left(\frac{500}{194}\right)^{2/3}(0.015)^{1/2} = 6.9$ fps $\Rightarrow Q = (6.9)(500) = 3450$ cfs

Freeboard $= 1.0 + (0.025)(6.9)(6)^{1/3} = 1.3 \Rightarrow$ Use 2' $\quad D_{min} = 6 + 2 = 8'$

$F = \frac{6.9}{\sqrt{(32.2)(6)}} = 0.50 \Rightarrow$ Subcritical

Sta. 198+45 to Sta. 216+40 - New Open Channel between End of Existing Channel Lining and Paseo Road



$Q_{100} = 1110$ cfs $\quad S_{PRO} = 1.0\%\pm$

$d = 4' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{210}{92}\right)^{2/3}(0.010)^{1/2} = 5.2$ fps $\Rightarrow Q = (5.2)(210) = 1090$ cfs

Freeboard $= 1.0 + (0.025)(5.2)(4)^{1/3} = 1.2 \Rightarrow$ Use 2' $\quad D_{min} = 4+2 = 6'$

$F = \frac{5.2}{\sqrt{(32.2)(4)}} = 0.46 \Rightarrow$ Subcritical

Sta. 216+40 to Sta. 216+95 - Replace Culvert at Paseo Road

3 - 10' x 5' RCB

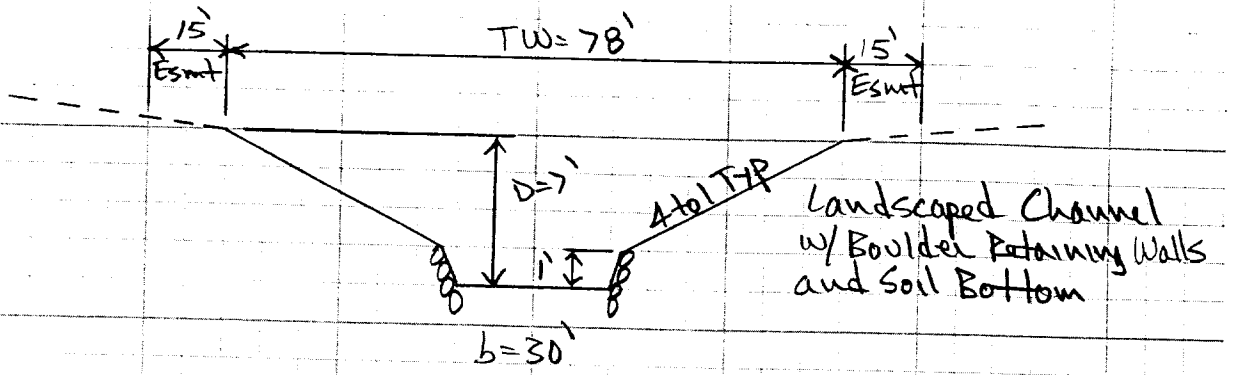
$Q_{100} = 1110$ cfs $\quad L = 55' \quad S_{PRO} = 0.7\% \quad AHW = 12.3 - 05.9 = 6.4'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2' \quad H_0 = 4' \quad LS_0 = (55)(0.007) = 0.4'$

$HW = 1.2 + 4 - 0.4 = 4.8'$

Sta. 216+95 to Sta 218+30 - New Open Channel between Paseo Road and Jefferson Street



$Q_{100} = 1110$ cfs $\quad S_{PRO} = 0.7\% \pm$

$d = 5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{214}{65}\right)^{2/3}(0.007)^{1/2} = 5.5$ fps $\Rightarrow Q = (5.5)(214) = 1175$ cfs

Freeboard $= 1.0 + (0.025)(5.5)(5)^{1/3} = 1.2 \Rightarrow$ Use 2' $\quad D_{min} = 5 + 2 = 7'$

$F = \frac{5.5}{\sqrt{(32.2)(5)}} = 0.43 \Rightarrow$ Subcritical

Sta. 218+30 to Sta. 219+10 - Replace Culvert at Jefferson Street

3 - 10' X 5' RCB

$Q_{100} = 1110$ cfs $\quad L = 80' \quad S_{PRO} = 0.7\% \pm \quad AHW = 14.0 - 07.5 = 6.5'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2' \quad H_0 = 5' \quad LS_0 = (80)(0.007) = 0.6'$

$HW = 1.2 + 5 - 0.6 = 5.6'$

COMP. WHA

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

FILE 90-809

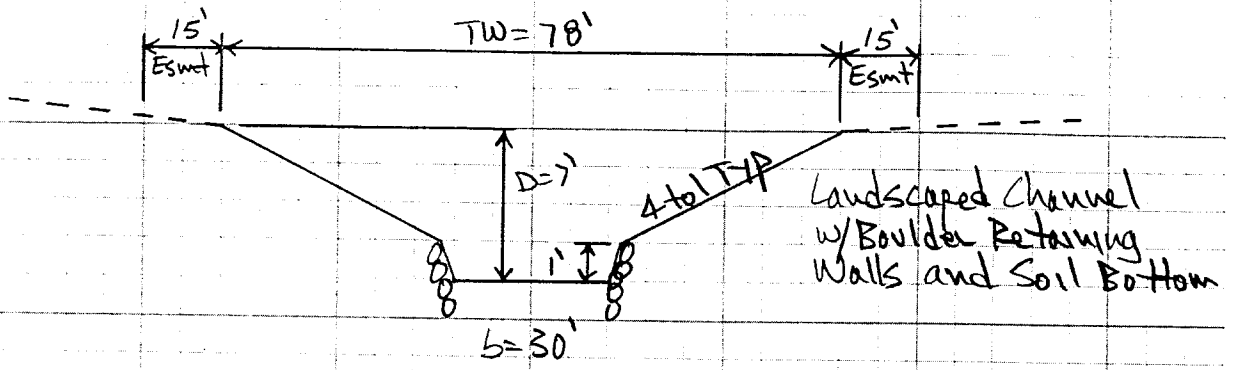
PROJ. Shooks Run

SHEET 21

SUBJ. Soft-Lined Alternative

OF

Sta 219+10 to Sta 222+50 - New Open Channel Between Jefferson Street and Madison Street



$Q_{100} = 1110$ cfs $\quad S_{PRO} = 1.2\%$

$d = 4.5' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{184}{61}\right)^{2/3}(0.012)^{1/2} = 6.8$ fps $\Rightarrow Q = (6.8)(184) = 1250$ cfs

Freeboard $= 1.0 + (0.025)(6.8)(4.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $\quad D_{min} = 4.5 + 2 = 6.5$

$F = \frac{6.8}{\sqrt{(32.2)(4.5)}} = 0.56 \Rightarrow$ Subcritical

Sta. 222+50 to Sta. 223+30 - Replace Culvert at Madison Street

3-10'x5' RCB

$Q_{100} = 1110$ cfs $\quad L = 80' \quad S_{PRO} = 1.2\% \pm \quad AHW = 20.0 - 12.4 = 7.6'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2' \quad H_0 = 4.5' \quad LS_0 = (80)(0.012) = 1.0'$

$HW = 1.2 + 4.5 - 1.0 = 4.7'$

COMP. [illegible]

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

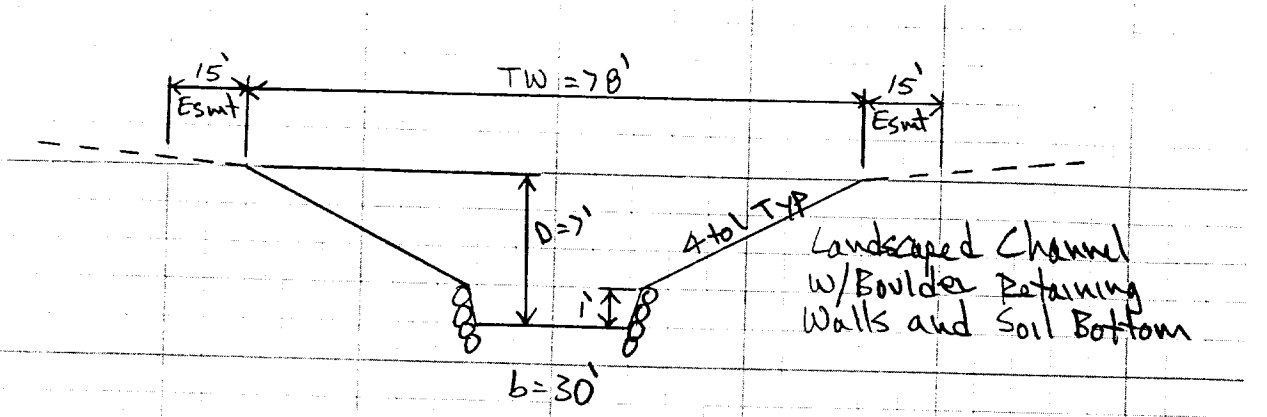
SUBJ. Soft-Lined Alternative

FILE 90-809

SHEET 22

OF

Sta. 223+30 to Sta. 226+25 - New Open Channel between Madison Street and Monroe Street



$Q_{100} = 1110$ cfs $\quad S_{PRO} = 1.2\% \pm$

$d = 4.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{184}{61}\right)^{2/3}(0.012)^{1/2} = 6.8$ fps $\Rightarrow Q = (6.8)(184) = 1250$ cfs

Freeboard $= 1.0 + (0.025)(6.8)(4.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $\quad D_{min} = 4.5 + 2 = 6.5$

$F = \frac{6.8}{\sqrt{(32.2)(4.5)}} = 0.56 \Rightarrow$ subcritical

Sta 226+25 to 227+05 - Replace Culvert at Monroe Street

3-10' x 5' RCB

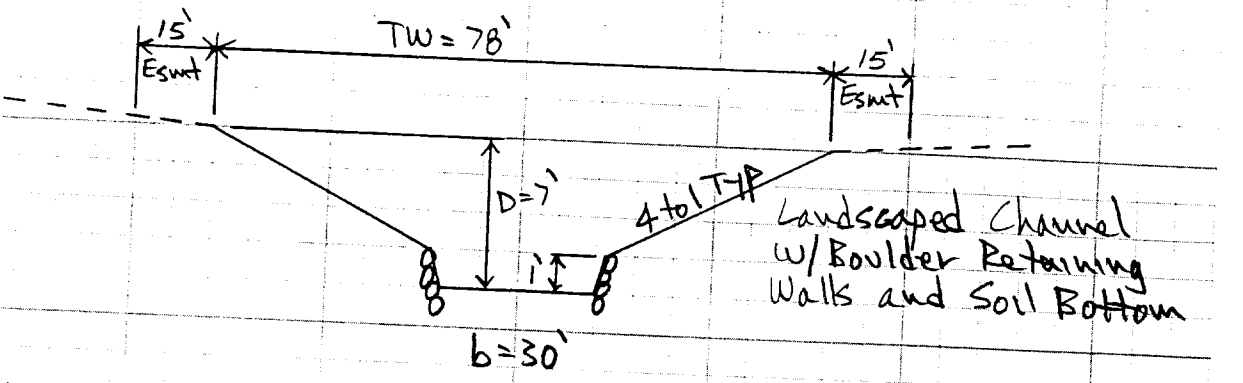
$Q_{100} = 1110$ cfs $\quad L = 80' \quad S_{PRO} = 1.2\% \pm \quad AHW = 23.5 - 16.7 = 6.8'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2' \quad H_0 = 4.5' \quad LS_0 = (80)(0.012) = 1.0'$

$HW = 1.2 + 4.5 - 1.0 = 4.7'$

Sta. 227+05 to Sta. 229+20 - New Open Channel between Monroe Street and Jackson Street



$Q_{100} = 1110$ cfs $S_{PRO} = 1.2\% \pm$

$d = 4.5' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{184}{61}\right)^{2/3}(0.012)^{1/2} = 6.8$ fps $\Rightarrow Q = (6.8)(184) = 1250$ cfs

Freeboard $= 1.0 + (0.025)(6.8)(4.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 4.5 + 2 = 6.5'$

$F = \frac{6.8}{\sqrt{(32.2)(4.5)}} = 0.56 \Rightarrow$ Subcritical

Sta. 229+20 to Sta. 234+15 - Replace Culvert at Jackson Street / LaSalle Street

3 - 10' x 5' RCB

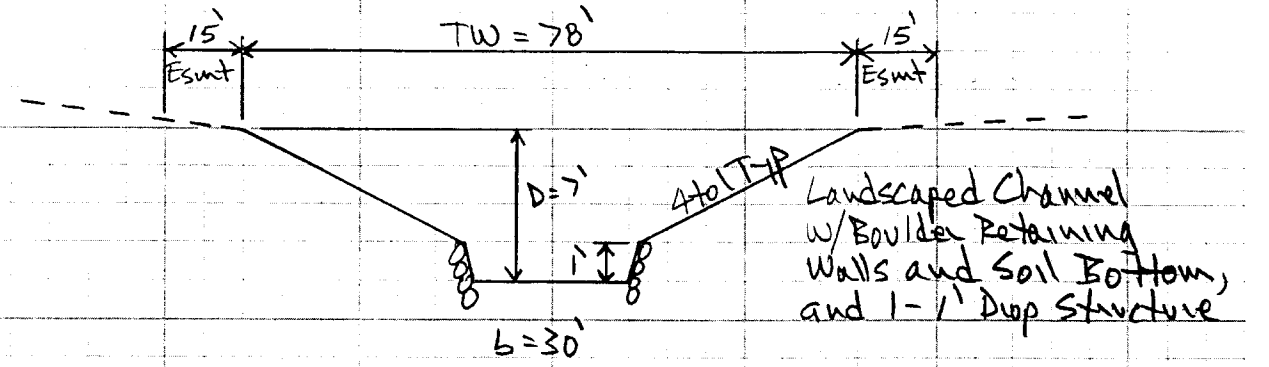
$Q_{100} = 1110$ cfs $L = 445'$ $S_{PRO} = 1.2\% \pm$ $\Delta HW = 31.5 - 25.0 = 6.5'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37$ $HW/D = 1.1$ $HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.9'$ $H_0 = 4.5'$ $LS_0 = (445)(0.012) = 5.3'$

$HW = 1.9 + 4.5 - 5.3 = 1.1'$

Sta. 234+15 to Sta 235+40 - New Open Channel between LaSalle Street and Pedestrian Path



$Q_{100} = 1070$ cfs $\quad S_{PRO} = 1.2\%\pm$

$d = 4.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{184}{61}\right)^{2/3}(0.012)^{1/2} = 6.8$ fps $\Rightarrow Q = (6.8)(184) = 1250$ cfs

Freeboard $= 1.0 + (0.025)(6.8)(4.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $\quad D_{min} = 4.5 + 2 = 6.5'$

$F = \frac{6.8}{\sqrt{(32.2)(4.5)}} = 0.56 \Rightarrow$ Subcritical

Sta. 235+40 to Sta. 235+90 - Replace Culvert at Pedestrian Path

3 - 10' x 5' RCB

$Q_{100} = 1070$ cfs $\quad L = 50' \quad S_{PRO} = 2.2\%\pm \quad \Delta HW = 35.6 - 28.6 = 6.8'$

Inlet Control $\Rightarrow Q/b = \frac{1070}{30} = 36 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.1' \quad H_0 = 4.5' \quad LS_0 = (50)(0.022) = 1.1'$

$HW = 1.1 + 4.5 - 1.1 = 4.5'$

COMP. [illegible]

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

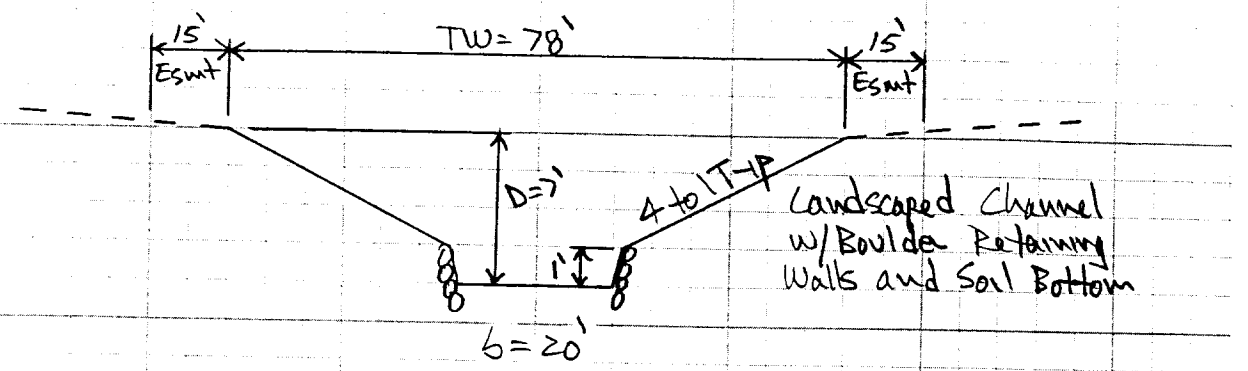
SUBJ. Soft-Lined Alternative

FILE 90-809

SHEET 25

OF

Sta. 235+90 to Sta 236+20 - New Open Channel between Pedestrian Path and C.R.I.P. Railroad



$Q_{100} = 1070$ cfs $\quad S_{PRO} = 1.2\% \pm$

$d = 5.0' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{164}{55}\right)^{2/3}(0.012)^{1/2} = 6.8$ fps $\Rightarrow Q = (6.8)(164) = 1115$ cfs

Freeboard $= 1.0 + (0.025)(6.8)(5.0)^{1/3} = 1.3 \Rightarrow$ Use 2' $\quad D_{MIN} = 5 + 2 = 7'$

$F = \frac{6.8}{\sqrt{(32.2)(5.0)}} = 0.54 \Rightarrow$ Subcritical

Sta. 236+20 to Sta. 236+75 - Replace Culvert at C.R.I.P. Railroad

2-9' x 5' RCB

$Q_{100} = 1070$ cfs $\quad L = 55' \quad S_{PRO} = 2.2\% \quad \Delta HW = 40.1 - 30.6 = 9.5'$

Inlet Control $\Rightarrow Q/b = \frac{1070}{18} = 59 \quad HW/D = 1.8 \quad HW = (1.8)(5) = 9.0$

Outlet Control $\Rightarrow H = 3.0' \quad H_0 = 5.0' \quad LS_0 = (55)(0.022) = 1.2'$

$HW = 3.0 + 5.0 - 1.2 = 6.8'$

COMP. WMA

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

FILE 90-809

PROJ. Shooks Run

SHEET 26

SUBJ. Soft-Lined Alternative

OF

Templeton Gap Road at Van Buren Channel – Replace Culvert

2-11'x6' RCB

$Q_{100} = 1460$ cfs $L = 100'$ $S_{EX} = 0.6\%$ $\Delta HW = 40.1 - 30.3 = 9.8'$

Inlet Control $\Rightarrow$ $Q/6 = \frac{1460}{22} = 66$ $HW/D = 1.5$ $HW = (1.5)(6) = 9.0'$

Outlet Control $\Rightarrow$ $H = 2.6'$ $D_c = 5.1'$ $H_0 = \frac{6+5.1}{2} = 5.6'$

$LS_0 = (100)(0.006) = 0.6'$ $HW = 2.6 + 5.6 - 0.6 = 7.6'$

B. STRUCTURAL FULL IMPROVEMENT ALTERNATIVE HYDRAULIC CALCULATIONS

COMP. [illegible]

CK.

DATE December 1, 1992

WILSON & COMPANY

LOC.

FILE 90-809

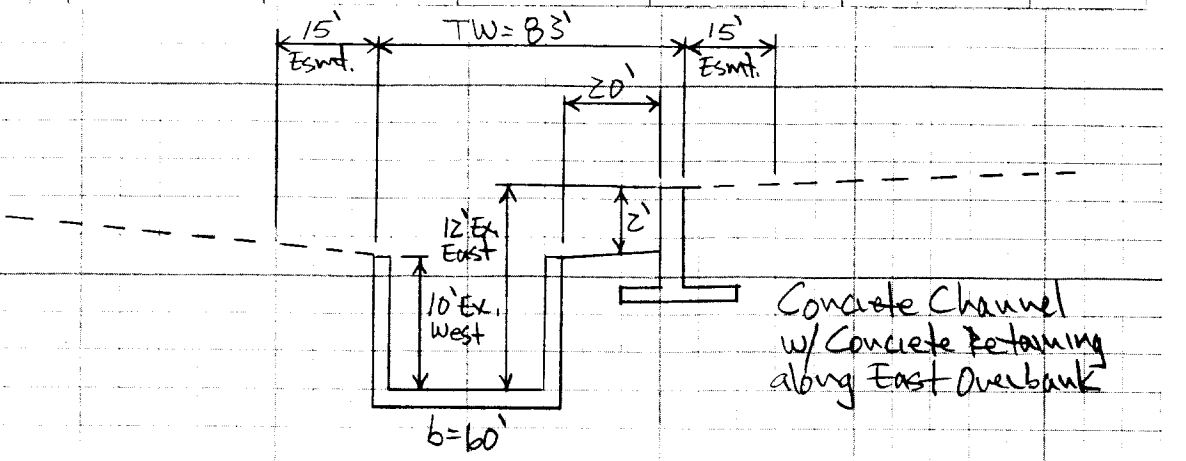
PROJ. Shooks Run

SHEET 1

SUBJ. Structural Alternative

OF

Sta. 0+25 to Sta. 9+75 - New open Channel between Fountain Creek confluence and Las Vegas Street



$Q_{100} = 6910$ cfs $S_{EX} = 0.4\%$

$d = 6' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{360}{72}\right)^{2/3}(0.004)^{1/2} = 21.2$ fps $\Rightarrow Q = (21.2)(360) = 7630$ cfs

Freeboard $= 1.0 + (0.025)(21.2)(6)^{1/3} = 2' \Rightarrow$ Use $2'$ $D_{min} = 6 + 2 = 8'$

$F = \frac{21.2}{\sqrt{(32.2)(6)}} = 1.53 \Rightarrow$ Supercritical

Sta. 9+75 to Sta. 10+80 - Replace bridge and dissipator at Las Vegas Street

5 - 12' x 10' RCB

$Q_{100} = 6910$ cfs $L = 70'$ $S_{EX} = 0.7\%$ $\Delta HW = 111.6 - 97.7 = 13.9'$

Inlet Control $\Rightarrow Q/b = \frac{6910}{60} = 115$ $HW/D = 1.2$ $HW = (1.2)(10) = 12'$

Outlet Control $\Rightarrow H = 3'$ $d_c = 7.5'$ $H_o = \frac{10 + 7.5}{2} = 9'$

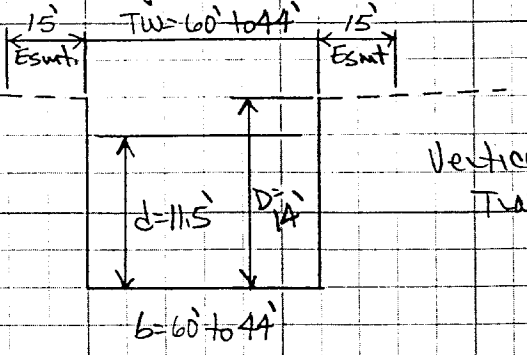
$LS_o = (70')(0.007) = 0.5'$ $HW = 3 + 9 - 0.5 = 11.5'$

COMP. WWO | WILSON & COMPANY | LOC. | FILE 90-809

CK. | PROJ. Shooks Run | SHEET 2

DATE December 1, 1992 | SUBJ. Structural Alternative | OF

Sta. 10+80 to Sta. 11+20 - New Concrete transition channel between Las Vegas Street and A.T.S.F. & D.R.G.W. Railroad



Vertical Walled Concrete Transition Channel

$Q_{100} = 6910$ cfs $S_{EX} = 1.0\%$

$d = 5.5'$ and $b = 44' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{242}{55}\right)^{2/3}(0.010)^{1/2} = 30.8$ fps $\Rightarrow Q = (30.8)(242) = 7455$ cfs

Actual $d = 12.0'$ to $11.5' \pm$ (Est'd/Exist HEC2) $\Rightarrow d = 11.5'$ and $b = 44' \Rightarrow A = 506$ sf $V = \frac{6910}{506} = 13.7$ fps

Freeboard $= 1.0 + (0.025)(13.7)(11.5)^{1/3} = 1.8' \Rightarrow$ Use $2'$ $D_{min} = 11.5 + 2.0 = 13.5 \Rightarrow$ Use $14'$

$F = \frac{13.7}{\sqrt{(32.2)(11.5)}} = 0.71 \Rightarrow$ Subcritical

Sta. 11+20 to 11+65 - Existing Culvert for A.T.S.F. & D.R.G.W. Railroad

Double $20' \times 16.5'$ Conc. Arch ($18.7' \times 15.4'$ RCB Equiv)

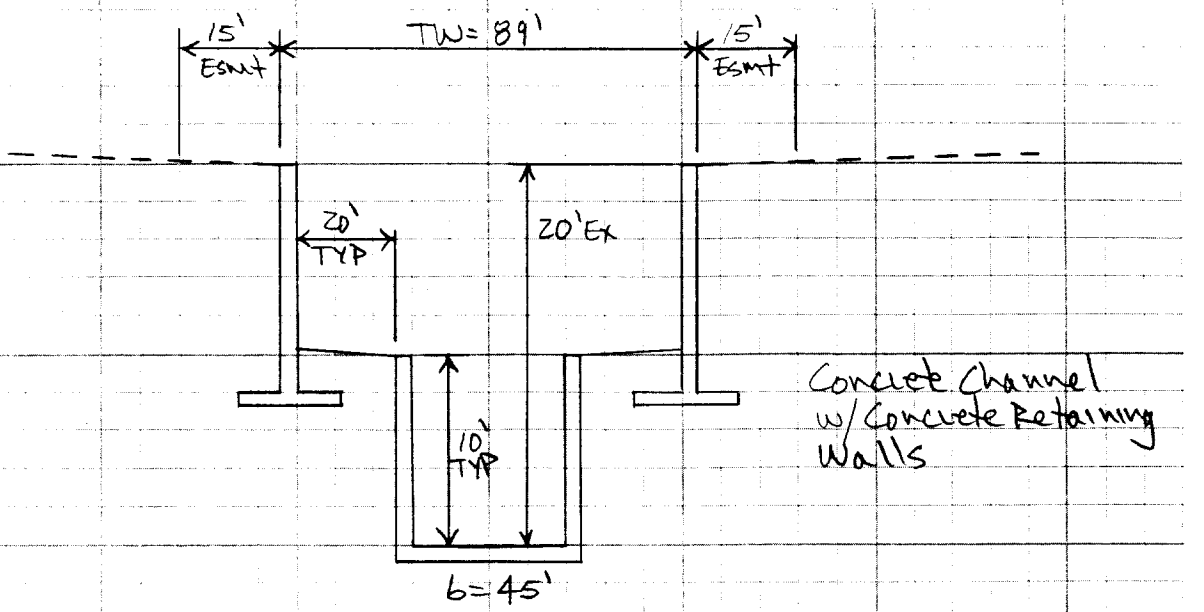
$Q_{100} = 6910$ cfs $L = 45'$ $S_{EX} = 1.3\%$ $\Delta HW = 23.2 - 98.7 = 24.5'$

Inlet Control $\Rightarrow Q/b = \frac{6910}{(2)(18.7)} = 185$ $HW/D = 1.1$ $HW = (1.1)(15.4) = 16.9'$

Outlet Control $\Rightarrow H = 3'$ $H_o = 11.5'$ $LS_o = (45)(0.013) = 0.6'$

$HW = 3 + 11.5 - 0.6 = 13.9'$

Sta. 11+65 to Sta. 15+60 - New open Channel between A.T.S.F. & D.R.G.W. Railroad and abandoned railroad



$Q_{100} = 6910$ cfs $S_{EX} = 1.2\%$

$d = 5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{225}{55}\right)^{2/3}(0.012)^{1/2} = 32.1$ fps $\Rightarrow Q = (32.1)(225) = 7220$ cfs

Actual $d = 16.9'$ to $13.5' \pm$ (Est'd / Exist HEC-2) $\Rightarrow d = 13.5' \Rightarrow A = 755$ $V = \frac{6910}{755} = 9.2$ fps

Freeboard $= 1.0 + (0.025)(9.2)(13.5)^{1/3} = 1.5' \Rightarrow$ Use 2' $D_{min} = 13.5 + 2 = 15.5'$

$F = \frac{9.2}{\sqrt{(32.2)(13.5)}} = 0.44$ Subcritical

Sta. 15+60 to 16+20 - Existing culvert for abandoned railroad

Double 20' x 17.9' Stone Masonry Arch (18.8' x 16.8' RCB Equiv)

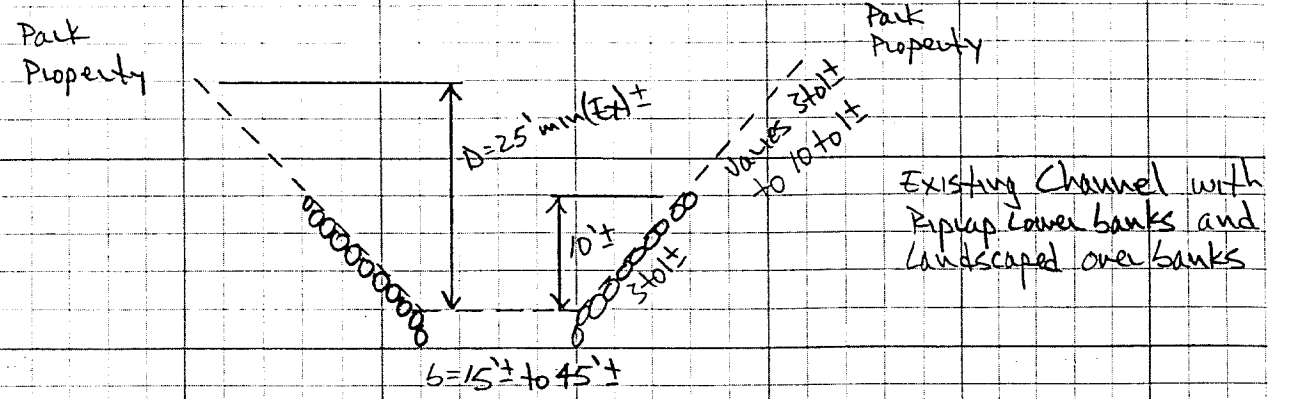
$Q_{100} = 6910$ cfs $L = 60'$ $S_{EX} = 0.7\%$ $AHW = 43.8 - 03.8 = 40.0'$

Inlet Control $\Rightarrow Q/b = \frac{6910}{(2)(18.8)} = 184$ $HW/D = 1.1$ $HW = (1.1)(16.8) = 18.5'$

Outlet Control $\Rightarrow H = 2.3'$ $H_o = 13.5'$ $LS_o = (60)(0.007) = 0.4'$

$HW = 2.3 + 13.5 - 0.4 = 15.4'$

Sta. 16+20 to Sta. 24+00 - Remove undesireable vegetation and debris from floodplain between abandoned railroad and Fountain Boulevard



Q_{100} = 6910 cfs to 6940 cfs S_{EX} = 0.7%±

$d = 11'$ and $b = 30' \pm \Rightarrow V = \left(\frac{1.49}{0.045}\right)\left(\frac{693}{100}\right)^{2/3}(0.007)^{1/2} = 10.1$ fps $\Rightarrow Q = (10.1)(693) = 7000$ cfs

Actual d = 18.5' to 15'± (Est'd/ Exist HEC2) $\Rightarrow d = 15'$ and $b = 30' \Rightarrow A = 1125$ sf $V = \frac{6940}{1125} = 6.2$ fps

Freeboard = $1.0 + 0.025(6.2)(15.0)^{1/3} = 1.4' \Rightarrow$ use 2.0' $D_{min} = 15 + 2 = 17.0'$

$F = \frac{6.2}{\sqrt{(32.2)(15.0)}} = 0.28 \Rightarrow$ Subcritical

Sta. 24+00 to Sta. 25+50 - Replace culvert at Fountain Boulevard

4 - 12' x 10' RCB

Q_{100} = 6940 cfs $L = 150'$ $S_{EX} = 0.7\%$ AHW = 30.3 - 10.3 = 20.0'

Inlet Control $\Rightarrow Q/b = \frac{6940}{48} = 145$ HW/D = 1.5 HW = (1.5)(10) = 15.0'

Outlet Control $\Rightarrow H = 4.6'$ $H_0 = 15'$ $LS_0 = (150)(0.007) = 1.1'$

$HW = 4.6 + 15 - 1.1 = 18.5'$

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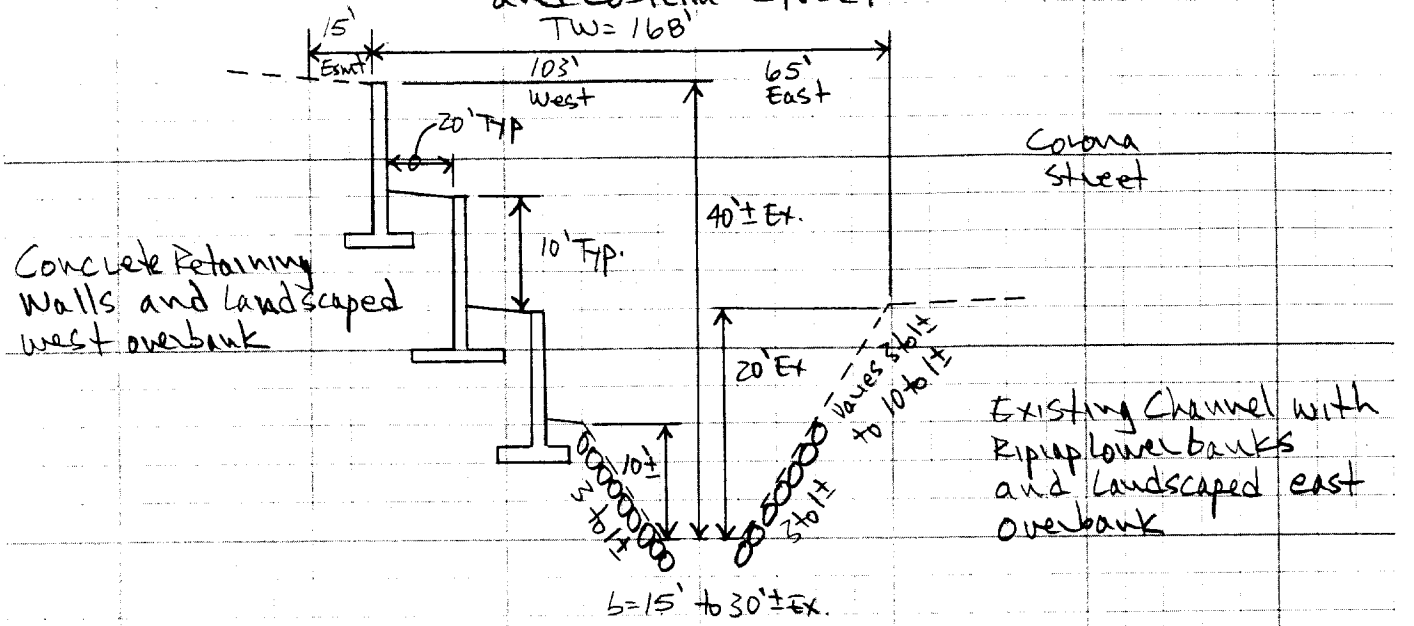
SHEET 5

OF

Sta. 25+50 to Sta. 48+65 - Remove undesireable vegetation and debris from floodplain and reduce slope of west overbank between Fountain Boulevard and Costilla Street



Q_{100} = 6840 cfs to 6820 cfs S_{EX} = 0.8%

$d = 10.5'$ and $b = 30' \pm \Rightarrow V = \left(\frac{1.49}{0.045}\right)\left(\frac{646}{96}\right)^{2/3}(0.008)^{1/2} = 10.6$ fps $\Rightarrow Q = (10.6)(646) = 6850$ cfs

Actual $d = 18.5'$ to $12.5' \pm$ (Est'd/Exist HEC-2) $\Rightarrow d = 12.5'$ and $b = 30' \Rightarrow A = 884$ sf $V = \frac{6840}{884} = 7.74$ fps

Freeboard $= 1.0 + (0.025)(7.7)(12.5)^{1/3} = 1.4 \Rightarrow$ Use 2.0' $D_{min} = 12.5 + 2 = 14.5'$

$F = \frac{7.7}{\sqrt{(32.2)(12.5)}} = 0.38 \Rightarrow$ subcritical

Sta. 48+65 to Sta. 50+65 - Replace culvert at Costilla Street

4 - 10' x 10' RCB

Q_{100} = 6820 cfs $L = 200'$ $S_{EX} = 0.6\%$ $HW = 50.1 - 29.9 = 20.2'$

Inlet Control $\Rightarrow Q/b = \frac{6820}{40} = 171$ $HW/D = 1.8$ $HW = (1.8)(10.0) = 18.0'$

Outlet Control $\Rightarrow H = 7.0'$ $H_0 = 12.5'$ $LS_0 = (200)(0.006) = 1.2'$

$HW = 7.0 + 12.5 - 1.2 = 18.3'$

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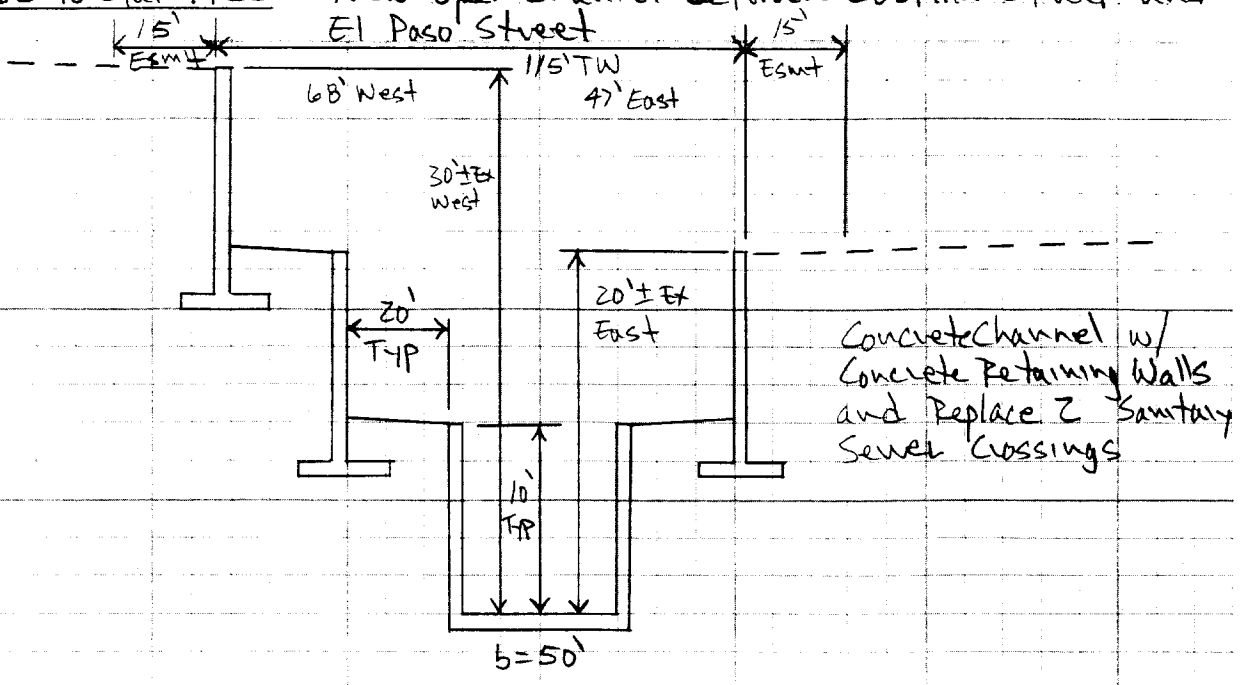
Sta. 50+65 to Sta. 71+55 - New open channel between Castilla Street and El Paso Street



Q_{100} = 6820 to 6705 cfs S_{Ex} = 0.8%

$d = 5.5' \Rightarrow V = \left(\frac{1.49}{0.015}\right)\left(\frac{275}{61}\right)^{2/3}(0.008)^{1/2} = 28.0 \text{ fps} \Rightarrow Q = (28.0)(275) = 7700 \text{ cfs}$

$\text{Freeboard} = 1.0 + (0.025)(28.0)(5.5)^{1/3} = 2.2' \Rightarrow \text{Use } 3' \Rightarrow D_{min} = 5.5 + 3 = 8.5'$

$F = \frac{28.0}{\sqrt{(32.2)(5.5)}} = 2.10 \Rightarrow \text{Supercritical}$

Sta. 71+55 to Sta. 72+80 - Replace culvert at El Paso Street

5 - 14'x10' RCB

Q_{100} = 6705 cfs L = 125' S_{Ex} = 1.0% $\Delta HW = 65 - 53.2 = 11.8'$

Inlet Control $\Rightarrow Q/b = \frac{6705}{70} = 96$ HW/D = 1.05 $HW = (1.05)(10.0) = 10.5'$

Outlet Control $\Rightarrow H = 2.0'$ $H_0 = 5.5'$ $LS_0 = (125)(0.01) = 1.3'$

$HW = 2.0 + 5.5 - 1.3 = 6.2'$

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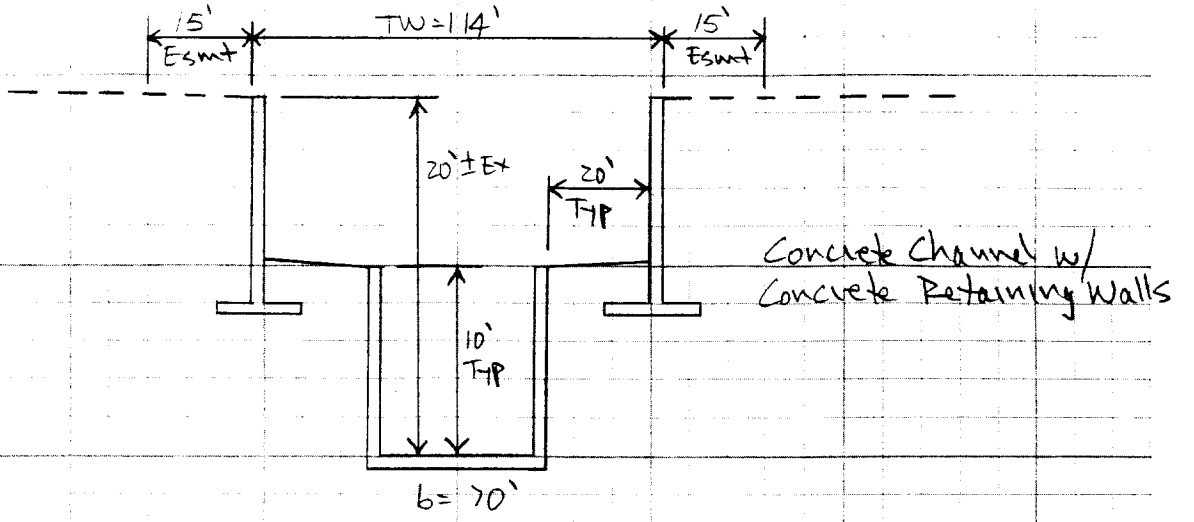
SHEET 7

OF

Sta. 72+80 to Sta. 76+80 - New open channel between El Paso Street and Pikes Peak Avenue



$Q_{100} = 6705$ cfs $\quad S_{EX} = 0.47\%\pm$

$d = 5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{350}{80}\right)(0.004)^{1/2} = 19.4$ fps $\Rightarrow Q = (19.4)(350) = 6790$ cfs

Actual $d = 10.5'\pm$ (Est'd / Exist HEC-2) $\Rightarrow A = 735$ sf $\Rightarrow V = \frac{6705}{735} = 9.1$ fps

Freeboard $= 1.0 + (0.025)(9.1)(10.5)^{1/3} = 1.5' \Rightarrow$ Use 2' $\quad D_{min} = 10.5 + 2 = 12.5'$

$F = \frac{9.1}{\sqrt{(32.2)(10.5)}} = 0.49 \Rightarrow$ Subcritical

Sta. 76+80 to Sta. 85+60 - Replace culverts at Pikes Peak Avenue / El Paso Street and at Kiowa Street

Pikes Peak Avenue / El Paso Avenue

5 - 14' X 10' RCB

$Q_{100} = 6705$ cfs $\quad L = 650' \quad S_{EX} = 1.0\% \quad AHW = 76.0 - 61.2 = 14.8'$

Inlet Control $\Rightarrow Q/b = \frac{6705}{70} = 96 \quad HW/D = 1.05 \quad HW = (1.05)(10) = 10.5'$

Outlet Control $\Rightarrow H = 2.7' \quad H_0 = 10.5' \quad LS_0 = (650)(0.01) = 6.5'$

$HW = 2.7 + 10.5 - 6.5 = 6.7'$

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SUBJ. Structural Alternative

OF

Kiowa Street

4 - 14' x 10' RCB

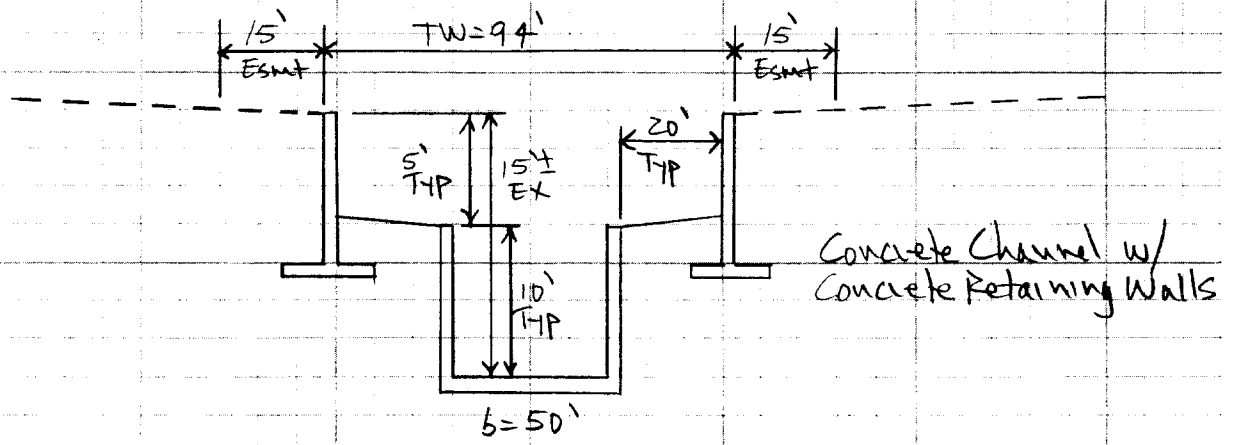
$Q_{100} = 5060$ cfs $L = 150'$ $S_{EX} = 0.13\%$ $\Delta HW = 76.0 - 62.4 = 13.6'$

Inlet Control $\Rightarrow Q/b = \frac{5060}{56} = 90$ $HW/D = 1.0$ $HW = (1.0)(10) = 10.0'$

Outlet Control $\Rightarrow H = 1.8'$ $H_o = 10.5'$ $LS_o = (150)(0.003) = 0.5'$

$HW = 1.8 + 10.5 - 0.5 = 11.8'$

Sta. 85+60 to Sta. 89+95 = New open channel between Kiowa Street and Bijou Street



$Q_{100} = 5060$ cfs $S_{EX} = 0.99\%$

$d = 4.5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{225}{54}\right)^{2/3}(0.009)^{1/2} = 26.5$ fps $\Rightarrow Q = (26.5)(225) = 5960$ cfs

Actual $d = 8.5' \pm$ (Est'd / Exist HEL-2) $\Rightarrow A = 425$ sf $\Rightarrow V = \frac{5060}{425} = 11.9$ fps

Freeboard $= 1.0 + (0.025)(11.9)(8.5)^{1/3} = 1.6' \Rightarrow$ Use $2.0'$ $D_{min} = 8.5 + 2 = 10.5'$

$F = \frac{11.9}{\sqrt{(32.2)(8.5)}} = 0.72 \Rightarrow$ Subcritical

Sta. 89+95 to Sta. 94+50 - Replace culvert at Bijou Street

4-14' x 10' RCB

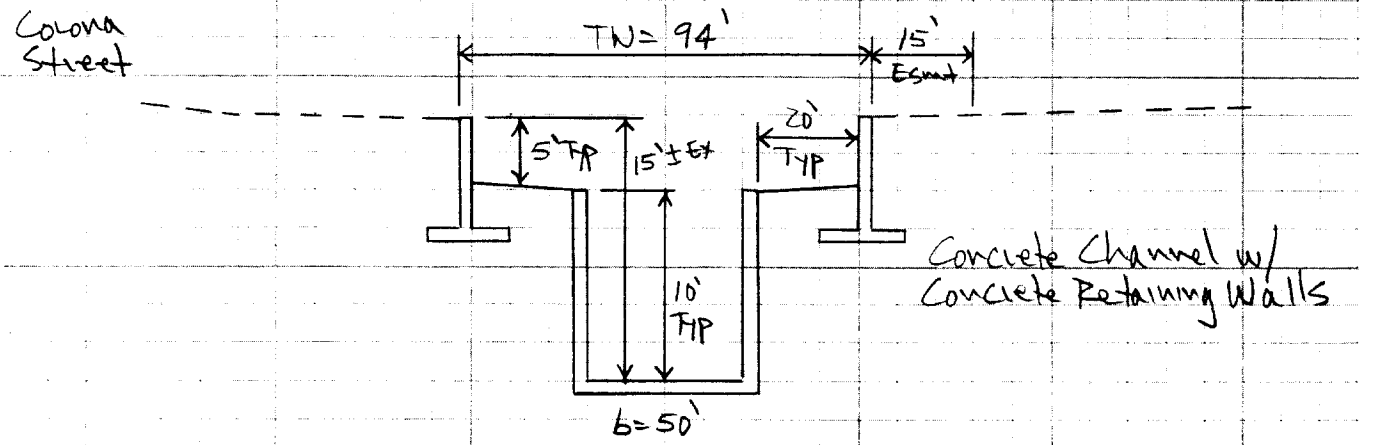
$Q_{100} = 5060$ cfs $L = 455'$ $S_{EX} = 0.6\%$ $HW = 82.0 - 69.8 = 12.2'$

Inlet Control $\Rightarrow Q/b = \frac{5060}{56} = 90$ $HW/D = 1.0$ $HW = (1.0)(10.0) = 10.0'$

Outlet Control $\Rightarrow H = 2.1'$ $H_o = 8.5'$ $LS_o = (455)(0.006) = 2.7'$

$HW = 2.1 + 8.5 - 2.7 = 7.9'$

Sta. 94+50 to Sta. 98+10 - New open channel between Bijou Street and Platte Avenue



$Q_{100} = 5060$ cfs $S_{EX} = 0.9\%$

$d = 4.5' \Rightarrow V = \left(\frac{1.49}{0.015}\right)\left(\frac{225}{59}\right)^{2/3}(0.009)^{1/2} = 26.5$ fps $\Rightarrow Q = (26.5)(225) = 5960$ cfs

Actual $d = 8' \pm$ (Est'd / Exist HEC-2) $\Rightarrow A = 400$ sf $\Rightarrow V = \frac{5060}{400} = 12.7$ fps

Freeboard $= 1.0 + (0.025)(12.7)(8)^{1/3} = 1.6' \Rightarrow$ Use 2' $D_{min} = 8 + 2 = 10'$

$F = \frac{12.7}{\sqrt{(32.2)(8)}} = 0.79$ Subcritical

Sta. 98+10 to Sta. 106+30 – Replace Culvert at Platte Avenue / School Athletic Field and Bridge at Boulder Street

4 - 12'x10' RCB

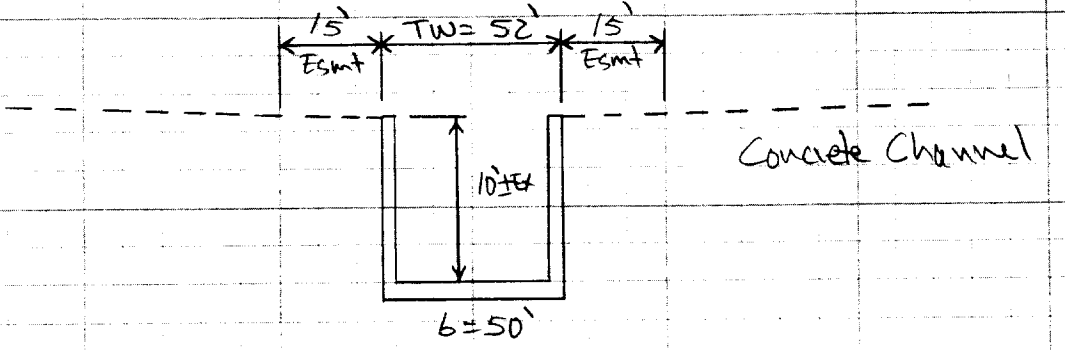
Q_{100} = 5020 cfs L = 695' S_{EX} = 0.5% AHW = 91.5 - 76.5 = 15.0'

Inlet Control ⇒ $Q/b = \frac{5020}{48} = 105$ HW/D = 1.1 HW = (1.1)(10.0) = 11.0'

Outlet Control ⇒ H = 3.4' H_0 = 8' LS_0 = (695)(0.005) = 3.5'

HW = 3.4 + 8 - 3.5 = 7.9'

Sta 106+30 to Sta 112+35 - New open channel between Boulder Street and 5th Main Street



Q_{100} = 5020 cfs S_{EX} = 0.9%

d = 4.5' ⇒ $V = \left(\frac{1.49}{0.013}\right)\left(\frac{225}{59}\right)^{2/3}(0.009)^{1/2}$ = 26.5 fps Q = (26.5)(225) = 5960 cfs

Freeboard = 1.0 + (0.025)(26.5)(4.5)^{1/3} = 2.1' ⇒ Use 3' D_{min} = 4.5 + 3 = 7.5'

$F = \frac{26.5}{\sqrt{(32.2)(4.5)}} = 2.20$ ⇒ Supercritical

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OF

Sta. 112+35 to Sta. 113+40 - Replace Culvert at St. Vrain Street

4 - 10' x 10' RCB

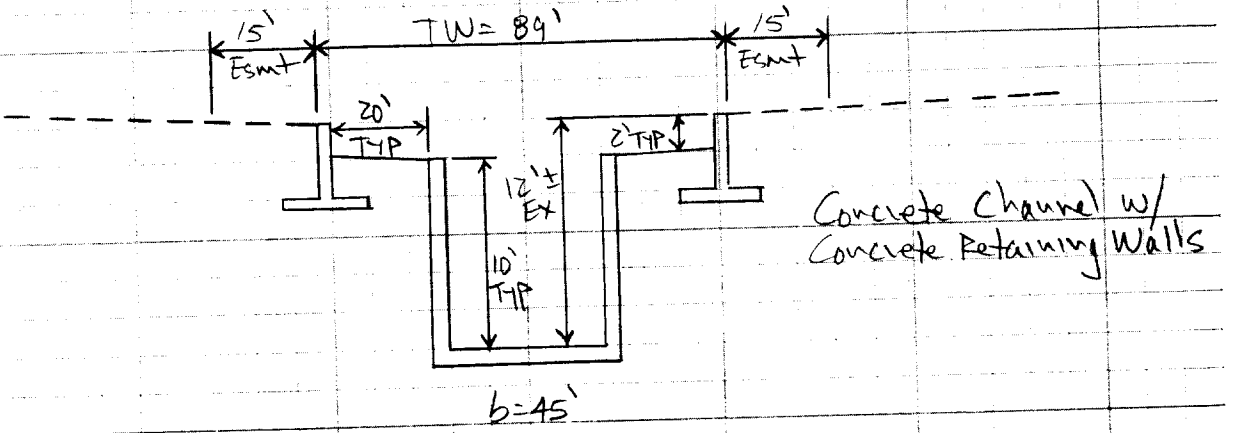
Q_{100} = 4935 cfs L = 105' S_{EX} = 0.4% AHW = 00.0 - 85.0 = 15.0'

Inlet Control ⇒ Q/6 = $\frac{4935}{40}$ = 123 HW/D = 1.3 HW = (1.3)(10.0) = 13.0'

Outlet Control ⇒ H = 3.3' H_0 = 4.5' LS_0 = (105)(0.004) = 0.4'

HW = 3.3 + 4.5 - 0.4 = 7.4'

Sta 113+40 to Sta 117+75 - New open channel between St. Vrain Street and Willamette Street



Q_{100} = 4935 cfs S_{EX} = 0.7%

d = 5' ⇒ $V = \left(\frac{1.49}{0.013}\right)\left(\frac{225}{55}\right)^{2/3}(0.007)^{1/2}$ = 24.5 fps ⇒ Q = (245)(225) = 5515 cfs

Actual d = 13' to 7.5'± (Est'd from Ex 1st HEC-2) ⇒ d = 7.5'± ⇒ A = 338 sf ⇒ V = $\frac{4935}{338}$ = 14.6 fps

Freeboard = 1.0 + (0.025)(14.6)(7.5)$^{1/3}$ = 1.7' ⇒ Use 2' D_{min} = 7.5 + 2 = 9.5'

F = $\frac{14.6}{\sqrt{(32.2)(7.5)}}$ = 0.94 ⇒ Subcritical

Sta. 117+75 to Sta 119+80 - Replace Culvert at Willamette Street

3-10'x10' RCB

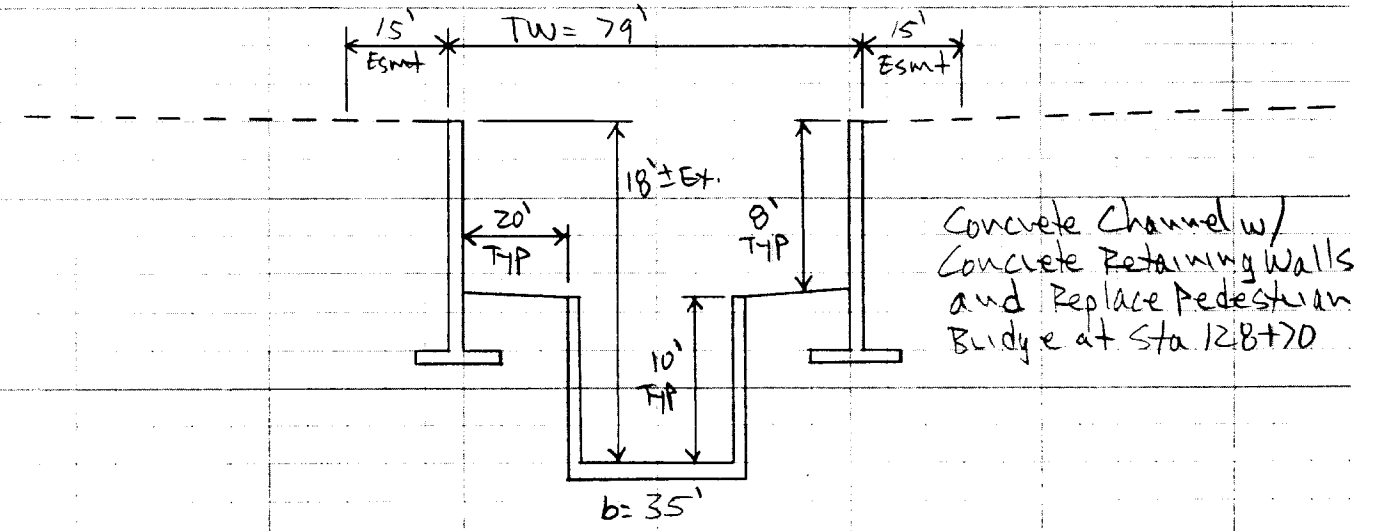
Q_{100} = 4875 cfs L = 205' S_{EX} = 0.1% AHW = 12.0 - 91.9 = 20.1'

Inlet Control ⇒ Q/b = $\frac{4875}{30}$ = 163 HW/D = 1.7 HW = (1.7)(10.0) = 17.0'

Outlet Control ⇒ H = 6.3' H_0 = 7.5' LS_0 = (205)(0.001) = 0.3'

HW = 6.3 + 7.5 - 0.3 = 13.5'

Sta. 119+80 to Sta. 135+15 - New open channel between Willamette Street and Cache La Poudre Street



Q_{100} = 4875 cfs S_{EX} = 0.17%

d = 6' ⇒ $V = \left(\frac{1.49}{0.013}\right)\left(\frac{210}{47}\right)^{2/3}(0.007)^{1/2}$ = 26.0 fps ⇒ Q = (26.0)(210) = 5460 cfs

Freeboard = 1.0 + (0.025)(26.0)(6)$^{1/3}$ = 2.2' ⇒ Use 3' Dmin = 6+3 = 9'

$F = \frac{26.0}{\sqrt{(32.2)(6)}}$ = 1.87 ⇒ Supercritical

Sta. 135+15 to Sta. 137+05 - Replace Culvert at Cache La Poudre Street

3-10' x 10' RCB

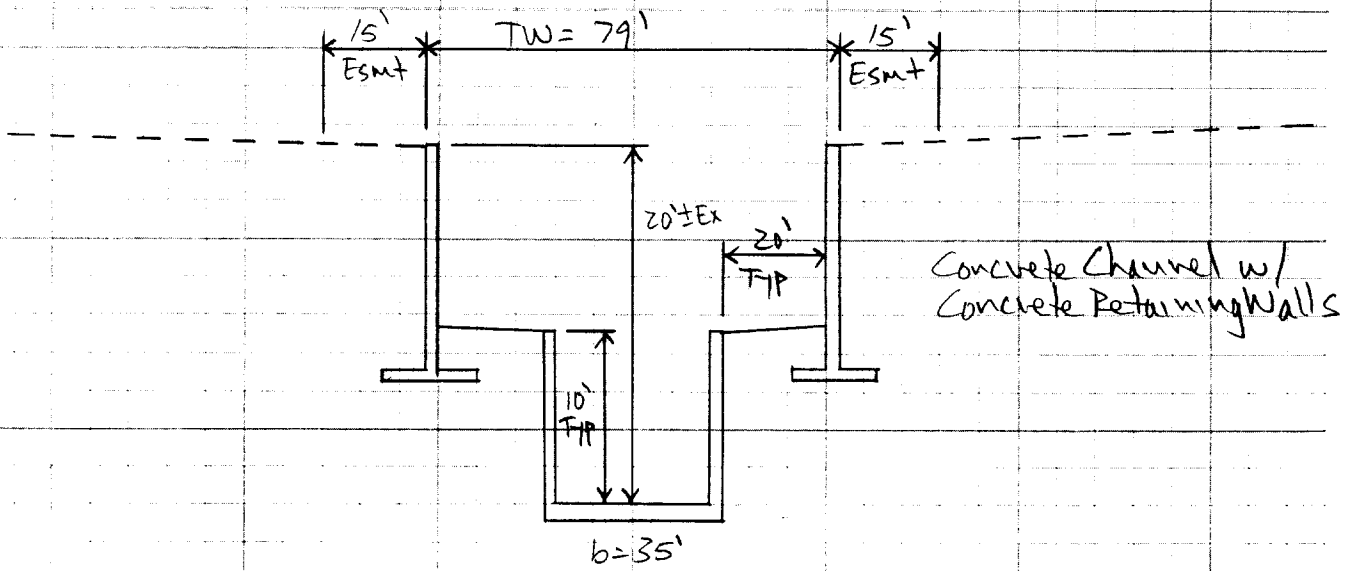
$Q_{100} = 4305$ cfs $L = 190'$ $S_{EX} = 0.12\%$ $AHW = 2610 - 0915 = 16.5'$

Inlet Control $\Rightarrow Q/6 = \frac{4305}{30} = 144$ $HW/D = 1.5$ $HW = (1.5)(10.0) = 15.0'$

Outlet Control $\Rightarrow H = 5.0$ $H_0 = 6'$ $LS_0 = (190)(0.002) = 0.4'$

$HW = 5.0 + 6 - 0.4 = 10.6'$

Sta. 137+05 to Sta 152+45 - New open channel between Cache La Poudre Street and Vintah Street



$Q_{100} = 4305$ cfs $S_{EX} = 0.7\%$

$d = 5.5' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{193}{46}\right)(0.007)^{1/2} = 24.9$ fps $\Rightarrow Q = (24.9)(193) = 4805$ cfs

Freeboard $= 1.0 + (0.025)(24.9)(5.5)^{1/3} = 2.1' \Rightarrow$ Use 3' $D_{min} = 5.5 + 3 = 8.5'$

$F = \frac{24.9}{\sqrt{(32.2)(5.5)}} = 1.87 \Rightarrow$ Supercritical

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OF

Sta. 152+45 to Sta. 153+55 - Replace Culvert at Uintah Street

2 - 14' x 10' RCB

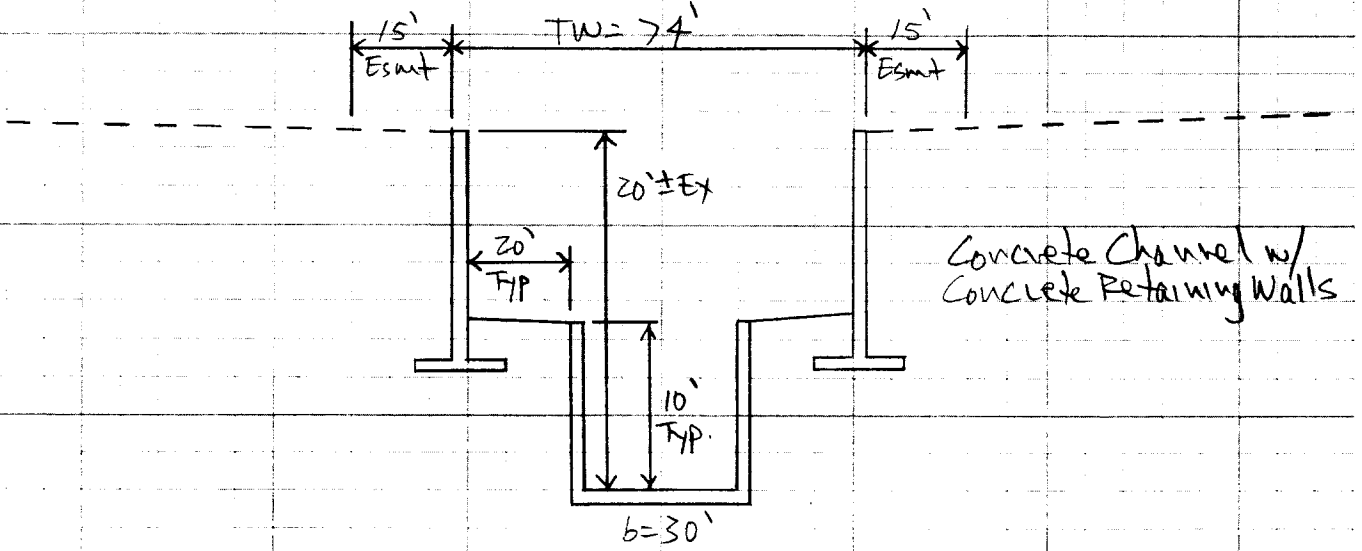
$Q_{100} = 3940$ cfs $L = 110'$ $S_{EX} = 1.2\%$ $AHW = 50.0 - 28.1 = 21.9'$

Inlet Control $\Rightarrow Q/b = \frac{3940}{28} = 141$ $HW/D = 1.5$ $HW = (1.5)(10) = 15.0'$

Outlet Control $\Rightarrow H = 4.4'$ $H_0 = 5.5'$ $LS_0 = (110)(0.012) = 1.3'$

$HW = 4.4 + 5.5 - 1.3 = 8.6'$

Sta. 153+55 to Sta. 157+55 - New open channel between Uintah Street and San Miguel Street



$Q_{100} = 3940$ cfs $S_{EX} = 1.1\%$

$d = 5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{150}{40}\right)^{2/3}(0.011)^{1/2} = 29.0$ fps $\Rightarrow Q = (29.0)(150) = 4350$ cfs

Actual $d = 15'$ to $11.5' \pm$ (Est'd / Exist HEC-2) $\Rightarrow d = 11.5' \Rightarrow A = 405$ sf $\Rightarrow V = \frac{3940}{405} = 9.7$ fps

Freeboard $= 1.0 + (0.025)(9.7)\sqrt{11.5} = 1.5' \Rightarrow$ Use 2' $D_{min} = 11.5 + 2 = 13.5'$

$F = \frac{9.7}{\sqrt{(32.2)(11.5)}} = 0.50 \Rightarrow$ Subcritical

Sta. 157+55 to Sta. 158+40 – Replace Culvert at San Miguel Street

2- 14' X 10' RCB

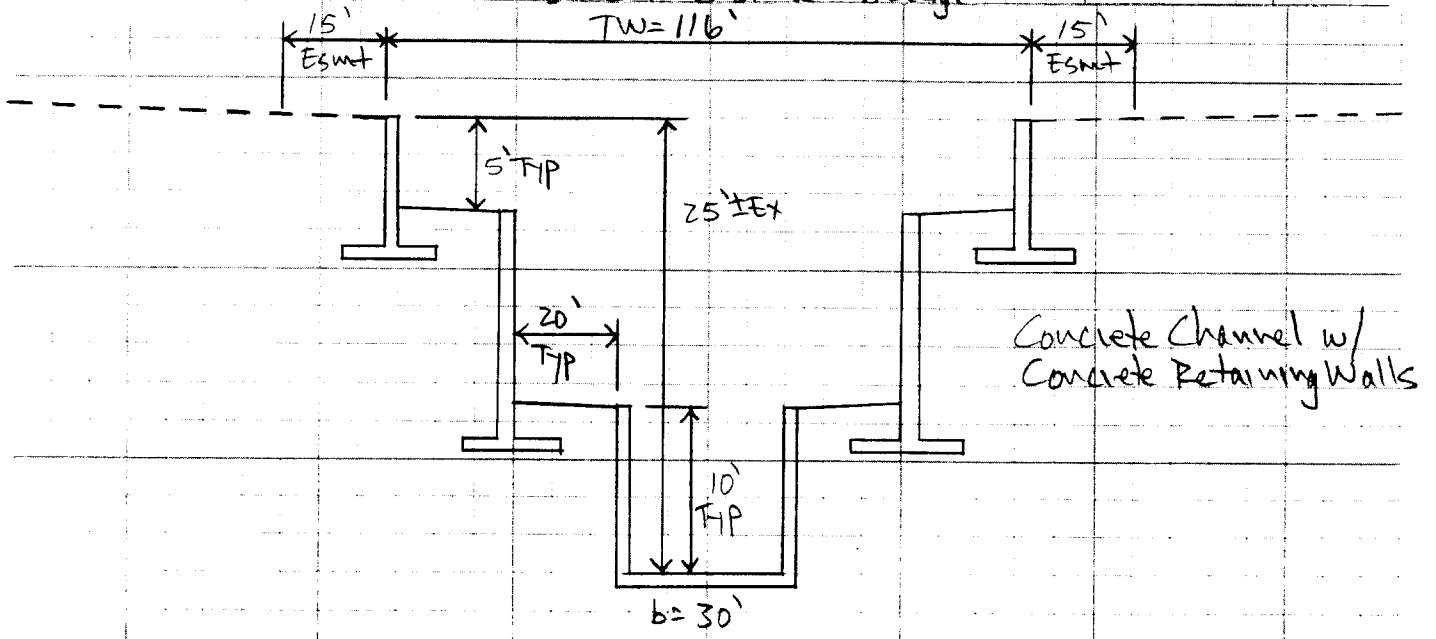
$Q_{100} = 3940$ $L = 85'$ $S_{EX} = 0.6\%$ $AHW = 52.5 - 33.1 = 19.4'$

Inlet Control $\Rightarrow Q/b = \frac{3940}{28} = 141$ $HW/D = 1.5$ $HW = (1.5)(10) = 15.0'$

Outlet Control $\Rightarrow H = 4.2'$ $h_o = 11.5'$ $LS_o = (85)(0.006) = 0.5'$

$HW = 4.2 + 11.5 - 0.5 = 15.2'$

Sta. 158+40 to Sta. 167+35 – New Open channel between San Miguel Street and Pedestrian Bridge



$Q_{100} = 3940$ cfs $S_{EX} = 1.0\%$

$d = 5' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{150}{40}\right)^{2/3}(0.010)^{1/2} = 27.7$ fps $\Rightarrow Q = (27.7)(150) = 4155$ cfs

Actual $d = 7.5' \pm$ (Est'd/Exist HEC-2) $\Rightarrow A = 225$ sf $v = \frac{3940}{225} = 17.5$ fps

Freeboard $= 1.0 + (0.025)(17.5)(7.5)^{1/3} = 1.9' \Rightarrow$ Use 2' $D_{min} = 7.5 + 2 = 9.5'$

$F = \frac{17.5}{\sqrt{(32.2)(7.5)}} = 1.13 \Rightarrow$ Supercritical

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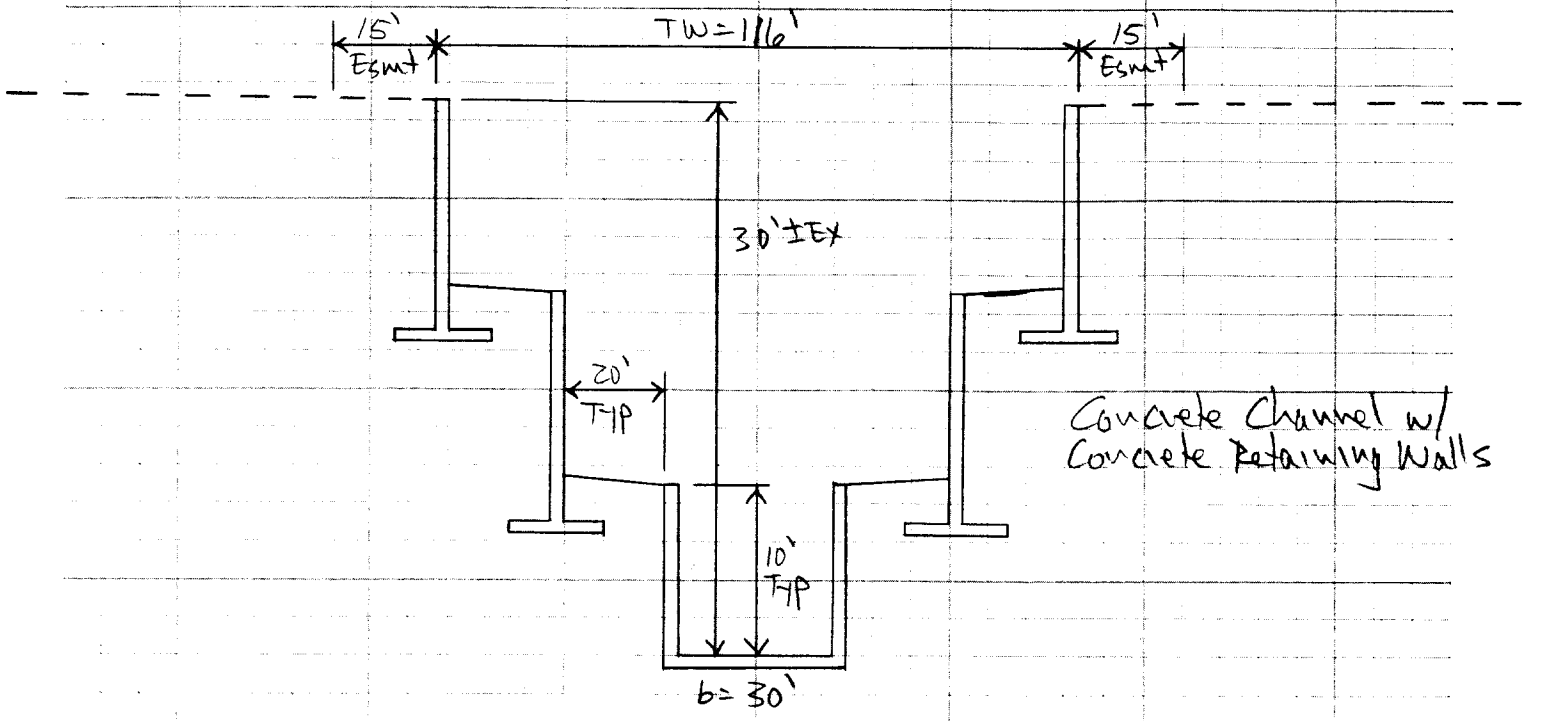
OF

Sta. 167+35 - Replace Pedestrian Bridge

Sta. 167+35 to Sta 176+25 - New open channel between Pedestrian Bridge and Patty Jewett Golf Course South Boundary



$Q_{100} = 3665$ cfs $\quad S_{EX} = 1.0\%$

$d = 5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{150}{40}\right)^{\frac{2}{3}}(0.010)^{1/2} = 27.7$ fps $\Rightarrow Q = (27.7)(150) = 4350$ cfs

Freeboard $= 1.0 + (0.025)(27.7)(5)^{1/3} = 2.2' \Rightarrow$ Use 3' $\quad D_{min} = 5+3 = 8'$

$F = \frac{27.7}{\sqrt{(32.2)(5)}} = 2.18 \Rightarrow$ Supercritical

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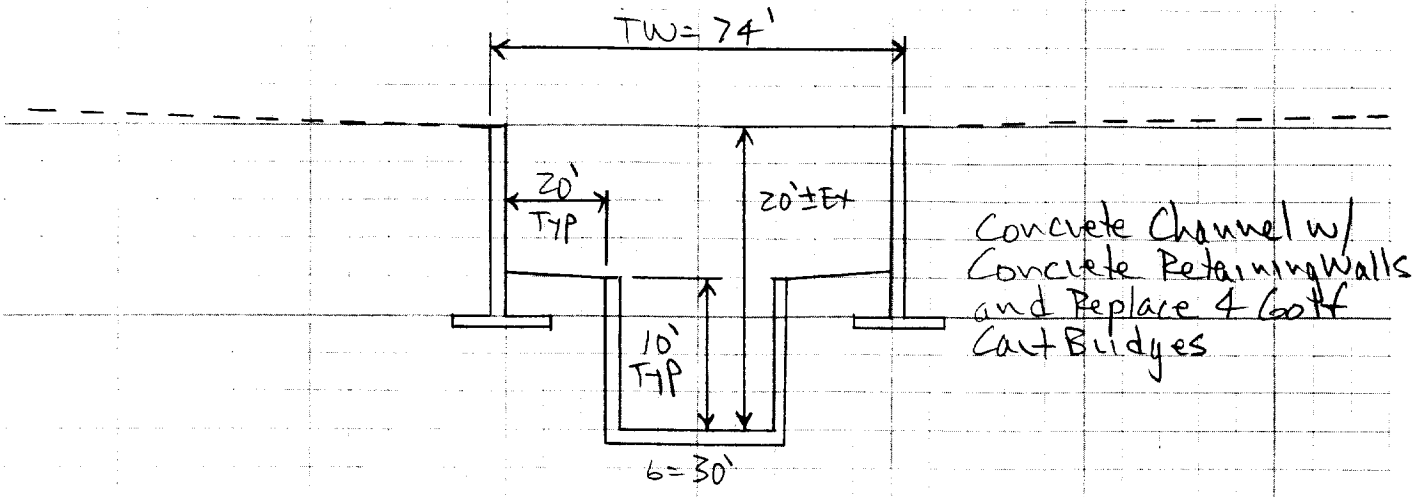
PROJ. Shooks Run

SHEET 17

SUBJ. Structural Alternative

OF

Sta. 176+25 to Sta. 189+05 - New Open Channel between Patty Jewett Golf Course South Boundary and Espanola Street



$Q_{100} = 3665$ cfs $S_{Ex} = 1.0\% + 6'$ Ex. Drop $S_{FLO} = 0.8\% \pm$

$d = 5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{150}{40}\right)^{2/3}(0.008)^{1/2} = 24.7$ fps $\Rightarrow Q = (24.7)(150) = 3705$ cfs

Freeboard $= 1.0 + (0.025)(24.7)(5)^{1/3} = 2.1' \Rightarrow$ use 3' $D_{min} = 5 + 3 = 8'$

$F = \frac{24.7}{\sqrt{(32.2)(5)}} = 1.95 \Rightarrow$ Supercritical

Sta. 189+05 to Sta 190+85 - Replace Culvet at Espanola Street

3-12' X 10' RCB

$Q_{100} = 3555$ cfs $L = 180'$ $S_{Ex} = 1.3\%$ $\Delta HW = 85.5 - 72.8 = 12.7'$

Inlet Control $\Rightarrow Q/b = \frac{3555}{36} = 99$ $HW/D = 1.05$ $HW = (1.05)(10) = 10.5'$

Outlet Control $\Rightarrow H = 2.0'$ $H_0 = 5'$ $LS_0 = (180)(0.013) = 2.3'$

$HW = 2.0 + 5' - 2.3 = 4.7'$

COMP. UMA

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

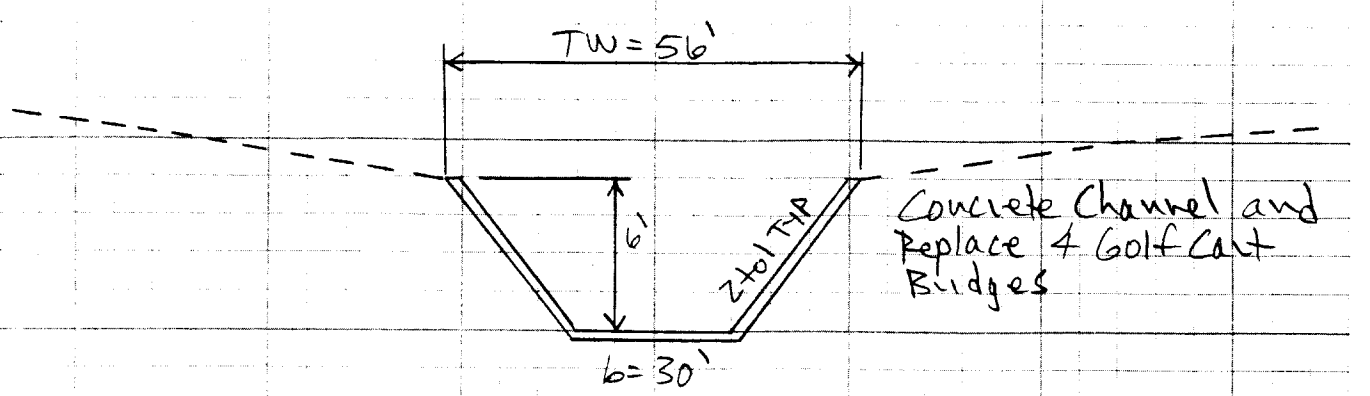
SUBJ. Structural Alternative

FILE 90-809

SHEET 18

OF

Sta. 190+85 to Sta 198+45 - Open Channel between Espanola Street and End of Existing Channel Lining



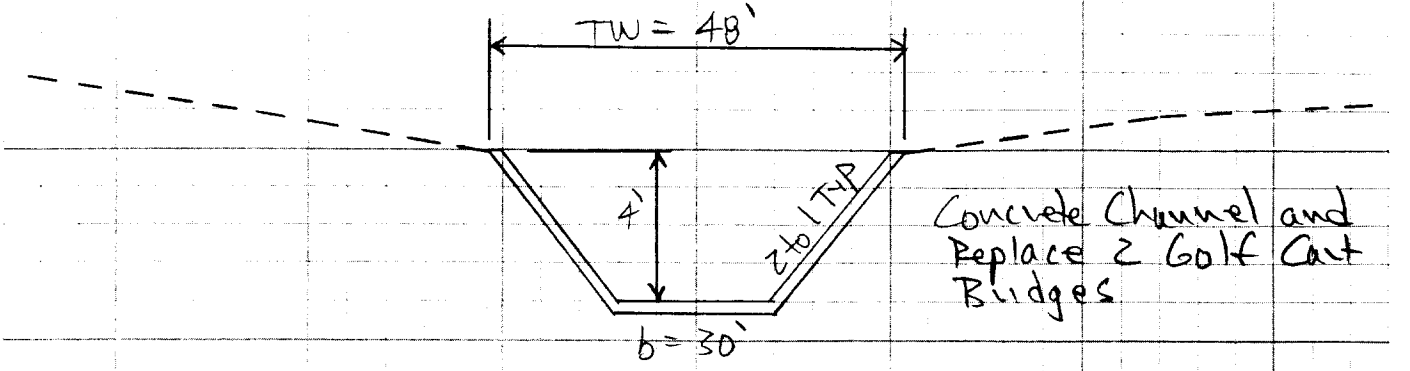
$Q_{100} = 3460$ cfs $S_{EX} = 1.4\% + 3'$ Ex. Drop $S_{PPD} = 1.5\% \pm$

$d = 3.5' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{130}{46}\right)^{2/3}(0.015)^{1/2} = 28.1$ fps $\Rightarrow Q = (28.1)(130) = 3655$ cfs

Freeboard $= 1.0 + (0.025)(28.1)(3.5)^{1/3} = 2.1' \Rightarrow$ Use 2.5' $D_{min} = 3.5 + 2.5 = 6.0'$

$F = \frac{28.1}{\sqrt{(32.2)(3.5)}} = 2.65 \Rightarrow$ Supercritical

Sta. 198+45 to Sta. 216+40 - New Open Channel between End of Existing Channel Lining and Paseo Road



$Q_{100} = 1110$ cfs $\quad S_{EX} = 1.0\%\pm$

$d = 2' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{68}{39}\right)^{2/3}(0.010)^{1/2} = 16.6$ fps $\Rightarrow Q = (16.6)(68) = 1130$ cfs

Freeboard $= 1.0 + (0.025)(16.6)(2)^{1/3} = 1.5' \Rightarrow$ Use $2' \quad D_{min} = 2+2 = 4'$

$F = \frac{16.6}{\sqrt{(32.2)(2)}} = 2.07 \Rightarrow$ Supercritical

Sta. 216+40 to Sta. 216+95 - Replace Culvert at Paseo Road

$3 - 10' \times 5'$ RCB

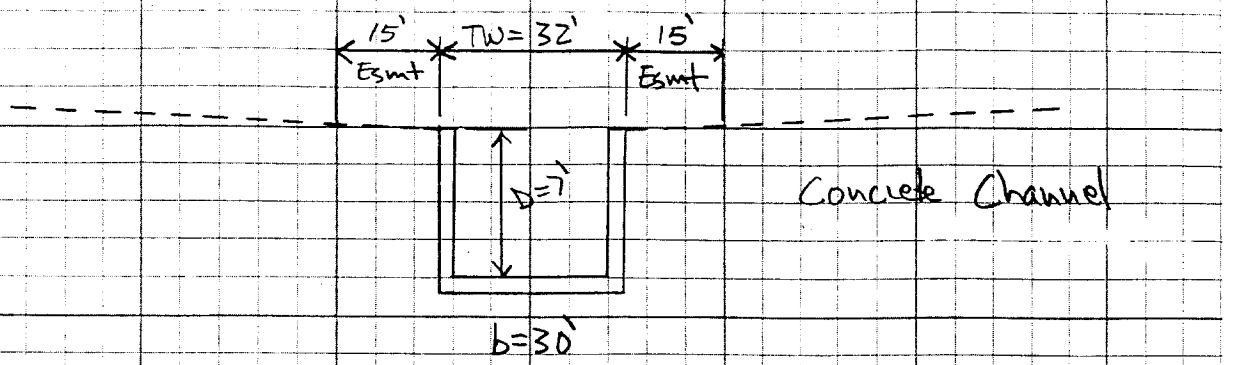
$Q_{100} = 1110$ cfs $\quad L = 55' \quad S_{PRO} = 0.7\% \quad AHW = 12.3 - 05.9 = 6.4'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2' \quad H_0 = 2' \quad LS_0 = (55)(0.007) = 0.4'$

$HW = 1.2 + 2 - 0.4 = 2.8'$

Sta. 216+95 to Sta 218+30 - New Open Channel between Paeo Road and Jefferson Street



Q_{100} = 1110 cfs S_{PRO} = 0.7% ±

$d = 2.5' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{7.5}{35}\right)^{2/3}(0.007)^{1/2} = 15.9 \text{ fps} \Rightarrow Q = (15.9)(75) = 1195 \text{ cfs}$

Actual $d = 5' \pm$ (Est'd / Exist HEC-2) $\Rightarrow A = 150 \text{ sf} \Rightarrow V = \frac{1110}{150} = 7.4 \text{ fps}$

Freeboard $= 1.0 + (0.025)(7.4)(5)^{1/3} = 1.3' \Rightarrow$ Use 2' $D_{min} = 5 + 2 = 7'$

$F = \frac{7.4}{\sqrt{(32.2)(5)}} = 0.58 \Rightarrow$ Supercritical

Sta. 218+30 to Sta. 219+10 - Replace Culvert at Jefferson Street

3 - 10' X 5' RCB

Q_{100} = 1110 cfs L = 80' S_{PRO} = 0.7% ± AHW = 14.0 - 07.5 = 6.5'

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37$ HW/D = 1.1 HW = (1.1)(5) = 5.5'

Outlet Control $\Rightarrow$ H = 1.2' H_O = 5' $LS_O = (80)(0.007) = 0.6'$

HW = 1.2 + 5 - 0.6 = 5.6'

COMP. [illegible]

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

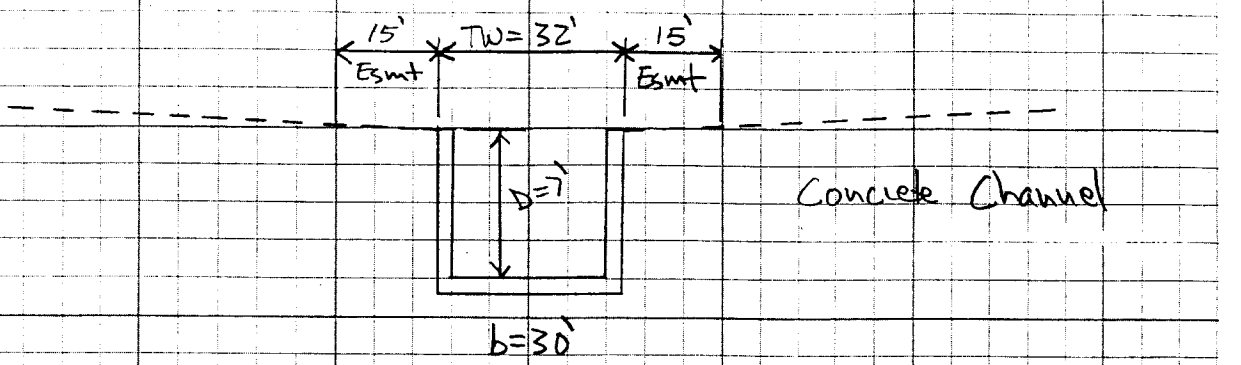
SUBJ. Structural Alternative

FILE 90-809

SHEET 21

OF

Sta. 219+10 to Sta 222+50 - New Open Channel between Jefferson Street and Madison Street



$Q_{100} = 1110$ cfs $S_{PRO} = 1.2\% \pm$

$d = 2' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{60}{34}\right)^{2/3}(0.012)^{1/2} = 18.3$ fps $\Rightarrow Q = (18.3)(60) = 1100$ cfs

Actual $d = 3' \pm$ (Est'd / Exist HEC-2) $\Rightarrow A = 90$ sf $\Rightarrow V = \frac{1110}{90} = 12.3$ fps

Freeboard $= 1.0 + (0.025)(12.3)(3)^{1/3} = 1.4' \Rightarrow$ Use 2' $D_{min} = 3 + 2 = 5'$

$F = \frac{12.3}{\sqrt{(32.2)(3)}} = 1.25 \Rightarrow$ Supercritical

Sta. 222+50 to Sta. 223+30 - Replace Culvert at Madison Street

3-10'x5' RCB

$Q_{100} = 1110$ cfs $L = 80'$ $S_{PRO} = 1.2\% \pm$ $AHW = 20.0 - 12.4 = 7.6'$

Inlet Control $\Rightarrow Q/b = \frac{1110}{30} = 37$ $HW/D = 1.1$ $HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2'$ $H_0 = 3'$ $LS_0 = (80)(0.012) = 1.0'$

$HW = 1.2 + 3 - 1.0 = 3.2'$

COMP. WWA

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

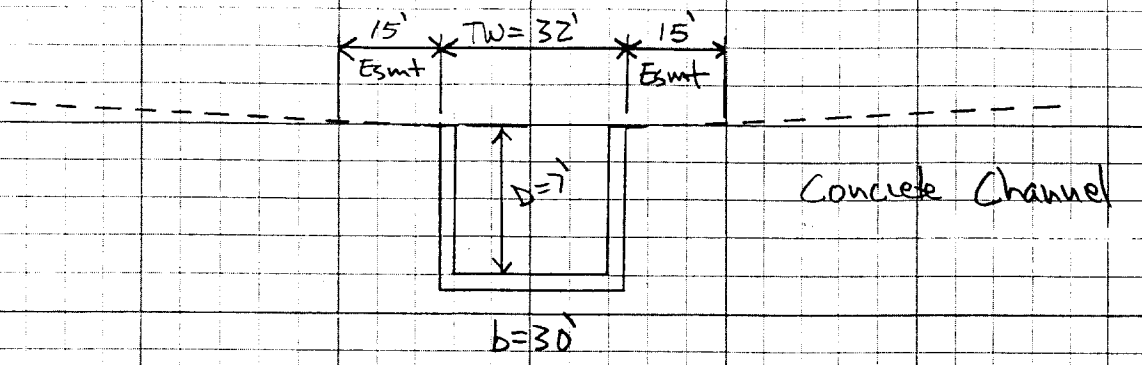
SUBJ. Structural Alternative

FILE 90-809

SHEET 22

OF

Sta. 223+30 to Sta 226+25 - New Open Channel between Madison Street and Monroe Street



Q_{100} = 1110 cfs S_{PRO} = 1.2% ±

$d = 2' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{60}{34}\right)^{2/3}(0.012)^{1/2} = 18.3$ fps $\Rightarrow Q = (18.3)(60) = 1100$ cfs

Actual d = 3' ± (Est 'd' / Exist HEC-2) $\Rightarrow A = 90$ sf $\Rightarrow v = \frac{1110}{90} = 12.3$ fps

Freeboard = $1.0 + (0.025)(12.3)(3)^{1/3} = 1.4' \Rightarrow$ Use 2' Dmin = 3+2 = 5'

$F = \frac{12.3}{\sqrt{(32.2)(3)}} = 1.25 \Rightarrow$ Supercritical

Sta 226+25 to 227+05 - Replace Culvert at Monroe Street

3-10' x 5' RCB

Q_{100} = 1110 cfs L = 80' S_{PRO} = 1.2% ± AHW = 23.5 - 16.7 = 6.8'

Inlet Control $\Rightarrow Q/6 = \frac{1110}{30} = 37$ HW/D = 1.1 HW = (1.1)(5) = 5.5'

Outlet Control $\Rightarrow$ H = 1.2' H_0 = 3' $LS_0 = (80)(0.012) = 1.0'$

HW = 1.2 + .3 - 1.0 = 3.2'

COMP. [illegible]

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

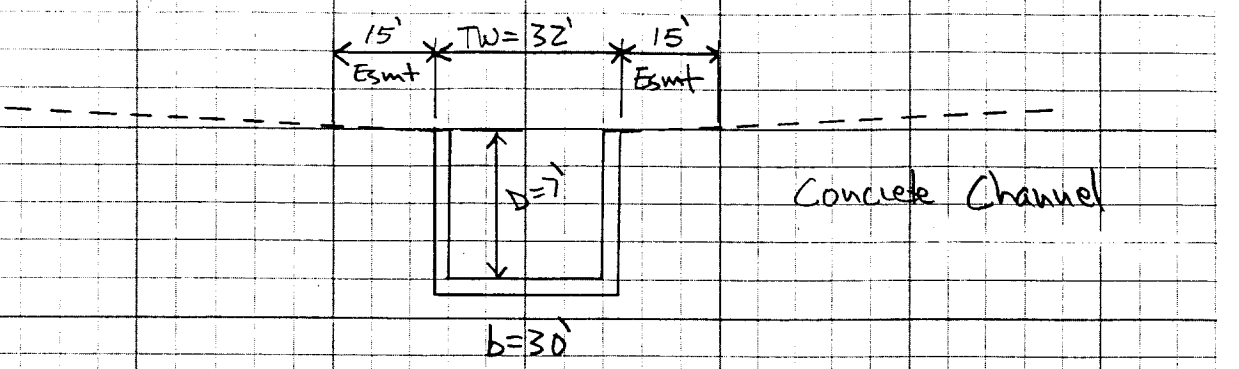
SUBJ. Structural Alternative

FILE 90-809

SHEET 23

OF

Sta. 222+05 to Sta 229+70 - New Open Channel between Monroe Street and Jackson Street



Q_{100}=1110 cfs S_{PRO}= 1.2% ±

$d=2' \Rightarrow V=\left(\frac{1.49}{0.013}\right)\left(\frac{60}{34}\right)^{2/3}(0.012)^{1/2}=18.3$ fps $\Rightarrow Q=(18.3)(60)=1100$ cfs

Actual d= 3' ± (Est'd/Exist HEC-2) $\Rightarrow A=90$ sf $\Rightarrow V=\frac{1110}{90}=12.3$ fps

Freeboard $=1.0+(0.025)(12.3)(3)^{1/3}=1.4' \Rightarrow$ Use 2' $D_{min}=3+2=5'$

$F=\frac{12.3}{\sqrt{(32.2)(3)}}=1.25 \Rightarrow$ Supercritical

Sta. 229+70 to Sta. 234+15 - Replace Culvert at Jackson Street / LaSalle Street

3 - 10' x 5' RCB

Q_{100}= 1110 cfs L= 445' S_{PRO}= 1.2% ± ΔHW= 31.5 - 25.0 = 6.5'

Inlet Control $\Rightarrow Q/b=\frac{1110}{30}=37$ HW/D=1.1 HW=(1.1)(5)=5.5'

Outlet Control $\Rightarrow H=1.9'$ $H_0=3'$ $LS_0=(445)(0.012)=5.3'$

HW = 1.9 + 3 - 5.3 = -0.4'

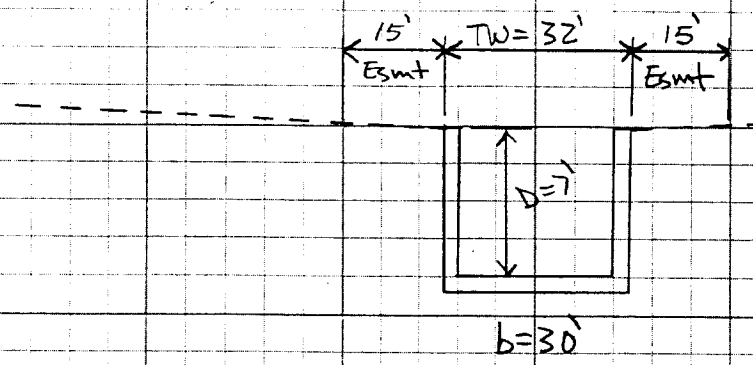
COMP. [illegible]
CK.
DATE December 2, 1992

WILSON & COMPANY

LOC.
PROJ. Shooks Run
SUBJ. Structural Alternative

FILE 90-809
SHEET 24
OF

Sta. 234+15 to Sta 235+40 - New Open Channel between LaSalle Street and Pedestrian Path



Q_{100}=1070 cfs S_{PRO} = 1.2% ±

$d=2' \Rightarrow V=\left(\frac{1.49}{0.013}\right)\left(\frac{60}{34}\right)^{2/3}(0.012)^{1/2}=18.3$ fps $\Rightarrow Q=(18.3)(60)=1100$ cfs

Actual d = 3.5' ± (Est'd/Exist HEC-2) $\Rightarrow A=105$ sf $\Rightarrow V=\frac{1070}{105}=10.2$ fps

Freeboard $=1.0+(0.025)(10.2)(3.5)^{1/3}=1.4' \Rightarrow$ Use 2' $D_{min}=3.5+2=5.5'$

$F=\frac{10.2}{\sqrt{(32.2)(3.5)}}=0.96 \Rightarrow$ Subcritical

Sta. 235+40 to Sta. 235+90 - Replace Culvert at Pedestrian Path

3 - 10' x 5' RCB

Q_{100}=1070 cfs L=50' S_{PRO} = 2.2% ± ΔHW = 35.6 - 28.6 = 6.8'

Inlet Control $\Rightarrow Q/b=\frac{1070}{30}=36$ HW/D = 1.1 HW = (1.1)(5) = 5.5'

Outlet Control $\Rightarrow H=1.1'$ $H_0=3.5'$ $LS_0=(50)(0.022)=1.1'$

HW = 1.1 + 3.5 - 1.1 = 3.5'

COMP. [illegible]

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

PROJ. Shooks Run

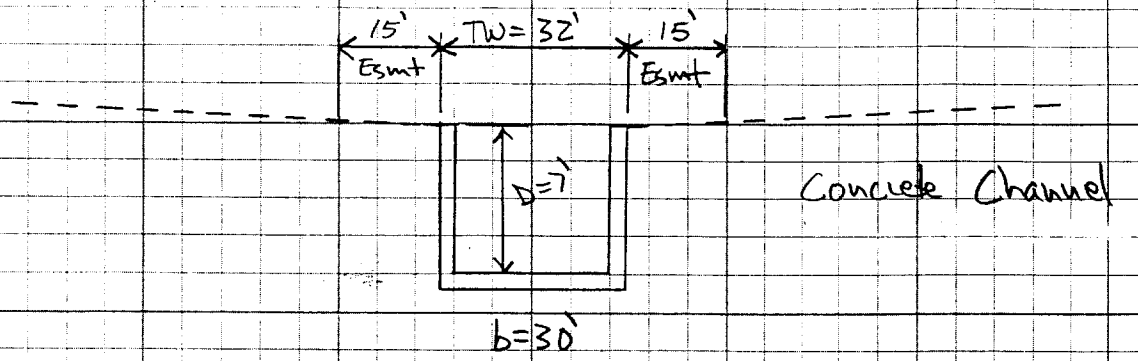
SUBJ. Structual Alternative

FILE 90-809

SHEET 25

OF

Sta. 235+90 to Sta 236+20 - New Open Channel between Pedestrian Path and C.R.I.P. Railroad



$Q_{100} = 1070$ cfs $S_{PRO} = 1.2\%$ ±

$d = 3' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{60}{86}\right)^{2/3}(0.012)^{1/2} = 21.9$ fps $\Rightarrow Q = (21.9)(60) = 1315$ cfs

Actual $d = 5' \pm$ (Est'd / Exist HEC-2) $\Rightarrow A = 100$ sf $\Rightarrow V = \frac{1070}{100} = 10.7$ fps

Freeboard $= 1.0 + (0.025)(10.7)(5)^{1/3} = 1.5' \Rightarrow$ Use 2' $D_{min} = 5 + 2 = 7'$

$F = \frac{10.7}{\sqrt{(32.2)(5)}} = 0.84 \Rightarrow$ Subcritical

Sta. 236+20 to Sta. 236+75 - Replace Culvert at C.R.I.P Railroad

2 - 9' X 5' RCB

$Q_{100} = 1070$ cfs $L = 55'$ $S_{PRO} = 2.2\%$ $A_{HW} = 40.1 - 30.16 = 9.5'$

Inlet Control $\Rightarrow Q/5 = \frac{1070}{18} = 59$ $HW/D = 1.8$ $HW = (1.8)(5) = 9.0$

Outlet Control $\Rightarrow H = 3.0'$ $H_0 = 5.0'$ $LS_0 = (55)(0.022) = 1.2'$

$HW = 3.0 + 5.0 - 1.2 = 6.8'$

COMP. WMA

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

FILE 90-809

PROJ. Shooks Run

SHEET 26

SUBJ. Structural Alternative

OF

Templeton Gap Road at Van Buren Channel – Replace Culvert

2-11'x6' RCB

$Q_{100} = 1460$ cfs $L = 100'$ $S_{EX} = 0.6\%$ $\Delta HW = 40.1 - 30.3 = 9.8'$

Inlet Control $\Rightarrow$ $Q/b = \frac{1460}{22} = 66$ $HW/D = 1.5$ $HW = (1.5)(6) = 9.0'$

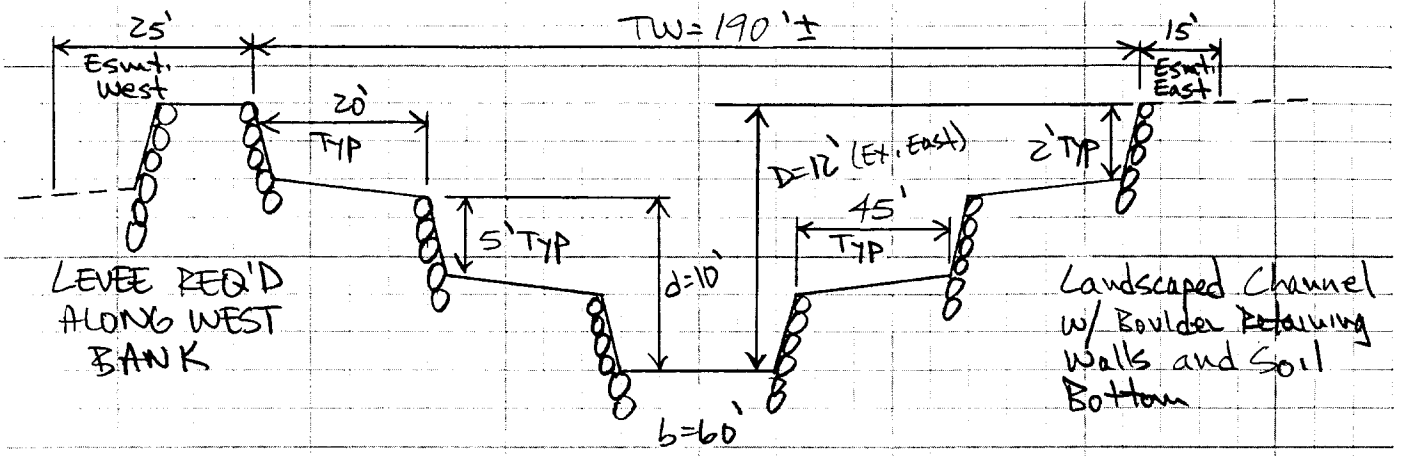
Outlet Control $\Rightarrow$ $H = 2.6'$ $D_c = 5.1'$ $H_0 = \frac{6+5.1}{2} = 5.6'$

$LS_0 = (100)(0.006) = 0.6'$ $HW = 2.6 + 5.6 - 0.6 = 7.6'$

C. SOFT-LINED FULL IMPROVEMENT WITH COMPLETE SHOOKS RUN DIVERSION AT THE VAN BUREN CHANNEL ALTERNATIVE HYDRAULIC CALCULATIONS

SOFT-LINED ALTERNATIVE w/ DIVERSION (VAN BUREN CHANNEL)

Sta. 0+25 to Sta. 9+75 - New open Channel between Fountain Creek Confluence and Las Vegas Street



$Q_{100} = 6750$ cfs $S_{EX} = 0.4\%$

$d = 10' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{1050}{170}\right)^{2/3}(0.004)^{1/2} = 6.3$ fps $\Rightarrow Q = (6.3)(1050) = 6615$ cfs

Freeboard $= 1.0 + (0.025)(6.3)(10)^{1/3} = 1.3' \Rightarrow$ Use 2' $D_{min} = 10 + 2 = 12'$ (Meet exist. east bank)

$F = \frac{6.3}{\sqrt{(32.2)(10)}} = 0.35 \Rightarrow$ Subcritical

Sta. 9+75 to Sta. 10+80 - Replace bridge and dissipator at Las Vegas Street

5 - 12' x 10' RCB

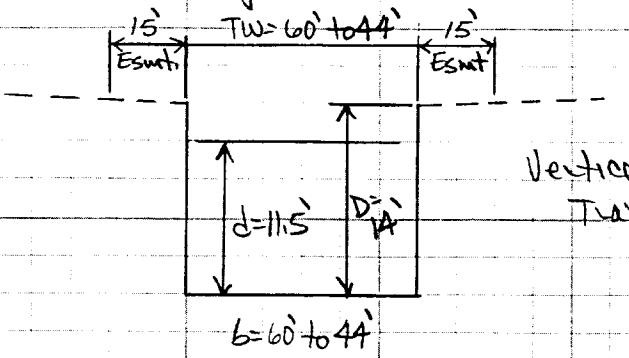
$Q_{100} = 6750$ cfs $L = 70'$ $S_{EX} = 0.7\%$ $AHW = 11.6 - 97.7 = 13.9'$

Inlet Control $\Rightarrow Q/b = \frac{6750}{60} = 113$ $HW/D = 1.2$ $HW = (1.2)(10) = 12'$

Outlet Control $\Rightarrow H = 2.7$ $d_c = 7.4'$ $H_o = \frac{10+7.4}{2} = 8.7'$

$LS_o = (70)(0.007) = 0.5'$ $HW = 2.7 + 8.7 - 0.5 = 10.9'$

Sta. 10+80 to Sta. 11+20 - New Concrete transition channel between Las Vegas Street and A.T.S.F. & D.R.G.W. Railroad



Vertical Walled Concrete Transition Channel

$Q_{100} = 6750$ cfs $S_{EX} = 1.0\%$

$d = 5.5'$ and $b = 44' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{242}{55}\right)^{2/3}(0.010)^{1/2} = 30.8$ fps $\Rightarrow Q = (30.8)(242) = 7455$ cfs

Actual $d = 12.0'$ to $11.5' \pm$ (Est'd/Exist HEC2) $\Rightarrow d = 11.5'$ and $b = 44' \Rightarrow A = 506$ sf $V = \frac{6750}{506} = 13.3$ fps

Freeboard $= 1.0 + (0.025)(13.3)(11.5)^{1/3} = 1.8' \Rightarrow$ Use $2'$ $D_{min} = 11.5 + 2.0 = 13.5 \Rightarrow$ Use $14'$

$F = \frac{13.3}{\sqrt{(32.2)(11.5)}} = 0.69 \Rightarrow$ Subcritical

Sta. 11+20 to 11+65 - Existing Culvert for A.T.S.F. & D.R.G.W. Railroad

Double $20' \times 16.5'$ Conc. Arch ($18.7' \times 15.4'$ RCB Equiv)

$Q_{100} = 6750$ cfs $L = 45'$ $S_{EX} = 1.3\%$ $AHW = 23.2 - 98.7 = 24.5'$

Inlet Control $\Rightarrow Q/b = \frac{6750}{(2)(18.7)} = 180$ $HW/D = 1.05$ $HW = (1.05)(15.4) = 16.2'$

Outlet Control $\Rightarrow H = 2.8'$ $H_0 = 11.5'$ $LS_0 = (45)(0.013) = 0.6'$

$HW = 2.8 + 11.5 - 0.6 = 13.7'$

COMP. MMD

CK.

DATE December 2, 1992

WILSON & COMPANY

LOC.

FILE 90-809

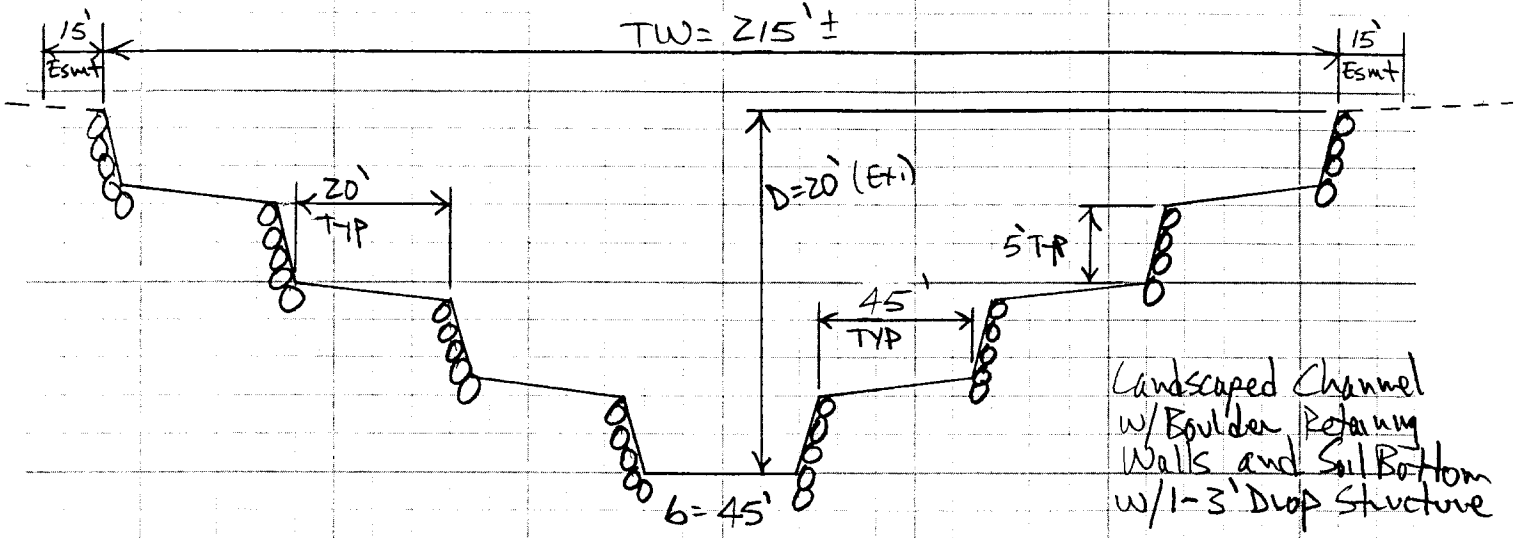
PROJ. Shooks Run

SHEET 3

SUBJ. Soft-Lined Alternative w/ Diversion

OF

Sta. 11+65 to Sta. 15+60 - Newopen Channel between A.T.S.F. & D.R.G.W. Railroad and abandoned railroad



$Q_{100} = 6750$ cfs $S_{EX} = 1.2\%$ $S_{PRO} = 0.5\% \pm$

$d = 11' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{1075}{197}\right)^{2/3}(0.005)^{1/2} = 6.5$ fps $\Rightarrow Q = (6.5)(1075) = 6990$ cfs

Actual d= 16.2' to 13' ± (Est'd / Exist HEC 2) $\Rightarrow d = 13' \Rightarrow A = 1425$ sf $V = \frac{6750}{1425} = 4.7$ fps

Freeboard $= 1.0 + 0.025(4.7)(13)^{1/3} = 1.3' \Rightarrow$ use 2.0' $D_{min} = 13 + 2.0 = 15'$

$F = \frac{4.7}{\sqrt{(32.2)(13)}} = 0.23 \Rightarrow$ Subcritical

Sta. 15+60 to 16+20 - Existing culvert for abandoned railroad

Double 20' x 17.9' Stone Masonry Arch (18.8' x 16.8' RCB Equiv)

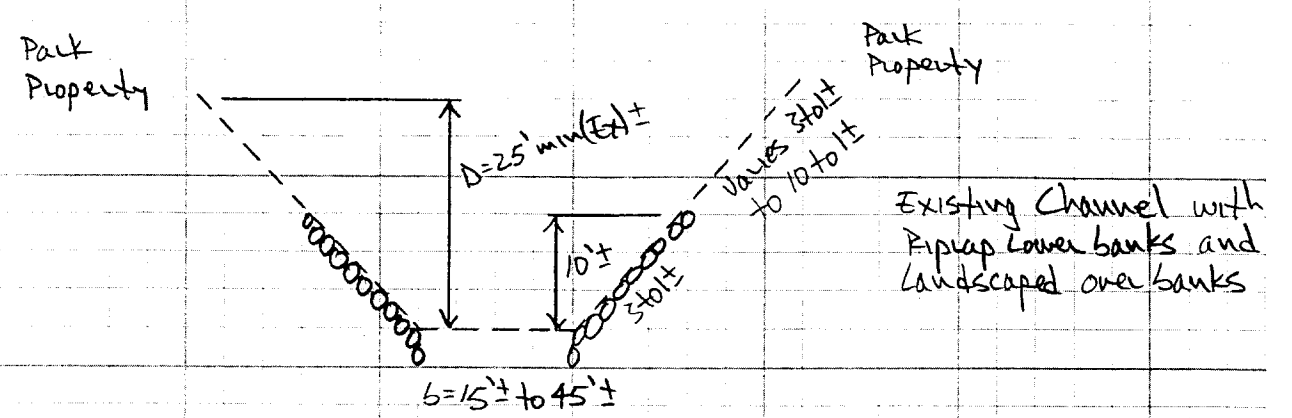
$Q_{100} = 6750$ cfs $L = 60'$ $S_{EX} = 0.7\%$ $AHW = 43.8 - 03.8' = 40.0'$

Inlet Control $\Rightarrow Q/b = \frac{6750}{2(18.8)} = 180$ $HW/D = 1.05$ $HW = (1.05)(16.8) = 17.6'$

Outlet Control $\Rightarrow H = 2.1'$ $H_0 = 13'$ $LS_0 = (60)(0.00) = 0.4'$

$HW = 2.1 + 13.0 - 0.4 = 14.7'$

Sta. 16+20 to Sta. 24+00 - Remove undesireable vegetation and debris from floodplain between abandoned railroad and Fountain Boulevard



Q_{100} = 6750 cfs to 6790 cfs S_{Ex} = 0.17%±

d = 11' and b = 30'± ⇒ $V=\left(\frac{1.49}{0.045}\right)\left(\frac{693}{100}\right)^{2/3}(0.007)^{1/2}$ = 10.1 fps ⇒ Q = (10.1)(693) = 7000 cfs

Actual d = 17.6' to 14'± (Est'd/ Exist HEC2) ⇒ d = 14' and b = 30' ⇒ A = 1008 sf $V=\frac{6740}{1008}$ = 6.7 fps

Freeboard = 1.0 + 0.025(6.7)(14)$^{1/3}$ = 1.4' ⇒ use 2.0' D_{min} = 14 + 2 = 16'

$F=\frac{6.7}{\sqrt{(32.2)(14)}}$ = 0.32 ⇒ Subcritical

Sta. 24+00 to Sta. 25+50 - Replace culvert at Fountain Boulevard

4 - 11' x 10' RCB

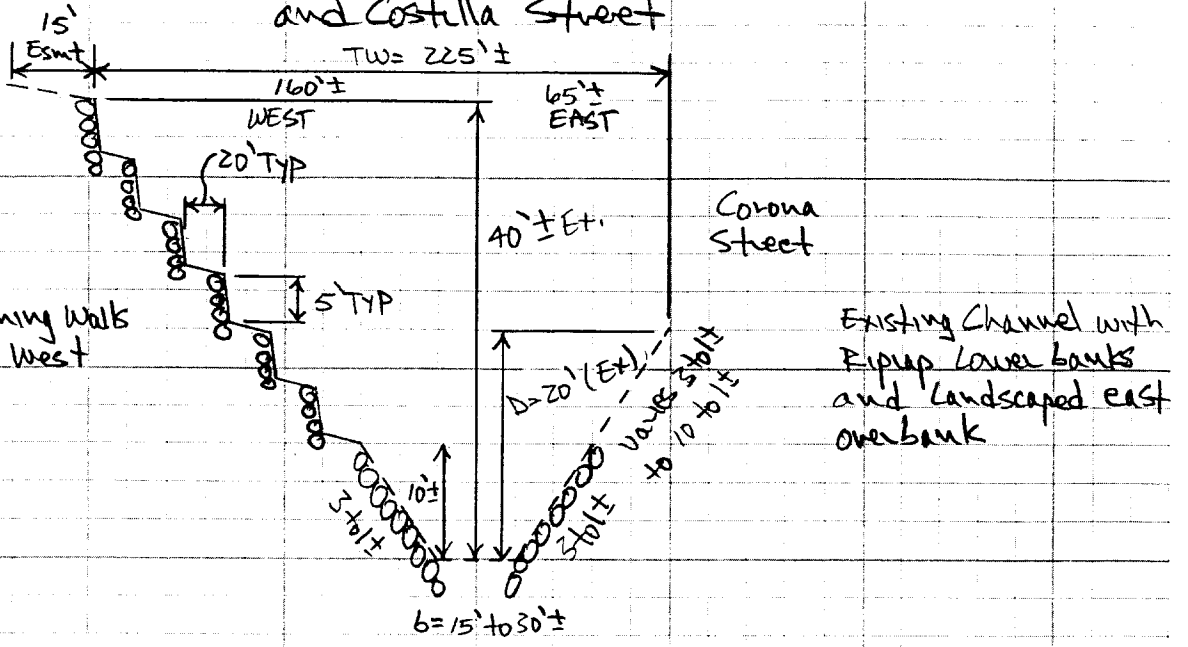
Q_{100} = 6790 cfs L = 150' S_{Ex} = 0.17% AHW = 30.3 - 10.3 = 20.0'

Inlet Control ⇒ $Q/b=\frac{6790}{44}$ = 154 HW/D = 1.6 HW = (1.6)(10) = 16.0'

Outlet Control ⇒ H = 5.2' H_0 = 14' LS_0 = (150)(0.007) = 1.1'

HW = 5.2 + 14 - 1.1 = 18.1'

Sta. 25+50 to Sta. 48+65 - Remove undesireable vegetation and debris from floodplain and reduce slope of West overbank between Fountain Boulevard and Costilla Street



Q_{100} = 6790 cfs to 6665 cfs $S_{EX} \doteq 0.18\%$

$d = 10.5'$ and $b = 30' \Rightarrow v = \left(\frac{1.49}{0.045}\right)\left(\frac{646}{96}\right)^{2/3}(0.008)^{1/2} = 10.6 fps \Rightarrow Q = (10.6)(646) = 6850 cfs$

Actual $d = 18.1'$ to $12.5' \pm$ (Est'd/Exist HEC2) $\Rightarrow d = 12.5'$ and $b = 30' \Rightarrow A = 884 sf$ $v = \frac{6665}{884} = 7.5 fps$

Freeboard $= 1.0 + (0.025)(7.5)(12.5)^{1/3} = 1.4' \Rightarrow$ Use $2.0'$ $D_{min} = 12.5 + 2.0 = 14.5'$

$F = \frac{7.5}{\sqrt{(32.2)(12.5)}} = 0.37 \Rightarrow$ Subcritical

Sta. 48+65 to Sta. 50+65 - Replace culvert at Costilla Street

4 - 10' x 10' RCB

$Q_{100} = 6665 cfs$ $L = 200'$ $S_{EX} = 0.6\%$ $HHW = 50.1 - 29.9 = 20.2'$

Inlet Control $\Rightarrow Q/b = \frac{6665}{40} = 167$ $HW/D = 1.75$ $HW = (1.75)(10.0) = 17.5'$

Outlet Control $\Rightarrow H = 6.5'$ $H_0 = 12.5'$ $LS_0 = (200)(0.006) = 1.2'$

$HW = 6.5 + 12.5 - 1.2 = 17.8'$

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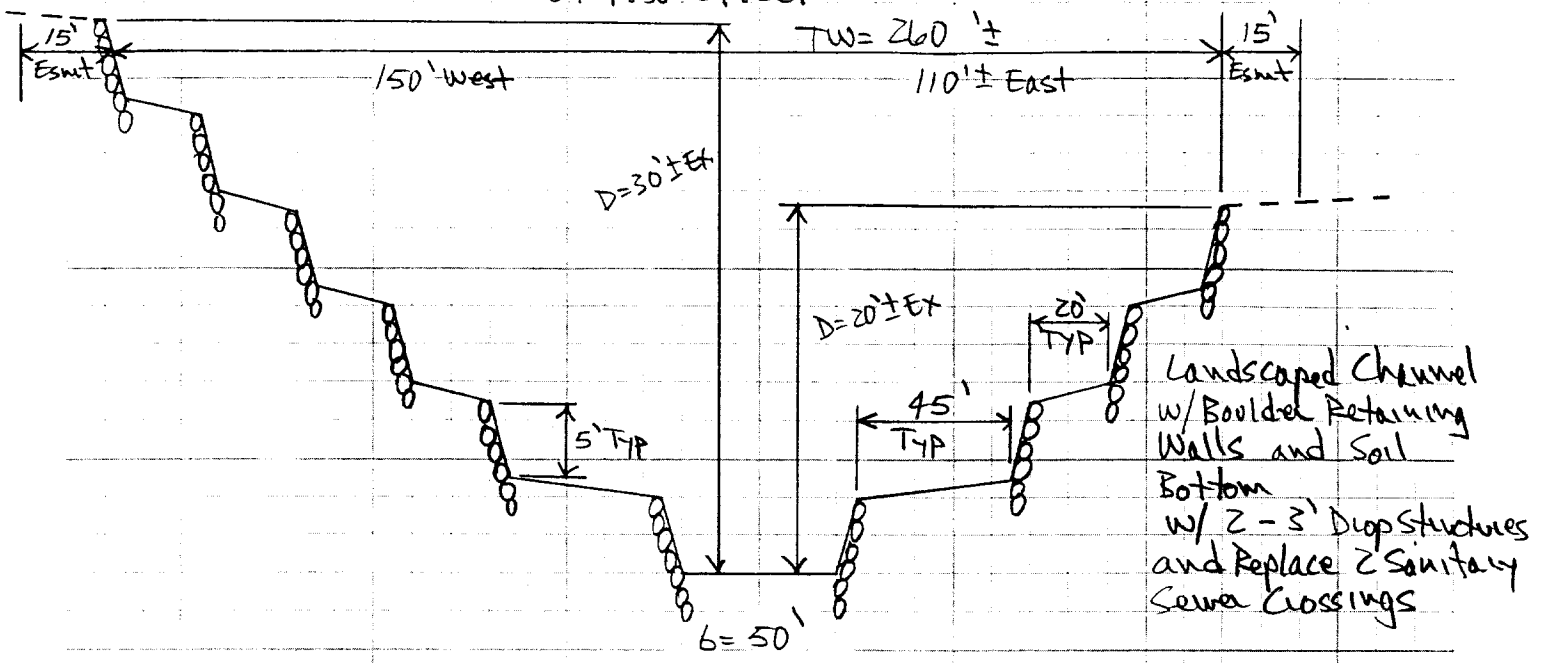
Sta. 50+65 to Sta. 71+55 - New open channel between Costilla Street and El Paso Street



Q_{100} = 6665 cfs to 6550 cfs S_{EX} = 0.8% S_{PRO} = 0.5% ±

$d = 10' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{950}{160}\right)^{2/3}(0.005)^{1/2} = 6.9$ fps $\Rightarrow Q = (6.9)(950) = 6555$ cfs

Freeboard = $1.0 + (0.025)(6.9)(10.0)^{1/3} = 1.4' \Rightarrow$ use 2.0' $\Rightarrow D_{min} = 10.0 + 2.0 = 12.0'$

$F = \frac{6.9}{\sqrt{(32.2)(10.0)}} = 0.38 \Rightarrow$ Subcritical

Sta. 71+55 to Sta. 72+80 - Replace culvert at El Paso Street

5 - 13' X 10' RCB

Q_{100} = 6550 cfs L = 125' S_{EX} = 1.0% AHW = 65 - 53.2 = 11.8'

Inlet Control $\Rightarrow Q/b = \frac{6550}{65} = 101$ HW/D = 1.05 HW = (1.05)(10.0) = 10.5'

Outlet Control $\Rightarrow$ H = 2.0' H_0 = 10.0' $LS_0 = (125)(0.01) = 1.3'$

HW = 2.0 + 10.0 - 1.3 = 10.7'

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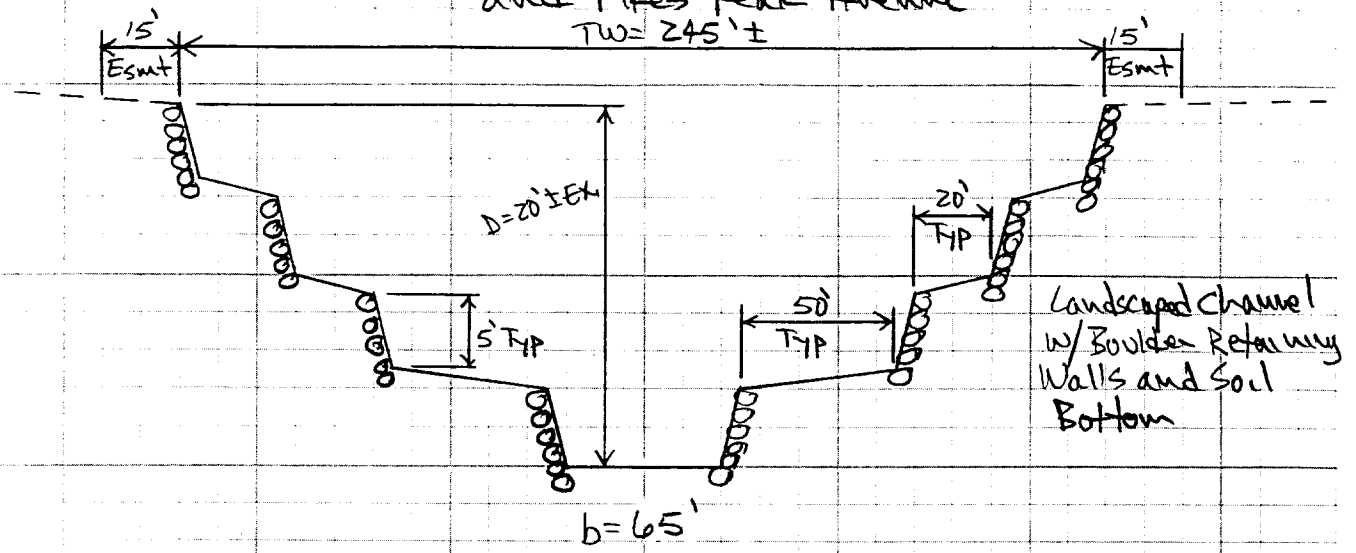
SUBJ. Soft-Lined Alternative w/Diversion

OF

Sta. 72+80 to Sta. 76+80 - New open channel between El Paso Street and Pikes Peak Avenue



Q_{100} = 6550 cfs S_{EX} = 0.4%±

$d = 9.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{1068}{184}\right)^{2/3}(0.004)^{1/2} = 6.1$ fps $\Rightarrow Q = (6.1)(1068) = 6515$ cfs

Actual d = 10.7'± (Est'd/Exist HEC 2) $\Rightarrow$ A = 1294 sf $V = \frac{6550}{1294} = 5.1$ fps

Freeboard = $1.0 + (0.025)(5.1)(10.7)^{1/3} = 1.3' \Rightarrow$ Use 2.0' $D_{min} = 10.7 + 2.0 = 12.7'$

$F = \frac{}{\sqrt{(32.2)(10.7)}} = 0.27 \Rightarrow$ Subcritical

Sta. 76+80 to Sta. 85+60 - Replace culverts at Pikes Peak Avenue/El Paso Street and at Kiowa Street

Pikes Peak Avenue/El Paso Avenue

5-13'X 10' RCB

Q_{100} = 6550 cfs L = 650' S_{EX} = 1.0% AHW = 76.0 - 61.2 = 14.8'

Inlet Control $\Rightarrow Q/b = \frac{6550}{65} = 101$ HW/D = 1.05 HW = (1.05)(10) = 10.5'

Outlet Control $\Rightarrow$ H = 2.8' H_o = 10.7' $LS_o = (650)(0.01) = 6.5'$

HW = 2.8 + 10.7 - 6.5 = 7.0'

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SUBJ. Soft-Lined Alternative w/ Diversion

OF

Kiowa Street

4 - 11' x 10' RCB

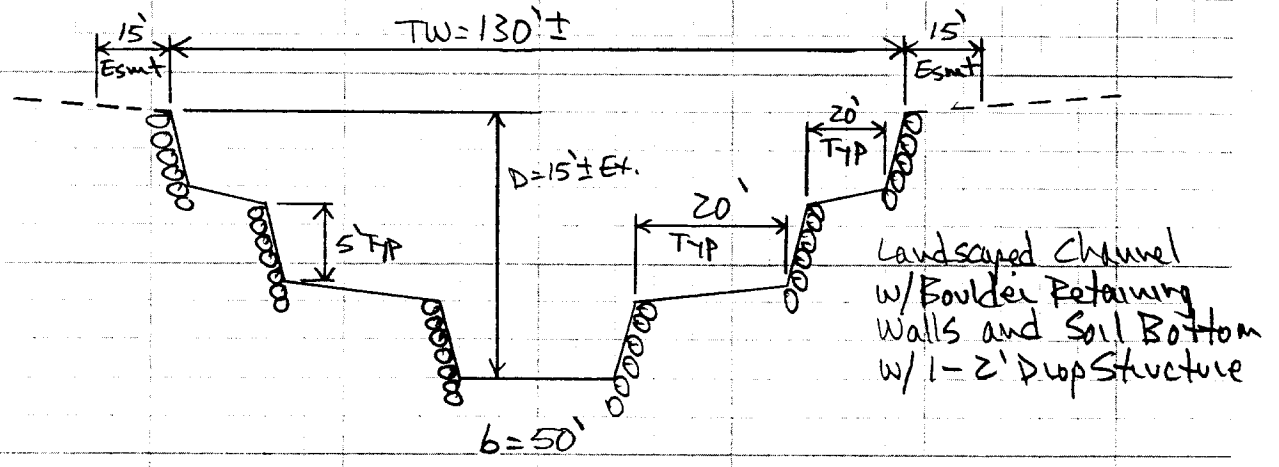
Q_{100} = 4120 cfs L = 150' S_{EX} = 0.3% AHW = 76.0 - 62.4 = 13.6'

Inlet Control ⇒ $Q/b = \frac{4120}{44} = 94$ HW/D = 1.05 HW = (1.05)(10) = 10.5'

Outlet Control ⇒ H = 1.19' H_0 = 10.5' LS_0 = (150)(0.003) = 0.5'

HW = 1.9 + 10.5 - 0.5 = 11.9'

Sta. 85+60 to Sta. 89+95 - New open channel between Kiowa Street and Bijou Street



Q_{100} = 4120 cfs S_{EX} = 0.9% S_{PRO} = 0.5% ±

$d = 9.0' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{610}{108}\right)^{2/3}(0.005)^{1/2} = 6.7$ fps $\Rightarrow Q = (6.7)(610) = 4085$ cfs

Freeboard = $1.0 + (0.025)(6.7)(9.0)^{1/3} = 1.3 \Rightarrow$ Use 2.0' $D_{min} = 9.0 + 2.0 = 11.0'$

$F = \frac{6.7}{\sqrt{(32.2)(9.0)}} = 0.39 \Rightarrow$ Subcritical

Sta. 89+95 to Sta. 94+50 - Replace culvert at Bijou Street

4-11'x10' RCB

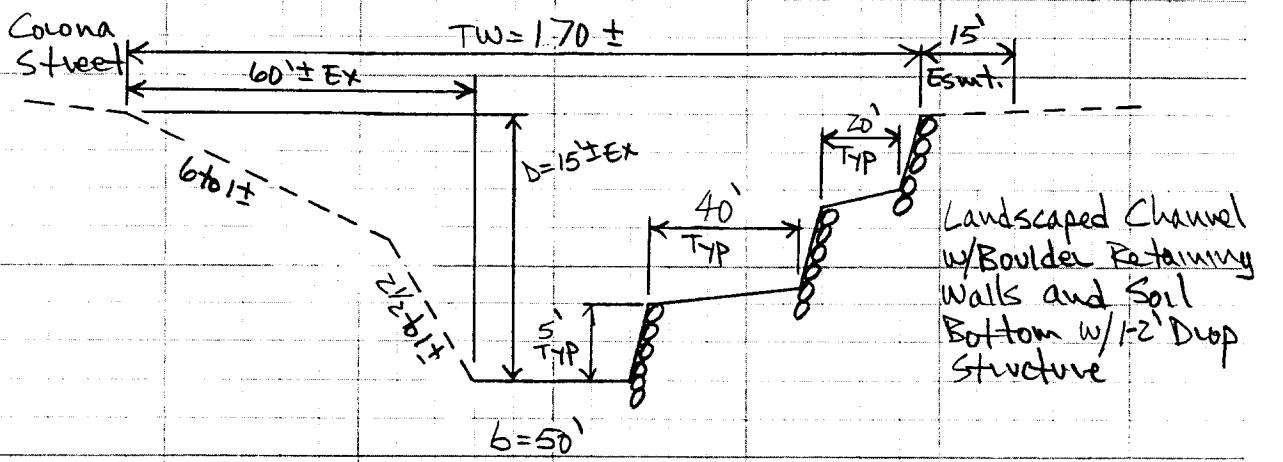
Q_{100} = 4120 cfs L = 455' S_{EX} = 0.6% AHW = 82.0 - 69.8 = 12.2'

Inlet Control ⇒ $Q/b = \frac{4120}{44} = 94$ HW/D = 1.05 HW = (1.05)(10.0) = 10.5'

Outlet Control ⇒ 2.5' H_o = 9.0' LS_o = (455)(0.006) = 2.7'

HW = 2.5 + 9.0 - 2.7 = 8.8'

Sta. 94+50 to Sta. 98+10 - New open channel between Bijou Street and Platte Avenue



Q_{100} = 4120 cfs S_{EX} = 0.9% S_{PRD} = 0.5% ±

d = 8.5' ⇒ $V = \left(\frac{1.49}{0.050}\right)\left(\frac{655}{121}\right)^{2/3}(0.005)^{1/2} = 6.5$ fps $Q = (6.5)(655) = 4260$ cfs

Freeboard = 1.0 + (0.025)(6.5)(8.5)^{1/3} = 1.3 ⇒ Use 2.0' D_{min} = 8.5 + 2.0 = 10.5'

$F = \frac{6.5}{\sqrt{(32.2)(8.5)}} = 0.39$ ⇒ Subcritical

Sta. 98+10 to Sta. 106+30 – Replace Culvert at Platte Avenue / School Athletic Field and Bridge at Boulder Street

4 - 10'x10' RCB

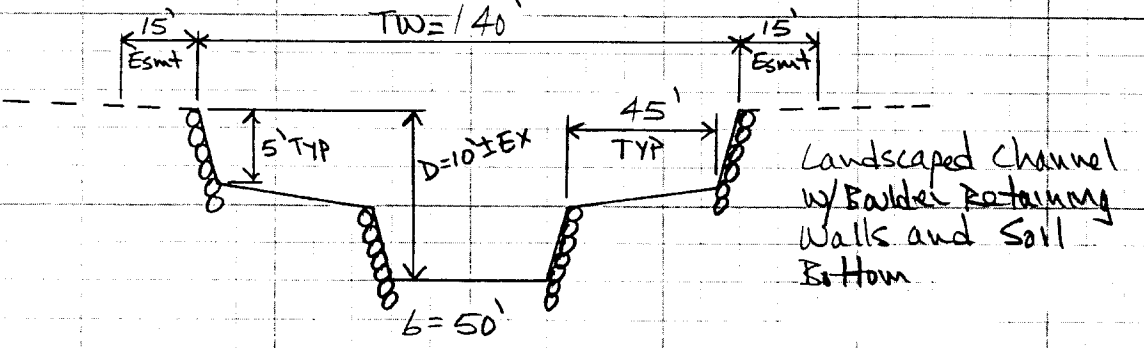
Q_{100} = 4080 cfs L = 695' S_{EX} = 0.15% AHW = 91.5 - 76.5 = 15.0'

Inlet Control ⇒ $Q/b = \frac{4080}{40} = 102$ HW/D = 1.1 HW = (1.1)(10.0) = 11.0'

Outlet Control ⇒ H = 3.6' H_o = 8.5' LS_o = (695)(0.005) = 3.5'

HW = 3.6 + 8.5 - 3.5 = 8.6'

Sta. 106+30 to Sta. 112+35 – New open channel between Boulder Street and St. Vrain Street



Q_{100} = 4080 cfs S_{EX} = 0.90%

$d = 7.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{600}{155}\right)^{2/3}(0.009)^{1/2} = 7.0$ fps $Q = (7.0)(600) = 4200$ cfs

Freeboard = $1.0 + (0.025)(7.0)(8.0)^{1/3} = 1.4' \Rightarrow$ Use 2' $D = 7.5 + 2.0 = 9.5'$

$F = \frac{7.0}{\sqrt{(32.2)(7.5)}} = 0.45 \Rightarrow$ Subcritical

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Sta. 112+35 to Sta. 113+40 - Replace Culvert at St. Vrain Street

3- 11' x 10' RCB

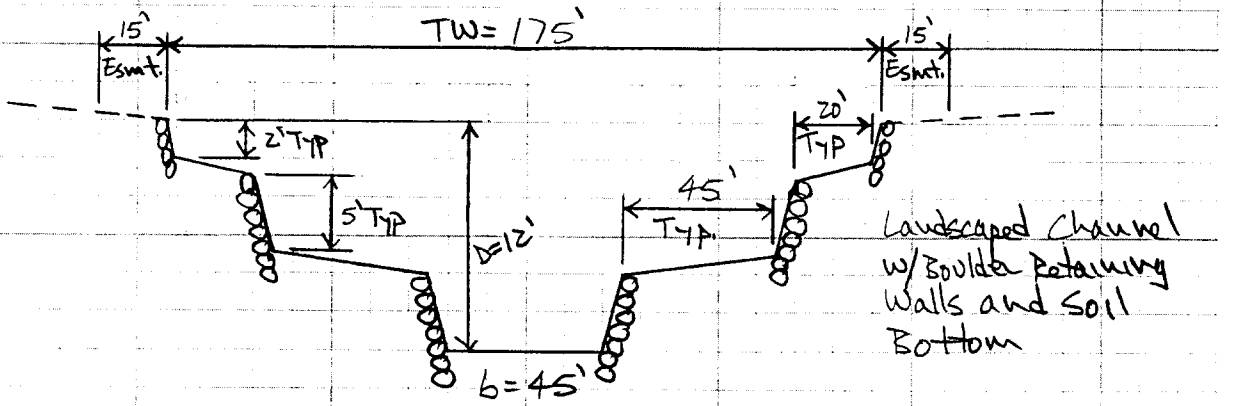
Q_{100} = 3990 cfs L=105' S_{EX} = 0.14% AHW = 00.0 - 85.0 = 15.0'

Inlet Control ⇒ Q/6 = $\frac{3990}{33}$ = 121 HW/D = 1.25 HW = (1.25)(10.0) = 12.5'

Outlet Control ⇒ H = 3.4' H_0 = 7.5' LS_0 = (105)(0.004) = 0.4'

HW = 3.4 + 7.5 - 0.4 = 10.5'

Sta. 113+40 to Sta. 117+75 - New open channel between St. Vrain Street and Willamette Street



Q_{100} = 3990 cfs S_{EX} = 0.17%

d = 8' ⇒ V = $\left(\frac{1.49}{0.050}\right)\left(\frac{630}{151}\right)^{2/3}(0.007)^{1/2}$ = 6.5 fps ⇒ Q = (6.5)(630) = 4095 cfs

Actual d = 12.5 to 10' ± (Est'd/Exist HEC-2) ⇒ d = 10' ⇒ A = 900 sf V = $\frac{3990}{900}$ = 4.4 fps

Freeboard = 1.0 + (0.025)(4.4)(10)$^{1/3}$ = 1.2 ⇒ Use 2' D = 10 + 2 = 12'

F = $\frac{4.4}{\sqrt{(32.2)(10)}}$ = 0.25 ⇒ Subcritical

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PROJ. Shooks Run

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SUBJ. Soft-Lined Alternative w/ Diversion

Sta. 117+75 to Sta 119+80 - Replace Culvert at Willamette Street

2-12'x10' RCB

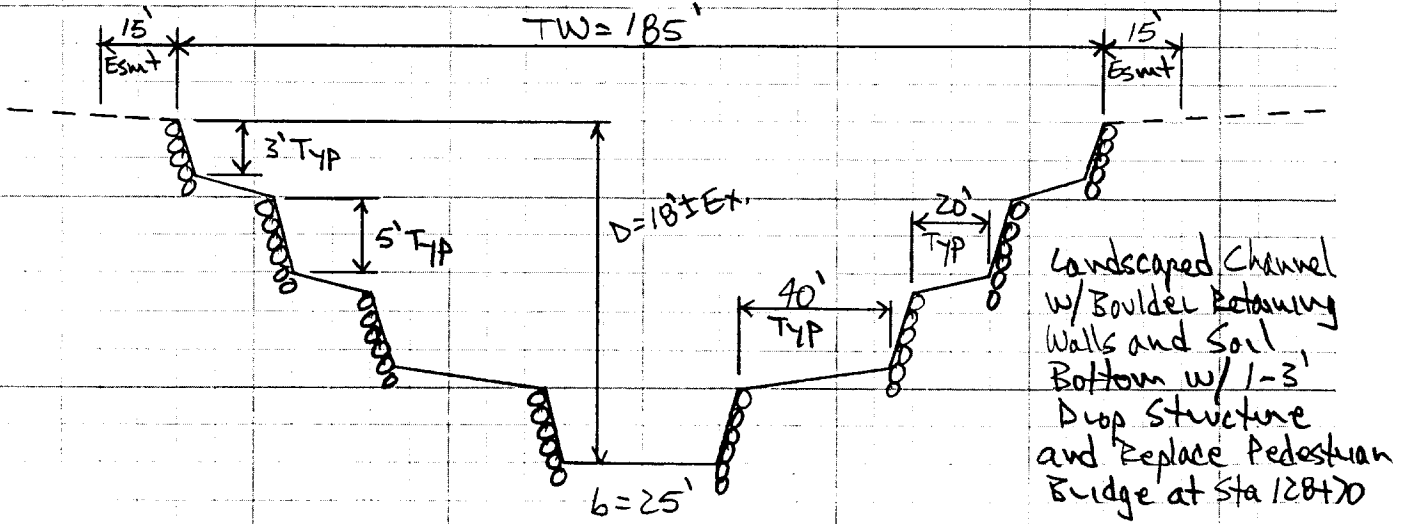
$Q_{100} = 3920$ cfs $L = 205'$ $S_{EX} = 0.1\%$ $HW = 12.0 - 9.9 = 2.1'$

Inlet Control $\Rightarrow Q/b = \frac{3920}{24} = 163$ $HW/D = 1.7$ $HW = (1.7)(10) = 17.0'$

Outlet Control $\Rightarrow$ $H = 6.2'$ $H_0 = 10'$ $LS_0 = (205)(0.001) = 0.3'$

$HW = 6.2 + 10 - 0.3 = 15.9'$

Sta. 119+80 to Sta. 135+15 - New open channel between Willamette Street and Cache La Poudre Street



$Q_{100} = 3920$ cfs $S_{EX} = 0.7\%$ $S_{PROP} = 0.5\% \pm$

$d = 10' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{650}{125}\right)^{2/3}(0.005)^{1/2} = 6.3$ fps $\Rightarrow Q = (6.3)(650) = 4095$ cfs

Freeboard $= 1.0 + (0.025)(6.3)(10)^{1/3} = 1.3' \Rightarrow$ Use 2' $D_{MIN} = 10 + 2 = 12'$

$F = \frac{6.3}{\sqrt{(32.2)(10)}} = 0.35 \Rightarrow$ Subcritical

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PROJ. Shooks Run SHEET 13

SUBJ. Soft-Lined Alternative w/ Diversion OF

Sta. 135+15 to Sta. 137+05 - Replace Culvert at Cache La Poudre Street

2 - 12' x 10' RCB

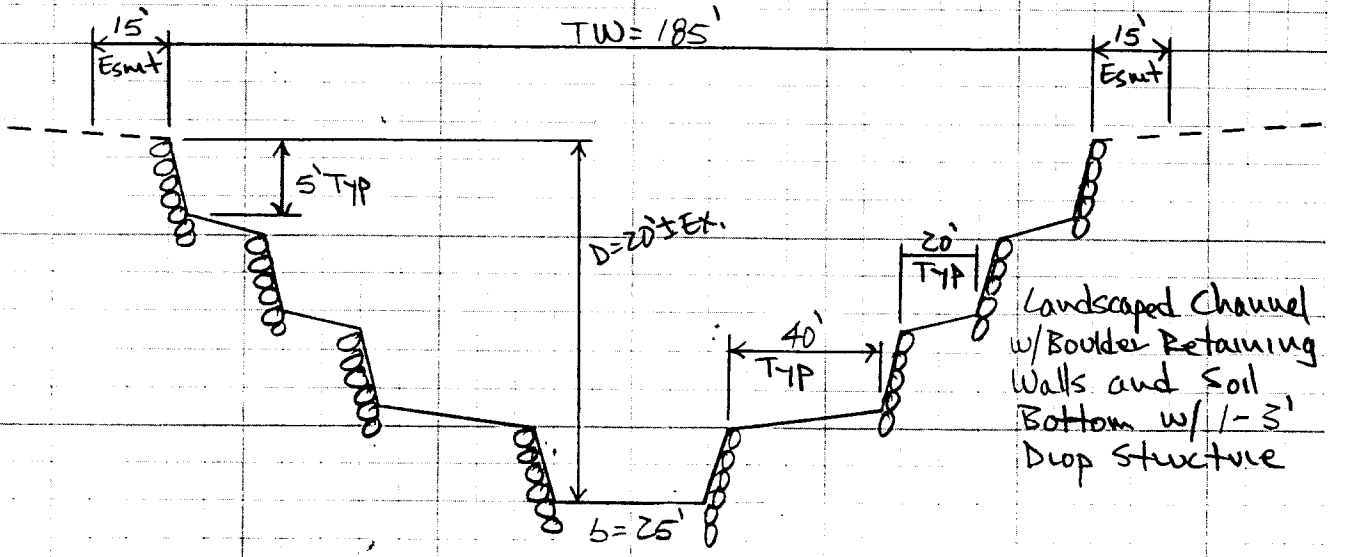
$Q_{100} = 3345$ cfs $L = 190'$ $S_{EX} = 0.2\%$ $AHW = 2610 - 0915 = 16.5'$

Inlet Control $\Rightarrow Q/b = \frac{3345}{24} = 139$ $HW/D = 1.45$ $HW = (1.45)(10) = 14.5'$

Outlet Control $\Rightarrow H = 4.5'$ $H_o = 10'$ $LS_o = (190)(0.002) = 0.4'$

$HW = 4.5 + 10 - 0.4 = 14.1'$

Sta. 137+05 to Sta 152+45 - New open channel between Cache La Poudre Street and Vintah Street



$Q_{100} = 3345$ cfs $S_{EX} = 0.7\%$ $S_{PRO} = 0.5\% \pm$

$d = 9.5' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{598}{124}\right)^{2/3}(0.005)^{1/2} = 6.0$ fps $\Rightarrow Q = (6.0)(598) = 3590$ cfs

Freeboard $= 1.0 + (0.025)(6.0)(9.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{MIN} = 9.5 + 2 = 11.5'$

$F = \frac{6.0}{\sqrt{(32.2)(9.5)}} = 0.34 \Rightarrow$ Subcritical

Sta. 152+45 to Sta. 153+55 - Replace Culvert at Uintah Street

2 - 10'x10' RCB

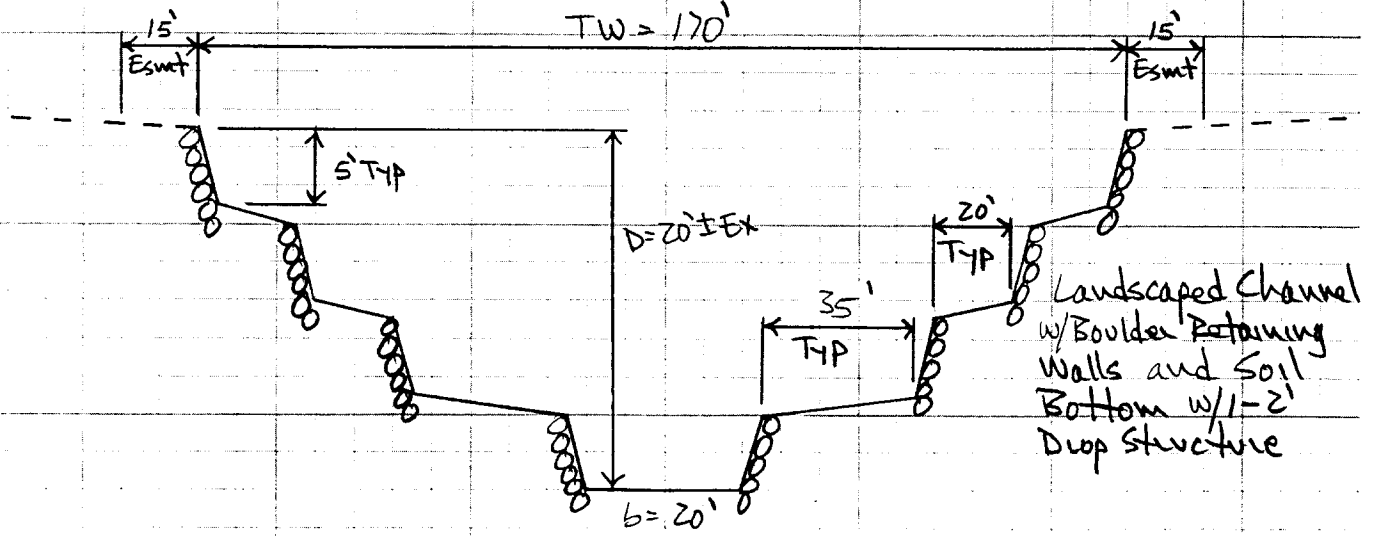
Q_{100} = 2980 cfs L = 110' S_{EX} = 1.2% AHW = 50.0 - 28.1 = 21.9'

Inlet Control ⇒ Q/b = $\frac{2980}{20}$ = 149 HW/D = 1.55 HW = (1.55)(10) = 15.5'

Outlet Control ⇒ H = 4.9' H_0 = 9.5' LS_0 = (110)(0.012) = 1.3'

HW = 4.9 + 9.5 - 1.3 = 13.1'

Sta. 153+55 to Sta. 157+55 - New open channel between Uintah Street and San Miguel Street



Q_{100} = 2980 cfs S_{EX} = 1.1% S_{PRO} = 0.5% ±

d = 9.5' ⇒ $V = \left(\frac{1.49}{0.050}\right)\left(\frac{505}{109}\right)^{2/3}(0.005)^{1/2}$ = 5.9 fps ⇒ Q = (5.9)(505) = 2980 cfs

Actual d = 15.5' to 12' ± (Est'd from Exist HEC 2) ⇒ d = 12' ⇒ A = 810 sf ⇒ V = $\frac{2980}{810}$ = 3.7 fps

Freeboard = 1.0 + (0.025)(3.7)(12)$^{1/3}$ = 1.2 ⇒ Use 2' D_{min} = 12 + 2 = 14'

$F = \frac{3.7}{\sqrt{(32.2)(12)}} = 0.19$ ⇒ Subcritical

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OF

Sta. 157+55 to Sta. 158+40 - Replace Culvert at San Miguel Street

2 - 10' x 10' RCB

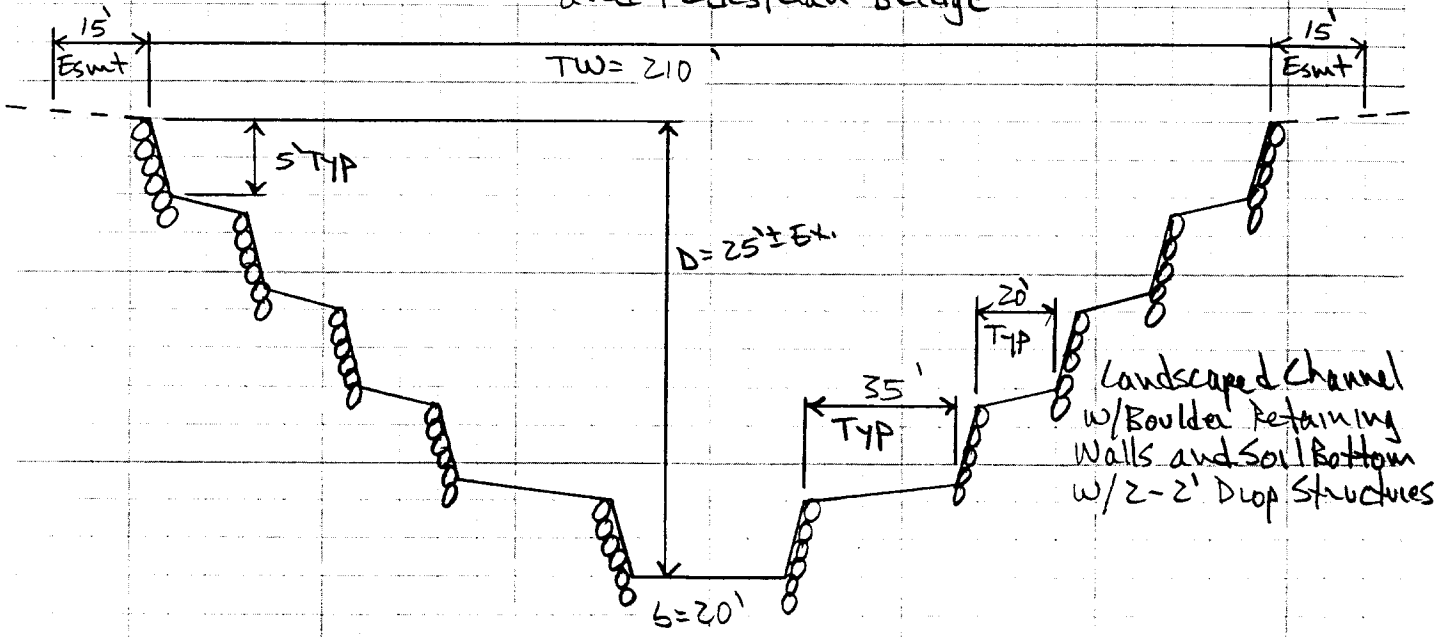
Q_{100} = 2980 L = 85' S_{EX} = 0.6% HW = 52.5 - 33.1 = 19.4'

Inlet Control ⇒ $Q/b = \frac{2980}{20} = 149$ HW/D = 1.55 HW = (1.55)(10) = 15.5'

Outlet Control ⇒ H = 4.7' H_o = 12' LS_o = (85)(0.006) = 0.5'

HW = 4.7 + 12 - 0.5 = 16.2'

Sta. 158+40 to Sta. 167+35 - New Open channel between San Miguel Street and Pedestrian Bridge



Q_{100} = 2980 cfs S_{EX} = 1.0% S_{PRO} = 0.5% ±

$d = 9.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{505}{109}\right)^{2/3}(0.005)^{1/2} = 5.9$ fps ⇒ Q = (5.9)(505) = 2980 cfs

Freeboard = $1.0 + (0.025)(5.9)(9.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 9.5 + 2 = 11.5'$

$F = \frac{5.9}{\sqrt{(32.2)(9.5)}} = 0.34 \Rightarrow$ Subcritical

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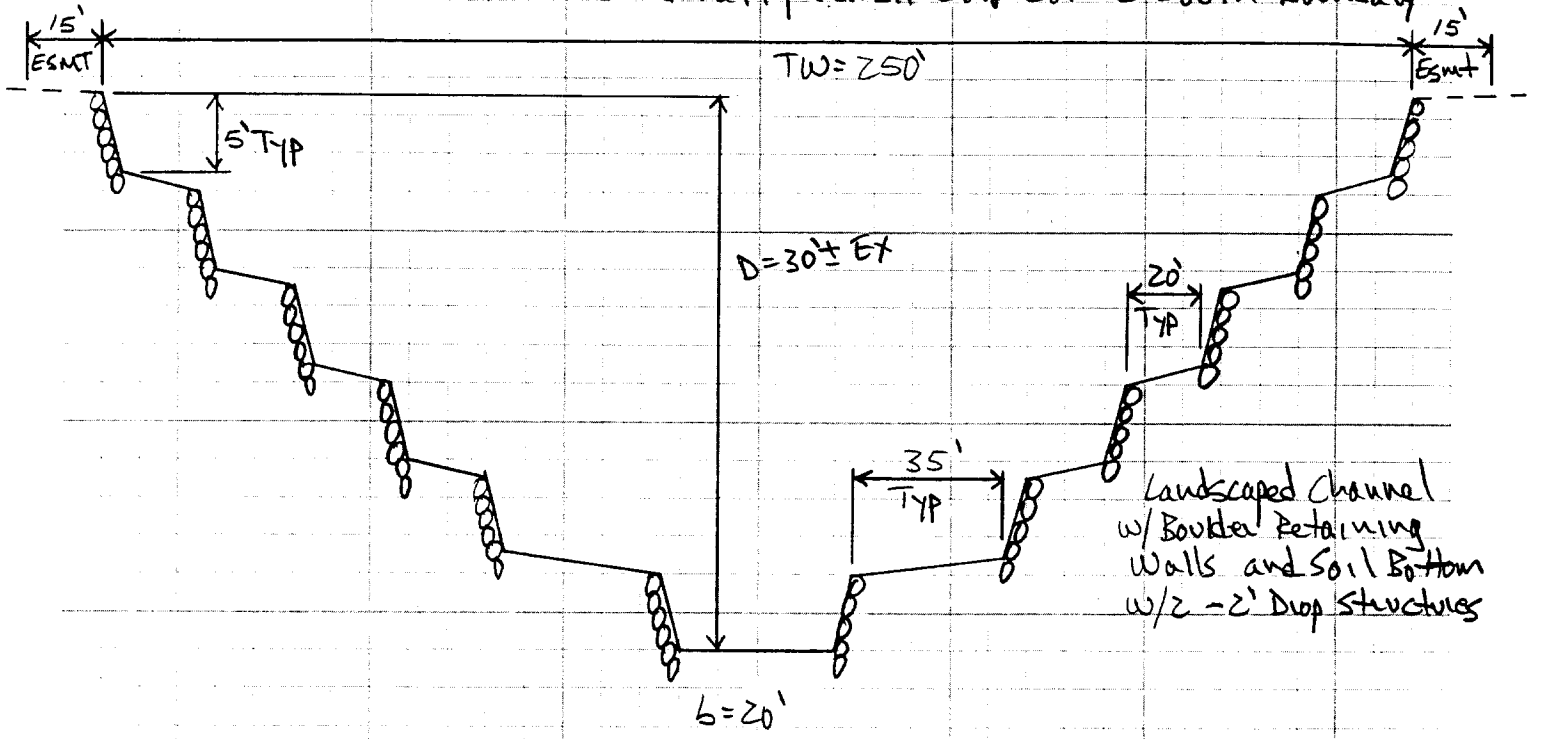
SUBJ. Soft-Lined Alternative w/ Division

OF

Sta. 167+35 - Replace Pedestrian Bridge

Sta. 167+35 to Sta 176+25 - New open channel between Pedestrian Bridge and Patty Jewett Golf Course South Boundary



$Q_{100} = 2690$ cfs $S_{EX} = 1.0\%$ $S_{PRO} = 0.5\% \pm$

$d = 9.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{505}{109}\right)^{2/3}(0.005)^{1/2} = 5.9$ fps $\Rightarrow Q = (5.9)(505) = 2980$ cfs

Freeboard $= 1.0 + (0.025)(5.9)(9)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 9 + 2 = 11'$

$F = \frac{5.9}{\sqrt{(32.2)(9.5)}} = 0.34 \Rightarrow$ Subcritical

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PROJ Shooks Run

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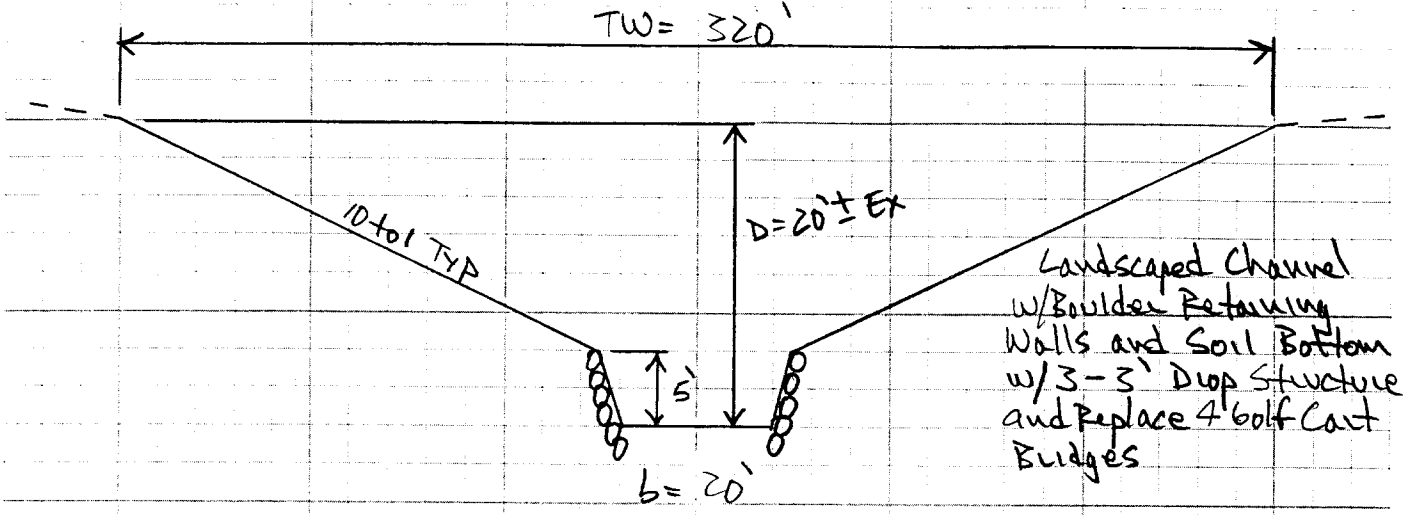
SUBJ. Soft-Lined Alternative w/Diversion

OF

Sta. 176+25 to Sta. 189+05 - New Open Channel between Patty Jewett Golf Course South Boundary and Espanola Street



Q_{100} = 2690 cfs S_{EX} = 1.0% + 6' Ex. Drop S_{PRO} = 0.8% ±

$d = 10' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{450}{130}\right)^{2/3}(0.008)^{1/2} = 6.1$ fps $\Rightarrow Q = (6.1)(450) = 2745$ cfs

Freeboard $= 1.0 + (0.025)(6.1)(10)^{1/3} = 1.3' \Rightarrow$ Use 2' $D_{min} = 10 + 2 = 12'$

$F = \frac{6.1}{\sqrt{(32.2)(10)}} = 0.34 \Rightarrow$ Subcritical

Sta. 189+05 to Sta 190+85 - Replace Culvert at Espanola Street

2-13' x 10' RCB

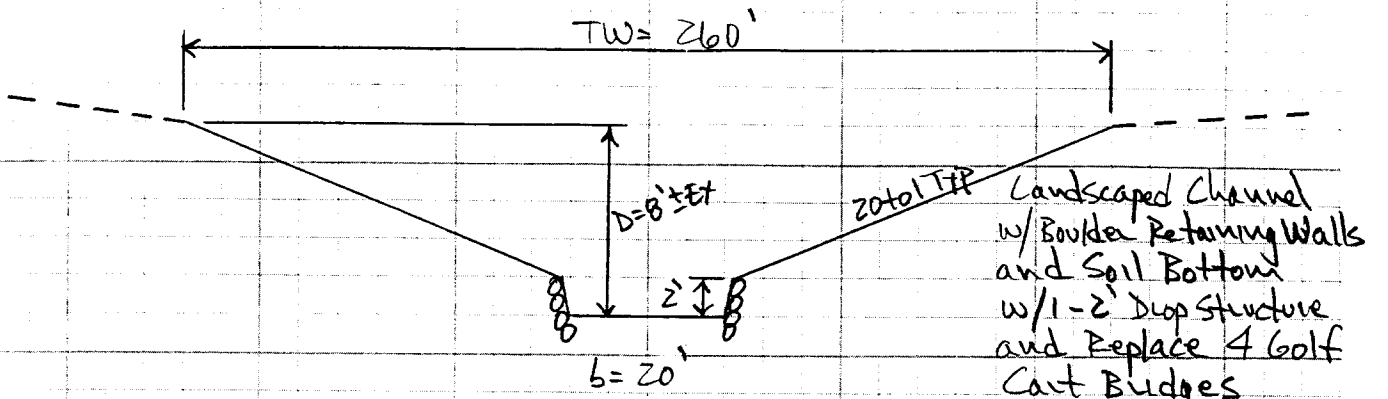
Q_{100} = 2580 cfs L = 180' S_{Et} = 1.3% AHW = 85.5 - 72.8 = 12.7'

Inlet Control $\Rightarrow Q/b = \frac{2580}{26} = 99$ HW/D = 1.05 HW = (1.05)(10) = 10.5'

Outlet Control $\Rightarrow H = 2.0'$ $H_o = 10'$ $LS_o = (180)(0.013) = 2.3'$

HW = 2.0 + 10 - 2.3 = 9.7'

Sta. 190+85 to Sta 198+45 - New Open Channel between Espanola Street and End of Existing Channel Lining



Q_{100} = 2490 cfs S_{EX} = 1.44% + 3' Ex Drop S_{PRO} = 1.5% ±

$d = 6' \Rightarrow V = \left(\frac{1.44}{0.050}\right)\left(\frac{440}{184}\right)^{2/3}(0.015)^{1/2} = 6.5$ fps $\Rightarrow Q = (6.5)(440) = 2860$ cfs

Freeboard = $1.0 + (0.025)(6.5)(6)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 6 + 2 = 8'$

$F = \frac{6.5}{\sqrt{(32.2)(6)}} = 0.47 \Rightarrow$ Subcritical

Sta. 216+40 to Sta 216+95 - Exist Culvert at Paseo Road

Q_{100} = 130 cfs $\Rightarrow$ Routine Maintenance Only

Sta. 216+95 to Sta 218+30 - Exist Open Channel between Paseo Road and Jefferson Street

Q_{100} = 130 cfs $\Rightarrow$ Routine Maintenance Only

Sta 218+30 to Sta 219+10 - Exist Culvert at Jefferson Street

Q_{100} = 130 cfs $\Rightarrow$ Routine Maintenance Only

Sta 219+10 to Sta 222+50 - Exist Open Channel between Jefferson Street and Madison Street

Q_{100} = 130 cfs ⇒ Routine Maintenance Only

Sta 222+50 to Sta 223+30 - Exist Culvert at Madison Street

Q_{100} = 130 cfs ⇒ Routine Maintenance Only

Sta 223+30 to Sta 226+25 - Exist Open Channel between Madison Street and Monroe Street

Q_{100} = 130 cfs ⇒ Routine Maintenance Only

Sta 226+25 to Sta 227+05 - Exist Culvert at Monroe Street

Q_{100} = 130 cfs ⇒ Routine Maintenance Only

Sta 227+05 to Sta 229+70 - Exist Open Channel between Monroe Street and Jackson Street

Q_{100} = 130 cfs ⇒ Routine Maintenance Only

Sta 229+70 to Sta 234+15 - Exist Culvert at Jackson Street/LaSalle Street

Q_{100} = 130 cfs ⇒ Routine Maintenance Only

Sta 234+5 to Sta 235+40 - Exist Open Channel between LaSalle Street and Pedestrian Path

⇒ Routine Maintenance Only

Sta 235+40 to Sta 235+90 - Exist Culvert at Pedestrian Path

⇒ Routine Maintenance Only

Sta 235+90 to Sta 236+20 - Exist Open Channel between Pedestrian Path and C.R.I.P. Railroad

⇒ Routine Maintenance Only

Sta. 236+20 to Sta 236+75 - Remove Exist Culvert at C.R.I.P. Railroad

⇒ $Q_{100} = 0$.

Temple Gap Road at Van Buren Channel - Replace Culvert

3-13' X 6' RCB

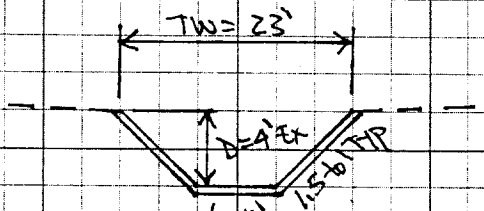
Q_{100} = 2530 cfs $L = 100'$ $S_{EX} = 0.6\%$ $HW = 40.1 - 30.3 = 9.8'$

Inlet Control ⇒ $Q/6 = \frac{2530}{39} = 65$ $HW/D = 1.5$ $HW = (1.5)(6) = 9.0'$

Outlet Control ⇒ $H = 2.5'$ $D_C = 5.1'$ $H_0 = \frac{6+5.1}{2} = 5.6'$

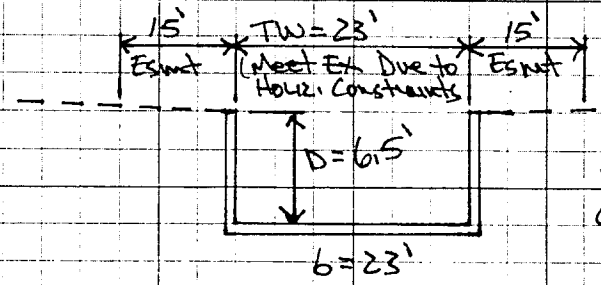
$LS_0 = (100)(0.006) = 0.6'$ $HW = 2.5 + 5.6 - 0.6 = 7.5'$

Van Buren Channel - Templeton Gap Road to Monument Creek - New Open Channel (7000 LF ±)
- Immediately D/S of Templeton Gap Road to El Paso Street ± ⇒ 2000 LF ±



Ex. Concrete - Lined Channel
$S_{Ex} = 0.99\% \pm$ (Field Survey)

$d_{Ex} = 4' \Rightarrow v_{Ex} = \left(\frac{1.49}{0.013}\right)\left(\frac{68}{25}\right)^{2/3}(0.009)^{1/2} = 21.2 \text{ fps} \Rightarrow Q_{Ex} = (21.2)(68) = 1440 \text{ cfs}$



New Vertical-Walled Concrete Lined Channel

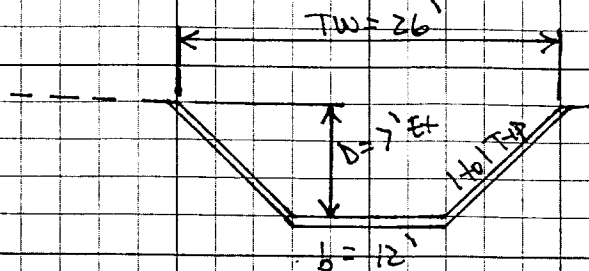
$Q_{100} = 2530 \text{ cfs}$ $S_{Ex} = 0.99\% \pm$

$d = 4.5' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{104}{32}\right)^{2/3}(0.009)^{1/2} = 23.9 \text{ fps} \Rightarrow Q = (23.9)(104) = 2485 \text{ cfs}$

$\text{Freeboard} = 1.0 + (0.025)(23.9)(4.5)^{1/3} = 2.0'$ $D_{MIN} = 4.5 + 2.0 = 6.5'$

$F = \frac{23.9}{\sqrt{(32.2)(4.5)}} = 1.99 \Rightarrow$ Supercritical

- Average between El Paso Street ± and Monument Creek ⇒ 5000 LF ±



Ex Concrete Lined Channel
$S_{Ex} = 1.0\% \pm$ (1971 Const. Plans)

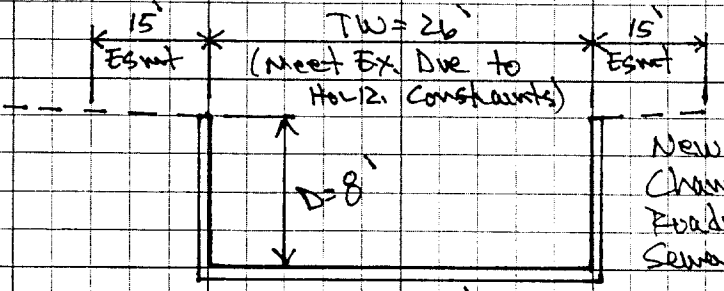
$d_{Ex} = 5' \Rightarrow v_{Ex} = \left(\frac{1.49}{0.013}\right)\left(\frac{85}{26}\right)^{2/3}(0.010)^{1/2} = 25.2 \text{ fps} \Rightarrow Q_{Ex} = (25.2)(85) = 2140 \text{ cfs}$

$d_{Ex} = 7' \Rightarrow v_{Ex} = \left(\frac{1.49}{0.013}\right)\left(\frac{133}{32}\right)(0.010)^{1/2} = 29.6 \text{ fps} \Rightarrow Q_{Ex} = (29.6)(133) = 3935 \text{ cfs}$

$\Rightarrow Q_{100}$ at T. Gap = 2530 cfs $A = 2.03$ sq mi $Q/A = \frac{2530}{2.03} = 1245 \text{ cfs} \pm /\text{sq mi}$

$\Sigma A = 2.03 + 1 \pm = 3.03$ sq mi $\Sigma Q = (3.03)(1245) = 3770 \text{ cfs} \Rightarrow$ Use 3800 cfs ±

(Assume basin attenuation is offset by higher density of added basin D/S of T. Gap)



New Vertical-Walled Concrete Channel w/ 4 - 70' ± Long Roadway Crossings and 1 Sanitary Sewer Crossing

$Q_{100} = 3800 \text{ cfs}$ $S_{Ex} = 1.0\%$

$d = 5.5' \Rightarrow v = \left(\frac{1.49}{0.013}\right)\left(\frac{143}{37}\right)^{2/3}(0.010)^{1/2} = 28.2 \text{ fps} \Rightarrow Q = (28.2)(143) = 4035 \text{ cfs}$

$\text{Freeboard} = 1.0 + (0.025)(28.2)(5.5)^{1/3} = 2.2' \Rightarrow$ Use 2.5' $D_{man} = 5.5 + 2.5 = 8.0'$

$F = \frac{28.2}{\sqrt{(32.2)(5.5)}} = 2.12 \Rightarrow$ Supercritical

D. SOFT-LINED FULL IMPROVEMENT WITH DETENTION PONDING ALONG THE CHANNEL ALTERNATIVE HYDRAULIC CALCULATIONS

COMP. WWP

CK.

DATE December 3, 1992

WILSON & COMPANY

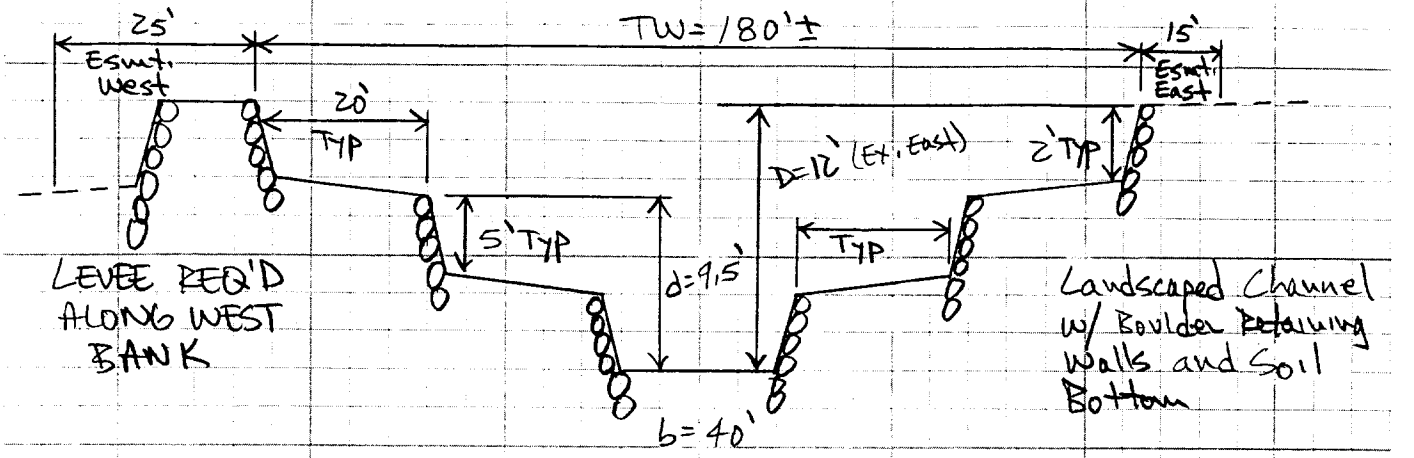
LOC. FILE 90-809

PROJ. Shooks Run SHEET 1

SUBJ. Soft-Lined Alternative w/Detention OF

SOFT-LINED ALTERNATIVE W/DETENTION

Sta. 0+25 to Sta. 9+75 - New open Channel between Fountain Creek confluence and Las Vegas Street



$Q_{100} = 4725$ cfs $\quad S_{EX} = 0.4\%$

$d = 9.5 \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{830}{159}\right)^{2/3}(0.004)^{1/2} = 5.7$ fps $\Rightarrow Q = (5.7)(830) = 4730$ cfs

Freeboard $= 1.0 + (0.025)(5.7)(9.5)^{1/3} = 1.3' \Rightarrow$ Use 2' $\quad D_{min} = 9.5 + 2 = 11.5'$

$F = \frac{5.7}{\sqrt{(32.2)(9.5)}} = 0.33 \Rightarrow$ Subcritical

Sta. 9+75 to Sta. 10+80 - Exist. bridge and dissipator at Las Vegas Street

Existing 40' X 10' Bridge

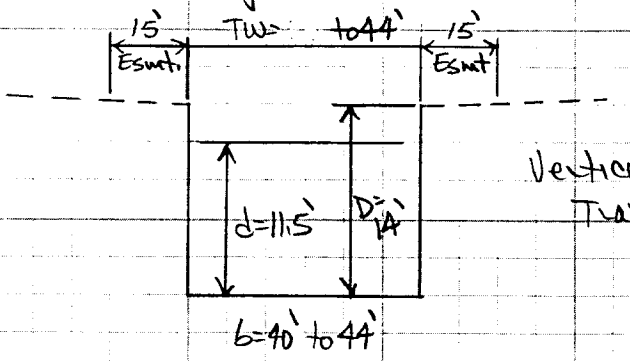
$Q_{100} = 4725$ cfs $\quad L = 70' \quad S_{EX} = 0.7\% \quad$ AHW $= 111.6 - 97.7 = 13.9'$

Inlet Control $\Rightarrow Q/b = \frac{4725}{40} = 118 \quad HW/D = 1.2 \quad HW = (1.2)(10) = 12'$

Outlet Control $\Rightarrow H = 2.9 \quad d_c = 7.5' \quad H_o = \frac{10+}{2} =$

$LS_o = (70)(0.007) = 0.5' \quad HW = 2.9 + 9 - 0.5 = 11.4'$

Sta. 10+80 to Sta. 11+20 - Exist Concrete transition channel between Las Vegas Street and A.T.S.F. & D.R.G.W. Railroad



Vertical Walled Concrete Transition Channel

$Q_{100} = 4725$ cfs $S_{EX} = 1.0\%$

$d = 4.5'$ and $b = 40' \Rightarrow V = \left(\frac{1.49}{0.013}\right)\left(\frac{180}{49}\right)^{2/3}(0.010)^{1/2} = 27.3$ fps $\Rightarrow Q = (27.3)(180) = 4915$ cfs

Actual $d = 12.0'$ to $11.5' \pm$ (Est'd/Exist HEC2) $\Rightarrow d = 11.5'$ and $b = 44' \Rightarrow A = 506$ sf $V = \frac{4725}{506} = 9.3$ fps

Freeboard $= 1.0 + (0.025)(9.3)(11.5)^{1/3} = 1.5' \Rightarrow$ Use 2' $D_{min} = 11.5 + 2.0 = 13.5 \Rightarrow$ Use 14'

$F = \frac{9.3}{\sqrt{(32.2)(11.5)}} = 0.48 \Rightarrow$ Subcritical

Sta. 11+20 to 11+65 - Existing Culvert for A.T.S.F. & D.R.G.W. Railroad

Double 20' x 16.5' Conc. Arch (18.7' x 15.4' RCB Equiv)

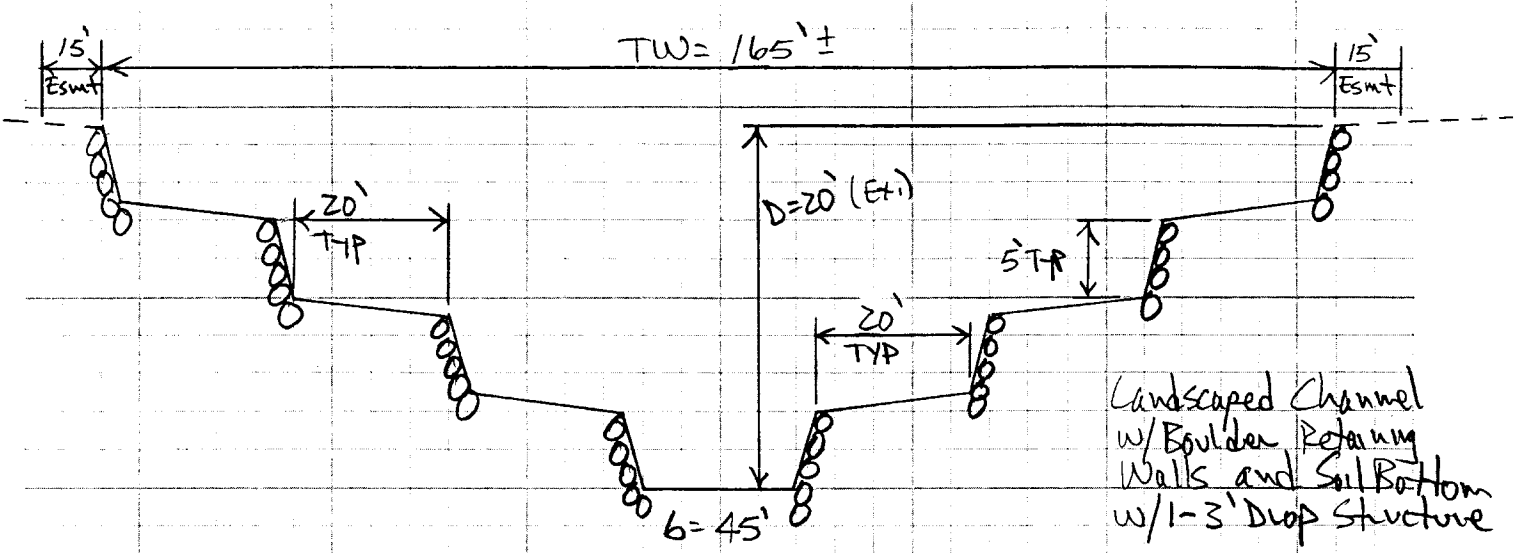
$Q_{100} = 4725$ cfs $L = 45'$ $S_{EX} = 1.3\%$ $\Delta HW = 23.2 - 98.7 = 24.5'$

Inlet Control $\Rightarrow Q/b = \frac{4725}{(2)(18.7)} = 126$ $HW/D = 0.9$ $HW = (0.9)(15.4) = 13.9'$

Outlet Control $\Rightarrow H = 1.4'$ $H_0 = 11.5'$ $LS_0 = (45)(0.013) = 0.6'$

$HW = 1.4 + 11.5 - 0.6 = 12.3'$

Sta. 11+65 to Sta. 15+60 - Newopen Channel between A.T.S.F. & D.R.G.W. Railroad and abandoned railroad



$Q_{100} = 4725$ cfs $S_{EX} = 1.2\%$ $S_{PRO} = 0.5\% \pm$

$d = 11' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{775}{147}\right)^{2/3}(0.005)^{1/2} = 6.4$ fps $\Rightarrow Q = (6.4)(775) = 4960$ cfs

Freeboard $= 1.0 + 0.025(6.4)(11)^{1/3} = 1.4' \Rightarrow$ use $2.0'$ $D_{min} = 11 + 2.0 = 13.0'$

$F = \frac{6.4}{\sqrt{(32.2)(11)}} = 0.34 \Rightarrow$ Subcritical

Sta. 15+60 to 16+20 - Existing culvert for abandoned railroad

Double 20' x 17.9' Stone Masonry Arch (18.8' x 16.8' RCB Equiv)

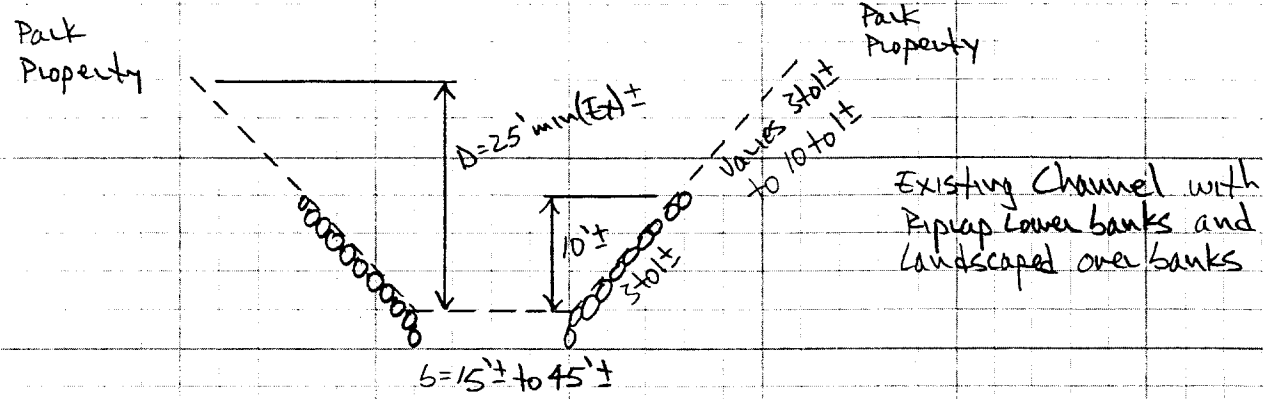
$Q_{100} = 4725$ cfs $L = 60'$ $S_{EX} = 0.7\%$ $AHW = 43.8 - 03.8' = 40.0'$

Inlet Control $\Rightarrow Q/b = \frac{4725}{2(18.8)} = 126$ $HW/D = 0.8$ $HW = (0.8)(16.8) = 13.4'$

Outlet Control $\Rightarrow H = 1.1'$ $H_0 = 11'$ $LS_0 = (60)(0.00) = 0.4'$

$HW = 1.1 + 11 - 0.4 = 11.7'$

Sta. 16+20 to Sta. 24+00 - Remove undesireable vegetation and debris from floodplain between abandoned railroad and Fountain Boulevard



Q_{100} = 4725 cfs to 4705 cfs S_{EX} = 0.17% ±

d = 9.5' and b = 30' ± ⇒ $V = \left(\frac{1.49}{0.045}\right)\left(\frac{556}{90}\right)^{2/3}(0.007)^{1/2} = 9.3$ fps ⇒ $Q = (9.3)(556) = 5170$ cfs

Freeboard = $1.0 + 0.025(9.3)(9.5)^{1/3} = 1.15'$ ⇒ use 2.0' $D_{min} = 9.5' + 2 = 11.5'$

$F = \frac{9.3}{\sqrt{(32.2)(9.5)}} = 0.53$ ⇒ Subcritical

Sta. 24+00 to Sta. 25+50 - Exist culvert at Fountain Boulevard

Exist 20'x9.5' Conc Arch and 20'x10.5' CMPA (Double 18'x9' RCB Equiv)

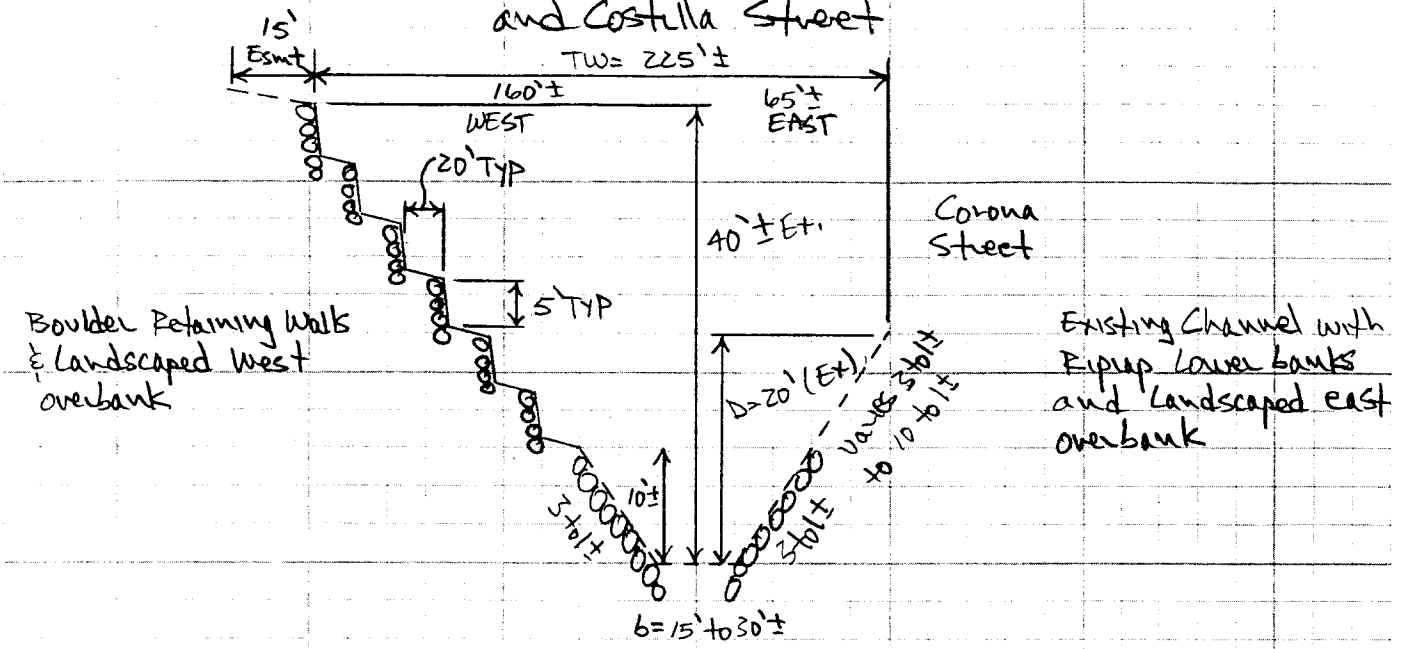
Q_{100} = 4705 cfs L = 150' S_{EX} = 0.17% AHW = 30.3 - 10.3 = 20.0'

Inlet Control ⇒ $Q/b = \frac{4705}{36} = 131$ HW/D = 1.6 HW = (1.6)(9) = 14.4'

Outlet Control ⇒ H = 4.5' H_0 = 9.5' $LS_0 = (150)(0.007) = 1.1'$

HW = 4.5' + 9.5' - 1.1' = 12.9'

Sta. 25+50 to Sta. 48+65 - Remove undesireable vegetation and debris from floodplain and reduce slope of west overbank between Fountain Boulevard and Costilla Street



Q_{100} = 4705 cfs to 4600 cfs $S_{EX} \doteq 0.8\%$

d = 9' and b = 30'± $\Rightarrow v = \left(\frac{1.49}{0.045}\right)\left(\frac{513}{87}\right)^{2/3}(0.008)^{1/2} = 9.7$ fps $\Rightarrow Q = (9.7)(513) = 4975$ cfs

Actual d = 12.9' to 10' ±(Est'd/Exist HEC2) $\Rightarrow$ d = 10' and b = 30' $\Rightarrow A = 600$ sf $v = \frac{4600}{600} = 7.7$ fps

Freeboard = $1.0 + (0.025)(7.7)(10)^{1/3} = 1.4' \Rightarrow$ Use 2.0' $D_{min} = 10 + 2.0 = 12'$

$F = \frac{7.7}{\sqrt{(32.2)(10)}} = 0.43 \Rightarrow$ Subcritical

Sta. 48+65 to Sta. 50+65 - Replace culvert at Costilla Street

3 - 12' x 10' RCB

Q_{100} = 4600 cfs L = 200' $S_{EX} = 0.6\%$ AHW = 50.1 - 29.9 = 20.2'

Inlet Control $\Rightarrow Q/b = \frac{4600}{36} = 128$ HW/D = 1.3 HW = (1.3)(10.0) = 13.0'

Outlet Control $\Rightarrow$ H = 3.8' H_0 = 10' $LS_0 = (200)(0.006) = 1.2'$

HW = 3.8 + 10 - 1.2 = 12.6'

COMP. UMA

CK.

DATE December 17, 1992

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LOC.

PROJ. Shooks Run

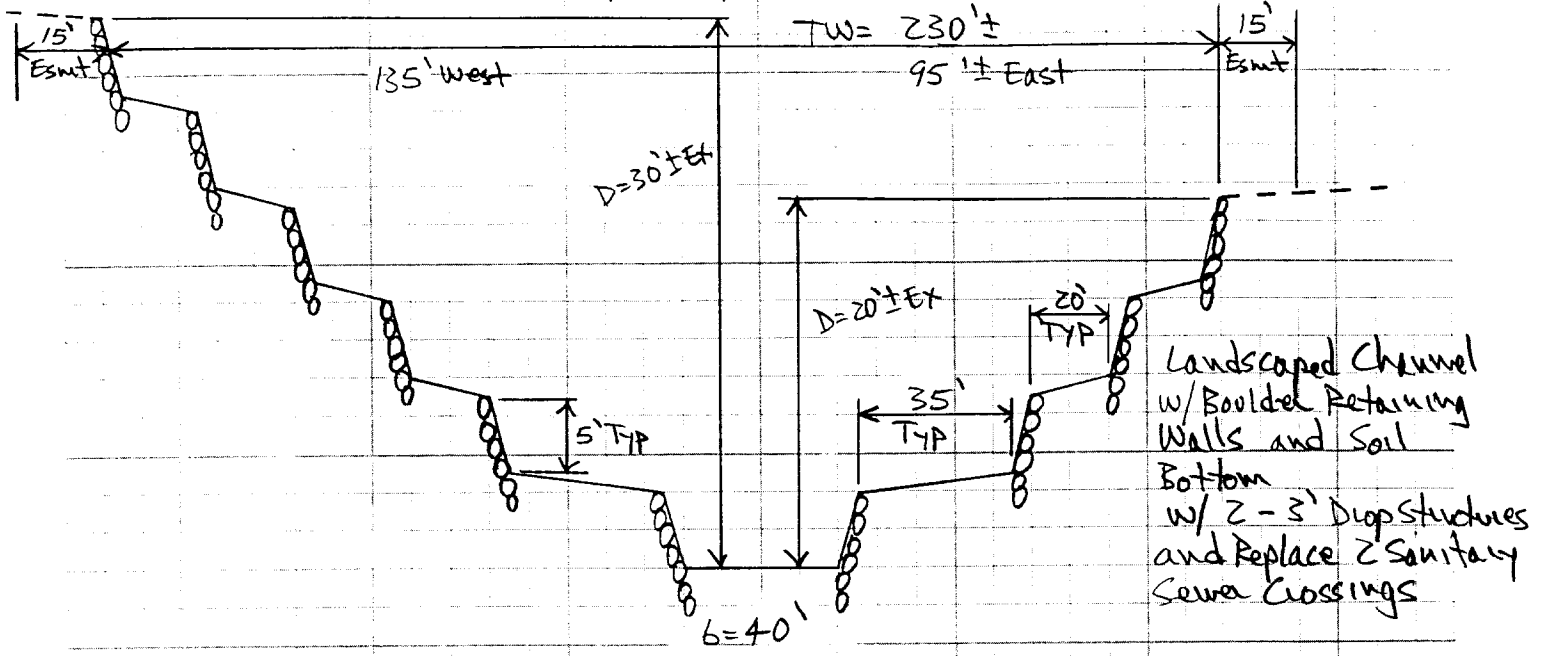
SUBJ. Soft-Lined Alternative w/ Detention

FILE 90-809

SHEET 6

OF

Sta. 50+65 to Sta. 71+55 - New open channel between Costilla Street and El Paso Street



Q_{100} = 4600 cfs to 4490 cfs S_{EX} = 0.8% S_{PRO} = 0.5%±

$d = 9.5' \Rightarrow v = \left(\frac{1.49}{0.050}\right)\left(\frac{695}{129}\right)^{2/3}(0.005)^{1/2} = 6.5$ fps $\Rightarrow Q = (6.5)(695) = 4520$ cfs

Freeboard = $1.0 + (0.025)(6.5)(9.5)^{1/3} = 1.3' \Rightarrow$ use 2.0' $\Rightarrow D_{min} = 9.5 + 2.0 = 11.5'$

$F = \frac{6.5}{\sqrt{(32.2)(9.5)}} = 0.37 \Rightarrow$ Subcritical

Sta. 71+55 to Sta. 72+80 - Replace culvert at El Paso Street

4 - 12' x 10' RCB

Q_{100} = 4490 cfs L = 125' S_{EX} = 1.0% AHW = 65 - 53.2 = 11.8'

Inlet Control $\Rightarrow Q/b = \frac{4490}{48} = 94$ HW/D = 1.05 HW = (1.05)(10.0) = 10.5'

Outlet Control $\Rightarrow H = 1.9'$ $H_0 = 10.0'$ $LS_0 = (125)(0.01) = 1.3'$

$HW = 1.9 + 9.5 - 1.3 = 10.1'$

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FILE 90-809

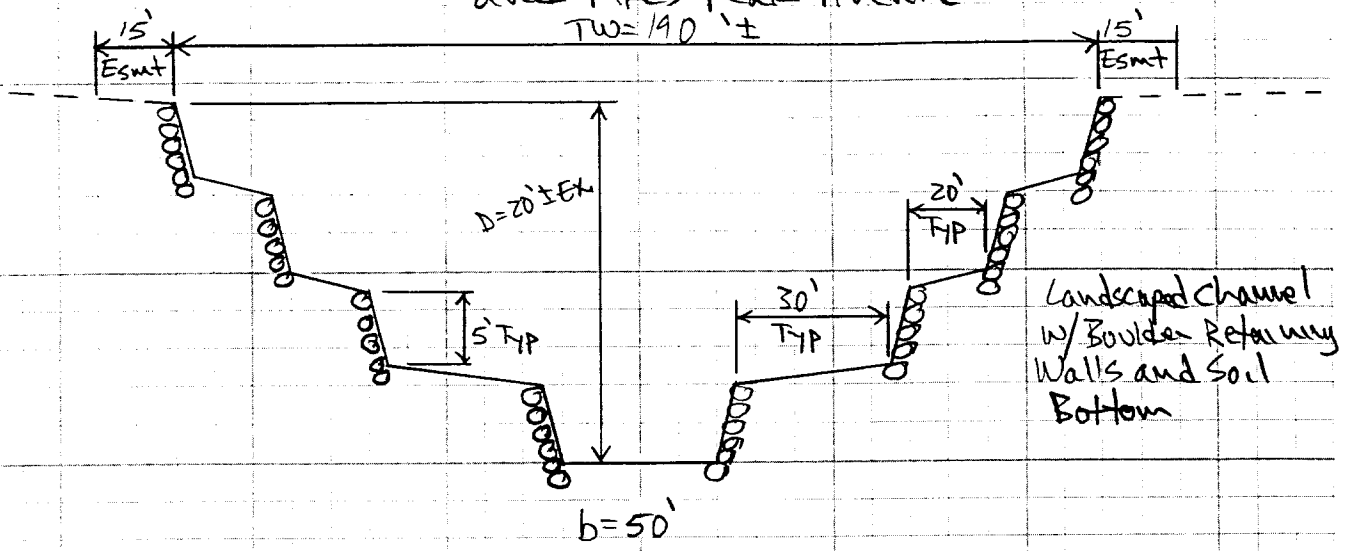
PROJ. Shooks Run

SHEET 7

SUBJ. Soft-Lined Alternative w/ Detention

OF

Sta. 72+80 to Sta. 76+80 - New open channel between El Paso Street and Pikes Peak Avenue



Q_{100} = 4490 cfs S_{EX} = 0.40% ±

$d = 9.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{745}{129}\right)^{2/3}(0.004)^{1/2} = 6.1$ fps $\Rightarrow Q = (6.1)(745) = 4545$ cfs

Actual d = 10.5' ± (Est'd / Exist HEC 2) $\Rightarrow$ A = 875 sf $V = \frac{4490}{875} = 5.1$ fps

Freeboard = $1.0 + (0.025)(5.1)(10.5)^{1/3} = 1.3' \Rightarrow$ Use 2.0' $D_{min} = 10.5 + 2.0 = 12.5'$

$F = \frac{5.1}{\sqrt{(32.2)(10.5)}} = 0.28 \Rightarrow$ Subcritical

Sta. 76+80 to Sta. 85+60 - Replace culverts at Pikes Peak Avenue / El Paso Street and at Kiowa Street

Pikes Peak Avenue / El Paso Avenue

4 - 12' X 10' RCB

Q_{100} = 4490 cfs L = 650' S_{EX} = 1.0% AHW = 76.0 - 61.2 = 14.8'

Inlet Control $\Rightarrow Q/b = \frac{4490}{48} = 94$ HW/D = 1.05 HW = (1.05)(10) = 10.5'

Outlet Control $\Rightarrow$ H = 2.7' H_0 = 10.5' $LS_0 = (650)(0.01) = 6.5'$

HW = 2.7' + 10.5 - 6.5 = 6.7'

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PROJ. Shooks Run SHEET 8

SUBJ. Soft-Lined Alternative w/ Detention OF

Kiowa Street

3 - 10' x 8' RCB (Equivalent w/ 3 - 120" RCP used in TR-20 Analysis)

$Q_{100} = 4035$ cfs $L = 150'$ $S_{EX} = 0.3\%$ $AHW = 80.0 - 62.4 = 17.6'$

Inlet Control $\Rightarrow Q/b = \frac{4035}{30} = 135$ $HW/D = 2.05$ $HW = (2.05)(8) = 16.4'$

Outlet Control $\Rightarrow H = 6.5'$ $H_0 = 10.5'$ $LS_0 = (150)(0.003) = 0.5'$

$HW = 6.5 + 10.5 - 0.5 = 16.5' \Rightarrow$ 15.5' in TR-20 Analysis $\Rightarrow$ OK
(Could be adjusted in Prelim. Design)

Sta 85+60 to Sta 98+10 - New detention pond between Kiowa Street and Platte Avenue and between Corona Street and El Paso Street

Sta. 98+10 to Sta. 106+30 – Replace Culvert at Platte Avenue / School Athletic Field and use existing bridge at Boulder Street

2 - 14' x 10' RCB

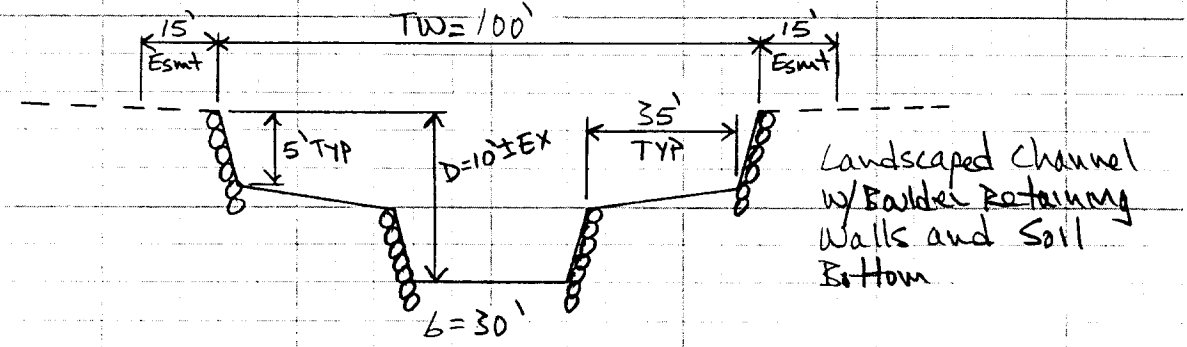
Q_{100} = 2590 cfs L = 695' S_{EX} = 0.15% AHW = 91.5 - 76.5 = 15.0'

Inlet Control ⇒ $Q/b = \frac{2590}{28} = 93$ HW/D = 1.0 HW = (1.0)(10.0) = 10.0'

Outlet Control ⇒ H = 5.8' H_o = 2.6' LS_o = (695)(0.005) = 3.5'

HW = 5.8 + 2.6 - 3.5 = 4.9'

Sta. 106+30 to Sta. 112+35 – New open channel between Boulder Street and St. Vrain Street



Q_{100} = 2590 cfs S_{EX} = 0.19%

$d = 7.5 \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{400}{115}\right)^{2/3}(0.009)^{1/2} = 6.5$ fps $Q = (6.5)(400) = 2600$ cfs

Freeboard = $1.0 + (0.025)(6.5)(7.5)^{1/3} = 1.3' \Rightarrow$ Use 2' D = 7.5 + 2.0 = 9.5'

$F = \frac{6.5}{\sqrt{(32.2)(7.5)}} = 0.42 \Rightarrow$ Subcritical

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Sta. 112+35 to Sta. 113+40 - Replace Culvert at St. Vrain Street

2 - 12' x 10' RCB

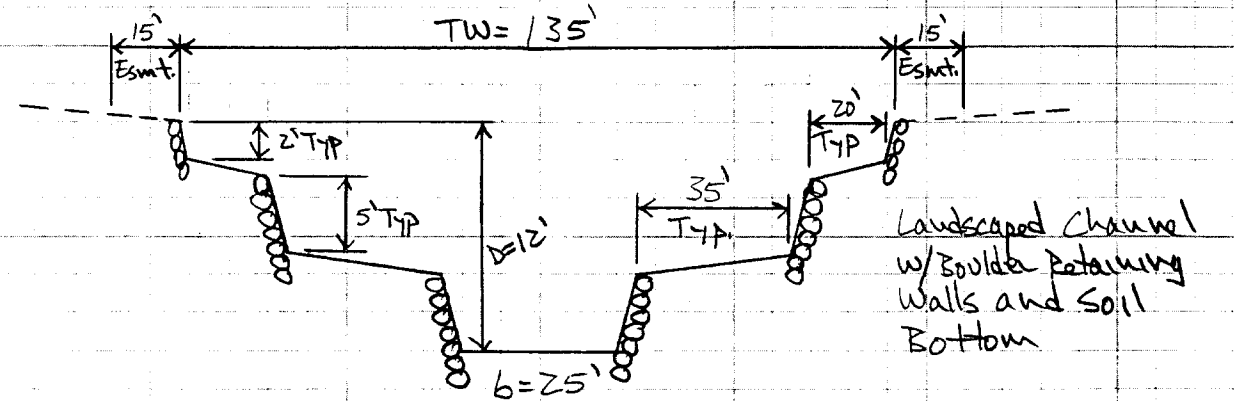
Q_{100} = 2400 cfs L = 105' S_{EX} = 0.4% AHW = 100.0 - 85.0 = 15.0'

Inlet Control ⇒ $Q/6 = \frac{2400}{24} = 100$ HW/D = 1.05 HW = (1.05)(10.0) = 10.5'

Outlet Control ⇒ H = 2.1' H_0 = 7.5' LS_0 = (105)(0.004) = 0.4'

HW = 2.1 + 7.5 - 0.4 = 9.2'

Sta. 113+40 to Sta. 117+75 - New open channel between St. Vrain Street and Willamette Street



Q_{100} = 2400 cfs S_{EX} = 0.7%

d = 8' ⇒ $V = \left(\frac{1.49}{0.050}\right)\left(\frac{4.10}{111}\right)^{2/3}(0.007)^{1/2} = 6.0$ fps ⇒ Q = (6.0)(410) = 2460 cfs

Freeboard = 1.0 + (0.025)(6.0)(8)^{1/3} = 1.3 ⇒ Use 2' D = 8 + 2 = 10'

$F = \frac{6.0}{\sqrt{(32.2)(8)}} = 0.37$ ⇒ Subcritical

Sta. 117+75 to Sta 119+80 - Exist Culvert at Willamette Street

20'x10' Conc Arch (17.8' x 8.9' RCB Equivalent - Provide Conc Invert at ouginal elev)

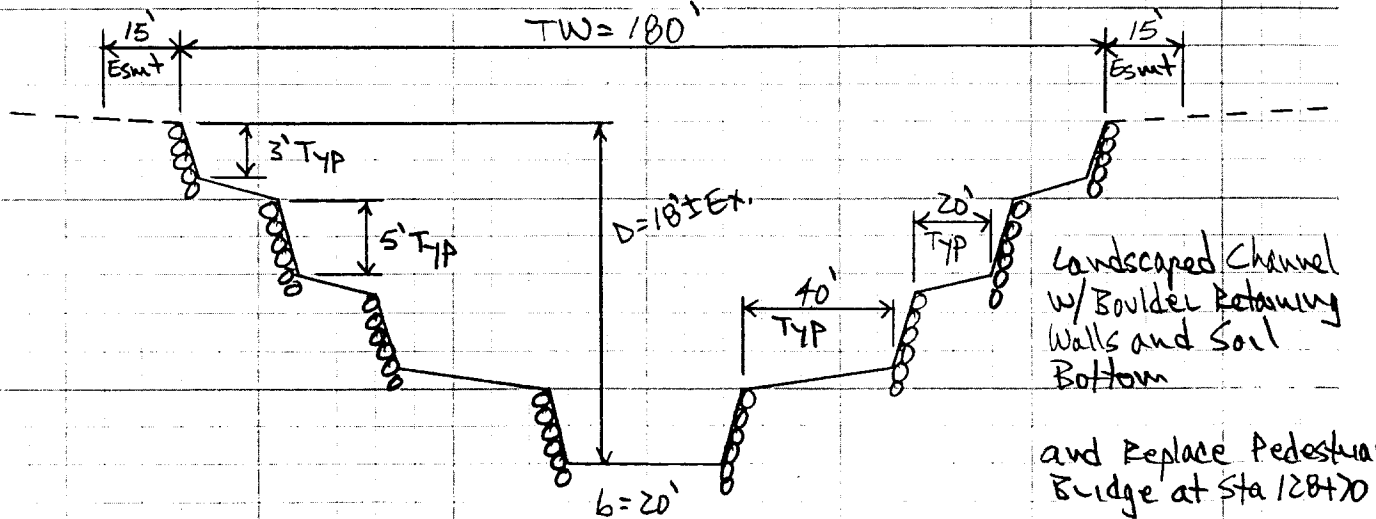
$Q_{100} = 2245$ cfs $L = 205'$ $S_{EX} = 0.1\%$ $AHW = 12.0 - 93.9 = 18.1'$

Inlet Control $\Rightarrow Q/b = \frac{2245}{17.8} = 126$ $HW/D = 1.55$ $HW = (1.55)(8.9) = 13.8'$

Outlet Control $\Rightarrow H = 4.4'$ $H_o = 8'$ $LS_o = (205)(0.001) = 0.3'$

$HW = 4.4 + 8 - 0.3 = 12.1'$

Sta. 119+80 to Sta. 135+15 - New open channel between Willamette Street and Cache La Poudre Street



$Q_{100} = 2245$ cfs $S_{EX} = 0.7\%$

$d = 8' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{400}{116}\right)^{2/3}(0.007)^{1/2} = 5.7$ fps $\Rightarrow Q = (5.7)(400) = 2280$ cfs

Freeboard $= 1.0 + (0.025)(5.7)(8)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 8 + 2 = 10'$

$F = \frac{5.7}{\sqrt{(32.2)(8)}} = 0.36 \Rightarrow$ Subcritical

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SUBJ. Soft-Lined Alternative w/ Detention
OF

Sta. 135+15 to Sta. 137+05 - Exist Culvert at Cache La Poudre Street

20'x10' Conc Arch w/ Upper 3.9' Blocked by Lower Ceiling & Utility Lines (19.0' x 5.8' RCB Equiv- Provide Conc. Invert at Proj. Elev)

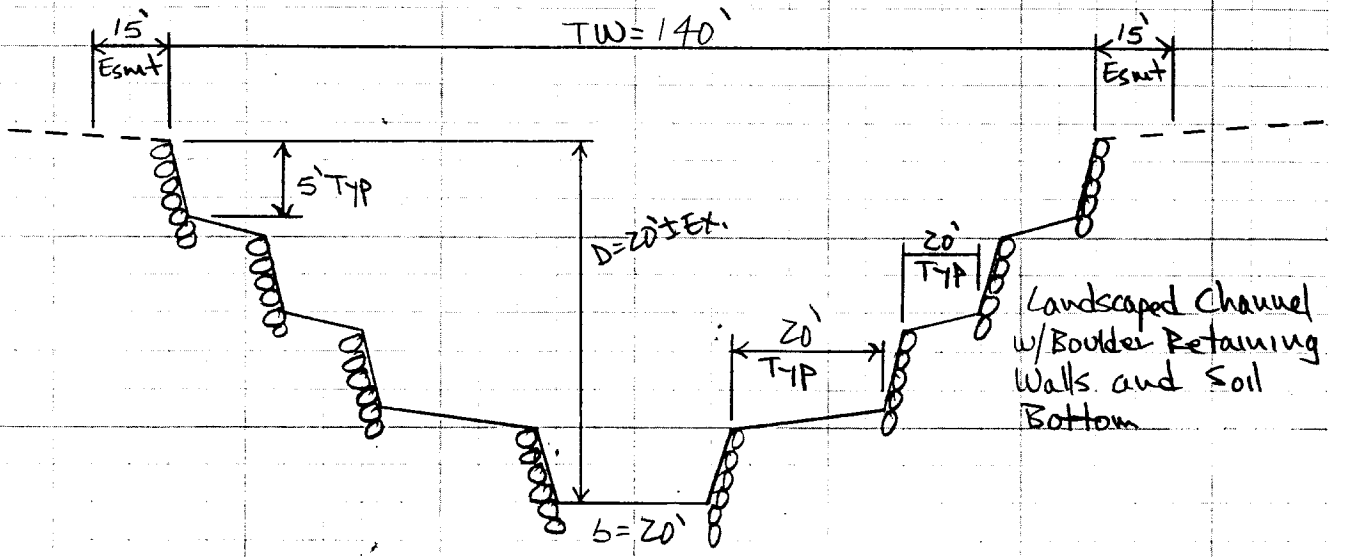
$Q_{100} = 1395$ cfs $L = 190'$ $S_{EX} = 0.2\%$ $AHW = 26.0 - 12.2 = 13.8$

Inlet Control $\Rightarrow Q/b = \frac{1395}{19.0} = 73$ $HW/D = 1.75$ $HW = (1.75)(5.8) = 10.2'$

Outlet Control $\Rightarrow H = 3.5'$ $H_o = 8'$ $LS_o = (190)(0.002) = 0.4'$

$HW = 3.5' + 8 - 0.4 = 11.1'$

Sta. 137+05 to Sta 152+45 - New open channel between Cache La Poudre Street and Vintah Street



$Q_{100} = 1395$ cfs $S_{EX} = 0.7\%$

$d = 7.5' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{250}{75}\right)^{2/3}(0.007)^{1/2} = 5.6$ fps $\Rightarrow Q = (5.6)(250) = 1400$ cfs

Freeboard $= 1.0 + (0.025)(5.6)(7.5)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 7.5 + 2 = 9.5'$

$F = \frac{5.6}{\sqrt{(32.2)(7.5)}} = 0.36 \Rightarrow$ Subcritical

COMP. WMH

CK.

DATE December 17, 1992

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LOC.

FILE 90-809

PROJ. Shooks Run SHEET 13

SUBJ. Soft-Lined Alternative w/Detention OF

Sta. 152+45 to Sta. 153+55 - Exist Culvert at Uintah Street

20'x10' Conc Arch (17.8'x8.9' RCB Equiv - Provide Conc Invert at orig. elev)

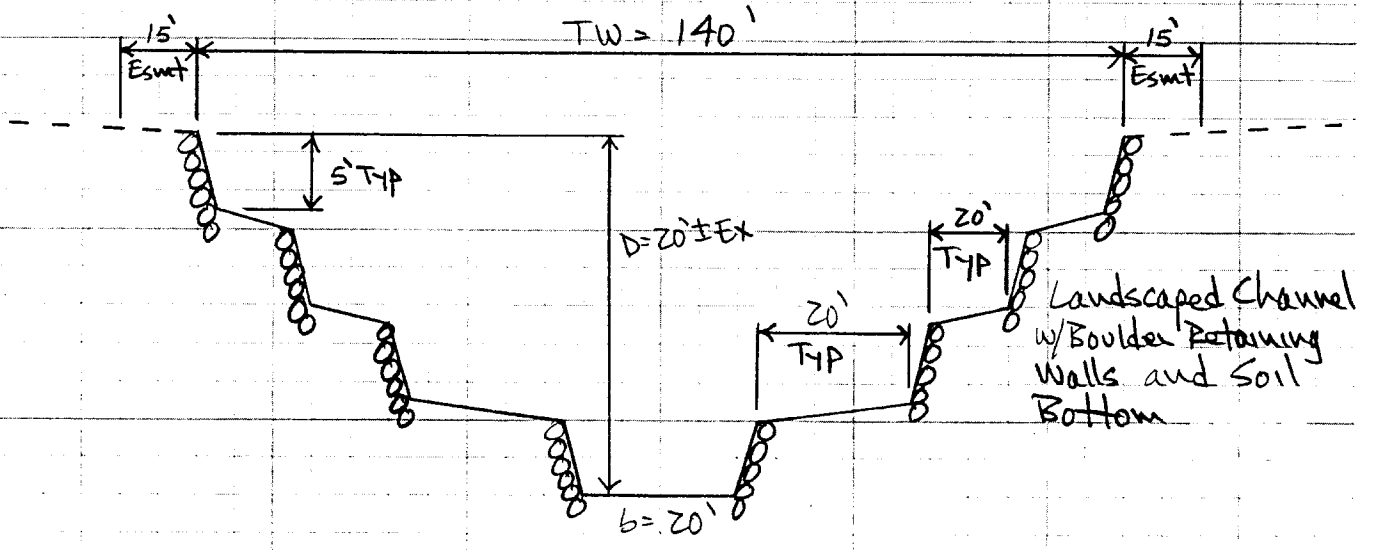
Q_{100} = 795 cfs L = 110' S_{EX} = 1.2% AHW = 50.0 - 28.4 = 21.6'

Inlet Control ⇒ Q/b = $\frac{795}{17.8}$ = 45 HW/D = 0.7 HW = (0.7)(8.9) = 6.2'

Outlet Control ⇒ H = 0.5' H_0 = 7.5' LS_0 = (110)(0.012) = 1.3'

HW = 0.5 + 7.5 - 1.3 = 6.7'

Sta. 153+55 to Sta. 157+55 - New open channel between Uintah Street and San Miguel Street



Q_{100} = 795 cfs S_{EX} = 1.1%

d = 6' ⇒ V = $\left(\frac{1.49}{0.050}\right)\left(\frac{160}{72}\right)^{2/3}(0.011)^{1/2}$ = 5.3 fps ⇒ Q = (5.3)(160) = 850 cfs

Actual d = 6.7' ± (Est'd from Exist HEC 2) ⇒ d = 6.7 ⇒ A = 202 sf ⇒ V = $\frac{795}{202}$ = 3.9' fps

Freeboard = 1.0 + (0.025)(3.9)(6.7)$^{1/3}$ = 1.2 ⇒ Use 2' D_{min} = 6.7 + 2 = 8.7'

$F = \frac{3.9}{\sqrt{(32.2)(6.7)}} = 0.27$ ⇒ Subcritical

Sta. 157+55 to Sta. 158+40 - Exist Culvert at San Miguel Street

20'×10' Conc Arch (17.8'×8.9' RCB Equiv - Provide Conc Invert at orginal elev)

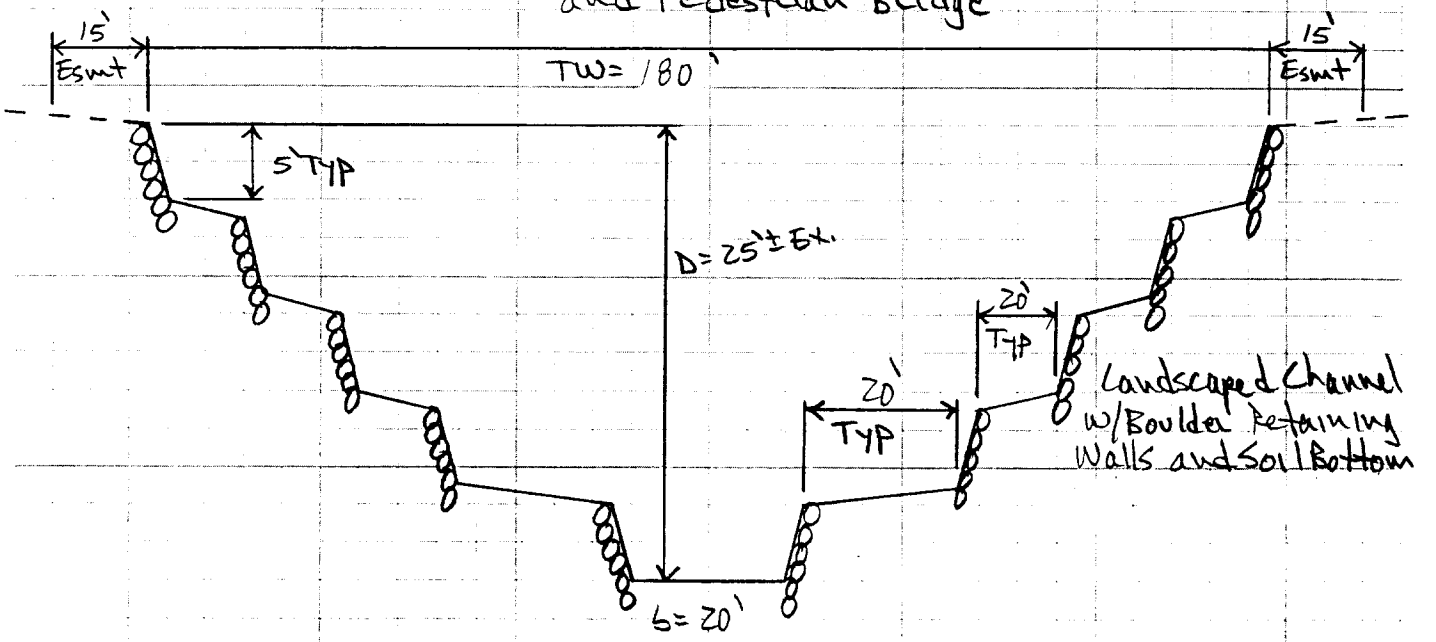
Q_{100} = 795 cfs L = 85' S_{EX} = 0.16% AHW = 52.5 - 34.6 = 17.9'

Inlet Control ⇒ $Q/b = \frac{795}{17.8} = 45$ HW/D = 0.7 HW = (0.7)(8.9) = 6.2'

Outlet Control ⇒ H = 0.5' H_o = 6.7' LS_o = (85)(0.006) = 0.5'

HW = 0.5 + 6.7 - 0.5 = 6.7'

Sta. 158+40 to Sta. 167+35 - New Open channel between San Miguel Street and Pedestrian Bridge



Q_{100} = 795 cfs S_{EX} = 1.0%

d = 6' ⇒ $V = \left(\frac{1.49}{0.050}\right)\left(\frac{160}{72}\right)^{2/3}(0.010)^{1/2}$ = 5.1 fps ⇒ Q = (5.1)(160) = 815 cfs

Freeboard = $1.0 + (0.025)(5.1)(6)^{1/3}$ = 1.2 ⇒ Use 2' D_{min} = 6 + 2 = 8'

$F = \frac{5.1}{\sqrt{(32.2)(6)}}$ = 0.37 ⇒ Subcritical

COMP. [illegible]

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FILE 90-809

PROJ. Shooks Run

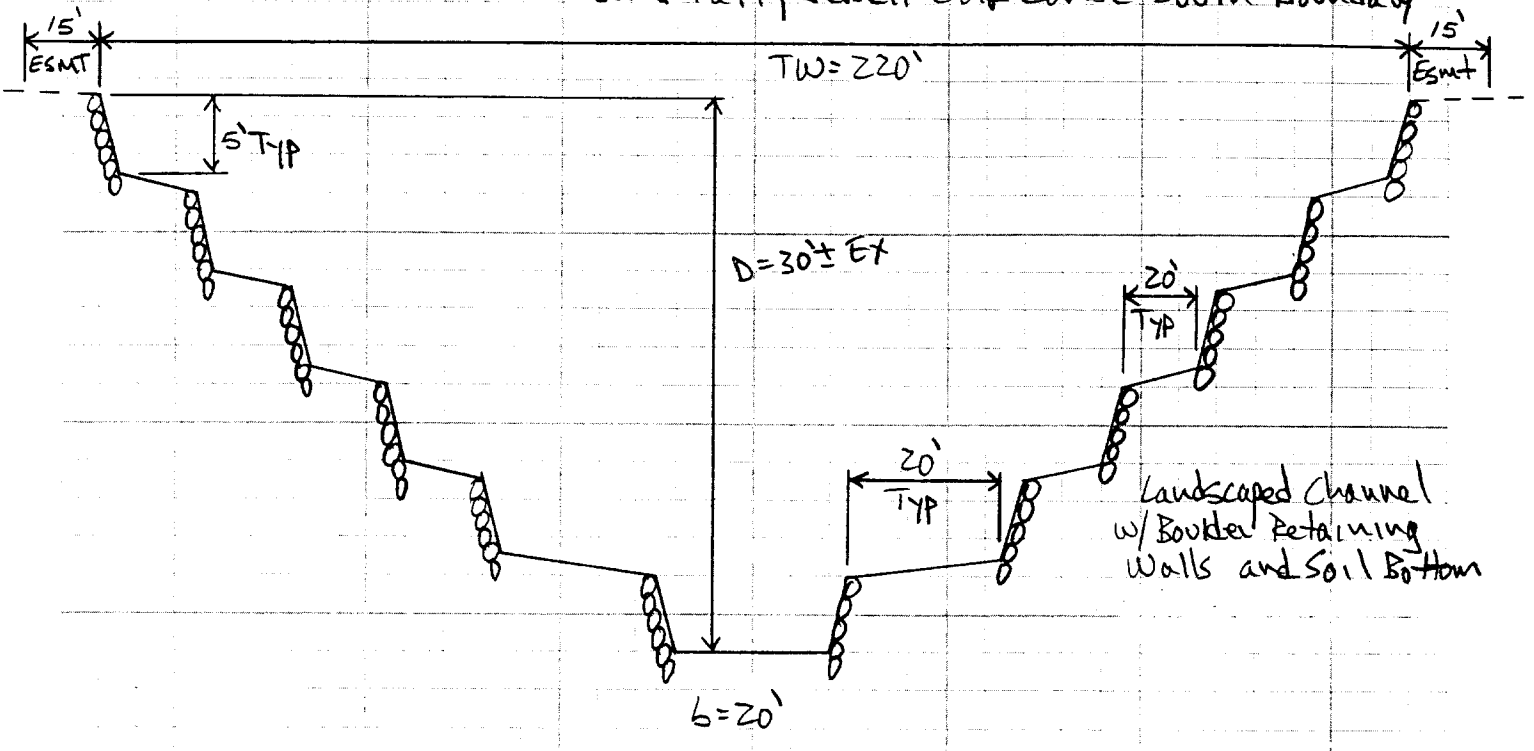
SHEET 15

SUBJ. Soft-Lined Alternative w/ Detention

OF

Sta. 167+35 - Replace Pedestrian Bridge

Sta. 167+35 to Sta 176+25 - New open channel between Pedestrian Bridge and Patty Jewett Golf Course South Boundary



$Q_{100} = 110$ cfs $\quad S_{EX} = 1.0\%$

$d = 2' \Rightarrow V = \left(\frac{1.49}{0.050}\right)\left(\frac{40}{24}\right)^{2/3}(0.010)^{1/2} = 4.2$ fps $\Rightarrow Q = (4.2)(40) = 170$ cfs

Freeboard $= 1.0 + (0.025)(4.2)(2)^{1/3} = 1.1 \Rightarrow$ Use 2' $\quad D_{min} = 2 + 2 = 4'$

$F = \frac{4.2}{\sqrt{(32.2)(2)}} = 0.52 \Rightarrow$ Subcritical

Sta 176+25 to Sta 189+05 - New detention pond on Patty Jewett Golf Course between south boundary and Espanola Street

Sta 189+05 to Sta 190+85 - Replace Culvert at Espanola Street

3 - 12' X 10' RCB

$Q_{100} = 3555$ cfs $L = 180'$ $S_{ft} = 1.39\%$ $AHW = 85.5 - 72.8 = 12.7'$

Inlet Control $\Rightarrow Q/b = \frac{3555}{36} = 99$ $HW/D = 1.05$ $HW = (1.05)(10) = 10.5'$

Outlet Control $\Rightarrow H = 2.0'$ $H_0 = 10'$ $LS_0 = (180)(0.013) = 2.3'$

$HW = 2.0 + 10 - 2.3 = 9.7'$

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FILE 90-809

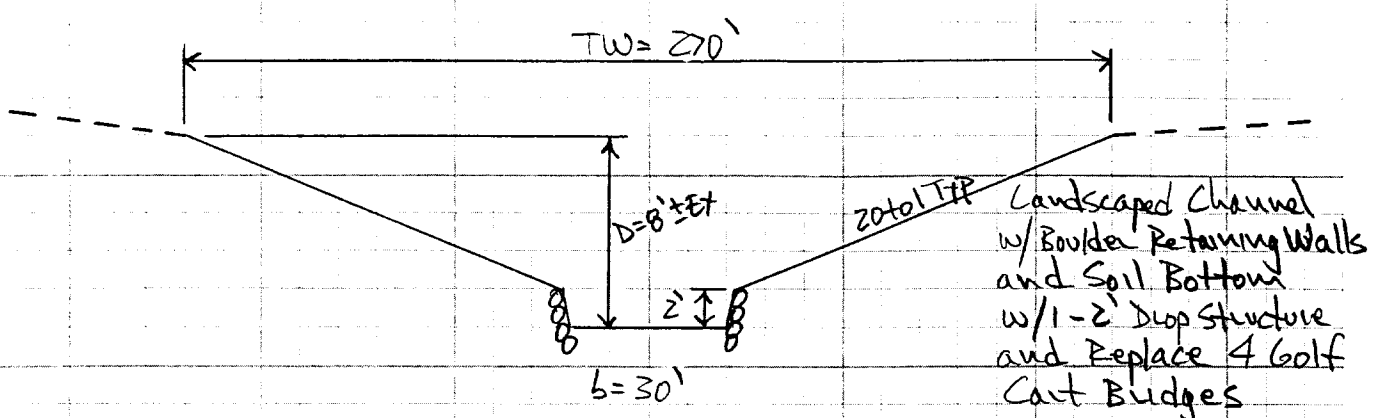
PROJ. Shooks Run

SHEET 17

SUBJ. Soft-Lined Alternative w/ Detention

OF

Sta. 190+85 to Sta 198+45 - New Open Channel between Espanola Street and End of Existing Channel Lining



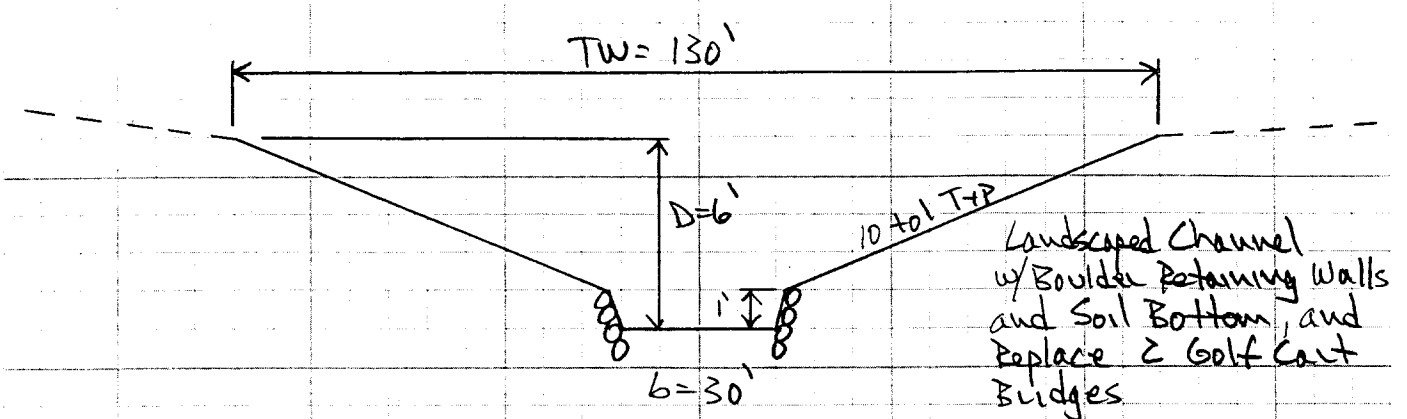
Q_{100} = 3460 cfs S_{EX} = 1.44% + 3' Ex Drop S_{PRO} = 1.5% ±

$d = 6' \Rightarrow V = \left(\frac{1.44}{0.050}\right)\left(\frac{500}{194}\right)^{2/3}(0.015)^{1/2} = 6.9$ fps $\Rightarrow Q = (6.9)(500) = 3450$ cfs

Freeboard = $1.0 + (0.025)(6.9)(6)^{1/3} = 1.3 \Rightarrow$ Use 2' $D_{min} = 6 + 2 = 8'$

$F = \frac{6.9}{\sqrt{(32.2)(6)}} = 0.50 \Rightarrow$ Subcritical

Sta. 198+45 to Sta. 216+40 - New Open Channel between End of Existing Channel Lining and Paseo Road



$Q_{100} = 1110$ cfs $\quad S_{PRO} = 1.0\%\pm$

$d = 4' \Rightarrow V = \left(\frac{1.49}{0.0150}\right)\left(\frac{210}{92}\right)^{2/3}(0.010)^{1/2} = 5.2$ fps $\Rightarrow Q = (5.2)(210) = 1090$ cfs

Freeboard $= 1.0 + (0.025)(5.2)(4)^{1/3} = 1.2 \Rightarrow$ Use $2'$ $\quad D_{min} = 4+2 = 6'$

$F = \frac{5.2}{\sqrt{(32.2)(4)}} = 0.46 \Rightarrow$ Subcritical

Sta. 216+40 to Sta. 216+95 - Replace Culvert at Paseo Road

$3 - 10' \times 5'$ RCB

$Q_{100} = 1110$ cfs $\quad L = 55' \quad S_{PRO} = 0.7\% \quad AHW = 12.3 - 05.9 = 6.4'$

Inlet Control $\Rightarrow Q/5 = \frac{1110}{30} = 37 \quad HW/D = 1.1 \quad HW = (1.1)(5) = 5.5'$

Outlet Control $\Rightarrow H = 1.2' \quad H_0 = 4' \quad LS_0 = (55)(0.007) = 0.4'$

$HW = 1.2 + 4 - 0.4 = 4.8'$