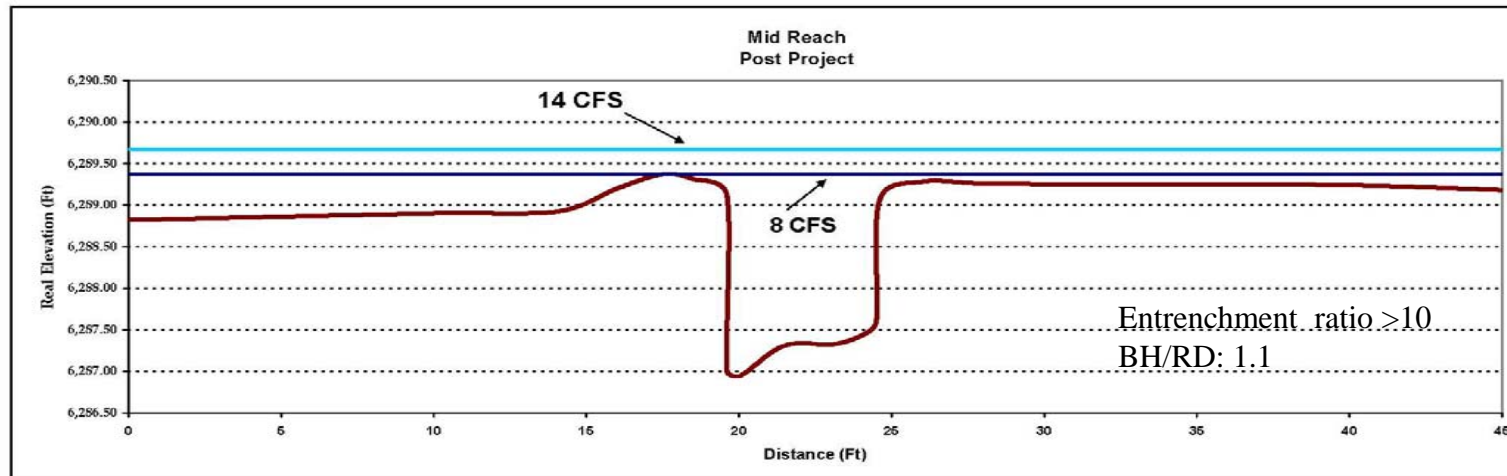
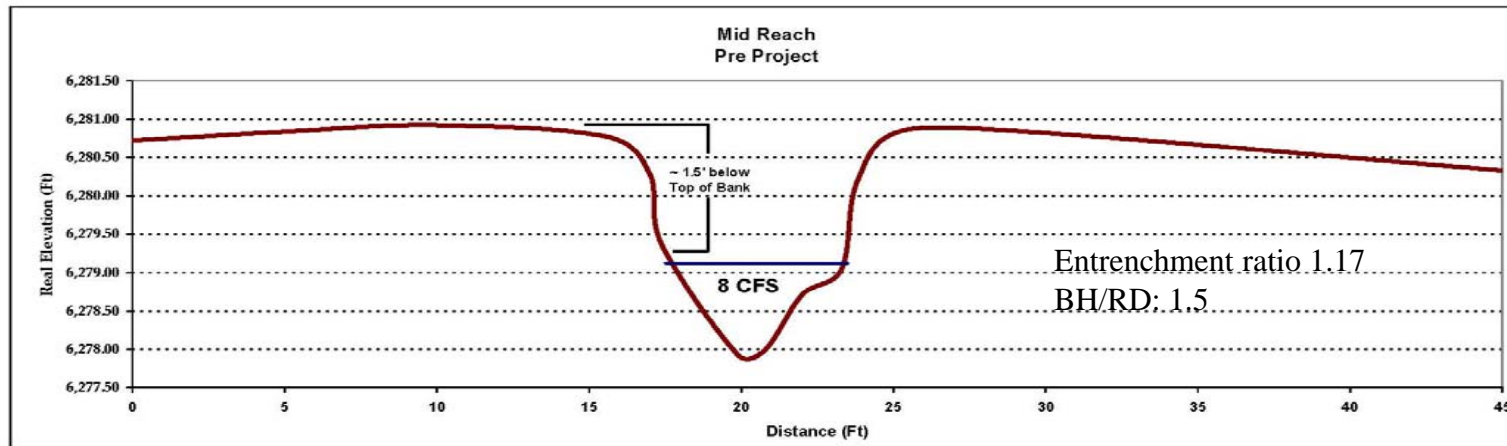
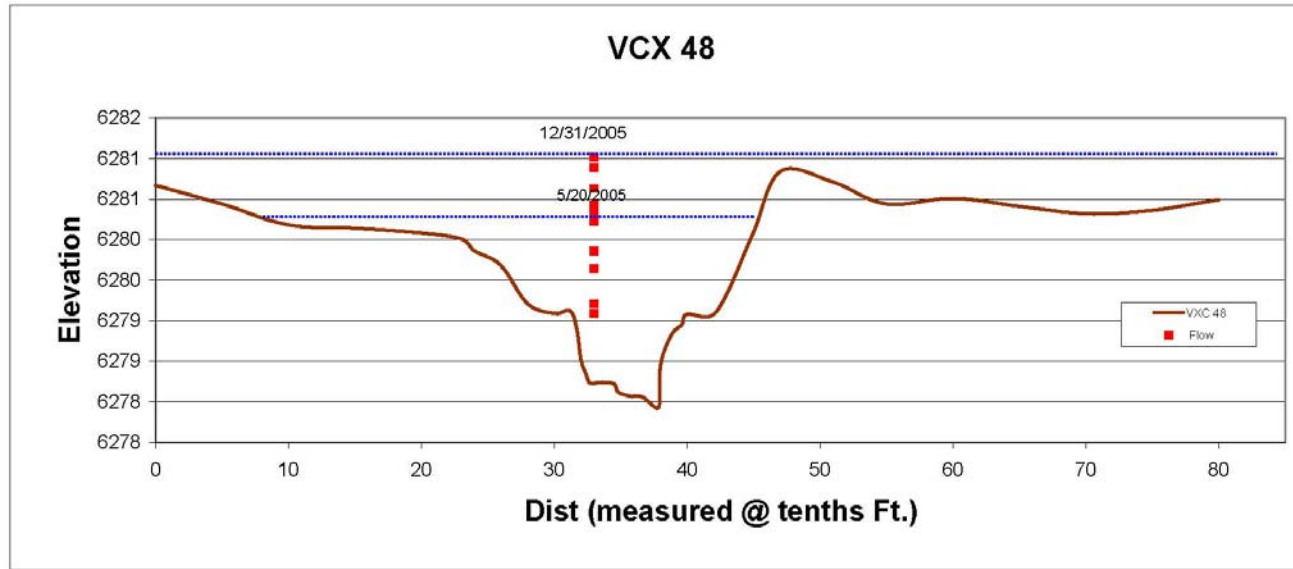


Channel capacity and over-banking

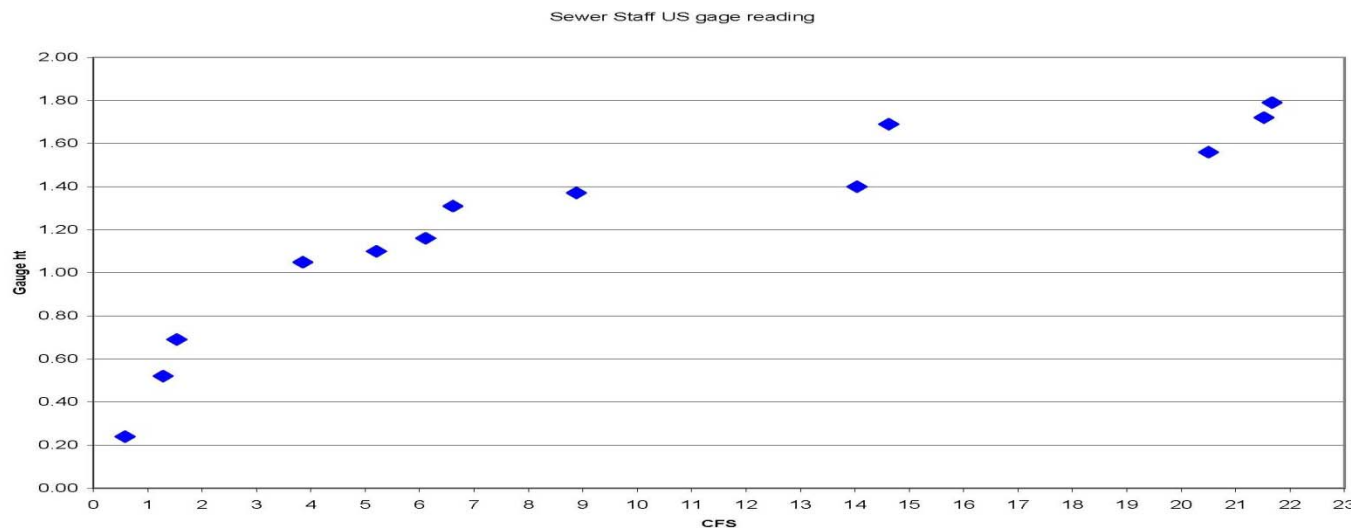


**Plant roots
cant reach
water even at
high flow**

Capacity, velocity, roughness, shear stress

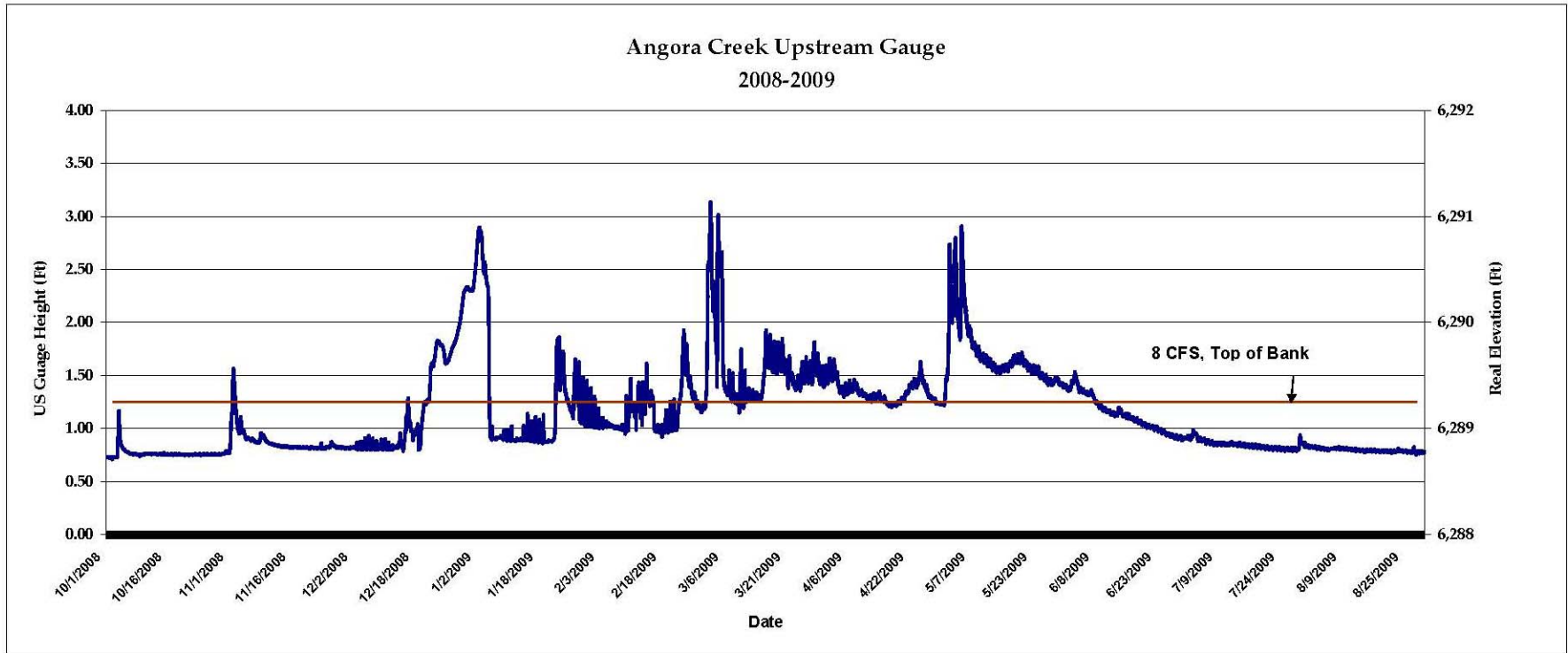


Pin flag flow
elevation and
note time



Rating curve
Flow
measurements
taken at staff gage
and recorder

Gauge records stream stage



Duration: Post-project shows stream is out of bank approximately 90 days in the 08-09 water year
Pre project channel was approximately 1 to 2 feet deeper and had 2 to 4 times the capacity. It was rarely out of bank—only large flood events

Groundwater wells

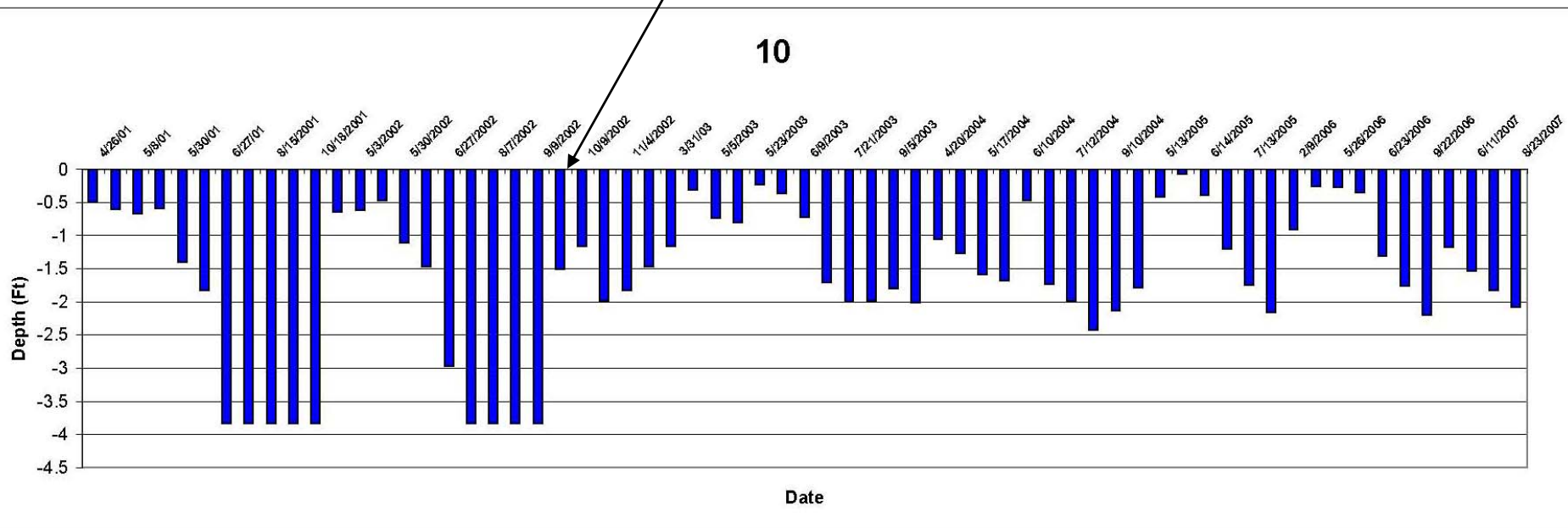
Depth to water changes dramatically

Water within root zone post-project

Pre-project wells dry (water >4') from late June thru fall to following spring

Water released into new channel

Post-project wells show water within 1-2 feet of surface within growing season (late June thru Sept)



Pre-restoration channel:

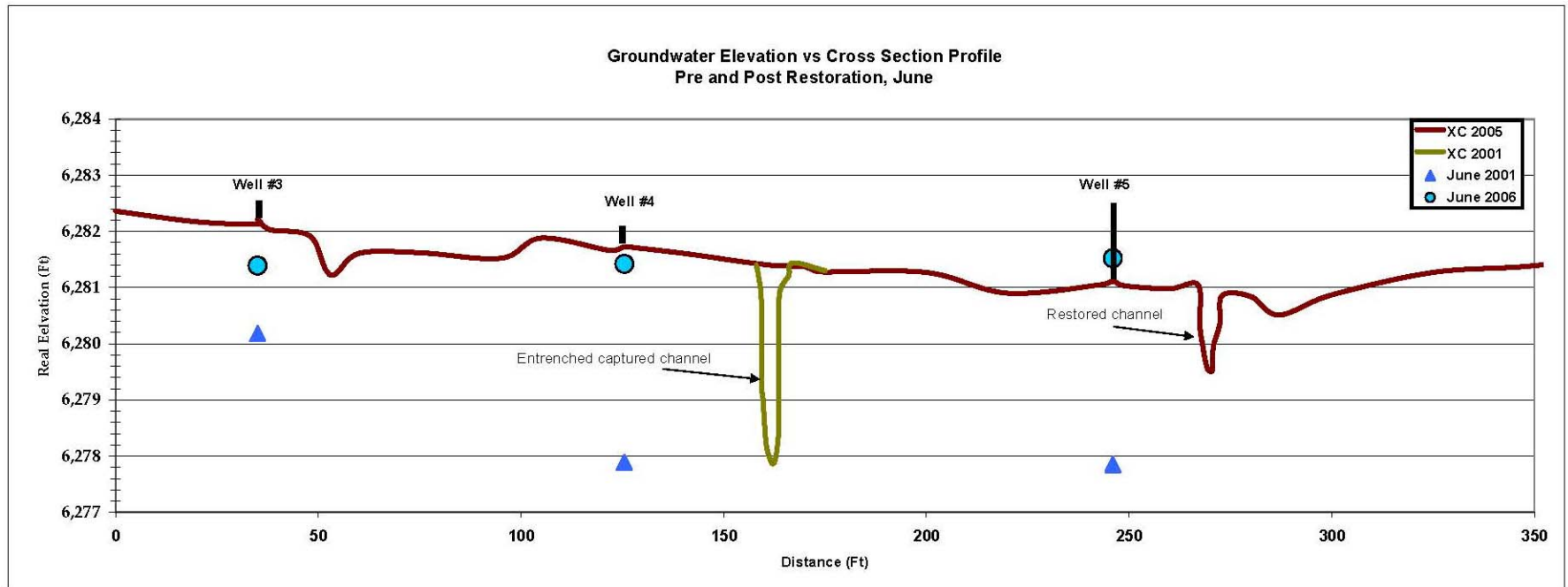
- incised and widened
- capacity 30 cfs
- groundwater 2-4' below surface
- water not available to plants



Relation of groundwater to cross section

Post-restoration channel

- smaller channel connected to meadow
- capacity 8cfs
- groundwater at or near surface
- restored channel has more water available to plants



Angora Vegetation Transects Cover

Pre	Upstream		Downstream		Control		Mid valley	
	Transect 1	2000	Transect 2	2000	Transect 3	2000	Transect 4	2002
	Carex sp.	90	Carex sp.	74	Carex sp.	63	Carex sp.	66
	Juncus sp.	0	Juncus sp.	14	Juncus sp.	17	Juncus sp.	0
	other	3	other	4	other	14	other	5
	litter, water bare	7	litter, water bare	8	litter, water bare	4	litter, water bare	29
	total veg cover	93		92		94		71
Post	Upstream		Downstream		Control		Mid valley	
	Transect 1	2003	Transect 2	2003	Transect 3	2003	Transect 4	2003
	Carex sp	74	Carex sp	71	Carex sp	66	Carex sp	76
	Junucs sp	3	Junucs sp	14	Junucs sp	9	Junucs sp	1
	other	14	other	8	other	16	other	4
	litter, water bare	9	litter, water bare	7	litter, water bare	6	litter, water bare	19
	total veg cover	91		93		91		81

Angora Sewer Reach Vegetation Monitoring

Plant Vigor
Average Height all carex species (cm)

	August-02	August-03	Change	
Transect 3	31	31	0	Control (US of project)
Transect 1	24	26	+2	Upstream reach
Transect 4	19	23	+4	Mid reach
Transect 2	19	38	+19	DS (most incised)



Vegetation photo points August 2000 and 2006

pre-post photo pairs



METRICS				Ang2000	Angora 2004
				Lower Reach Below Project	Lower Reach Below Project
<i>Diversity & Richness metrics</i>					
Total Benthic Richness (distinct benthic taxa only)				36	30
Chironomid Richness				12	12
Number of EPT Taxa				10.00	10.00
Number Of Ephemeroptera Taxa				4.00	4.00
Number Of Plecoptera Taxa				3.00	2.00
Number Of Trichoptera Taxa				3.00	4.00
<i>Compositional metrics</i>					
Percent Dominant taxon				45.73	33.63
Percent EPT				18.03	6.62
Percent Ephemeroptera				3.23	1.43
Percent Plecoptera				1.71	4.47
Percent Trichoptera				0.00	0.00
Percent Chironomidae				60.72	76.74
<i>Pollution Tolerance Metrics</i>					
Community Tolerance value (Modified HBI)				5.15	5.83
Percent Sensitive EPT				10.25	5.19
Percent Insensitive EPT				0.00	0.00
Percent sensitive (all organisms)				11.39	6.26
Percent insensitive (all organisms)				0.00	0.00
<i>Functional Feeding metrics</i>					
Percent Shredders				8.54	0.53
Percent Scrapers				12.90	0.53
Percent Collector-Filterers				48.01	48.05
Percent Collector-Gatherers				20.68	44.86
Percent Predators				9.87	6.03

Ang2000	Angora 2004
Middle Reach Active Project	Middle Reach Active Project
26	25
12	8
2.00	7.00
1.00	2.00
0.00	2.00
1.00	3.00
16.85	37.20
21.54	5.49
15.85	1.83
0.00	1.83
0.00	0.00
42.68	77.13
7.22	6.44
0.00	3.05
15.85	0.00
0.00	3.35
38.62	0.00
0.41	2.40
8.50	2.40
0.41	50.00
36.99	36.23
47.56	8.98

Ang2000	Angora 2004
Upper Reach Control	Upper Reach Control
34	28
11	8
11.00	9.00
4.00	5.00
3.00	2.00
4.00	2.00
35.77	46.21
30.46	64.26
4.41	5.78
1.20	52.71
0.00	0.00
59.92	20.58
5.69	2.80
1.90	54.15
0.00	0.00
1.90	54.15
0.00	0.00
0.70	7.80
24.05	7.45
37.47	8.51
18.14	23.05
18.94	50.71

Expected Response (Restoration)
Increase
Decrease
Increase
Increase
Increase
Increase
Decrease
Increase
Increase
Increase
Decrease
Increase
Decrease
Increase
Decrease
Increase
Decrease
Decrease
Varies

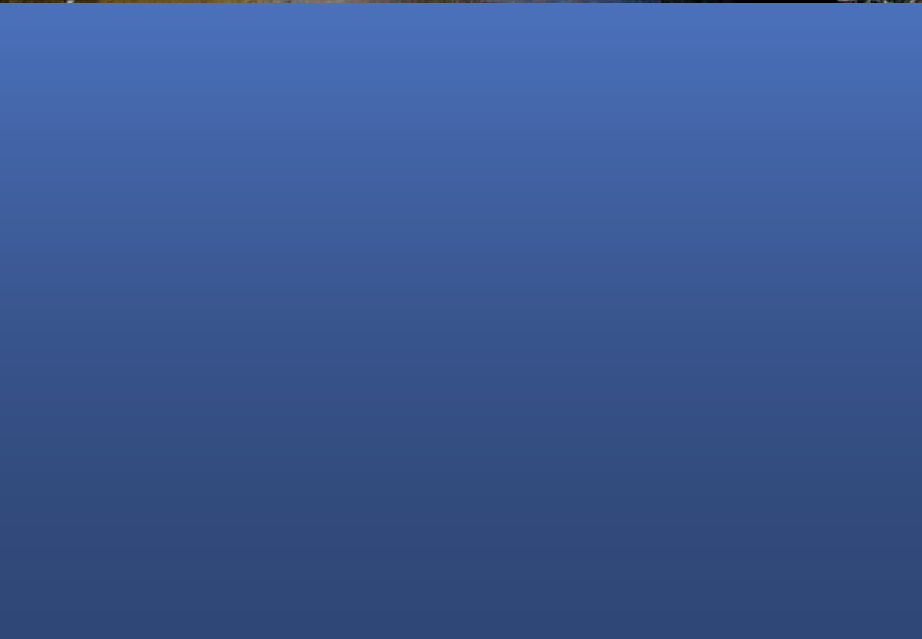


Aquatic
invertebrates



Photo points







Costs

- Vegetation Monitoring (3 yrs) \$15000
- Aquatic Invertebrate Monitoring Contracts (4 yrs) \$19000
- CSP Personnel: surveys, measurements, analysis (6yrs) \$33000
- Equipment \$4000

Estimated Total \$72,000

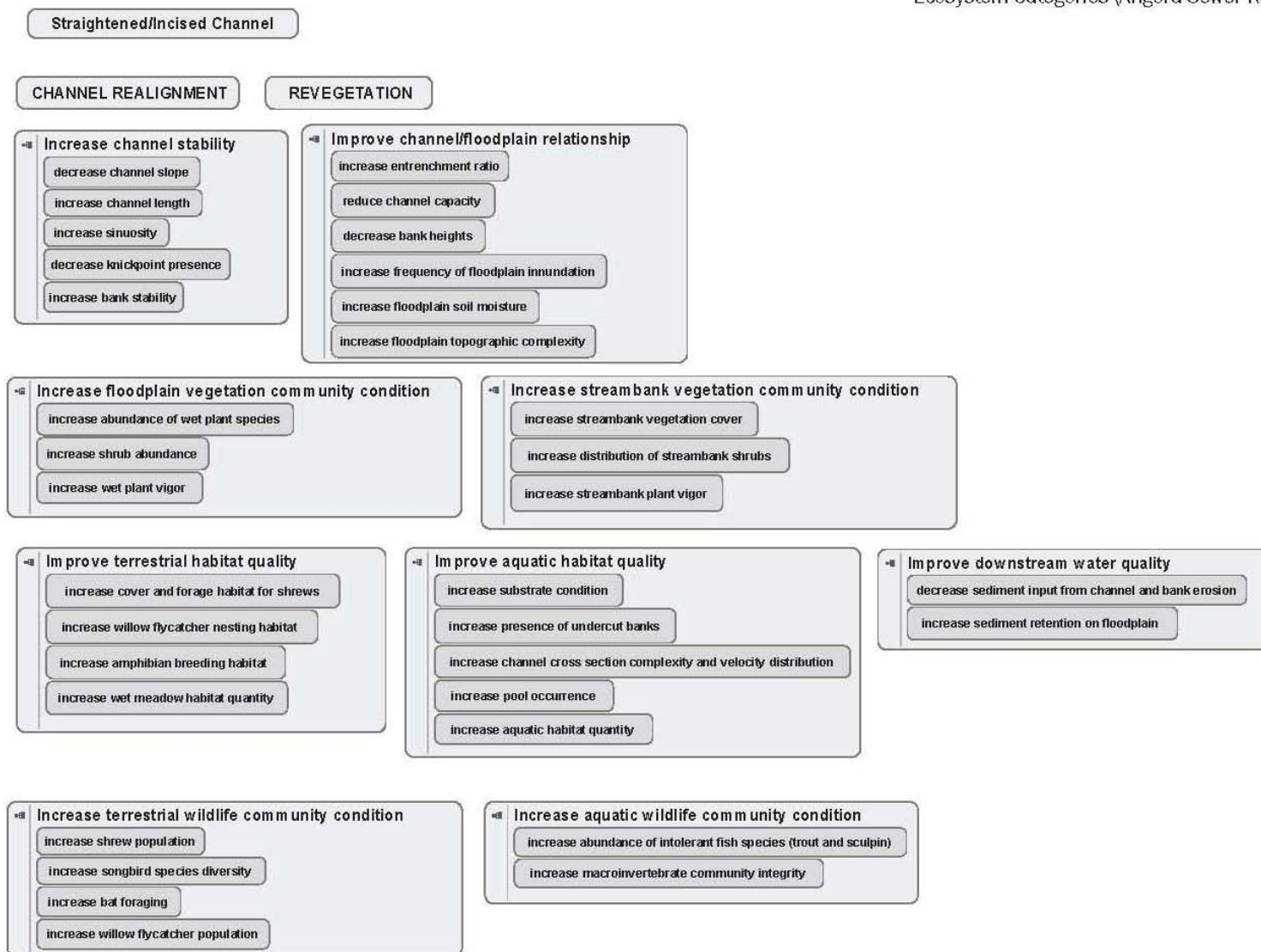
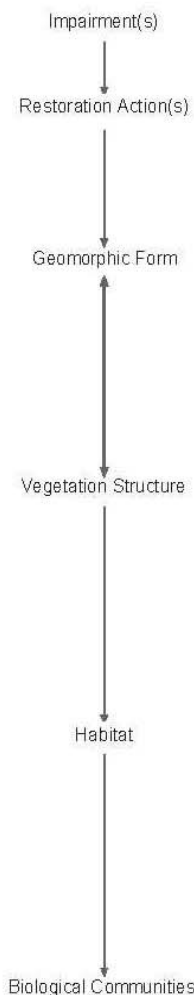
Project Objectives Diagram

Angora Creek and Washoe Meadows Enhancement

Project Phase IV Sewer Meadow Reach

Ecosystem Categories (Angora Sewer Reach)

Ecosystem Categories
Attribute Response Linkage



Research Needed

- Should there be a separate analysis for aquatic invertebrates in sand bed systems?
- Is more monitoring needed to show the habitat response linkage to the changes in physical parameters?
- Besides the easy to monitor changes in frequency and duration of floodplain inundation, how best to demonstrate water quality benefits?

Special Thanks

- Matt Kiese; River Run Consulting
- Nathan Shasha
Right-hand man



Data Assessment

- Entrenchment
- Sinuosity, Slope
- Cross-sectional area, Channel capacity
- Velocity, Roughness
- Groundwater elevation and timing
- Flow frequency & duration
- Channel roughness factor
- Deposition and erosion patterns
- Bed and bank stability
- Root depth vs. bank height
- Vegetation response
- Aquatic invertebrate response