Klineline Bridge Scour Monitoring

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Overview

- Background
- Challenge
- Goals for Monitoring
- Devices chosen
- Installation
- Results

Long, Sordid History of Scour…

1949 – Pier Settlement

1956 – Pier Collapse

Scour in Watershed Continues…

Pond dike breached
– head cut travels toward bridge site

Recent Activity

2004: Scour and structural deficiencies noted during regular inspections lead to a grant application for replacement.

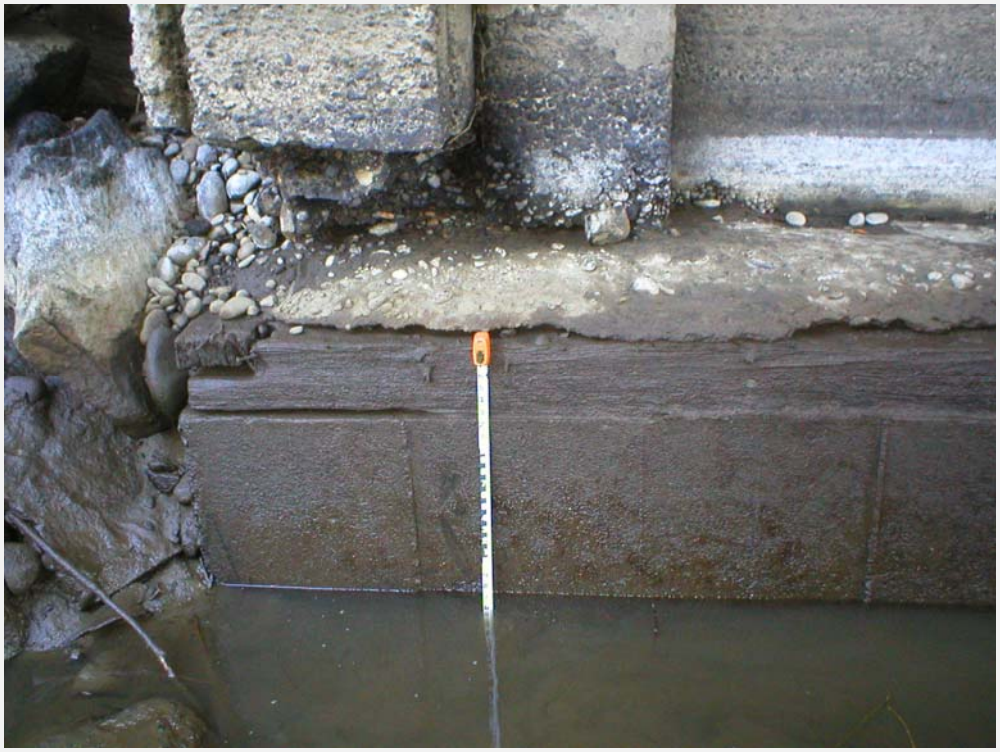
2005: Load Restricted – Design began for a replacement structure

2006: Intermittent road closures due to high water

Early 2008: Construction begins

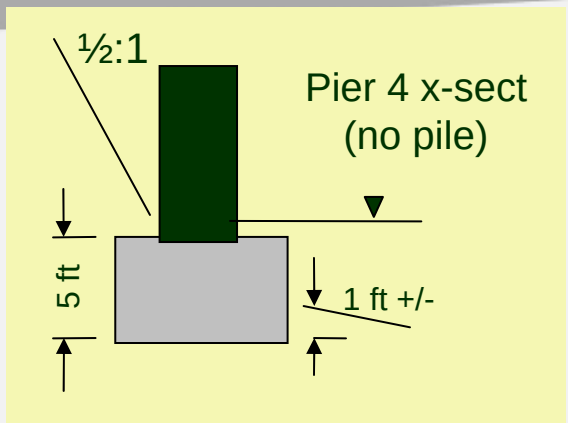
Spread Footing: Exposed!

Significantly more scour damage noted during the 2006 low flow inspection



5 ft deep spread footing
with 4 ft exposed
and ½:1 slope behind

: Scour Holes: approx. 4’ in depth



Concrete Apron

Pier 4

Spread Footing with 15’ Sheet Pile and concrete behind apron Installed 1956+/-

Main Stream Channel

Pier 3

Rip Rap

Sheet Pile (bent over 2’ +/-)

Now What?

Hired consultant engineering team – hydraulic, structural, and geotech to provide expertise in design and mitigation measures

Declared an 'emergency' in order to expedite environmental permit process

Determined Plan of Action (POA) for:

- Repair/Temporary Stabilization
- Ongoing Monitoring

Challenges Encountered

- Regulatory agencies had different priorities for emergency repair – limited what could be done on short time frame (maintenance vs. improvement)
- Raining while stream diversion in-place
- Monitoring Devices not designed or all received when construction began
- Little technology available locally regarding monitoring devices and suitability – on our own to figure it out….

Goals for Monitoring

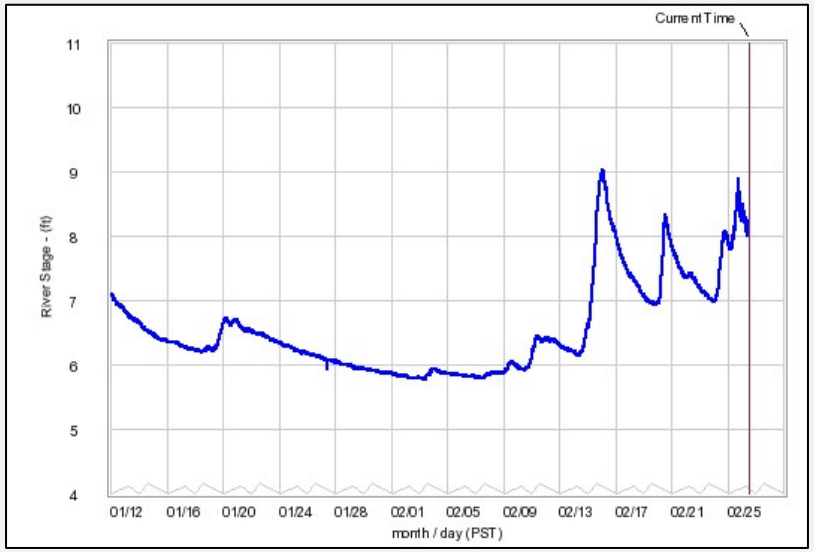
- Use bridge during lower-flow periods
- 24 hour ‘automated’ monitoring
- Proactive alarming capabilities
- Ability to access monitoring data remotely
- Survey control used to cross check automation

Devices Chosen

1. Flow gage with background data regarding shear stresses and material displacement forces
2. Sonar for river bed movement
3. Tilt meter for pier and downstream sheet pile

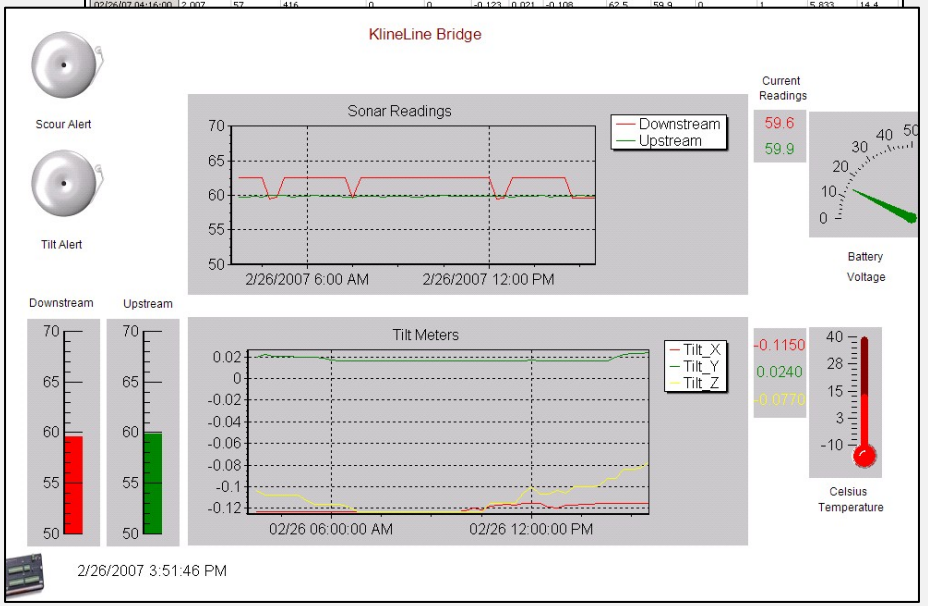
Real-time Data

Sutron Data Logger NOAA River Data Website



Campbell Data Logger

Timestamp	Year_RTM	Day_RTM	Hour_Minute_RTM	Scour_Alert	Tilt_Alert	Tilt_X	Tilt_Y	Tilt_Z	Sonar_1	Sonar_2	Downstream	UpStream	Temp	Battery
02/26/07 02:01:00	2,007	57	201	0	0	-0.123	0.024	-0.09199999	62.5	62.5	0	0	5.851	14.4
02/26/07 02:16:00	2,007	57	216	0	0	-0.123	0.024	-0.09199999	62.5	59.9	0	1	5.938	14.4
02/26/07 02:31:00	2,007	57	231	0	0	-0.123	0.022	-0.097	62.5	59.9	0	1	5.978	14.4
02/26/07 02:46:00	2,007	57	246	0	0	-0.123	0.024	-0.1	62.5	59.8	0	1	5.999	14.4
02/26/07 03:01:00	2,007	57	301	0	0	-0.123	0.023	-0.1	62.5	59.9	0	1	5.999	14.4
02/26/07 03:16:00	2,007	57	316	0	0	-0.123	0.023	-0.1	62.5	59.9	0	1	5.978	14.4
02/26/07 03:31:00	2,007	57	331	0	0	-0.123	0.022	-0.1	62.5	59.9	0	1	5.935	14.4
02/26/07 03:46:00	2,007	57	346	0	0	-0.123	0.02	-0.103	62.5	59.8	0	1	5.893	14.4
02/26/07 04:01:00	2,007	57	401	0	0	-0.123	0.022	-0.108	62.5	59.8	0	1	5.853	14.4



The Repair

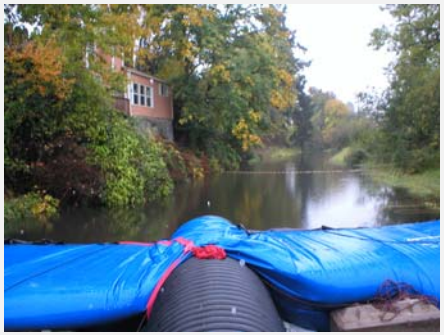
Stream Diversion

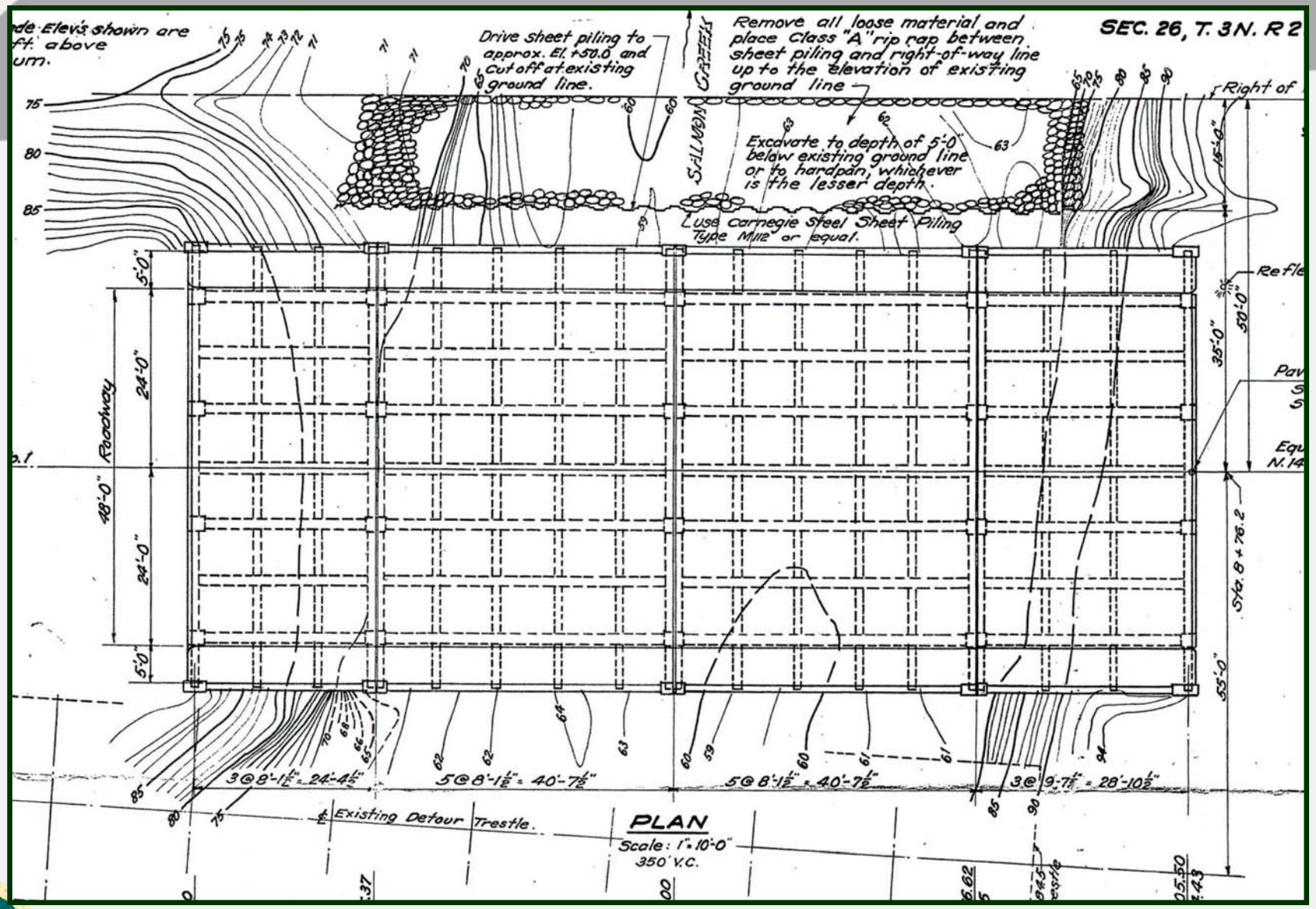
Track Hoe Access

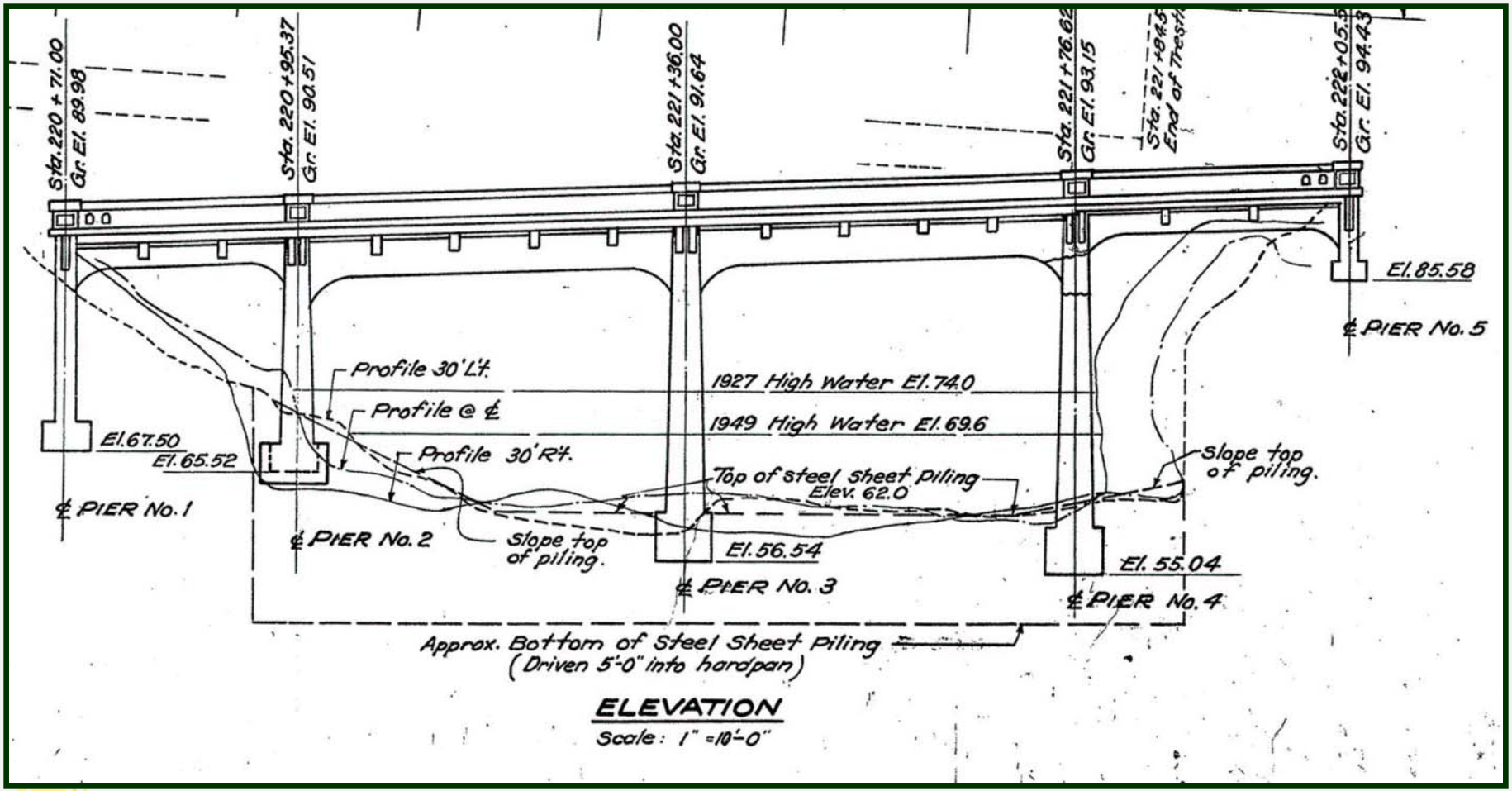
Block Placement

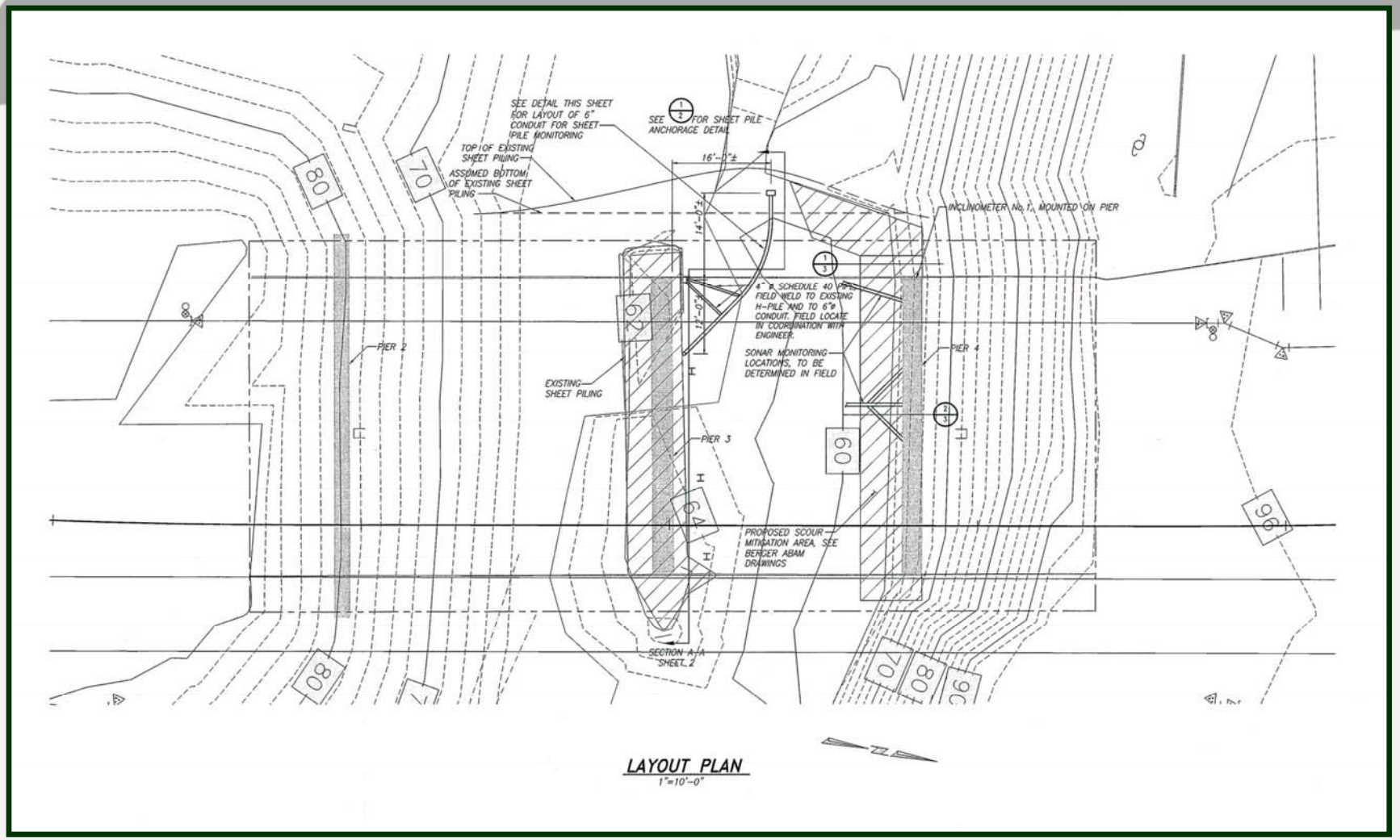
Tying the Blocks Together

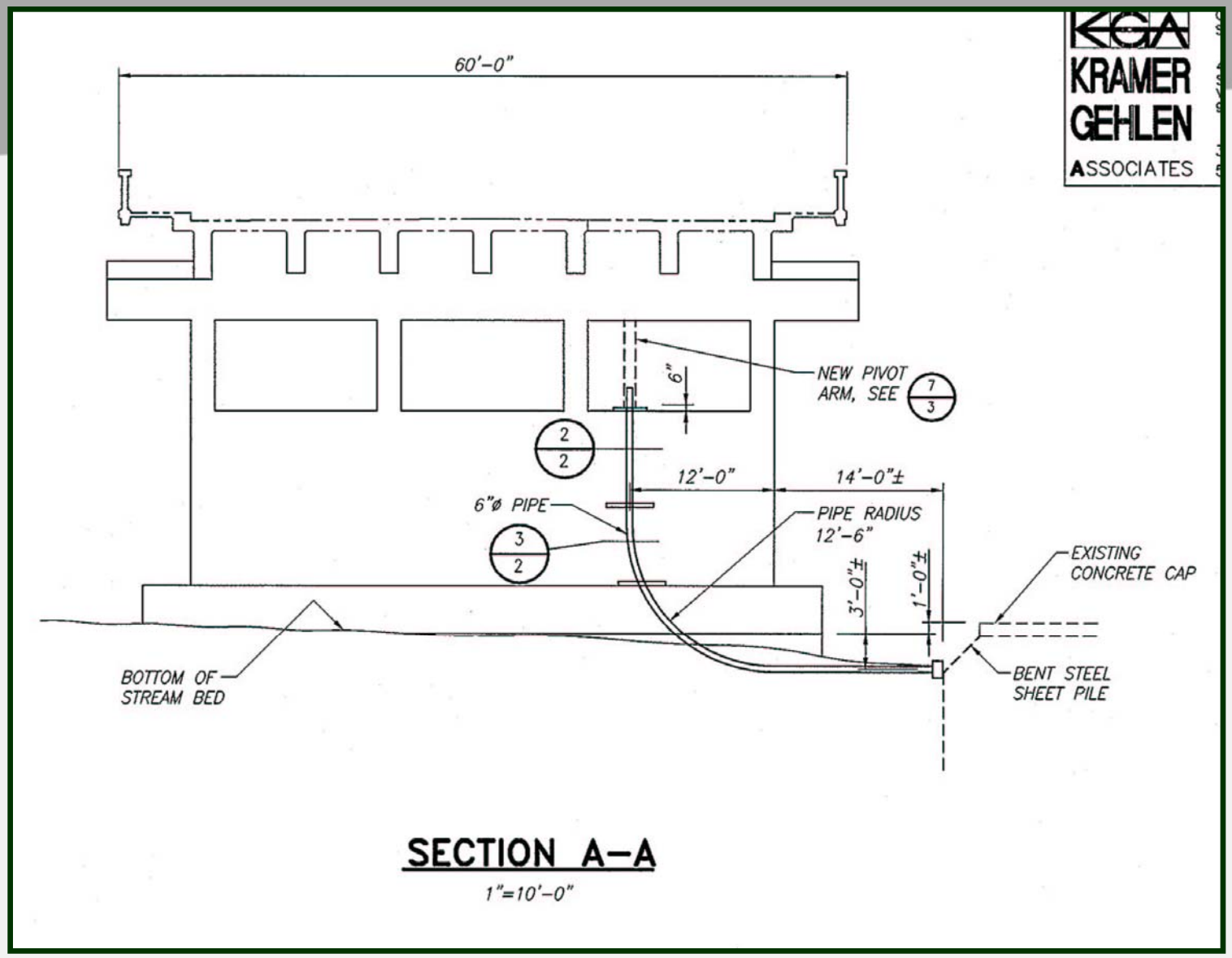
Install Monitoring Devices

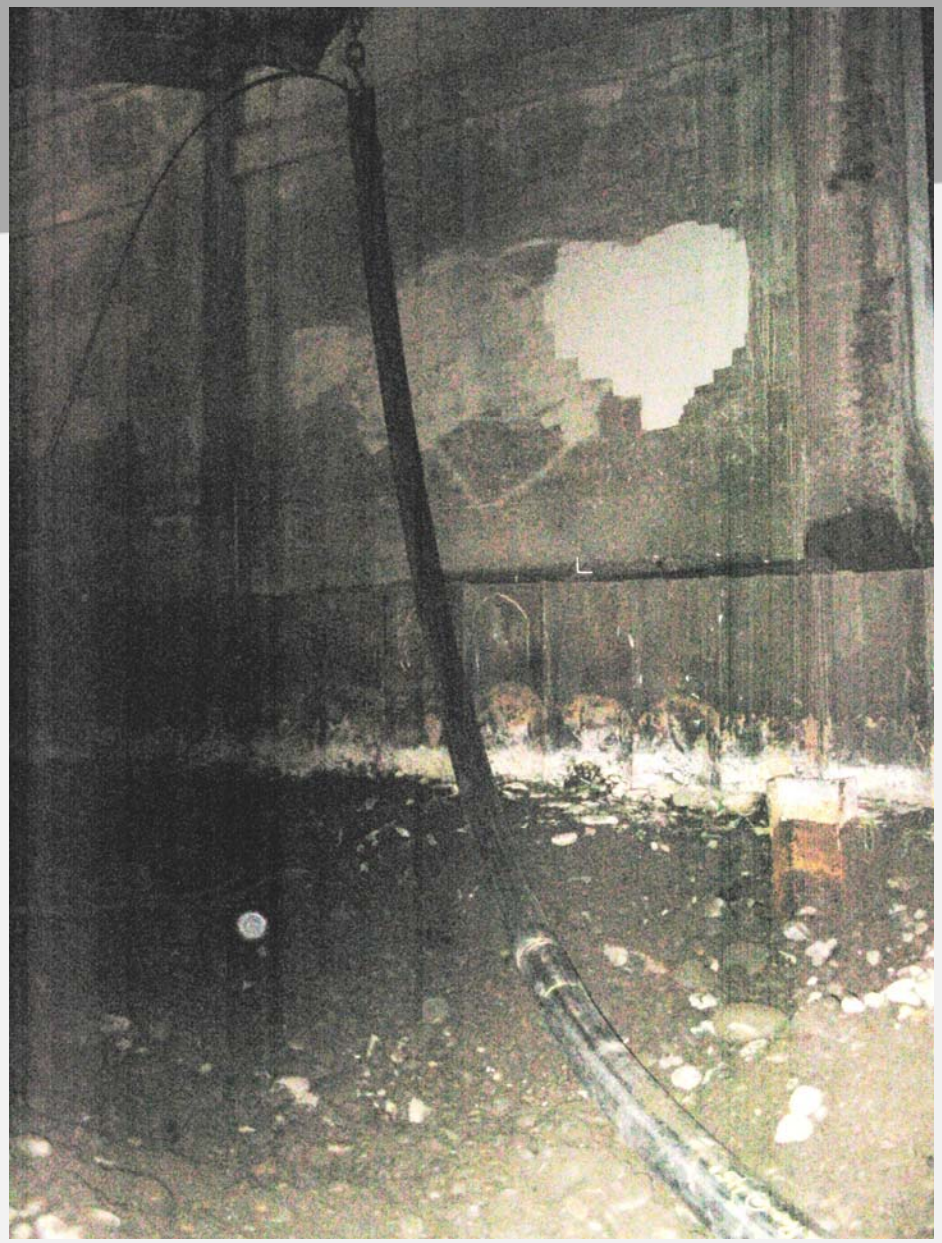


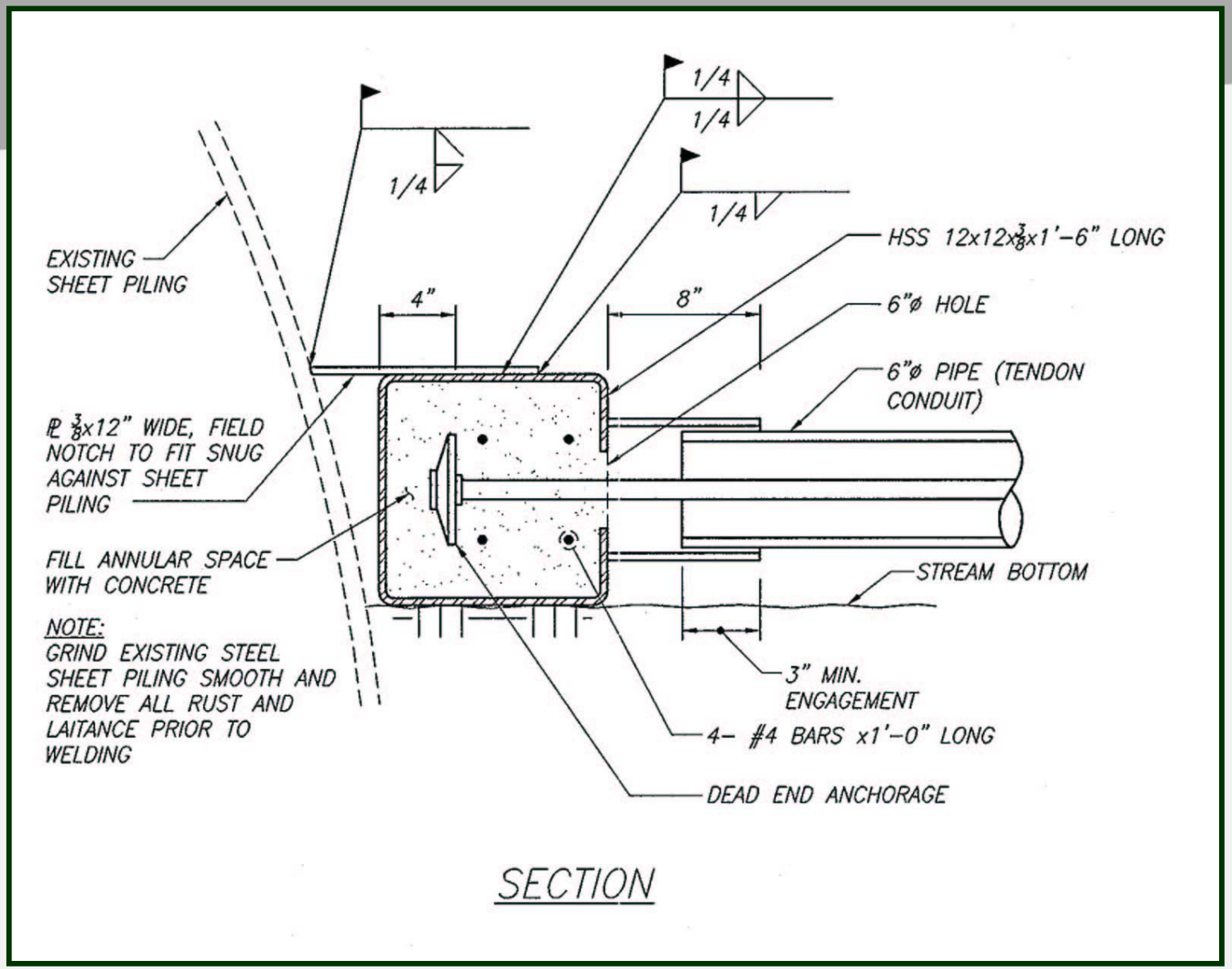

Drive sheet piling to approx. El. +50.0 and cut off at existing ground line.
Remove all loose material and place Class "A" rip rap between sheet piling and right-of-way line up to the elevation of existing ground line
SEC. 26, T. 3N. R 2
Excavate to depth of 5'-0" below existing ground line or to hardpan, whichever is the lesser depth.
Use Carnegie Steel Sheet Piling Type M112 or equal.
Roadway
24'-0"
40'-0"
5'-0"
3@8'-1½" = 24'-4½"
5@8'-1½" = 40'-7½"
5@8'-1½" = 40'-7½"
3@9'-7½" = 28'-10½"
℄ Existing Detour Trestle.
PLAN
Scale: 1" = 10'-0"
350' V.C.
Sta. 8 + 76.2
35'-0"
55'-0"

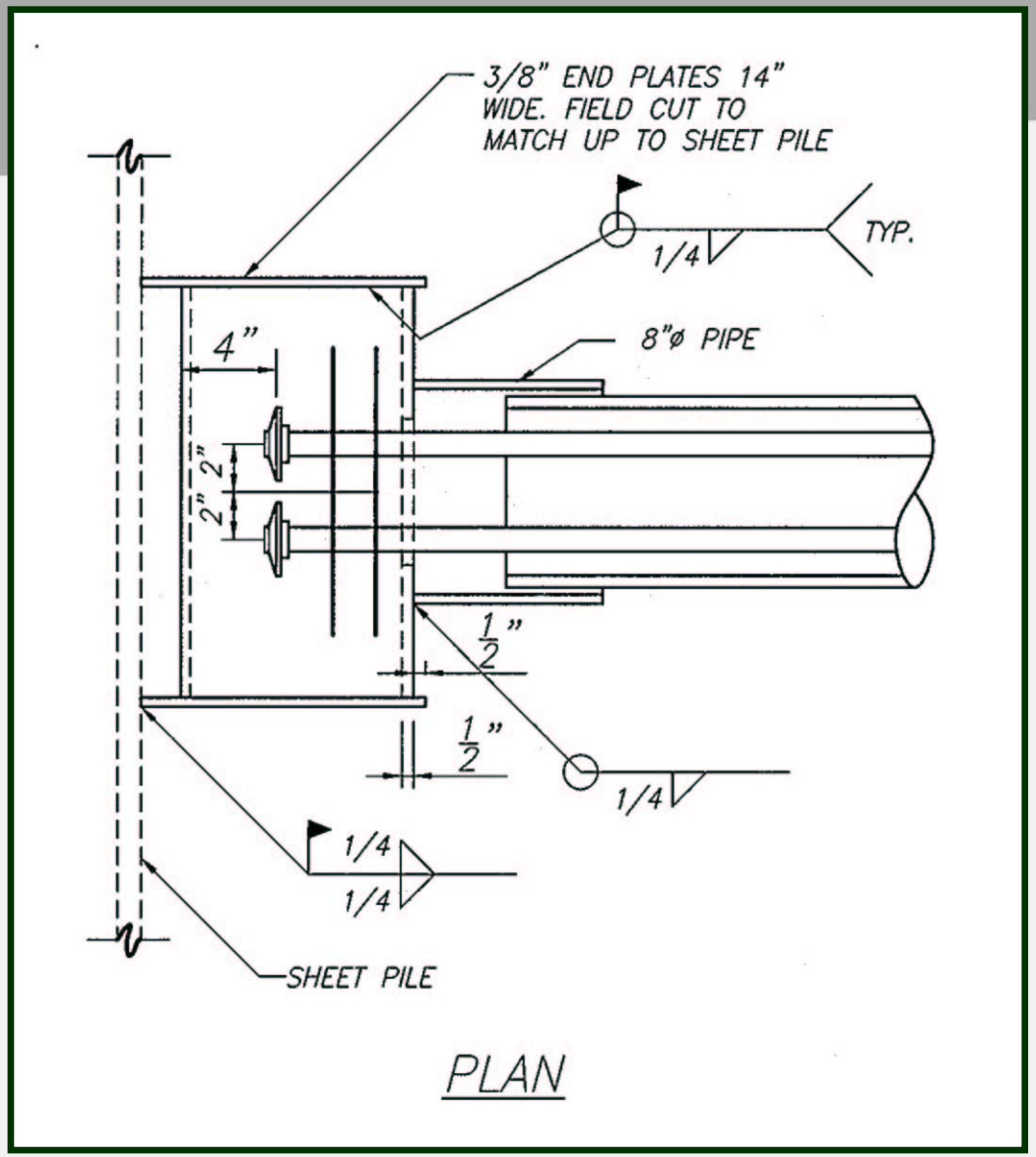

Sta. 220+71.00
Gr. El. 89.98
Sta. 220+95.37
Gr. El. 90.51
Sta. 221+36.00
Gr. El. 91.64
Sta. 221+76.62
Gr. El. 93.15
Sta. 222+05.43
Gr. El. 94.43
El. 85.58
℄ PIER No. 5
Profile 30' Lt.
Profile @ ℄
Profile 30' Rt.
1927 High Water El. 74.0
1949 High Water El. 69.6
El. 67.50
El. 65.52
℄ PIER No. 1
℄ PIER No. 2
Slope top of piling.
Top of steel sheet piling Elev. 62.0
Slope top of piling.
El. 56.54
℄ PIER No. 3
El. 55.04
℄ PIER No. 4
Approx. Bottom of Steel Sheet Piling
(Driven 5'-0" into hardpan)
ELEVATION
Scale: 1" = 10'-0"

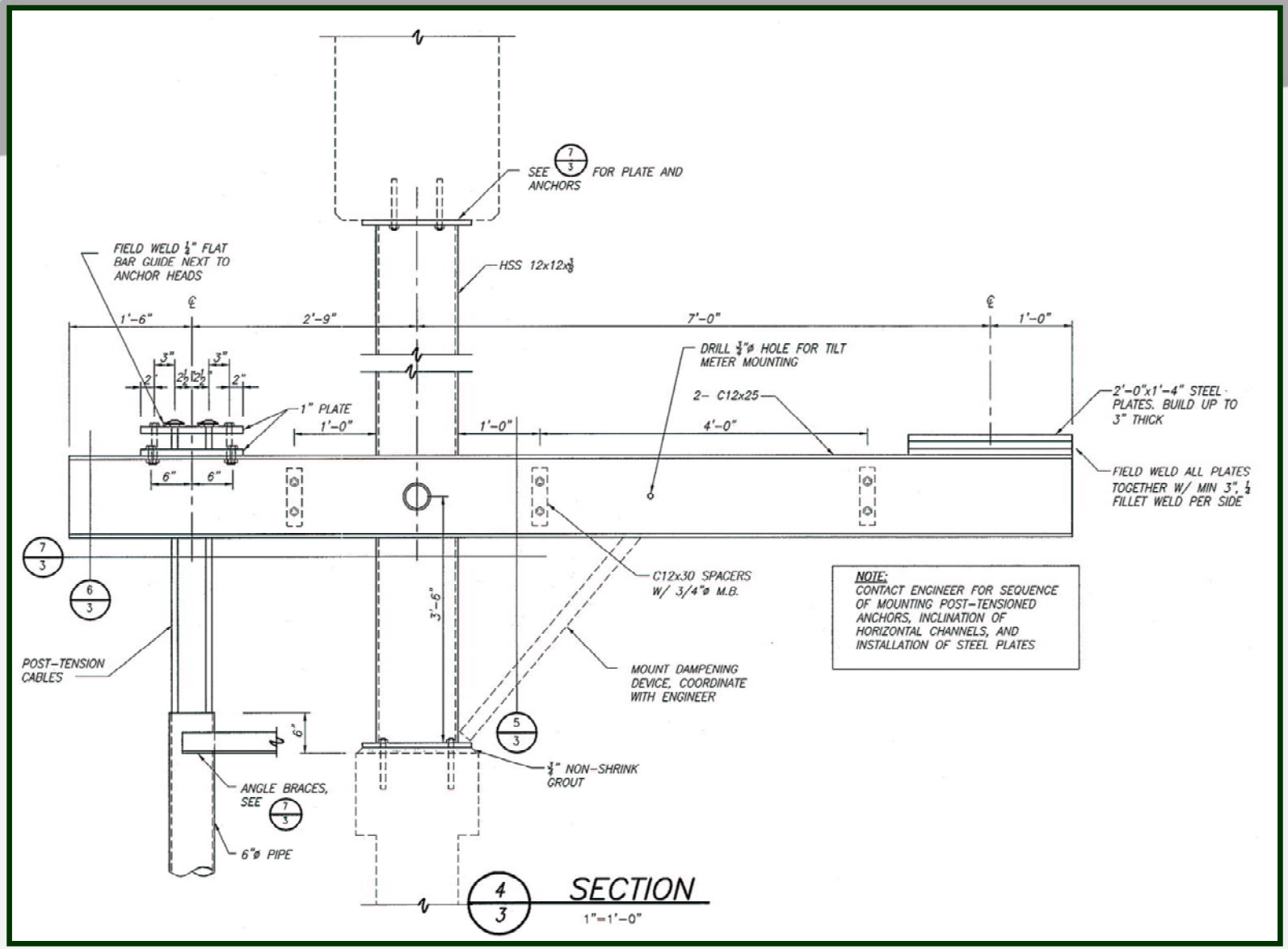

SEE DETAIL THIS SHEET FOR LAYOUT OF 6" CONDUIT FOR SHEET PILE MONITORING
SEE 1/2 FOR SHEET PILE ANCHORAGE DETAIL
TOP OF EXISTING SHEET PILING
ASSUMED BOTTOM OF EXISTING SHEET PILING
16'-0"±
14'-0"±
11'-0"±
INCLINOMETER No.1, MOUNTED ON PIER
1/3
4" ø SCHEDULE 40 PIPE FIELD WELD TO EXISTING H-PILE AND TO 6"ø CONDUIT. FIELD LOCATE IN COORDINATION WITH ENGINEER.
SONAR MONITORING LOCATIONS, TO BE DETERMINED IN FIELD
PIER 2
PIER 3
PIER 4
EXISTING SHEET PILING
2/3
PROPOSED SCOUR MITIGATION AREA, SEE BERGER ABAM DRAWINGS
SECTION A-A SHEET 2
80
70
60
64
96
LAYOUT PLAN
1"=10'-0"

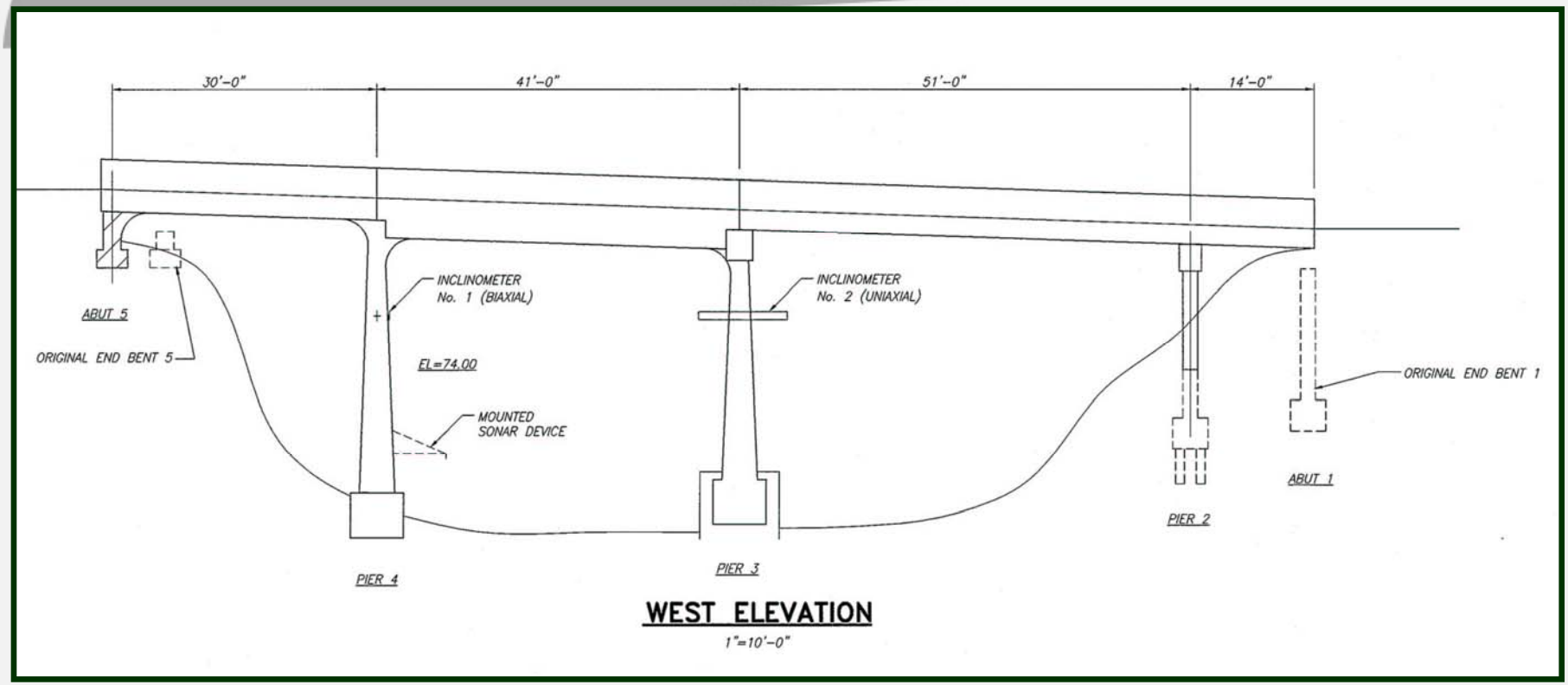

KGA
KRAMER
GEHLEN
ASSOCIATES
60'-0"
6"
NEW PIVOT ARM, SEE 7/3
2/2
12'-0"
14'-0"±
6"ø PIPE
3/2
PIPE RADIUS 12'-6"
3'-0"±
1'-0"±
EXISTING CONCRETE CAP
BOTTOM OF STREAM BED
BENT STEEL SHEET PILE
SECTION A-A
1"=10'-0"

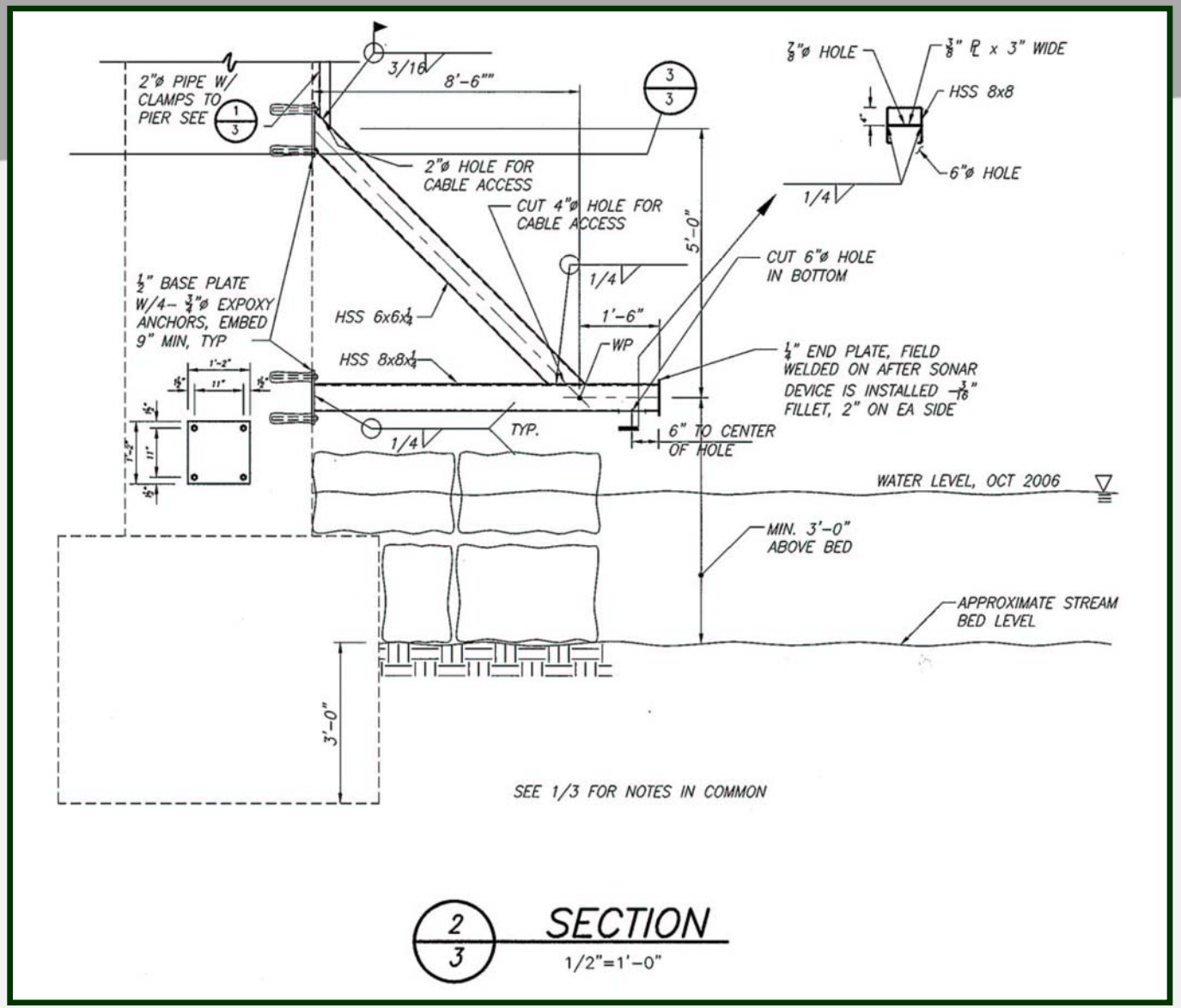



1/4
1/4
1/4
1/4
EXISTING SHEET PILING
HSS 12x12x3/8x1'-6" LONG
4"
8"
6"ø HOLE
6"ø PIPE (TENDON CONDUIT)
PL 3/8x12" WIDE, FIELD NOTCH TO FIT SNUG AGAINST SHEET PILING
FILL ANNULAR SPACE WITH CONCRETE
STREAM BOTTOM
NOTE:
GRIND EXISTING STEEL SHEET PILING SMOOTH AND REMOVE ALL RUST AND LAITANCE PRIOR TO WELDING
3" MIN. ENGAGEMENT
4- #4 BARS x1'-0" LONG
DEAD END ANCHORAGE
SECTION


3/8" END PLATES 14" WIDE. FIELD CUT TO MATCH UP TO SHEET PILE
TYP.
1/4
8"ø PIPE
4"
2"
2"
1/2"
1/2"
1/4
1/4
1/4
SHEET PILE
PLAN


SEE 7/3 FOR PLATE AND ANCHORS
FIELD WELD ¼" FLAT BAR GUIDE NEXT TO ANCHOR HEADS
HSS 12x12x⅜
1'-6"
2'-9"
7'-0"
1'-0"
DRILL ¾"ø HOLE FOR TILT METER MOUNTING
2- C12x25
4'-0"
1" PLATE
1'-0"
1'-0"
2'-0"x1'-4" STEEL PLATES. BUILD UP TO 3" THICK
FIELD WELD ALL PLATES TOGETHER W/ MIN 3", ¼ FILLET WELD PER SIDE
3"
2"
2½"
2½"
3"
2"
6"
6"
7/3
6/3
C12x30 SPACERS W/ ¾"ø M.B.
3'-6"
NOTE:
CONTACT ENGINEER FOR SEQUENCE OF MOUNTING POST-TENSIONED ANCHORS, INCLINATION OF HORIZONTAL CHANNELS, AND INSTALLATION OF STEEL PLATES
POST-TENSION CABLES
MOUNT DAMPENING DEVICE, COORDINATE WITH ENGINEER
6"
5/3
¾" NON-SHRINK GROUT
ANGLE BRACES, SEE 7/3
6"ø PIPE
4/3 SECTION
1"=1'-0"


30'-0"
41'-0"
51'-0"
14'-0"
INCLINOMETER No. 1 (BIAXIAL)
INCLINOMETER No. 2 (UNIAXIAL)
ABUT 5
ORIGINAL END BENT 5
EL=74.00
MOUNTED SONAR DEVICE
ORIGINAL END BENT 1
ABUT 1
PIER 2
PIER 3
PIER 4
WEST ELEVATION
1"=10'-0"


2"ø PIPE W/ CLAMPS TO PIER SEE 1/3
3/16
8'-6""
3/3
2"ø HOLE FOR CABLE ACCESS
CUT 4"ø HOLE FOR CABLE ACCESS
5'-0"
1/4
CUT 6"ø HOLE IN BOTTOM
7/8"ø HOLE
3/8" PL x 3" WIDE
HSS 8x8
6"ø HOLE
1/4
1/2" BASE PLATE W/4- 3/4"ø EXPOXY ANCHORS, EMBED 9" MIN, TYP
HSS 6x6x1/4
1'-6"
WP
HSS 8x8x1/4
1/2" END PLATE, FIELD WELDED ON AFTER SONAR DEVICE IS INSTALLED 3/16" FILLET, 2" ON EA SIDE
1'-2"
11"
1/4
TYP.
6" TO CENTER OF HOLE
WATER LEVEL, OCT 2006
MIN. 3'-0" ABOVE BED
APPROXIMATE STREAM BED LEVEL
3'-0"
SEE 1/3 FOR NOTES IN COMMON
2/3 SECTION
1/2"=1'-0"


160

And Then… Two Weeks Later…

On Nov 7th, 2007

- Approximately – 3700 cfs (87 yr storm)
- Closure criteria – 1000 cfs
- Bridge closed for 8 days

Problems with Monitoring

Block rotation from Continued scour and debris build-up

Closure Criteria

CLOSURE TRIGGERS

RISK LEVEL	River Flow (cfs)	Chg in Flow (Δ cfs)	Scour Depth (ft)	Tilt - sheet pile (deg)	Tilt Bridge (deg)	*MONITOR STATUS*
Low						No Action
Guarded						Warnings Issued
Elevated						Remote Monitoring
High						Onsite Monitoring
Severe						Full Closure

Results

- Two full road closures this past winter
- Two close calls

The End… Questions/Comments?