Appendix G:

Tractive Stress Calculations

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Computation Sheet

NRCS-ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/1/09	Checked by [illegible]	Date 2/4/[illegible]	Job No.
Subject			Sheet 3/.1 of

CHECK TODD'S DESIGN GEOMETRY

NOTE: MOST SURVEY INFO USES NAVD 88

AT SPILLWAY LET MEAN DEPTH = MAX DEPTH = 2.5'

ALSO, XSEC AT DAM CAN HAVE SMALLER AREA THAN UPSTREAM CROSS SECTION BECAUSE AT DAM THE XSEC IS AT A BREAK POINT BETWEEN A C CHANNEL - FLAT AND AN A-CHANNEL STEEP. THE A CHANNEL WILL CARRY A GIVEN Q AT A MUCH SMALLER XSECTIONAL AREA.

CHANNEL ELEV AT DAM (128+93) = 482.4 - 2.5 = 479.9 NAV88

EXISTING GROUND ELEV AT 136+50 FROM CAD PROFILE = 482.9 NAVD 88 GREEN LINE

NEAREST SHOTS ARE PT 9120 → 482.61 51' US,
9118 481.88 80' DS.

AV. = (482.9 + 481.88)/2 = 482.4 NAVD 88 = elev. at 136+50

STREAM IS IRREGULAR GOING TO A NEW BOTTOM = 482.9 AT 136+50 IS REASONABLE. OK

PROPOSED SLOPE CHANNEL BOTTOM = $\frac{482.9 - 479.9}{136+50 - 128+93}$ ← SHOULD R 420.0 NAVD NEW DAM ELEV

$= \frac{3.0}{757'} = .00396$ ← TOO HIGH

THIS IS SLOPE TODD WANTS

IF DROP US. INVERT AT 136+50 TO 482.5 GET $S = \frac{2.6}{757} = .0034$ OK

CALCULATE SHEAR STRESS FOR MAX BANKFULL DEPTH = 2.5 FT

$\tau = \gamma D S = \frac{62.4\ LBF}{FT^3}\ 2.5\ FT\ (.0034) = 0.5304\ LB/FT^2$

WHICH EQUALS RIVERMORPH PREDICTION.

<u>Steele Brook Feasibility Study: Notes</u>

Gentlemen, I have been looking at the two design scenarios; Alt.3: Notch Spillway / Ramping, and Alt.4: Full spillway removal. And here is what I have come up with. I believe that we have talked about parts of this data in the past, but figured I would reiterate and elaborate so that we could move forward with the modeling and other analysis all being on the same page.

<u>Alternative 3: Notch Spillway / Ramping</u>

The foundation of the proposed channel is based on a geomorphically correct channel, and natural channel design concepts. Basically, design a channel-floodplain system where the channel is shaped by the bankfull flow.

Drop the elevation of the entire spillway 1.0 ft, from elev. 483.4 to elev. 482.4.
Notch the "new" spillway with a channel which matches the bankfull channel dimensions
Bankfull channel dimensions:

- Wbkf = 40'
- Dbkf = 2.5' (mean depth)
- Abkf = 100 ft2
- Sbkf = 0.0034 ft/ft (this Sbkf is measured from sta. 128+93 to sta. 136+50)

The channel materials will be composed of in-situ sand and gravels. Our pebble count of the riffle revealed a d50 of 12 mm (~ 0.5" gravel) and a d84 of 51 mm (~ 2.1" gravel). Keep in mind that this pebble count was in the riffle, and is not a true composite of the reach. It is likely, that the particle size may decrease slightly if the pools are factored in. Due to the bacteria concern, and the need to stick our head underwater to get the pool sample, for the feasibility study will should just use the riffle data.

Based on the above Bkf channel dimensions, I had Rivermorph run an entrainment calculator, based on Shields curve for <u>Threshold of Motion,</u> which indicates that the critical shear stress at the Bkf flow is 0.50 lb/ft2, and the movable particle size is 28.6 mm (~1.2" gravel). Keep in mind that this is just a predictive tool, but for the level of detail needed fro this study, having an alluvial channel with the capacity to entrain a particle in the d50-d84 range is pointing towards a vertically stable alluvial channel.

Down stream of the dam, the channel will transition to a step-pool system with a slope of 0.05 ft/ft. There will be between 12 and 13 individual steps, which will extend from the dam down to about sta. 127+25. Ben has drafted a profile of this. I will start to work on the channel dimensions associated with that. Clearly, the channel will decrease in width, due to the dramatic increase in slope.

Alternative 4: Full Removal of Spillway

Again, the foundation of the proposed channel is based on a geomorphically correct channel, and natural channel design concepts. Basically, design a channel-floodplain system where the channel is shaped by the bankfull flow.

Remove the entire spillway, splash pad and footer of the dam, and construct a new channel from sta.128+65 (~ 23' down stream of dam) to sta. 140+00 (~ 1,107' upstream of dam).

Bankfull channel dimensions:

Wbkf = 40'
Dbkf = 2.5' (mean depth)
Abkf = 100 ft2
Sbkf = 0.0083 ft/ft (this Sbkf is measured from sta. 128+65 to sta. 140+00)

Notice that the mean depth and width are the same as alternative 3. Due to the increase in slope, it is likely that the width of the cannel would actually decrease to something like 37-38 feet, however, for the purpose of the feasibility study and the entrainment calculations, it was easier to keep it the same.

Based on the above Bkf channel dimensions, I had Rivermorph run an entrainment calculator, based on Shields curve for Threshold of Motion, which indicates that the critical shear stress at the Bkf flow is 1.21 lb/ft2, and the movable particle size is 196.1 mm (~8.0" cobble). Again, keep in mind that this is just a predictive tool, but for the level of detail needed fro this study, having an alluvial channel with the capacity to entrain a particle well in excess of the dmax of the in-situ materials, clearly points to a vertically unstable alluvial channel. Therefore, there would be the need to truck in cobble to form the entire channel boundary (similar to what we are going to do with Merwins). Fro the purposes of the feasibility analysis, we could use the 8.0" cobble as the d50 for the channel boundary materials.

One of the key factors is the ability to construct a channel-floodplain system. Taking the 0.0083 ft/ft slope, I drew cross sections showing a bankfull channel and a floodplain for this alternative. The cross sections are drawn for Ben's cross sections 342.1, 342.2, 343.3, 342.5, 342.6 and 342.7. Using Rosgen's reported data of average Entrenchment Ratio (ER) for C4 and C3 stream types, I used an ER for the channel of 2.9. Rosgen's data reports that approx 72% of C3 stream types have an ER between 2.3 and 3.14.

I was able construct a channel-floodplain system for all but one of the above cross-sections with a minimum ER of 2.9, and often going above that towards an ER of 4.5 in some cases, while still leaving the vegetated peninsula on the west and staying within the floodpool area. The one cross-section that does not work is 342.1 which is the dam, where the ER drops down to 2.2. That said the dam cross section would be part of the transitional reach to B stream type below, and having an ER of 2.2 would fit the bill for a B stream type (in fact it is the upper range for a B).

To do this, the channel centerline alignment needs to shift slightly from what Ben has on the plan view. To be more specific, the centerline for cross-section 342.5 shifts 45 feet to the east, 342.6 shifts 35 feet to the east, and 342.7 can stay as is, or perhaps shift 5 feet to the east.

So ignoring the in-situ sediment for now, this alternative is more doable than I originally thought. We still would have to deal with massive amounts of excavation, and massive amounts of material coming in. Also the down is still dealing with some decent vertical walls associated with the Dam wing walls, however, there are a lot of vertical walls along this channel.

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/1/09	Checked by	Date	Job No.
Subject REFERENCE RIFFLES — SLOPES			Sheet 32.1 of

FROM CAD,
REFERENCE RIFFLE IS AT 140+18 51' US 344

THERE IS ALSO AN UPSTREAM RIFFLE AT 142+31
41' DS 345

PLOT HEC-RAS PROFILES AND XSECS FROM EXISTING HEC-RAS MODEL SEE 33-39

FROM XSEC 342.8 (139+01) GOING UPSTREAM PROFILES GET STEEPER

FROM XSEC 342.7 (136+80)
342.8 (139+01)
TO XSEC 344 (139+66)

} THIS HAVE BERMS ON LEFT THAT WILL CONFINE FLOW YET HEC-RAS MODEL ASSUMES UNIMPEDED FLOW TO POND AREA TO LEFT. SO EXISTING

REAL WORLD SITUATION ACTUALLY CONFINES FLOW TO DEEP CHANNEL AND WILL CAUSE HIGHER WATER SURFACES AT THESE XSECS. ON THE OTHER HAND THE FEMA Q'S USED IN HEC-RAS ARE ABNORMALLY HIGH

XSEC 345 (142+72) HAS ALL FLOW IN CHANNEL UP TO 10-YR 100-YR HAS MINOR LEVEE ON RIGHT TO OVERTOP.
346 HAS MOST OF 10-YR IN CHANNEL

SLOPE FROM 346 TO 345 (142+72) ARE A GOOD ESTIMATE OF FLOW WITHOUT POND BACKWATER
GET THESE SLOPES FROM ENERGY GRADES ON PROFILE SHT 34.1 TO 34.3 TABLES

YR FLOOD	E.G. ELEV 346	E.G. ELEV 345 (142+72)	ΔH ELEV	DIST. BETWEEN XSECS	E.G. SLOPE
1	489.89	487.04	2.85	448	.00636
2	490.78	488.17	2.61		.00583
10	492.23	489.52	2.71		.00605
100	493.99	491.11	2.88		.00642

(1, 2, 10 yr slopes:) PRETTY STEEP

SCALED FR. PROFILE

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/1/09	Checked by	Date	Job No.
Subject			Sheet 32.2 of

THE RIFFLES ARE BETWEEN 344 (139+66)
AND 345 (142+72)

TRY TO CHARACTERIZE ENERGY GRADE THIS EXPERIENCES NOW. I.E. BEFORE DAM MODIFICATION

NOTE: MOST OF FLOW AT 342.8 FOR 1 AND 2-YR IS NOT HIGHER THAN THAT SHOWN. EVEN IF WATER DOES NOT HAVE FULL ACCESS TO "RIGHT CHANNEL"; THE DIVIDE IS AT 2-YR ELEV. SEE SHT 36

HENCE:
ASSUME NO MORE BACKWATER GETS UP TO 344

MOST OF 1+2 YR ARE IN MAIN CHANNEL AT 344 & 345
SEE SHT 37 AND 38.

SO 2-YR EG SLOPE FROM 345 (142+72) TO 344 (139+66) ON SHT 34.1 IS SAME AS 345 TO 346

SO SLOPE IS SAME AS 2-YR ON SHT 32.1 = .00583

GET 1&2-YR DEPTHS AT 344 AND 345 FROM SHT 34.2

YR-STORM	DEPTH 344	DEPTH 345	AVG.	GET TRACTIVE STRESS MAX WITH AV. DEPTH AND S=.00583 $T = \gamma DS$	
1	2.67	2.28	2.48	0.90	Q=221
2	3.17	3.16	3.16	1.15	Q=405

SO IF TODD'S EXISTING RIFFLE SAMPLE COMES FROM RIFFLES BETWEEN 344 AND 345 IT MAY BE EXPERIENCING TRACTIVE STRESSES BETWEEN 0.90 AND 1.15 LB/FT²

HOWEVER, IF WE LOWER HIGH MC&MB. Q'S DOWN TO A USGS REF. Q$_2$ OF 226 CFS AND THEN ADJUST THIS TO A PRORATED 1½ YR = $\frac{(221+405)/2}{405} \times 226 = 175$ CFS

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

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Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/1/09	Checked by	Date	Job No.
Subject			Sheet 32.3 of

THE PRORATION USE M&McB 1 YR = 221 TO ARRIVE
2 YR = 405

AT A M&MBE 1½ YR / M&MBE 2YR RATIO

THIS WAS MULT. × USGS 2YR = 226 TO

GET USGS 1½ YR = 175 CFS BANKFULL

ASSUMES BANKFULL IS ABOUT 1½ YR.

ALSO IF HEC-RAS LOWER CHANNEL N DOWN TO

.03 WHICH MIGHT BE OKAY IF CHANNEL BANK VEG. IS SMALL, WILL GET A LOWER WATER DEPTH AND TRACTIVE STRESS.

MAYBE THIS COULD DROP AV MAX DETH OF 344 + 345 BY 20% TO

2.48 × .80 = 1.98 FT

THIS ALSO LOWERS TRACTIVE STRESS TO .8(90) = 0.72 LB/FT²

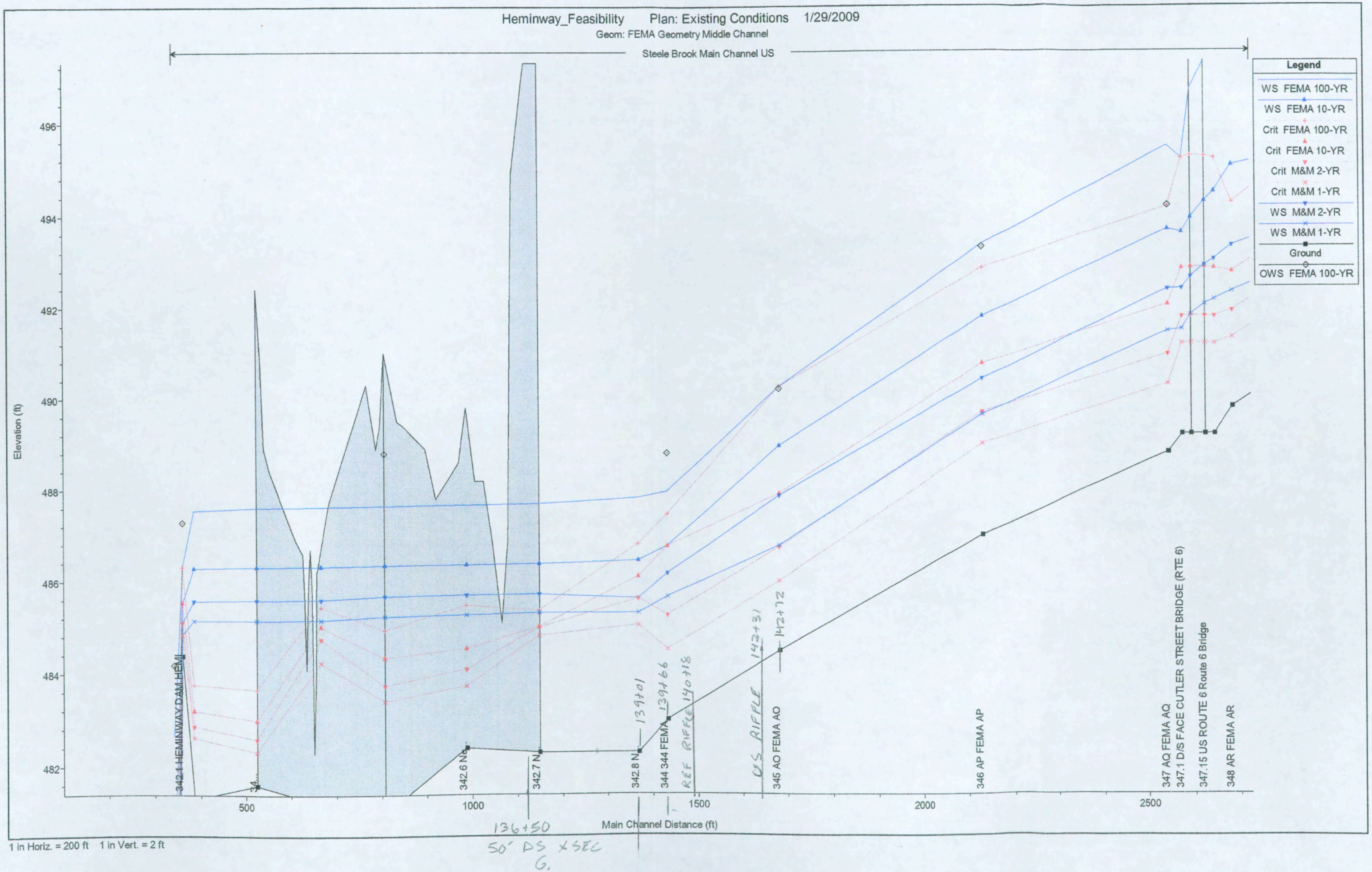
THIS IS STILL MORE THAN TODD'S T = .5 LB/FT² THAT ENTRAINS A 1.2" GRAVEL
d_{50} = 0.5"
d_{84} = 2.1"

SO THIS BED IS SOMEWHAT MOBILE AT T = 0.5 LB/FT
AND WE THINK BANKFULL IS ACTUALLY T = 0.72 LB/FT²

IF WE MAKE TRACTIVE STRESS THROUGH POND = 0.5 LB/FT²

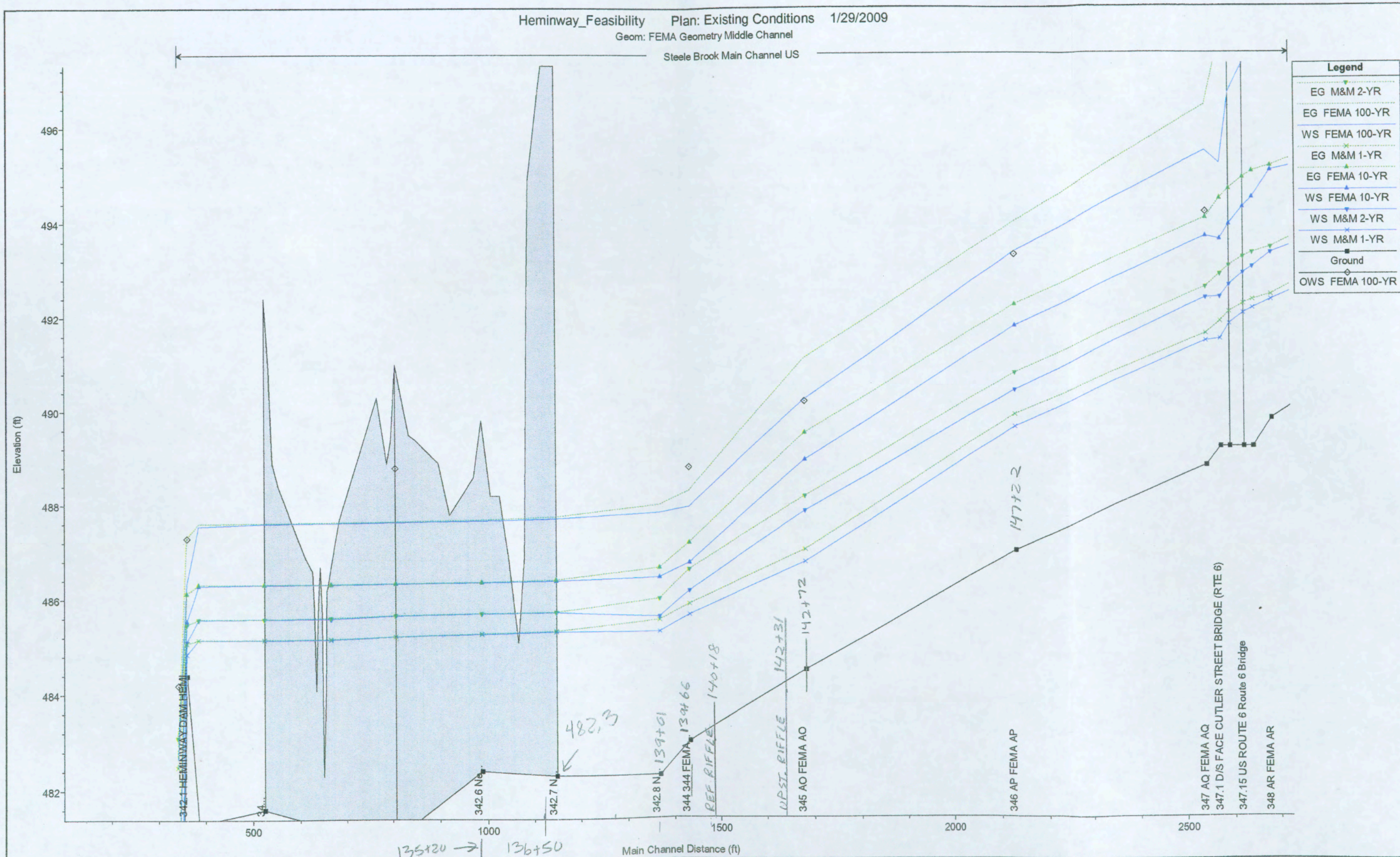
IT IS LESS THAN WHAT RIFFLE BETWEEN 344 TO 345 GETS NOW.

BUT POND SUBSTRATE IS PROB FINER THAN SUBST. AT 344 TO 345.



Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
Steele Brook Main Channel US
Legend
WS FEMA 100-YR
WS FEMA 10-YR
Crit FEMA 100-YR
Crit FEMA 10-YR
Crit M&M 2-YR
Crit M&M 1-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
OWS FEMA 100-YR
Elevation (ft)
496
494
492
490
488
486
484
482
500
1000
1500
2000
2500
Main Channel Distance (ft)
1 in Horiz. = 200 ft 1 in Vert. = 2 ft
342.1 HEMINWAY DAM HEMI
342.6 N
342.7 N
342.8 N
344 344 FEMA
345 AO FEMA AO
346 AP FEMA AP
347 AQ FEMA AQ
347.1 D/S FACE CUTLER STREET BRIDGE (RTE 6)
347.15 US ROUTE 6 Route 6 Bridge
348 AR FEMA AR
139+01
139+66
140+18
REF RIFFLE
142+31
142+72
US RIFFLE
136+50
50' DS XSEC
6.

34.1 OF ___



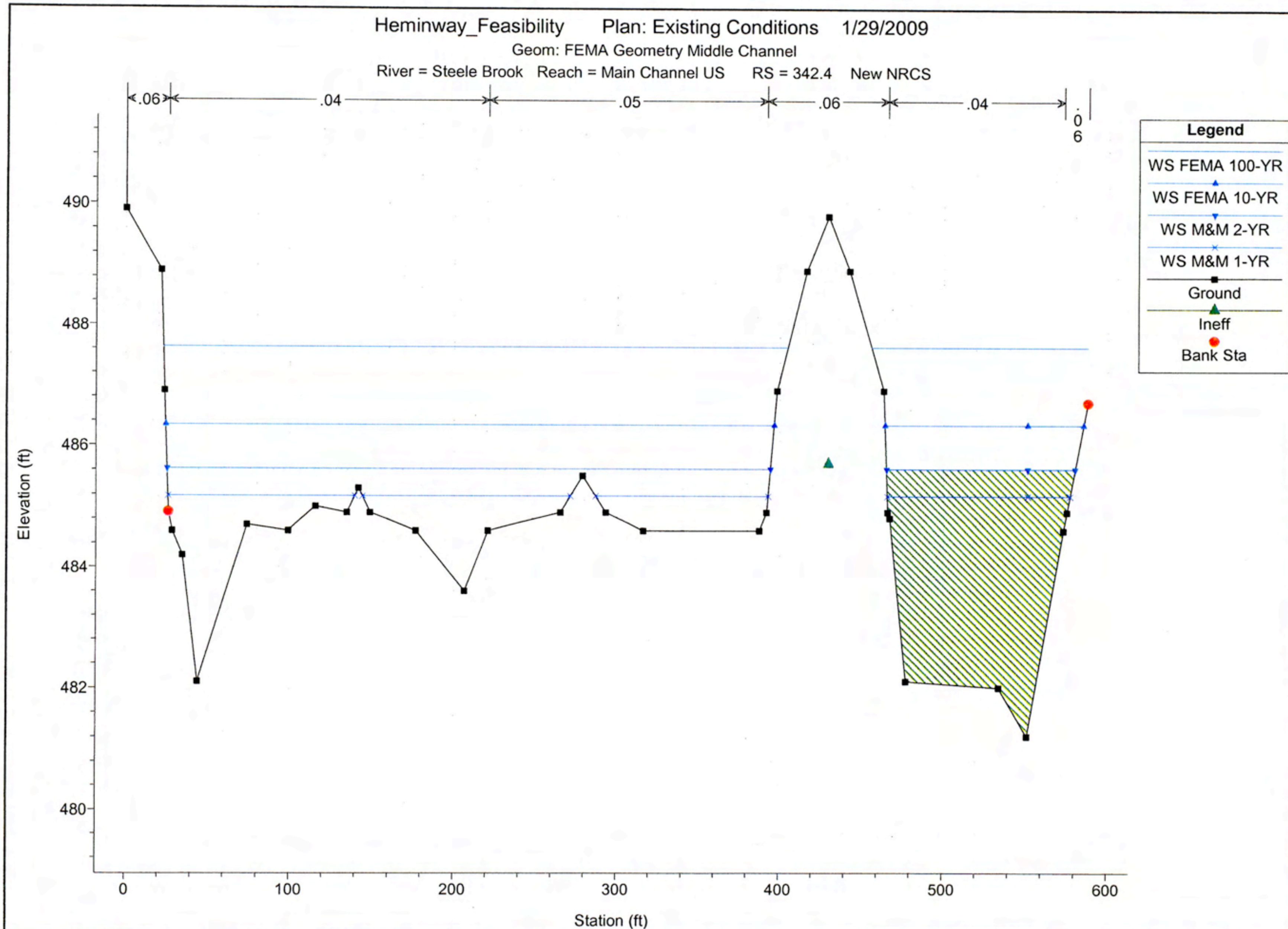
1 in Horiz. = 200 ft 1 in Vert. = 2 ft

HEC-RAS Plan: EXIST River: Steele Brook Reach: Main Channel US

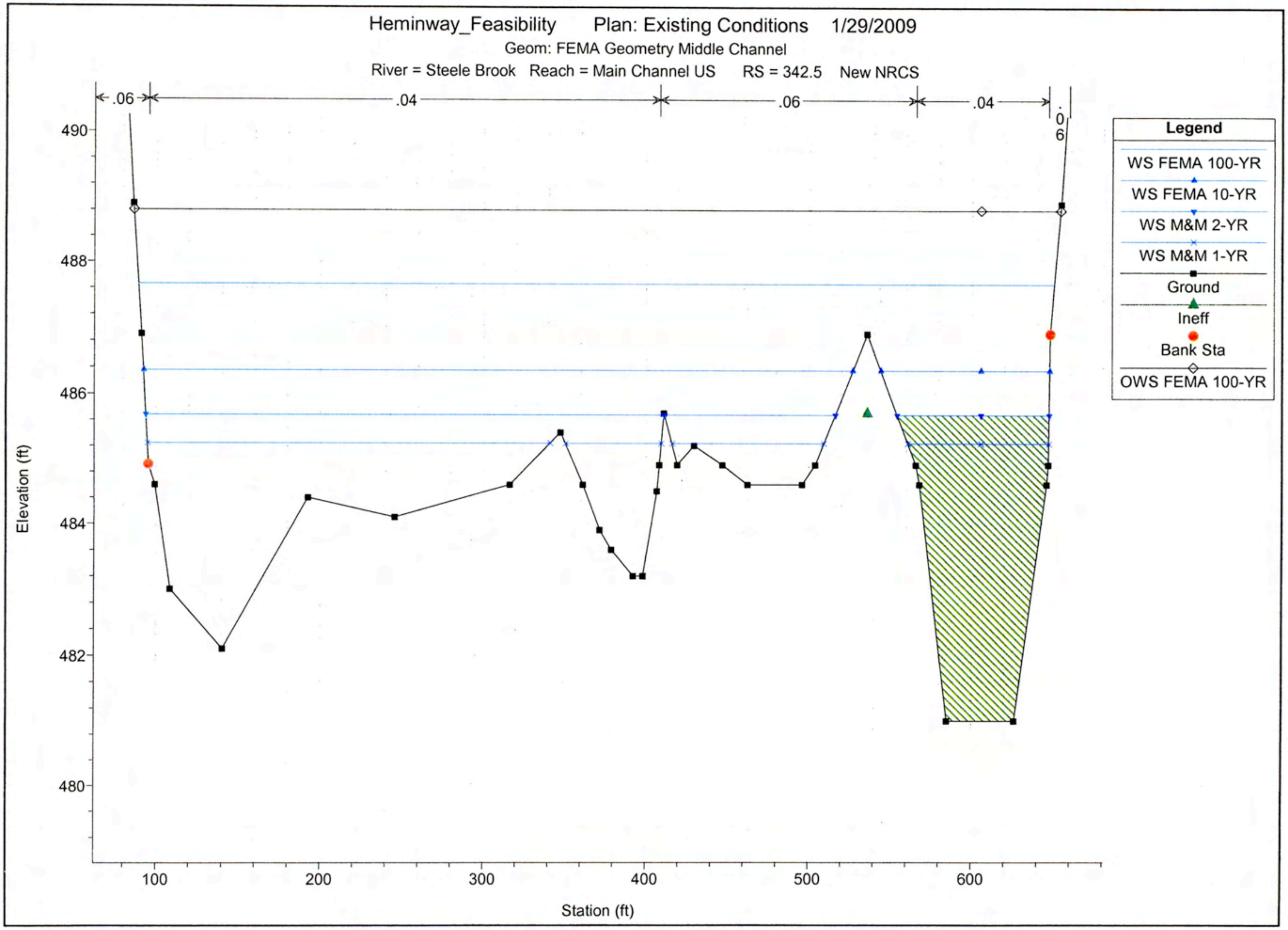
Reach	River Sta		Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel US	347	AQ	FEMA 100-YR	2060.00	488.80	495.49	494.17	496.44	0.006461	7.82	263.30	59.98	0.66
Main Channel US	347	AQ	FEMA 10-YR	820.00	488.80	493.68	492.03	494.07	0.003679	4.97	165.01	48.85	0.48
Main Channel US	347	AQ	M&M 2-YR	405.00	488.80	492.38	490.95	492.60	0.003030	3.81	106.41	40.80	0.42
Main Channel US	347	AQ	M&M 1-YR	221.00	488.80	491.46	490.29	491.60	0.002767	3.09	71.50	35.13	0.38
Main Channel US	346	AP	FEMA 100-YR	2060.00	487.00	493.36	492.84	493.99	0.005183	6.99	443.84	243.63	0.59
Main Channel US	346	AP	FEMA 10-YR	820.00	487.00	491.78	490.74	492.23	0.005507	5.41	158.61	101.37	0.57
Main Channel US	346	AP	M&M 2-YR	405.00	487.00	490.41	489.69	490.78	0.007099	4.84	83.67	42.55	0.61
Main Channel US	346	AP	M&M 1-YR	221.00	487.00	489.63	488.99	489.89	0.006914	4.13	53.56	33.89	0.58
Main Channel US	345	AO	FEMA 100-YR	2060.00	484.50	490.24	490.24	491.11	0.007982	8.35	385.03	233.93	0.72
Main Channel US	345	AO	FEMA 10-YR	820.00	484.50	488.95	487.91	489.52	0.006568	6.08	134.89	45.18	0.62
Main Channel US	345	AO	M&M 2-YR	405.00	484.50	487.86	486.75	488.17	0.004795	4.50	89.99	37.36	0.51
Main Channel US	345	AO	M&M 1-YR	221.00	484.50	486.78	486.00	487.04	0.005785	4.10	53.89	29.61	0.54
Main Channel US	344	344	FEMA 100-YR	2060.00	483.00	487.95	487.46	488.29	0.009053	5.64	484.10	258.52	0.69
Main Channel US	344	344	FEMA 10-YR	820.00	483.00	486.76	486.76	487.18	0.012686	6.04	204.68	203.02	0.78
Main Channel US	344	344	M&M 2-YR	405.00	483.00	486.17	485.27	486.62	0.008067	5.50	94.53	169.75	0.63
Main Channel US	344	344	M&M 1-YR	221.00	483.00	485.67	484.53	485.89	0.003659	3.80	58.13	23.56	0.43
Main Channel US	342.8		FEMA 100-YR	2060.00	482.30	487.83	486.82	487.99	0.003047	4.81	789.43	383.93	0.43
Main Channel US	342.8		FEMA 10-YR	820.00	482.30	486.46	486.10	486.66	0.005099	4.77	317.18	282.63	0.52
Main Channel US	342.8		M&M 2-YR	405.00	482.30	485.64	485.62	486.00	0.010719	5.52	120.35	186.37	0.72
Main Channel US	342.8		M&M 1-YR	221.00	482.30	485.32	485.05	485.56	0.007710	4.20	73.16	115.51	0.60
Main Channel US	342.7		FEMA 100-YR	2060.00	482.30	487.71	485.37	487.75	0.000432	1.60	1305.71	483.04	0.17
Main Channel US	342.7		FEMA 10-YR	820.00	482.30	486.39	485.01	486.41	0.000327	1.16	712.30	389.28	0.15
Main Channel US	342.7		M&M 2-YR	405.00	482.30	485.73	485.00	485.74	0.000226	0.83	491.81	291.80	0.11
Main Channel US	342.7		M&M 1-YR	221.00	482.30	485.32	484.82	485.33	0.000242	0.78	282.81	273.71	0.11
Main Channel US	342.65			Lat Struct									
Main Channel US	342.6		FEMA 100-YR	1822.43	482.40	487.68	485.48	487.69	0.000197	1.11	1862.58	629.53	0.11
Main Channel US	342.6		FEMA 10-YR	777.42	482.40	486.37	484.54	486.38	0.000152	0.83	1061.42	560.23	0.10
Main Channel US	342.6		M&M 2-YR	398.21	482.40	485.71	484.10	485.71	0.000100	0.61	715.53	486.98	0.08
Main Channel US	342.6		M&M 1-YR	220.61	482.40	485.27	483.74	485.29	0.000349	0.87	280.79	433.47	0.14

HEC-RAS Plan: EXIST River: Steele Brook Reach: Main Channel US

Reach	River Sta		Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
				(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Main Channel US	347	AQ	FEMA 100-YR	496.44	495.49	0.95	2.36	0.10		2060.00		59.98
Main Channel US	347	AQ	FEMA 10-YR	494.07	493.68	0.38	1.83	0.01		820.00		48.85
Main Channel US	347	AQ	M&M 2-YR	492.60	492.38	0.22	1.82	0.01		405.00		40.80
Main Channel US	347	AQ	M&M 1-YR	491.60	491.46	0.15	1.70	0.01		221.00		35.13
Main Channel US	346	AP	FEMA 100-YR	493.99	493.36	0.62	2.86	0.03	366.08	1660.86	33.06	243.63
Main Channel US	346	AP	FEMA 10-YR	492.23	491.78	0.45	2.70	0.01	3.03	815.18	1.79	101.37
Main Channel US	346	AP	M&M 2-YR	490.78	490.41	0.36	2.60	0.01		405.00		42.55
Main Channel US	346	AP	M&M 1-YR	489.89	489.63	0.26	2.84	0.00		221.00		33.89
Main Channel US	345	AO	FEMA 100-YR	491.11	490.24	0.87	2.23	0.16	24.72	1630.55	404.73	233.93
Main Channel US	345	AO	FEMA 10-YR	489.52	488.95	0.57	2.29	0.05		820.00		45.18
Main Channel US	345	AO	M&M 2-YR	488.17	487.86	0.31	1.53	0.01		405.00		37.36
Main Channel US	345	AO	M&M 1-YR	487.04	486.78	0.26	1.14	0.01		221.00		29.61
Main Channel US	344	344	FEMA 100-YR	488.29	487.95	0.34	0.24	0.05	1045.20	1014.81		258.52
Main Channel US	344	344	FEMA 10-YR	487.18	486.76	0.42	0.44	0.07	247.20	572.80		203.02
Main Channel US	344	344	M&M 2-YR	486.62	486.17	0.45	0.60	0.02	16.33	388.67		169.75
Main Channel US	344	344	M&M 1-YR	485.89	485.67	0.22	0.33	0.00		221.00		23.56
Main Channel US	342.8		FEMA 100-YR	487.99	487.83	0.16	0.21	0.04	496.65	602.39	960.96	383.93
Main Channel US	342.8		FEMA 10-YR	486.66	486.46	0.20	0.19	0.05	67.08	387.94	364.97	282.63
Main Channel US	342.8		M&M 2-YR	486.00	485.64	0.37	0.16	0.11	1.77	307.83	95.41	186.37
Main Channel US	342.8		M&M 1-YR	485.56	485.32	0.24	0.16	0.07		193.77	27.23	115.51
Main Channel US	342.7		FEMA 100-YR	487.75	487.71	0.04	0.05	0.01	4.42	2042.46	13.13	483.04
Main Channel US	342.7		FEMA 10-YR	486.41	486.39	0.02	0.03	0.00	0.72	817.23	2.05	389.28
Main Channel US	342.7		M&M 2-YR	485.74	485.73	0.01	0.02	0.00	0.12	404.53	0.35	291.80
Main Channel US	342.7		M&M 1-YR	485.33	485.32	0.01	0.05	0.00	0.02	220.98		273.71
Main Channel US	342.65			Lat Struct								
Main Channel US	342.6		FEMA 100-YR	487.69	487.68	0.02	0.03	0.00	274.52	1544.46	3.45	629.53
Main Channel US	342.6		FEMA 10-YR	486.38	486.37	0.01	0.02	0.00	66.44	710.43	0.55	560.23
Main Channel US	342.6		M&M 2-YR	485.71	485.71	0.01	0.03	0.00	17.59	380.52	0.09	486.98
Main Channel US	342.6		M&M 1-YR	485.29	485.27	0.01	0.05	0.00	7.71	212.89		433.47



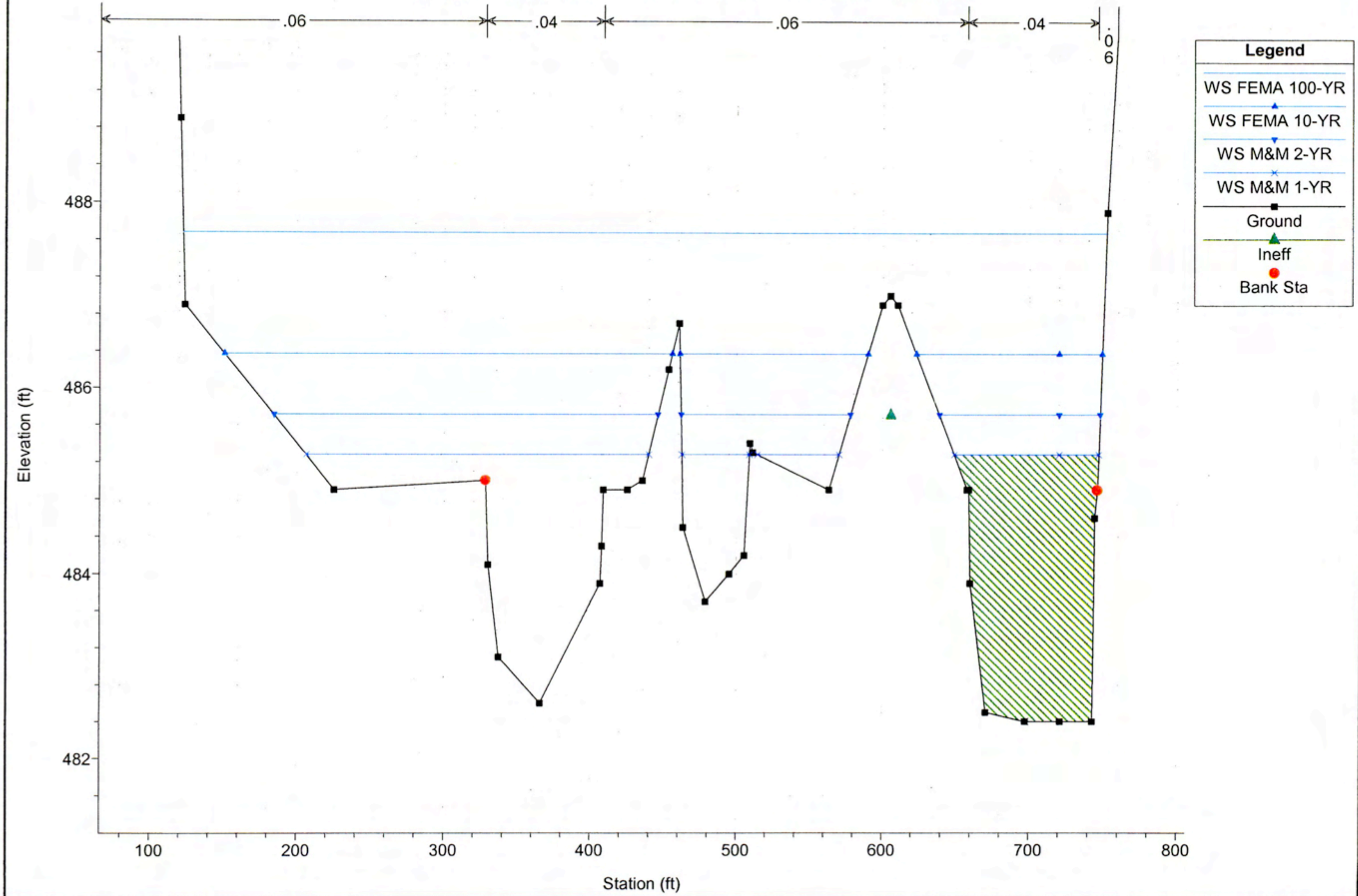
Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
River = Steele Brook Reach = Main Channel US RS = 342.4 New NRCS
.06
.04
.05
.06
.04
.06
Legend
WS FEMA 100-YR
WS FEMA 10-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
Ineff
Bank Sta
Elevation (ft)
490
488
486
484
482
480
0
100
200
300
400
500
600
Station (ft)

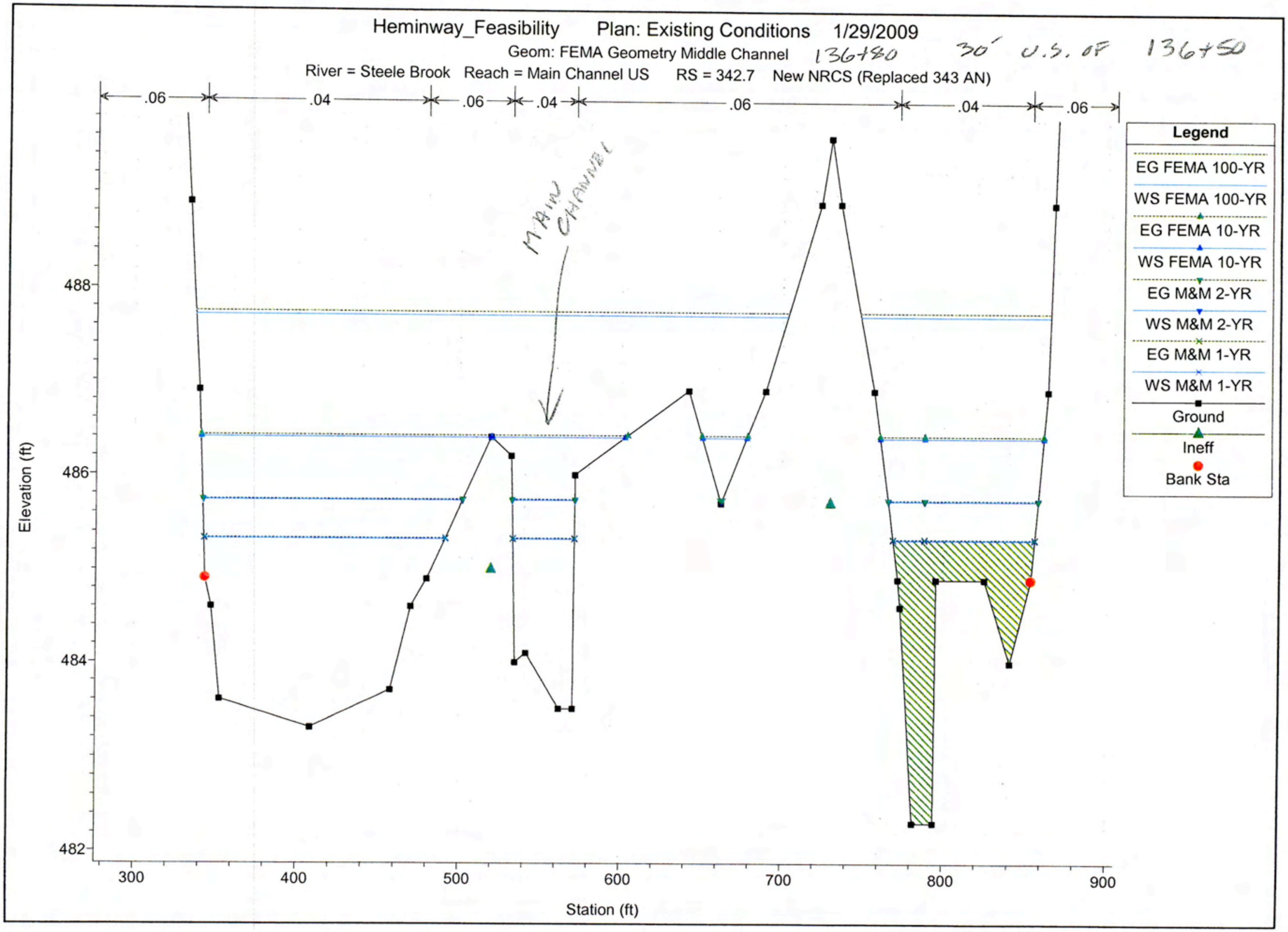

Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
River = Steele Brook Reach = Main Channel US RS = 342.5 New NRCS
.06
.04
.06
.04
0
6
Legend
WS FEMA 100-YR
WS FEMA 10-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
Ineff
Bank Sta
OWS FEMA 100-YR
Elevation (ft)
490
488
486
484
482
480
100
200
300
400
500
600
Station (ft)

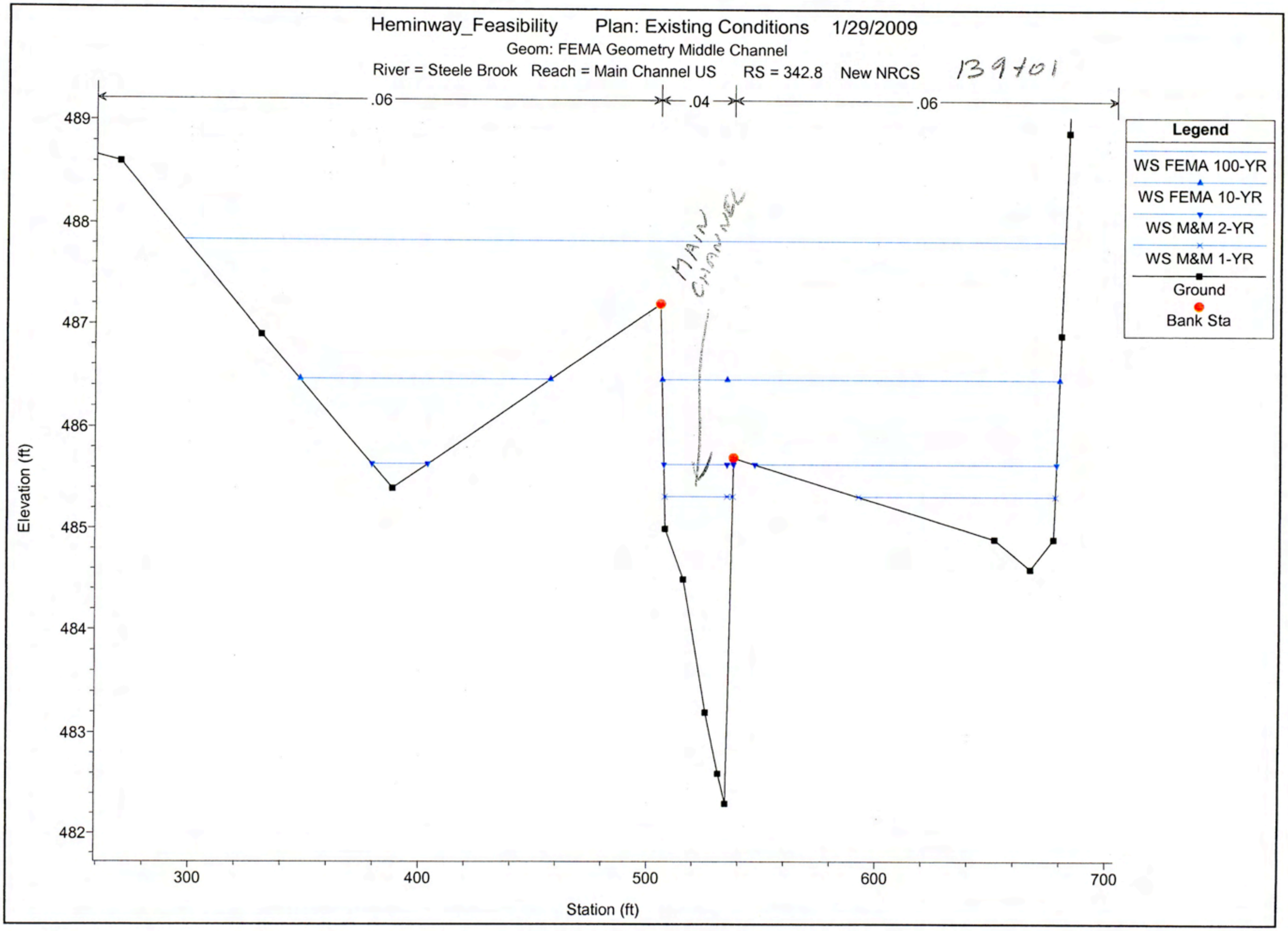
Heminway_Feasibility Plan: Existing Conditions 1/29/2009

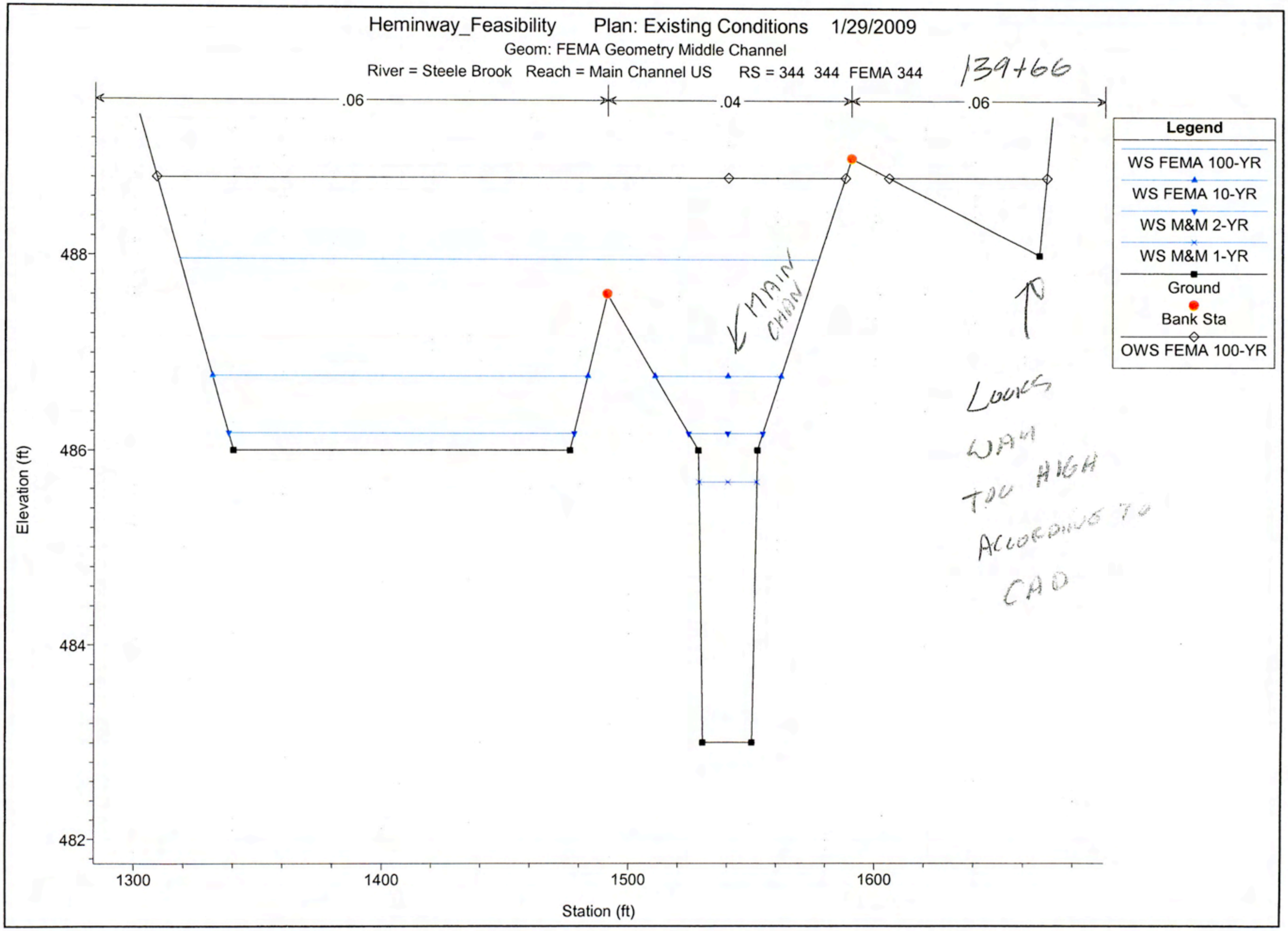
Geom: FEMA Geometry Middle Channel

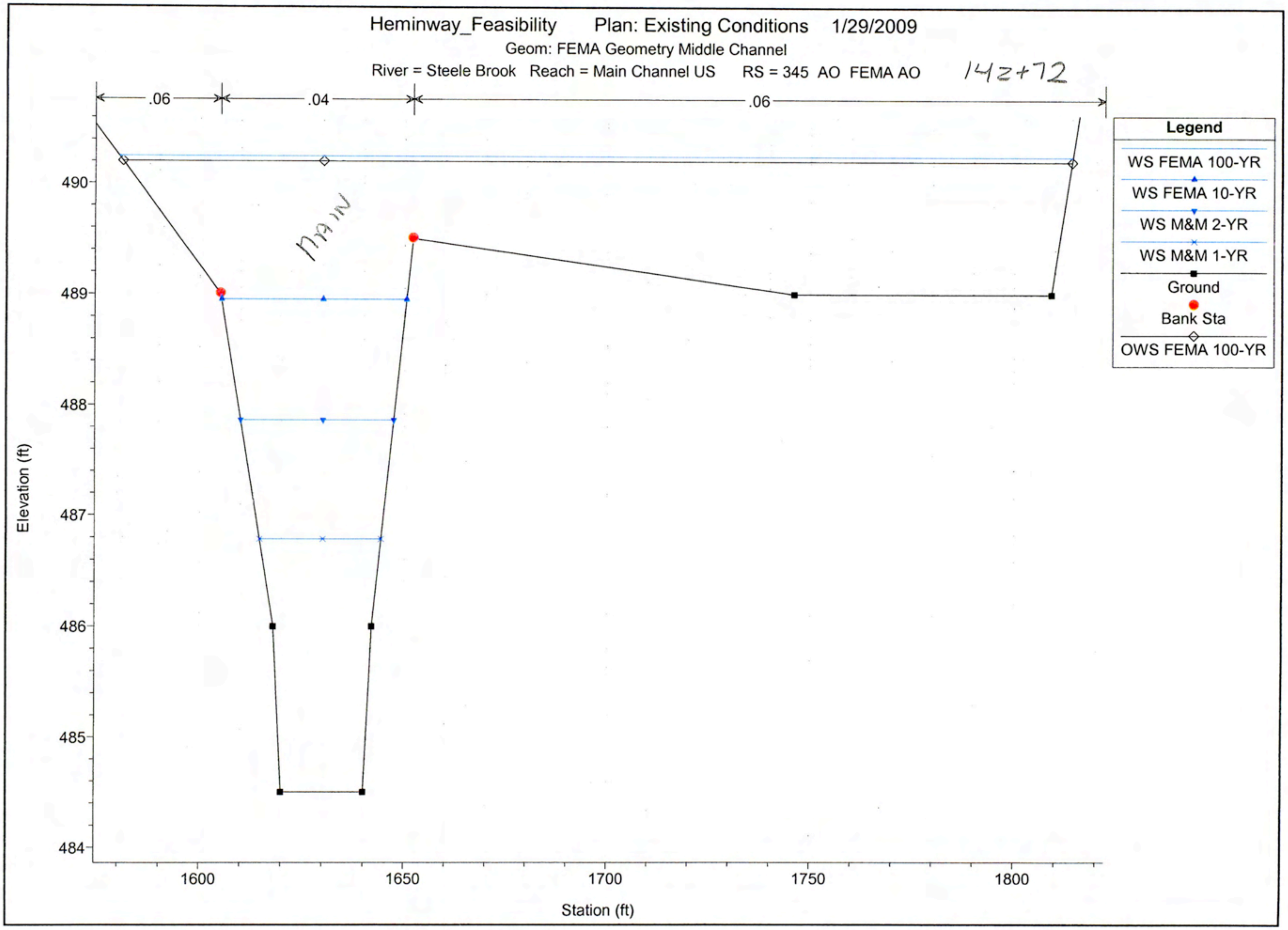
River = Steele Brook Reach = Main Channel US RS = 342.6 New NRCS



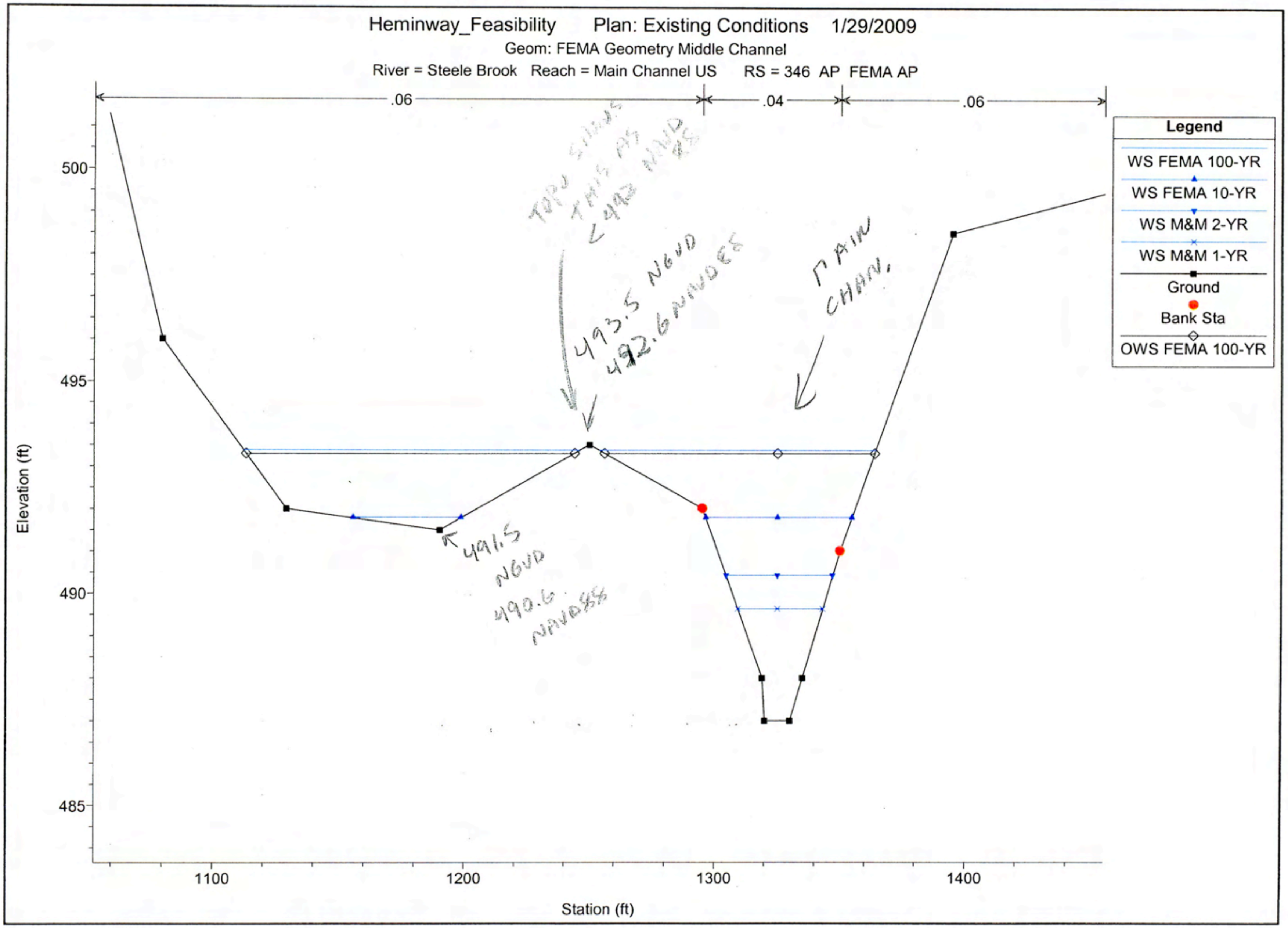

Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
136+80 30' U.S. OF 136+50
River = Steele Brook Reach = Main Channel US RS = 342.7 New NRCS (Replaced 343 AN)
.06
.04
.06
.04
.06
.04
.06
MAIN CHANNEL
Legend
EG FEMA 100-YR
WS FEMA 100-YR
EG FEMA 10-YR
WS FEMA 10-YR
EG M&M 2-YR
WS M&M 2-YR
EG M&M 1-YR
WS M&M 1-YR
Ground
Ineff
Bank Sta
Elevation (ft)
488
486
484
482
300
400
500
600
700
800
900
Station (ft)


Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
River = Steele Brook Reach = Main Channel US RS = 342.8 New NRCS
139+01
.06
.04
.06
MAIN CHANNEL
Legend
WS FEMA 100-YR
WS FEMA 10-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
Bank Sta
Elevation (ft)
489
488
487
486
485
484
483
482
Station (ft)
300
400
500
600
700


Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
River = Steele Brook Reach = Main Channel US RS = 344 344 FEMA 344
139+66
.06
.04
.06
Legend
WS FEMA 100-YR
WS FEMA 10-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
Bank Sta
OWS FEMA 100-YR
MAIN CHAN
LOOKS WAY TOO HIGH ACCORDING TO CAD
Elevation (ft)
488
486
484
482
1300
1400
1500
1600
Station (ft)


Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
River = Steele Brook Reach = Main Channel US RS = 345 AO FEMA AO
14z+72
.06
.04
.06
Main
Legend
WS FEMA 100-YR
WS FEMA 10-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
Bank Sta
OWS FEMA 100-YR
Elevation (ft)
490
489
488
487
486
485
484
1600
1650
1700
1750
1800
Station (ft)

38 of —


Heminway_Feasibility Plan: Existing Conditions 1/29/2009
Geom: FEMA Geometry Middle Channel
River = Steele Brook Reach = Main Channel US RS = 346 AP FEMA AP
.06
.04
.06
Legend
WS FEMA 100-YR
WS FEMA 10-YR
WS M&M 2-YR
WS M&M 1-YR
Ground
Bank Sta
OWS FEMA 100-YR
Elevation (ft)
500
495
490
485
Station (ft)
1100
1200
1300
1400
MAIN CHAN.
493.5 NGVD
492.6 NAVD88
491.5 NGVD
490.6 NAVD88

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/1/09	Checked by	Date	Job No.
Subject			Sheet 40 of

NOW ESTIMATE TRACTIVE STRESSES THROUGH POND
FROM 341.1 DAM (128+94)
TO 342.7 (~~135~~+80) JUST 30' US OF 13650

GET ENERGY GRADE ELEV: (FROM TABLE SHT 41)
DIST = 13680 - 12894 = 786 FT

YR-FLOOD	E.G. ELEV 342.7 13680	E.G. ELEV 342.1 DAM	ΔH E.G. (FT)	DIST BETWEEN XSECS (FT)	E.G. SLOPE
1	485.33	485.09	.24	786	.000305
2	485.74	485.48	.26	↕	.00033
10	486.41	486.13	.28	↕	.00036
100	487.75	487.31	.44	↓	.00056

GET EXISTING TRACTIVE STRESS ACROSS POND
USE T = γDS   GET MAX D. FROM PG 41
MAX D = WS - MIN CHAN ELEV   AT XSEC 342.4

YR FLOOD	MAX DEPTH (FT)	E.G. SLOPE	T (LB/FT²)
1	3.96	.000305	0.075
2	4.41	.00033	0.0908
10	5.13	.00036	0.1152
100	6.42	.00056	0.224 ← ALMOST TRIPLE T 1½ YR.

NOTE: ~~THE~~ PRESENT T 1½ YR = .082 LB/FT²
NEW 1½ YR T = .5 LB/FT²

INCREASE = $\frac{.5}{.082}$ = 6.1 TIMES GREATER

HEC-RAS Plan: EXIST River: Steele Brook Reach: Main Channel US

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Min Ch El	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Main Channel US	342.8	FEMA 100-YR	487.99	487.83	482.30	0.16	0.21	0.04	496.65	602.39	960.96	383.93
Main Channel US	342.8	FEMA 10-YR	486.66	486.46	482.30	0.20	0.19	0.05	67.08	387.94	364.97	282.63
Main Channel US	342.8	M&M 2-YR	486.00	485.64	482.30	0.37	0.16	0.11	1.77	307.83	95.41	186.37
Main Channel US	342.8	M&M 1-YR	485.56	485.32	482.30	0.24	0.16	0.07		193.77	27.23	115.51
Main Channel US	342.7 13680	FEMA 100-YR	487.75	487.71	482.30	0.04	0.05	0.01	4.42	2042.46	13.13	483.04
Main Channel US	342.7	FEMA 10-YR	486.41	486.39	482.30	0.02	0.03	0.00	0.72	817.23	2.05	389.28
Main Channel US	342.7	M&M 2-YR	485.74	485.73	482.30	0.01	0.02	0.00	0.12	404.53	0.35	291.80
Main Channel US	342.7	M&M 1-YR	485.33	485.32	482.30	0.01	0.05	0.00	0.02	220.98		273.71
Main Channel US	342.65		Lat Struct									
Main Channel US	342.6	FEMA 100-YR	487.69	487.68	482.40	0.02	0.03	0.00	274.52	1544.46	3.45	629.53
Main Channel US	342.6	FEMA 10-YR	486.38	486.37	482.40	0.01	0.02	0.00	66.44	710.43	0.55	560.23
Main Channel US	342.6	M&M 2-YR	485.71	485.71	482.40	0.01	0.03	0.00	17.59	380.52	0.09	486.98
Main Channel US	342.6	M&M 1-YR	485.29	485.27	482.40	0.01	0.05	0.00	7.71	212.89		433.47
Main Channel US	342.5	FEMA 100-YR	487.66	487.65	481.00	0.01	0.02	0.00	2.73	1819.55	0.14	560.98
Main Channel US	342.5	FEMA 10-YR	486.35	486.35	481.00	0.01	0.02	0.00	0.43	776.99		538.06
Main Channel US	342.5	M&M 2-YR	485.68	485.67	481.00	0.01	0.05	0.00	0.12	398.09		515.08
Main Channel US	342.5	M&M 1-YR	485.24	485.23	481.00	0.00	0.06	0.00	0.01	220.59		484.88
Main Channel US	342.45		Lat Struct									
Main Channel US	342.4	FEMA 100-YR	487.64	487.62	481.20	0.02	0.01	0.00	1.33	1813.66		513.51
Main Channel US	342.4	FEMA 10-YR	486.34	486.33	481.20	0.01	0.01	0.00	0.20	777.22		492.69
Main Channel US	342.4	M&M 2-YR	485.62	485.61	481.20	0.02	0.02	0.00	0.08	398.12		483.56
Main Channel US	342.4	M&M 1-YR	485.18	485.16	481.20	0.01	0.01	0.00	0.01	220.60		457.57
Main Channel US	342.3	FEMA 100-YR	487.62	487.62	481.60	0.01	0.01	0.00	0.64	833.97	430.54	381.00
Main Channel US	342.3	FEMA 10-YR	486.33	486.32	481.60	0.00	0.01	0.00	0.09	382.84	200.31	375.50
Main Channel US	342.3	M&M 2-YR	485.60	485.60	481.60	0.00	0.01	0.00	0.01	286.45	1.07	346.49
Main Channel US	342.3	M&M 1-YR	485.16	485.16	481.60	0.00	0.00	0.00	0.00	145.96	0.12	326.07
Main Channel US	342.2	FEMA 100-YR	487.61	487.55	481.30	0.05	0.02	0.28		1265.15		229.49
Main Channel US	342.2	FEMA 10-YR	486.32	486.30	481.30	0.02	0.01	0.17		583.24		221.98
Main Channel US	342.2	M&M 2-YR	485.60	485.59	481.30	0.01	0.01	0.11		287.54		219.61
Main Channel US	342.2	M&M 1-YR	485.16	485.16	481.30	0.00	0.00	0.07		146.08		218.17
Main Channel US	342.1 HEMINWAY DAM	FEMA 100-YR	487.31	486.33	484.40	0.97	0.02	0.27		1265.15		82.70
Main Channel US	342.1 HEMINWAY DAM	FEMA 10-YR	486.13	485.55	484.40	0.58	0.02	0.16		583.24		82.66
Main Channel US	342.1 HEMINWAY DAM	M&M 2-YR	485.48	485.12	484.40	0.36	0.14	0.08		287.54		82.64
Main Channel US	342.1 HEMINWAY DAM	M&M 1-YR	485.09	484.86	484.40	0.23	0.34	0.03		146.08		82.62

12894

Computation Sheet
NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project		
	STEELE BROOKE		
By: CEG	Date: 2/2/09	Checked by	Date	Job No.
Subject			Sheet 42 of

REFINE BANKFULL CHANNEL GEOMETRY

TODD NEEDS EXISTING ENERGY GRADE FOR BANKFULL AT REFERENCE RIFFLE 140+17.73

FROM SHT 34.1 MEASURED ENERGY GRADE OF 1-YR FROM 344 TO 345 SEE SHEET 34.2

ENERGY GRADE DROP 1-YR: 487.04 - 485.89 = 1.15 FT
CHANNEL DIST. FROM PROF. = 244'

$S = \frac{1.15}{244} = .0047$ TODD AND I SAID N = .035 IS REASONABLE

LOOK AT XSECS 344 SHT 37   ALL 1-YR CONT. IN CHANNEL
345   ALL 1-YR 2, 410 CONTAINED IN CHANNEL

HEC-RAS USES 1-YR Q = 221 CFS HERE. Q_2 = 405

NOTE M & McBr TR-20 HAD Q_2 = 405 CFS.

USGS 2-YR = 221 NON URB
350 URBANIZED SHT 16.3 BUT USED VERY LOOSE BF RATIO

TODD AND I DID FOLLOWING WORK OVER THE PHONE
RIVERMORPH FOR REFERENCE RIFFLE HAS
N = .035
d_{50} = 13 mm
S = .0047
Bkfl Width = 39.49 FT
BK Depth = 3.5 MAX DEPTH   MEAN DEPTH = 2.38   R = 2.25'
AREA 94.08 FT²
V = 5.0 FT/SEC
Q = 470 CFS   > M & McBr 2-YR
T = 0.66 LB/FT²

IF TODD USES Bkfl Field Meas. Slope = .0021 MEAS FROM RIFFLE TO 200' D.S. STEEPEST ~~AREA~~ REACH IN VICINITY.
V = 3.34
Q_2 = 341.4
T = 0.29 LB/FT²

IF USES

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/2/09	Checked by	Date	Job No.
Subject			Sheet 43.1 of

REFINE EXISTING TRACTIVE STRESS FOR BANKFULL FLOW AT THE REFERENCE RIFFLE. (140+17.73)

REFINING TRACTIVE STRESS AT THE REFERENCE RIFFLE WILL HELP ANALYZE HOW STABLE THE EXISTING STREAM BED IS. WATER SURFACE SLOPE OR ENERGY GRADE IS AN IMPORTANT INPUT VARIABLE TO TRACTIVE STRESS. TODD'S PRIOR BANKFULL SHOTS AT THE REFERENCE RIFFLE AND GOING DOWNSTREAM SHOWED BANKFULL SLOPE = .0021. HOWEVER, THERE WERE NOT ENOUGH OF THEM TO BE FULLY CONFIDENT TO SAY HOW ACCURATE THIS WAS. THE HEC-RAS 1-YR ENERGY GRADE SLOPE IS ,0047.

TO MEASURE THIS SLOPE ANOTHER WAY THE AVERAGE STREAM BOTTOM ELEV. OF THE REFERENCE RIFFLE AND SEWER LINE RIFFLE UPSTREAM AT 142+31 WERE DETERMINED AND A SLOPE CALCULATED. SEE SHTS 44.1–44.3, 45.1-45.3 TODD SENT THIS DATA FROM RIVERMORPH

FOR REFERENCE RIFFLE AV. ELEV OF APPROX. EQUAL SPACED POINTS OVER THE RIFFLE = 483.40 FOR BW = 37'

FOR SEWER LINE RIFFLE AV. ELEV = 483.92 FOR BOT. WIDTH = 25'

CHANNEL DISTANCE BETWEEN RIFFLES FROM HEC-RAS PROFILE SHT 34.1 = 150'
FROM PLAN VIEW SHT 10 = 206' PL ON CAD = 211'
FROM TODD'S NOTES = 197'
(213' YELLOW LINE ON CAD)

HEC-RAS 345 TO 344 = 250 FT
345 IS 41' US OF UPSTREAM RIFFLE
344 IS 52' DS OF REF RIFFLE
} BEN HAS ELIMINATED THESE
SO DIST BETWEEN RIFFLES = 250-41-52 = 157 FT

BEN SAID THE YELLOW LINE BETWEEN SEWER RIFFLE AND THE REFERENCE RIFFLE IS THE REAL DISTANCE = 213 FT

SLOPE BETWEEN RIFFLES = $\frac{483.92 - 483.40}{213} \cong .00244$

NOTE THESE ELEVATIONS REPRESENT DIFFERENT BOTTOM WIDTHS SLOPE MIGHT NOT BE THAT VALID.

Computation Sheet

NRCS–ENG–523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE		
By CEG	Date 2/2/09	Checked by	Date	Job No.
Subject			Sheet 43.2 of

ANOTHER WAY TO ESTIMATE THE SLOPE IS TO

TAKE WATER SURFACE AT EST. BANKFUL = 433 CFS (NOTE THIS HAS SOME ERROR BECAUSE WE ASSUMED A SLOPE OF .0035 AT BOTH XSECS TO GET WATER SURFACE) AND ADD VELOCITY HEAD.

FROM SHT 44.4 AT W.S. ELEV 486.11 Q = 433 CFS

V = 4.42 FT/SEC

VEL. HEAD = $\frac{(4.42)^2}{2(32.2)} = 0.303$ FT

E.G. ELEV = 486.11 + .303 = 486.41 FT

FROM SHT 45.4

AT SEWER LINE RIFFLE W.S. ELEV = 487.1 Q = 433

VEL. = 3.77 FT/SEC

VEL H. = $\frac{3.77^2}{2(32.2)} = 0.22$

ENERGY GRADE = 487.1 + 0.22 = 487.32

ENERGY GRADE SLOPE BETWEEN THE 2 RIFFLES ≈

$$\frac{487.32 - 486.41}{213} \cong .00427$$

IF WE AVERAGE THE TWO SLOPE METHODS WE GET

$$\frac{.00244 + .00427}{2} = .0034$$

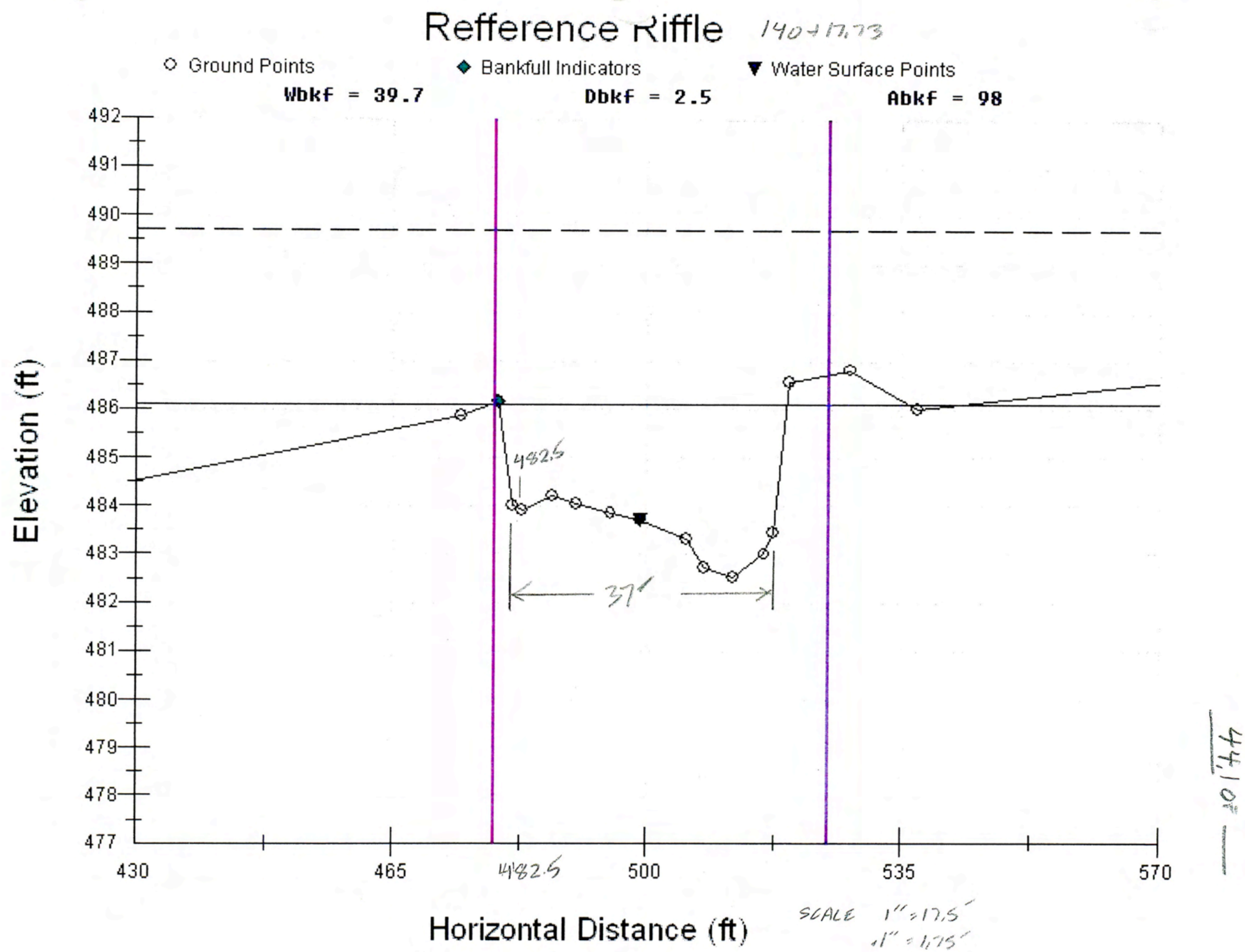
THIS IS OUR BEST ESTIMATE OF THE BANKFUL ENERGY GRADE EXISTING AT THE REFERENCE RIFFLE. IT HAS A MEAN DEPTH OF 2.47 FT.

TRACTIVE STRESS AT THE REF RIFFLE (T) = γDS

$T = \frac{62.4 \text{ LB}}{\text{FT}^3}(2.47)\text{FT}(.0034) = 0.52 \text{ LB}/\text{FT}^2$

FROM SHT 31.2

TODD'S SHIELD'S ENTRAINMENT FOR T = 0.5 LB/FT² ENTRAINS A 28.6 mm PARTICLE OR 1.2" D50 RIFFLE = 0.5" AND D84 = 2.1 INCHES, SO THIS RIFFLE PROBABLY MOBILIZES IN BANKFULL EVEN


Refference Riffle
140+17.73
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 39.7
Dbkf = 2.5
Abkf = 98
Elevation (ft)
492
491
490
489
488
487
486
485
484
483
482
481
480
479
478
477
482.5
37'
430
465
482.5
500
535
570
Horizontal Distance (ft)
SCALE 1" = 17.5'
.1" = 1.75'
44.10'

Reference-Riffle-Summary Report.txt
RIVERMORPH CROSS SECTION SUMMARY

River Name: Steele Brook
Reach Name: Reach 1
Cross Section Name: G-Riffle-2
Survey Date: 09/25/08

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	500	
30.694	0	498	
59.016	0	496	
94.795	0	494	
132.581	0	492	
169.482	0	490	
207.207	0	488	
294.936	0	486	
342.813	0	484	
381.99	0	483.211	
413.256	0	484	
474.498	0	485.87	
479.54	0	486.17	BKF
481.566	0	484.01	
482.739	0	483.91	
487.027	0	484.22	
490.3	0	484.04	
495	0	483.85	
498.953	0	483.7	LEW
505.397	0	483.3	
507.848	0	482.71	
511.856	0	482.51	
516.103	0	483	
517.311	0	483.44	
519.571	0	486.55	
527.786	0	486.81	
537.085	0	486	
656.479	0	488	
659.841	0	490	
663.48	0	492	
667.129	0	494	
670.882	0	496	
677.706	0	498	
684.717	0	500	

SKIP TOO CLOSE

AV. ELEV. BOXED PTS FROM STREAMBED = 4350.56/9 = 483.40

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	489.69	489.69	489.69
Bankfull Elevation (ft)	486.1	486.1	486.1
Floodprone Width (ft)	483.99	-----	-----
Bankfull Width (ft)	39.64	17.56	22.07
Entrenchment Ratio	12.21	-----	-----

Mean Depth (ft)	2.46	1.98	2.85
Maximum Depth (ft)	3.59	2.33	3.59
Width/Depth Ratio	16.11	8.87	7.74
Bankfull Area (sq ft)	97.64	34.83	62.8
Wetted Perimeter (ft)	42.12	20.83	25.95
Hydraulic Radius (ft)	2.32	1.67	2.42
Begin BKF Station	479.61	479.61	497.17
End BKF Station	519.24	497.17	519.24

Entrainment Calculations

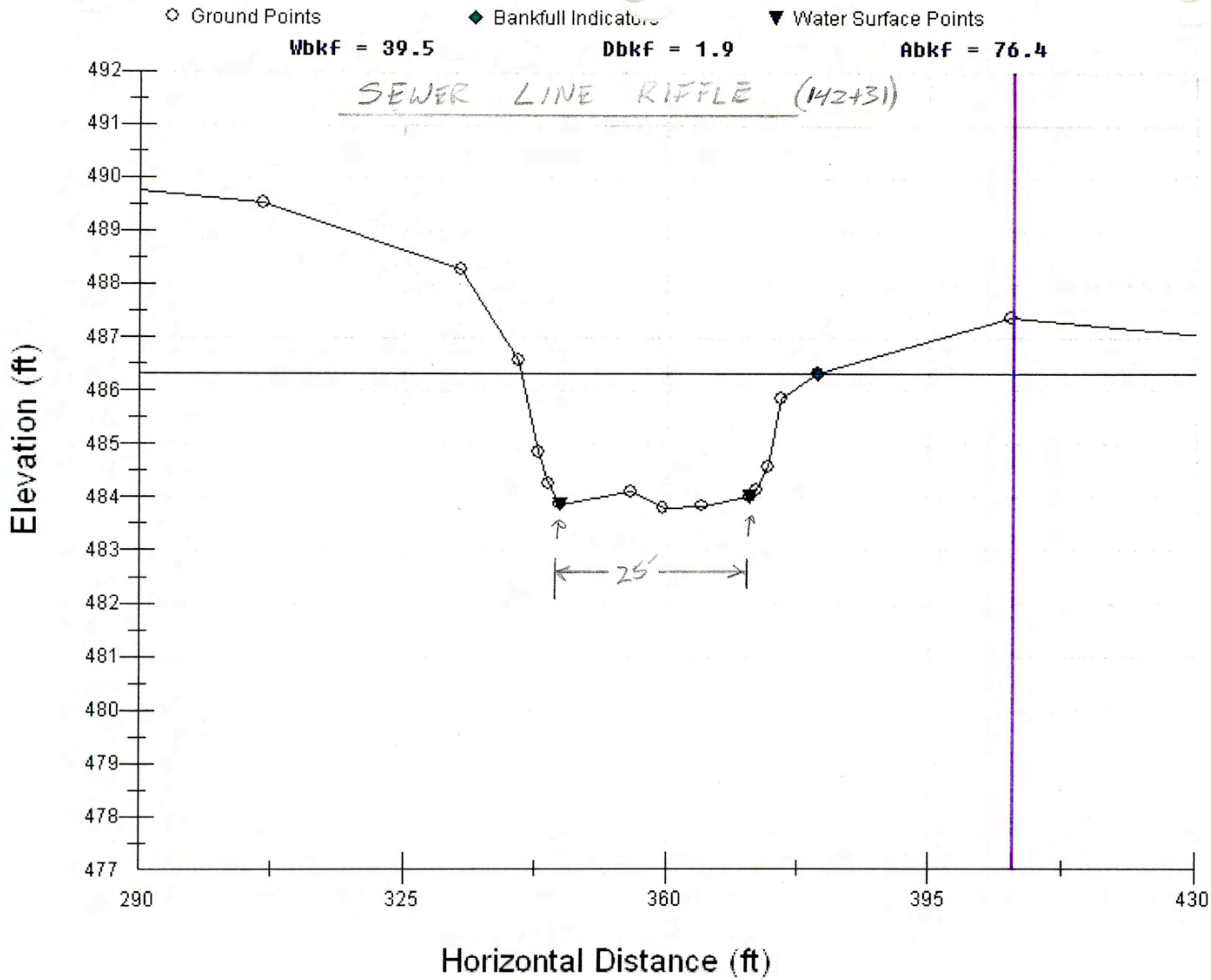
Entrainment Formula: Shields Curve

	Channel	Left Side	Right Side
Slope	0.0035	0	0
Shear Stress (lb/sq ft)	0.51		
Movable Particle (mm)	29.3		

REFERENCE RIFFLE - (R-RIFFLE)

ELEV	DEPTH	AREA	WET PER	WIDTH	HYD RAD	MEAN D	SLOPE	ROUGH	R/D84	VELOCITY	U/U*	U^2/2g	DISCHARGE	SHEAR	POWER	POWER/W	FROUDE	TRANSPORT
(ft)	(ft)	(sq ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	[n] (ft^(1/6))		(fps)		(ft)	(cfs)	(psf)	(lb/s)	(lb/ft/s)		(lb/s)
485.21	2.7	63.02	39.8	38.16	1.58	1.65	0.0035	0.035	0	3.41	8.08	0.18	214.81	0.35	46.91	1.23	0.47	1.44
485.31	2.8	66.84	40.06	38.32	1.67	1.74	0.0035	0.035	0	3.54	8.15	0.19	236.4	0.36	51.63	1.35	0.47	2.46
485.41	2.9	70.68	40.32	38.49	1.75	1.84	0.0035	0.035	0	3.65	8.22	0.21	257.9	0.38	56.33	1.46	0.47	3.78
485.51	3	74.54	40.58	38.66	1.84	1.93	0.0035	0.035	0	3.77	8.29	0.22	281.23	0.4	61.42	1.59	0.48	5.13
485.61	3.1	78.41	40.84	38.82	1.92	2.02	0.0035	0.035	0	3.88	8.34	0.23	304.35	0.42	66.47	1.71	0.48	6.6
485.71	3.2	82.3	41.1	38.99	2	2.11	0.0035	0.035	0	3.99	8.4	0.25	328.26	0.44	71.69	1.84	0.48	8.19
485.81	3.3	86.21	41.36	39.16	2.08	2.2	0.0035	0.035	0	4.09	8.46	0.26	352.96	0.45	77.09	1.97	0.49	9.89
485.91	3.4	90.13	41.62	39.32	2.17	2.29	0.0035	0.035	0	4.21	8.52	0.28	379.58	0.47	82.9	2.11	0.49	11.68
486.01	3.5	94.08	41.88	39.49	2.25	2.38	0.0035	0.035	0	4.31	8.57	0.29	405.9	0.49	88.65	2.24	0.49	13.58
486.11	3.6	98.03	42.15	39.65	2.33	2.47	0.0035	0.035	0	4.42	8.62	0.3	432.91	0.51	94.55	2.38	0.5	15.56
486.21	3.7	102.04	42.96	40.32	2.37	2.53	0.0035	0.035	0	4.47	8.64	0.31	455.76	0.52	99.54	2.47	0.49	17.27

NOTE: The Yellow row is the Bankfull discharge from the reference riffle.


Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 39.5
Dbkf = 1.9
Abkf = 76.4
SEWER LINE RIFFLE (142+31)
25'
Elevation (ft)
492
491
490
489
488
487
486
485
484
483
482
481
480
479
478
477
290
325
360
395
430
Horizontal Distance (ft)

45, OF

Sewerline-Riffle-Summary Report.txt
RIVERMORPH CROSS SECTION SUMMARY

River Name: Steele Brook
Reach Name: Reach 1
Cross Section Name: G-Riffle-1
Survey Date: 09/25/08

Cross Section Data Entry

BM Elevation: 0 ft
Backsight Rod Reading: 0 ft

TAPE	FS	ELEV	NOTE
0	0	500	
12.504	0	498	
22.102	0	496	
25.066	0	494	
55.926	0	494	
125.495	0	492	
202.147	0	490	
271.117	0	490	
306.473	0	489.53	
332.594	0	488.27	
340.213	0	486.57	
342.897	0	484.85	
344.183	0	484.27	
345.718	0	483.87	LEW
355.332	0	484.1	
359.545	0	483.8	
364.793	0	483.84	
371.148	0	484.01	REW
371.885	0	484.14	
373.481	0	484.58	
375.287	0	485.86	
380.065	0	486.33	BKF
405.744	0	487.37	
447.724	0	486.82	
527.329	0	486.56	
560.746	0	488	
567.217	0	490	
572.339	0	492	
578.851	0	494	
587.13	0	496	
595.424	0	498	
612.3	0	500	

NAVD 88 DATUM

AV. ELEV BOXED PTS =
2419.62/5 = 483.92

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	488.86	488.86	488.86
Bankfull Elevation (ft)	486.33	486.33	486.33
Floodprone Width (ft)	243.17	-----	-----
Bankfull Width (ft)	39.48	17.71	21.77
Entrenchment Ratio	6.16	-----	-----
Mean Depth (ft)	1.94	2.09	1.81
Maximum Depth (ft)	2.53	2.46	2.53

Width/Depth Ratio	20.35	8.47	12.03
Bankfull Area (sq ft)	76.42	36.93	39.48
Wetted Perimeter (ft)	40.6	20.77	24.71
Hydraulic Radius (ft)	1.88	1.78	1.6
Begin BKF Station	340.59	340.59	358.3
End BKF Station	380.07	358.3	380.07

Entrainment Calculations

Entrainment Formula: Shields Curve

	Channel	Left Side	Right Side
Slope	0.0035	0	0
Shear Stress (lb/sq ft)	0.41		
Movable Particle (mm)	22.6		

SEWER LINE RIFFLE (S-RIFFLE)

ELEV	DEPTH	AREA	WET PER	WIDTH	HYD RAD	MEAN D	SLOPE	ROUGH	R/D84	VELOCITY	U/U*	U^2/2g	DISCHARG	SHEAR	POWER	POWER/W	FROUDE	TRANSPORT
(ft)	(ft)	(sq ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	[n] (ft^(1/6))		(fps)		(ft)	(cfs)	(psf)	(lb/s)	(lb/ft/s)		(lb/s)
485.9	2.1	60.52	35.42	34.44	1.71	1.76	0.0035	0	0	3.51	7.99	0.19	212.33	0.37	46.37	1.35	0.47	2.23
486	2.2	64.03	36.62	35.61	1.75	1.8	0.0035	0	0	3.51	7.9	0.19	224.65	0.38	49.06	1.38	0.46	2.84
486.1	2.3	67.65	37.83	36.78	1.79	1.84	0.0035	0	0	3.51	7.81	0.19	237.35	0.39	51.84	1.41	0.46	3.51
486.2	2.4	71.38	39.04	37.95	1.83	1.88	0.0035	0	0	3.51	7.73	0.19	250.44	0.4	54.7	1.44	0.45	4.25
486.3	2.5	75.24	40.24	39.13	1.87	1.92	0.0035	0	0	3.51	7.64	0.19	263.98	0.41	57.65	1.47	0.45	5.07
486.4	2.6	79.24	42.46	41.32	1.87	1.92	0.0035	0.035	0	3.81	8.31	0.23	302.21	0.41	66	1.6	0.49	5.52
486.5	2.7	83.51	45.12	43.94	1.85	1.9	0.0035	0.035	0	3.79	8.29	0.22	316.22	0.4	69.06	1.57	0.48	5.7
486.6	2.8	88.03	47.86	46.65	1.84	1.89	0.0035	0.035	0	3.77	8.29	0.22	332.13	0.4	72.54	1.55	0.48	6.05
486.7	2.9	92.84	50.79	49.57	1.83	1.87	0.0035	0.035	0	3.76	8.28	0.22	349.01	0.4	76.22	1.54	0.48	6.2
486.8	3	97.95	53.72	52.49	1.82	1.87	0.0035	0.035	0	3.75	8.27	0.22	366.87	0.4	80.13	1.53	0.48	6.74
486.9	3.1	103.34	56.65	55.41	1.82	1.87	0.0035	0.035	0	3.75	8.27	0.22	387.06	0.4	84.53	1.53	0.48	7.27
487	3.2	109.03	59.58	58.32	1.83	1.87	0.0035	0.035	0	3.76	8.28	0.22	409.87	0.4	89.52	1.53	0.48	7.81
487.1	3.3	115.01	62.51	61.24	1.84	1.88	0.0035	0.035	0	3.77	8.29	0.22	433.92	0.4	94.77	1.55	0.48	8.61
487.2	3.4	121.28	65.44	64.16	1.85	1.89	0.0035	0.035	0	3.79	8.29	0.22	459.23	0.4	100.3	1.56	0.49	9.45
487.3	3.5	127.84	68.37	67.07	1.87	1.91	0.0035	0.035	0	3.81	8.31	0.23	487.56	0.41	106.48	1.59	0.49	10.63

NOTE: The yellow row is the corresponding discharge for the bankfull dischage at the reference riffle.

NOTE: The green row is the discharge based on the field indicator for bankfull in the sewer-line reach. This reach is impacted, do not trust BKF.

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/2/09	Checked by	Date	Job No.
Subject FUTURE HEC-RAS AGREED TO MODEL GFOM.			Sheet 46 of

TODD, JOE, BEN, AND I HAD A TELECONFERENCE AND AGREED:

1) FOR ALT 3 THE DAM WILL BE CUT DOWN 1' FT ACROSS THE 81 FT LENGTH. THEN A BANKFULL CHANNEL WILL BE CUT 2.5 DEEPER IN MIDDLE OF DAM THAT LOWERS [GRADE CONTROL AT THE DAM BY 3.5' TODD WILL REFINE WIDTH OF CUT AT DAM BECAUSE DAM IS ACTUALLY A TRANSITION ZONE BETWEEN C TYPE CHANNEL AND AN A TYPE - MT STREAM CHANNEL.

2) THE FUTURE CHANNEL THROUGH THE POND WILL:

a) USE SAME SINUOSITY AS EXISTING MODEL.

b) HAVE A CHANNEL BOTTOM SLOPE OF .0035 AND CARRY THIS UPSTREAM UNTIL IT DAYLIGHTS ABOVE EXISTING CHANNEL.

c) HAVE BANKFULL WIDTH = 39 FT

D) HAVE MEAN DEPTH = 2.5 FT

E) AREA = 94 FT^2

QUICK CALCULATION INDICATES THE CHANNEL WILL DAYLIGHT ABOUT 150 UPSTREAM OF 136+50 THIS IS STILL 95' D.S. OF 342.8 139+01. AT CHANNEL BOTTOM = 482.3. BEN ALSO SHOWED MIGHT BE GOOD TO STOP CHANNEL EXCAVATION AT 342.7 NEAR 136+50 THIS PREVENTS INCISION AND DAMAGING GOOD RIPARIAN VEGETATION. PERHAPS COULD PUT IN A 0.5' DROP GRADE CONTROL STRUCTURE.

3) STARTING CHANNEL AT 3.5' BELOW PRESENT DAM CREST IS NEEDED TO GET DEEP ENOUGH CHANNEL TO CREATE FLOODPLAINS, INSTEAD OF PONDS. THIS WILL REDUCE WATER TEMPERATURE AND EVICT GEESE THEREBY IMPROVING WATER QUALITY.

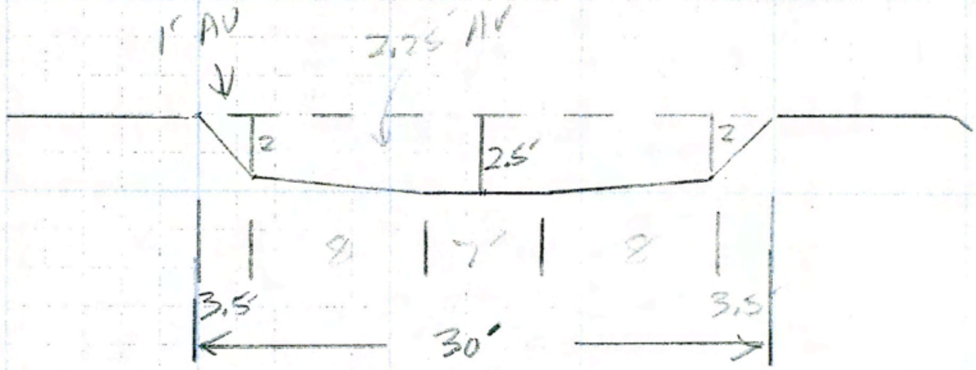
Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/3/09	Checked by	Date
Job No.			
Subject		Sheet 49 of	

ESTIMATE FLOW THROUGH TODD'S PROPOSED DAM NOTCH



UPSTREAM VEL. HEAD EST. AT 4.42 FT/SEC FROM RIVERMORPH SHT 44.4

$$V_{HEAD} = \frac{V^2}{2G} = \frac{4.42^2}{2(32.2)} = 0.30 \text{ FT}$$

SO ADD 0.3 TO H IN WEIR EQ

$Q = CLH^{3/2}$ USE 3.0 FOR C

$$Q = 3(7)(2.2)^{3/2} = 98.4$$
$$= 3(16)(2.55)^{3/2} = 195.5$$
$$= 3(7)(1.3)^{3/2} = 31.1$$

TOTAL Q = 325 CFS ← CLOSE ENOUGH

REASONABLE BANKFULL Q.

M&M HAND 2YR = 405 USGS URBAN 350
1YR = 221

WE THINK BANKFULL IN CT IS 1.2YR

SO Q_{BFL} = 221 + .2 (405-221) = 260 CFS.

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/3/09	Checked by	Date	Job No.
Subject			Sheet 50 of

TODD SAID UPSTREAM REF. RIFFLE THAT HAD BANKFULL Q = 433 CFS AT SLOPE = .0035 AND W ≈ 40 FT MIGHT BE OVERSIZED SHT 444 LATER NEW ESTIMATE OF BANKFULL 330 CFS

I SAID WE JUST DO NOT KNOW, BECAUSE WE HAVE NO GOOD GAUGE DATA FOR STEELE BROOK. WE DO NOT KNOW WHAT BANKFULL Q IS WITH VERY GOOD PRECISION

WE WILL ULTIMATELY NEED TO DO SOME SORT OF THRESHOLD CHANNEL ARMORING OF THE INSITU SANDS. IF CHANNEL IS A BIT OVERSIZED BEDLOAD CAN SETTLE IN IT FOR AWHILE AND THEN BE WASHED OUT BY BIGGER STORMS. THAT'S BETTER THAN BEING UNDERSIZED AND HAVE CHANNEL RIPPED APART.

ALSO, AT DESIGN PHASE, IF MANY ~~LOG JAMS~~ LWD ROOT WADS OR MIXED FEATURES ARE PLACED, THIS WILL IMPEDE FLOW SO STARTING A BIT OVERSIZED IS A GOOD THING.

NEXT DRAW TYPICAL FISH RAMP WEIRS GOING DOWNSTREAM OF DAM (SEE NEXT SHT)

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

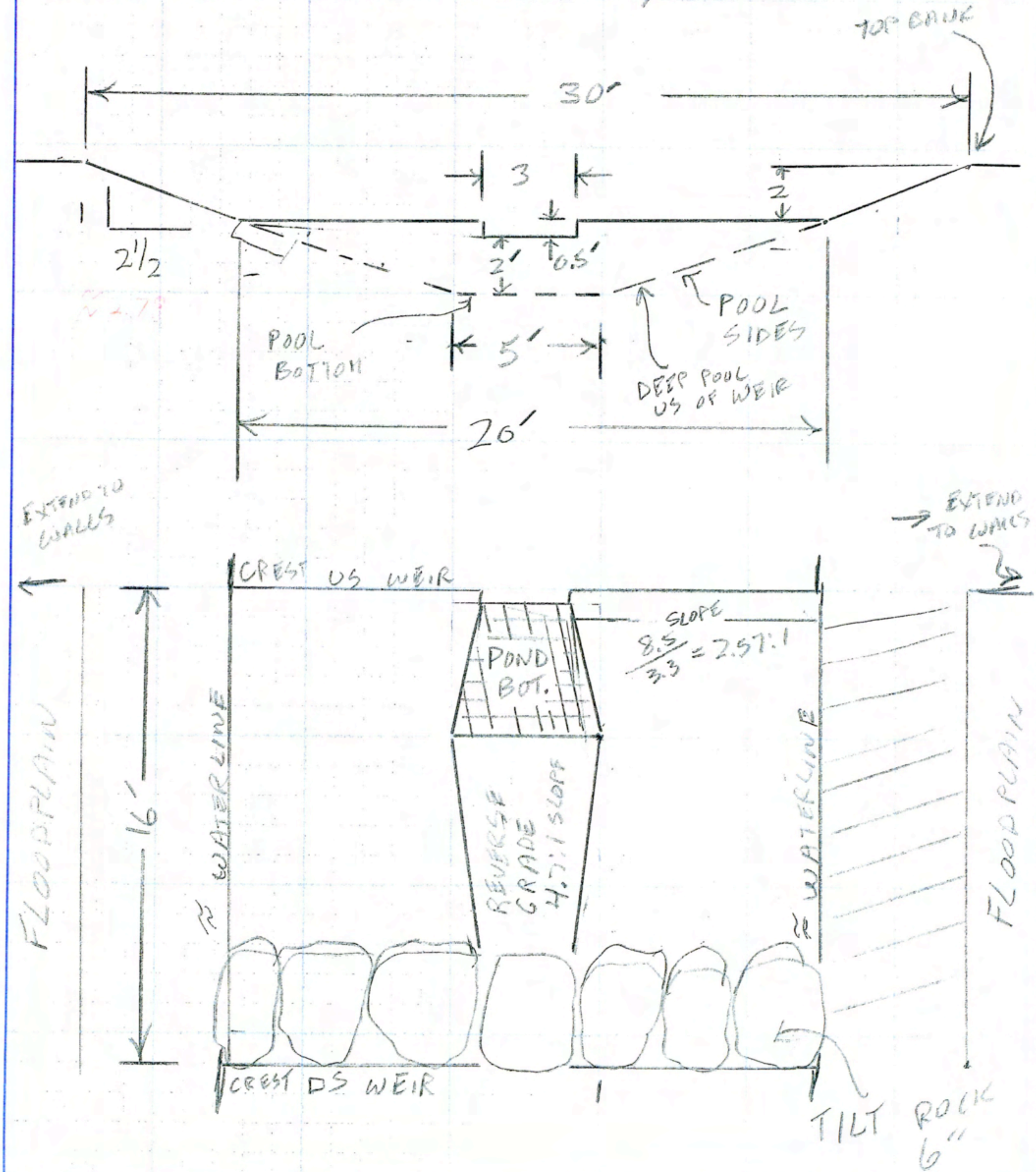
U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG / Date 2/3/09	Checked by	Date	Job No.
Subject 1-203 364 1009 TODD FAX			Sheet 51.1 of

FISH RAMP POOL WEIRS

TYPICAL POOL WEIR LOOKING UPSTREAM

PROPOSED WEIR SECTIONS FOR FISH RAMP DOWNST. OF DAM 5% GRADE 0.8 FT/WEIR LIFT

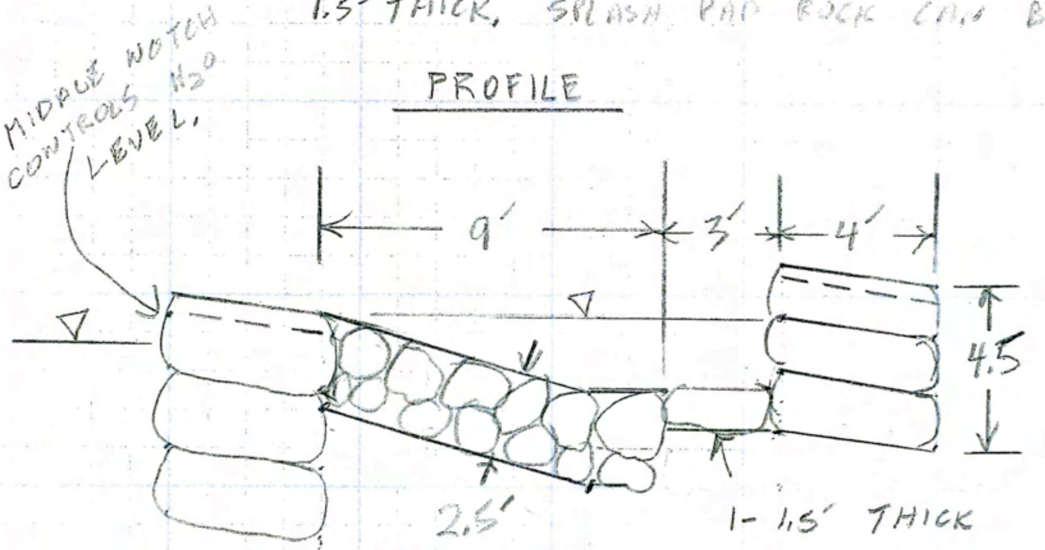


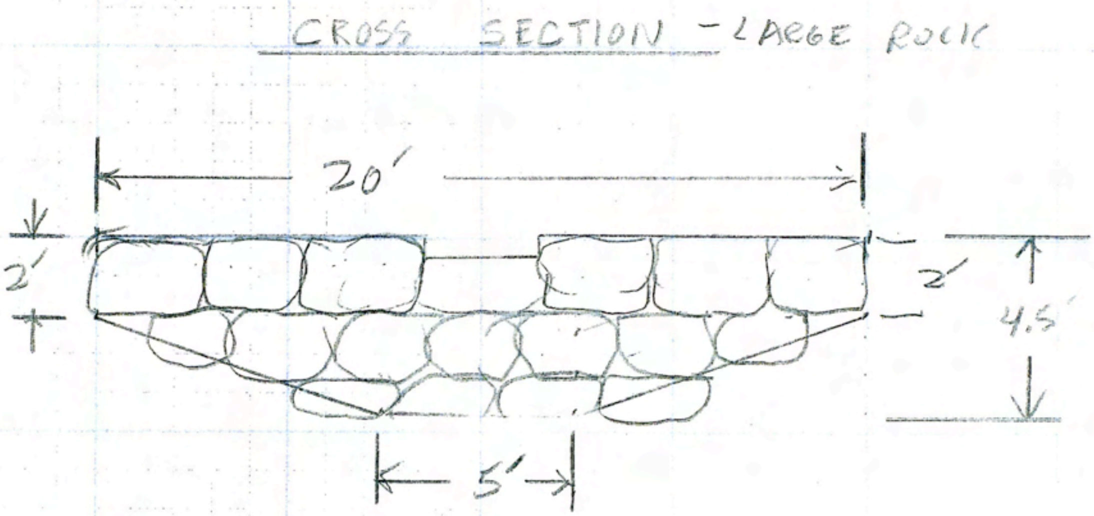
Computation Sheet
NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/24/09	Checked by BCS	Date
Job No.			
Subject FISH LADDER PROFILE			Sheet 51.2 of

SEE 109.2 WEIR ROCK = 1'-2' THICK TOP ROCK AT LEAST 1.5' THICK, SPLASH PAD ROCK CAN BE 1' THICK





Computation Sheet

NRCS–ENG-523A Rev. 6-2002

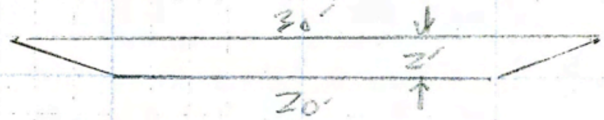
U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK			
By CEG	Date 2/3/09	Checked by	Date	Job No.
Subject				Sheet 52 of

FISH RAMP Q, DEPTH, VELOCITY CALC.

NOTE: 30' WIDTH AT TOP OF BANK BLENDS NICELY WITH DAM NOTCH UPSTREAM

ESTIMATE Q AT 2' DEPTH OVER WEIR



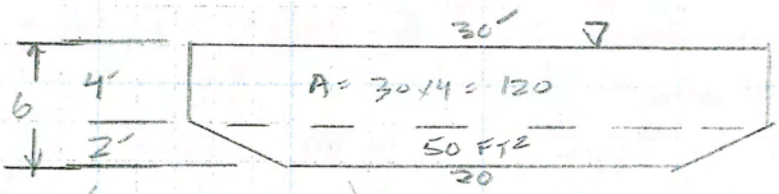
S = .05 N = .065 FROM USGS WATER SUPPLY PAPER 1849 PG 197 MERCED RIVER

$A = \left(\frac{20+30}{2}\right) 2 = 50\ FT^2$ $R = \frac{50}{20 + 2\sqrt{5^2+2^2}} = 1.624\ FT$

$Q = \frac{1.486}{N} A R^{2/3} S^{1/2} = \frac{1.486}{.065} (50)(1.624)^{2/3} (.05)^{1/2} = 353\ CFS$

> BANKFULL BUT NO REAL NEED TO HAVE BANKFULL FLOW BELOW FLOODPLAIN IN THE FISH LADDER. THE ENTIRE FISH LADDER WILL BE ROCKED AND NOT VEGETATED WITH FLOW CONCENTRATED TOWARD SMALLEST FEASIBLE POOL TO AID IN BEDLOAD FLUSHING, KEEPING WATER COOL AND ~~TO~~ KEEP POOL WET IN DROUGHT TIMES WITH MINIMAL BELOW GRADE PERCOLATION.

EST. Q AT 6' DEPTH – NOTE: SOME PARTS OF CHANNEL DOWNSTREAM ARE ONLY 30' WIDE



TOTAL A = 120+50 = 170 FT²

$W.P. = \left(4 + \sqrt{5^2+2^2}\right)2 + 20 = 38.77\ FT$

$R = A/W.P. = 170/38.77 = 4.38$

$Q = \frac{1.486(170)}{.065}(4.38)^{2/3}(.05)^{1/2} = 2327\ CFS$ > FEMA 100 YR = 2060 CFS

$V = Q/A = 2327/170 = 13.4\ FT/SEC$ WAHOO!

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE		
By CEG	Date 2/13/09	Checked by	Date	Job No.
Subject			Sheet 53 of

NOTE, FEMA Q'S ~~ARE PROBABLY~~ COULD BE HIGH

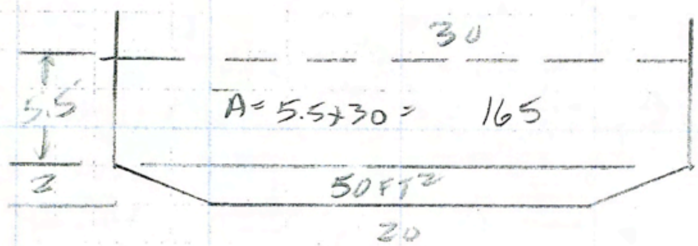
MALONE & MACBROOMS 100-YR TR20 = 2288 CFS

FROM USGS REG EQ. SCI INVEST 2004-5160
PG 18 TYPICAL RATIO OF 500 TO 100 YR =

$$\frac{369\,(5.73)^{.804}}{276\,(5.73)^{.781}} = \frac{1501.69}{1079} = 1.39$$

SO EST. 500-YR = 2288 × 1.39 = 3181 CFS ← COULD STILL BE HIGH!

EST. FLOW DEPTH AT 7.5'



TOTAL $A = 215\ FT^2$

$$W.P. = 2\left[5.5 + \sqrt{5^2+2^2}\right] + 20 = 41.77 \qquad R = A/WP = \frac{215}{41.77} = 5.15$$

$$Q = \frac{1.486}{.065}(215)(5.15)^{2/3}(.05)^{1/2} = 3279\ CFS$$

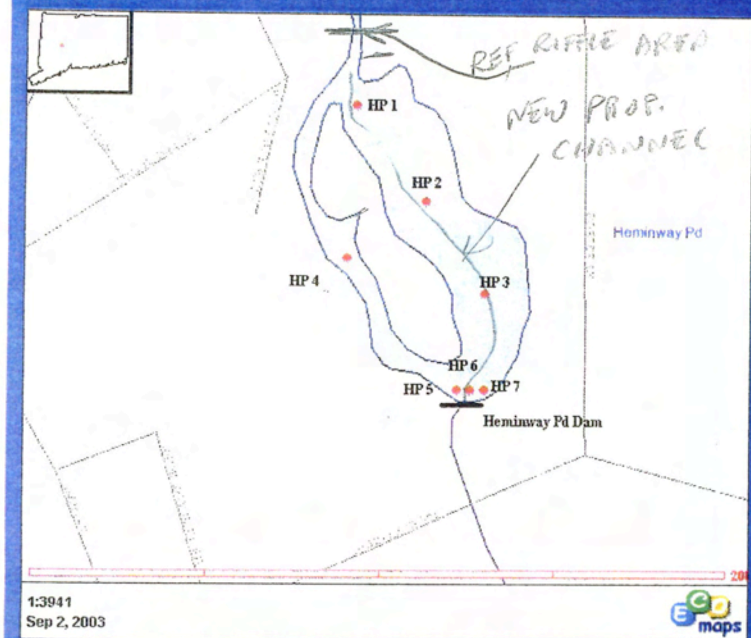
≈ 500-YR ~~STORM~~ FLOOD

$$V = \frac{Q}{A} = \frac{3279}{215} = 15.2\ FT/SEC \rightarrow FAST$$

SIZE ROCK WITH ISBASH FOR QUICK EST. PROFILE ON SHT 7 SHOWS 100-YR HAS 3' BACK WATER ON THE FIRST FISH WEIR AND 10-YR IS RIGHT AT 1ST WEIR ELEV. SO 100-YR Q AND VELOCITY IS MORE THAN ADEQUATE FOR ~~a~~ QUANTITY CALC.

Heminway Pond Sediment Sampling - August 2003

Sampling Locations



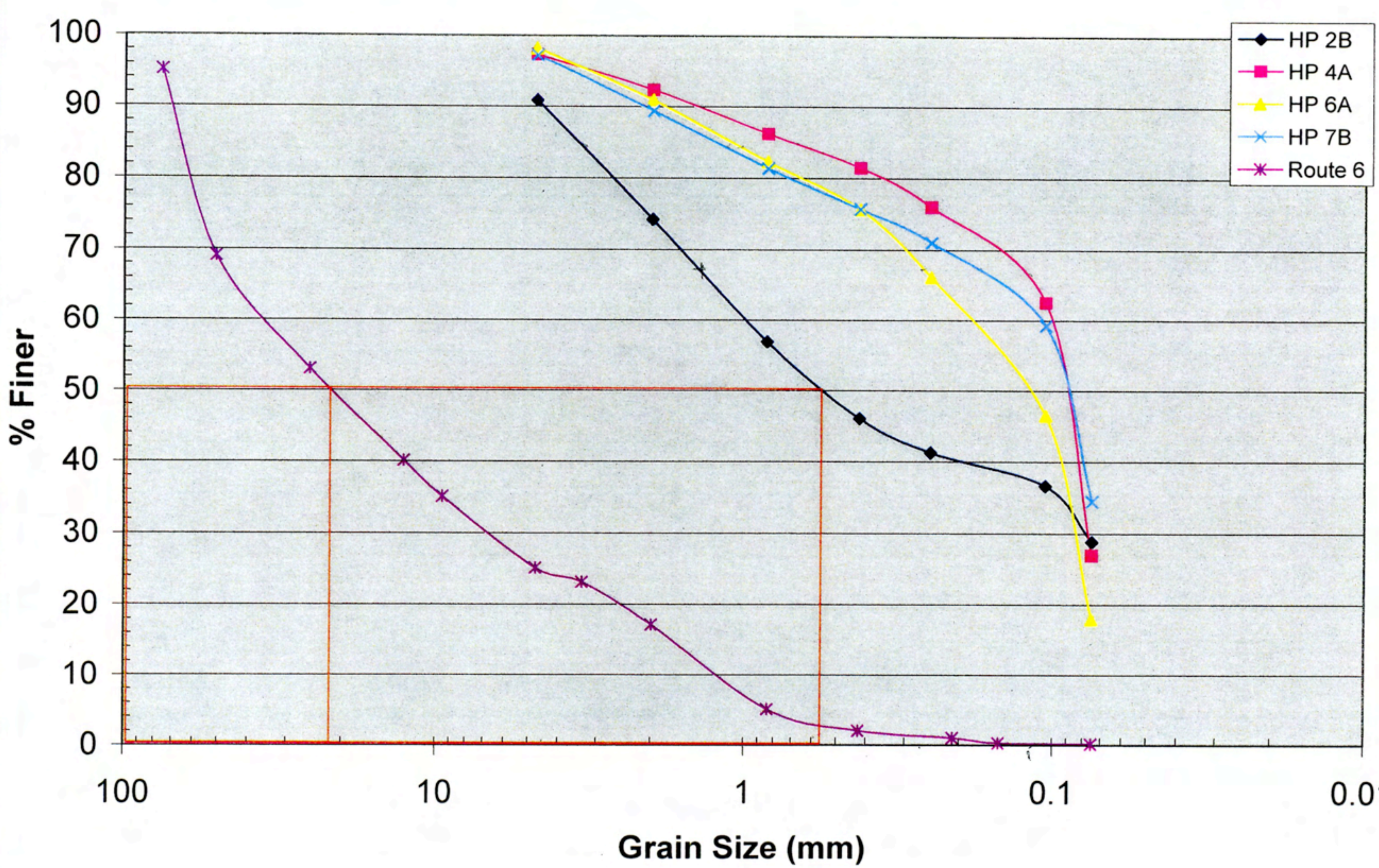
Sediment Core

Sediment Core

Results

- No Pesticides or PCB's detected
- Most sediments not likely to pose risk to aquatic life or people
- Isolating sediments at station HP4 should be evaluated because the levels of metals and PAHs are slightly higher than benchmarks

Heminway Pond Sediment Sample Gradations



Computation Sheet
NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOK		
By: CEG	Date: 2/4/09	Checked by	Date	Job No.
Subject			Sheet 56 of

ANALYZE MORE SEDIMENT DATA FROM DEP
SEE SHT 47 AND 48

THE NEW CHANNEL WILL FLOW THROUGH HP 5,6,7 AND HP 3 AND GO TO REF RIFFLE UPSTREAM OF HP 1
HP 2 & HP4 ARE IN SIDE POND AREAS PROB BOTH NEAR DAM
SAMPLE GRAD. AVAILABLE ARE 6A, 7B. THERE IS NO 3 OR 5

SAMPLE	D_{16}	D_{35}	D_{50} (mm)	D_{67}	D_{84}	D_{100}
HP6A	0.08	0.09	.14	.27	1	4.8 (D_{90})
HP7B	~~[illegible]~~	0.08	0.09	.17	1.03	4.8 (D_{90})
HP2B		0.09	0.57	1.5	3.3	4.8 (D_{90})
HP4A		0.08	0.09	0.11	.68	4.8
AVERAGE OF 4			0.22	0.51	1.50	

NOTE, THE REF. RIFFLE SAMPLE HERE WAS MORE GRAVELLY WITH D_{50} = 1.2"

NOTE HP2B AND HP4A ARE LIKELY IN QUIET POOL AREAS AWAY FROM THE CENTRAL ~~ALLUVIAL~~ CHANNEL THAT FLOWS THROUGH THE ALLUVIAL FAN OF SEDIMENT GROWING ACROSS THE POND.

TODD ALSO WALKED DOWN THE POND AS FAR AS HE COULD GO DOWN THE CENTRAL CHANNEL TO ABOUT 13H30, HE FOUND IT WAS COARSE SAND WITH A FEW LARGER 1/4" PEA STONE SIZE PARTICLES, IE. 6 mm PARTICLES

NOTE, ABOVE 4 DEP SAMPLES HAVE LARGEST PARTICLES = ~~5~~ 4.8 mm, NOT TO DIFFERENT FROM TODD'S CHANNEL WALK

THE 4 DEP PARTICLES HAVE AV D_{50} = 0.22 mm AND D_{84} = 1.5 mm

TODD ALSO SAID THERE ARE ABOUT 4 RIFFLES INCLUDING THE REF RIFFLE AT AND SEWER LINE WITH 2 MORE UPSTREAM GOING TO THE RT 6 BRIDGE THE LONG POOLS ARE QUITE SANDY, UPSTREAM OF RT 6 THE STREAM GETS MORE COBBLY

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/14/09	Checked by	Date	Job No.
Subject			Sheet 57 of

SEE PROFILE SHT ~~51~~ 58

NOTE: BEN HAS CONVERTED ALL HEC-RAS MODELS TO NAVD 88 DATUM

THE RIFFLES TODD MENTIONS PROVIDE STABILITY TO THE SYSTEM.

THE REF RIFFLE HAS $D_{50} = 0.5''$ AND $D_{84} = 2.1$ (SHT 31.2)

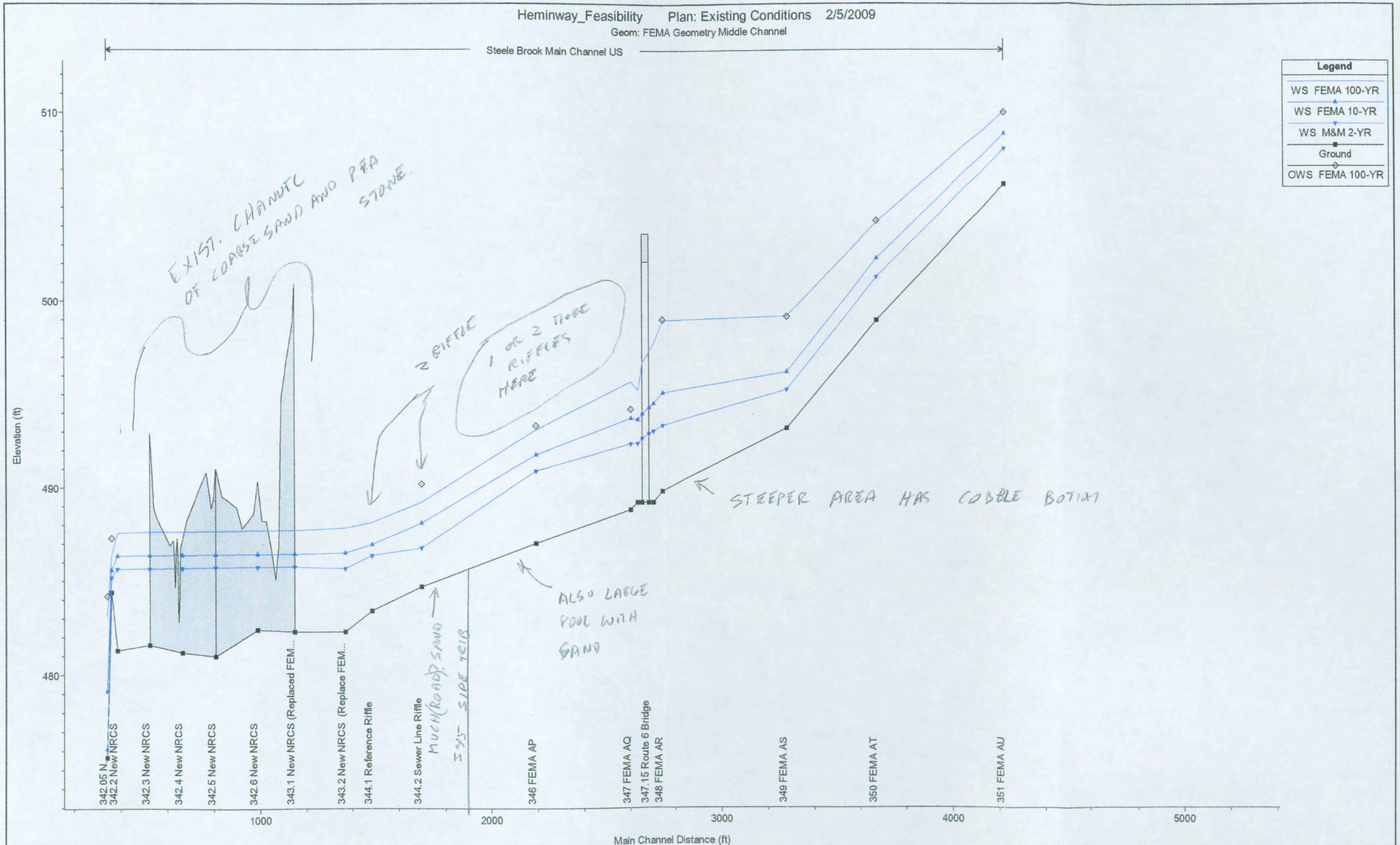
ASSUME OTHER RIFFLES HAVE THIS, TOO

147' US OF 345 A SIDE TRIB FEEDS IN THAT FEEDS LARGE AMOUNTS OF SAND TO SYSTEM. PROBABLY ROAD SAND. JUST D.S. OF 346

INITIAL ANALYSIS ESTIMATED FUTURE BANKFULL STRESS AT .5 LB/FT^2

SHIELD'S ENTRAINMENT SHOWS 0.5 LB/FT ENTRAINS ≥ 8mm BY SHIELDS DATA OR 90 mm (3.5)" PARTICLE USING RO[illegible] RIVER MORPH, SO CHANNEL WILL REQUIRE SOME SORT OF ARMORING? WAIT UNTIL HEC-RAS MODEL FUTURE CONDITION IS FINALIZED.

[illegible] WHAT [illegible] FLOWS [illegible] EXCEED [illegible] BANKFULL.



1 in Horiz. = 400 ft 1 in Vert. = 5 ft

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK			
By CEG	Date 2/5/09	Checked by	Date	Job No.
Subject				Sheet 59 of

CHECK OUT ANDREWS EQ. IN RIVERMORPH FOR STREAM COMPETENCY.

METHOD REQUIRES FOLLOWING INPUT.

D_{50} BED, PARTICLE WHICH 50% OF PARTICLES ARE FINER ON THE BED (IN MM).

DMAX BAR = LARGEST PARTICLE FOUND IN BAR (mm).

D_{50} BAR PARTICLE AT WHICH 50% OF PARTICLES ARE FINER ON THE BAR (mm).

PROGRAM THEN CALCULATES A D_i bar / D_{50} bed WHICH EQUALS THE RATIO OF DMAX BAR / D50 BED.
SO THIS INFERS D_i Bar = D_{max} BAR

THE METHOD YIELDS DIMENSIONLESS SHEAR STRESS.

METHOD 1 USES THE CRITICAL DIMENSIONLESS SHEAR STRESS EQUATION:

$T_c = .0834 * (D_{50}\,BED / D_{50}\,BAR)$ ^ -0.872

WHERE T_c = CRITICAL DIMENSIONLESS SHEAR STRESS

APPLICABLE WHEN D_{50}BED/D_{50} BAR = 3.0-7.0

METHOD 2 = $T_c = .0384 * (D_i\,bar / D_{50}\,bed)$ ^ -0.887

APPLICABLE WHEN $D_i$bar / D_{50}bed = (1.3-3.0)

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
	STEELE BROOK			
By	Date	Checked by	Date	Job No.
CEG	2/15/09			
Subject				Sheet 60 of ____

FOR D50BED = 25 mm   DmaxBAR = 50   D50BAR = 20   SLOPE = .0035
RIVERMORPH GIVES THIS OUTPUT

Method 1   D50/BED BAR = 1.25

τ_c = .0687

Depth Needed = 5.31 FT   ASSUME FLOW DEPTH WHERE PARTICLE MOBILIZES

D50BED/BAR ≠ 3.0–7.0   METHOD 1 DOES NOT APPLY

METHOD 2   DmaxBAR / D50BED = 2
T_c = 0.0208
DEPTH NEEDED = 1.61 FT

NOTE Dibar OR DmaxBAR = 2.0 IS WITHIN 1.3–3.0 SO METHOD 2 APPLIES

NOTE: NEH-654 EQ. 8-19 GIVES

$T_c = T^{*}(\gamma_s - \gamma_D) D$ WHERE

T_c = CRITICAL SHEAR IN LB/FT²

T^{*} = dimensionless SHIELDS PARAMETER (ASSUME THIS IS CRITICAL DIMENS. SHEAR)

γ_s = SPECIFIC WEIGHT SEDIMENT

γ_w = SPECIFIC WEIGHT WATER

D = PARTICLE DIAM. FEET

SO ASSUME τ^{*} = 0.0208 FROM ABOVE
γ_s = 165 LB/FT³ γ_w = 62.4 $\gamma_s - \gamma_w$ = 102.6 LB/FT³
D = 25 mm = 1" = 1/12' = .08333'

$T_c = .0208 \left(102.6 \frac{LB}{FT^3}\right)(.08333\ FT) = 0.1778\ LB/FT^2$

Adjustment for mixtures

Natural streambeds seldom have uniform bed gradations. The critical bed shear stress equation must be modified for mixtures. There are two approaches: one is to select a τ^* that is characteristic of mixtures; the other is to select a percent finer grain size that is characteristic of initiation of motion. Meyer-Peter and Muller (1948) and Gessler (1971) determined that when $R^* > 400$, the critical Shields parameter for sediment mixtures was about 0.047 when median grain size was used. Neill (1968) determined from his data that in gravel mixtures, most particles became mobile when τ^* was 0.030, when median grain size was used for D. Andrews (1983) found a slight difference in τ^* for different grain sizes in a mixture, and presented the equation 8–22:

$$\tau_i^* = 0.0834\left(\frac{D_i}{D_{50}}\right)^{-0.872} \qquad \text{(eq. 8–22)}$$

where:

subscript, i =Shields parameter and grain size for size class i

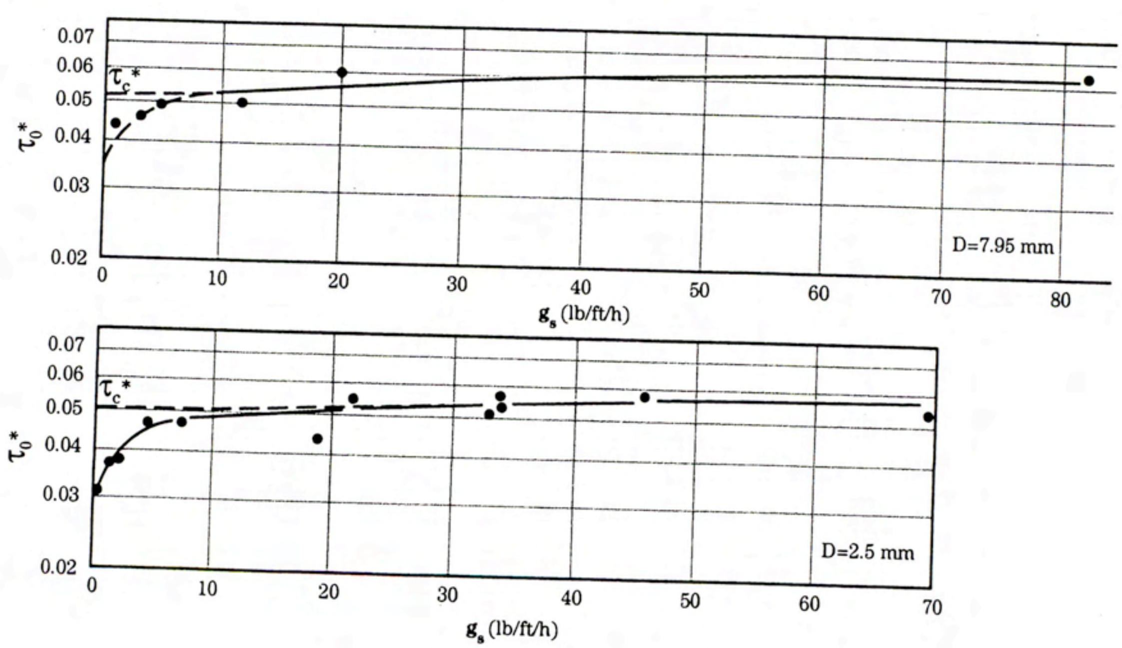
D_{50} =median diameter of the subsurface material

The minimum value for τ^* was found to be 0.020. According to Andrews, the critical shear stress for individual particles has a very small range; therefore, the entire bed becomes mobilized at nearly the same shear stress. However, Wilcock (1998) and Wilcock and McArdell (1993) have demonstrated that this near-equal mobility result applies only to unimodal sediments with a small to modest standard deviation. In coarse beds with a wide range of sizes (especially mixtures of sand and gravel), the fines may begin to move at flows much smaller than the coarse grains.

Gessler's concept for particle stability

Critical shear stress is difficult to define because entrainment is sporadic at low shear stresses caused by bursts of turbulence. Due to the difficulty in defining initiation of motion in a flume, the Shields curve was developed by extrapolating measured sediment transport rates back to zero. Unfortunately, the relationship between the Shields parameter and sediment transport is not linear at low shear stresses. This phenomenon was demonstrated by Paintal (1971) (fig. 8–12). Note that the extrapolated critical dimensionless shear stress was about 0.05, but the actual critical dimensionless shear stress was 0.03.

Figure 8–12 Variation in Shields parameter with decreasing sediment load



Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
	STEELE BROOK			
By: CEG	Date: 2/5/09	Checked by	Date	Job No.
Subject				Sheet 62 of

NOTE! RIVERMORPH HAS SHIELD ENTRAINMENT FUNCTION AND SHOWS FOR T_c 0.1778 LB/FT^2 → 0.18 LB/FT^2

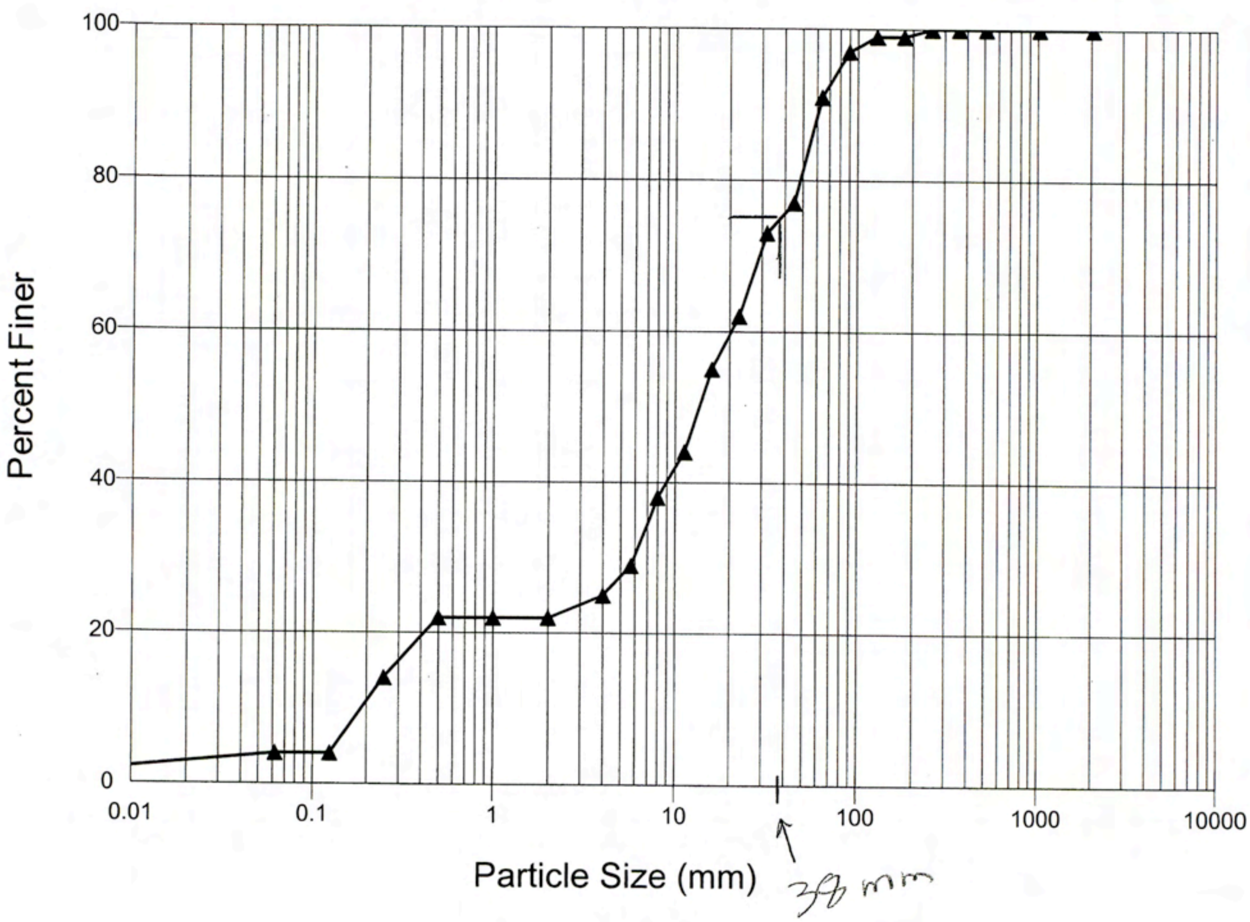
10.9 mm ≅ 0.43" ENTRAINS BY SHIELDS CURVE

42.42 mm ≅ 1.67" ENTRAINS BY ROSGENS REAL WORLD MT STREAM DATA IN COLORADO

SO IN THIS CASE ANDREWS IS ABOUT ½ IN BETWEEN AT 1" DIAM.

HOW DOES THIS COMPARE TO DESIGN ARMORING FROM ~~SR-24~~ ERDC TN-EMRRP-SR-29 FISCHENICH TABLE 2
1" GRAVEL ⟶ 0.33 LB/FT^2 PERMISSIBLE SHEAR EVEN THOUGH ANDREWS SAY CRITICAL SHEAR IS 0.18 LB/FT^2 PERMISSIBLE T SHOULD BE < CRITICAL

Reference-Riffle



RIVERMORPH PARTICLE SUMMARY

CEG 2/05/09 STEELE BROOK

River Name: Steele Brook
Reach Name: Reach 1
Sample Name: Reference-Riffle
Survey Date: 01/29/2009

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	4	4.00	4.00
0.062 - 0.125	0	0.00	4.00
0.125 - 0.25	10	10.00	14.00
0.25 - 0.50	8	8.00	22.00
0.50 - 1.0	0	0.00	22.00
1.0 - 2.0	0	0.00	22.00
2.0 - 4.0	3	3.00	25.00
4.0 - 5.7	4	4.00	29.00
5.7 - 8.0	9	9.00	38.00
8.0 - 11.3	6	6.00	44.00
11.3 - 16.0	11	11.00	55.00
16.0 - 22.6	7	7.00	62.00
22.6 - 32.0	11	11.00	73.00
32 - 45	4	4.00	77.00
45 - 64	14	14.00	91.00
64 - 90	6	6.00	97.00
90 - 128	2	2.00	99.00
128 - 180	0	0.00	99.00
180 - 256	1	1.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.31
D35 (mm)	7.23
D50 (mm)	13.86
D84 (mm)	54.5
D95 (mm)	81.33
D100 (mm)	255.99
Silt/Clay (%)	4
Sand (%)	18
Gravel (%)	69
Cobble (%)	9
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE		
By CEG	Date 2/6/09	Checked by BLS	Date 2/25/09	Job No.
Subject				Sheet 75.0 of

BEN HAS FINISHED BOTH MATURE N AND NEWLY CONSTRUCTED-N PARTIAL DAM REMOVAL HEC-RAS RUNS. HE MODIFIED THE NEWLY CONSTRUCTED N'S FROM SHT 66-72 A BIT.

THERE IS VERY LITTLE DIFFERENCE IN THE ENERGY GRADE OR WATER SURFACE OF NEWLY CONSTRUCTED N-VALUES VS MATURE N-VALUE RUN.

THE 10-YR MATURE N RUN HAS A HYD. JUMP FROM 3442 SEWER LINE TO 3441 RIFFLE. MAYBE NOT A JUMP. POSSIBLY UNABLE TO SOLVE THE ENERGY EQUATION.

PLOT MATURE N-VALUE BKF, 10, +100-YR PROFILES AND SUMMARY TABLE 75.2 - 78

CALCULATE TRACTIVE STRESSES AND FIND ASSOCIATED PARTICLES THAT MOVE UNDER THAT STRESS

$\tau = \gamma D S$

LET D = WATER DEPTH, LET S = ENERGY GRADE SLOPE. MEASURE WATER DEPTHS AT PROFILES

YR-PROF, XSEC	MAX DEPTH (FT)	EG. SLOPE	τ LB/FT²
BKF.L MATN ALT 3 343.1 - 342.6	2.15	(485.02 - 484.5)/159 = .00327	.439
10-YR MTN ALT 3 343.1-342.6	2.9	(485.61 - 485.25)/159 = .00226	.409
100-YR "	3.8	(486.72 - 486.17)/159 = .003459	.820
BKF MatN ALT 3 342.3-342.2	2.9	(483.22 - 483.16)/140 = .000429	.0776
10-YR "	3.8	(484.18 - 484.09)/140 = .000643	.152
100-YR "	5.2	(485.73 - 485.64)/140 = .000643	.209

(depths noted: "per midway" for first group; "Depth Midway" for second group)

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOK		
By: CEG	Date: 2/9/09	Checked by: BLS	Date: 2/25/09	Job No.
Subject			Sheet 75.1 of

CONTINUE TRACTIVE STRESS

YR-PROF. X-SEC	MAX DEPTH (FT)	EG. SLOPE	T LB/FT²
BKfl Mat. N + EXIST 344.2 SEWER LINE - 343.2	3.55	(486.77 - 485.92)/325 = .0026	.576
110-YR "	3.50 (CRIT DEPTH — DEPTH AT REF RIFFLE)	(488.18 - 486.17)/325 = .00618	1.35
100-YR Mat. N + Exist Sewer LINE 344.2 - 343.2	4.75 @ Ref. Riff	(489.22 - 487.25)/325 = .00606	1.80
BKfl - EXIST 343.1 - 342.6	1.3 / 2.25	(484.99 - 484.76/159 = .00182	0.256 (0.216)
10-YR "	2.8 / 3.15	(485.61 - 485.51/159 = .000629	0.1236 (0.1091)
100-YR "	4.1 / 4.4	(486.85 - 486.79/159 = .000377	0.1035 (0.016)
Depth middle Reach		YES! IMPORT CEG.	
BKfl EXIST 342.3 - 342.2	4.1 / 4.3	(484.59 - 484.58)/140 = .00071 (.000071)	0.1905
10-YR "	4.4 / 5.2	(485.46 - 485.45)/140 = .000071	0.230
100-YR "	6.35	(486.73 - 486.71)/140 = .000143	0.567

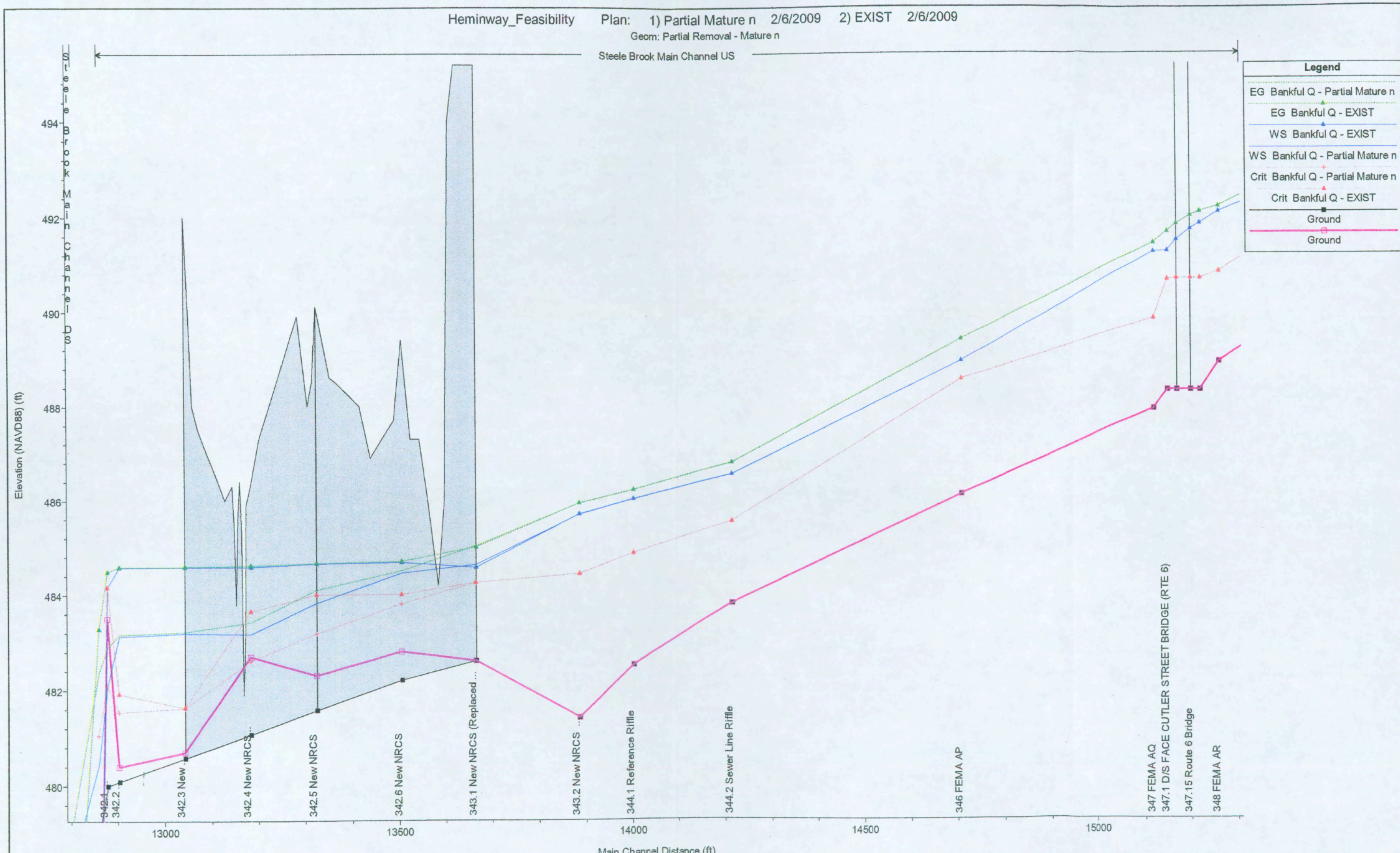
SHT 82 SHOWS PARTIAL RUN WITH NEWLY CONSTRUCTED FLOODPLAIN N-VALUES DOES NOT CHANGE ENERGY GRADE MUCH FROM THE MATURE N VALUE RUN AND THE DEPTHS ARE SIMILAR TO 0.3' DIFFERENT EXCEPT FOR HYD. JUMP AT REF. RIFFLE.

THE CROSS SECTIONS FROM THE REF RIFFLE AT 344.1 TO THE DAM AT 342.1 HAVE THE SAME DEPTH FOR THE MOST PART IN THE CHANNEL AND FLOODPLAIN DEEP PARTS.

SO DO NOT CALCULATE DIFFERENT TRACTIVE STRESSES FOR THE FLOODPLAINS.

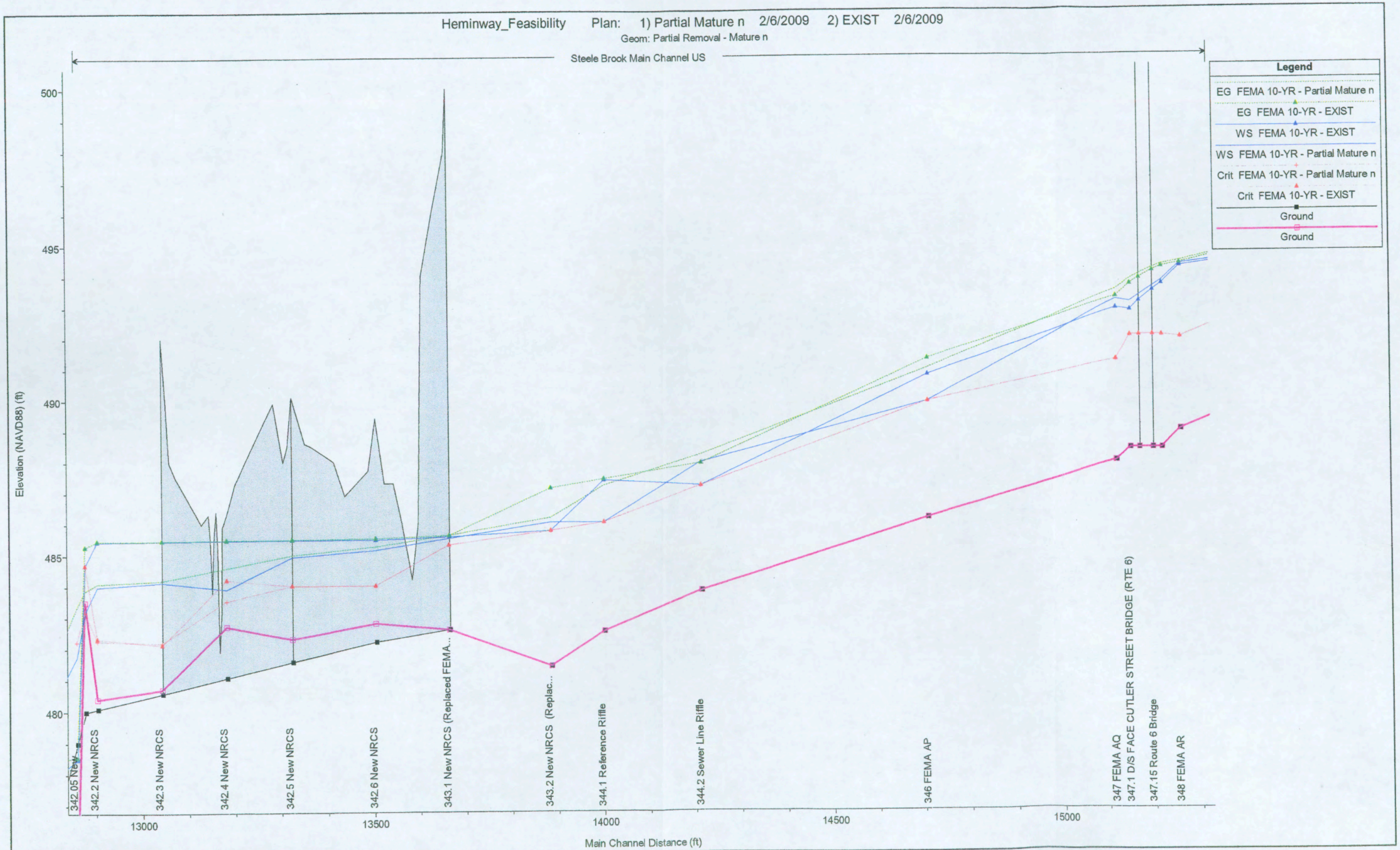
SHEETS 83-85 SHOW THERE MIGHT BE ~~FLOODPLAIN~~ CHANNEL SEEPAGE INTO FLOODPLAIN TROUGHS.

Checked by BLS 2/25/09



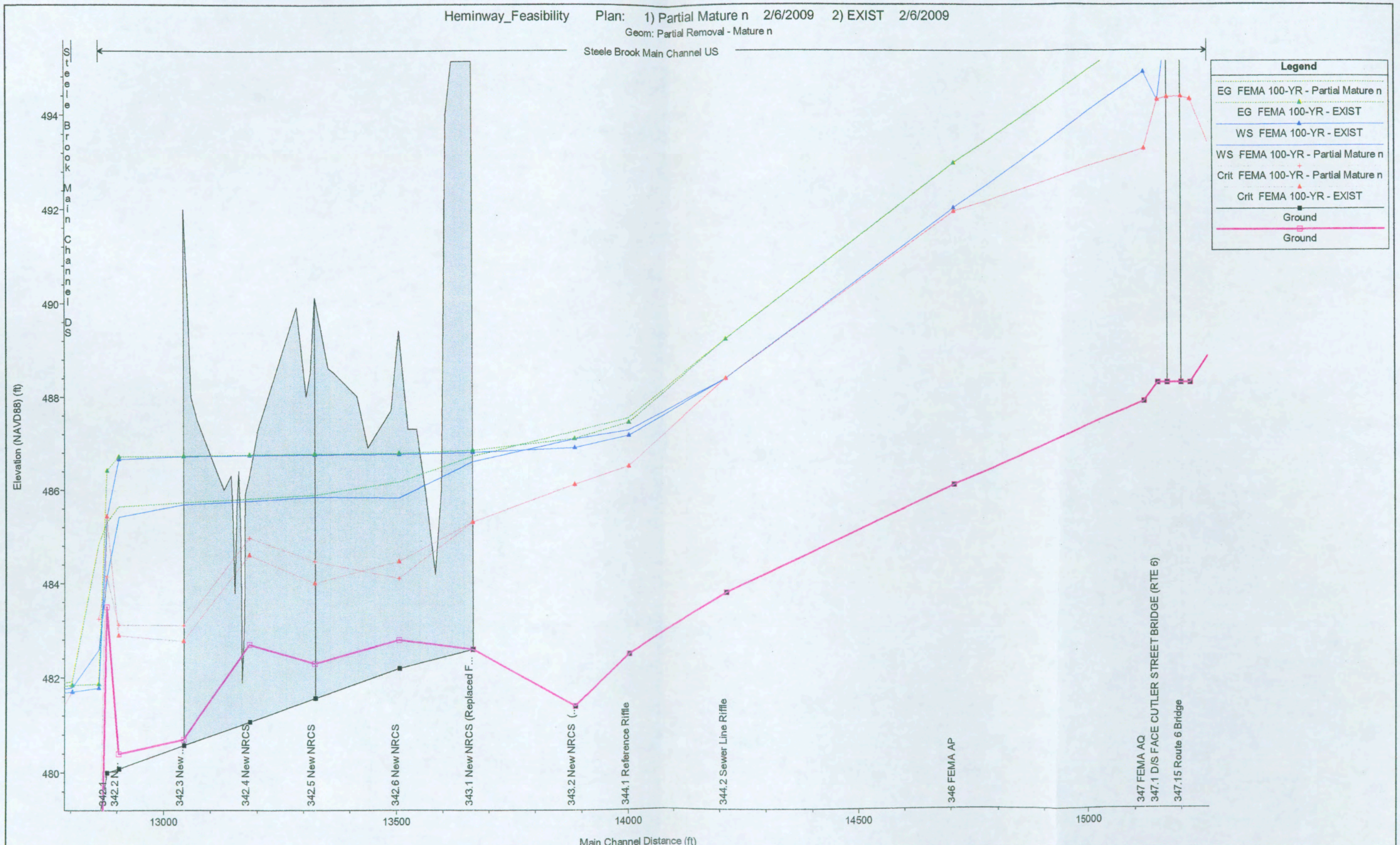
1 in Horiz. = 200 ft 1 in Vert. = 2 ft

Checked by BLS 2/24/09



1 in Horiz. = 200 ft 1 in Vert. = 3 ft

Checked by BLS 2/25/...



1 in Horiz. = 200 ft 1 in Vert. = 2 ft

SHT 78 OF __

checked by BLS 2/25/09

HEC-RAS Plan: Partial Mature n

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel US	346 AP	FEMA 100-YR	2060.00	486.10	492.03	491.95	492.97	0.008531	8.36	344.78	209.41	0.75
Main Channel US	346 AP	FEMA 10-YR	820.00	486.10	489.86	489.86	490.92	0.018611	8.28	98.98	46.34	1.00
Main Channel US	346 AP	Bankful Q	330.00	486.10	488.93	488.54	489.39	0.011044	5.43	60.73	36.14	0.74
Main Channel US	344.2	FEMA 100-YR	2060.00	483.80	488.38	488.38	489.22	0.006883	8.96	428.85	231.15	0.77
Main Channel US	344.2	FEMA 10-YR	820.00	483.80	487.94	487.18	488.18	0.002040	4.53	327.52	225.02	0.41
Main Channel US	344.2	Bankful Q	330.00	483.80	486.53	485.53	486.77	0.002984	4.00	84.68	45.03	0.46
Main Channel US	344.1	FEMA 100-YR	2060.00	482.50	487.29	486.51	487.54	0.003254	5.46	616.76	375.40	0.51
Main Channel US	344.1 } Rod Riffle	FEMA 10-YR	820.00	482.50	486.00	486.00	487.19	0.014441	8.74	93.86	39.52	1.00
Main Channel US	344.1	Bankful Q	330.00	482.50	486.01	484.86	486.20	0.002322	3.51	94.08	39.93	0.40
Main Channel US	343.2	FEMA 100-YR	2060.00	481.40	487.09	486.11	487.25	0.002262	4.87	828.81	389.85	0.43
Main Channel US	343.2	FEMA 10-YR	820.00	481.40	486.01	485.74	486.17	0.002464	4.17	337.51	174.51	0.42
Main Channel US	343.2	Bankful Q	330.00	481.40	485.68	484.42	485.92	0.002433	3.87	85.23	173.68	0.42
Main Channel US	343.1	FEMA 100-YR	2060.00	482.60	486.60	485.31	486.72	0.002146	4.44	1207.67	476.41	0.41
Main Channel US	343.1	FEMA 10-YR	820.00	482.60	485.52	485.30	485.61	0.002193	3.53	512.40	392.65	0.39
Main Channel US	343.1	Bankful Q	330.00	482.60	484.62	484.24	485.02	0.007627	5.07	65.04	282.17	0.69
Main Channel US	342.65 Embankment & FP		Lat Struct									
Main Channel US	342.6	FEMA 100-YR	1807.81	482.20	485.83	484.11	486.17	0.005136	6.26	622.34	599.54	0.63
Main Channel US	342.6	FEMA 10-YR	762.59	482.20	485.14	484.00	485.25	0.002271	3.56	444.18	523.75	0.40
Main Channel US	342.6	Bankful Q	322.26	482.20	484.45	483.80	484.50	0.001308	2.20	283.02	446.31	0.29
Main Channel US	342.5	FEMA 100-YR	1807.81	481.57	485.84	484.47	485.88	0.000569	2.44	1529.26	551.38	0.22
Main Channel US	342.5	FEMA 10-YR	762.59	481.57	484.92	484.00	484.98	0.001115	2.84	716.41	520.50	0.29
Main Channel US	342.5	Bankful Q	322.26	481.57	483.82	483.18	484.09	0.004551	4.17	77.99	393.39	0.55
Main Channel US	342.45 Embankment		Lat Struct									
Main Channel US	342.4	FEMA 100-YR	1807.81	481.07	485.76	484.97	485.80	0.000580	2.64	1331.93	496.84	0.22
Main Channel US	342.4	FEMA 10-YR	762.59	481.07	483.89	483.52	484.57	0.008616	6.98	169.73	367.10	0.78
Main Channel US	342.4	Bankful Q	322.26	481.07	483.17	482.61	483.42	0.004835	4.21	99.92	170.09	0.56
Main Channel US	342.3	FEMA 100-YR	1628.29	480.58	485.69	483.12	485.73	0.000260	1.91	1345.66	376.01	0.16
Main Channel US	342.3	FEMA 10-YR	726.59	480.58	484.13	482.18	484.18	0.000537	2.10	535.23	321.61	0.21
Main Channel US	342.3	Bankful Q	310.54	480.58	483.19	481.63	483.22	0.000369	1.38	324.12	300.44	0.16

Checked by BCS 2/25/09

HEC-RAS Plan: Partial Mature n (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main Channel US	342.2	FEMA 100-YR	1628.29	480.09	485.42	483.12	485.64	0.001220	4.15	573.37	222.07	0.34
Main Channel US	342.2	FEMA 10-YR	726.59	480.09	483.99	482.26	484.09	0.000872	2.76	379.52	217.12	0.27
Main Channel US	342.2	Bankful Q	310.54	480.09	483.12	481.54	483.16	0.000473	1.66	263.32	211.33	0.19
Main Channel US	342.1 HEMINWAY DAM	FEMA 100-YR	1628.29	480.00	484.15	484.15	485.30	0.007411	8.61	189.18	82.63	1.00
Main Channel US	342.1 HEMINWAY DAM	FEMA 10-YR	726.59	480.00	483.19	483.19	483.86	0.008484	6.60	110.10	81.00	1.00
Main Channel US	342.1 HEMINWAY DAM	Bankful Q	310.54	480.00	482.10	482.10	482.90	0.008079	7.19	43.17	26.98	1.00
Main Channel US	342.05	FEMA 100-YR	1628.29	479.00	482.59	483.25	484.83	0.132978	12.02	135.44	76.62	1.59
Main Channel US	342.05	FEMA 10-YR	726.59	479.00	481.73	482.22	483.34	0.206503	10.16	71.48	72.62	1.81
Main Channel US	342.05	Bankful Q	310.54	479.00	480.46	481.05	482.37	0.214143	11.11	27.96	25.26	1.86
Main Channel DS	341.2	FEMA 100-YR	2840.00	476.00	481.79	481.70	481.92	0.002770	2.93	995.06	541.91	0.25
Main Channel DS	341.2	FEMA 10-YR	1130.00	476.00	480.09	480.09	481.34	0.049050	8.99	125.66	50.09	1.00
Main Channel DS	341.2	Bankful Q	330.00	476.00	478.37	478.37	479.16	0.055942	7.11	46.43	29.33	1.00
Main Channel DS	341.1	FEMA 100-YR	2840.00	471.00	481.62	479.80	481.72	0.001250	3.26	1195.91	480.36	0.18
Main Channel DS	341.1	FEMA 10-YR	1130.00	471.00	477.43	475.39	478.02	0.009378	6.26	187.20	40.67	0.47
Main Channel DS	341.1	Bankful Q	330.00	471.00	474.47	473.37	474.74	0.009941	4.13	80.48	32.36	0.45
Main Channel DS	341 AL	FEMA 100-YR	2840.00	470.70	481.58	479.60	481.67	0.000411	3.50	1617.65	558.12	0.20
Main Channel DS	341 AL	FEMA 10-YR	1130.00	470.70	476.81	475.25	477.61	0.004056	7.23	163.72	36.95	0.56
Main Channel DS	341 AL	Bankful Q	330.00	470.70	473.48	473.17	474.05	0.009729	6.08	54.24	28.76	0.78

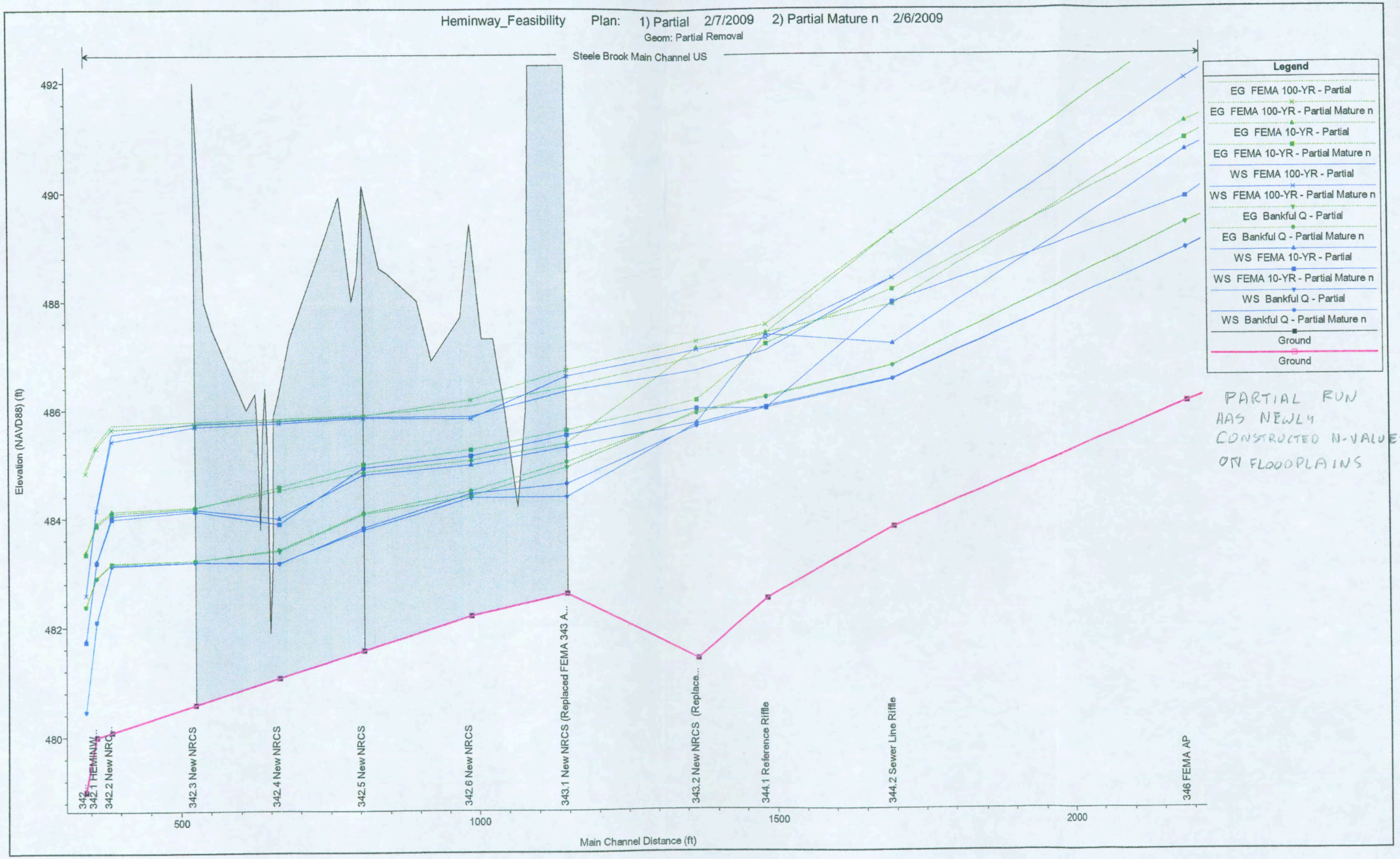
Checked by BLS 2/25/09

THERE IS NO 81

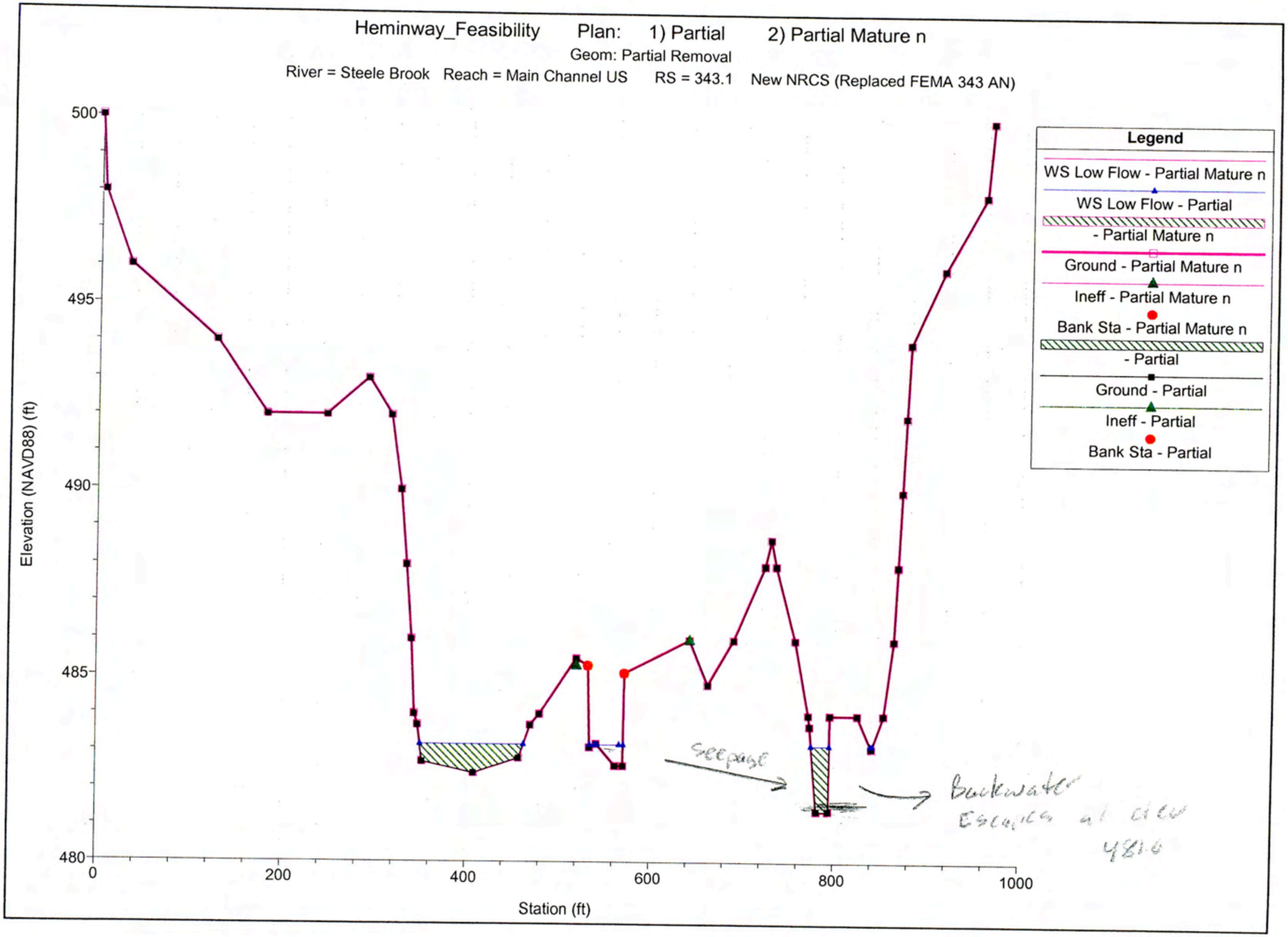
HEC-RAS Plan: EXIST River: Steele Brook Reach: Main Channel US

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Length Wtd.	Hydr Radius C	Max Chl Dpth
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	(ft)	(ft)
Main Channel US	346 AP	FEMA 10-YR	820.00	486.10	490.71	489.86	491.23	0.006642	5.78	143.88	73.80	0.62	491.54	2.63	4.61
Main Channel US	346 AP	Bankful Q	330.00	486.10	488.93	488.54	489.39	0.011069	5.44	60.68	36.12	0.74	494.00	1.64	2.83
Main Channel US	344.2	FEMA 10-YR	820.00	483.80	487.18	487.18	487.90	0.006831	7.12	167.07	182.90	0.73	209.70	2.89	3.38
Main Channel US	344.2	Bankful Q	330.00	483.80	486.53	485.53	486.77	0.002975	4.00	84.76	45.08	0.46	213.25	2.27	2.73
Main Channel US	344.1	FEMA 10-YR	820.00	482.50	487.36	486.00	487.39	0.000477	2.12	635.52	382.51	0.19	102.91	3.45	4.86
Main Channel US	344.1	Bankful Q	330.00	482.50	486.01	484.86	486.20	0.002307	3.50	94.27	40.28	0.40	116.18	2.25	3.51
Main Channel US	343.2	FEMA 10-YR	820.00	481.40	485.74	485.74	487.12	0.013999	9.41	87.15	173.84	1.00	218.88	2.56	4.34
Main Channel US	343.2	Bankful Q	330.00	481.40	485.69	484.42	485.92	0.002412	3.86	85.47	173.70	0.41	220.59	2.52	4.29
Main Channel US	343.1	FEMA 10-YR	820.00	482.60	485.57	485.30	485.61	0.000588	1.85	526.13	399.51	0.20	157.57	2.42	4.17
Main Channel US	343.1	Bankful Q	330.00	482.60	484.57	484.24	484.99	0.008488	5.25	62.89	279.81	0.72	158.32	1.55	3.17
Main Channel US	342.65 Embankment & FP		Lat Struct												
Main Channel US	342.6	FEMA 10-YR	743.78	482.80	485.47	484.00	485.51	0.000587	1.74	505.57	560.61	0.20	150.64	2.20	3.97
Main Channel US	342.6	Bankful Q	318.32	482.80	484.68	484.00	484.70	0.000394	1.09	312.06	472.71	0.16	158.00	1.47	3.18
Main Channel US	342.5	FEMA 10-YR	743.78	482.30	485.48	484.00	485.48	0.000064	0.59	1296.95	539.06	0.07	138.42	2.28	5.38
Main Channel US	342.5	Bankful Q	318.32	482.30	484.65	484.00	484.66	0.000152	0.68	499.82	509.38	0.10	148.07	1.48	4.55
Main Channel US	342.45 Embankment		Lat Struct												
Main Channel US	342.4	FEMA 10-YR	743.78	482.70	485.46	484.20	485.47	0.000090	0.51	1116.99	493.14	0.07	190.55	1.76	5.16
Main Channel US	342.4	Bankful Q	318.32	482.70	484.58	483.65	484.61	0.001040	1.10	258.77	481.30	0.21	141.81	0.88	4.28
Main Channel US	342.3	FEMA 10-YR	600.07	480.70	485.46	482.13	485.46	0.000031	0.48	1239.36	375.57	0.04	138.09	3.59	5.56
Main Channel US	342.3	Bankful Q	247.83	480.70	484.58	481.63	484.59	0.000030	0.40	628.56	336.64	0.04	139.34	2.72	4.68
Main Channel US	342.2	FEMA 10-YR	600.07	480.40	485.43	482.33	485.45	0.000150	1.13	530.44	222.09	0.10	25.65	3.91	5.03
Main Channel US	342.2	Bankful Q	247.83	480.40	484.58	481.92	484.58	0.000058	0.60	415.05	219.23	0.06	25.65	3.06	4.18
Main Channel US	342.1 HEMINWAY DAM	FEMA 10-YR	600.07	483.50	484.68	484.68	485.27	0.005725	6.16	97.43	82.66	1.00	18.35	1.15	1.18
Main Channel US	342.1 HEMINWAY DAM	Bankful Q	247.83	483.50	484.16	484.16	484.48	0.006752	4.57	54.28	82.63	0.99	18.35	0.65	0.66

checked by, BLS
2/25/09

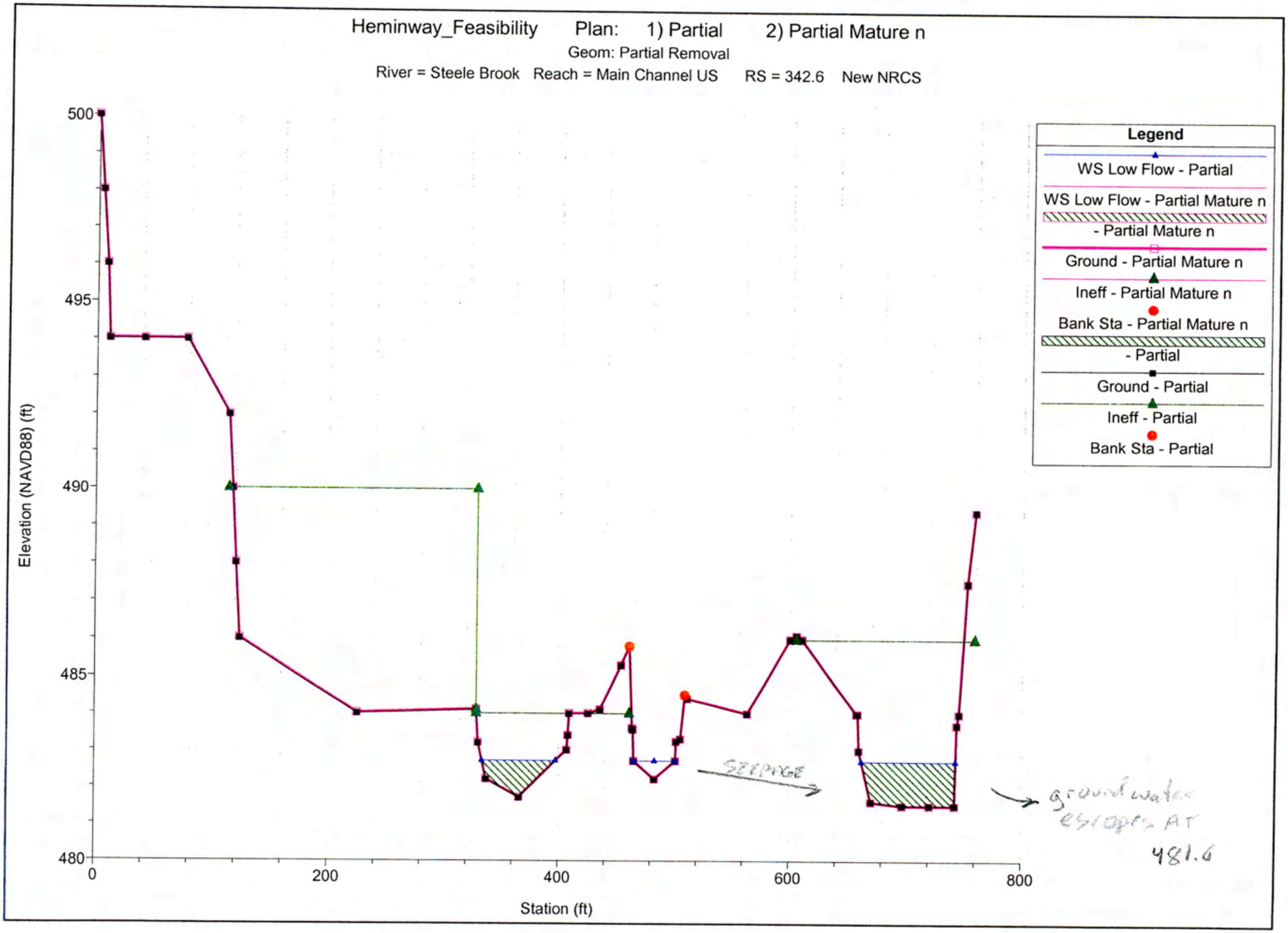


PARTIAL RUN HAS NEWLY CONSTRUCTED N-VALUES ON FLOODPLAINS

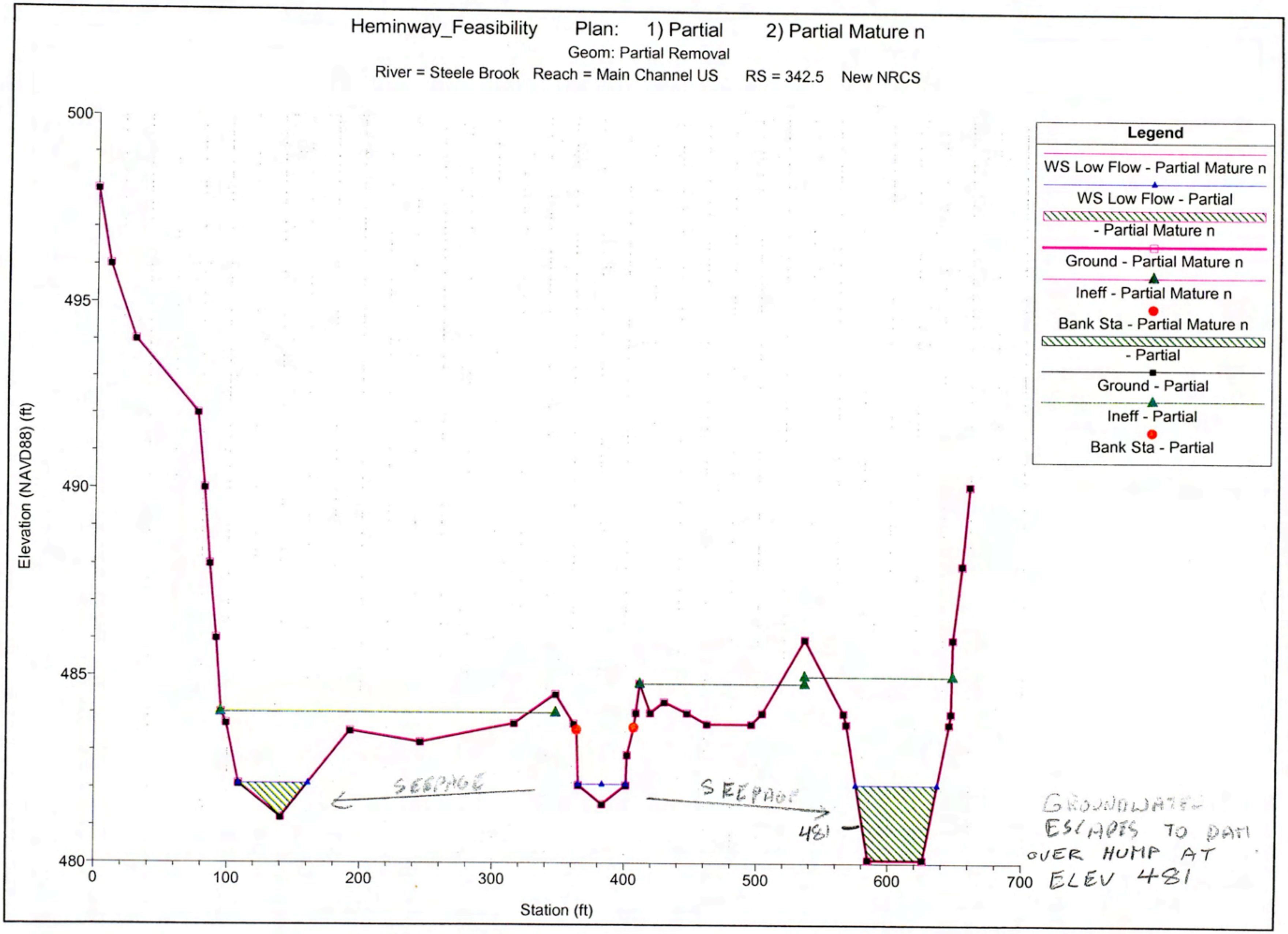


Heminway_Feasibility Plan: 1) Partial 2) Partial Mature n
Geom: Partial Removal
River = Steele Brook Reach = Main Channel US RS = 343.1 New NRCS (Replaced FEMA 343 AN)
Legend
WS Low Flow - Partial Mature n
WS Low Flow - Partial
- Partial Mature n
Ground - Partial Mature n
Ineff - Partial Mature n
Bank Sta - Partial Mature n
- Partial
Ground - Partial
Ineff - Partial
Bank Sta - Partial
Elevation (NAVD88) (ft)
Station (ft)
500
495
490
485
480
0
200
400
600
800
1000
seepage
Backwater

83 of ___



Heminway_Feasibility Plan: 1) Partial 2) Partial Mature n
Geom: Partial Removal
River = Steele Brook Reach = Main Channel US RS = 342.6 New NRCS
Legend
WS Low Flow - Partial
WS Low Flow - Partial Mature n
- Partial Mature n
Ground - Partial Mature n
Ineff - Partial Mature n
Bank Sta - Partial Mature n
- Partial
Ground - Partial
Ineff - Partial
Bank Sta - Partial
Elevation (NAVD88) (ft)
500
495
490
485
480
Station (ft)
0
200
400
600
800
SEEPAGE
groundwater escapes AT 481.6



GROUNDWATER SLOPE = 1'/180 = .0056

TO 0.5/180 = .0028

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOK		
By CEG	Date 2/7/09	Checked by B-D	Date
Job No.			
Subject			Sheet 86. of

FROM SHT 75.1

PLOT THE HAND CALCULATED TRACTIVE STRESS ON TRACTIVE STRESS GRAPHS PLOTTED BY HEC-RAS. (SEE 87-89)

NOTE, THE HEC-RAS TRACTIVE STRESS VALUES VARY TREMENDOUSLY BECAUSE EG. SLOPE AT SINGLE XSECS VARY GREATLY AS CALCULATED BY HEC-RAS.

FOR INSTANCE, AT BKFL EXIST MODEL SHT 80

SLOPE MEASURED BY EG LINE ELEV ARE

343.2 - 343.1 = (485.92 - 484.99)/220.54 = .004216

343.1 - 342.6 = (484.99 - 484.70)/158.32 = .001832

EG SLOPE AT 343.1 IS .008488 I.E. STEEPER THAN BOTH THE APPROACH AND EXIT, SO IT IS NOT REASONABLE, HENCE IT IS NOT A GOOD IDEA TO USE THESE TRACTIVE STRESSES THAT ARE BASED ON THE EG. SLOPE CALCULATED AT A SINGLE POINT.

ON HEC-RAS HYD REF MANUAL VERS. 3.1 SHT 2-10

EQ 2-12 E.G. SLOPE = $S_f = \left(\frac{Q}{K}\right)^2$ THIS IS THE EQUATION THAT GIVES THE ERRATIC SLOPES.

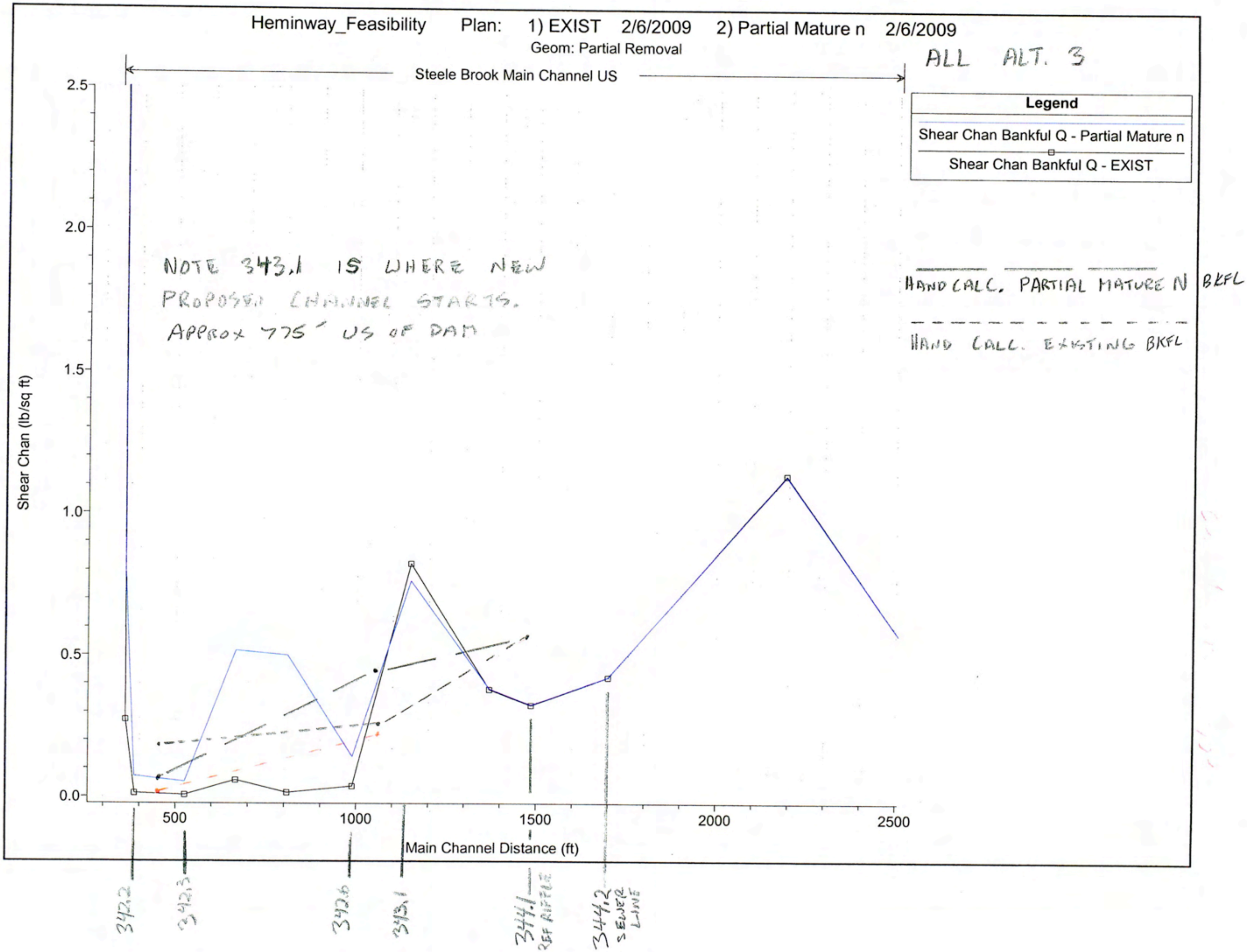
EQ. 2-13 TO 2-16 GIVE REACH FRICTION SLOPE = $\bar{S}_f$. THIS IS GRAPHICALLY SHOWN ON FIG 2-1 SHT 2-3.

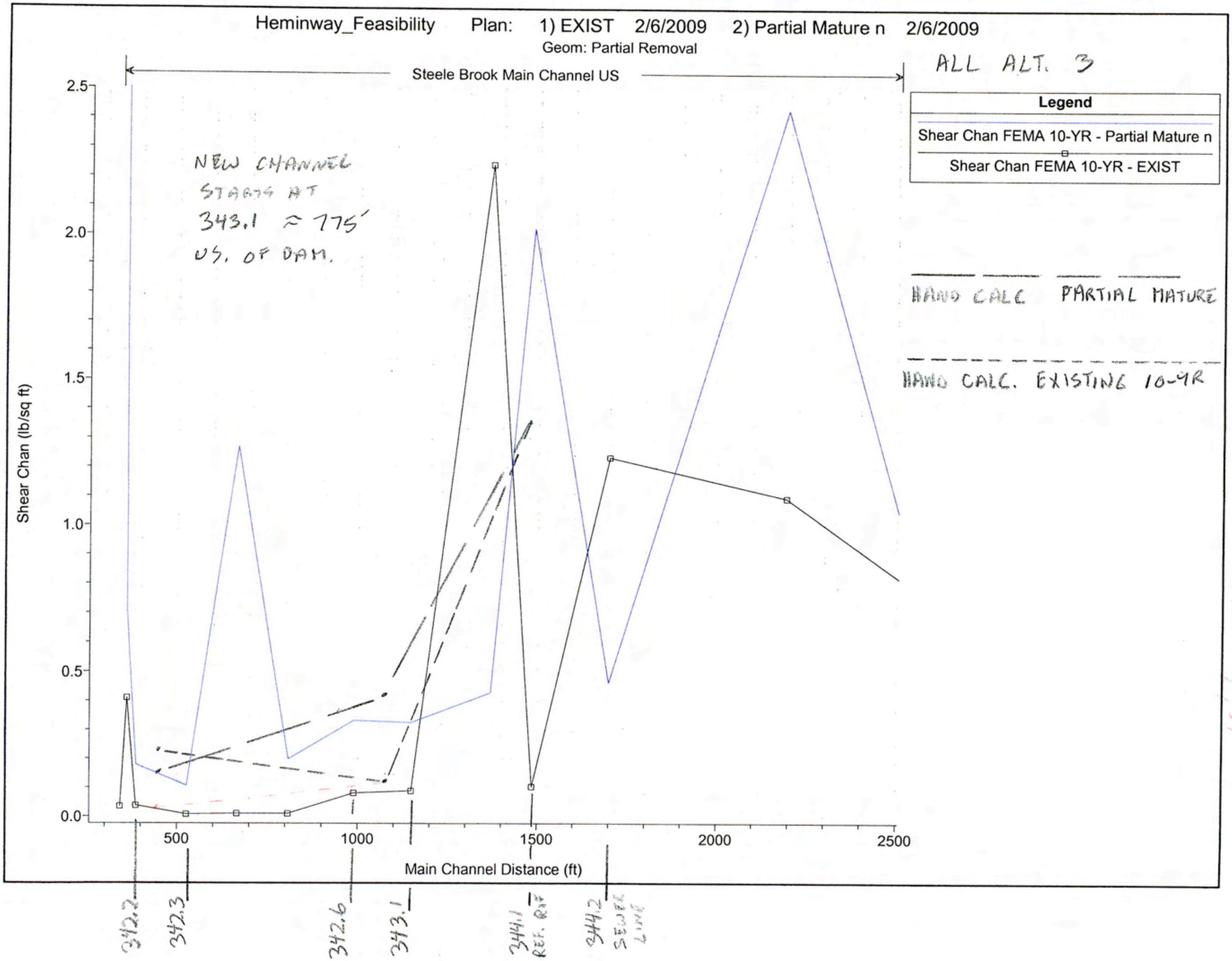
THIS ONE SHOWS THE ENERGY USED UP BY FRICTION BUT DOES NOT ACCOUNT FOR VELOCITY HEAD AND EXPANSION + CONTRACTION LOSSES.

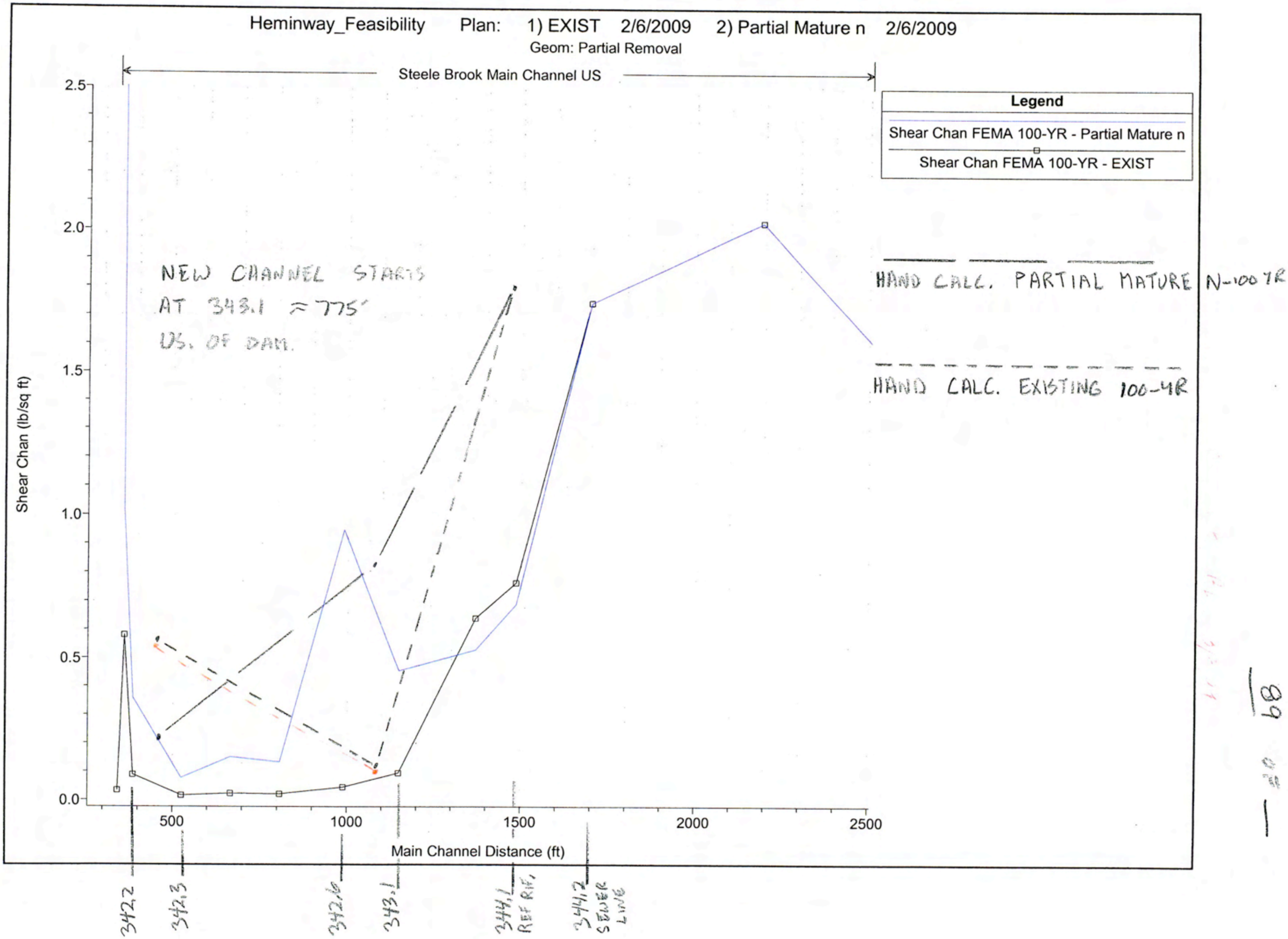
NOTE: CLASSICAL TRACTIVE STRESS DERIVATION ON FLOOD PLAIN MODELING USING HEC-RAS FIRST ED. PAGES 31 AND 32 SHOW $\tau = \frac{F_f}{PL}$ = FRICTION / SURFACE AREA.

SO IT MIGHT BE BETTER IF HEC-RAS USED $\bar{S}_f$ = FRICTION SLOPE FOR A REACH TO CALCULATE τ (TRACT.

CEGS 7/2008


Heminway_Feasibility Plan: 1) EXIST 2/6/2009 2) Partial Mature n 2/6/2009
Geom: Partial Removal
Steele Brook Main Channel US
ALL ALT. 3
Legend
Shear Chan Bankful Q - Partial Mature n
Shear Chan Bankful Q - EXIST
NOTE 343.1 IS WHERE NEW PROPOSED CHANNEL STARTS. APPROX 775' US OF DAM
HAND CALC. PARTIAL MATURE N BKFL
HAND CALC. EXISTING BKFL
Shear Chan (lb/sq ft)
0.0
0.5
1.0
1.5
2.0
2.5
500
1000
1500
2000
2500
Main Channel Distance (ft)
342.2
342.3
342.6
343.1
344.1 REF RIFFLE
344.2 SEWER LINE


Heminway_Feasibility Plan: 1) EXIST 2/6/2009 2) Partial Mature n 2/6/2009
Geom: Partial Removal
Steele Brook Main Channel US
Legend
Shear Chan FEMA 10-YR - Partial Mature n
Shear Chan FEMA 10-YR - EXIST
Shear Chan (lb/sq ft)
Main Channel Distance (ft)
0.0
0.5
1.0
1.5
2.0
2.5
500
1000
1500
2000
2500
ALL ALT. 3
NEW CHANNEL STARTS AT 343.1 ≈ 775' US. OF DAM.
HAND CALC PARTIAL MATURE N 10-YR
HAND CALC. EXISTING 10-YR
342.2
342.3
342.6
343.1
344.1 REF. RIF
344.2 SEWER LINE


Heminway_Feasibility Plan: 1) EXIST 2/6/2009 2) Partial Mature n 2/6/2009
Geom: Partial Removal
Steele Brook Main Channel US
Legend
Shear Chan FEMA 100-YR - Partial Mature n
Shear Chan FEMA 100-YR - EXIST
Shear Chan (lb/sq ft)
Main Channel Distance (ft)
0.0
0.5
1.0
1.5
2.0
2.5
500
1000
1500
2000
2500
NEW CHANNEL STARTS AT 343.1 ≈ 775' US. OF DAM.
HAND CALC. PARTIAL MATURE N-100 YR
HAND CALC. EXISTING 100-YR
342.2
342.3
342.6
343.1
344.1 REF RIF.
344.2 SEWER LINE

Steele Brook Particle Sizes Entrained - Shields and Rosgen Existing and Alternate 3

REACH AND FLOOD	EXISTING SAMPLE DIAM. mm (In)	EXISTING MAX. SHEAR LBS/SQ FT	EXISTING PARTICLE SIZE ENTRAINED Shields Data (mm) (inch)	EXISTING PARTICLE SIZE ENTRAINED Rosgen Data (mm) (inch)	ALTERNATIVE 3 MAX. SHEAR LBS/SQ FT	ALTERNATIVE 3 PARTICLE SIZE ENTRAINED Shields Data (mm) (inch)	ALTERNATIVE 3 PARTICLE SIZE ENTRAINED Rosgen Data (mm) (inch)
344.2 - 343.2 (Across ref. riffle)							
D50	13.9 (0.54)						
D84	54.5 (2.14)						
Bankfull		Essentially same as alternative 3			0.58	32 (1.3)	101 (4)
10-yr		Essentially same as alternative 3			1.35	126 (5)	187 (7.4)
100-yr		Essentially same as alternative 3			1.8	222 (8.7)	230 (9)
343.1 - 342.6 (First 159' of channel)							
D84	? 5 (0.2)						
Bankfull		0.26	14 (0.55)	56 (2.2)	0.44	24 (0.9)	84 (3.3)
10-yr		0.12	8 (0.32)	32 (1.26)	0.41	22 (0.87)	79 (3.1)
100-yr		0.13	8 (0.32)	34 (1.3)	0.82	52 (2.1)	132 (5.2)
342.3 - 342.2 (25' -165' US of Dam)						closer to 5.5mm on plot	
D50	0.22						
D75	1.0						
Bankfull		0.19	11 (0.43)	46 (1.8)	0.078	5 (0.2)	24 (0.94)
			1.9 (0.075)	8 (0.315)		5.5 (0.217)	
10-yr		0.23	13 (0.51)	53 (2.1)	0.15	9 (0.35)	39 (1.54)
			2.0 (0.079)	9 (0.354)			
100-yr		0.57	32 (1.3)	101 (4.0)	0.21	12 (0.47)	49 (1.9)
			4 (0.157)	18 (0.709)			

Computation Sheet
NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOK		
By: CEG	Date: 2/?/09	Checked by: BLS	Date: 3/3/09
Subject		Job No.	Sheet 91 of

SELECT SUITABLE CHANNEL AND FLOODPLAIN ARMOR
FROM ERDC TN-EMRRP-SR-29

NOTE EQ 9 + 10 ADJUST T_{AVG} TO BE T_{MAX}

T CALCULATED HERE IS FROM DEEP CHANNEL ST
NOTE A TYPICAL HYD RADIUS / MAX DEPTH @ 3441 $\frac{2.25}{3.51} = .64$

@ 3431 $\frac{1.55}{3.17} = .488$

@ 3442 $\frac{2.27}{2.73} = 0.83$

AV. .652

SO T AS REDUCE T'S max depth by MULT × .65

EQ 10 $T_{max} = 2.65\,T\left(\frac{R_c}{W}\right)^{-0.5}$

FROM CAD MODEL $\frac{R_c}{W} = \frac{160}{40} = 4$

$2.65\,(4)^{-.5} = 1.325$

SO THIS IS < T_{MAX} 1.5T IN EQ 9

SO USE THE EQ 9

SO DO T × .65 × 1.5 × 1.15* FOR TRAP EFFECTS = 1.12

NOTE .65 × 1.5 = .975 SO OUR ORIGINAL ESTIMATE OF USING HALF DEPTH TO GET T_{max} IS USEFUL.

USE TABLE 2 PERMISSIBLE SHEAR AND VELOCITIES ON SHEET 5 of SR-29

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOK		
By: CEG	Date: 2/7/09	Checked by:	Date: 3/5/09	Job No.

Subject: SUITABLE CHANNEL ARMOR BY SR-29

Sheet 92 of

DO REF RIFFLE AT 344.1 — DATA SAME FOR EXISTING AND ALT 3
GET T FROM SHT 75-75.1

Bnk#1 T = .576 × 1.12 = 0.645 LB/FT² → 2" GRAVEL

10-YR T = 1.35 × 1.12 = 1.51 LB/FT² → 5" COBBLE

100-YR T = 1.8 × 1.12 = 2.02 LB/FT² → 6" COBBLE — } smaller than Shields

NOTE SHT 98.3 AND 98.4 HAVE A MORE ACCURATE INTERPOLATION.

REACH FROM 343.1 - 342.6 ALT. 3 — THIS IS FIRST ... FEET OF THE NEW CHANNEL

Bnk#1 = .439 × 1.12 = 0.49 LB/FT² → 1.5" GRAVEL

10-YR = .409 × 1.12 = 0.45 LB/FT² → 1.5" GRAVEL — } ABOUT 1.5 × SHIELDS

100-YR = .820 × 1.12 = 0.92 LB/FT² → 3" GRAVEL

REACH FROM 343.1 - 342.6 EXISTING

Bnk#1 = .256 × 1.12 = .286 LB/FT² → 1" GRAVEL — TWICE SHIELDS

10-YR = .1236 × 1.12 = .1384 LB/FT² → <1" GRAVEL — } THESE ARE ... TABLE

100-YR = .1035 × 1.12 = .1159 LB/FT² → <1" GRAVEL

REACH 342.3 TO 342.2 ALT 3 25 TO 165' ...

Bnk#1 = .0976 × 1.12 = .109 LB/FT² → FINE GRAVEL

10-YR = .152 × 1.12 = 0.170 LB/FT² → ? 1/2" GRAVEL ...

100-YR = .209 × 1.12 = 0.234 LB/FT² → ? 3/4" GRAVEL ...

REACH 342.3 TO 342.2 EXISTING

Bnk#1 = .1905 × 1.12 = 0.213 → ? 3/4" GRAVEL ...

10-YR = .230 × 1.12 = 0.257 → ? 3/4" GRAVEL ...

100-YR = .507 × 1.12 = 0.565 → 2" GRAVEL — } 1.5 SHIELDS

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOKE		
By: CEG	Date: 2/11/09	Checked by:	Date: / /	Job No.:

Subject: SUITABLE ARMOR BY NAT. (COOP MISSOURI REP 108) Sheet 93 of

NOTE 654 EQ TS14C-4 USES $D_{50} = \frac{\gamma R S e}{4} = \frac{T_c}{4}$

NOTE THIS IS AV. T BECAUSE R IS USED
TO MEASURE THE MAX T WE MAY BASE UPON D.
MULTIPLY BY 0.65 TO GET AV. T (SEE SHT 90)

DO REF. RIFFLE AT 344.1 FOR EXISTING AND ALT. 3

GET T FROM SHT 75-75.1

DNKFL T = .576 x .65/4 = .0936' = 1.12"
10-YR T = 1.35 x .65/4 = 0.219' = 2.63"
100-YR T = 1.8 x .65/4 = 0.2925' = 3.51"
} MUCH LESS THAN SHIELDS DATA

REACH FROM 343.1 - 342.6 ALT. 3 FIRST 159' OF NEW CHANNEL

BKFl = .439 x .65/4 = .071' = 0.856 INCH
10-YR = .409 x 65/4 = .066 = 0.80 INCH
100-YR = .820 x 65/4 = .133' = 1.60 INCHES
} SLIGHTLY SMALLER THAN SHIELDS

REACH FROM 342.3 - 342.2 ALT 3 25' - 165' U.S. OF DAM

BKFl = 0.0776 x .65/4 = .01261' = 0.15 INCH
10-YR = 0.152 x .65/4 = .0247' = 0.3 INCH
100-YR = 0.209 x .65/4 = .03396' = 0.4 INCH
} PROB. BELOW LIMITS OF METHOD.
→ CLOSE TO SHIELDS

NOTE: THESE USE AVERAGE TRACTIVE STRESS

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE			
By CEG	Date 2/11/09	Checked by	Date	Job No.
Subject USE LANE'S METHOD FOR ON SITE GRADATIONS				Sheet 94 of

SEE 654 8-19

USE LANE'S METHOD FOR COARSE GRAINED SOILS

WHEN D_{75} IS BETWEEN 0.25 AND 5 INCHES IE 6.33 mm AND 127 mm

8-24 $T_{ab} = 0.4\, D_{75}$ T_{ab} = ALLOWABLE SHEAR LB/FT²
D_{75} IN INCHES

FOR CHANNEL BOTTOM

FOR CHANNEL SIDES

8-25 $T_{as} = 0.4 K\, D_{75}$

$$K = \sqrt{\frac{z^2 - \cot^2 \phi}{1+z^2}} = \sqrt{\frac{2^2 - \cot^2 34.5}{1+2^2}} = .71$$

FOR SAND IN POOL FROM 4/10 SAMPLES GET

SHT 56 AV. $D_{67} = 0.51$ mm

$D_{84} = 1.5$ m

$D_{75} \approx (0.51 + 1.5)2 = 1.01\, mm \rightarrow 1.0\, mm$

FROM FIG 8-14 FOR SLIGHTLY ROUNDED ASSUME $\phi_R = 34.5°$

FROM FIG 8-15

K FOR A SIDE SLOPE OF 2H:1V K=0.6

FIG 8-16 SINCE $D_{75} < 6.33$ mm USE

GIVE Ta directly

CHART USES D_{50} FROM SHT 56 $D_{50} = 0.22$ mm

FOR LOW CONTENT OF FINE SEDIMENT $T = 0.048$ LB/FT²

FOR REFERENCE RIFFLE PARTICLE DATA SHT 63

$D_{75} = 38\,mm \rightarrow 1.5''$ USE EQ ~~8-24~~ 8-24 AND 8-25

$T_{ab} = 0.4\, D_{75} = 0.4(1.5) = 0.6$ LB/FT² } CLOSE TO SHIELDS.

$T_{as} = 0.4(.71)\, 1.5 = 0.426$ LB/FT²

Computation Sheet
NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOKE			
By: CEG	Date: 2/12/09	Checked by:	Date:	Job No.
Subject				Sheet 95 of

BACK CALCULATE LANE'S METHOD TO GET PART SIZES FOR CERTAIN TRACTIVE STRESSES

$\frac{\tau_{ab}}{0.4} = D_{75}$ ALLOWABLE BOTTOM STRESS
GET MAX DEPTH STRESSES FROM SHT 75-75.1

FOR REACH REF. RIFFLE AT 344.1 ALT 3 AND EXISTING

BKFL	T = 0.576	0.576/0.4 =	1.44 in	37 mm
10-YR	= 1.35	1.35/0.4 =	3.38 in	86 mm
100-YR	= 1.8	1.8/0.4 =	4.50 in	114 mm

FOR REACH 343.1-342.6 ALT 3

BKFL	T: 0.439	0.439/0.4 =	1.09 → 1.1 in	28 mm
10-YR	T: 0.409	0.409/0.4 =	1.02 → 1.0 in	25 mm
100-YR	T: 0.820	0.820/.4 =	2.05 → 2.1 in	53 mm

FOR REACH 342.3-342.2 ALT 3

BKFL	T: .0776	0.0776/0.4 = 0.194" < .25 USE OTHER FIG. 8-16	2.4 mm LOW SEDIMENT D_{50}
10-YR	T: 0.152	.152/.4 = 0.38"	10 mm
100-YR	T: 0.209	.209/.4 = 0.52"	13 mm

343.1 - 342.6 EXISTING

BKFL	T = 0.26	0.26/.4 =	0.65 →	0.65"	17 mm
10-YR	T = 0.12	0.12/.4 =	0.30	0.30"	8 mm
100-YR	T = 0.13	0.13/.4 =	0.325	0.33"	8 mm

REACH 342.3-342.2 EXISTING

BKFL	T = 0.19	0.19/.4 =	0.475	0.48"	12 mm
10-YR	T = 0.23	0.23/.4 =	0.575	0.58"	15 mm
100-YR	T = 0.57	0.57/.4 =	1.425	1.4"	36 mm

Steele Brook Particle Sizes Entrained - Existing - All Methods							
			EXISTING CONDITION - PARTICLE SIZES				
			CRITICAL PAR. SIZES ENTRAINED		ALLOWABLE PARTICLE SIZES		
REACH AND FLOOD	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	Rivermorph Shields Data mm (inch)	Rivermorph Rosgen Data mm (inch)	ACOE Craig F. Stream Note 29 mm (inch)	National Highway Report 108 mm (inch)	Lanes Method mm (inch)
344.2 - 343.2 (Across ref. riffle)							
D50	13.9 (0.54)						
D84	54.5 (2.14)						
Bankfull		0.58	32 (1.3)	101 (4)	51 (2)	28 (1.1)	37 (1.4)
10-yr		1.35	126 (5)	187 (7.4)	127 (5)	67 (2.6)	86 (3.4)
100-yr		1.8	222 (8.7)	230 (9)	152 (6)	89 (3.5)	114 (4.5)
343.1 - 342.6 (First 159' of channel)							
D84	? 5 (0.2)						
Bankfull		0.26	14 (0.55)	56 (2.2)	25 (1)		17 (0.65)
10-yr		0.12	8 (0.32)	32 (1.26)	< 1" gravel		8 (0.3)
100-yr		0.13	8 (0.32)	34 (1.3)	< 1" gravel		8 (0.33)
342.3 - 342.2 (25' -165' US of Dam)							
D50	0.22						
D75	1.0						
Bankfull		0.19	11 (0.43)	46 (1.8)	? 3/4" gravel		12 (0.48)
10-yr		0.23	13 (0.51)	53 (2.1)	? 3/4" gravel		15 (0.58)
100-yr		0.57	32 (1.3)	101 (4.0)	51 (2)		36 (1.4)

Steele Brook Particle Sizes Entrained - Alternate 3 - All Methods

			ALTERNATE 3 CONDITION - PARTICLE SIZES				
			CRITICAL PAR. SIZES ENTRAINED		ALLOWABLE PARTICLE SIZES		
REACH AND FLOOD	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	Rivermorph Shields Data mm (inch)	Rivermorph Rosgen Data mm (inch)	ACOE Craig F. Stream Note 29 Table 2 mm (inch)	National Highway Report 108 D50 Particle mm (inch)	Lanes Method for D75 Particle mm (inch)
344.2 - 343.2 (Across ref. riffle)							
D50	13.9 (0.54)						
D84	54.5 (2.14)						
Bankfull		0.58	32 (1.3)	101 (4)	51 (2)	28 (1.1)	37 (1.4)
10-yr		1.35	126 (5)	187 (7.4)	127 (5)	67 (2.6)	86 (3.4)
100-yr		1.8	222 (8.7)	230 (9)	152 (6)	89 (3.5)	114 (4.5)
343.1 - 342.6 (First 159' of channel)							
D84	? 5 (0.2)						
Bankfull		0.44	24 (0.9)	84 (3.3)	38 (1.5)	22 (0.86)	28 (1.1)
10-yr		0.41	22 (0.87)	79 (3.1)	38 (1.5)	20 (0.8)	25 (1.0)
100-yr		0.82	52 (2.1)	132 (5.2)	76 (3)	41 (1.6)	53 (2.1)
342.3 - 342.2 (25' -165' US of Dam)							
D50	0.22						
D75	1						
Bankfull		0.078	5 (0.2)	24 (0.94)	? Fine gravel	? 3.8 (0.15)	2.4
10-yr		0.15	9 (0.35)	39 (1.54)	? 1/2" gravel	? 8 (0.3)	10 (0.38)
100-yr		0.21	12 (0.47)	49 (1.9)	~~? 3/4" gravel~~	? 10 (0.4)	~~13 (0.52)~~ 14 0.53

Footnotes.
For the stream Note SR-29, the average stream tractive stress based upon hydraulic radius is typically modified to produce maximum tractive stress with suggested facors of safety for both location and time . Location F.S = 1.5 and time factor = 1.1 to 1.2. Basic tractive stresses shown on the spreadsheet were the original study tractive stresses based upon maximum channel depth. For this SR 29 method, these original maximum tractive stresses were multiplied by 0.65 to convert to an average tractive stress (based on hydraulic radius). This was then multiplied by a location F.S. of 1.5 and a time F.S. of 1.15. These tractive stresses were the value used in Table 2 of SR-29.
National Highway Report 108 method was produced from data done on highway ditches with round rock and flows up to 1,000 cfs. This method links D50 size with a tractive stress.
Lanes method uses equations for channel bottom and channel sides to link an allowable D75 particle with a design tractive stress. It applies to D75 particles ranging from from 0.25 inch to 5 inches. For particles less than 0.25 inches, Fig 8-16 in NEH654 is used to link a tractive stress with a D50 size. The values reported here for the channel bottom equation. The 2.4 mm bankfull diam of the dam came from Fig. 8-16. Tmax was used.
Note the Rivermorph data is to show the critical stress at where a particle of a certain size first entrains. The SR-29, Highway 108 and Lanes method are actually design methods with some level of conservativism built into them. Ironically, the critical stress data from Rosgen from Colorado streams produces the most conservative results at least at these ranges of tractive stress.

98.1 OF

98.2 FOLLOWS

CHECKED CEG 3/9/09

Steele Brook Particle Sizes Entrained - Existing And Alternate 3 - Assumptions

In Alternative 1 (Existing) and Alternative 3 (Dam Notched), the tractive stress assumptions used for each method vary somewhat, mainly because the technical references describing the methods use various forms of tractive stress. Suspect values are in bold italics. All results for ACOE, National Highway Report 108, and Lanes methods are for round rock. Most of these stresses were arrived at by the previous hand calculations. However, this excel program has been written to also calculate them automatically to get an extra accuracy check. The unique

Rivermorph data is from the tractive stress curve in that program and uses the maximum shear stress in the third column. This shear is calculated from the maximum channel depth.

The ACOE Craig Fischenich Stream Note 29 Table 2 Method uses tractive stress as follows: The average stream tractive stress based upon hydraulic radius is typically modified to produce maximum tractive stress with suggested facors of safety for both location and time . Location F.S = 1.5 and time factor = 1.1 to 1.2. So for column 4 of this spread sheet, ACOE SHEAR, the maximum tractive stresses of column 3 were multiplied by 0.65 to apprximate an average tractive stress (based on hydraulic radius). This was then multiplied by a location F.S. of 1.5 and a time F.S. of 1.15. These ACOE SHEAR stresses of column 4 were used in Table 2 of SR-29.

The National Highway Report 108 Method was produced from data done on highway ditches with round rock and flows up to 1,000 cfs. This method links D50 size with average tractive stress τavg based upon hydraulic radius. The basic formula used in NEH 654 Eq. TSC-4 is $D50 = \tau avg/4$ where D50 is in ft. For this spreadsheet the formula embedded in the column for the 108 method obtains average shear by multiplying max shear in column 3 by 0.65 and also converts the units of D50 to inches.

Lanes Method uses equations for channel bottom and channel sides to link an allowable D75 particle with a design tractive stress. It applies to D75 particles ranging from from 0.25 inch to 5 inches, using NEH654 eq. 8-24. In this spreadsheet, the equation is rearranged to solve for D75 such that $D75 = \tau ab/0.4$, where τab is the allowable shear stress in lbs/sqft and D75 is in inches. The maximum shear stress of column 3 was used for allowable shear. This is consistent with Alt 3 and also shows the particle size that can be expected to remain in place in the deepest part of the channel. Particles larger than 5 inches are out of range of the method and are shown in bold italics. For particles less than 0.25 inches, Fig 8-16 in NEH654 is used to link a tractive stress with a D50 size. Why it uses D50 instead of D75 is one of life's mysteries. The middle curve for low content of sediment in suspension was used. The 2.4 mm bankfull diam. of the dam came from Fig. 8-16.

Note, the Rivermorph data is to show the critical stress at where a particle of a certain size first entrains. The ACOE SR-29, Highway 108 and Lanes method are actually design methods with some level of conservatism built into them. Ironically, the critical stress data from Rosgen from Colorado streams produces the most conservative results at least at these ranges of tractive stress.

Wherever, any of the data are off the figures, the results are published in bold italics and the best guess is shown.

CHECKED CEG 3/11/09

Steele Brook Particle Sizes Entrained - Existing Condition - All Methods

				-------- CRITICAL PARTICLE -------- ----------SIZES ENTRAINED --------		------------ ALLOWABLE PARTICLE SIZES --------------				
REACH AND FLOOD	**EXISTING SAMPLE DIAM. mm (inch)**	**MAX. SHEAR LBS/SQ FT**	**ACOE Uses Sp Max. Shear LBS/SQ FT**	**Rivermorph Shields Data Uses Max. Shear mm (inch)**	**Rivermorph Rosgen Data Uses Max. Shear mm (inch)**	**ACOE Craig F. Stream Note 29 Uses Spec. Max. Shear mm (inch)**	**National Highway Report 108 Uses Avg. Shear mm**	**(inch)**	**Lanes Method Uses Max. Shear mm**	**(inch)**
344.2 - 343.2 (Across ref. riffle)										
D50	13.9 (0.54)									
D84	54.5 (2.14)									
Bankfull		0.58	0.65	32 (1.3)	101 (4)	48 (1.9)	29	1.1	37	1.5
10-yr		1.35	1.51	126 (5)	187 (7.4)	114 (4.5)	67	2.6	86	3.4
100-yr		1.8	2.02	222 (8.7)	230 (9)	155 (6.1)	89	3.5	114	4.5
343.1 - 342.6 (First 159' of channel)										
D50	?									
D84	5 (0.22)									
Bankfull		0.22	0.25	13 (0.51)	50 (2.0)	***< 1" gravel***			14	0.6
10-yr		0.11	0.12	7 (0.28)	30 (1.2)	***< 1" gravel***			7	0.3
100-yr		0.10	0.11	7 (0.28)	28 (1.1)	***< 1" gravel***			6	0.3
342.3 - 342.2 (25' -165' US of Dam)										
D50	0.22 (.0087)									
D75	1 (.039)									
D84	1.5 (0.059)									
Bankfull		0.018	0.02	2 (0.079)	8 (0.31)	sandy loam				***< .1***
10-yr		0.022	0.02	2 (0.079)	9 (0.35)	sandy loam				***< .1***
100-yr		0.055	0.06	4 (0.16)	18 (0.71)	***< fine gravel***			1	0.04

CHECKED CEG 3/11/09

98.4 OF ___
99 FOLLOWS

Steele Brook Particle Sizes Entrained - Alternate 3 - All Methods

				CRITICAL PARTICLE SIZES ENTRAINED		ALLOWABLE PARTICLE SIZES				
REACH AND FLOOD	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	ACOE Uses Sp Max. Shear LBS/SQ FT	Rivermorph Shields Data Uses Max. Shear mm (inch)	Rivermorph Rosgen Data Uses Max. Shear mm (inch)	ACOE Craig F. Stream Note 29 Uses Spec. Max. Shear mm (inch)	National Highway Report 108 Uses Avg. Shear mm	(inch)	Lanes Method Uses Max. Shear mm	(inch)
344.2 - 343.2 (Across ref. riffle)										
D50	13.9 (0.54)									
D84	54.5 (2.14)									
Bankfull		0.58	0.65	32 (1.3)	101 (4)	48 (1.9)	29	1.1	37	1.5
10-yr		1.35	1.51	126 (5)	187 (7.4)	114 (4.5)	67	2.6	86	3.4
100-yr		1.8	2.02	222 (8.7)	230 (9)	155 (6.1)	89	3.5	114	4.5
343.1 - 342.6 (First 159' of channel)										
D50	?									
D84	5 (0.2)									
Bankfull		0.44	0.49	24 (0.9)	84 (3.3)	38 (1.5)	22	0.9	28	1.1
10-yr		0.41	0.46	22 (0.87)	79 (3.1)	30 (1.2)	20	0.8	26	1.0
100-yr		0.82	0.92	52 (2.1)	132 (5.2)	71 (2.8)	41	1.6	52	2.1
342.3 - 342.2 (25' -165' US of Dam)										
D50	0.22 (.0087)									
D75	1 (.039)									
D84	1.5 (0.059)									
Bankfull		0.078	0.09	5 (0.2)	24 (0.94)	***> Fine gravel***	***4***	***0.2***	***5***	***0.2***
10-yr		0.15	0.17	9 (0.35)	39 (1.54)	***? 1/2" gravel***	7	0.3	10	0.4
100-yr		0.21	0.24	12 (0.47)	49 (1.9)	***? 3/4" 1 inch***	10	0.4	13	0.5

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project			
	STEELE BROOK			
By CEG	**Date** 2/12/09	**Checked by** BLS	**Date** 2/26/09	**Job No.**
Subject STABILITY ANALYSIS OF ALT. 4				**Sheet** 99 **of**

ALTERNATE 4 REMOVES THE ENTIRE DAM AND EXCAVATES A STEEPER CHANNEL FLOODPLAIN DOWN THROUGH THE EXISTING POND.

PROFILES ON 100-102 SHOW 2 10 100-YR EXISTING AND FULL DAM REMOVAL WITH MATURE N VALUES ON THE FLOODPLAIN. WOOPS BEN MODIFIED CONVEYANCE METHOD SO REDO THESE.

BANKFULL AND 10-YR ENERGY GRADE LINES FUTURE ARE APPROX. EQUAL TO THE EXISTING UPSTREAM OF THE SEWER LINE RIFFLE.

10-YR WATER SURFACE IS 0.3' HIGHER AT SEWER LINE RIFFLE.

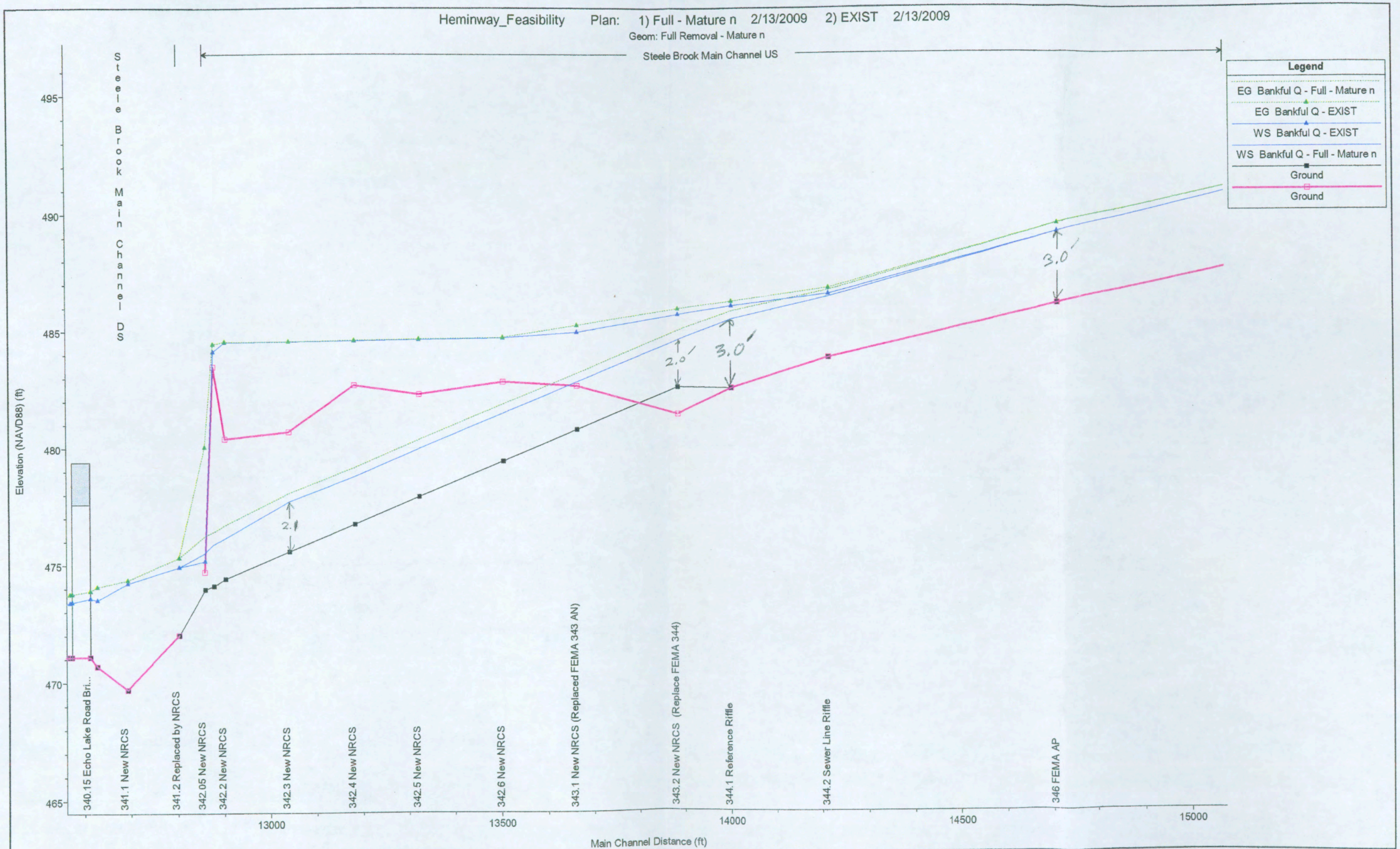
100-YR WATER SURFACE AND ENERGY GRADE LINE ARE COINCIDENT UPSTREAM OF THE REF. RIFFLE, SO THERE WILL BE NO INCREASED TRACTIVE STRESS IN FUTURE RESN. OF THE REFERENCE RIFFLE

ALT. 4

GET ENERGY GRADES MAX DEPTHS AND T = γDS γ=62.4 SEE SHTS 101-105

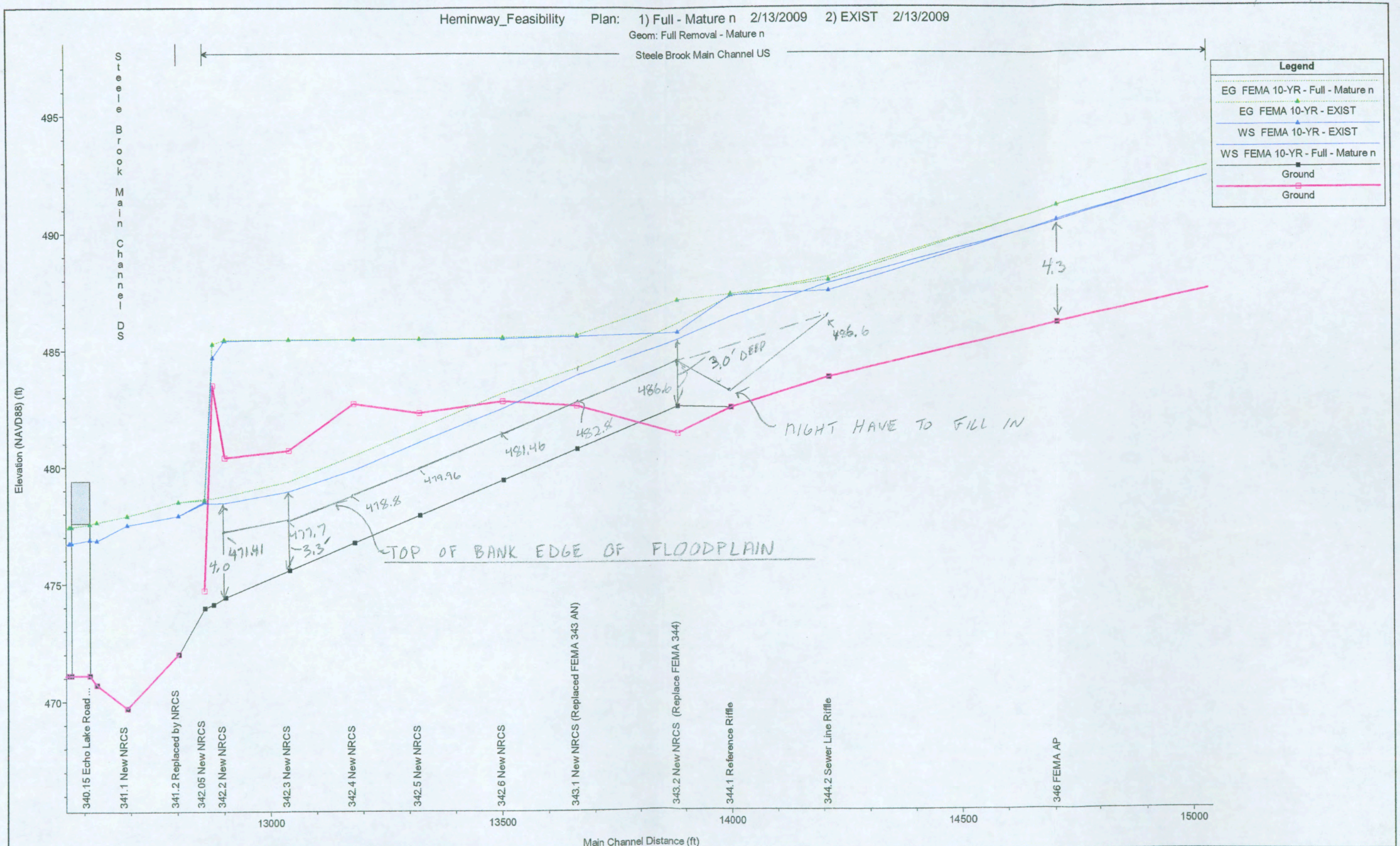
STORM & REACH	EG. US	EG. DS	DIST FROM PROF. FT	EG. SLOPE	MAX D. ROLLER REACH	T LB/FT2
BKfl 344.2-344.1 SEWER TO REF.	486.68	485.77	212	.00429	3.0	0.80
BKfl 344.1-342.3	485.77	478.06	955	.00807	2.0	1.01
BKfl 342.3-341.2 THROUGH DAM	478.06	475.30	238	.0116	2.1	1.52
BKfl 346-344.2 US SEWER	489.51	486.68	490	.00578	3.0	1.08
10-YR 344.2-343.2 AC REF	488.10	486.12	318	.00623	4.0	1.56
10 343.2-342.3	486.12	479.37	838	.00805	3.3	1.66
10 342.3-342.05 DAM	479.37	478.62	182	.00412	4.0	1.03
10 346-344.2 US SEWER	491.07	488.10	490	.00606	4.3	1.63
100 344.2-344.1 SEWER TO REF	489.22	487.43	212	.00844	4.6	2.42
100 344.1-342.5	487.43	483.34	670	.006104	5.0	1.96
100 342.5-342.05 DAM	483.34	482.45	463	.00192	7.8	0.93
100 346-344.2 US SEWER	492.97	489.22	490	.00765	5.8	2.77

Checked by BLS 2/26/09



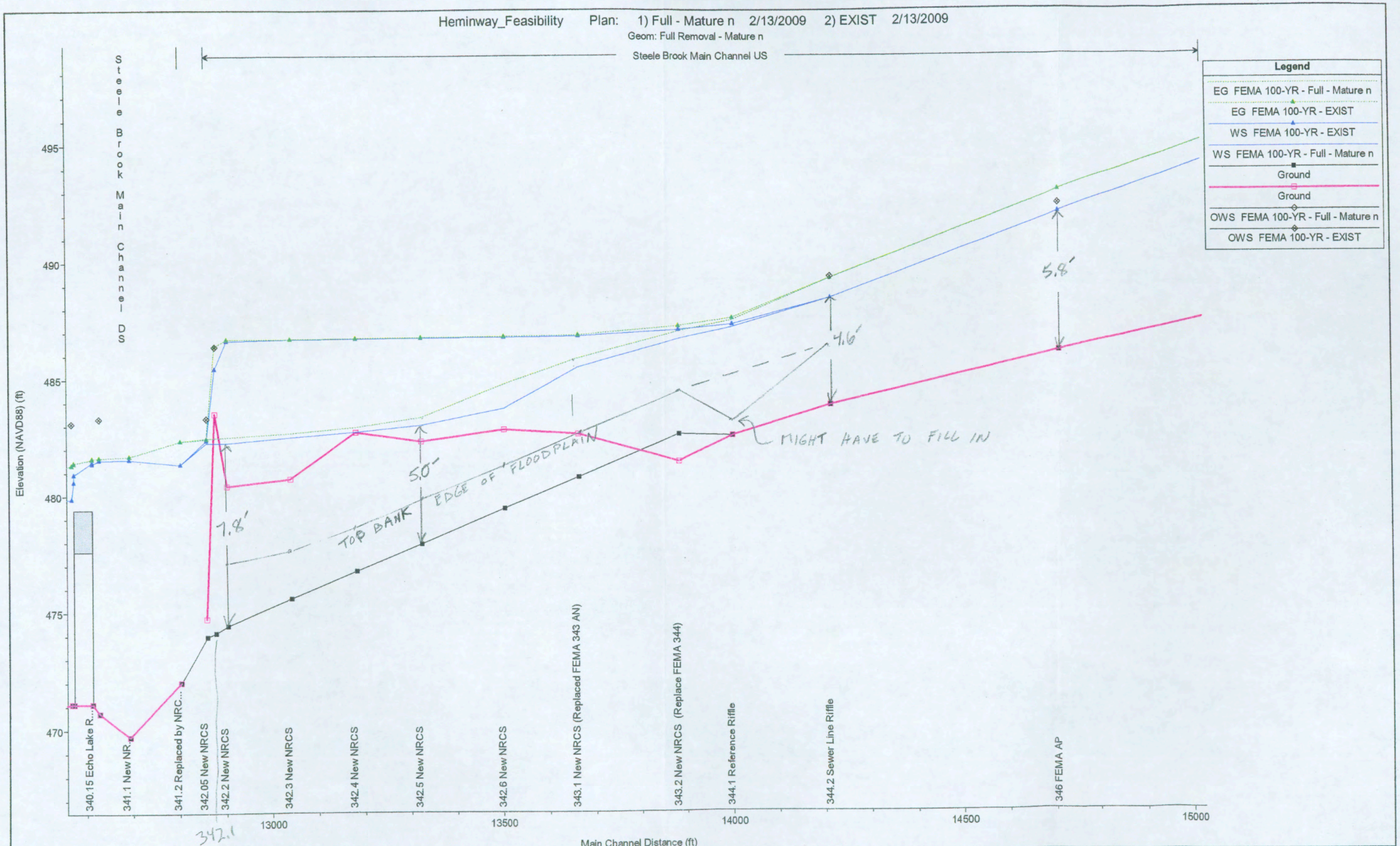
1 in Horiz. = 200 ft 1 in Vert. = 4 ft

checked by BGS 2/26/09



1 in Horiz. = 200 ft 1 in Vert. = 4 ft

checked by BLS 2/26/09



1 in Horiz. = 200 ft 1 in Vert. = 4 ft

Checked by BLS 2/26/09

HEC-RAS Plan: Full - Mature n

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main Channel US	347.15 ROUTE 6		Bridge									
Main Channel US	347.1	FEMA 100-YR	2060.00	488.30	494.39	494.31	496.88	0.018287	12.65	162.81	31.49	0.98
Main Channel US	347.1	FEMA 10-YR	820.00	488.30	492.79	491.94	493.61	0.008810	7.27	112.84	31.04	0.67
Main Channel US	347.1	Bankful Q	330.00	488.30	491.18	490.63	491.60	0.008810	5.24	63.02	30.58	0.64
Main Channel US	347 AQ	FEMA 100-YR	2060.00	487.90	494.86	493.28	495.70	0.005485	7.37	279.63	61.63	0.61
Main Channel US	347 AQ	FEMA 10-YR	820.00	487.90	492.83	491.15	493.21	0.003532	4.90	167.47	49.16	0.47
Main Channel US	347 AQ	Bankful Q	330.00	487.90	491.11	489.80	491.31	0.003023	3.59	92.03	38.56	0.41
Main Channel US	346 AP	FEMA 100-YR	2060.00	486.10	492.04	491.95	492.97	0.008430	8.32	346.89	210.20	0.74
Main Channel US	346 AP	FEMA 10-YR	820.00	486.10	490.42	489.86	491.07	0.009314	6.48	126.75	52.83	0.72
Main Channel US	346 AP	Bankful Q	330.00	486.10	489.16	488.54	489.51	0.007810	4.77	69.19	38.63	0.63
Main Channel US	344.2	FEMA 100-YR	2060.00	483.80	488.38	488.38	489.22	0.006883	8.96	428.85	231.15	0.77
Main Channel US	344.2	FEMA 10-YR	820.00	483.80	487.82	487.18	488.10	0.002432	4.84	301.38	221.70	0.45
Main Channel US	344.2	Bankful Q	330.00	483.80	486.41	485.53	486.68	0.003532	4.23	79.49	42.07	0.50
Main Channel US	344.1	FEMA 100-YR	2060.00	482.50	487.14	486.51	487.43	0.003835	5.77	578.98	360.74	0.55
Main Channel US	344.1	FEMA 10-YR	820.00	482.50	486.40	486.00	487.25	0.008700	7.43	115.38	270.52	0.79
Main Channel US	344.1	Bankful Q	330.00	482.50	485.45	484.86	485.77	0.005306	4.56	72.39	38.56	0.59
Main Channel US	343.2	FEMA 100-YR	2060.00	482.57	486.67	486.05	486.99	0.005384	6.57	789.13	374.13	0.58
Main Channel US	343.2	FEMA 10-YR	820.00	482.57	485.44	485.44	486.12	0.010760	7.24	205.00	326.75	0.78
Main Channel US	343.2	Bankful Q	330.00	482.57	484.59	484.12	485.00	0.008823	5.12	64.97	61.91	0.66
Main Channel US	343.1	FEMA 100-YR	2060.00	480.74	485.47	484.50	485.86	0.004562	6.71	683.23	386.42	0.55
Main Channel US	343.1	FEMA 10-YR	820.00	480.74	483.91	483.48	484.21	0.005021	5.32	324.75	267.36	0.54
Main Channel US	343.1	Bankful Q	330.00	480.74	482.78	482.29	483.14	0.007876	4.88	88.27	200.07	0.63
Main Channel US	342.65 Embankment & FP		Lat Struct									
Main Channel US	342.6	FEMA 100-YR	2018.46	479.41	483.71	483.65	484.74	0.010882	9.70	409.93	262.78	0.84
Main Channel US	342.6	FEMA 10-YR	820.00	479.41	482.48	482.40	483.14	0.009003	6.98	198.68	245.77	0.72
Main Channel US	342.6	Bankful Q	330.00	479.41	481.46	480.96	481.85	0.008313	5.02	65.91	44.18	0.64
Main Channel US	342.5	FEMA 100-YR	2018.46	477.91	483.00	482.12	483.34	0.003575	6.25	782.44	371.02	0.50
Main Channel US	342.5	FEMA 10-YR	820.00	477.91	481.05	480.95	481.63	0.007965	6.67	233.20	288.30	0.68
Main Channel US	342.5	Bankful Q	330.00	477.91	479.96	479.46	480.35	0.008213	5.00	66.23	46.13	0.64

Checked by BLS 2/26/09

HEC-RAS Plan: Full - Mature n (Continued)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Main Channel US	342.45 Embankment		Lat Struct									
Main Channel US	342.4	FEMA 100-YR	2018.46	476.74	482.73	480.93	482.92	0.001727	4.85	973.50	369.69	0.35
Main Channel US	342.4	FEMA 10-YR	820.00	476.74	479.86	479.78	480.47	0.008397	6.81	222.93	229.10	0.70
Main Channel US	342.4	Bankful Q	330.00	476.74	478.77	478.29	479.17	0.008525	5.06	65.31	41.33	0.65
Main Channel US	342.3	FEMA 100-YR	2014.80	475.57	482.49	479.76	482.67	0.001194	4.46	976.12	289.13	0.30
Main Channel US	342.3	FEMA 10-YR	820.00	475.57	478.94	478.61	479.37	0.005619	5.88	260.39	186.87	0.58
Main Channel US	342.3	Bankful Q	330.00	475.57	477.70	477.12	478.06	0.007145	4.80	70.49	61.49	0.60
Main Channel US	342.2	FEMA 100-YR	2014.80	474.41	482.26	478.77	482.50	0.001166	4.80	756.66	208.83	0.30
Main Channel US	342.2	FEMA 10-YR	820.00	474.41	478.45	477.34	478.74	0.002921	4.81	280.50	182.64	0.43
Main Channel US	342.2	Bankful Q	330.00	474.41	476.15	475.96	476.71	0.014701	6.01	54.91	34.27	0.84
Main Channel US	342.1 HEMINWAY DAM	FEMA 100-YR	2014.80	474.10	482.25	478.35	482.46	0.000473	4.17	564.98	91.72	0.26
Main Channel US	342.1 HEMINWAY DAM	FEMA 10-YR	820.00	474.10	478.44	477.01	478.65	0.001068	4.06	237.05	80.28	0.35
Main Channel US	342.1 HEMINWAY DAM	Bankful Q	330.00	474.10	475.87	475.65	476.41	0.007738	5.89	56.07	34.34	0.81
Main Channel US	342.05	FEMA 100-YR	2014.80	473.95	482.25	478.20	482.45	0.000440	4.07	578.65	92.17	0.25
Main Channel US	342.05	FEMA 10-YR	820.00	473.95	478.43	476.86	478.62	0.000924	3.87	248.82	80.72	0.33
Main Channel US	342.05	Bankful Q	330.00	473.95	475.50	475.50	476.22	0.012215	6.80	48.55	33.90	1.00
Main Channel DS	341.2	FEMA 100-YR	2840.00	472.00	481.34	478.91	482.33	0.006138	8.22	364.50	51.86	0.52
Main Channel DS	341.2	FEMA 10-YR	1130.00	472.00	477.90	476.29	478.49	0.006745	6.23	188.19	50.17	0.51
Main Channel DS	341.2	Bankful Q	330.00	472.00	474.90	474.37	475.30	0.013590	5.11	64.52	33.62	0.65
Main Channel DS	341.1	FEMA 100-YR	2840.00	469.70	481.55	477.10	481.68	0.000959	3.82	1204.63	474.70	0.20
Main Channel DS	341.1	FEMA 10-YR	1130.00	469.70	477.50	474.10	477.89	0.003114	5.11	229.94	41.05	0.35
Main Channel DS	341.1	Bankful Q	330.00	469.70	474.21	471.93	474.35	0.002262	2.97	111.29	32.45	0.28
Main Channel DS	341 AL	FEMA 100-YR	2840.00	470.70	481.53	479.60	481.62	0.000431	3.57	1589.34	556.95	0.20
Main Channel DS	341 AL	FEMA 10-YR	1130.00	470.70	476.84	475.25	477.62	0.003994	7.19	164.61	37.01	0.56
Main Channel DS	341 AL	Bankful Q	330.00	470.70	473.51	473.17	474.07	0.009226	5.98	55.20	28.85	0.76
Main Channel DS	340.2	FEMA 100-YR	2840.00	471.10	481.37	477.64	481.60	0.000813	5.03	1295.13	553.34	0.28
Main Channel DS	340.2	FEMA 10-YR	1130.00	471.10	476.87	474.64	477.54	0.002585	6.53	173.05	30.04	0.48
Main Channel DS	340.2	Bankful Q	330.00	471.10	473.60	472.66	473.90	0.002874	4.41	74.78	29.96	0.49

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE WATERSHED		
By CEG	Date 2/13/09	Checked by CEG + BLS	Date 3/10/09	Job No.
Subject				Sheet 105.1 of

105.2 FOLLOWS

[FOR ALT. 4]
THE NEW CHANNEL WILL NEED ARMORING
THE EXISTING SANDS ARE CLEARLY NOT ADEQUATE
AT THE NEW STEEP SLOPE.

BRACKET STABILITY WITH RIVERMORPH SHIELDS
AND ROSGEN PARTICLE STABILITY HIGHWAY
REPORT 108, FISHENICK SR-29 TABLE 2, AND LANES METHOD

HIGHWAY REPORT 108 USES
654 eq TS14C-4 $D_{50} = \frac{\gamma R S_e}{4}$ D_{50} IN FT

BE CONSERV. AND USE THE DMAX INSTEAD OF R

NOTE, WE WILL USE Q'S AS LARGE AS 2,840 CFS AND
108 METHOD IS UP TO ONLY 1,000 CFS, SO GOING CONSER.
IS WARRANTED. NO TO BE CONSISTANT WITH ALT 3 USE
T_{AVG} LET T_{AVG} = $T_{max} \times 0.65$ IN EXCELL SPREADSHT
NOTE $\gamma R S_e = T_0$ AVG TRACT. OR STRESS ~~$\gamma D S_e = T$~~

LET EXCELL FIND D_{50} = .65 $T/4 \times 12$ → GIVES D_{50} IN INCHES

FOR [ACOE FISHENICK STRM NOTE 29]
~~BUT~~ FIRST ADJUST T_{max} WITH 0.65 (FOR AV.) × 1.5 (FOR MAX.) × 1.15 (FOR TIME)

AT DESIGN LEVEL WE SHOULD USE
INTERPOLATE VALUES FOR TABLE 2 eq SR-29-10 (THIS IS FOR PLANNING LEVEL) (i.e. need to save for at planning level with EQ. 29-9)

[NOTE LANES] EQ. 654 8-24 IS

$T_{ab} = 0.4\, D_{75}$ = T allowable channel bottom bed

is good up to 5" PARTICLE. AND DOWN TO 1/4" APPX.

$D_{75} = \frac{T_{ab}}{0.4}$ D_{75} IS IN INCHES

SO LET EXCELL FIND ALL THESE.
LET $T_{ab} = T_{max}$ shear FOUND FROM MAX DEPTH COL C in EXCEL

USE FIG 8-16 FOR PARTICLES < 1/4" to 6 mm.

ALL THESE ALT. 4 CHANNEL TRACTIVE STRESSES
AND PARTICLE SIZES ARE CALCULATE AND OR LISTED ON
SHTS 107.1 C, D, AND E.

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE WATERSHED		
By CEG	Date 3/10/09	Checked by	Date	Job No.
Subject				Sheet 105.2 of

RECORD BEN SMITH'S COMMENTS FOR FUTURE DESIGN WORK.

DIFFERENCES IN Q'S

100-YR FEMA DS OF POND	2840 CFS
100-YR FEMA IN POND (HEC-RAS USED 2000 TO 2015 WITH LAT. STR. SPILLOVER)	2000 CFS
TR-20 100-YR FLOW	22[illegible] CFS
USGS 100-YR REGRESSION	1238 CFS

THESE COULD MAKE A HUGE DIFFERENCE DEPENDING ON WHAT IS SELECTED DURING FINAL DESIGN.

ITEMS ... TRACTIVE STRESS ASSUMPTIONS ARE SAME AS ALT 3 SEE 107.1 C, D, E

Steele Brook Particle Sizes Entrained - Alternate 4 - All Methods for Channel Tractive Stress

In alternative 4, the breakpoints between significant changes in energy grade slope are not the same for floods of different return frequency as they were for alternate 3. Hence different reaches are shown below. Rivermorph data is from the tractive stress curve there. Suspect values are in bold italics. ACOE comes from reading Table 2 directly. National Highway Report and Lanes methods come from equations in NEH 654 chapter 8 that have a functional relationship between particle size and allowable tractive stress. In Lanes method, particles above 5 inches are out of range of the method and are shown in bold italics. All results for ACOE, National Highway Report 108 and Lanes methods are for round rock.

			ALTERNATE 4 CONDITION - PARTICLE SIZES									
			CRITICAL PART. SIZES ENTRAINED				ALLOWABLE PARTICLE SIZES					
			Rivermorph				ACOE Craig F. Stream Note 29 Table 2		Nat. Highway Report 108 D50 Particle		Lanes Method for D75 Particle	
			Shields Data		Rosgen Data							
FLOOD AND REACH	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)
Bankful Flood												
D50 Ref riffle	13.9 (0.54)											
D84 Ref riffle	54.5 (2.14)											
346 - 344.2 (u.s. sewer line)		1.08	84	3.3	160	6.3	81.28	3.2	92	3.6	69	2.7
344.2 - 344.1 (Sewer Line to Ref. Riffle)		0.8	51	2.0	127	5.0	60.96	2.4	68	2.7	51	2.0
344.1 - 352.3 (342.3)		1.01	75	3.0	152	6.0	76.2	3.0	86	3.4	64	2.5
342.3 - 341.2 (through dam)		1.52	63 (163)	2.5 (6.4)	209	8.2	116.8	4.6	130	5.1	97	3.8
10-YR Flood												
D50 Ref riffle	13.9 (0.54)											
D84 Ref riffle	54.5 (2.14)											

			CRITICAL PART. SIZES ENTRAINED				ALLOWABLE PARTICLE SIZES					
			------------ Rivermorph ---------- -				ACOE Craig F. Stream Note 29 Table 2		Nat. Highway Report 108 D50 Particle		Lanes Method for D75 Particle	
			Shields Data		Rosgen Data							
FLOOD AND REACH	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)
346 - 344.2 (u.s. sewer line)		1.63	180	7.1	219	8.6	124.5	4.9	139	5.5	104	4.1
344.2 - 343.2 (S. line to across Ref. Riffle)		1.56	165	6.5	216	8.5	119.4	4.7	133	5.2	99	3.9
343.2 - 342.3		1.66	189	7.4	221	8.7	127	5.0	142	5.6	105	4.2
342.3 - 342.05 (through dam)		1.03	81	3.2	157	6.2	78.74	3.1	88	3.5	65	2.6
100-YR Flood)												
D50 Ref riffle	13.9 (0.54)											
D84 Ref riffle	54.5 (2.14)											
346 - 344.2 (u.s. sewer line)		2.77	651	***25.6***	321	12.6	210.8	8.3	237	9.3	176	***6.9***
344.2 - 344.1 (Sewer Line to Ref. Riffle)		2.42	460	***18.1***	291	11.5	185.4	7.3	207	8.1	154	***6.1***
344.1 - 342.5		1.9	265	***10.4***	245	9.6	144.8	5.7	162	6.4	121	4.8
342.5 - 342.05 (through dam)		0.93	65	2.6	144	5.7	71.12	2.8	79	3.1	59	2.3

IMPROVE SO TRACTIVE STRESS ASSUMPTIONS ARE SAME AS ALT. 3 AND BRING ASSUMPTION TO FRONT.

Footnotes.
For the stream Note SR-29, the average stream tractive stress based upon hydraulic radius is typically modified to produce maximum tractive stress with suggested facors of safety for both location and time . Location F.S = 1.5 and time factor = 1.1 to 1.2. Basic tractive stresses shown on the spreadsheet were the original study tractive stresses based upon maximum channel depth. For this SR 29 method, these original maximum tractive stresses were multiplied by 0.65 to convert to an average tractive stress (based on hydraulic radius). This was then multiplied by a location F.S. of 1.5 and a time F.S. of 1.15. These tractive stresses were the value used in Table 2 of SR-29.
National Highway Report 108 method was produced from data done on highway ditches with round rock and flows up to 1,000 cfs. This method links D50 size with a tractive stress.
Lanes method uses equations for channel bottom and channel sides to link an allowable D75 particle with a design tractive stress. It applies to D75 particles ranging from from 0.25 inch to 5 inches. For particles less than 0.25 inches, Fig 8-16 in NEH654 is used to link a tractive stress with a D50 size. The values reported here for the channel bottom equation. The 2.4 mm bankfull diam of the dam came from Fig. 8-16.
Note the Rivermorph data is to show the critical stress at where a particle of a certain size first entrains. The SR-29, Highway 108 and Lanes method are actually design methods with some level of conservativism built into them. Ironically, the critical stress data from Rosgen from Colorado streams produces the most conservative results at least at these ranges of tractive stress.

107.1B OF ___

107.1 C, D & E Follow

Steele Brook Particle Sizes Entrained - Alternate 4 - All Methods for Channel Tractive Stress

In Alternative 4, the breakpoints between significant changes in energy grade slope are not the same for floods of different return frequency as they were for Alternate 3. Hence different reaches are shown below. The technical references describing the various methods for determing particle size below use different assumptions for calculating tractive stress. The tractive stress assumptions used for alternate 4 have been kept consistent with the tractive stress assumptions used for Alternate 3. This is done, so that realistic comparisons can be made between Alternates 3 and 4. Suspect values are in bold italics. All results for ACOE, National Highway Report 108, and Lanes methods are for round rock. The unique tractive stress assumptions for each method are shown next:

Rivermorph data is from the tractive stress curve in that program and uses the maximum shear stress in the third column. This shear is calculated from the maximum channel depth.

The **ACOE Craig Fischenich Stream Note 29 Table 2 Method** uses tractive stress as follows: The average stream tractive stress based upon hydraulic radius is typically modified to produce maximum tractive stress with suggested facors of safety for both location and time . Location F.S = 1.5 and time factor = 1.1 to 1.2. So for column 4 of this spread sheet, ACOE SHEAR, the maximum tractive stresses of column 3 were multiplied by 0.65 to apprximate an average tractive stress (based on hydraulic radius). This was then multiplied by a location F.S. of 1.5 and a time F.S. of 1.15. These ACOE SHEAR stresses of column 4 were used in Table 2 of SR-29.

The **National Highway Report 108 Method** was produced from data done on highway ditches with round rock and flows up to 1,000 cfs. This method links D_{50} size with average tractive stress τ_{avg} based upon hydraulic radius. The basic formula used in NEH 654 Eq. TSC-4 is $D_{50} = \tau_{avg}/4$ where D_{50} is in ft. For this spreadsheet the formula embedded in the column for the 108 method obtains average shear by multiplying max shear in column 3 by 0.65 and also converts the units of D_{50} to inches.

Lanes Method uses equations for channel bottom and channel sides to link an allowable D_{75} particle with a design tractive stress. It applies to D_{75} particles ranging from from 0.25 inch to 5 inches, using NEH654 eq. 8-24. In this spreadsheet, the equation is rearranged to solve for D_{75} such that $D_{75} = \tau_{ab}/0.4$, where τ_{ab} is the allowable shear stress in lbs/sqft and D_{75} is in inches. The maximum shear stress of column 3 was used for allowable shear. This is consistent with Alt. 3 and also shows the particle size that can be expected to remain in place in the deepest part of the channel. If particles are less than 0.25 inches by the equation, than Fig 8-16 in NEH654 is viewed manually to link a tractive stress with a D_{50} size. Why it uses D_{50} instead of D_{75} is one of life's mysteries. The middle curve for low content of sediment in suspension is probably most useful for CT streams where soils are mostly sandy loams with little silt or clay. Particles larger than 5 inches are out of range for the equation and particles less than 0.1 mm are out of range for Fig. 8-16. Any of these are shown in bold italics.

Note the **Rivermorph data** is used to show the critical stress at where a particle of a certain size first entrains. The **ACOE SR-29, Highway 108 and Lanes** methods are actually design methods with some level of conservatism built into them. Ironically, the **critical stress data from Rosgen** from Colorado streams produces the most conservative results; at least at these ranges of tractive stress.

CHECKED BY CEG 3/9/09

107.1C OF ___

107.1 D FOLLOWS

CHECKED BY CEG 3/9/09

107.1D OF_
107.1E FOLLOWS

STEELE BROOK ALTERNATE 4 CONDITION - CHANNEL PARTICLE SIZES

FLOOD AND REACH	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	ACOE SHEAR LBS/SQ FT	CRITICAL PART. SIZES ENTRAINED — Rivermorph Uses Max. Shear — Shields Data (mm)	Shields Data (inch)	Rosgen Data (mm)	Rosgen Data (inch)	ALLOWABLE PARTICLE SIZES — ACOE Craig F. Stream N. 29 Table 2 Uses Spec. Max. Shear (mm)	ACOE (inch)	Nat. Highway Report 108 D50 Particle Uses Avg. Shear (mm)	Nat. Highway (inch)	Lanes Method for D75 Particle Uses Max. Shear (mm)	Lanes (inch)
Bankful Flood													
D50 Ref riffle	13.9 (0.54)												
D84 Ref riffle	54.5 (2.14)												
346 - 344.2 (u.s. Sewer line)		1.08	1.21	84	3.3	160	6.3	91.44	3.6	53	2.1	69	2.7
344.2 - 344.1 (Sewer line to Ref. riffle)		0.8	0.90	51	2.0	127	5.0	68.58	2.7	40	1.6	51	2.0
344.1 - 342.3		1.01	1.13	75	3.0	152	6.0	86.36	3.4	50	2.0	64	2.5
342.3 - 341.2 (through dam)		1.52	1.70	163	6.4	209	8.2	129.5	5.1	75	3.0	97	3.8
10-YR Flood													
D50 Ref riffle	13.9 (0.54)												
D84 Ref riffle	54.5 (2.14)												
346 - 344.2 (u.s. Sewer line)		1.63	1.83	180	7.1	219	8.6	139.7	5.5	81	3.2	104	4.1
344.2 - 343.2 (S. line to across Ref. riffle)		1.56	1.75	165	6.5	216	8.5	132.1	5.2	77	3.0	99	3.9
343.2 - 342.3		1.66	1.86	189	7.4	221	8.7	142.2	5.6	82	3.2	105	4.2

CHECKED BY CEG 3/9/09

107.1E OF __
107.2 FOLLOWS

STEELE BROOK ALTERNATE 4 CONDITION - CHANNEL PARTICLE SIZES

FLOOD AND REACH	EXISTING SAMPLE DIAM. mm (In)	MAX. SHEAR LBS/SQ FT	ACOE SHEAR LBS/SQ FT	CRITICAL PART. SIZES ENTRAINED – Rivermorph Uses Max. Shear – Shields Data (mm)	Shields Data (inch)	Rosgen Data (mm)	Rosgen Data (inch)	ALLOWABLE PARTICLE SIZES – ACOE Craig F. Stream N. 29 Table 2 Uses Spec. Max. Shear (mm)	ACOE (inch)	Nat. Highway Report 108 D50 Particle Uses Avg. Shear (mm)	Nat. Highway (inch)	Lanes Method for D75 Particle Uses Max. Shear (mm)	Lanes Method (inch)
342.3 - 342.05 (through dam)		1.03	1.15	81	3.2	157	6.2	86.36	3.4	51	2.0	65	2.6
100-YR Flood)													
D50 Ref riffle	13.9 (0.54)												
D84 Ref riffle	54.5 (2.14)												
346 - 344.2 (u.s. Sewer line)		2.77	3.11	651	***25.6***	321	12.6	236.2	9.3	137	5.4	176	***6.9***
344.2 - 344.1 (Sewer line to Ref. riffle)		2.42	2.71	460	***18.1***	291	11.5	205.7	8.1	120	4.7	154	***6.1***
344.1 - 342.5		1.9	2.13	265	***10.4***	245	9.6	162.6	6.4	94	3.7	121	4.8
342.5 - 342.05 (through dam)		0.93	1.04	65	2.6	144	5.7	78.74	3.1	46	1.8	59	2.3

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project STEELE BROOKE		
By CEG	Date 2/23/09	Checked by BLS	Date 3/3/09	Job No.
Subject			Sheet 107.2 of

TRACTIVE STRESS ANALYSIS OF FLOODPLAIN ALTY

DRAW IN FLOODPLAIN ELEVATIONS ON 10-YR AND 100-YR PROFILES SHTS 101 AND 102.

FOR 100 YR — NOTE $T_{FLOODPLAIN} < T_{CHANNEL}$ (SEE SHT 99)

ENERGY GRADE SLOPE 343.1 TO 342.5

= (485.8 − 483.3)/325 = .00769

(485.76 − 483.34)/340.35 = .007393

DEPTH AT 343.1 = 2.8′ DEPTH ON FLOODPLAIN

T = γDS

T = 62.4 (2.8) (.00769) = (1.34 LB/FT²) ON EDGE FLOODPLAIN

.007393 — 1.29

ENERGY GRADE SLOPE FROM 342.5 TO 342.1

= (483.3 − 482.4)/445 = .00202

(483.34 − 482.46)/447.01 = .001968

DEPTH AT 342.2 = 5.2

T = 62.4 (5.2) (.00202) = (0.66 LB/FT²) ON EDGE FLOODPLAIN

5.5 — .001968 — 0.68

FOR 10 YR → $T_{FP} < T_{CHANNEL}$ (SHT 99)

EG SLOPE 344.1 TO 343.1

= (487.3 − 484.2)/332 = .00934 ← OK

336.76 — .009027

Channel Bott. SLOPE = (482.6 − 474.4)/978 = .00838 ✓ OK

WATER DEPTH AT 343.2 = 0.9′ AT 343.2

T = 62.4 (0.9) .00934) = (0.52 LB/FT²) EDGE FLOODPLAIN

EG SLOPE 343.1 TO 342.3 = (484.2 − 479.4)/620 = .0077

DEPTH 1.5 AT 343.1 ON EDGE FLOODPLAIN

T = 62.4 (1.5)(.0077) = (0.72 LB/FT²)

0.73

FROM TABLE 2 SR-29 JUTE NET TAKES 0.45 LB/FT²

STRAW WITH NET TAKES 1.5–1.65 LB/FT²

HARDWOOD TREES HAVE 0.41 TO 2.5 LB/FT²

654 TABLE 8-4 HAS SAFE VALUES

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project		
	STEELE BROOKE		
By CEG	**Date** 2/23/09	**Checked by** BLS	**Date** 3/3/09
Job No.			
Subject			**Sheet** 107.3 **of**

NOTE EFH CHAPT 7 WATERWAYS PAGE 7-8 AND TABLE 7-1 SAY SAND IS EASILY ERODEABLE AND HAS ALLOWABLE STRESS OF 0.02 LB/FT^2.

FIGURE 7-5 REFINES THIS FURTHER
ASSUMING A D_{75} = 1 mm FROM DEP SAMPLE DATA
$\tau_a = \tau_{allowable} = 0.4\ LB/FT^2$ (LAST VALUE ON FIGURE)

ALSO A VEGETAL RETARDANCE OF D ~~ALONG~~ INPUT TO TABLE 7-5 HAS $C_I = 4.44$

FROM EQ. 7-4 $\tau_{va} = 0.75\,C_I = 0.75(4.44) = 3.33\ LB/FT^2$?

NOTE E ~~OR~~ BURNED STUBBLE HA $C_I = 2.88$

HERE $\tau_{av}\ 0.75(2.88) = 2.16\ LB/FT^2$

Total STRESS ALLOWED FOR SOIL + TYPE VEG = 2.16 + .4 = 2.56 LB/FT^2

NOTE SR-39 TABLE 2 HAS CLASS C TURF = 1.0 LB/FT^2
B TURF = 2.1 LB/FT^2
A TURF = 3.7 LB/FT^2

SO THESE TWO ARE IN THE BALL PARK.

654 Table TS14I-4 HAS
GRASS TURF EXCELLENT → 3.2 LB/FT^2 ESTABLISHED

LIVE BRUSH WATTLEFENCE INITIAL 0.2 – 2 LB/FT^2
ESTABLISHED 1.0 – 5.4 LB/FT^2

STREAMBANK SOIL BIO HAS PG 34
DECIDUOUS TREES RIGHT AFTER CONST = 0.4 LB/FT^2
AFTER 3-4 SEASONS = 2.4 LB/FT^2

SO USE STRAW AND NET WITH COIR WITH SEED MIX OF GRASS AND WILLOWS USE COIR TO LAST 3 YEARS BY THEN WILLOW WILL ESTABLISHED

COULD ALSO USE JUTE + STRAW IF LASTS ONE YEAR WHILE GRASS COMES UP.

Computation Sheet

NRCS–ENG-523A Rev. 6-2002

U.S. Department of Agriculture
Natural Resources Conservation Service

State	Project: STEELE BROOKE		
By: CEG	Date: 2/23/09	Checked by: BLS	Date: 3/3/09
Subject		Job No.	Sheet 107.4 of

LANDLOCK EROSION CONTROL MATS FROM SI GEOSOLUTIONS HAS A DOUBLE PLASTIC NET OF STRAW CALLED S2 AND LASTS ONE YEAR CAN TAKE UP TO $\frac{16.5}{20} \times 2 = 1.65$ LB/FT² SHEAR.

CS2 STRAW + COCONUT BLEND TAKES UP TO $\frac{18.5}{20} \times 2 = 1.85$ LB/FT² AND LASTS 2 YRS.

STANDARD ROLLS ARE 6.5 × 138.5 FT LONG = 100 yd²

~~CABL~~ CAN ALSO GET 7.5 × 120 = 100 YD²
AND 12.5 × 432 = 600 YD²

MAY BE COVERED BY JUTE OR PLASTIC NETS

CALL 1-800-FIX-SOIL

FROM SHT 107.2
NOTE MAX TRACTIVE STRESS FOR 10-YR = 0.72 LB/FT²
FOR 100-YR 1.34 LB/FT²

SO PLAIN STRAW ~~MAT~~ AND PLASTIC NET MAT WILL DO IT, IF GET QUICK GRASS COVER.

Steele Brook Stability Analysis

Basic Stream Stability Concepts:

The flowing water of streams applies an erosive force to stream beds and banks. When this erosive force is high enough, significant amounts of stream bed and bank particles can be eroded and carried downstream. This is known as bedload movement. The strength of this erosive potential as applied to a unit area of the stream bed or bank can be measured with a quantity called tractive stress. Commonly, this is designated in pounds of downstream force per each square foot of the bed or bank. Typically, tractive stress increases when stream flows get deeper or the slope of the water surface from upstream to downstream gets steeper.

Fields of study such as fluvial geomorphology and hydraulic engineering have produced various tables that show how much tractive stress must be applied to move various sizes of particles lying on stream beds and banks. Typically, the earth and rock materials on these streams have a range and distribution of particle sizes known as a gradation. Describing how diameters of these particles vary within a gradation is commonly done with a measurement concept called effective diameter. The definition of effective diameter is best done by example. The D_{50} effective diameter is defined as that particle diameter within a gradation where 50 percent of the weight of the gradation is comprised of particles smaller than the D_{50} diameter. Similarly, the D_{84} would be defined as that particle diameter within a gradation where 84 percent of the weight of the gradation is comprised of particles smaller than the D_{84} diameter.

Several tools exist to link tractive stress with the particle sizes of the bedload. One of these is the Rivermorph computer program that catalogs and analyzes many features of fluvial geomorphology. Several graphical curves of Rivermorph show what size particles of sand, gravel, cobble, and rock will move under various applied tractive stresses. One of these curves is based upon 50 samples of Colorado streams as measured by David Rosgen where the particles moved range from ¼ to 16 inch diameters.

Steele Brook Geomorphology and Hydraulic Features:

For many years Steele Brook has flown into Heminway Pond. The relatively flat water slope of the pond causes the water velocity of Steele Brook to slow down as it enters the pond. In turn this causes sand and gravel carried by Steele Brook to settle out near the end of flood flows and create a delta extending nearly 2/3 of the way across the Pond. When Heminway Dam is partially or fully removed as described in Alternatives 3 and 4, the water surface slopes through the pond will become much steeper. Water surface slopes of some portions of the channel just upstream of the pond may increase a bit as well. These increased water slopes will increase tractive stress applied to the new channel and parts of the old channel as well. The net result will be to increase the erosion of channel sand and gravel and consequent bedload movement.

All streams naturally carry some amount of bedload. It cannot and should not be eliminated. Much work has been done in this feasibility study to begin to characterize how much the tractive stress and bedload movement of Steele Brook will increase as the dam is partially or fully removed. To fully characterize the increases in tractive stress will definitely take more work later on in advanced conceptual stages or design stages of the Steel Brook Project. Nevertheless, a brief description of the methods and results of this tractive stress work done so for will be described next. This will be very useful to guide future conceptual and design work.

The pond and channels were surveyed and a topographic map was produced. Further measurements were done during a geomorphic analysis to characterize a desired natural range of stream channel widths and depths, and floodplain widths. A pebble count sample was done of the stream armor gradation at the reference riffle and the D_{50} and D_{84} effective diameters were calculated. Also, effective diameters on six pond sample gradations done by the CT-DEP were utilized. The preferred channel and floodplain geometry was then used to design the size and location of the new channel in alternatives 3 and 4. Next, the flow behavior of the existing and new channels was modeled using the HEC-RAS computer program. From the water surface flow depths and slopes predicted by HEC-RAS, tractive stress was calculated at various parts of the existing and new channels. Finally, the previously mentioned Rosgen curve in Rivermorph was used to show the effects of how tractive stress in the existing and proposed channels will move particles of various sizes.

The predicted particle sizes moved by the stream at various locations under various flood levels are summarized in Tables _and _. These tables are organized to compare particle size movement of Alternative 3 and 4 to existing conditions. For convenience, the D_{50} and D_{84} effective diameters are shown at the bottom of the tables. Thus, the tables approximate how mobile the stream armor is under existing conditions and in Alternatives 3 and 4. To reduce table complexity the tractive stress causing the particle size movement is omitted. The level of particle sampling done in the channel and pond is considered reasonable for beginning to analyze alternatives in this feasibility study. However, it must be mentioned more particle size sampling and gradation measurement must be done for advanced conceptual analysis and final design analysis to refine this predictive channel behavior.

Also, it must be pointed out the water surface flood profiles predicted by HEC-RAS are fairly complex. The Echo Lake Bridge and the narrow deep channel upstream of the bridge create flooded backwater in the existing condition and alternatives 3 and 4. This helps reduce water surface slopes and tractive stress upstream in the pond area, thereby reducing bedload movement. In alternatives 3 and 4, the newly created floodplain in the dam area is a transition zone and will still be narrower than the floodplain upstream. This in turn has a backwater effect for about 50 to 300 feet upstream that reduces bedload movement somewhat as compared to the channel further upstream.

<u>Channel Stability:</u>

Conclusions from Table _ for comparing existing conditions to alt. 3 (for partial dam removal) and suggestions for future analysis are:

1. Particle movement from the reference riffle going upstream is essentially the same in the existing condition and in alt. 3.
2. Upstream of the reference riffle, the stream can move 4, 7.4, and 9.0 inch particles in the respective 1 ½, 10, and 100 year flood frequency flows. The reference riffle D_{50} size = 0.5 inch and the D_{84} size = 2.1 inches. The particles in upstream pools are even finer. So the stream armor of this portion of the stream is fairly mobile in the existing condition and will remain so in alt. 3.
3. In the upper 2/3 reach of the pond, alt. 3 will have a significantly greater capability to move particles downstream than the existing condition. For example, the existing 10-year can move a 1.2 inch particle while alt. 3 will be able to move a 3.1 inch particle. In both the existing case and alt. 3, the predicted particle sizes moved are substantially larger than the existing surface particles estimated at a D_{84} size of 0.22 inches. This analysis shows the armor in the pond is unstable even in the existing condition and supports why the pond delta continues to grow. Typically at the peak of a flood bedload movement is high and towards the end of the flood bedload settles out increasing the size of the delta.
4. In the reach 25 to 165 feet upstream of the dam, the particle sizes moved in both the existing condition and alt. 3 are smaller than upstream. The tractive stress here is reduced from downstream backwater. Nevertheless, alt. 3 will have significantly greater capability to move particles than the existing conditions. Also, alt. 3 will remove most of the upstream pond that is effective at trapping sediment on the tail end of flood flows. Hence, alt. 3 can move much more bedload downstream as compared to the existing condition.
5. Some level of additional stream armor would be reasonable for alt. 3. The extent of this can only be designed after stakeholders decide how much risk they are willing to assume for additional channel movement and bedload transport.

Conclusions from Table _ for comparing existing conditions to alt. 4 (for full dam removal) and suggestions for future analysis are:

1. Particle movement from the reference riffle going upstream will be greater in alt. 4 than the existing condition.
2. Upstream of the reference riffle up to the sewer line, the alt. 4 channel can move 5, 8.5, and 11.5 inch cobbles in the respective 1 ½, 10, and 100 year flood frequency flows. The reference riffle D_{50} size = 0.5 inch and the D_{84} size = 2.1 inches. The particles in upstream pools are even finer. So the existing stream armor of this portion of the stream will become very mobile in alt 4.
3. In the reach through the pond, alt. 4 will significantly increase the size of particles that can be moved as compared to the existing condition. For example, the existing 10-year can move a 1.2 inch particle while alt. 4 will be able to move an 8.7 inch particle. In both the existing case and alt. 4, the predicted particle sizes moved are substantially larger than the existing surface particles.
4. In the reach through the dam, the particle sizes moved in alt. 4 are larger for the 1 ½-year than the 10 and 100-year floods, because of backwater in higher floods.
5. Alt. 4 shows an even greater need for additional stream armoring than alt. 3. Again this can only be designed after stakeholders decide how much risk they are willing to assume for additional channel movement and bedload transport.

107.5

TABLE ? - STEELE BROOK - COMPARE SIZES OF STREAMBED PARTICLES MOVED BY VARIOUS FLOOD FLOWS FOR THE EXISTING CONDITION AND FOR ALTERNATE 3

	SECTION OF STEELE BROOK					
	SEWER LINE TO REFERENCE RIFFLE		UPSTREAM 2/3 OF THE POND		25' - 165' UPSTREAM OF THE DAM	
RETURN FRE-QUENCY FLOWS	EXISTING CONDI-TION (INCH)	ALTER-NATE 3 (INCH)	EXISTING CONDI-TION (INCH)	ALTER-NATE 3 (INCH)	EXISTING CONDI-TION (INCH)	ALTER-NATE 3 (INCH)
1 1/2 -Year	4.0	4.0	2.0	3.3	0.31	0.94
10 -Year	7.4	7.4	1.2	3.1	0.35	1.5
100 -Year	9.0	9.0	1.1	5.2	0.71	1.9

Existing surface particles in the reference riffle have D_{50} = 0.5 inch and D_{84} = 2.1 inches. Existing surface particles in the upstream 2/3 of the pond have D_{84} = 0.22 inch. Existing surface particles 25' - 165' upstream of the dam have D_{50} = 0.0087 inch and D_{84} = 0.059 inch.

TABLE ? - STEELE BROOK - COMPARE SIZES OF STREAMBED PARTICLES MOVED BY VARIOUS FLOOD FLOWS FOR THE EXISTING CONDITION AND FOR ALTERNATE 4

	SECTION OF STEELE BROOK					
	SEWER LINE TO REFERENCE RIFFLE		THROUGH THE POND		THROUGH THE DAM	
RETURN FRE-QUENCY FLOWS	EXISTING CONDI-TION (INCH)	ALTER-NATE 4 (INCH)	EXISTING CONDI-TION (INCH)	ALTER-NATE 4 (INCH)	EXISTING CONDI-TION (INCH)	ALTER-NATE 4 (INCH)
1 1/2 -Year	4.0	5.0	0.31 - 2.0	6.0	NA	8.2
10 -Year	7.4	8.5	0.35 - 1.2	8.7	NA	6.2
100 -Year	9.0	11.5	0.71 - 1.1	9.6	NA	5.7

Existing surface particles in the reference riffle have a D_{50} Size = 0.5 inch and a D_{84} size = 2.1 inches. Existing surface particles in the pond have a D_{50} = .0087 inch and a D_{84} size that ranges from .059 to 0.2 inch through the pond. The dam is a large concrete structure.

Canal and Floodplain Stability:

In alternative 4, the canal on the west side will carry a very small part of Steele Brook flows. To reduce the danger of pedestrians falling of the walled sides of this canal, it is recommended the canal be filled in with earth and vegetated with grass and dogwoods to form an intermittent waterway. Tractive stress analysis shows upon initial seeding this canal will be vulnerable to erosion. Planning level calculations show protecting this new seeding with mulch net consisting of two layers of plastic net with straw mulch sewed between the layers would be reasonable protection until a grass sod with dogwoods becomes established.

The floodplains for alternates 3 and 4 would be similarly vulnerable to erosion as analyzed with tractive stress. For about one year until grass sod and riparian perennial hardwoods become established, these floodplains would also need the straw mulch net described above. The above assumes the alt. 3 floodplain would be mostly relatively flat vegetated areas with a few very shallow flooded areas. If the stakeholders and permit agencies opt for small dugout ponds here that could also function as sediment traps and if the stakeholders can contend with some erosion on the floodplain than much of this temporary straw mulch net could be eliminated. In alt.4, the overall floodplain slope is steeper at 0.8 % and the floodplain is narrower, so that the entire floodplain should be covered with the straw mulch net.