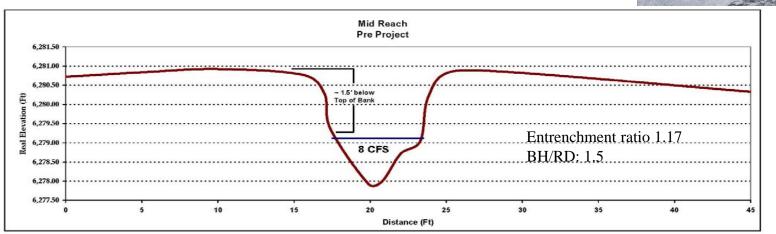
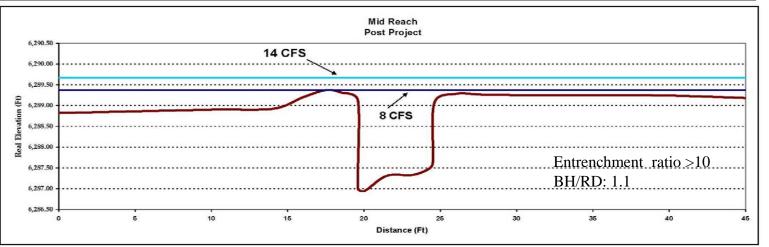
# Channel capacity and overbanking

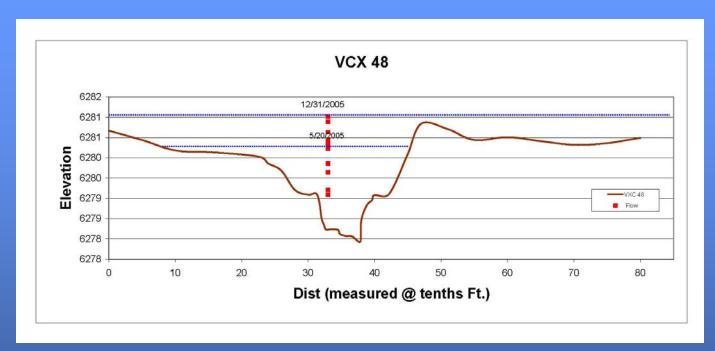




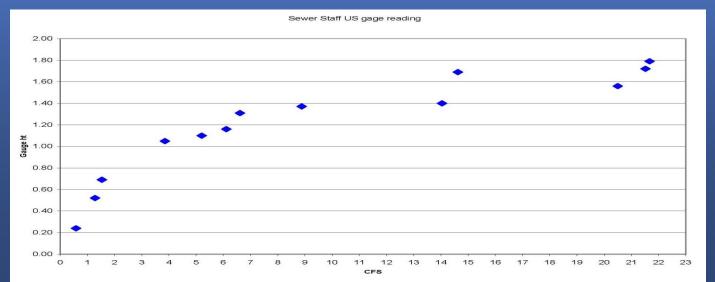
Plant roots cant reach water even at high flow



## Capacity, velocity, roughness, shear stress

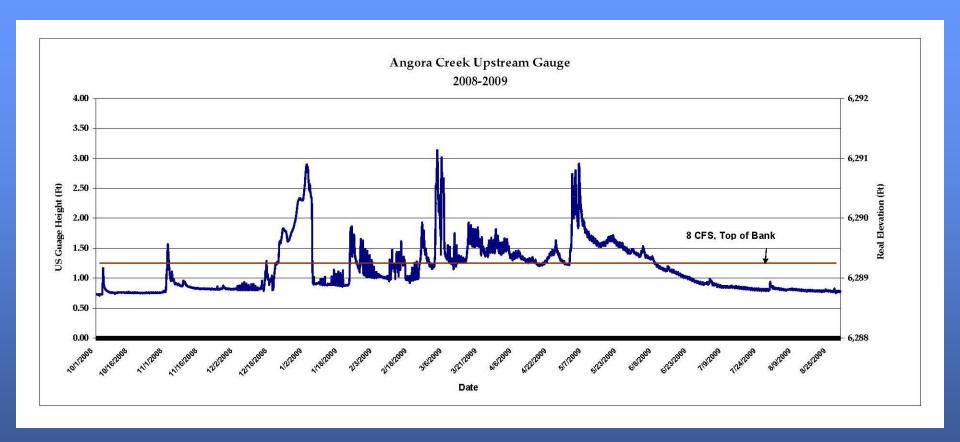


Pin flag flow elevation and note time



Rating curve Flow measurements taken at staff gage and recorder

## Gauge records stream stage



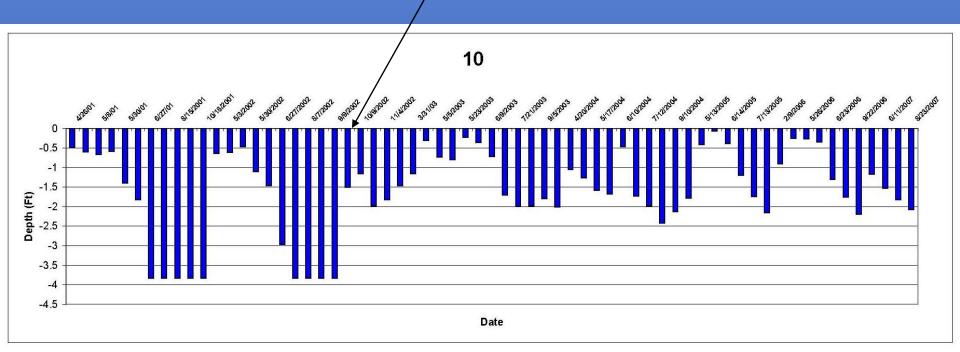
Duration: Post-project shows stream is out of bank approximately 90 days in the 08-09 water year Pre project channel was approximately 1 to 2 feet deeper and had 2 to 4 times the capacity. It was rarely out of bank—only large flood events

### 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

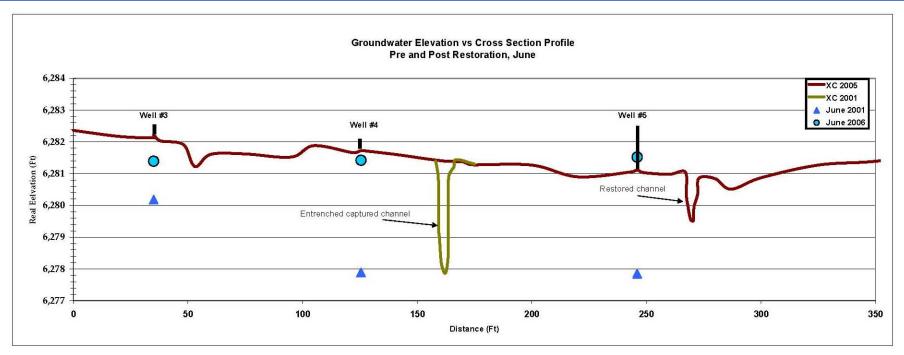


Relation of groundwater to cross section

#### Post-restoration channel

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





Pre	<u>U</u> psteam		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 ve	g cover	93		92		94		71
Post	Upsteam		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 ve	g cover	91		93		91		81

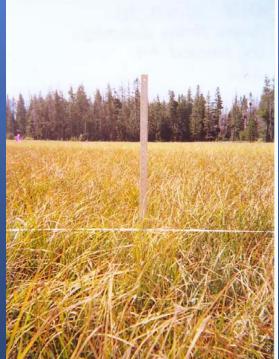
Angora Sewer	Reach Vegetation	on Monitoring	1	
	Plant Vigor Average Heigh	t all carex sp	ecies (cm	)
	August-02	August-03	Change	
Transect 3	31	31	0	Control (US of project)
Transect 1	24	26	+2	Upstream reach
Transect 4	19	23	+4	Mid reach
Transect 2	19	38	+19	DS (most incised)





Vegetation photo points August 2000 and 2006

pre-post photo pairs



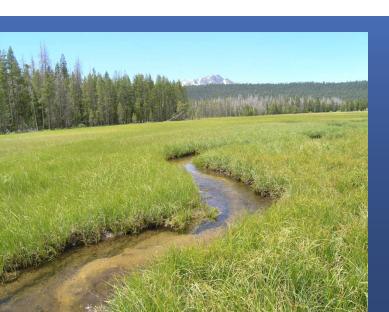


METRICS	Ang2000	Angora 2004  Lower Reach Below Project	
Diversity & Richness metrics	Lower Reach Below Project		
Total Benthic Richness (distinct benthic taxa only)	36		
Chironomid Richness	12	12	
Number of EPT Taxa	10.00	10.00	
Number Of Ephemeroptera Taxa	4.00	4.00	
Number Of Plecoptera Taxa	3.00	2.00	
Number Of Trichoptera Taxa	3.00	4.00	
Compositional metrics			
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	
Pollution Tolerance Metrics			
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	
Functional Feeding metrics			
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
15.85	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
6.50	2.40
0.41	50.00
36.99	36.23
47.50	0.00

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

I	Expected
-1	Response
١	(Restoration)
Ì	Increase
Ī	Decrease
ı	Increase
	Increase
Ī	Increase
	Increase
ŀ	Decrease
ł	Increase
ł	Increase
ł	Increase
ı	Increase
İ	Decrease
ŀ	
Ì	Increase
	Decrease
[	Increase
ł	Decrease
ŀ	Increase
ı	Decrease
İ	Decrease
ı	Varies



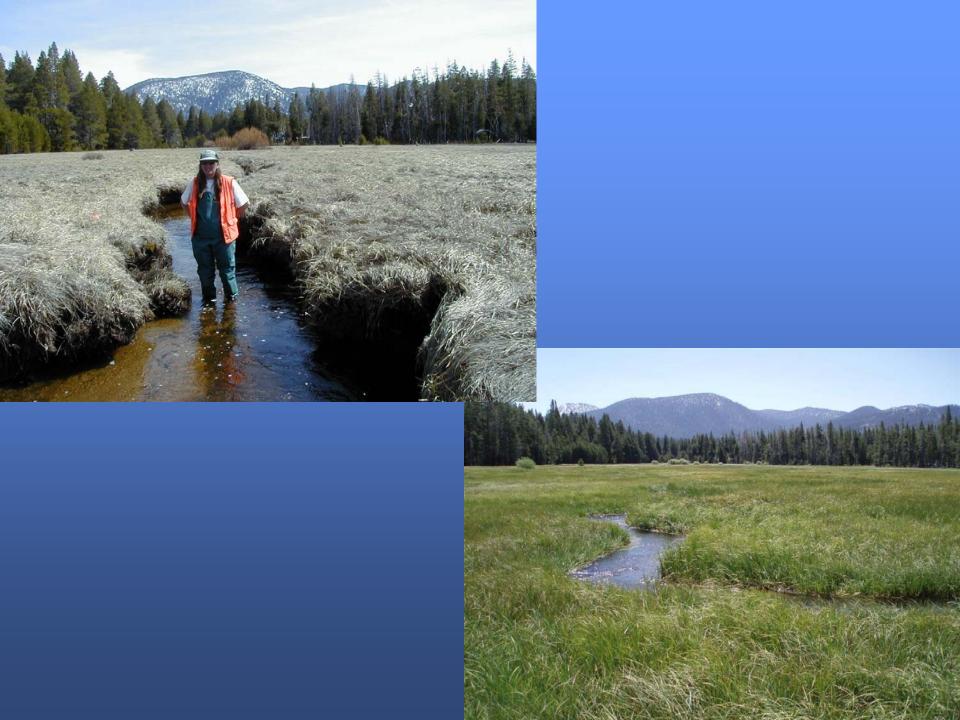
Aquatic invertebrates





# 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

Angora Creek and Washoe Meadows Enhancement Ecosystem Categories Project Phase IV Sewer Meadow Reach Attribute Response Linkage Ecosystem Categories (Angora Sewer Reach) Impairment(s) Straightened/Incised Channel Restoration Action(s) CHANNEL REALIGNMENT REVEGETATION Improve channel/floodplain relationship Increase channel stability increase entrenchment ratio decrease channel slope increase channel length reduce channel capacity Geomorphic Form increase sinuosity decrease bank heights decrease knickpoint presence increase frequency of floodplain innundation increase bank stability increase floodplain soil moisture increase floodplain topographic complexity Increase floodplain vegetation community condition Increase streambank vegetation community condition Vegetation Structure increase abundance of wet plant species increase streambank vegetation cover increase shrub abundance increase distribution of streambank shrubs increase wet plant vigor increase streambank plant vigor Im prove terrestrial habitat quality Improve aquatic habitat quality Improve downstream water quality increase cover and forage habitat for shrews increase substrate condition decrease sediment input from channel and bank erosion increase sediment retention on floodplain increase presence of undercut banks increase willow flycatcher nesting habitat Habitat increase amphibian breeding habitat increase channel cross section complexity and velocity distribution increase pool occurrence increase wet meadow habitat quantity increase aquatic habitat quantity Increase terrestrial wildlife community condition Increase aquatic wildlife community condition increase shrew population increase abundance of intolerant fish species (trout and sculpin) Biological Communities increase songbird species diversity increase macroinvertebrate community integrity increase bat foraging increase willow flycatcher population

**Project Objectives Diagram** 

## 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 Kiesse; River Run Consulting
- Nathan ShashaRight-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