Watershed Assessment of River Stability and Sediment Supply Study on a Trout Stream (a Tool for Design Justification)

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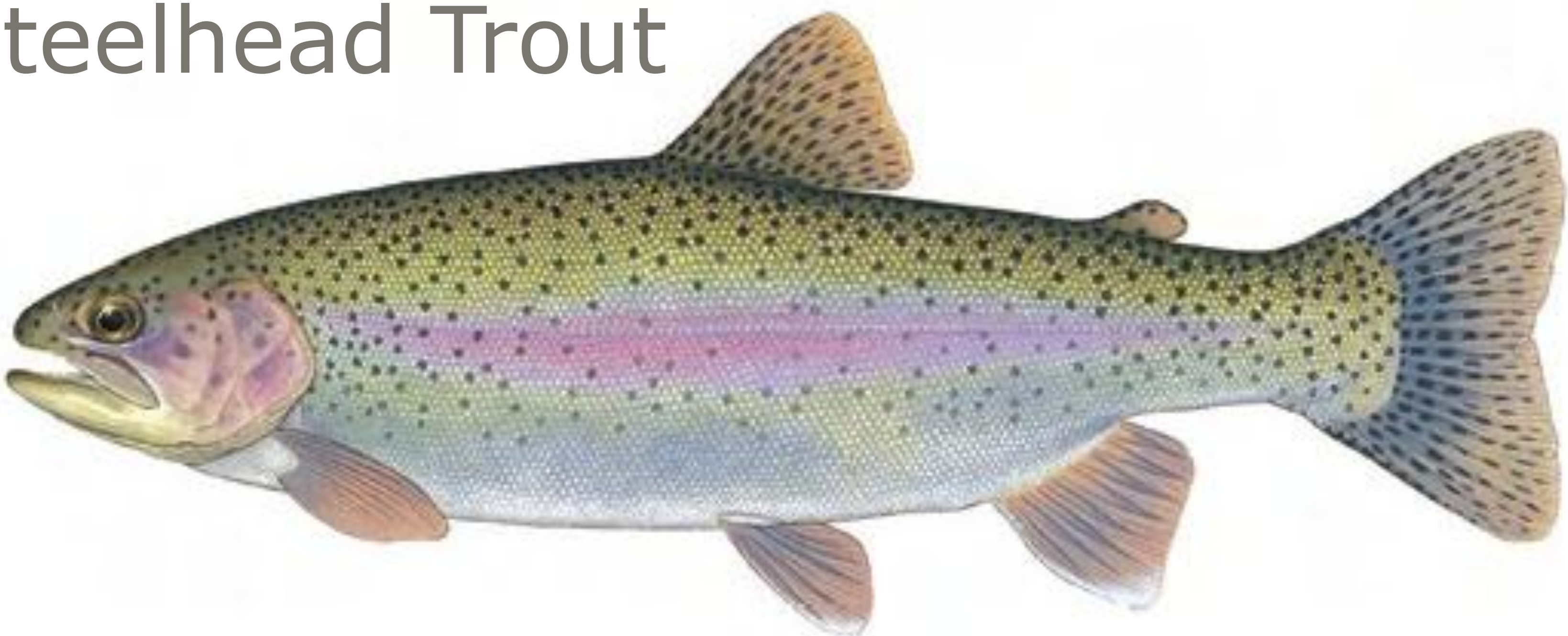
Stantec
November 16, 2011

Steelhead Trout



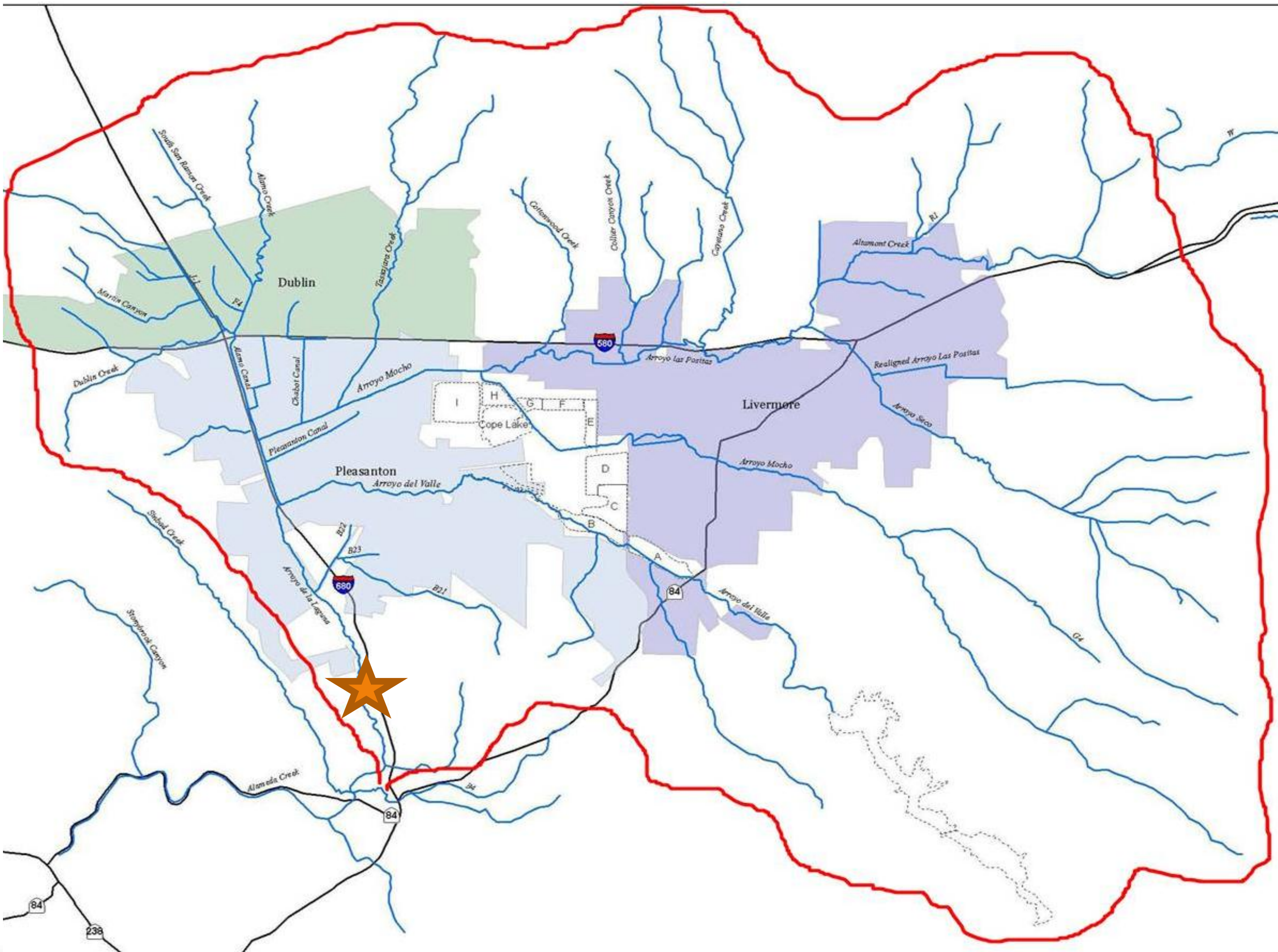
Zone 7 Water District
Urban Creeks Council
Barry Southerland – NRCS
Laurel Collins – Watershed Sciences

Watershed opportunities

Alameda Creek Alliance

Salmonid fish passage barrier on Alameda Creek

Sacramento River
DELTA
Mokelumne River
San Pablo Bay
Concord
Stockton
Clifton Court Forebay
Oakland
Bethany Reservoir
San Francisco
San Francisco Bay
Dublin
Livermore
Pleasanton
Modesto
South Bay Aqueduct
Lake Del Valle
California Aqueduct
San Joaquin River
San Jose
Zone 7
Pacific Ocean
H.O. Banks Delta Pumping Plant
Bethany Reservoir
Zone 7 Transmission Facilities
Reservoir
Patterson Pass WTP
Well Fields
Main Groundwater Basin Boundary
Del Valle WTP
Lake Del Valle
South Bay Aqueduct
San Luis Reservoir
City of Pleasanton
City of Livermore
Dublin San Ramon Services District
California Water Service Company



Dublin
Pleasanton
Livermore
Cope Lake
South San Ramon Creek
Alamo Creek
Tassajara Creek
Cottonwood Creek
Collier Canyon Creek
Cayetano Creek
Altamont Creek
Martin Canyon
Dublin Creek
Alamo Canal
Chabot Canal
Arroyo Mocho
Pleasanton Canal
Arroyo del Valle
Arroyo las Positas
Realigned Arroyo Las Positas
Arroyo Seco
Sinbad Creek
Stonybrook Canyon
Arroyo de la Laguna
Alameda Creek
580
680
84
238

Watershed

Upper reaches of watershed where salmonids want to go

Watershed

Other impediments to passage upstream; typical development

Watershed

Numerous arroyos with urban encroachments

ADLL Study Reach

Upper portion of study reach

ADLL Study Reach

Mid channel bars overgrown with vegetation

ADLL Study Reach

Long backwater pools with short riffles

ADLL Study Reach

Alternating mid channel bars beginning to form

ADLL Study Reach

Failed bank stabilization measures throughout

ADLL Study Reach

Looking upstream at one of two major eroding banks

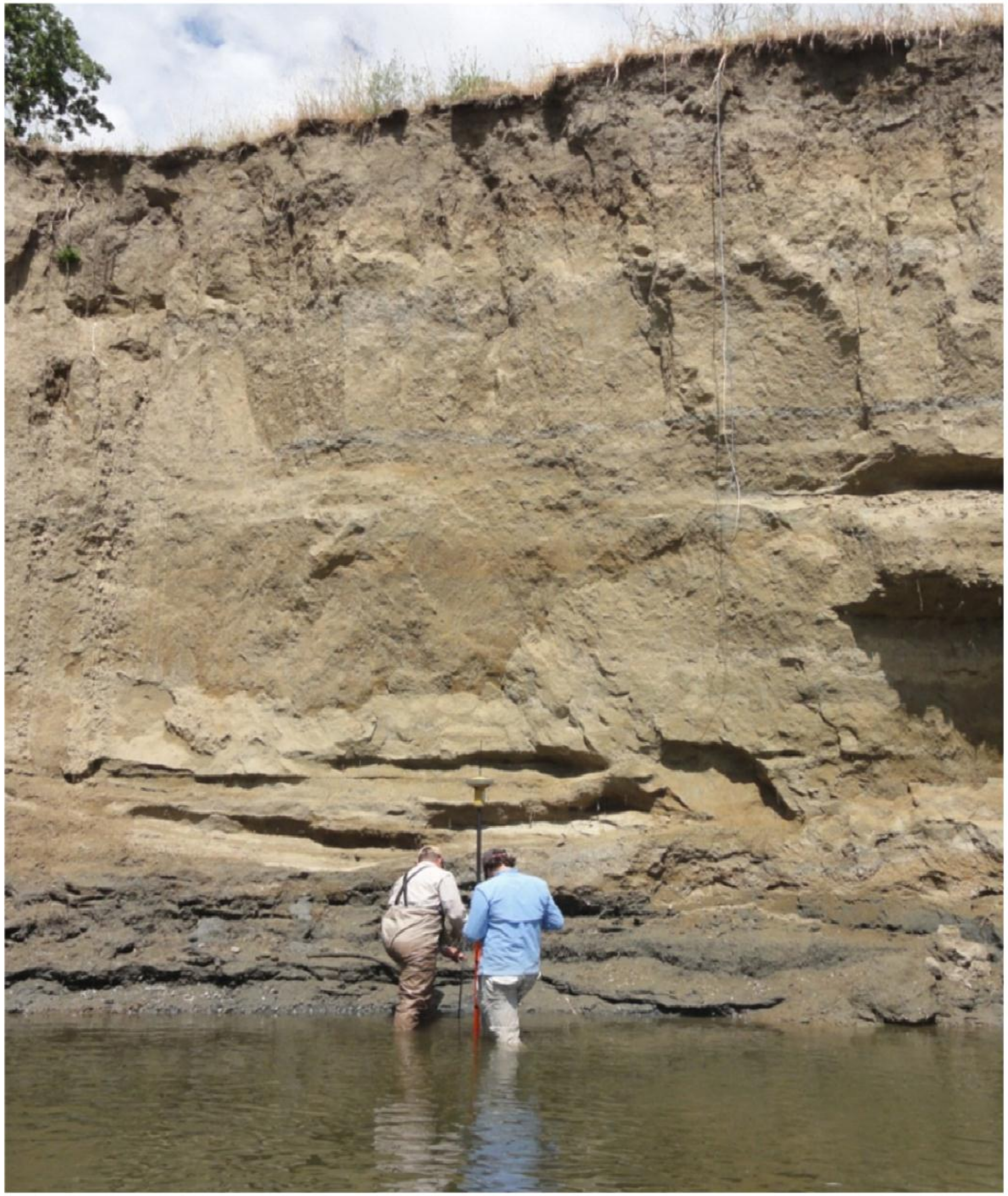
ADLL Study Reach

View looking downstream of same bank

ADLL Study Reach

Flow at approximately 1,800 cfs (bankfull discharge 1,900 cfs)

ADLL Study Reach



View of second major eroding bank

Longitudinal Profile
Cross Sections
Pebble Counts
Bar Samples
Scour Chains
Bank Profiles
BANCS

Wood Survey

Geomorphic survey using survey grade GPS

ADLL Study Reach

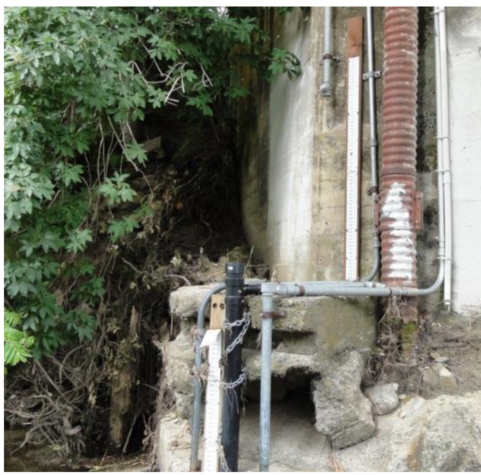
Scour chain

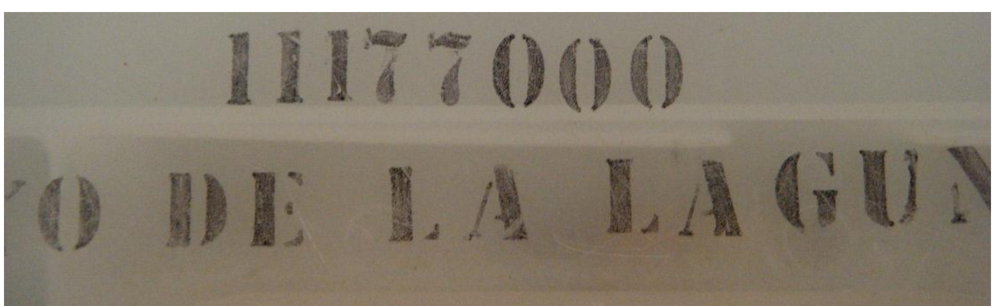
ADLL Study Site

Fisheries biologist marking and cataloging LWD habitat

ADLL Study Reach

Stream gage located beneath bridge





Summary....*USGS GAGE STATION* Data/Records for STREAM CHANNEL CLASSIFICATION

Station NAME:	Arroyo de le Laguna near Pleasanton			Station Number:	11176900
LOCATION:	Pleasanton, CA				
Period of RECORD:	95	yrs		Mean Annual DISCHARGE:	64 cfs
Drainage AREA:	257920 acres	403	mi^2	Drainage Area Mn ELEV:	280 ft
Reference REACH SLOPE:	0.0020	ft/ft		Valley Type:	VII
Stream Type:	F			HUC:	

"BANKFULL" CHARACTERISTICS

Determined from FIELD MEASUREMENT			Determined from GAGE DATA Analysis		
Bankfull WIDTH (W_{bkf})	97.6	ft	Bankfull WIDTH (W_{bkf})	N/A	ft
Bankfull Mean DEPTH (d_{bkf})	5.36	ft	Bankfull MEAN DEPTH (d_{bkf})	N/A	ft
Bankfull Xsec AREA (A_{bkf})	523.50	ft^2	Bankfull Xsec AREA (A_{bkf})	N/A	ft^2
Wetted PERIMETER (W_p)	102.6	ft	Wetted PERIMETER (W_p)	N/A	ft
Bankfull STAGE (Gage Ht)	6.980	ft	Bankfull STAGE (Gage Ht)	N/A	ft
Est. Mean VELOCITY (u)	3.63	ft/sec	Mean VELOCITY (u)	N/A	ft/sec
Est. Bkf. DISCHARGE (Q_{bkf})	1900.0	cfs	Bankfull DISCHARGE (Q_{bkf})	1900.0	cfs

Bankfull DISCHARGE associated with **"field-determined"** Bankfull STAGE		cfs
Recurrence Interval (Log-Pearson) associated with **"field-determined"** Bankfull Discharge	1.80	yrs

From the *Annual Peak Flow Frequency Analysis* data for the Gage Station, determine:

1.5 Year R.I. Discharge........ =	1552.0	cfs	10 Year R.I. Discharge........ =	8325.0	cfs
2.0 Year R.I. Discharge.........=	2584.0	cfs	25 Year R.I. Discharge........=	10383.0	cfs
5.0 Year R.I. Discharge.........=	5957.0	cfs	50 Year R.I. Discharge........ =	11298.0	cfs

MEANDER GEOMETRY

Meander Length (L_m)		ft	Radius of Curvature (R_C)		ft
Belt Width (W_{blt})		ft	Meander Width Ratio (W_{blt}/W_{bkf})		ft/ft

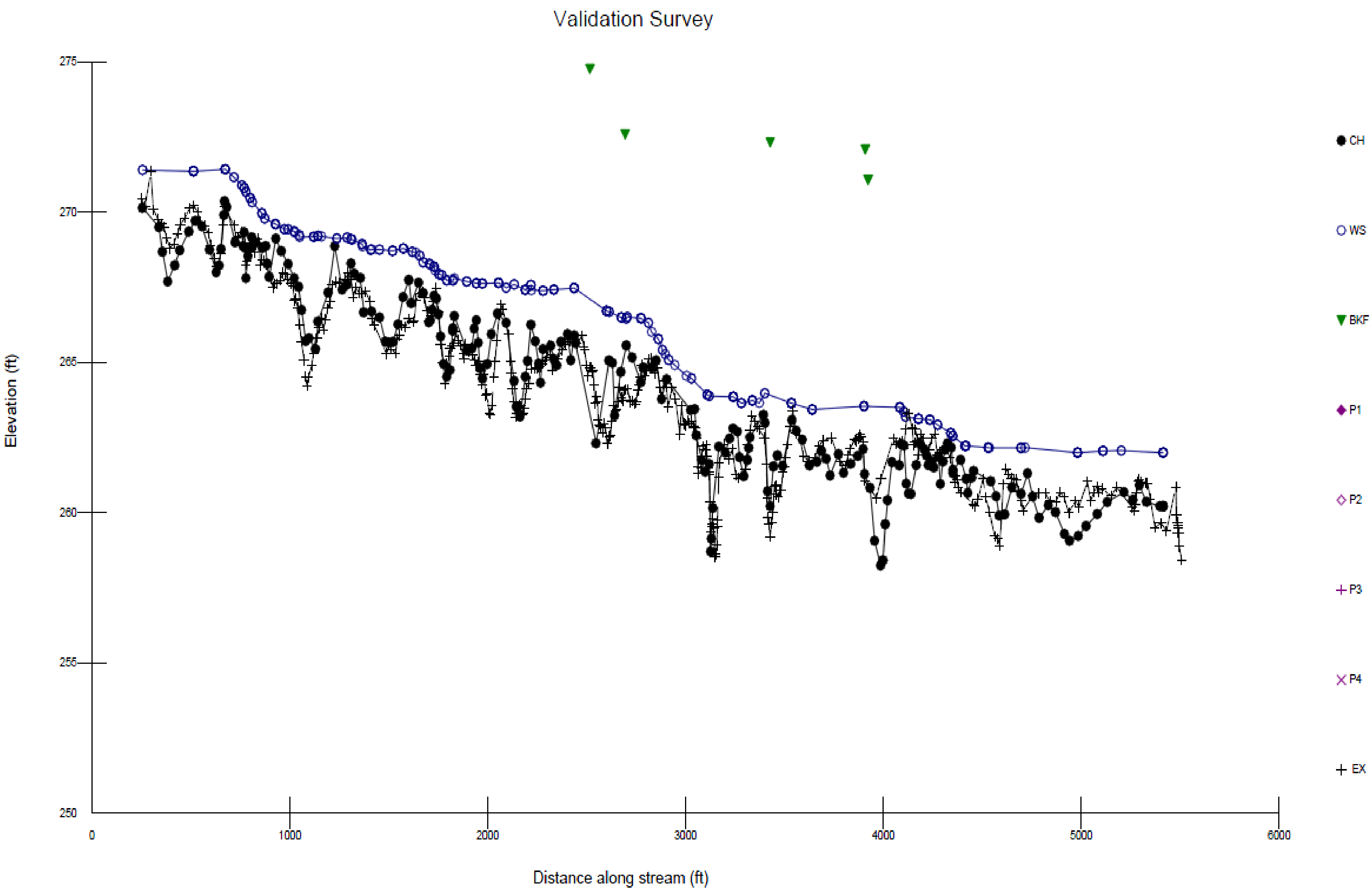
HYDRAULIC GEOMETRY

Based on *USGS Discharge Summary Notes* data (Form 9-207) and regression analyses of measured discharge (**Q**) with the hydraulic parameters of Width (**W**), Area (**A**), Mean Depth (**d**) & Mean Velocity (**u**), determine the *intercept coefficient* (**a**) and the *slope exponent* (**b**) values for a power function of the form $Y = aX^b$, when Y is one of the selected hydraulic parameters and X is a given discharge value (**Q**).

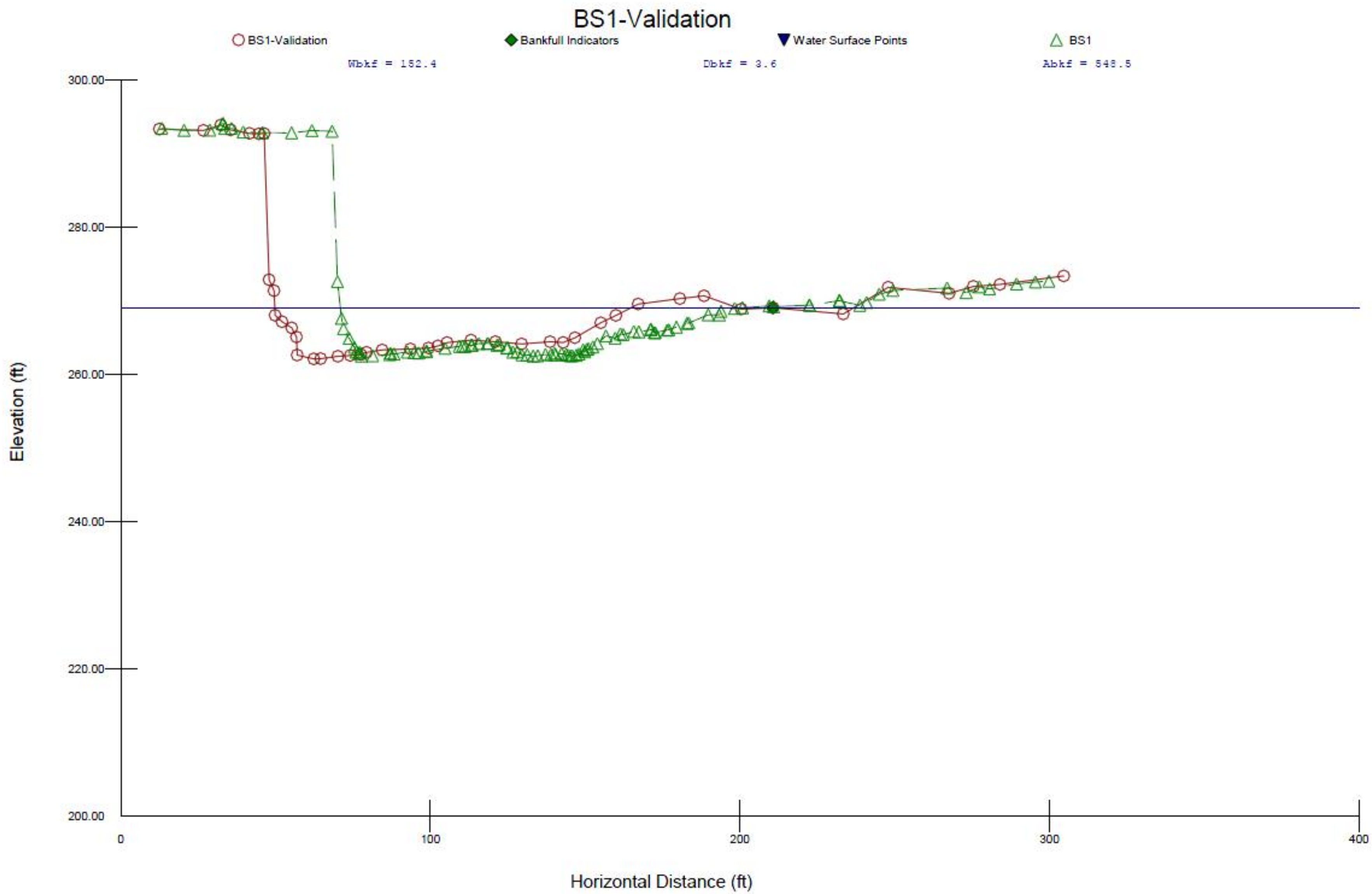
	Width (W)	Depth (d)	Area (A)	Velocity (u)
Intercept Coefficient: (a)				
Slope Exponent: (b)				

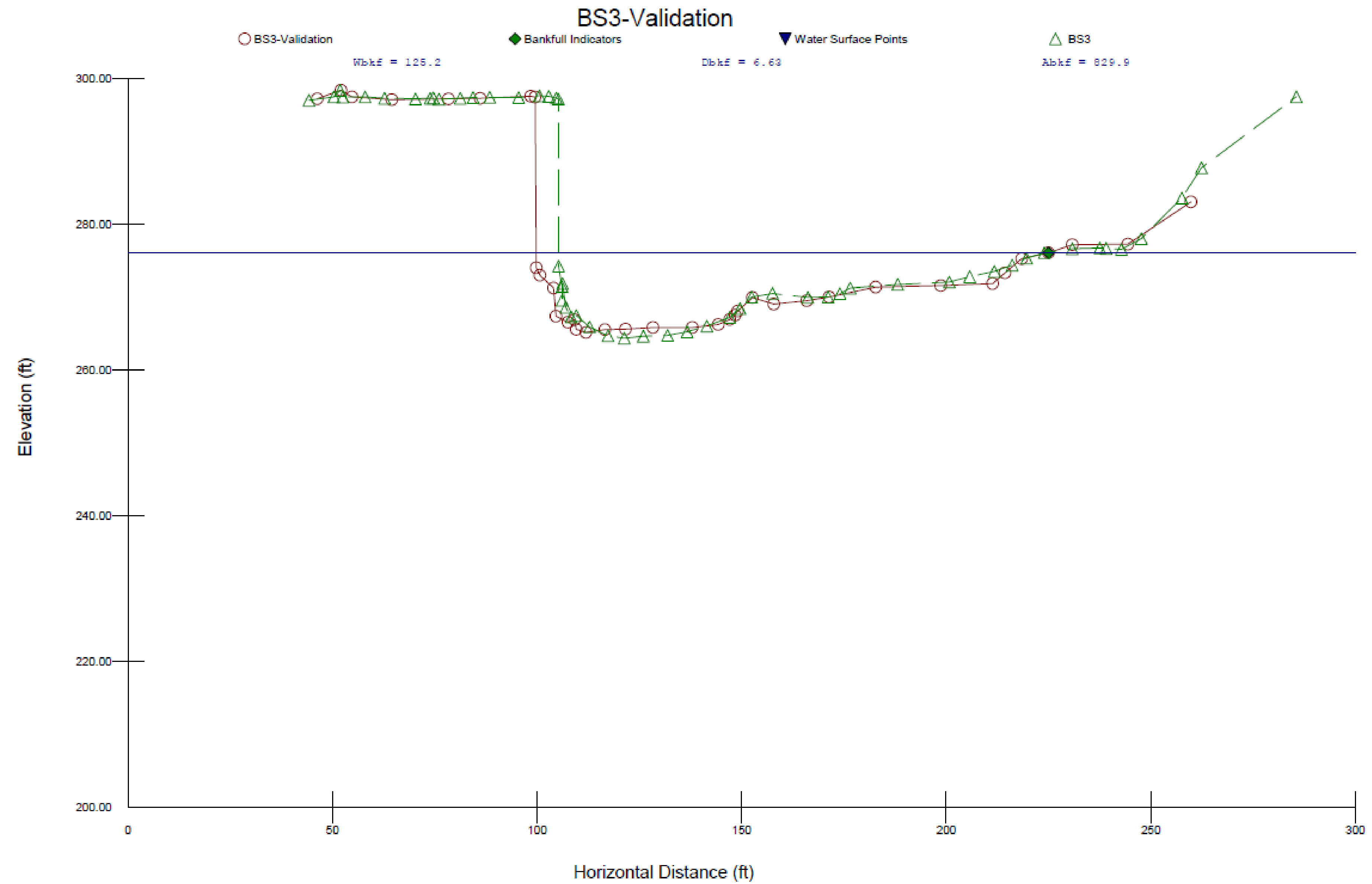
Hydraulic Radius: $R = A / W_p$		ft	**Manning's *n*** at Bankfull Stage		Coeff.

n = 1.49 [(Area) (Hydraulic Radius $^{2/3}$) (Slope $^{1/2}$)] / Q_{bkf}



Validation Survey
Elevation (ft)
Distance along stream (ft)
275
270
265
260
255
250
0
1000
2000
3000
4000
5000
6000
CH
WS
BKF
P1
P2
P3
P4
EX


BS1-Validation
BS1-Validation
Bankfull Indicators
Water Surface Points
BS1
Wbkf = 152.4
Dbkf = 3.6
Abkf = 548.5
300.00
280.00
260.00
240.00
220.00
200.00
Elevation (ft)
0
100
200
300
400
Horizontal Distance (ft)



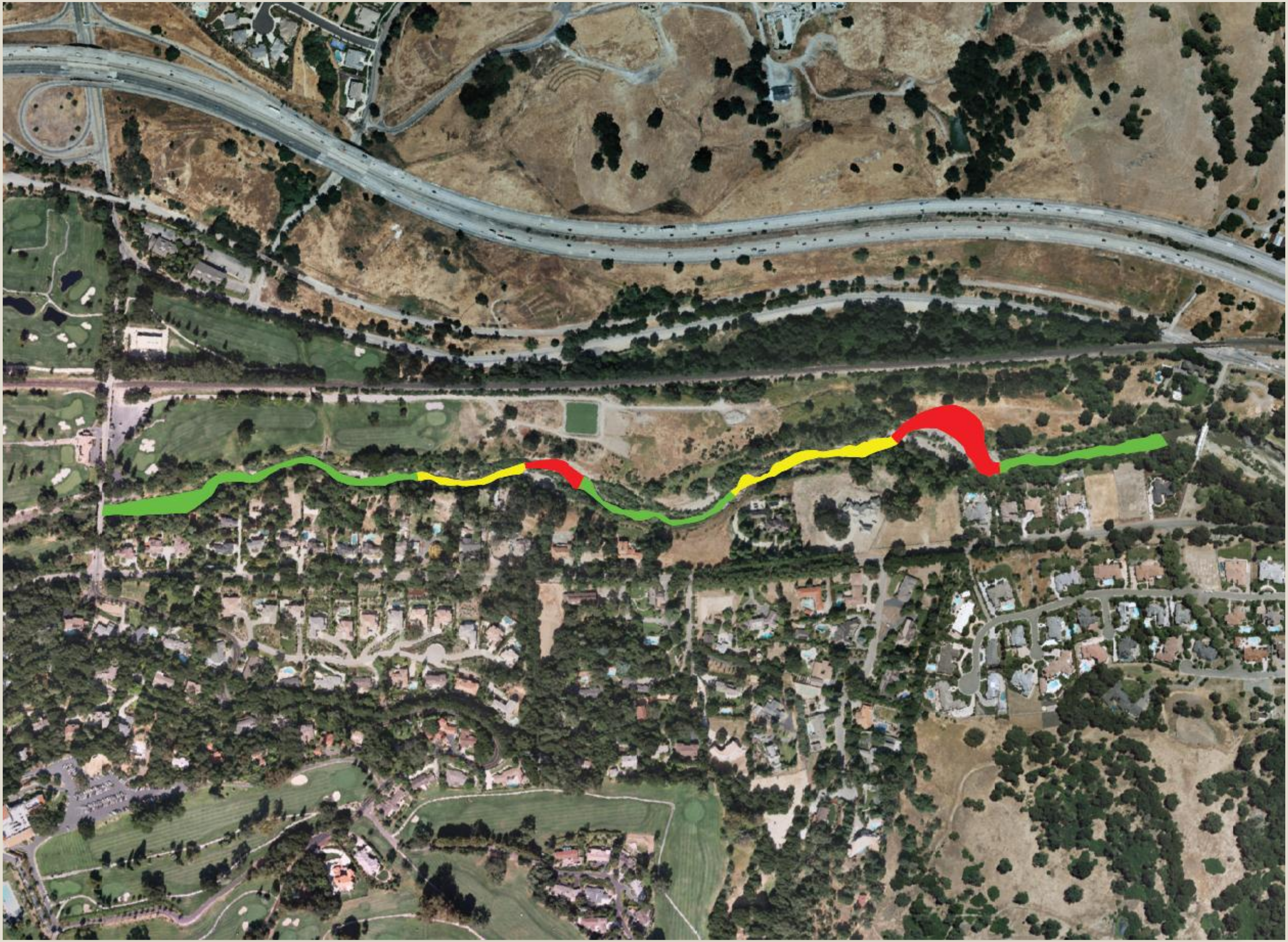
BS3-Validation
BS3-Validation
Bankfull Indicators
Water Surface Points
BS3
Wbkf = 125.2
Dbkf = 6.63
Abkf = 829.9
300.00
280.00
260.00
240.00
220.00
200.00
Elevation (ft)
0
50
100
150
200
250
300
Horizontal Distance (ft)

Data Comparison Form

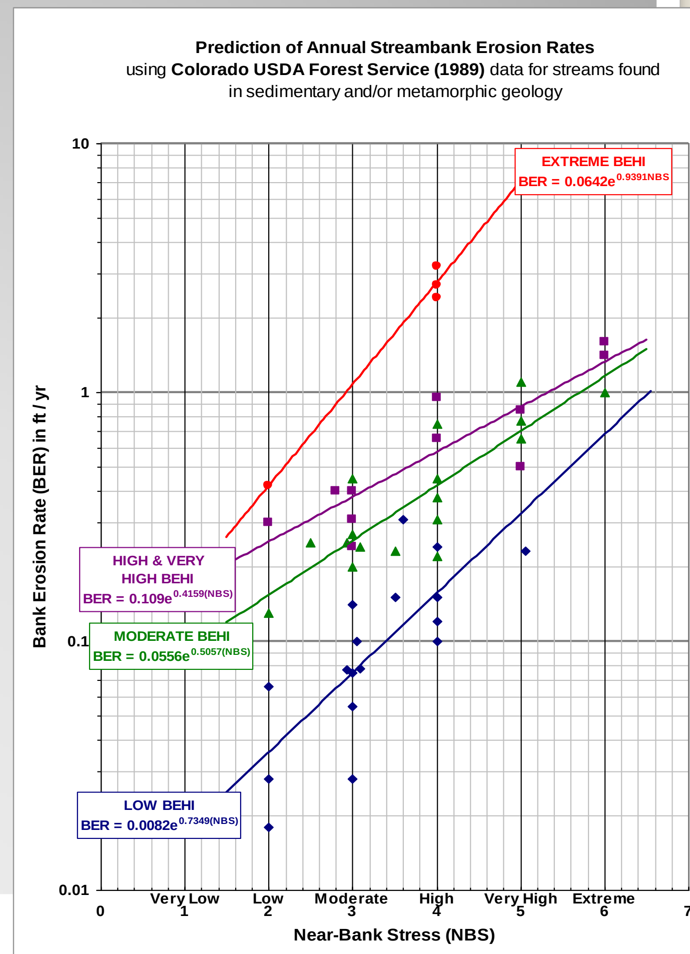
Stream: **Arroyo de la Laguna** Reach: **Castlewood Dr to Verona Rd**

Observers: **MFA, MAV, MJG** Date (Yr 1): **5/18/2010** Date (Yr 2): **7/25/2011**

		Riffle XS-1:		Riffle XS-2:		Pool XS-3:	
		Station 42+69		Station 46+76		Station 22+02	
		Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Cross-section Dimensions	Width (W_{bkf})	129.9	152.4	75.8	79.4	118.7	125.2
	Mean Depth (d_{bkf})	4.54	3.6	5.75	5.72	6.5	6.63
	Width/Depth Ratio (W/d)	28.6	42.3	13.2	13.9	18.3	18.9
	Cross-Sectional Area (A_{bkf})	589.7	548.6	435.9	454.2	771.6	830.1
	Max Bankfull Depth (d_{max})	6.57	6.94	7.65	7.94	11.73	10.94



Example: Geomorphic Reach Assessment - BANCS



- 400 ft Eroding Bank Length
- How Much Sediment will Erode and When

Stream: ADLL			Location: Left Bank				
Graph Used: CO		Total Bank Length (ft):		4,890		Date: 8/18/2010	
Observers: MFA, MV, JC, MG			Valley Type: VIII			Stream Type: B4c	

(1) Station (ft)				(2) BEHI rating (Worksheet 3-11) (adjective)	(3) NBS rating (Worksheet 3-12) (adjective)	(4) Bank erosion rate (Figure 3-9 or 3-10) (ft/yr)	(5) Length of bank (ft)	(6) Study bank height (ft)	(7) Erosion subtotal [(4)×(5)×(6)] (ft^3/yr)	(8) Erosion Rate (tons/yr/ft) {[(7)/27] × 1.3 / (5)}
1	0+00	TO	1+58.7	VL	L	0.000	158.7	1	0.0	0.000
2	1+58.7	TO	2+48.1	L	L	0.036	89.5	4	12.9	0.007
3	2+48	TO	4+19.5	VL	VL	0.000	171.4	1	0.0	0.000
4	4+19.5	TO	4+78.5	L	M	0.075	59.0	5	22.2	0.018
5	4+78	TO	5+52.8	M	M	0.253	74.3	15	282.7	0.183
6	5+52.8	TO	6+09.5	L	L	0.036	56.6	15	30.5	0.026
7	6+09	TO	7+60.4	VL	VL	0.000	150.9	15	0.0	0.000
8	7+60.4	TO	8+43.8	L	M	0.075	83.4	10	62.8	0.036
9	8+44	TO	8+80.9	L	H	0.158	37.1	6	35.1	0.046
10	8+80.9	TO	10+63.4	VL	VL	0.000	182.5	6	0.0	0.000
11	10+63	TO	10+97.1	L	VL	0.017	33.7	15	8.7	0.012
12	10+97.1	TO	11+87.0	L	L	0.036	89.9	15	48.5	0.026
13	11+87	TO	12+90.8	M	L	0.153	103.8	12	190.3	0.088
14	12+90.8	TO	14+10.4	L	H	0.158	119.6	10	188.5	0.076
15	14+10	TO	14+89.2	L	M	0.075	78.8	8	47.5	0.029
16	14+89.2	TO	17+26.9	VL	L	0.000	237.7	8	0.0	0.000
17	17+27	TO	17+88.8	L	VL	0.017	61.8	8	8.5	0.007
18	17+88.8	TO	18+30.2	H	H	0.575	41.5	20	477.1	0.554
19	18+30	TO	18+61.1	VH	VH	0.872	30.9	30	808.1	1.260
20	18+61.1	TO	20+04.8	E	VH	7.027	143.7	30	30,293.4	10.150
21	20+05	TO	20+93.6	E	M	1.074	88.8	25	2,383.8	1.293
22	20+93.6	TO	21+19.5	L	L	0.036	25.9	6	5.6	0.010
23	21+19	TO	30+01.1	VL	VL	0.000	881.7	6	0.0	0.000
24	30+01.1	TO	30+54.1	VL	VL	0.000	53.0	6	0.0	0.000
25	30+54	TO	32+56.4	L	H	0.158	202.2	8	255.0	0.061
26	32+56.4	TO	35+09.1	VL	VL	0.000	252.8	8	0.0	0.000
27	35+09	TO	35+80.2	L	VL	0.017	71.0	7	8.5	0.006
28	35+80.2	TO	36+99.0	L	VL	0.017	118.8	15	30.6	0.012
29	36+99	TO	41+04.2	E	VH	7.027	405.2	30	85,416.8	10.150
30	41+04.2	TO	41+71.1	E	M	1.074	66.9	20	1,437.5	1.034
31	41+71	TO	42+55.4	VL	L	0.000	84.3	20	0.0	0.000
32	42+55.4	TO	43+53.9	L	M	0.075	98.5	7	51.9	0.025
33	43+54	TO	48+90.4	L	L	0.036	536.5	4	77.1	0.007

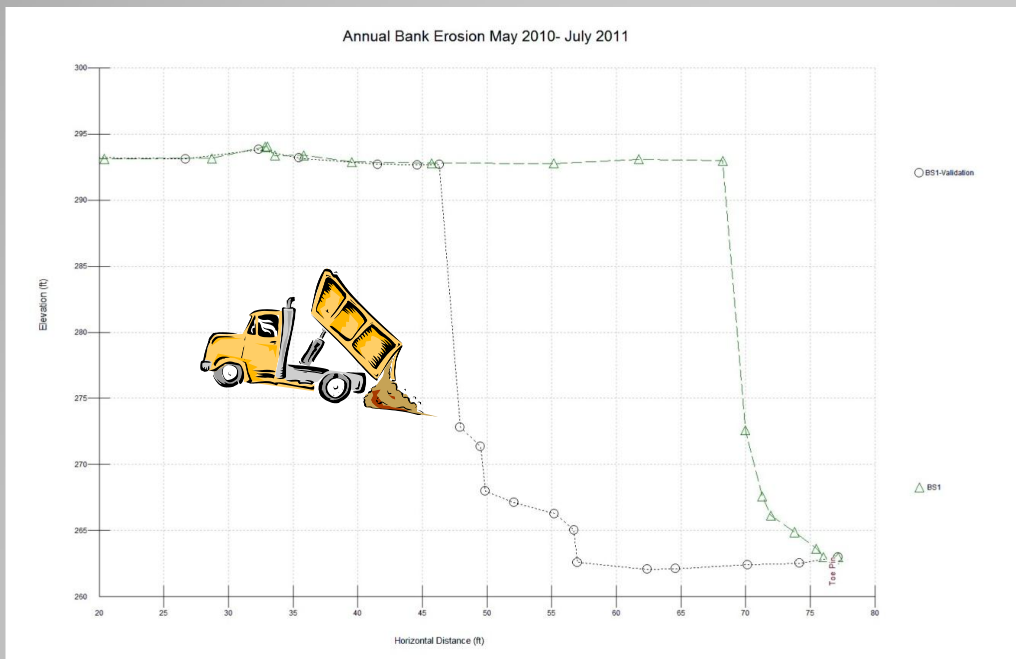
Sum erosion subtotals in Column (7) for each BEHI/NBS combination	Total Erosion (ft^3/yr)	122183.6
Convert erosion in ft^3/yr to yds^3/yr {divide Total Erosion (ft^3/yr) by 27}	Total Erosion (yds^3/yr)	4525.3
Convert erosion in yds^3/yr to tons/yr {multiply Total Erosion (yds^3/yr) by 1.3}	Total Erosion (tons/yr)	5882.9
Calculate erosion per unit length of channel {divide Total Erosion (tons/yr) by total length of stream (ft) surveyed}	Total Erosion (tons/yr/ft)	1.2

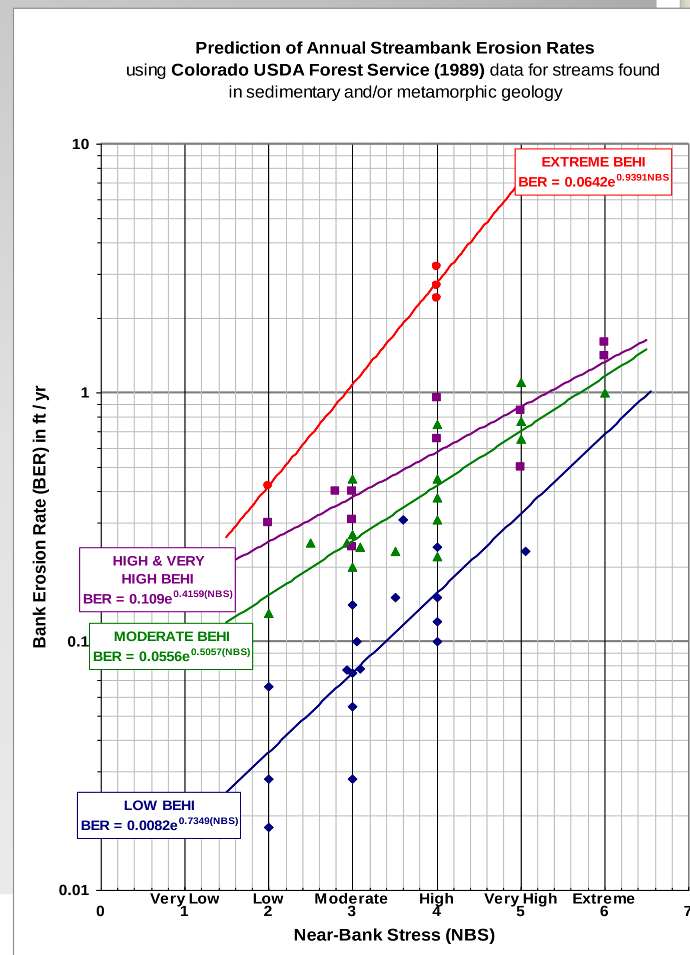
88% of sediment inputs from bank erosion at two locations

Prediction: 17 FT

Actual: 20.5 FT

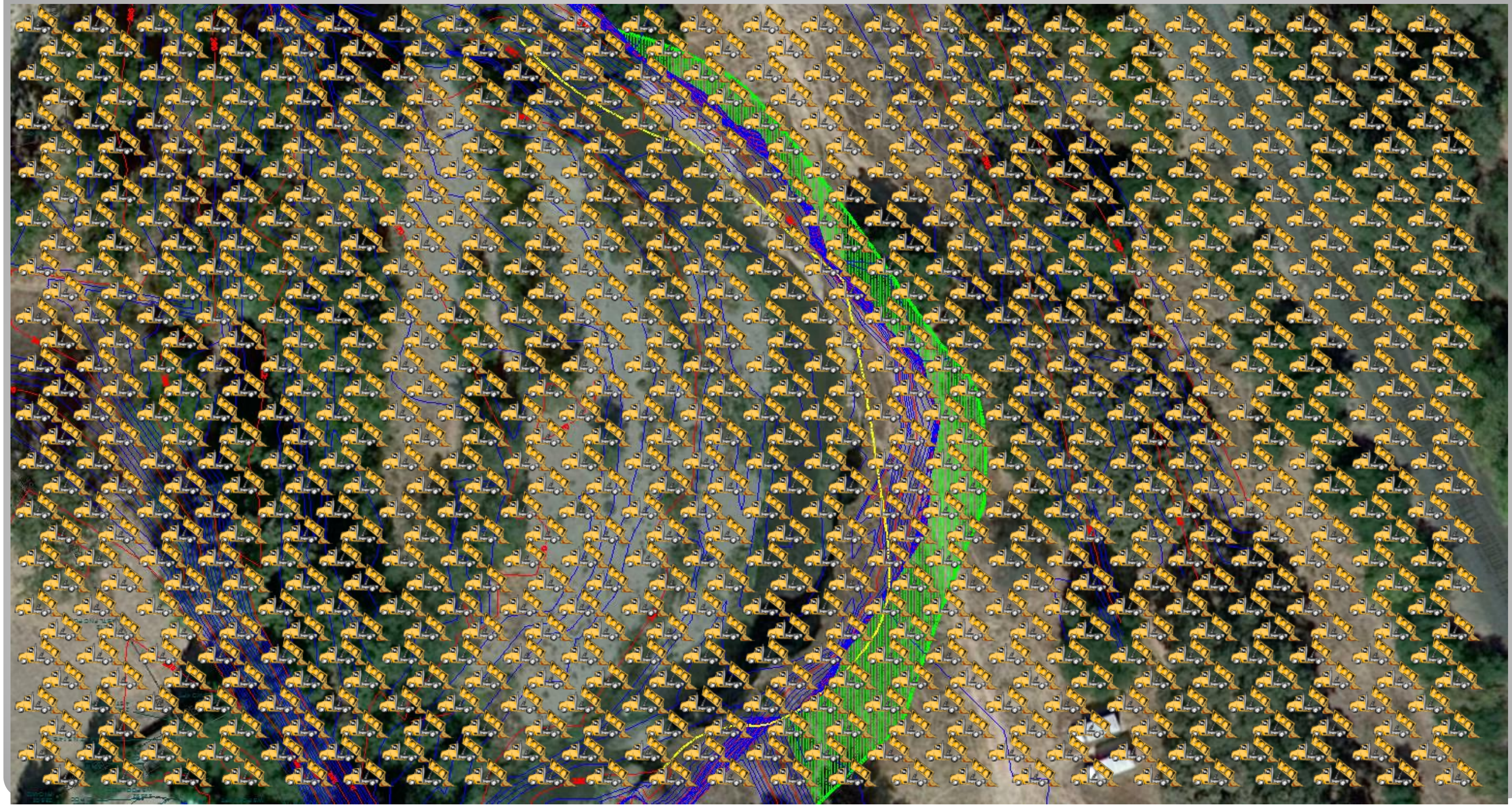
Example: Geomorphic Reach Assessment - BANCS





- 20.5 Ft/yr
- 635 cubic ft/yr/ft – 2.3 Dump Trucks/yr ft

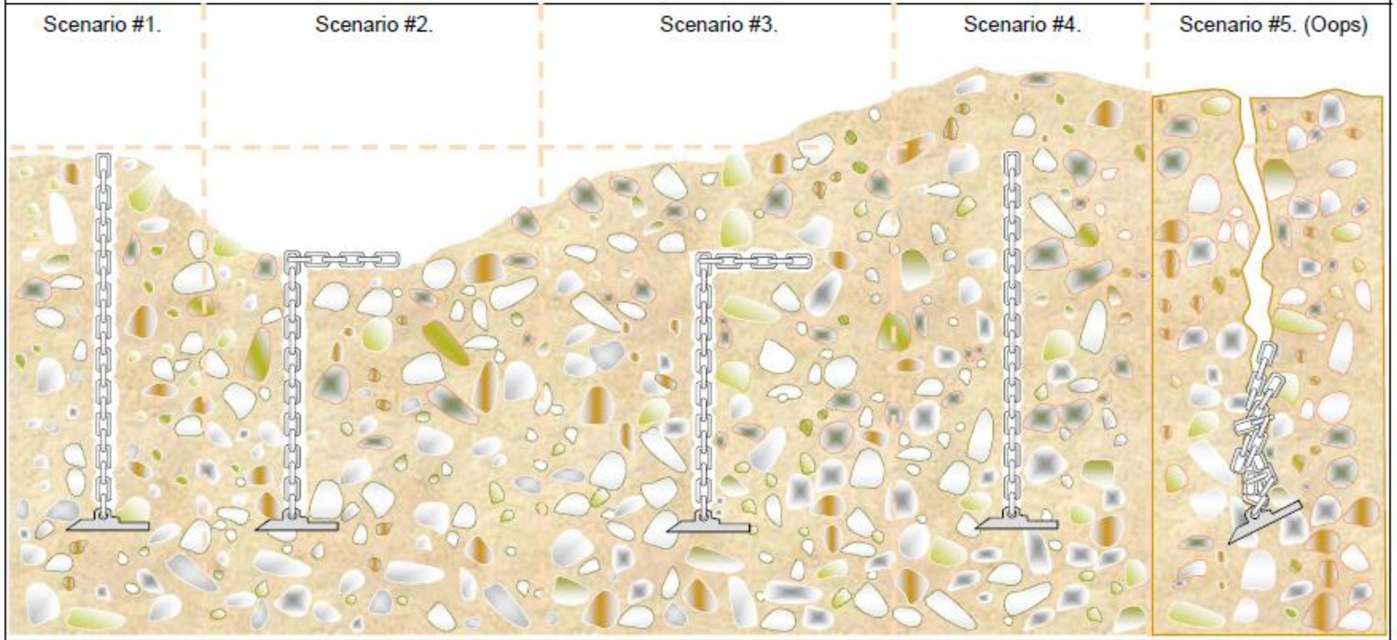
Example: Geomorphic Reach Assessment - BANCS



- ~400ft bank – 2.3 Dump Trucks/yr ft - 920Trucks(384)

Worksheet 4-4. Field form to document scour chain results and corresponding bed-elevation changes.

Stream:		Arroyo de la Laguna				Location: Castlewood Dr to Verona Rd					
Observers:		MFA, MAV, MJG				Stream Type: F4 -> B4c		Valley Type: VIII / II		Date: 10-31-2011	
		Installation Data (1st Year)				Recovery Data (2nd Year)					
		From cross-section		Particles near chain		Chain recovery				Particles near chain	
		Station (ft)	Elevation (ft)	Largest (mm)	2nd Largest (mm)	Scenario # (1–5)	Scour depth[a] (ft)	Elevation[b] (ft)	Net change[c] (ft)	Largest (mm)	2nd Largest (mm)
Riffle	Chain #1	86.9	262.65			#4	N/A	263.28	-0.63	90 *	
Riffle	Chain #2	113.2	263.93			#4	N/A	264.61	-0.68	90 *	
Glide	Chain #3	126.6	265.43			#4	N/A	266.32	-0.89	90 *	
Glide	Chain #4	142.4	266.06			#4	N/A	267.31	-1.25	90 *	



[a] Scenario 2 or 3. Scenario 2: Enter length of chain exposed. Scenario 3: Enter length of chain exposed then subsequently buried.
[b] Scenario 3 or 4. Scenario 3: Enter elevation of bed at same station @ 2nd year. Scenario 4: Enter depth of material over chain.
[c] Scenario 3: Subtract 1st and 2nd year elevations to calculate net change in bed.

Fish transport corridor
Sediment impediments
Lack of habitat
Lack of diversity

How to tailor design?

Fish transport corridor
Sediment impediments
Lack of habitat
Lack of diversity

How to tailor design?

WARSSS provides means to begin quantifying all of these and can be the cornerstone to restoring function.

Qsed
Shear Stress
Wood/FT