APPENDIX C - CALCULATIONS

C.1	Channel Design (Design Calculation, Figures, Tables, etc.)
C.2	In-Stream Structure Design (Design Calculation, Figures, Tables, etc.)
C.3	Temporary Grade Control Structure Design (Design Calculation, Figures, Tables, etc.)
C.4	Riprap Gutters Design (Design Calculation, Figures, Tables, etc.)
C.5	Environmental Enhancement Plan (Design Calculation, Figures, Tables, etc.)
C.6	Water Line Relocation (Design Calculation, Figures, Tables, etc.) (not included, previously submitted)
C.7	Sewer Line Relocation (Design Calculation, Figures, Tables, etc.) (not included, previously submitted)

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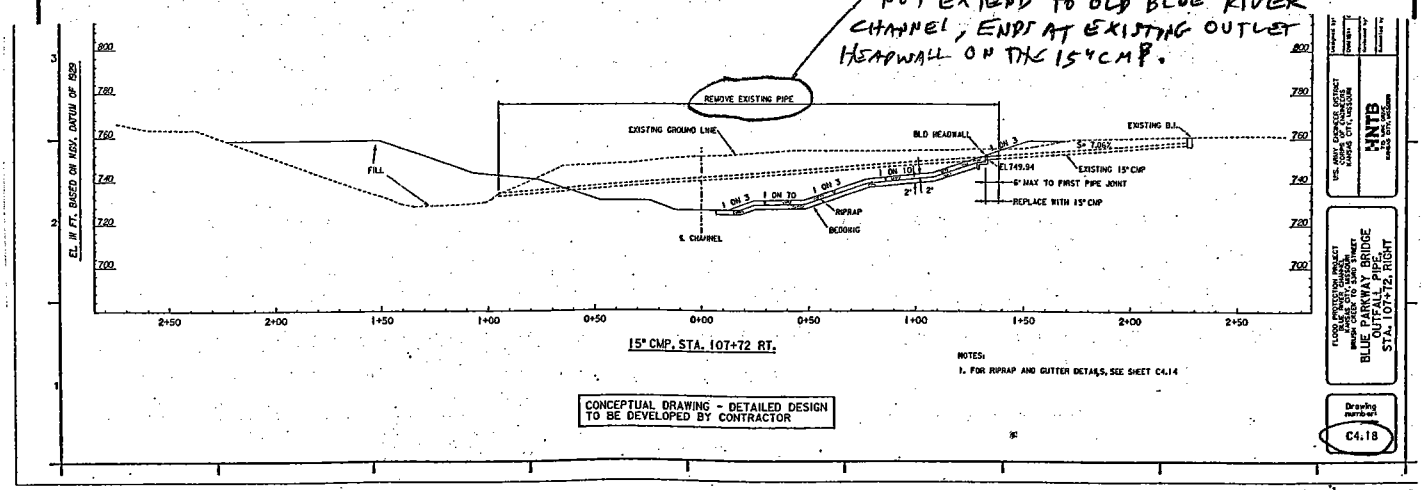
North Kansas City, MO 64116
Phone:(816) 421-4232 Fax: (816) 421-1956

BLUE RIVER CHANNEL MODIFICATIONS
Project (BRUSH CREEK TO 53rd ST.)
Job No. 2007-2154
Calculated by W. STROBACH Date 05/23/08
Checked by E. PREWITT Sheet No. 1 of 5

STA 107+72 (RB) MODIFY OUTLET END EXISTING 15" STORM DRAIN

INFO FROM 65% CONTRACT DRAWINGS

BASED ON PAST EXPERIENCE OF WORKING ON NEARBY UTILITY CORRIDOR, PROJECT, EXISTING PIPE DOES NOT EXTEND TO OLD BLUE RIVER CHANNEL, ENDS AT EXISTING OUTLET HEADWALL ON THE 15" CMP.



GUTTER AND OUTFALL STRUCTURE SCHEDULE					
℄ STATION		OUTFALL STRUCTURES			B = BOTTOM WIDTH (FT.)
LEFT BANK	RIGHT BANK	SIZE	GATEWELL	FLAPGATE	
87+77 CHANNEL		36" CMP			5'
	90+65 CHANNEL				5'
93+00 CHANNEL		10" CMP			8'
104+60 CHANNEL		30" CMP			5'
107+00 CHANNEL		15" CMP		X	5'
	107+72 CHANNEL	15" CMP			4'

← CONTRACT DRAWING C4.14

→ NOTE: A FLAP GATE IS NOT INDICATED FOR THIS DRAINAGE STRUCTURE. THIS WAS VERIFIED IN RESPONSE TO BIDDER QUESTION #8

Responses to Bidder Questions
W912DQ-07-R-0042
29 August 2007

8. Dwg. C4.18, 15" CMP, Sta. 107+72 RT. Appears that a flap gate should be added to the new headwall for the 15" CMP otherwise high channel flows are going to back up landward inside of the existing 15" CMP. Please clarify?

RESPONSE: No flapgate is necessary.

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STA 107+72 (RB) MODIFY OUTLET END EXISTING 15" STORM DRAIN

COULD NOT VERIFY OUTLET END OF EXISTING STRUCTURE DURING MY FIELD TRIP OF 03/06/08

Sta 107+72 (RB). There is an existing 15" CMP outlet called out on Dwg C3.3 and profile shown on Dwg C4.18 that empties on to the right bank just north of the Blue Parkway Bridge. The outlet end of this 15" CMP could not be found as it is buried below fill that was dumped over it from the new Blue Parkway Bridge construction.

ASSUME APAC WILL UNCOVER THE OUTLET END OF THIS DRAINAGE STRUCTURE TOWARD END OF THEIR CONTRACT TO CONSTRUCT THE NEW BLUE PARKWAY BRIDGE

ALTHOUGH NEW CMP IS CALLED OUT FOR USE IN THIS MODIFICATION, SPECIFICATIONS REQUIRE USE OF RCP

1.2 GENERAL INFORMATION (SECTION 33-40-01)

The Contractor is to relocate and/or extend existing drainage systems affected by the project, especially those currently discharging to the Blue River, as needed to facilitate the discharge to the Blue River following completion of the project. Existing pipelines are to be extended using reinforced concrete pipe (RCP). Pipelines shall be extended with the same sized pipe unless additional storm drainage enters the system in the new segments. In the later case the additional segments shall be designed for the flow that enters the system. The Design and Construction shall meet the requirements of the Kansas City Metro Chapter, American Public Works Association, Standard Specifications and Design Criteria (APWA) as revised, adopted and approved by the Director of Public Works. These (City's) standards and specifications contain material, equipment, design criteria and construction requirements, for infrastructure items proposed for construction within the City limits of Kansas City, Missouri. These standards are available through links from the Kansas City Missouri Web site, Public Works Department Page.

IN AREAS OF CONFLICT, SPECS CONTROL OVER DRAWINGS

52.236-21 SPECIFICATIONS AND DRAWINGS FOR CONSTRUCTION (FEB 1997)

(a) The Contractor shall keep on the work site a copy of the drawings and specifications and shall at all times give the Contracting Officer access thereto. Anything mentioned in the specifications and not shown on the drawings, or shown on the drawings and not mentioned in the specifications, shall be of like effect as if shown or mentioned in both. In case of difference between drawings and specifications, the specifications shall govern. In case of discrepancy in the figures, in the drawings, or in the specifications, the matter shall be promptly submitted to the Contracting Officer, who shall promptly make a determination in writing. Any adjustment by the Contractor without such a determination shall be at its own risk and expense. The Contracting Officer shall furnish from time to time such detailed drawings and other information as considered necessary, unless otherwise provided.

∴ NEW RCP WILL BE USED FOR MODIFICATION OF THIS STRUCTURE. THIS ALSO IS KCMO PREFERENCE.

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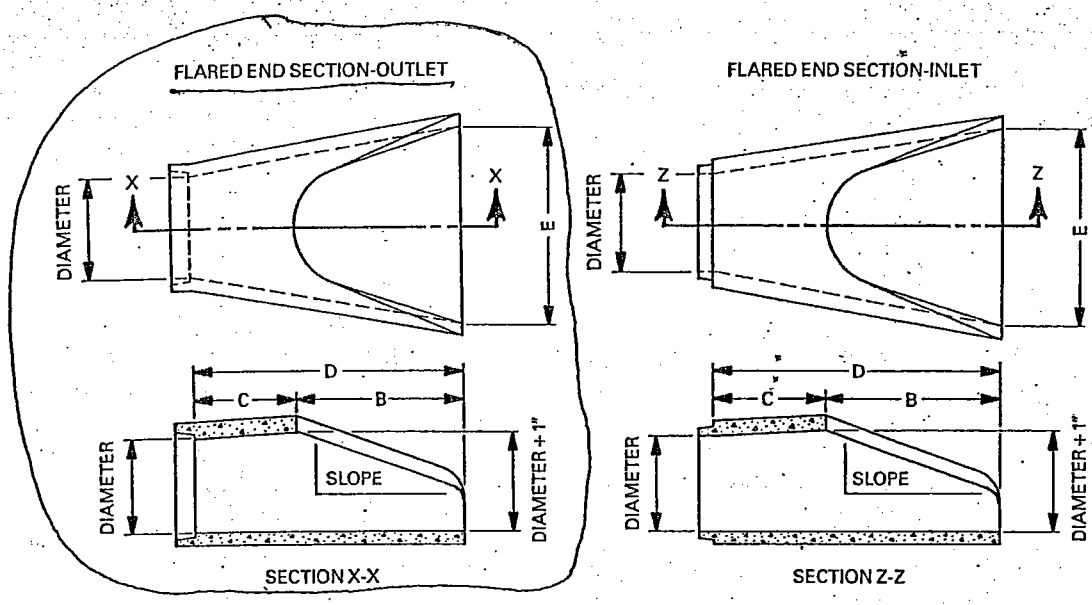
STA 107+72 (RB) MODIFY OUTLET END EXISTING 15" STORM DRAIN

SINCE A FLAP GATE IS NOT REQUIRED, A REINFORCED CONCRETE HEADWALL IS NOT REQUIRED, WILL USE A FLARED CONCRETE END SECTION - OUTLET. TYPICAL FLARED END SECTION - OUTLET IS SHOWN BELOW.

CSR Hydro Conduit

Flared End Section
12" - 72" Diameter



Pipe Diameter	Wall Thickness	Slope	B	C	D	E	Unit Weight
12	2¼	3:1	24	49	73	24	730
15	2¼	3:1	27	46	73	30	910
18	2½	3:1	27	46	73	36	1190
21	2¾	3:1	36	37	73	42	1370
24	3	3:1	42	31½	73½	48	1770
27	3¼	3:1	48	25½	73½	54	2130
30	3½	3:1	54	19¾	73¾	60	2380
33	3¾	3:1	60	36	96	66	3870
36	4	3:1	63	34¾	97¾	72	5320
42	4½	3:1	63	35	98	78	5920
48	5	3:1	72	26	98	84	7470
54	5½	2.4:1	66	34	100	90	8810
60	6	2:1	60	39	99	96	11180
72	7	2:1	78	21	99	108	13980

Dimensions in inches weights in pounds

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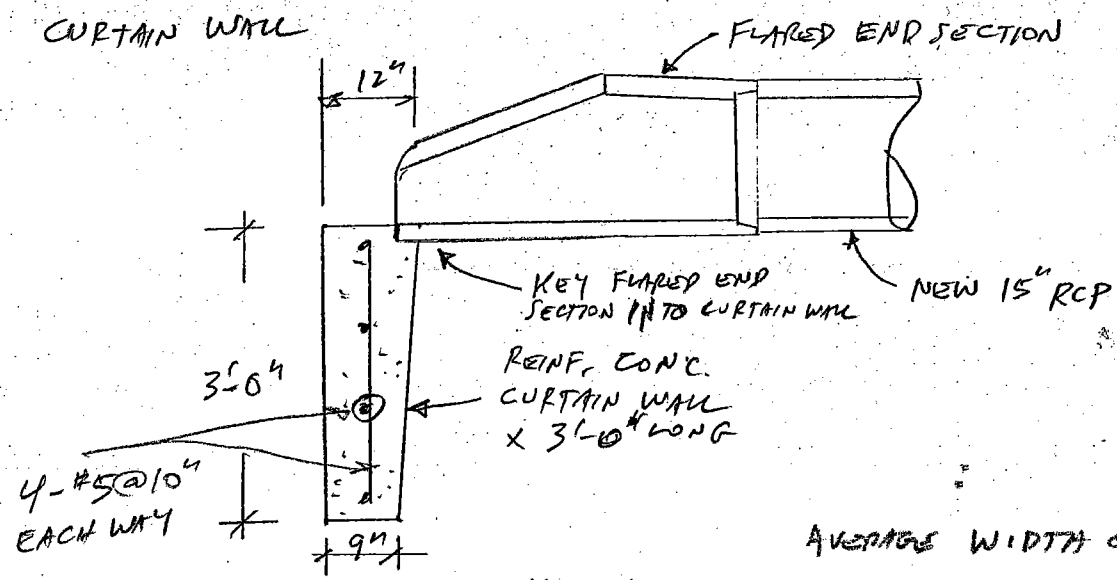
Project: BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST.)
Job No. 2007-2154
Calculated by W. STROBACH Date 05/23/08
Checked by E. PREWITT Sheet No. 4 of 5

STA 107+72 (RB) MODIFY OUTLET END EXISTING 15" STORM DRAIN

ATTACH FLARED END SECTION TO REINFORCED CONCRETE CURTAIN WALL



ELEVATION
NOT TO SCALE

AVERAGE WIDTH OF CURTAIN WALL = $\frac{12+9}{2} = 10.5"$

CHECK REINF. STEEL REQUIREMENTS

EM 1110-2-2104, PARAGRAPH 2-8a.

$$A_s = .0028 \times \underset{\text{AVG. WIDTH}}{10.5} \times \underset{\text{SPACING}}{10"} = .294 \text{ in}^2 < \underset{\#5@10"}{.358 \text{ in}^2}$$

OK

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BLUE RIVER CHANNEL MODIFICATIONS
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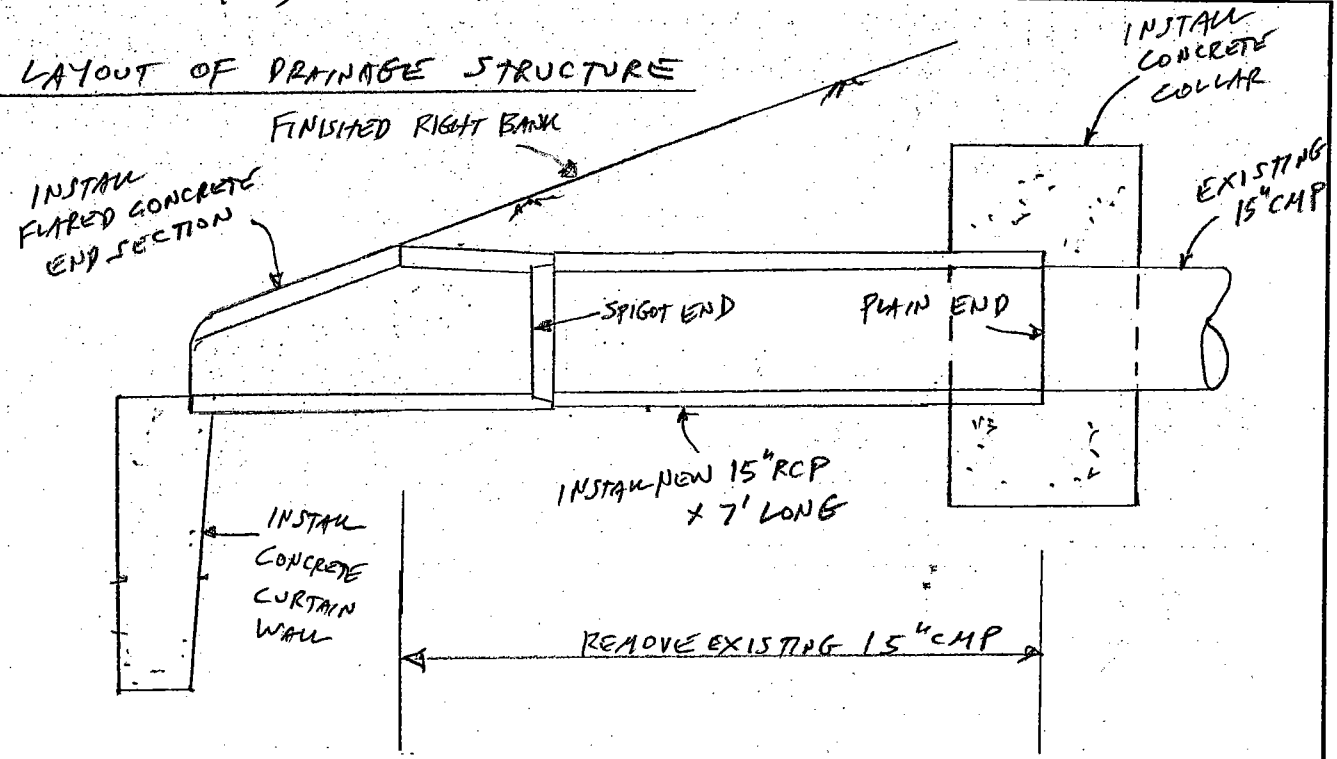
Checked by E. PREWITT Sheet No. 5 of 5

STA 107+72 (RB) MODIFY OUTLET END EXISTING 15" STORM DRAIN

LAYOUT OF DRAINAGE STRUCTURE



ELEVATION

NOT TO SCALE

PER SPECIFICATIONS SECTION 33 40 01, ITEM 1.2, EXISTING STORM WATER LINES ARE TO BE EXTENDED USING RCP

REMOVE PORTION OF EXISTING 15" CMP TO PROVIDE ROOM TO INSTALL FLARED CONCRETE END SECTION AND MATCH FINISHED TEMPLATE SLOPE AS SHOWN.

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Checked by E. PREWITT Sheet No. 1 of 11

STA 107+00 (LB) DESIGN REINF. CONCRETE OUTLET STRUCTURE – 18" PIPE

TASK: DESIGN REINFORCED CONCRETE OUTLET STRUCTURE* FOR THE EXISTING 18" PIPE AT STA 107+00 (LB)

EXISTING DRAINAGE STRUCTURE CHANGE IN SIZE AND TYPE OF PIPE

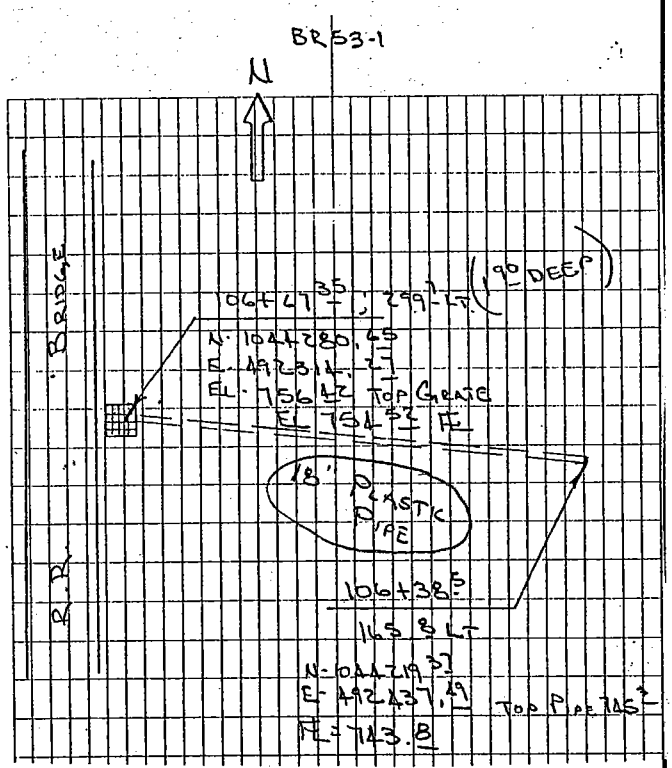
CONTRACT DRAWINGS C3.3 (PLAN) AND C4.14 (GUTTER AND OUTFALL STRUCTURE SCHEDULE) INDICATED THAT A 15" CMP EXISTED AT THIS LOCATION.

HOWEVER ESI SURVEY OF 05/06/08 DISCOVERED AN 18" PLASTIC PIPE AT THE OUTLET END OF THIS STORM DRAIN. (SEE BELOW)

61.28 +
123.22 = 137.62

(19) MAY 6, 2008 LONG

LOCATE STORM SEWERS ON LEFT SIDE OF BLUE RIVER 53RD ST.



A = A REINFORCED CONCRETE OUTLET STRUCTURE IS NEEDED AT THIS LOCATION TO SUPPORT THE FLAP GATE THAT IS CALLED OUT →

65% DRAWING (C4.14)

GUTTER AND OUTFALL STRUCTURE SCHEDULE

℄ STATION		OUTFALL STRUCTURES			B = BOTTOM WIDTH (FT.)
LEFT BANK	RIGHT BANK	SIZE	GATEWELL	FLAPGATE	
87+77 CHANNEL		36" CMP			5'
	90+65 CHANNEL				5'
93+00 CHANNEL		10" CMP			8'
104+60 CHANNEL		30" CMP			5'
107+00 CHANNEL		15" CMP		(X)	5'
	107+72 CHANNEL	15" CMP			4'

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Job No. 2007-2154
Calculated by W. STROBACH Date 03/19/08
Checked by E. PREWITT Sheet No. 2 of 11

STA 107+00 (LB) DESIGN REINF. CONC. OUTLET STRUCTURE - 18" PIPE

5.3 DESIGN CRITERIA :

The following considerations are to guide the design of the storm drainage outfall structures. The Contractor shall produce a design of his choosing subject to these criteria; complete calculations supporting the selected design are to be submitted to the Kansas City District, U.S. Army Corps of Engineers in accordance with the submittal guidance in the Summary of Work Specification.

a. The base bid considers the outfalls being designed and constructed with the conceptual riprap design provided in the included plan set. An option for pipe outfalls in lieu of the riprap gutters, except within the limits of the upstream transition, shall also be provided. This includes the pipes at Station 93+00, Station 104+60, Station 107+00, and Station 107+72. A conceptual design of vertical drop junction boxes and RCP outfalls is included in the plan set.
b. The use of grouted riprap within the outfall gutter design is prohibited.
c. The Contractor shall design the outfalls for the existing storm drainage structures and tributaries based on EM 1110-2-1610, EM 1110-2-2902, EM 1110-2-1413, EM 1110-2-1415, and shall include the slope protection criteria on the Kansas City District USACE Website at: http://www.nwk.usace.army.mil/local protection/levees.html The design guidance criteria for turbulent flow areas shall be used around structures. The local guidance also has riprap and bedding rock gradations that are typically used in the Kansas City area.

EM 1110-2-2902 - IS STRUCTURAL, (CONDUITS, CULVERTS & PIPES)
EM'S 1110-2-1413, 1415 & 1610 ARE ALL HYDRAULIC RELATED
ANOTHER CORPS STRUCTURAL EM THAT NEEDS TO BE USED IS
EM 1110-2-2104 (STRENGTH DESIGN FOR REINF. CONC. HYDRAULIC STRUCTURES)

1-4. Background (EM 1110-2-2104)

a. A reinforced concrete hydraulic structure is one that will be subjected to one or more of the following: submergence, wave action, spray, chemically contaminated atmosphere, and severe climatic conditions. Typical hydraulic structures are stilling-basin slabs and walls, concrete-lined channels, portions of powerhouses, spillway piers, spray walls and training walls, floodwalls, intake and outlet structures below maximum high water and wave action, lock walls, guide and guard walls, and retaining walls subject to contact with water.

THE SUBJECT OUTLET STRUCTURE IS A REINF. CONC. HYDRAULIC STRUCT.

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STA 107+00 (LB) DESIGN REINF. CONC. OUTLET STRUCTURE - 18" PIPE

INFO FROM EM 1110-2-2902 (CONDUITS, CULVERTS & PIPES)

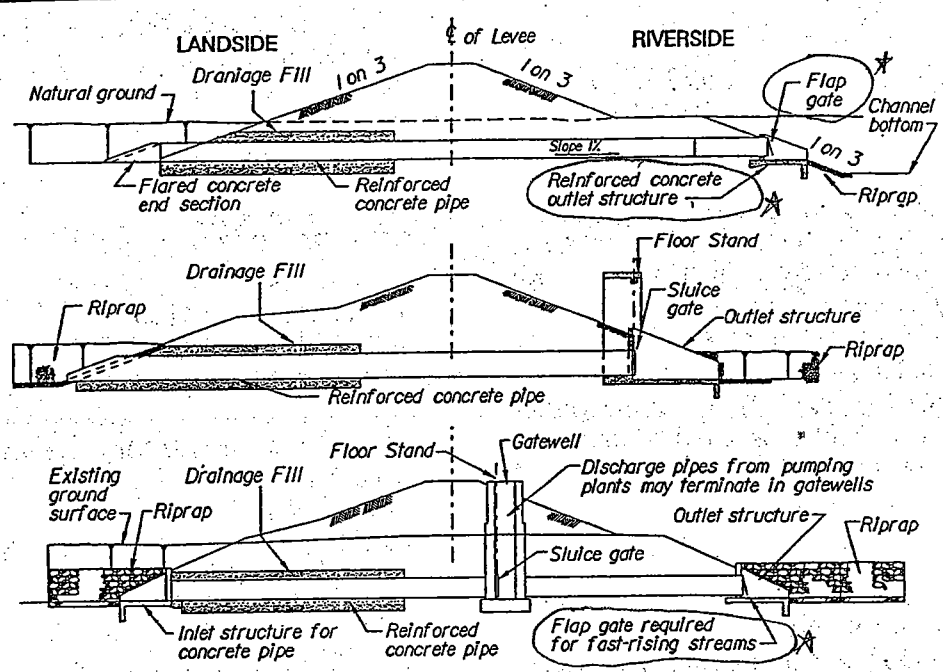

Figure 3-4. Typical sections, drainage structures through levees

f. Outlet structures. Outlet structures are normally cast-in-place concrete, U-wall-type structures. Pile bents may also be used.

THIS EM 1110-2-2902 DEFINES SHAPE OF REINFORCED CONCRETE OUTLET STRUCTURE

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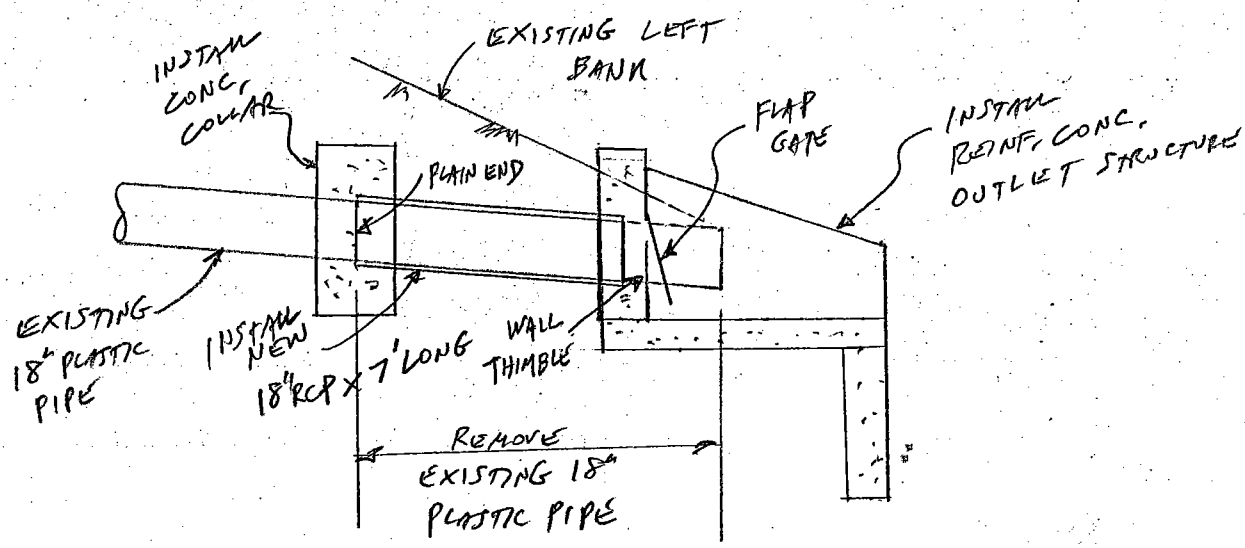
STA 107+00 (LB) DESIGN REINF. CONCRETE OUTLET STRUCTURE - 18" PIPE

LAYOUT OF DRAINAGE STRUCTURE



ELEVATION
Scale: 1" = 5'

PER SPECIFICATIONS SECTION 33 40 01; ITEM 1.2, EXISTING STORM WATER LINES ARE TO BE EXTENDED USING RCP.

REMOVE PORTION OF EXISTING 18" PLASTIC PIPE TO PROVIDE ROOM TO INSTALL CONCRETE OUTLET STRUCTURE AND MATCH FINISHED TEMPLATE SLOPE TO BACK OF HEADWALL

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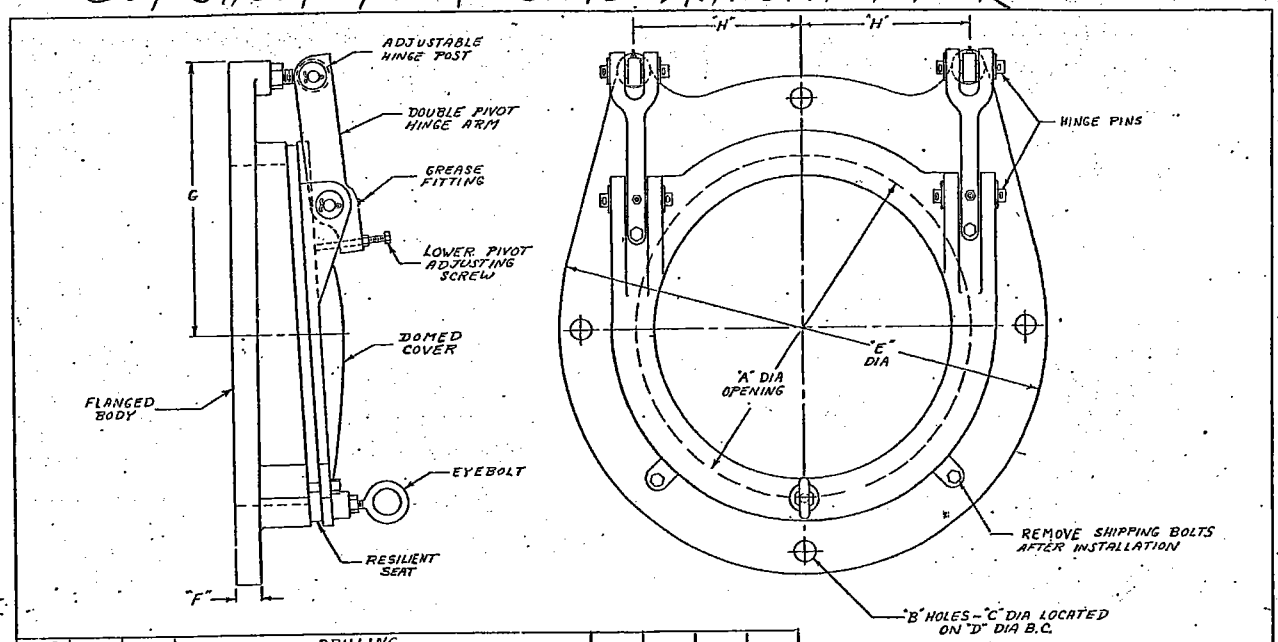
STA 107+00 (LB) DESIGN REINF. CONCRETE OUTLET STRUCTURE - 18" PIPE

CUT SHEET FROM GATE MANUFACTURER



FLAP VALVE SIZE	ITEM NO.	A*	DRILLING B	C	D	LOCATION	TYPE	TEMPLATE NO.	"E"	"F"	"G"	"H"
12" DIA	01	12.00 1/4	4	0.75"	17.00"	STRADDLE ℄'S	#25# STD	B-012031	19.00"	1.00"	9.75"	6.00"
	02	12.00 1/4	4	1.00"		STRADDLE ℄'S	#125# STD	B-012031				
	03		4	0.75"		ON ℄'S		B-012026				
14" DIA	04	14.00 1/4	4	0.87"	18.75	STRADDLE ℄'S	#25# STD	B-014012	21.00"	1.12"	12.00"	7.00"
	05	14.00 1/4	4	1.12"		STRADDLE ℄'S	#125# STD	B-014012				
	06		4	0.87"		ON ℄'S		B-014014				
15" DIA	07	15.00 1/4	8	0.87"	20.00"	STRADDLE ℄'S	#25# STD	B-015014	22.00"	1.12"	12.00"	7.50"
	08	15.00 1/4	8	1.12"		STRADDLE ℄'S	#125# STD	B-015014				
	09		4	0.87"		ON ℄'S		B-015015				
16" DIA	10	16.00 1/4	8	0.87"	21.25	STRADDLE ℄'S	#25# STD	B-016018	23.50"	1.12"	12.75"	8.00"
	11	16.00 1/4	8	1.12"		STRADDLE ℄'S	#125# STD	B-016018				
	12		4	0.87"		ON ℄'S		B-016004				
18" DIA	13	18.00 1/4	8	0.87"	22.75	STRADDLE ℄'S	#25# STD	B-018065	25.00"	1.25"	14.50"	9.25"
	14	18.00 1/4	8	1.25"		STRADDLE ℄'S	#125# STD.	B-018065				
	15		4	0.87"		ON ℄'S		B-018066				

ALT.	CHANGE	BY	CKD.	DATE	ALT.	CHANGE	BY	CKD.	DATE	ALT.	CHANGE	BY	CKD.	DATE
A1	4 HOLES WERE 12	LCT	PAL	1/11/84										
A2	8 HOLES WERE 16	JS	PAL	12/84										
B	TEMPLATE WAS B-01401													

STD PARTS ~ E-15113

*TO MATE WITH 25/125 LB. STD. PER ANSI B16.1

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ASSEMBLY - 12" DIA THRU 18" DIA
STANDARD FLAP VALVES
SERIES FV-AC

DRAWN W.E.U.	DESIGNED	DATE 12-3-73	
CHECKED	APPROVED	SCALE	
INDEX SYMBOL	ORDER NO.	DWG. NO. D-22676	

BASED ON PAST CORPS OF ENGINEER DESIGN EXPERIENCE FOR THIS RELATIVELY SMALL OUTLET STRUCTURE:

ALLOW 1' CLEAR FROM EDGE OF OPENING TO SIDEWALLS (PROVIDE ROOM FOR MAINTENANCE)

ALLOW 1' CLEAR FROM OPENING INVERT TO TOP OF BASE SLAB (PROVIDE ADEQUATE ROOM FOR GATE TO SEAT)

PROVIDE 2' CLEAR FROM TOP OF OPENING TO TOP OF HEADWALL TO ACCOMODATE FLAP GATE OPERATION

PROVIDE 16" THICK HEADWALL TO PROVIDE ADEQUATE ROOM TO EMBED 18" RCP AND FLAP GATE WALL THIMBLE, ALSO PROVIDE 12" THICK KEY (SEE SHT 6)

PROVIDE 8" THICK SIDEWALLS & BASE SLAB BASED ON SHORT HEIGHT OF SIDEWALLS

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Calculated by W. STROBACH Date 05/22/08
Checked by E. PREWITT Sheet No. 6 of 11

STA 107+00 (LB) DESIGN REINF. CONCRETE OUTLET STRUCTURE - 18" PIPE

From: Everett Hosking [everetth@rodneyhunt.com]
Sent: Friday, May 09, 2008 3:44 PM
To: Bill Strobach
Cc: Kent Miller (kmiller@fluidequip.com)
Subject: 18" Diameter Wall Thimble
Attachments: E-43563.pdf

INFO REGARDING FLAP GATE WALL THIMBLE

May 9, 2008
NORTON SCHMIDT CONSULTING ENGINEERS
Bill Strobach

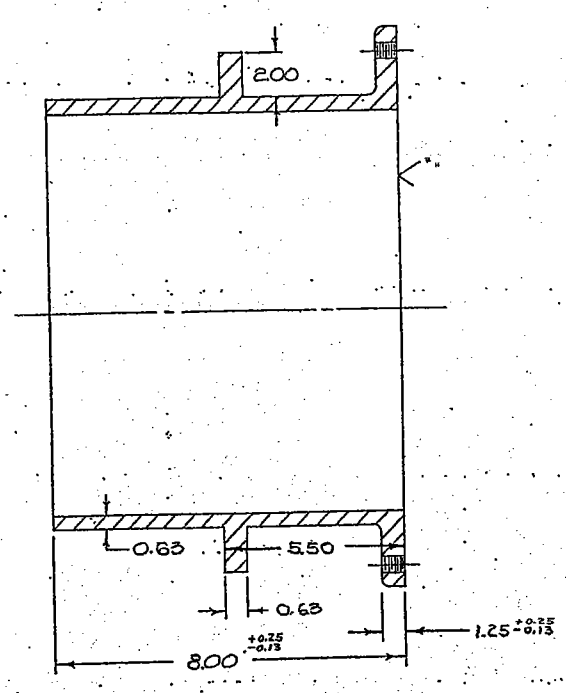
The wall thimble drawing E-43563 would work well with the 18" pipe entering the 16" thick headwall from the opposite side.
Our thimble would butt against the pipe end at the mid point of the wall. The "F" section thimble has a circular front flange and a circular back up "grouting" ring at about the mid-barrel length. Using wall thimble E-43563, for your application, there would be 2-3/8" between the flange and the ring. This distance is sufficient for establishing a water seal with 4,000 psi concrete (3/4" aggregate).

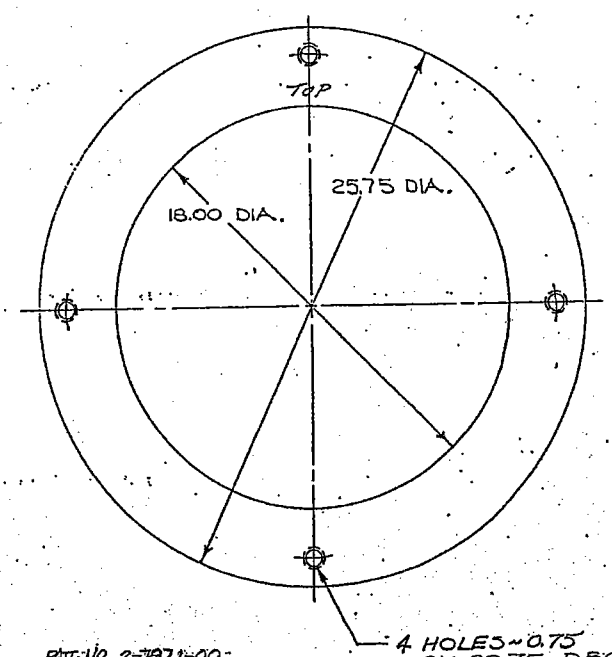
We have included a representative drawing for an 18" diameter flap gate. Drawing D-22676-13 bolts up to the thimble on a reduced 25# drilling template.

EVERETT HOSKING,
3 5/8", EVERETT OKed THIS CHANGE ON HIS E-MAIL OF 05/23/08
5.50" - (.63" + 1.25") = 3.62"

Everett Hosking, P.E.
Ev Hosking
Senior Project Engineer
RODNEY HUNT COMPANY
Tel: 1.800.448.8860 x283
fax: 1.978.544.7204

NOTES





PATT. NO. 2-7871-00

TEMP. NO. B-018066

ALT.	CHANGE	BY	CKD.	DATE	ALT.	CHANGE	BY	CKD.	DATE

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DETAIL: 18" DIA. WALL THIMBLE
F-SECTION, 8" DEEP

DRAWN P. WEST	DESIGNED P. W.	DATE 1-29-93
CHECKED	APPROVED	SCALE 3"=12"
INDEX SYMBOL IBM P.L.	ORDER NO.	DWG. NO. E-43563

PATTERN SHOP FROM E-36628 & E-38222-09 Issued

NORTON & SCHMIDT
Consulting Engineers, LLC
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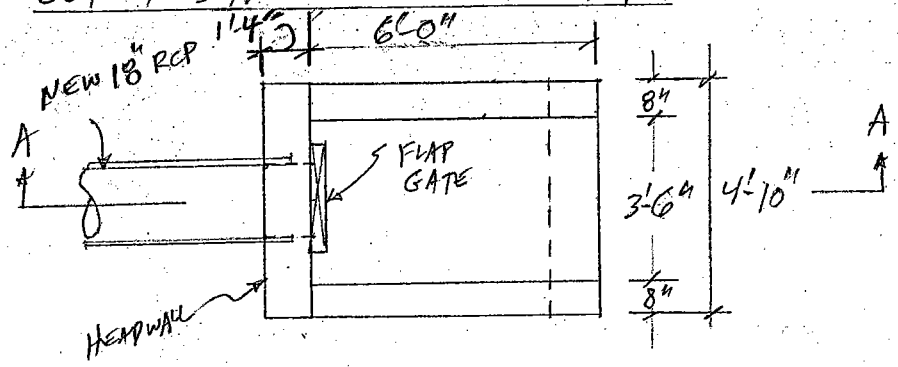
North Kansas City, MO 64116
Phone:(816) 421-4232 Fax: (816) 421-1956

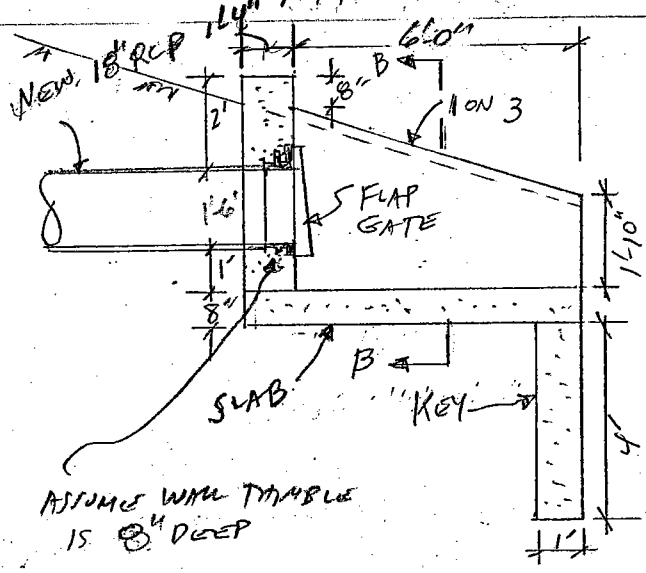
Project: BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST.)
Job No. 2007-2154 REVISED 05/23/08
Calculated by W. STROBACH Date 03/19/08
Checked by E. PREWITT Sheet No. 7 of 11

STA 107+00 (LB) DESIGN REINF. CONC. OUTLET STRUCTURE – 18" RCP

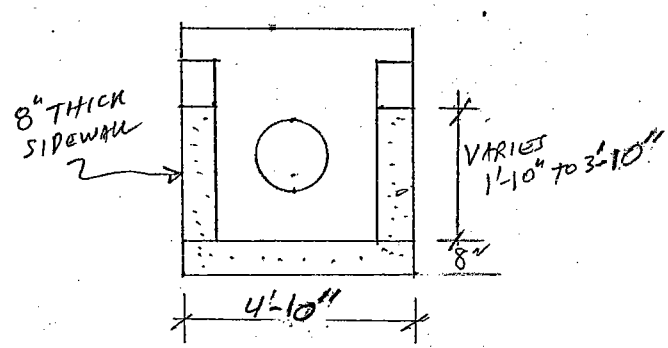
OUTLET STRUCTURE GEOMETRY



PLAN
NOT TO SCALE



SECTION A
NOT TO SCALE



NOTE: FLAP GATE NOT SHOWN FOR CLARITY

SECTION B
NOT TO SCALE

MAXIMUM SIDEWALL HEIGHT = 3'-10"

FROM EM 1110-2-2104, PARA 3-7

IF WALL HEIGHT GREATER THAN 10', HAVE TO USE MINIMUM WALL THICKNESS OF 12", WITH REINFORCEMENT IN BOTH FACES.

∴ FOR WALL HEIGHT = 3'-10", CAN USE 8" THICKNESS, IF WALL STRUCTURALLY ADEQUATE

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Project BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST.)
Job No. 2007-2154
Calculated by W. STROBACH Date 03/19/08
Checked by E. PREWITT Sheet No. 8 of 11

STA 107+00 (LB) DESIGN REINF. CONC. OUTLET STRUCTURE – 18" RCP

DETERMINE MOMENT CAPACITIES OF REINFORCED CONCRETE WALLS AND SLABS USING EM 1110-2-2104 (STRENGTH DESIGN FOR REINFORCED-CONCRETE HYDRAULIC STRUCTURES)

USE 4KSI CONCRETE
USE 60KSI REINF. STEEL

FOR CONCRETE CLEARANCES, PARAGRAPH 2-6.
EQUAL TO OR LESS THAN 12" IN THICKNESS, WILL BE IN ACCORDANCE WITH ACI 318

FORMULAE FROM EM 1110-2-2104:

EM 1110-2-2104
30 Jun 92

$$K_u = 1 - \sqrt{1 - \frac{M_n + P_n(d - h/2)}{0.425 f'_c b d^2}} \quad \text{(D-3)}$$

$$A_s = \frac{0.85 f'_c K_u b d - P_n}{f_y} \quad \text{(D-4)}$$

Table D-1

Minimum Effective Depth

f'_c (psi)	f_y (psi)	ρ^*/ρ_b	K_u	d_s (in.)
3000	60	0.25	0.125765	$\sqrt{\frac{3.3274 M_n^{**}}{b}}$
4000	60	0.25	0.125765	$\sqrt{\frac{2.4956 M_n^{**}}{b}}$
5000	60	0.25	0.118367	$\sqrt{\frac{2.1129 M_n^{**}}{b}}$

* See Section 3-5, Maximum Tension Reinforcement
** M_n units are inch-kips.

D-2

$$M_n = \frac{M_u}{\phi}$$

$$M_u = 1.7 H_f (D+L)$$

where H_f = hydraulic factor = 1.3

$$K_u = 1 - \sqrt{1 - \frac{M_n + P_n(d - \frac{h}{2})}{.425 f'_c b d^2}}$$

$$A_s = \frac{.85 f'_c K_u b d}{f_y}$$

$$\rho_b = .85 \beta_1 \frac{f'_c}{f_y}\left(\frac{87{,}000}{87{,}000 + f_y}\right)$$

$$\rho_b = .85 \times .85 \times \left(\frac{4}{60}\right)\left(\frac{87{,}000}{87{,}000 + 60{,}000}\right)$$

$$\rho_b = .0285$$

$$\rho_{max} = .75 \rho_b = .0071$$

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Project BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST.)
Job No. 2007-2154 REVISE 05/23/08
Calculated by W. STROBACH Date 05/01/08
Checked by E. PREWITT Sheet No. 9 of 11

STA 107+00 (LB) DESIGN REINF. CONC. OUTLET STRUCTURE – 18" RCP

MINIMUM REINFORCEMENT REQUIREMENTS FOR 16" THICK HEADWALL, 12" THICK KEY & 8" THICK SIDEWALLS AND SLAB.

FROM EM 1110-2-2104, PARAGRAPH 2-8 a.

AREA OF REINF. = .0028 X GROSS AREA

FOR 12" THICK WALL @ 12" SPACING (NOT USED)

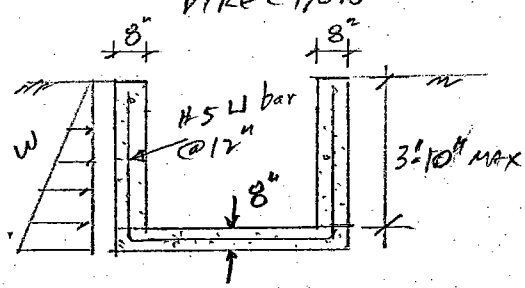
$A_s = .0028 \times 12 \times 12 = .40 \text{ in}^2$ 2-#4 = .393 in²

∴ PLACE #4 @ 12" IN EACH FACE IN EACH DIRECTION

FOR 8" THICK WALLS @ 12" SPACING

$A_s = .0028 \times 8 \times 12 = .269 \text{ in}^2$ – USE #5 = .307 in²

∴ PLACE #5 @ 12" IN CENTER OF WALL IN EACH DIRECTION



NEED TO DETERMINE IF #5 @ 12" IN CENTER OF 8" SIDEWALLS WILL LATERALLY SUPPORT EARTH LOAD, W.

FOR 16" THICK HEADWALL @ 12" SPACING

$A_s = .0028 \times 16 \times 12 = .538 \text{ in}^2$ 2-#5 = .614 in²

∴ PLACE #5 @ 12" IN EACH FACE IN EACH DIRECTION

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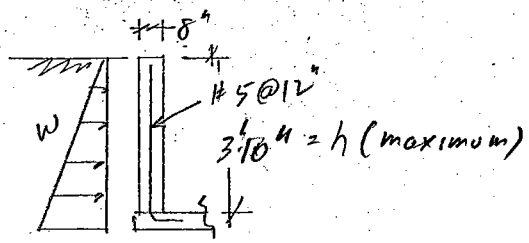
STA 107+00 (LB) DESIGN REINF. CONC. OUTLET STRUCTURE – 18" RCP

DETERMINE LOAD CARRYING CAPACITY OF #5 @12" IN 8" WALL USING EM 1110-2-2104 CRITERIA



$d = 4"$

ASSUME $W = 120^{\#}/ft^2/'$ → CONSERVATIVE → SEE GARY VANKLEUSEN MEMO, NEXT PAGE

$W_u = 1.7 H_f W$ (EQUATION 3-3 OF EM 1110-2-2104) ← HYDRAULIC FACTOR = 1.3

$\therefore W_u = 1.7 \times 1.3 \times .120 = .265\ K/ft^2/'$

$M_u = \frac{W_u h^3}{6} = \frac{.265 \times 3.833^3}{6} = 2.76K'$ 2.48

$M_n = \frac{M_u}{\phi} = \frac{2.76}{.9} = 3.07K'$

$K_u = 1 - \sqrt{1 - \frac{M_n \times 12}{.425 \times 4 \times 12 \times 4^2}} = 1 - \sqrt{1 - \frac{M_n}{27.2}}$

$K_u = 1 - \sqrt{1 - \frac{2.76}{27.2}} = .0521$

$A_s = \frac{.85 \times 4 \times K_u \times 12 \times 4}{60} = 2.72 K_u = .14 in^2 < .307 in^2$ OK (#5@12")

FLEXURAL BENDING STRESSES OK

CHECK SHEAR

MAX SHEAR IN WALL IS AT TOP OF BASE SLAB

$V_u = \frac{W_u h^2}{2} = \frac{.265 \times 3.833^2}{2} = 1.95 K_{ips}$ (ACTUAL)

FOR SHEAR, CAN'T USE EM 1110-2-2104 BECAUSE LOAD NOT UNIFORM AND WALL DOESN'T SPAN BETWEEN SUPPORTS ∴ USE ACI 318-05

EQ (11-1) $\phi V_n \geq V_u$ $V_n = V_c + \cancel{V_s}$ NO SHEAR STEEL $\phi_{shear} = .75$ (9.3.2.3)

(11-3) $V_c = 2\sqrt{f'_c}\, bwd$

$V_c = 2\sqrt{4000} \times 12 \times 4 = 6{,}077^{\#} = 6.07K$

$\phi V_c = .75 \times 6.07 = 4.55 K_{ips} > 1.95 K_{ips}$ ∴ Shear is OK

Gary J. Van Riessen, P.E.
A Professional Corporation
Consulting Geotechnical Engineer
230 SW Main Street, Suite 206
Lee's Summit, Missouri 64063
816.272.5590(Office) 816.830.6576 (Cell)
816.272.5510 (Facsimile)

Facsimile transmittal

To:	Bill Strobach Norton &Schmidt	**Fax:**	816.421.1956
From:	Gary J. Van Riessen, P.E.	**Date:**	March 19, 2008
Re:	Lateral Earth Pressures Outlet Structure @ 18" CMP Channel Improvements Brush Creek to 53rd Street	**Pages:**	1
CC:			

( ) Urgent X For Review ( ) Please Comment ( ) Please Reply ( ) Please Recycle

Notes: Pursuant to your electronic request of March 12, 2008, the proposed use of a lateral earth pressure equal to 120 pounds/square foot/foot is reasonable, if not slightly conservative. Typically, a submerged at-rest earth pressure would be roughly equal to 30-35 pounds/square foot/foot for buoyant soil plus 62.4 pounds/square foot/foot for the water pressure, yielding a total earth pressure of approximately 95 pounds/square foot/foot.

Contact this office with any questions.

Regards,

Gary J. Van Riessen, P.E.

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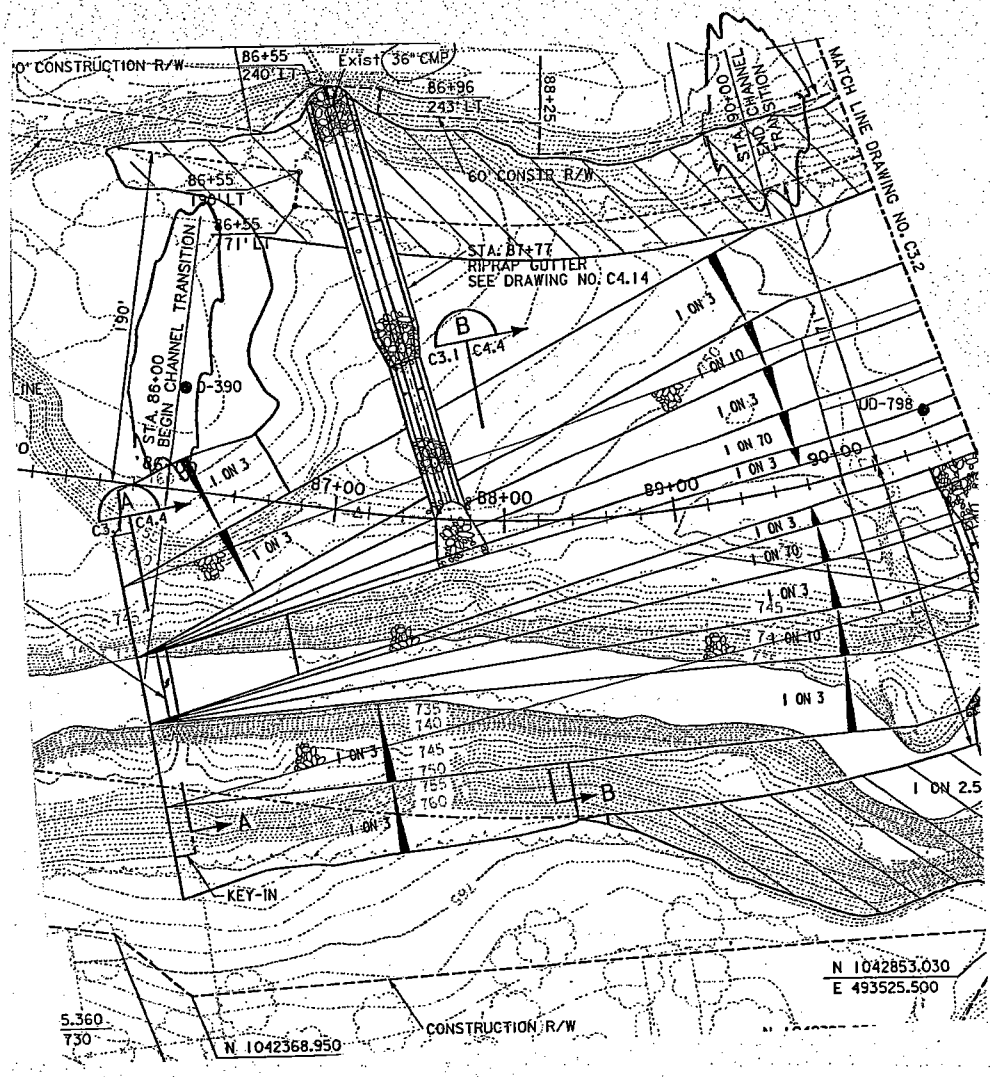
BLUE RIVER CHANNEL MODIFICATIONS
Project (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/15/08
Checked by E. PREWITT Sheet No. 1 of 8

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)
DESIGN SHEET PILE WALL (UPSTREAM)
INFO FROM 35% PLAN SET



PLAN SHEET 3.1

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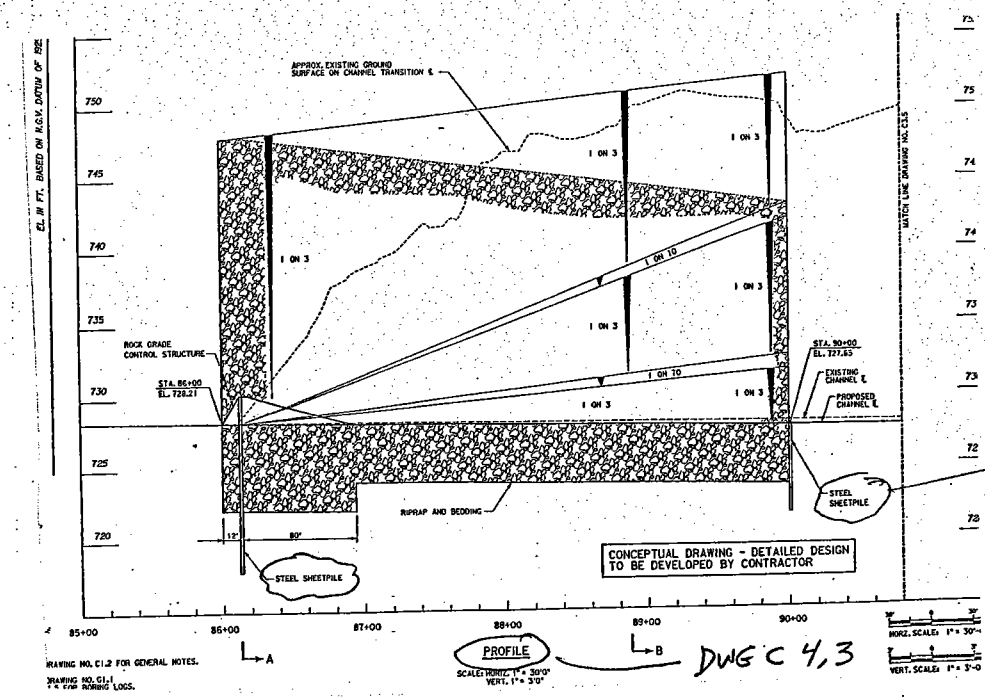
Project BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/15/08
Checked by E. PREWITT Sheet No. 2 of 8

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

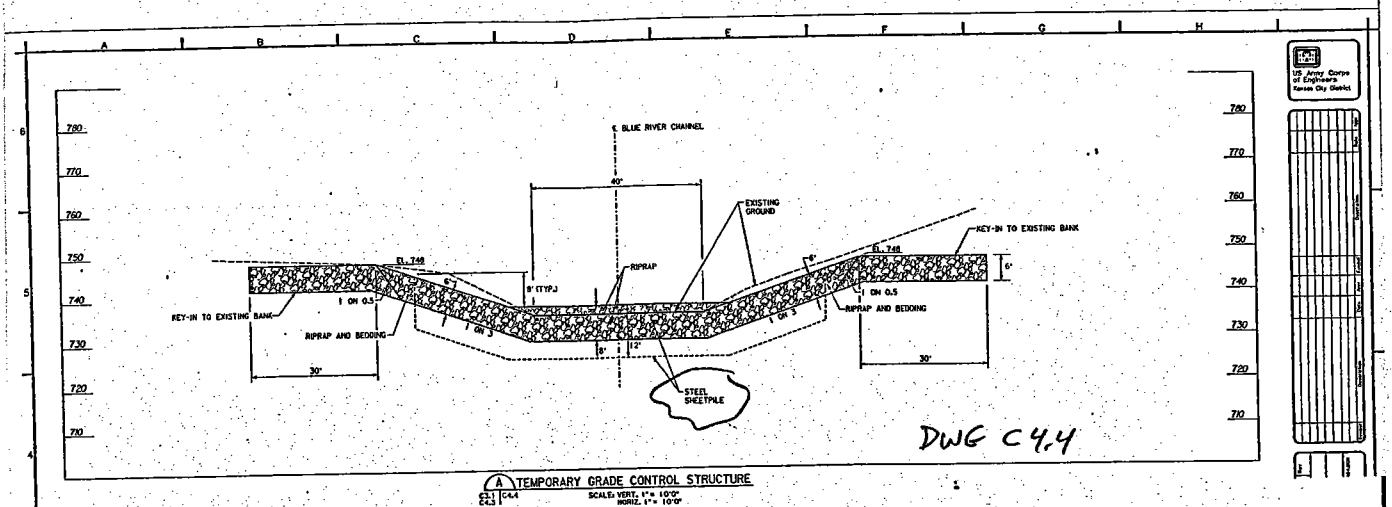
DESIGN SHEET PILE WALL (UPSTREAM)

INFO FROM 35% PLAN SET



PER HDR, 07/15/08 DOWNSTREAM SHEET PILING WILL NOT BE USED FOR FINAL DESIGN

DWG C 4.3



DWG C 4.4

A TEMPORARY GRADE CONTROL STRUCTURE
C3.1 C4.4
SCALE: VERT. 1" = 10'0" HORIZ. 1" = 10'0"

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Checked by E. PREWITT Sheet No. 3 of 8

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

APPLICABLE COE DESIGN CRITERIA:

DESIGN OF SHEET PILE WALL EM 1110-2-2504

IN REVIEWING THIS DOCUMENT, THERE ARE NO LOADING CASES SHOWN FOR THE DESIGN OF THE SHEET PILE WALL USED FOR THIS TYPE OF TEMPORARY GRADE CONTROL STRUCTURE.

IN FACT, THERE IS NO COE CRITERIA FOR THE DESIGN OF SHEET PILE WALL USED FOR THIS TYPE OF TEMPORARY GRADE CONTROL STRUCTURE.

ON 01/25/08, I CALLED THE KANSAS CITY DISTRICT COE OFFICE AND TALKED TO CHARLEY DETRICK (GEOTECH. ENGR) AND SIV SIVAKUMAR (STRUCTURAL SECTION CHIEF) AND THEY DID NOT OF KNOW ANY SUCH DESIGN CRITERIA EITHER.

SIV SAID THAT THE OMAHA DISTRICT COE OFFICE DESIGNED THE SHEET PILE WALLS ON L-385, AND SUGGESTED THAT I CALL THEM.

CHARLEY SUGGESTED THAT I CALL OUR DESIGN REVIEWER. IN LIEU OF THIS APPROACH, DECIDED TO DEVELOPE LOAD CASES BASED ON ENGINEERING JUDGEMENT. THIS METHODOLOGY WAS APPROVED IN THE DESIGN VERIFICATION MEMORANDUM

2.3. Temporary Grade Control Structure

2.3.4 Applicable design criteria
The applicable design criteria include the following USACE and Engineer Manuals as listed below.

- Slope Stability EM 1110-2-1902
- Geotechnical Investigations EM 1110-1-1804
- Laboratory Soil Testing EM 1110-2-1906
- Design of Sheet Pile Wall EM 1110-2-2504
- Hydraulic Design for Flood Control Channel EM 1110-2-1601

The design criteria provided in Blue River Channel Modifications Brush Creek to 53rd Street, Jackson County, Construction Specifications are summarized below.

- Rock for riprap should be sized to maintain stability and prevent excessive scour for flows up to and including 44,500 cfs and upstream end of transition should be designed to prevent failure by flanking. ← SPEC 1 11 02-4, PARA 3.3 i
- Steel sheetpile cutoff wall should be designed for stability up to 44,500 cfs. It appears that there is no USACE design document that specifically addresses the loading cases imposed on the steel sheet pile cutoff wall for this type of temporary grade control structure. Loading cases will be developed based on engineering judgement. ←

BLUE RIVER CHANNEL MODIFICATIONS

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CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

LOADING CASES TO BE USED BASED ON GARY VAN RIESSEN'S (GEOTECH ENGR) SUGGESTIONS:

From: Gary VanRiessen [mailto:gary.vanriessen@sbcglobal.net]
Sent: Friday, January 25, 2008 9:59 AM
To: Bill Strobach
Subject: Re: Blue River Channel Modifications (Brush Creek to 53rd St.)-Temporary Grade Control Struct.

Generally, I would suggest the use of active/passive earth pressure coefficients based on a minimum angle of internal friction of 35 degrees. (ROCK), USE 20 DEGREES FOR SOIL. ← FROM GVR 07/15/08

I would also suggest the following loading conditions based on a sequential evaluation process.

Condition 1 @ Low Flow
Use differential pressure roughly equivalent to 2 feet of water head.

Condition 2 @ Intermediate Flow/Partial Pool
Use differential pressure derived from scour of two feet of riprap on downstream side of sheetpile and hydro-dynamic/water flow pressures applied on upstream side of sheetpile.

Condition 3 - Maximum Flood Condition
Similar to Condition 2, but with reduced magnitude of pressures due to water flow. I suspect that this condition really exhibits low probability/concern because of the depth of water over the control structure.

Condition 4 - Post Flood and Post Scour
Similar to Condition 1, but with differential pressure equivalent to 2 feet of water head and 2 feet of riprap.
hope this helps.

Regards,

Gary J. Van Riessen, P.E.

Assume $W_{ROCK \& SOIL} = 120\ \#/ft^3$ (MOIST), $(120-62.4) = 57.6\ \#/ft^3$ (SUBMERG)

$P_{ACTIVE\ ROCK_{SUBM}} = 57.6 \times .271 + 62.4 = 78\ \#/ft^2/'$

$P_{PASSIVE\ ROCK_{SUBM}} = 57.6 \times 3.69 + 62.4 = 275\ \#/ft^2/'$

$\tan\phi = 35°$ (ROCK)

$Ka_R = \tan^2(45° - \frac{\phi}{2}) = .271$

$Kp_R = \tan^2(45° + \frac{\phi}{2}) = 3.69$

$\tan\phi = 20°$ (SOIL)

$Ka_s = \tan^2(45° - \frac{\phi}{2}) = .490$

$Ka_r = \tan^2(45° + \frac{\phi}{2}) = 2.04$

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BLUE RIVER CHANNEL MODIFICATIONS

Project (BRUSH CREEK TO 53rd ST)

Job No. 2007-2154

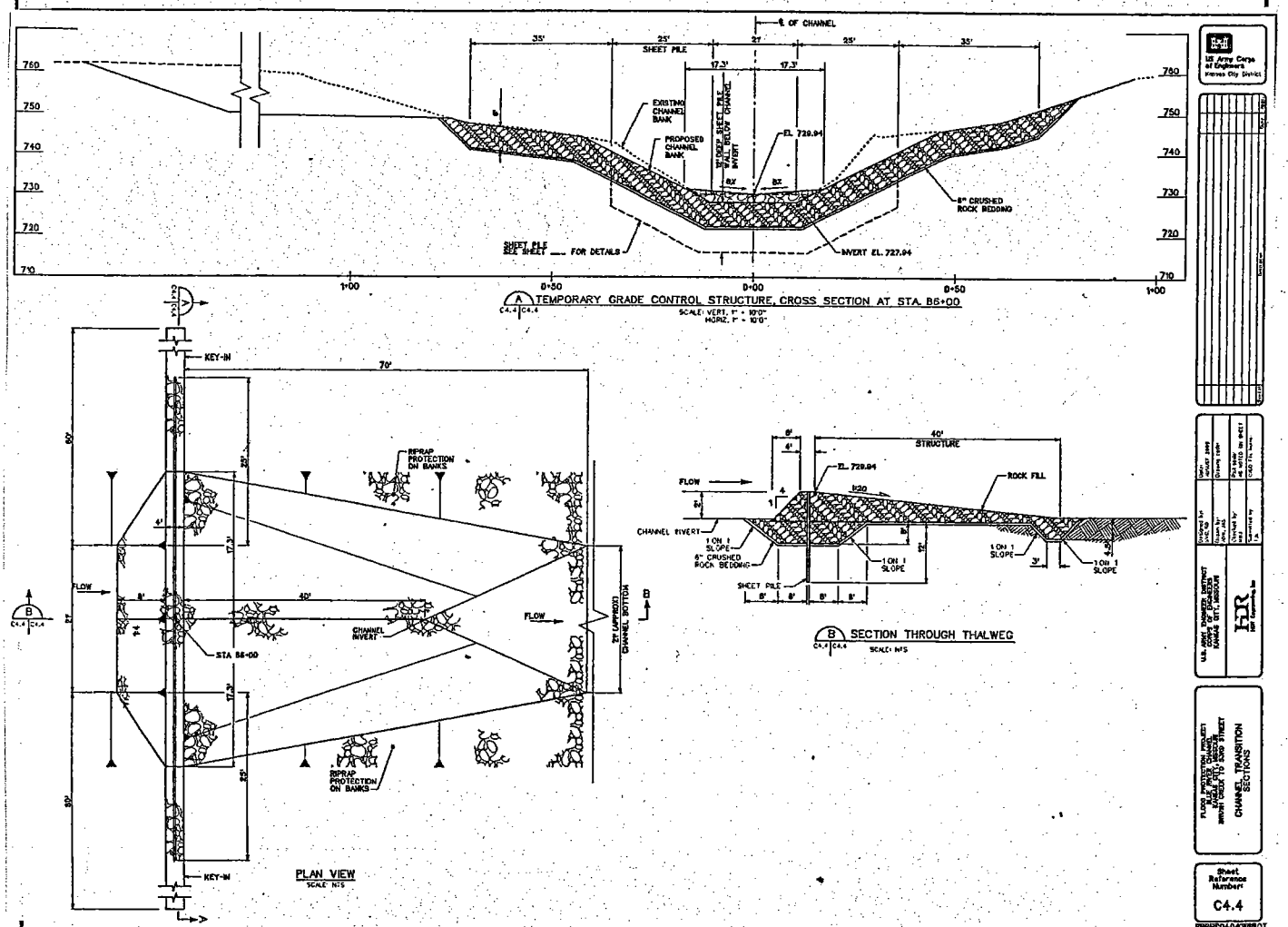
Calculated by W. STROBACH Date 07/21/08

Checked by E. PREWITT Sheet No. 5 of 8

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

INFO FROM HDR



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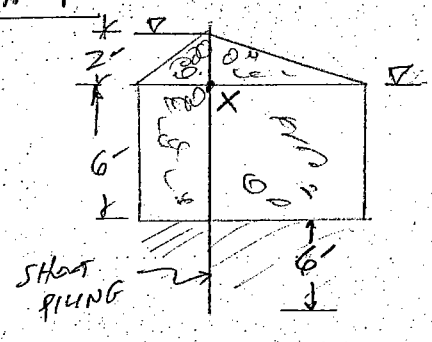
Project: BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/21/08
Checked by E. PREWITT Sheet No. 6 of 8

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

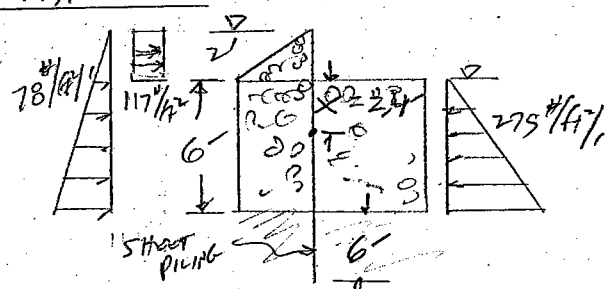
CONDITION 1



2' DIFFERENTIAL WATER HEAD
ASSUME ROCK & SOIL LOADS COUNTER BALANCE EACH OTHER

$$\text{MAX MOMENT}_x = \frac{wh^3}{6} = \frac{62.4 \times 2^3}{6} = 83.3\ \text{\#/ft}$$
LOW

CONDITION 2



2' DIFFERENTIAL WATER HEAD
ASSUME WATER VELOCITY = 11'/SEC (CONSERVATIVE)

$$\text{HYDRODYNAMIC FORCE} = \frac{V^2}{2g} \times 62.4 = 117\ \text{\#/ft}^2$$

2' ROCK SCOURED OUT DOWNSTREAM OF SHEET PILING

2.9' ?

MAX MOMENT IN SHEET PILING OCCURS WHERE V = 0, at x

$$117(2) + \frac{78(2+x)^2}{2} = \frac{275(x)^2}{2}, \quad x = 2.4'$$

989 ≈ 792

$$\text{MAX MOMENT} = 117 \times 2 \times (2.4+1) + \frac{78 \times 4.4^3}{6} - \frac{275 \times 2.4^3}{6}$$

$$= 796\ \text{\#ft} + 1107\ \text{\#ft} - 634\ \text{\#ft} = 1269\ \text{\#ft}$$

913 1529 1118 1324 ✓

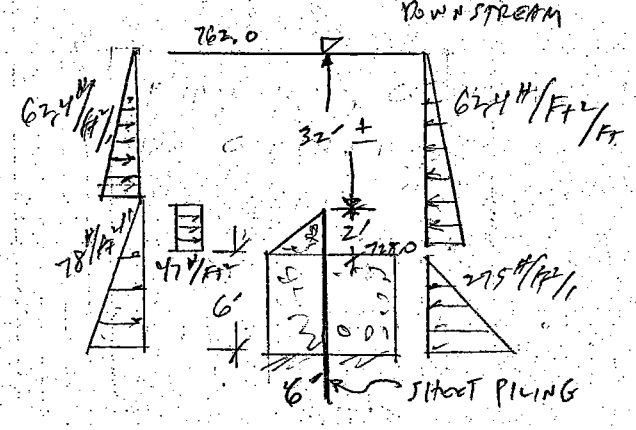
1209 ≈ 1238
1170 1156

CONDITION 3 (50 YR FLOOD DESIGN FLOW) NO HYDRAULIC JUMP, NO DIFFERENTIAL WATER HEAD

AT DESIGN FLOW, VELOCITIES AT SHEET PILE = 7'/SEC

2' ROCK SCOURED OUT DOWNSTREAM

$$\text{HYDRODYNAMIC FORCE} = \frac{V^2}{2g} \times 62.4 = 47\ \text{\#/ft}^2$$



BY INSPECTION, CONDITION 2 IS A WORSE LOADING CONDITION THAN CONDITION 3

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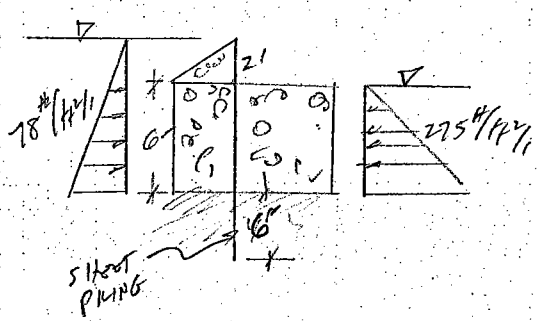
CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

CONDITION 4

2' DIFFERENTIAL WATER HEAD
+2' ROCK SCOURED ON DOWNSTREAM SIDE



THIS LOADING CONDITION NOT CONTROL EITHER BECAUSE NOT AT SEVERE AS CONDITION 2

DEPTH OF SHEET PILING OK BY INSPECTION

∴ MAXIMUM MOMENT IN SHEET PILING = 1269#/ft

CALL MIKE JONES OF HAMMER & STEEL CO (913-681-9295)

HE REFERRED ME TO CHAPARRAL STEEL WEBSITE @ WWW.SHEET-PILING.COM

RECOMMENDED USE OF PZC 13 SHEET PILING, $Z = 24.2 in^3/ft$ (SEE NEXT SHEET)

$S = \frac{M}{Z} = \frac{1269 \times 12}{24.2} = 629$ PSI VERY LOW $\frac{1324 \times 12}{24.2} = 657$ PSI OK

BUT PZC 13 IS THE MOST ECONOMICAL SHEET PILE SECTION FOR THIS APPLICATION @ 24.7#/ft² ← USE

THE SMALLEST FLAT SHEET SECTION PS 27.5 WEIGHS 27.5#/ft²
$Z = 1.9 in^3/ft$

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BLUE RIVER CHANNEL MODIFICATIONS
Project (BRUSH CREEK TO 53rd ST)
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CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)
DESIGN SHEET PILE WALL (UPSTREAM)

CHAPARRAL
SHEET PILING PROPERTIES

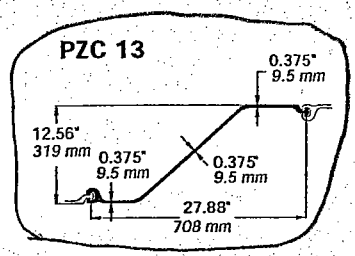
PZC

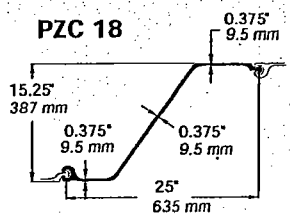
NOT MFG'D YET

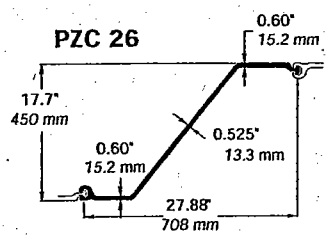
USE (AVAILABLE)

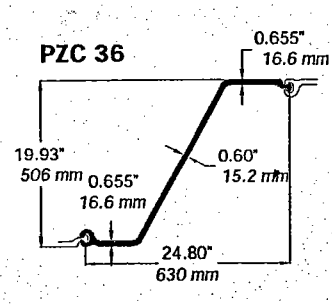
Section	Section Modulus* in.³/ft (cm³/m)	Nominal Width in. (mm)	Weight* lbs/ft² (kg/m²)	Moment of Inertia* in.⁴/ft (cm⁴/m)
PZC 12	22.3	27.88	20.0	139.7
	1,200	708	97.6	19,080
PZC 13	24.2	27.88	21.7	152.0
	1,300	708	106.0	20,755
PZC 14	26.0	27.88	23.7	164.3
	1,400	708	115.5	22,445
PZC 17	31.0	25.00	22.3	236.1
	1,670	635	108.8	32,235
PZC 18	33.5	25.00	24.2	255.5
	1,800	635	118.2	34,890
PZC 19	36.1	25.00	26.4	276.6
	1,945	635	128.8	37,780
PZC 25	45.7	27.88	29.9	404.1
	2,455	708	145.9	55,190
PZC 26	48.4	27.88	31.8	428.1
	2,600	708	155.4	58,460
PZC 28	51.3	27.88	34.0	455.1
	2,755	708	166.1	62,145
PZC 34	63.8	24.80	37.5	634.8
	3,430	630	183.2	86,685
PZC 36	67.0	24.80	39.6	667.4
	3,600	630	193.2	91,140
PZC 38	70.7	24.80	42.0	706.3
	3,800	630	205.1	96,450

*Per Unit of Wall









PZ

Section	Section Modulus* in.³/ft (cm³/m)	Nominal Width in. (mm)	Weight* lbs/ft² (kg/m²)	Moment of Inertia* in.⁴/ft (cm⁴/m)
PZ 22	18.4	22.00	22.6	85.1
	990	559	110.6	11,620
PZ 27	31.0	18.00	27.7	187.3
	1,660	457	135.1	25,580
PZ 35	48.9	22.64	35.0	369.5
	2,635	575	170.8	50,455
PZ 40	61.3	19.69	40.0	502.7
	3,300	500	195.2	68,645

*Per Unit of Wall

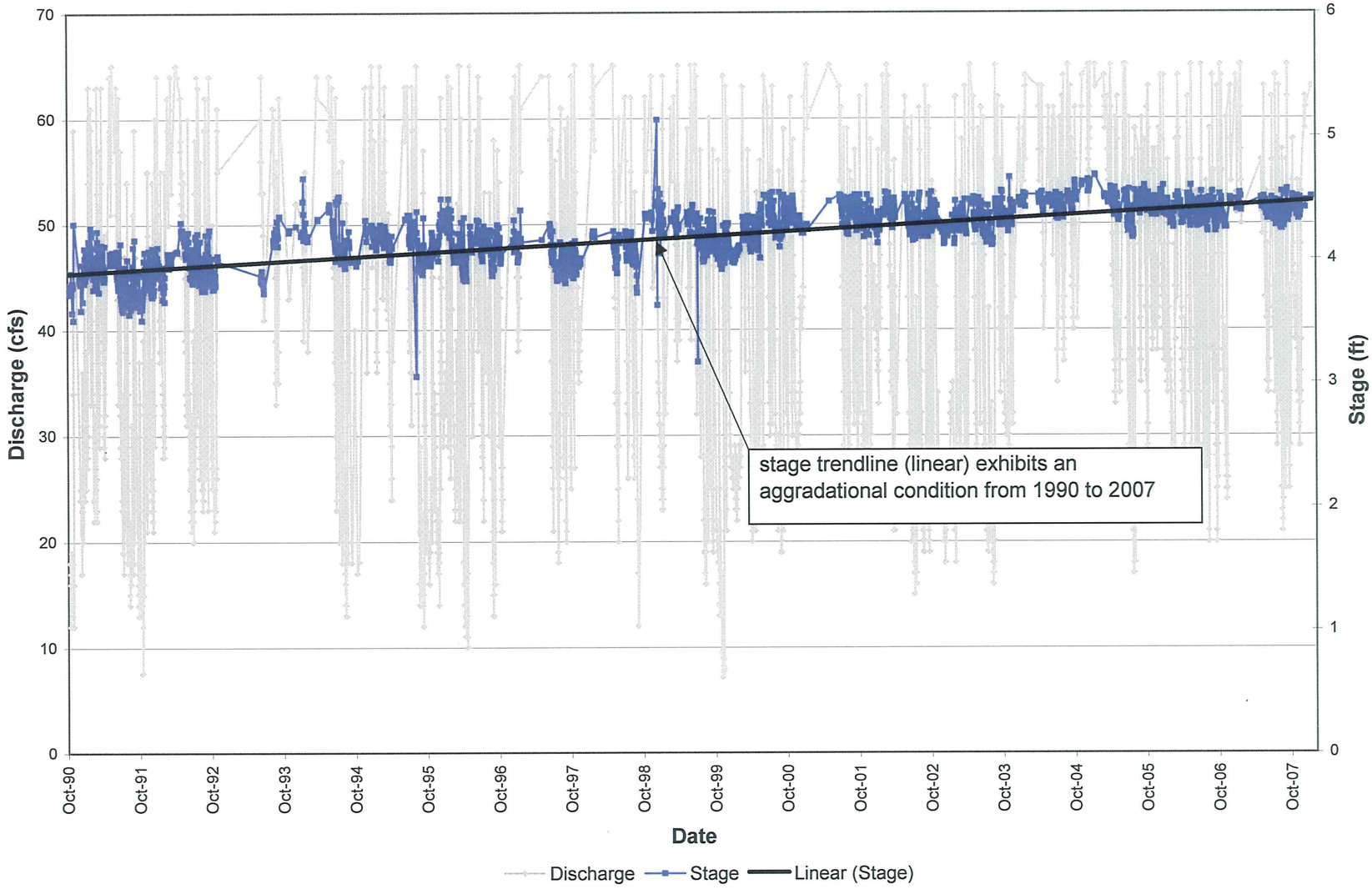
PZ sheet piling is a traditional sheet piling profile produced in North America. These sections are named for weight. For example, PZ 35 weighs 35 pounds per square foot of wall.

PZC sections are the "latest generation" of sheet piling profiles and were developed to be lighter, wider, and stronger than the older traditional PZ sections. PZC profiles are named for their strength in metric designations. For example, PZC 18 has a Section Modulus of 1,800 cm³/meter. **PZC profiles should always be the designer's first choice in order to provide the end user the most efficient retention wall with the most efficient ratio of section modulus to weight.**

GRADE 50 IS THE MOST COMMON STEEL STRENGTH THAT THESE SHEET PILE SECTIONS COME IN

HYDRAULIC - CALCULATIONS

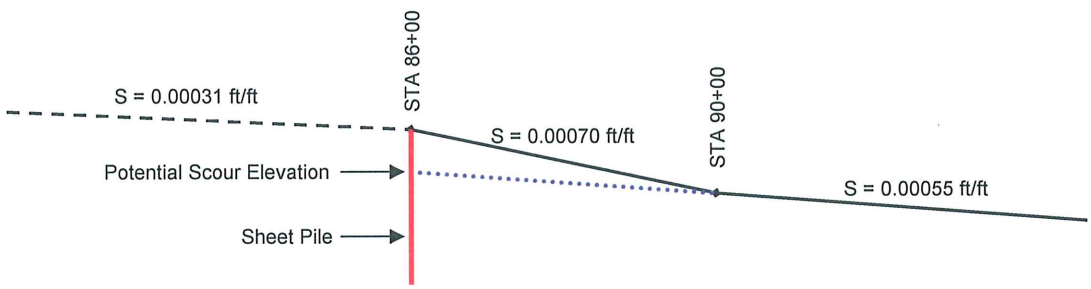
Figure E.3.1: USGS Stream Gage 06893500
Daily Stage and Discharge Data for Discharges <= 65 cfs (median)
Blue River at E. 95th Street, Kansas City, MO



Transitionary channel grading begins at STA 86+00
Existing channel flowline elevation = 728.21 feet

Transitionary channel grading ends at STA 90+00
Proposed channel flowline elevation = 727.93 feet

Design channel slope is 0.00055 ft/ft
FEMA Flood Insurance Study shows bed slope of approximately 0.00031 ft/ft (natural streambed slope)



The channel may be expected to scour to an equilibrium bed slope.
If station 90+00 is assumed as the fixed point then:
If the equilibrium slope = 0.00055 ft/ft, then the potential scour elevation at 86+00 = 728.15 feet
If the equilibrium slope = 0.00031 ft/ft, then the potential scour elevation at 86+00 = 728.05 feet
Based on results from Table E.3.1:
If the equilibrium slope = 0.00000005 ft/ft, then the potential scour elevation at 86+00 = 727.93 feet
If the equilibrium slope = 0.00000034 ft/ft, then the potential scour elevation at 86+00 = 727.93 feet
If the equilibrium slope = 0.00009081 ft/ft, then the potential scour elevation at 86+00 = 727.97 feet
Based on results from Table E.3.2:
If the equilibrium slope = 0.00000001 ft/ft, then the potential scour elevation at 86+00 = 727.93 feet
If the equilibrium slope = 0.00000157 ft/ft, then the potential scour elevation at 86+00 = 727.93 feet
If the equilibrium slope = 0.00010292 ft/ft, then the potential scour elevation at 86+00 = 727.97 feet
If the existing sheet pile in the vicinity os Stanely Palmer Engineering is assumed as a fixed point then:
Approximate streambed elevation at the existing sheet pile in the vicinity of Stanely Palmer Engineering is 724.20 feet.
If the equilibrium slope = 0.00 ft/ft, then the potential scour elevation at 86+00 = 724.20 feet
This elevation will be the potential scour elevation under the worest case conditions.

Table E.3.1: Estimation of equilibrium slope using equation 6.18, HEC-20

Parameter	Description	Clay Loam	Sand	Gravel
K_s	Shields parameter[1]	0.047	0.047	0.047
D_c (feet)	critical bed material size (use D_{90})[2]	0.000164	0.00066	0.032808
γ_s	specific weight of sediment[3]	62.4	62.4	62.4
γ	specific weight of water	62.4	62.4	62.4
K_u	constant	1.486	1.486	1.486
q (50-yr)	channel discharge per unit width[4]	122	122	122
n	Manning's roughness	0.03	0.03	0.03
S_{eq} (ft/ft)	equilibrium slope	0.00000005	0.00000034	0.00009081

Notes:
1. Estimated using guidance described in EM 1110-2-1418.
2. D_{90} is estimated based on the guidance provided in "Estimating Particle-Size Distribution from Limited Soil Texture Data" (see references).
3. Assumed Value.
4. 50-year unit discharge is computed at station 95+90.

Table E.3.2: Estimation of equilibrium slope using equation 6.19, HEC-20

Parameter	Description	Clay Loam	Sand	Gravel
K_u	constant	60.1	60.1	60.1
D_{50} (feet)	material size passing 50%[1]	0.000033	0.00033	0.016404
D_{90} (feet)	material size passing 90%[1]	0.000164	0.00066	0.032808
n	Manning's roughness	0.03	0.03	0.03
q (50-yr)	channel discharge per unit width[2]	122	122	122
S_{eq} (ft/ft)	equilibrium slope	0.00000010	0.00000157	0.00010292

Notes:
1. D_{90} and D_{50} are estimated based on the guidance provided in "Estimating Particle-Size Distribution from Limited Soil Texture Data" (see references).
2. 50-year unit discharge is computed at station 95+90.

STRUCTURAL - CALCULATIONS

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BLUE RIVER CHANNEL MODIFICATIONS

Project (BRUSH CREEK TO 53rd ST)

Job No. 2007-2154

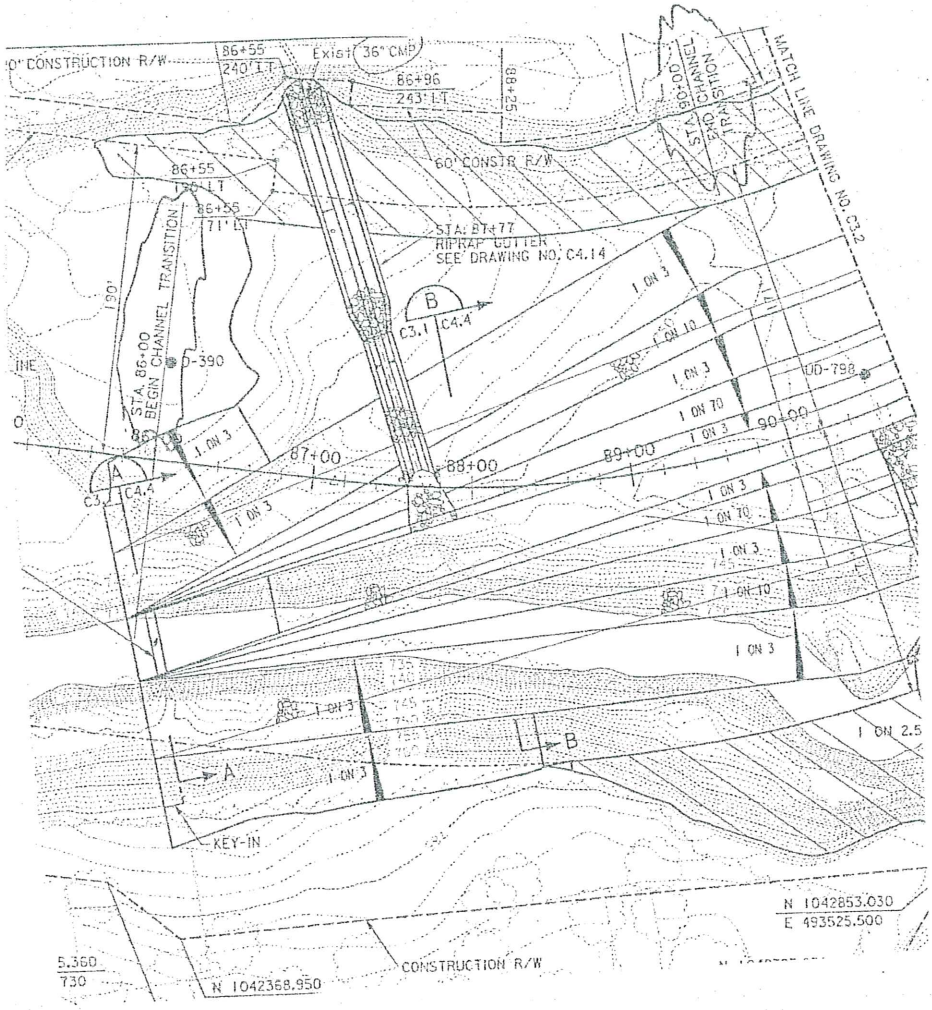
Calculated by W. STROBACH Date 07/15/08

Checked by _____ Sheet No. 1 of _____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

INFO FROM 35% PLAN SET



PLAN SHEET 3.1

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BLUE RIVER CHANNEL MODIFICATIONS

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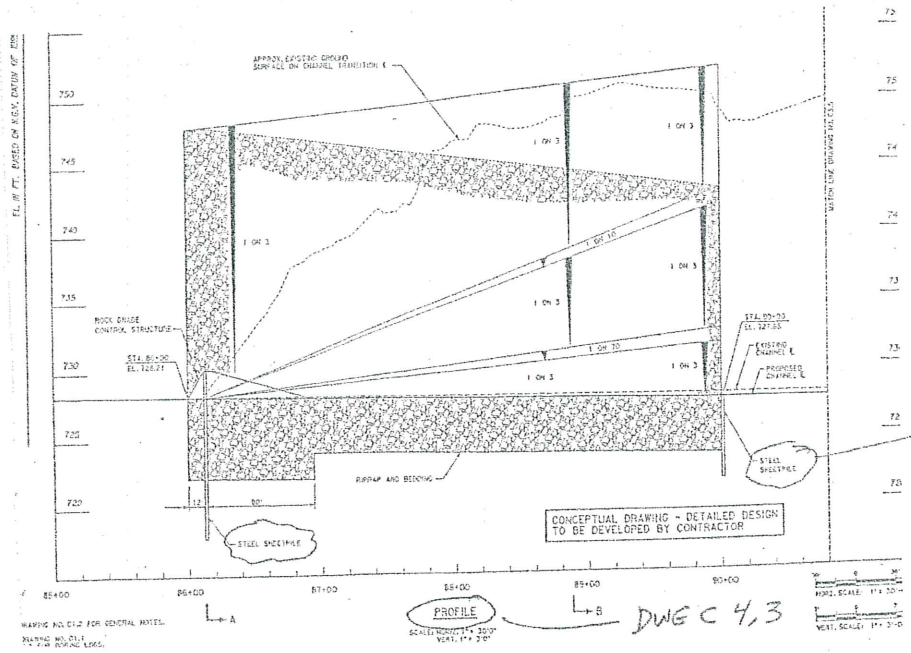
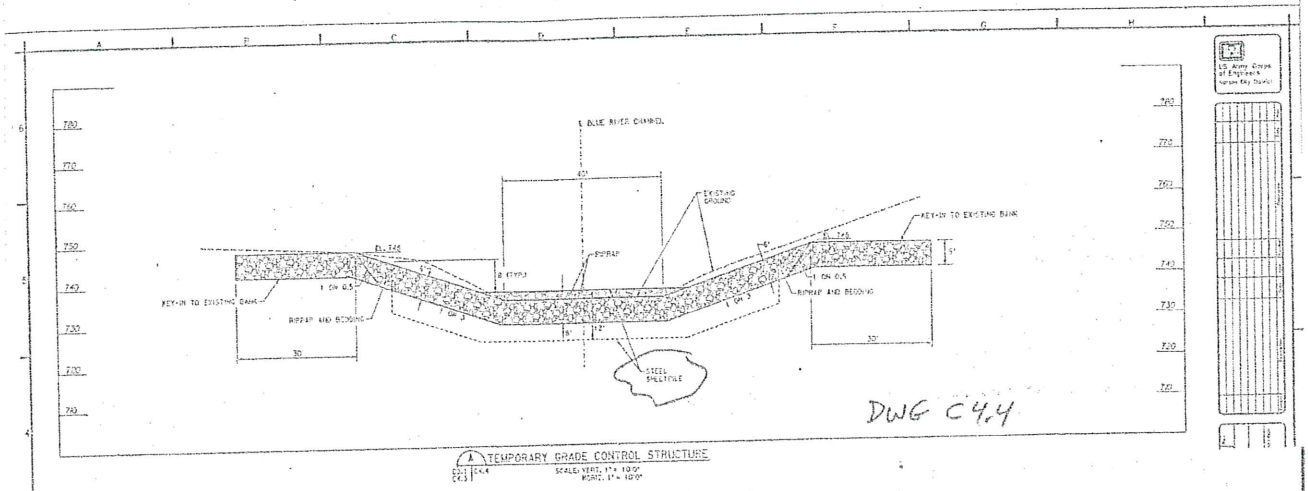
CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

INFO FROM 35% PLAN SET



PER HDR, 07/15/08 DOWNSTREAM SHEET PILING WILL NOT BE USED FOR FINAL DESIGN



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Project BLUE RIVER CHANNEL MODIFICATIONS (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/15/08
Checked by _____ Sheet No. 3 of _____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

APPLICABLE COE DESIGN CRITERIA:

DESIGN OF SHEET PILE WALL EM 1110-2-2504

IN REVIEWING THIS DOCUMENT, THERE ARE NO LOADING CASES SHOWN FOR THE DESIGN OF THE SHEET PILE WALL USED FOR THIS TYPE OF TEMPORARY GRADE CONTROL STRUCTURE.

IN FACT, THERE IS NO COE CRITERIA FOR THE DESIGN OF SHEET PILE WALL USED FOR THIS TYPE OF TEMPORARY GRADE CONTROL STRUCTURE.

ON 01/25/08, I CALLED THE KANSAS CITY DISTRICT COE OFFICE AND TALKED TO CHARLEY DETRICK (GEOTECH. ENGR) AND SIV SIVAKUMAR (STRUCTURAL SECTION CHIEF) AND THEY DID NOT OF ANY SUCH DESIGN CRITERIA EITHER.

SIV SAID THAT THE OMAHA DISTRICT COE OFFICE DESIGNED THE SHEET PILE WALLS ON L-385, AND SUGGESTED THAT I CALL THEM.

CHARLEY SUGGESTED THAT I CALL OUR DESIGN REVIEWER. IN LIEU OF THIS APPROACH, DECIDED TO DEVELOPE LOAD CASES BASED ON ENGINEERING JUDGEMENT. THIS METHODOLOGY WAS APPROVED IN THE DESIGN VERIFICATION MEMORANDUM

2.3. Temporary Grade Control Structure

2.3.4 Applicable design criteria
The applicable design criteria include the following USACE and Engineer Manuals as listed below.

- Slope Stability EM 1110-2-1902
- Geotechnical Investigations EM 1110-1-1804
- Laboratory Soil Testing EM 1110-2-1906
- Design of Sheet Pile Wall EM 1110-2-2504
- Hydraulic Design for Flood Control Channel EM 1110-2-1601

The design criteria provided in Blue River Channel Modifications Brush Creek to 53rd Street, Jackson County, Construction Specifications are summarized below.

- Rock for riprap should be sized to maintain stability and prevent excessive scour for flows up to and including 44,500 cfs and upstream end of transition should be designed to prevent failure by flanking. ← SPEC 1 11 02-4, PARA 3.3.L
- Steel sheetpile cutoff wall should be designed for stability up to 44,500 cfs. It appears that there is no USACE design document that specifically addresses the loading cases imposed on the steel sheet pile cutoff wall for this type of temporary grade control structure. Loading cases will be developed based on engineering judgement. ←

BLUE RIVER CHANNEL MODIFICATIONS

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Project (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/15/08
Checked by _____ Sheet No. 4 of _____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)
LOADING CASES TO BE USED BASED ON GARY VAN RIESSEN'S (GEOTECH ENGR) SUGGESTIONS:

From: Gary VanRiessen [mailto:gary.vanriessen@sbcglobal.net]
Sent: Friday, January 25, 2008 9:59 AM
To: Bill Strobach
Subject: Re: Blue River Channel Modifications (Brush Creek to 53rd St.)-Temporary Grade Control Struct.

Generally, I would suggest the use of active/passive earth pressure coefficients based on a minimum angle of internal friction of 35 degrees. (ROCK), USE 20 DEGREES FOR SOIL. ← FROM GVR 07/15/08

I would also suggest the following loading conditions based on a sequential evaluation process.

Condition 1 @ Low Flow
Use differential pressure roughly equivalent to 2 feet of water head.

Condition 2 @ Intermediate Flow/Partial Pool
Use differential pressure derived from scour of two feet of riprap on downstream side of sheetpile and hydro-dynamic/water flow pressures applied on upstream side of sheetpile.

Condition 3 - Maximum Flood Condition
Similar to Condition 2, but with reduced magnitude of pressures due to water flow. I suspect that this condition really exhibits low probability/concern because of the depth of water over the control structure.

Condition 4 - Post Flood and Post Scour
Similar to Condition 1, but with differential pressure equivalent to 2 feet of water head and 2 feet of riprap.
hope this helps.

Regards,

Gary J. Van Riessen, P.E.

Assume $W_{ROCK\ \&\ SOIL} = 120\ \#/ft^3$ (MOIST), $(120-62.4) = 57.6\ \#/ft^3$ (SUBMERG)

$P_{ACTIVE\ ROCK\ SUBM} = 57.6 \times .271 + 62.4 = 78\ \#/ft^2/'$

$P_{PASSIVE\ ROCK\ SUBM} = 57.6 \times 3.69 + 62.4 = 275\ \#/ft^2/'$

$\tan\phi = 35°$ (ROCK)
$Ka_R = \tan^2(45° - \frac{\phi}{2}) = .271$
$Kp_R = \tan^2(45° + \frac{\phi}{2}) = 3.69$
$\tan\phi = 20°$ (SOIL)
$Ka_s = \tan^2(45° - \frac{\phi}{2}) = .490$
$Ka_r = \tan^2(45° + \frac{\phi}{2}) = 2.04$

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BLUE RIVER CHANNEL MODIFICATIONS

Project (BRUSH CREEK TO 53rd ST)

Job No. 2007-2154

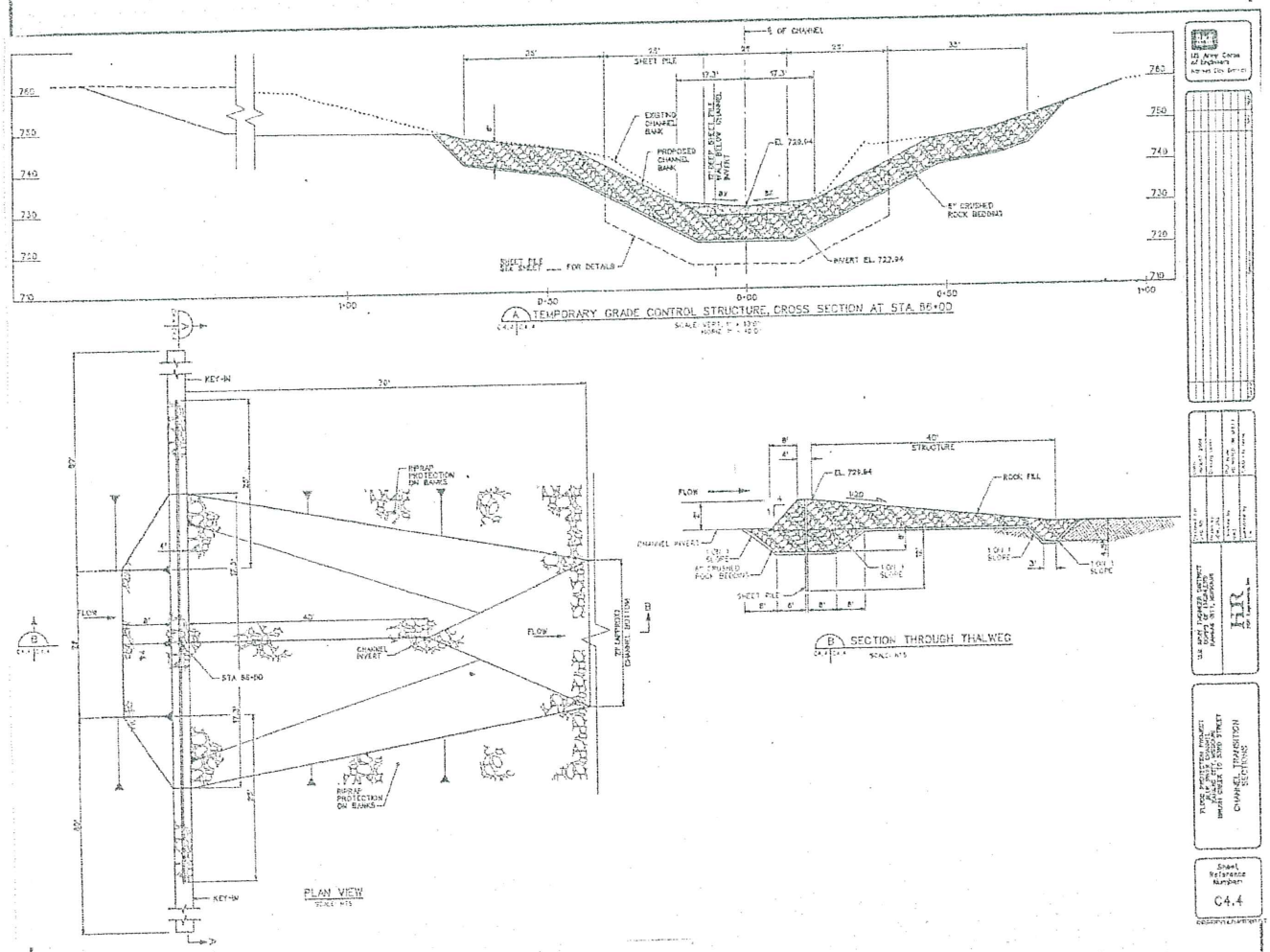
Calculated by W. STROBACH Date 07/21/08

Checked by _____ Sheet No. 5 of _____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

INFO FROM HDR



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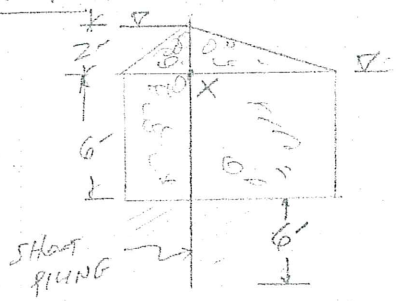
BLUE RIVER CHANNEL MODIFICATIONS
Project (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/21/08
Checked by _____ Sheet No. 6 of _____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

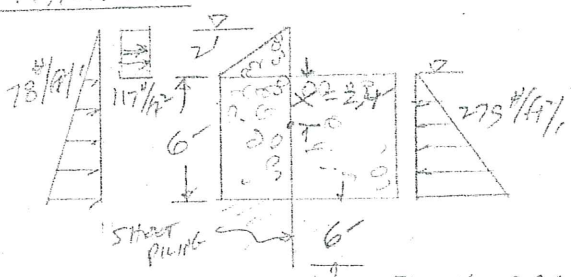
CONDITION 1



2' DIFFERENTIAL WATER HEAD
ASSUME ROCK & SOIL LOADS COUNTER BALANCE EACH OTHER

$$\text{MAX MOMENT}_X = \frac{wh^3}{6} = \frac{62.4 \times 2^3}{6} = 83.3\ \text{\#/ft LOW}$$

CONDITION 2



2' DIFFERENTIAL WATER HEAD
ASSUME WATER VELOCITY = 11'/SEC (CONSERVATIVE)

$$\text{HYDRODYNAMIC FORCE} = \frac{V^2}{2g} \times 62.4 = 117\ \text{\#/ft}^2$$

2' ROCK SCOURED OUT DOWNSTREAM OF SHEET PILING

MAX MOMENT IN SHEET PILING OCCURS WHERE V = 0, at X

$$117(2) + \frac{78(2+x)^2}{2} = \frac{275(x)^2}{2}, \quad x = 2.4'$$

$$\text{MAX MOMENT} = 117 \times 2 \times (2.4+1) + \frac{78 \times 4.4^3}{6} - \frac{275 \times 2.4^3}{6}$$

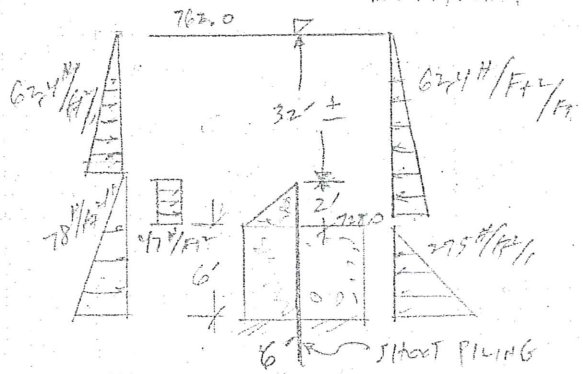
$$= 796\ \text{\#ft} + 1107\ \text{\#ft} - 634\ \text{\#ft} = 1269\ \text{\#ft}$$

CONDITION 3 (50YR FLOOD DESIGN FLOW) NO HYDRAULIC JUMP, NO DIFFERENTIAL WATER HEAD

AT DESIGN FLOW, VELOCITIES AT SHEET PILE = 7'/SEC

2' ROCK SCOURED OUT DOWNSTREAM

$$\text{HYDRODYNAMIC FORCE} = \frac{V^2}{2g} \times 62.4 = 47\ \text{\#/ft}^2$$



BY INSPECTION, CONDITION 2 IS A WORSE LOADING CONDITION THAN CONDITION 3

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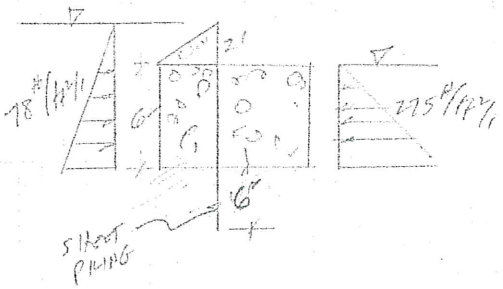
BLUE RIVER CHANNEL MODIFICATIONS
Project (BRUSH CREEK TO 53rd ST)
Job No. 2007-2154
Calculated by W. STROBACH Date 07/24/08
Checked by _____ Sheet No. 7 of ____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

CONDITION 4

2' DIFFERENTIAL WATER HEAD
+2' ROCK SCOURED ON DOWNSTREAM SIDE



THIS LOADING CONDITION NOT CONTROL EITHER BECAUSE NOT AT SEVERE AS CONDITION 2

DEPTH OF SHEET PILING OK BY INSPECTION

∴ MAXIMUM MOMENT IN SHEET PILING = 1269#/ft²

CALL MIKE JONES OF HAMMER & STEEL CO (913-681-9295)

HE REFERRED ME TO CHAPARRAL STEEL WEBSITE
@ WWW.SHEET-PILING.COM

RECOMMENDED USE OF PZC 13 SHEET PILING, Z = 24.2 in³/ft
(SEE NEXT SHEET)

$S = \frac{M}{Z} = \frac{1269 \times 12}{24.2} = 629$ PSI VERY LOW

BUT PZC 13 IS THE MOST ECONOMICAL SHEET PILE SECTION FOR THIS APPLICATION @ 24.7 #/ft² ← USE

THE SMALLEST FLAT SHEET SECTION PS 27.5 WEIGHS 27.5#/ft²
Z = 1.9 in³/ft

BLUE RIVER CHANNEL MODIFICATIONS

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Job No. 2007-7154
Calculated by W. STROBACH Date 07/21/08
Checked by _____ Sheet No. 8 of _____

CHANNEL STA 86+00 (TEMPORARY GRADE CONTROL STRUCTURE)

DESIGN SHEET PILE WALL (UPSTREAM)

CHAPARRAL
SHEET PILING PROPERTIES

PZC

NOT AFFORD'D YET

USE (AVAILABLE)

Section	Section Modulus* in.³/ft (cm³/m)	Nominal Width in. (mm)	Weight* lbs/ft² (kg/m²)	Moment of Inertia* in.⁴/ft (cm⁴/m)
PZC 12	22.3	27.88	20.0	139.7
	1,200	708	97.6	19,080
PZC 13	24.2	27.88	21.7	152.0
	1,300	708	106.0	20,755
PZC 14	26.0	27.88	23.7	164.3
	1,400	708	115.5	22,445
PZC 17	31.0	25.00	22.3	236.1
	1,670	635	108.8	32,235
PZC 18	33.5	25.00	24.2	255.5
	1,800	635	118.2	34,890
PZC 19	36.1	25.00	26.4	276.6
	1,945	635	128.8	37,780
PZC 25	45.7	27.88	29.9	404.1
	2,455	708	145.9	55,190
PZC 26	48.4	27.88	31.8	428.1
	2,600	708	155.4	58,460
PZC 28	51.3	27.88	34.0	455.1
	2,755	708	166.1	62,145
PZC 34	63.8	24.80	37.5	634.8
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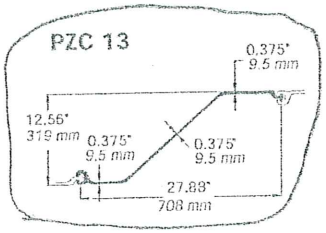
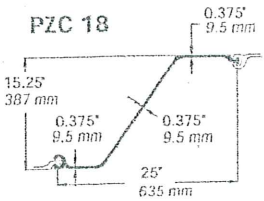
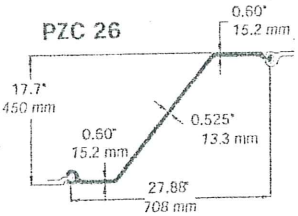
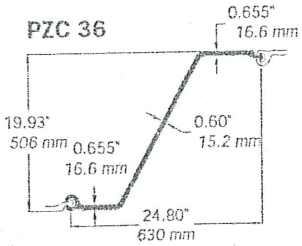
*Per Unit of Wall









PZ

Section	Section Modulus* in.³/ft (cm³/m)	Nominal Width in. (mm)	Weight* lbs/ft² (kg/m²)	Moment of Inertia* in.⁴/ft (cm⁴/m)
PZ 22	18.4	22.00	22.6	85.1
	990	559	110.6	11,620
PZ 27	31.0	18.00	27.7	187.3
	1,660	457	135.1	25,580
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PZ 40	61.3	19.69	40.0	502.7
	3,300	500	195.2	68,645

*Per Unit of Wall

PZ sheet piling is a traditional sheet piling profile produced in North America. These sections are named for weight. For example, PZ 35 weighs 35 pounds per square foot of wall.

PZC sections are the "latest generation" of sheet piling profiles and were developed to be lighter, wider, and stronger than the older traditional PZ sections. PZC profiles are named for their strength in metric designations. For example, PZC 18 has a Section Modulus of 1,800 cm³/meter. <u>PZC profiles should always be the designer's first choice in order to provide the end user the most efficient retention wall with the most efficient ratio of section modulus to weight.</u>

GRADE 50 IS THE MOST COMMON STEEL STRENGTH THAT THESE SHEET PILE SECTIONS COME IN