Codornices Creek Restoration Project

2011 Supplemental Monitoring Report

Phase 2 Vegetation Monitoring
Phase 3 Geomorphic Monitoring

RWQCB Permit number: 02-01-C0763
USACOE Permit number: 28288-1S
DFG Notification Number: 1600-2006-0169-3

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Codornices Creek Monitoring 2011

1. Overview

This Supplemental Report presents the 2011 monitoring results for Phase 2 and Phase 3 of the Codornices Creek Restoration Project and follows the January 2010 report that summarized the first five years of monitoring the restoration of Lower Codornices Creek (FarWest Restoration Engineering, 2010).

To date, three phases of Codornices Creek restoration have been completed. Phase 1 was completed in 2005, Phase 2 in 2006 and Phase 3 in 2010. Phase I, from the Union Pacific Railroad (UPRR) tracks to 5th street, had no scheduled monitoring for 2011. Phase 2, from 5th to 6th street, had Year 5 vegetation monitoring completed. Phase 3, between 6th Street and 8th Street, had the first year of geomorphic monitoring done.

The following is a calendar of scheduled monitoring activities for the three phases of the Codornices Creek Restoration Project for the 2011 and 2012 calendar years. This supplement summarizes the scheduled monitoring for 2011 and includes **Phase 2 vegetation monitoring** and **Phase 3 geomorphic monitoring**.

The 2012 Monitoring Report will include geomorphic monitoring of all three phases, vegetation monitoring for Phase 3, and BMI and fish survey monitoring of all three phases.

Calendar Year 2011					
Project Phase	*Task 1: Geomorphic Survey*	*Task 2: Vegetation Survey*	*Task 3: BMI Survey*	*Task 4: Fish Survey*	*Task 5: Report*
I	None (Yr. 7)	None (Yr. 7)	None	None	**Supplement**
II	None (Yr. 4)	**Fall 2011 (Yr. 5)**	None	None	
III	**Summer 2011 (Yr. 1)**	None (as-builts)	None	None	
Calendar Year 2012					
Phase	*Geomorphic Survey*	*Vegetation Survey*	*BMI Survey*	*Fish Survey*	*Report*
I	January (Yr. 8)	None (Yr. 8)	Spring 2012	Spring 2012	Report
II	January 2012 (Yr. 5)*	None (Yr. 6)	Spring 2012	Spring 2012	
III	Spring 2012 (Yr. 2)	Spring 2012 (Yr. 2)	Spring 2012	Spring 2012	

2. Vegetation Monitoring Results (Phase 2 Only)

Year 5 / December 2011

2.1. METHODS:

The project monitoring was performed in accordance with the elements of the Monitoring and Mitigation Plan (MMP) prepared by FarWest Restoration Engineering (FRE) dated

April 16, 2006. The MMP describes the project goals, monitoring questions, performance criteria and monitoring protocols required to evaluate the success of the restoration project towards achieving project objectives. The vegetation monitoring was broken down into four separate tasks. Monitoring for each task was conducted separately using distinct methods:

MMP Task 2.1: Task 2.1 monitors the soil bioengineering components of the project. For year 5, the entire canopy was evaluated for percent cover.

Year	Criteria
Year 1: 2006	Sprouts
Year 2: 2007	2-feet tall
Year 3: 2008	4-feet tall
Year 4: 2009	6-feet tall
Year 5: 2010	Evaluate entire canopy for percent cover
Year 10: 2015	Evaluate entire canopy for percent cover

MMP Task 2.2: This task evaluates the success of the live staking outside the active channel bank. Similar to Task 2.1, the entire canopy was evaluated for percent cover for year 5.

Year	Criteria
Year 1: 2006	Survival
Year 2: 2007	Survival
Year 3: 2008	1-foot tall
Year 4: 2009	2-feet tall
Year 5: 2010	Evaluate entire canopy for percent cover
Year 10: 2010	Evaluate entire canopy for percent cover

MMP Task 2.3: Container plants are being monitored under this task. The entire site was surveyed and all living plants from the planting plan and additional plants installed by volunteers since the project completion were tallied and compiled on a per species basis. Dead plants were noted but not compiled.

MMP Task 2.4: The final task measures percent cover of native and nonnative plants in 10 randomly sampled 3 foot by 3 foot plots using the Daubenmire method as detailed in the USFS Technical Reference: Sampling Vegetation Attributes, 1996.

2.2. RESULTS

2.2.1. MMP Tasks 2.1 and 2.2: Soil Bioengineering and Live Stakes

The riparian canopy provides cover over 99% of the creek channel. The 5th street Bridge has a gap in canopy, otherwise the channel has complete coverage. The canopy extends beyond the channel banks 10-20 feet on both sides. Overall, the entire site has riparian canopy coverage of approximately 85%.

2.2.2. MMP Task 2.3: Container Planting

More container plants were noted in 2011 than in 2009. This is most likely due to a greater success rate of detecting plants in 2011 than in 2009. Many of the plants planted as containers are beginning to self-colonize the site.

		2007		**2008**		***2009***		***2011***	
Species	**Specified**	*#*	*% survival from previous period*	*#*	*% survival from previous period*	*#*	*% survival from previous period*	*#*	*% survival from previous period*
Acer macrophyllum	14	10	*71%*	11	*110%*	*4*	*36%*	*6*	*150%*
Aesculus californica	0		*0*		*0*	*1*	*NA*	*0*	*0%*
Alnus rhombifolia	16	16	*100%*	9	*63%*	*12*	*120%*	*8*	*67%*
Corylus cornuta	0		*0*	1	*NA*	*1*	*100%*	*0*	*0%*
Quercus agrifolia	13	12	*92%*	10	*83%*	*7*	*70%*	*9*	*130%*
Oregon Ash	0	1	*NA*	1	*100%*	*0*	*0%*	*1*	*NA*
Baccharis pilularis	24	21	*88%*	18	*86%*	*9*	*50%*	*9*	*100%*
Mimulus aurantiacus	33	19	*58%*	13	*68%*	*6*	*46%*	*8*	*133%*
Rosa californica	61	46	*75%*	46	*100%*	*35*	*76%*	*38*	*109%*
Ribes sanguineum	60	44	*73%*	19	*43%*	*12*	*63%*	*30*	*250%*
Ribes menziesii	13	5	*38%*	1	*20%*	*0*	*0%*	*0*	*0%*
Symphoricarpos albus	18	13	*72%*	2	*15%*	*1*	*50%*	*1*	*100%*
Populus fremontii	32	32	*100%*	26	*81%*	*29*	*112%*	*33*	*114%*
Rubus parviflorus	37	27	*73%*	5	*19%*	*3*	*60%*	*6*	*200%*
TOTAL # OF INDIV.	**321**	**246**	*77%*	**162**	*66%*	***117***		***149***	

2.2.3. MMP Task 2.4: Percent Cover

The 2011 survey of percent cover indicates a significant increase in bare ground and a decrease in native species. This was primarily due to over half of the survey plots falling underneath the riparian canopy. It was observed that these plots were dominated by bare ground and invasive species such as bindweed and nasturtium.

2011		Species Native		Species Exotic Forbs		Species Exotic Grasses		Species Bare Soil	
Cover Class	Mid-point	Number	Product	Number	Product	Number	Product	Number	Product
1-5%	2.5	3	7.5	2	5	1	2.5	2	5
5-25%	15	3	45	6	90	2	30	0	0
26-50%	37.5	1	37.5	2	75	2	75	3	112.5
51-75%	62.5	0	0	0	0	0	0	3	187.5
76-95%	85	0	0	0	0	0	0	2	170
96-100%	97.5	0	0	0	0	0	0	0	0
Total Canopy			90		170		107.5		475
Number of Samples			10		10		10		10
% Canopy Cover			9%*		17%		11%		48%
Species Composition			8%		16%		10%		44%
Frequency			70%		100%		50%		100%

** Percent canopy is for herbaceous and shrub layer only. Canopy estimates do not include tree canopy, which in many instances approaches 100% cover.*

2.3. DISCUSSION

2.3.1. MMP Task 2.1 and 2.2: Soil Bioengineering and Live Stakes

The willow used for soil bioengineering is healthy and robust. No bare areas were observed except directly under the Fifth Street bridge. The willows are growing vigorously, approaching 25-feet in height and have formed a complete canopy over the creek--as a result no watercress and cattails were observed. This is in stark contrast to site conditions two years ago, where much of the channel was colonized by cattails and watercress.

The only location were cattails are currently present is at the downstream end of Phase 1 at the Union Pacific Railroad (UPRR) culvert. This location had willow completely removed in 2009 and willow cover remains thin today.

There is evidence of willow recruitment throughout the reach. Most notably on the right bank just downstream of the bypass channel where a willow log deposited along the bank and began sprouting a dense row of willow trunks.

As part of the ongoing maintenance the willow has been selectively thinned. The canopy remains completely enclosed and there are areas with sightlines to the creek. Some areas of willow, including the majority of willows on the left bank of the creek, have not been thinned and provide middle and upper canopy structure.

In Phase 2, the diameter of the willow has grown to be 2 ½ - 6 inches; few smaller willow canes exist, suggesting the willow riparian structure is entering the more mature stage of development were more shade tolerant species can begin to colonize the understory.

Less than 5% of the originally planted stakes' canopy cover may be attributed to ninebark and blackberry stakes as only three plants of each species were observed.

Dogwood was a component of the live fascines and is present throughout the length of Phase 2. Overall dogwood provides approximately 5% of the canopy.

2.3.2. MMP Task 2.3: Container Planting

More container plants were found in 2011 than in 2009. For the most part this does not indicate additional plantings since 2009, but instead indicates the difficulty in finding all of the plants on-site during the survey. Alders are the one species that indicate a decline from 2009, however they were extremely difficult to find intermixed with the dense willow. It is likely that additional alders exist on-site that were undetected during the 2011 survey.

Many of the Big leaf maple trees did not survive the first year, however those that are alive this year appear robust and healthy. The cottonwoods are over 15 feet tall throughout the site. Some species are beginning to increase in numbers, especially those that reproduce vegetatively. The California rose continues to do very well. Pink-flowering currant is self-colonizing as is Thimbleberry. Some of the currants on the left bank are approaching 6 feet tall.

2.3.3. MMP Task 2.4: Percent Cover

The greatest difference between 2011 monitoring and subsequent years is the dominance of the willow canopy. Prior to 2011 the survey plots sampled open areas on the banks and floodplains. In 2011 there were not enough locations outside of the riparian canopy, therefore many of the plots were surveyed under the canopy. This had a dramatic effect on the results. Plots under the riparian canopy were dominated by bare ground.

The right bank in Phase 2 shows a significant decrease in bare soil, approaching 100% cover. In previous years, plants and seeding appeared to be struggling on the right bank compared to the left bank.

2.4. General Notes

Irrigation was permanently turned off prior to the summer of 2011. The lack of irrigation didn't seem to have an effect on the established plants.

The site soils continue to improve. The floodplain areas are subject to frequent flooding and have become significantly spongier as sediment and debris settles out after each large storm. This organic matter is beginning to have an effect on the soils that were over compacted and fairly inhospitable immediately after restoration.

Weed whipping is keeping the site's fairly tidy appearance and is likely suppressing many exotic species. Aster chilensis, yarrow and poppies are being avoided during the weed whipping, although, as mentioned above, some of the cuttings are accidentally being mowed. Species such as Himalayan blackberry and broom would likely be more prevalent without weed whipping.

Bindweed, bristly ox-tongue, Himalayan blackberry, nasturtium, Algerian ivy and fennel are all abundant on-site. Each species appear to be increasing in abundance since 2007 despite ongoing maintenance and management to control their spread. Bindweed now exists along the entire channel corridor. It is currently climbing into the canopy. Site maintenance should include removing the bindweed where it climbs into the canopy. No vinca was noted, although an exhaustive survey was not conducted. Two 6' tall acacia trees were spotted on the left bank.

2.5. Maintenance Recommendations

2.5.1. Remove acacia on left bank.
2.5.2. Remove Algerian ivy. Patches are expanding and should be controlled immediately.
2.5.3. Actively remove bindweed where climbing on willows and trees.
2.5.4. Locate and remove Himalayan blackberry. Numerous small patches exist throughout the site with larger patches on the left bank.
2.5.5. Remove nasturtium.
2.5.6. Empty trash cans on-site more frequently.
2.5.7. Remove trash dumped under bridges and along the channel.
2.5.8. Plant under the willow canopy with shade tolerant species. The site has matured to a degree suitable for more shade tolerant species. This is an activity that could be taken on by volunteers such as the Codornices Creek Watershed Council and would increase plant diversity on-site.

3. Geomorphic Survey (Phase 3 Only)

Year 1 / September 2011

3.1. Methods

A profile survey and two cross section surveys were completed September 14th 2011.

The profile survey extended from the 6th street culvert at the downstream end up to the 8th street culvert on the upstream end. Thalweg, water surface, point bars and floodplain surface elevations were recorded and plotted against design data. No as-built survey was available for reference.

The cross sections extended from the Codornices Creek Trail across the floodplain and channel to the opposite fence line. Representative pebble counts were completed at both cross sections to characterize the channel substrate.

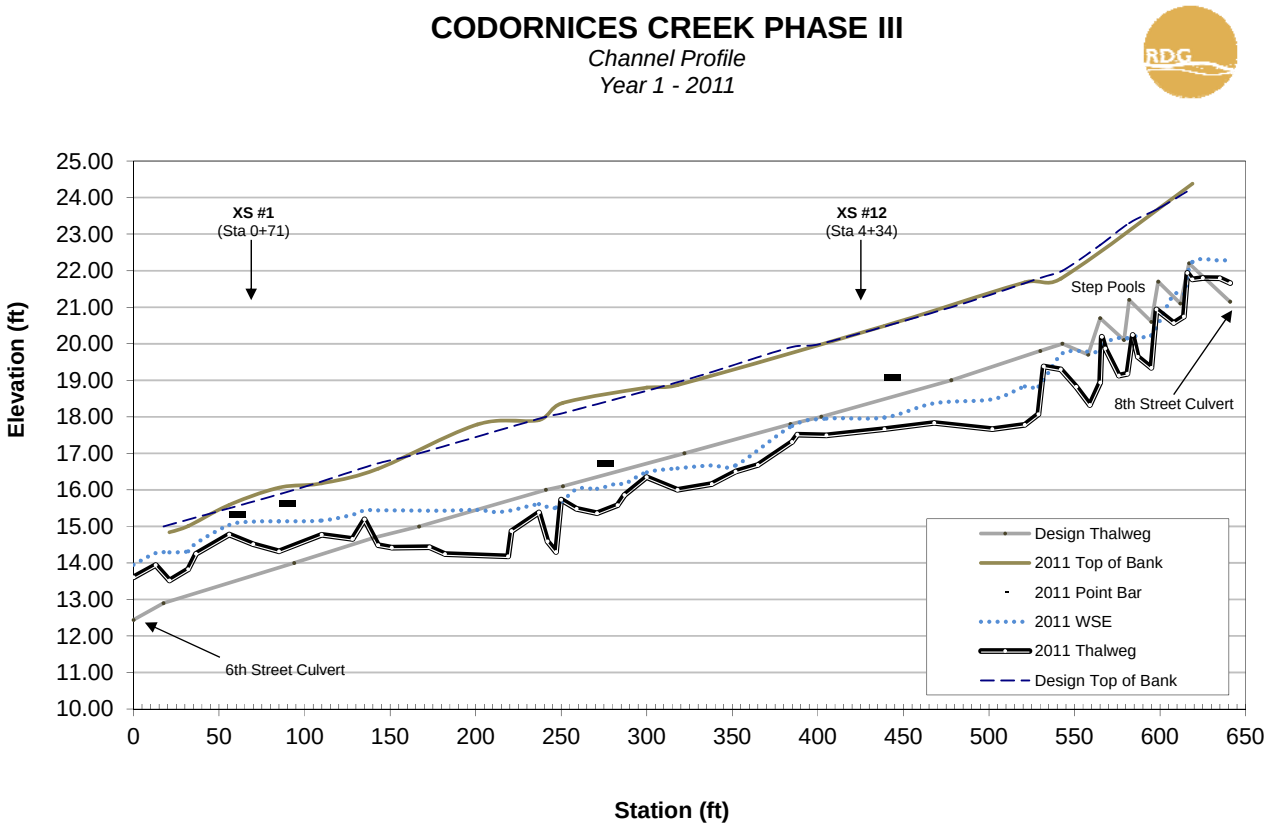
3.2. Results

3.2.1. Channel Profile

The survey indicates the floodplain surface was built at the design elevations throughout the length of the project and it appears that the majority of the grade control structures were set lower than the design elevations. No as-built plans were available to reference, but it is assumed that the channel thalweg elevation was built slightly lower than the design elevation.

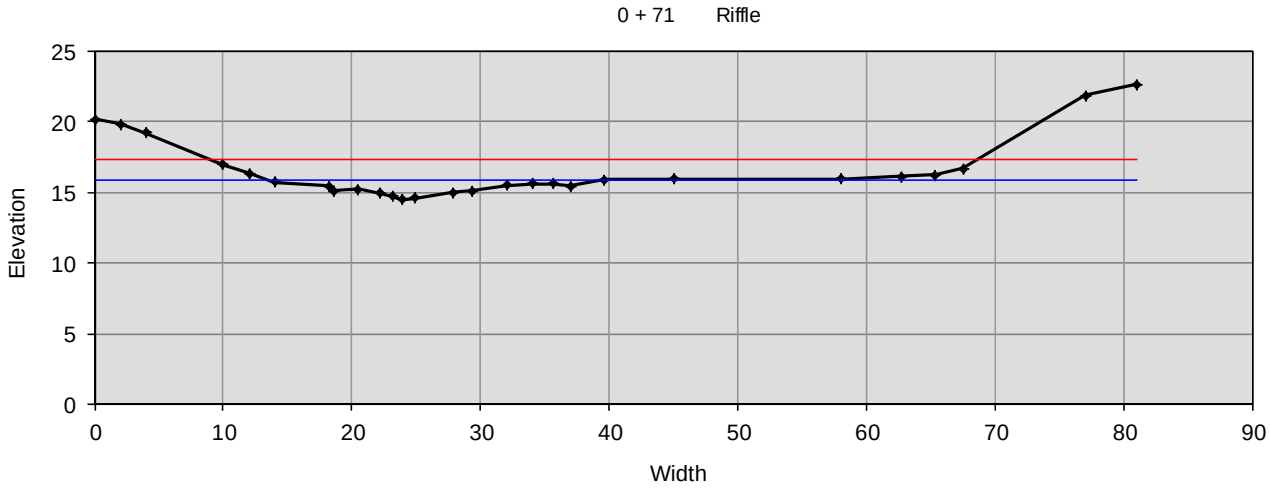
The survey verifies general site observations that the channel has scoured at the upstream end and aggraded at the downstream end. The upstream end of the project the channel has scoured to hardpan clay. Downstream the channel has deposited sediment in the channel and the floodplain where the 6th street culvert backwaters the creek during storm flows. The step pools at the upstream end of the project have remained stable.

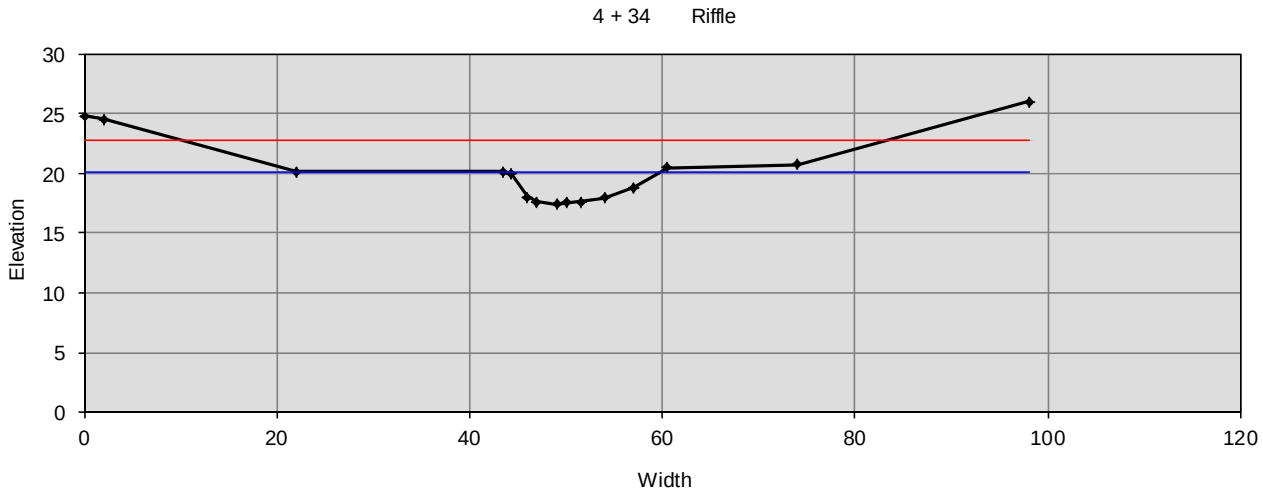
Riffle and pool morphology have begun to develop within the channel with the exception of areas scoured to hardpan. The hardpan is hampering sediment deposition in these areas and limiting development of depositional feature such as point bars.



3.2.2. Cross Sections

Two riffle cross sections were surveyed in the project reach. Cross section #1 is in the lower portion of the creek and is influenced by the culvert backwater. Cross section #2 is upstream in the location adjacent to the hardpan bed. Both cross sections were marked in the field with rebar and will be resurveyed in future years for purposes of comparison.





3.3. Discussion

It is typical for new restoration sites to see the greatest adjustment in the first few years after construction as the channel responds to the physical conditions of the site. This adjustment is being observed at Phase 3. As was observed in the prior two phases, the channel has been quick to develop pools and riffles. All of the outside bends are forming scour pools as well as below each of the steps. Riffles are forming at the cross over points. In addition, point bars are forming along the outside bends.

The channel profile has adjusted throughout the length of the project. The deposition of sediment at the downstream end of the project reach and the scour to hardpan in the upper reach should continue to be monitored to ensure the channel begins to reach a dynamic equilibrium as expected. Even as the channel profile has evolved in the first year, the grade control structures are performing well to protect from undesirable adjustments.

The downstream sedimentation reduces the conveyance of flood flows through the 6th street culvert as compared to the design morphology. The scouring to hardpan in the upstream section of the restoration provides little habitat but may be a temporary condition as the channel continues to make minor adjustments in the next few years. Future monitoring of Phase 3 will indicate whether the adjustment to the channel during this first year has any negative effects on the ecological potential of the site.

3.3.1. 6th Street Culvert

It is unknown if the current condition of the culvert has more or less conveyance than the pre-existing conditions. Although it appears there is more sediment in the bottom of the culvert today than prior to the project, the headwall was raised approximately 10 inches

which allows for greater hydraulic head during storm flows and may compensate for the greater level of sediment in the culvert.

The cause of the aggradation in this area is likely due to two conditions. The first condition is the backwater effect from the culvert, slowing the velocities behind the culvert and reducing the competency to move sediment in this location. The second condition is aggradation within the upstream portion of Phase 2, which has raised the tie-in elevation for Phase 3. This higher elevation of Phase 2 reduces the slope through the culvert and downstream portion of Phase 3 adding to the reduction in competency to transport sediment in the lower section of Phase 3.

The channel is adjusting by depositing sediment through this section and effectively raising the slope through the culvert and the lower reach of Phase 3. It is reasonable to expect, and monitoring should be focused on verifying this evolution, that the lower section of Phase 3 will continue to deposit sediment, especially on the floodplain. This will lead to a reduction in the channel width and an increase in channel slope, both of which will lead to a more competent channel in the lower reach until the channel achieves greater equilibrium in this area.

3.3.2. Upstream Channel

The grade control structures in the upstream portion of Phase 3 are maintaining the channel grade through this portion of the project reach. Ideally hardpan would not be exposed anywhere along the length of the channel. Hardpan hinders both sediment deposition and formation of geomorphic features such as pools and riffles.

The channel scouring is likely a result of a combination of conditions, including 8th street culvert baffles trapping sediment before it enters the project reach, and the channel being competent for moving sediment larger than what was available within the channel.

As part of the objectives to provide fish passage for this project, baffles were installed in the 8th street culvert. This culvert has an unconventional entrance, producing significant loss in conveyance (the culvert is inlet controlled). This enabled fish passage baffles to be installed without affecting the conveyance of the culvert. The baffles are working to increase the water surface depth within the culvert while providing a natural bed substrate. During the first winter these baffles were installed they captured approximately 15 cubic yards of sediment. This reduced the amount of sediment entering Phase 3 and may have added to the degree of scour observed on-site.

There is potential to increase habitat value of the channel where the upstream channel has scoured to hardpan. See the maintenance recommendations below.

3.4. Maintenance Recommendations

3.4.1. Continue to monitor the deposition at the downstream portion of the project site. If it appears 6th street culvert has limited capacity, treatements can be considered to improve sediment competency through the reach. This would include modifying the upstream end of the Phase 2 channel and/or removing material from the Phase 3 channel and placing it on the floodplain to increase the depth of the channel adjacent to the culvert. It should be noted that these are two items that are likely to occur on their own, so it is not recommended pursuing these options unless there is immediate concern over the culvert capacity.

3.4.2. Emergent and riparian vegetation can play an important role in reducing the amount of hardpan exposed in the channel. Adding willow to the channel toe and at riffle locations will accelerate the stabilization of the channel and increase sediment deposition in these areas.

4. Conclusion

Overall the vegetation for Phase 2 and the channel morphology for Phase 3 are performing well. For Phase 2, the structure of the riparian plant community is well established. The challenge is to develop efficient and effective methods to suppress invasive plants that are likely to reduce the ecological health of the riparian corridor if not kept at bay. This unfortunately is common to all urban restoration projects. For Phase 3, the channel has adjusted during the first winter. These adjustments should continue to be monitored, but do not appear to affect the overall and long term health and success of the project. Adaptive management, such as planting of additional willows may accelerate the restoration of sections of channel that have scoured to hardpan, otherwise no channel work is suggested at this time.

PHASE 2: Nasturtium and bare ground under willow canopy - 9.22.11

PHASE 2: Mature willow canopy encloses entire creek channel - 9.22.11

PHASE 3: Step pool channel below 8th Street Culvert - 10.24.11

PHASE 3: Step Pool channel during high flows - 2.17.2011

PHASE 3: Looking upstream from 6th street during high flows - 9.17.11

PHASE 3: Looking upstream from 6th Street after construction - 2.21.11

PHASE 3: Looking upstream from 6th Street - 12.8.11

PHASE 3: Channel entering 6th street culvert during storm - 2.17.2011