STREAM MONITORING REPORT 2010

SR 9: Nooksack Road Vicinity to Cherry Street All Weather Reconstruction (MP 93.00 to 97.18)

Bone Creek Stream Re-alignment Site
Whatcom County, WA

Prepared by

WSDOT NORTHWEST REGION BIOLOGY

January 2011

Washington State
Department of Transportation

STREAM MONITORING REPORT

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Executive Summary

The Washington State Department of Transportation realigned and enhanced a 656 foot section of Bone Creek, a tributary to the Sumas River, along State Route 9 to mitigate for unavoidable stream and stream buffer impacts due to roadway reconstruction associated with the SR 9, Nooksack Road Vicinity to Cherry Street Vicinity All-weather Reconstruction Project completed in the summer of 2006.

Stream impacts included filling a 520 foot long reach of Bone Creek and moving it 200 feet west of the existing roadway, as well as impacting 0.87 acre of stream buffer. Stream mitigation included re-creating a new, longer channel with stream habitat elements such as large woody debris; leaving a backwater channel and enhancing 2.91 acre of stream buffer.

This stream mitigation site will be monitored for five years and adaptive management employed if the site fails to meet yearly performance standards as specified in the Hydraulic Project Approval (HPA #100355-2) for the project. This report documents the results of year-four monitoring and will be submitted to the Washington State Department of Fish and Wildlife (WDFW), US Army Corps of Engineers (USACE), the Washington State Department of Ecology (WDOE).

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Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
EJL	engineered log jams
LWD	large woody debris
MP	mile post
OHWM	ordinary high water mark
SR	State Route
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WSDOT	Washington State Department of Transportation
WRIA	Water Resource Inventory Area

Chapter 1. Introduction

The Washington Department of Transportation (WSDOT) has re-aligned approximately 520 feet of Bone Creek (WRIA 01.0011) at river mile 0.75 and installed habitat features as part of the State Route (SR) 9, Nooksack Road Vicinity to Cherry Street Vicinity Project. To compensate for unavoidable stream and stream buffer impacts, WSDOT re-created a new, longer channel matching the existing stream width and depth, added stream habitat elements, left a backwater channel, and enhanced the stream buffer. Stream monitoring was conducted to document the effects of the stream re-alignment of Bone Creek. The results of the third year of five-year stream monitoring along Bone Creek for the Washington State Department of Transportation (WSDOT) document the stream re-alignment is meeting performance standards for the new channel as proposed in the mitigation report (WSDOT 2005) to satisfy HPA requirements.

Chapter 2. Proposed Project

2.1 Location

The Bone Creek stream realignment is located on a 2.91 acre land parcel east of SR 9 near milepost (MP) 93.83 and immediately south of the City of Sumas. Bone Creek is a tributary to the Sumas River which eventually drains to the Fraser River system in Canada (Figure 1). Specifically, the site is located in Section 3, Township 40 North, Range 04 East, Whatcom County, Washington.

2.2 Project History

A portion of this project included a new road alignment for SR 9 from MP 94.58 (Garrison Road) to MP 97.18 [(Front Street (SR 547)]. This new alignment utilized an existing northeasterly/southwesterly right-of-way that paralleled the Burlington Northern Santa Fe Railroad lines. Impacts to Bone Creek were unavoidable since there was insufficient room to widen the road without crossing into the adjacent railroad right-of-way. Alternatives to stream re-alignment such as a bridge crossing were considered, but it was determined best for the resource to relocate the stream away from SR 9 and allow creation of a riparian buffer between the stream and the road and treatment of stormwater runoff before it entered the creek.

At the Bone Creek site a 656-foot long stream channel with habitat features and off-channel habitat was created with an average 100-foot enhanced stream buffer (2.91 acres) to compensate for filling 520 linear feet of fish-bearing stream and 0.87 acre of stream buffer impact. This stream design proposed a total of 12 large woody debris (LWD) jams along the entire length of the new channel for fish habitat and bank protection. WSDOT also re-planted native riparian vegetation. A total of 51 pieces of LWD were installed. The stream re-alignment and habitat elements were completed in September 2006 and riparian plantings were

installed March 2007. Riparian vegetation monitoring will be conducted with the results contained in a separate WSDOT monitoring report.

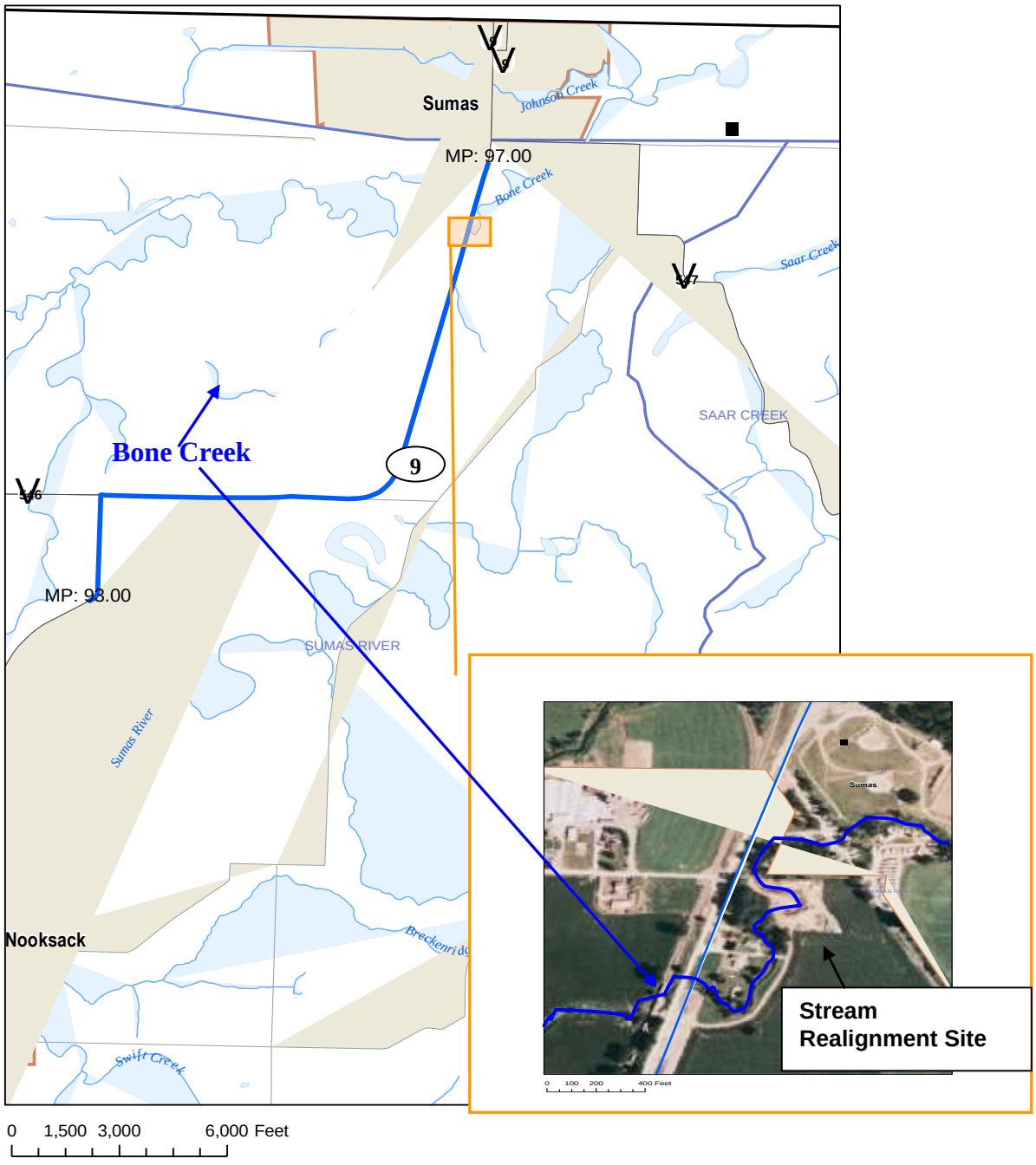


Figure 1. Vicinity map for the SR 9 Bone Creek stream realignment with site map inset, Whatcom County, Washington.

Chapter 3. Goals, Objectives, Performance Criteria

WSDOT has developed stream-monitoring protocols for this project, to be implemented yearly for a total of five years to demonstrate the intended goals and objectives are met.

3.1 Goals and Objectives

The goal of the Bone Creek channel re-alignment is to create a stable (in equilibrium) channel that mimics or improves existing channel function. The specific objectives of the stream mitigation plan are discussed in detail in the *Final Wetland and Stream Mitigation Plan for SR 9: Nooksack Road Vicinity to Cherry Street All-weather Reconstruction* (WSDOT 2005; pages 28-29). Briefly, these objectives are:

- Enhance riparian vegetation to stabilize stream banks in these areas; provide shade and cover for fish; provide sources of organic matter (both coarse and fine) to increase the invertebrate prey base for fish;
- Reduce non-native vegetation (e.g. reed canarygrass and Himalayan blackberry) and provide a native seed source;
- Plant a larger riparian buffer (average 100 feet) than what currently exists to allow for additional water quality improvement prior to stormwater reaching the creek;
- Plant to encourage the long-term recruitment of LWD and pool formation;
- Install LWD to encourage the formation of scour pool habitat and provide sources of organic matter (both coarse and fine) to increase the invertebrate prey base for fish;
- Retain an off-channel area to provide more fish habitat than currently exists;
- Move Bone Creek away from the new SR 9 alignment to preclude the need for future streambank armoring at this location.

WSDOT collected reference reach data within the existing channel to be re-aligned before the channel re-alignment occurred to provide existing baseline data. The reference reach is an unconfined channel segment which is stable and in equilibrium.

3.2 Performance Criteria

Performance criteria describe measurable attributes that can be used to evaluate success in meeting the goals and objectives of a compensatory mitigation project. Performance measures are used to guide site management activities during the monitoring period. Success standards are benchmarks measured during the final year of monitoring that are used to help evaluate compliance with regulatory requirements. Performance measures will be used to verify that the mitigation is on track to achieve the success standards. The specific evaluation criteria

approved in the *Final Wetland and Stream Mitigation Plan for SR 9: Nooksack Road Vicinity to Cherry Street All-weather Reconstruction* (WSDOT 2005) are as follows:

Interim Performance Measures

1. **Cross-sections and stream thalweg profile:**
    - Establish four permanent benchmarks tied to surveyed elevations. One at each critical meander bend.
    - Monitor each station during summer low flow.
    - Cross-sectional analysis will include bankfull depth/width, wetted depth/width, substrate composition analysis, and percent embeddedness.
2. **Stability of In-stream Structures:**
    - The exposed surface length of structures will be measured using low flow notches as a reference point in order to measure migration or loss of bankside material.
    - A visual review of geotextiles, under-cutting of structures, etc. will be performed.
    - LWD will be tagged for representative location and movement.
3. **General Attributes:**
    - Obvious bank erosion
    - Observed wildlife
    - Canopy cover will be measured with a standard forestry canopy densiometer.
    - Temperature
    - Other observed physical features
4. **Photo Points:**
    - Establish photo points for each structure.
5. **Install and Monitor a Stream Staff Gauge**
6. **Monitoring Report**
    - An annual report will be prepared detailing the monitoring results. The target date for the report will be October 31 of each of the monitoring years. The monitoring report will be submitted with the riparian monitoring report due January of each monitoring year to WDFW, USACE, and the WDOE.

Success Standards

Year 5:

- The bankfull width/depth and wetted width/depth ratio will be maintained within 80% of the reference reach data.
- Substrate composition will be maintained within 90% of the D_{50} (the size at which 50% of the pebbles are finer) from the reference reach data.
- All placed LWD will be retained within the newly created channel.

- Newly created streambanks will not show any more additional bank deformation than the reference reach based on the linear feet of bank instability at bankfull.

Chapter 4. Results of Years 1-4 Monitoring

Baseline monitoring of the existing channel was conducted on September 6, 2005, one year prior to the channel realignment. First year monitoring of the new stream channel was conducted on October 2, 2007. Year 2 monitoring occurred on September 9, 2008. Year 3 monitoring occurred on September 22, 2009. Year 4 monitoring was conducted on September 24, 2010 (Table 1). Minor changes to the interim performance measures were made the first year of monitoring due to existing site conditions as follows:

Cross-sections and stream thalweg profile:

- Eight permanent benchmarks tied to surveyed elevations were established on each side of the streambank at each cross-section located at four meander bends.

Stability of In-stream Structures:

- LWD was not tagged due to the depth of water at the time of monitoring. However, a count of all structures was conducted to ensure number and placement as indicated in the construction notes.

Photo Points

- Photo points were taken at each cross-section to document overall stream, riparian, and structure conditions**.**

4.1 Cross-section information and general physical attributes at Bone Creek

Cross-section measurements and general physical attributes of Bone Creek were collected and data recorded at three cross-sections during baseline monitoring prior to the channel realignment. The same measurements were taken at cross-sections one, two, three, and four during year-one, year-two, year-three, and year-four monitoring (Table 1; Appendix A and B).

Table 1. Stream and Wildlife Data Collected at each Cross-section for the SR 9 Bone Creek stream channel realignment.

Date	Cross-section (X-S) location	Photo point	Habitat Unit	Wetted width (ft)	Wetted depth (in)	Bankfull Width (ft)	Bankfull Depth (ft)			Percent Embeddedness	Stream Bank Instability (ft)	Water Temperature		Canopy cover (%)	Wildlife	Structures/comments
							1	2	3			Degree C	Time			
9/24/2010	1		glide	28.0	39.0	34.8	2.8	3.8	2.4	0	0	11.0	11:00 AM	28	beaver activity observed	all LWD structures immersed; silt bottom with muck in places
	2		glide	37.3	35.5	44.2	2.6	3.3	1.8	0	0	12.0		29	birds seen or heard: American crow, cedar waxwings, house sparrow, spotted towhee, black capped chickadees, European startling, California gull	vegetation-high vigor
	3		glide	37.9	30.0	41.4	2.8	2.5	1.5	0	0	12.0		49	riparian cover high even with beaver damage; den in bank	
	4		glide	20.6	33.0	31.1	1.9	3.0	0.6	0	0	12.0		56		
Averages				**31.0**	**34.4**	**37.9**	**2.5**	**3.2**	**1.6**	**0**	**0**	**11.8**		**41**		
9/22/2009																
	1	1	glide	12.6	10.0	29.2	2.3	3.1	2.3	0	0	13.0	9:36 AM	16	Substrate is silty sand and muck.	Lemna across channel; riparian vegetation-high vigor, low invasives
	2	2	glide	10.5	5.0	39.4	2.2	2.8	1.3	0	0	16.0	9:54 AM	12	cedar waxwings	
	3	3	glide	0	0.0	36.6	2.5	2.7	1.4	0	0	N/A	N/A	15		Channel is dry at this location-substrate is mud
	4	4	glide	1.5	2.0	22.9	1.6	2.5	0.75	0	0	14.0	10:15 AM	36	swallow, American robin, black capped chickadee; beaver activity observed	Sandy-silty bottom; 41 pieces of LWD installed.
Averages				**6.2**	**4.3**	**32.0**	**2.2**	**2.8**	**1.4**	**0**	0	14.3		20		
9/9/2008	1	1	glide	33.5	48.0	36.5	3.5	4.3	2.9	0	0	15.0	9:54 AM	22	ducks, crows	benchmarks under water 1.6' too low, channel forming mid channel 4', lemna filling channel
	2	2	glide	45.6	44.0	54.7	4.0	3.7	1.7	0	0	15.0	10:22 AM	5	Dark eyed juncos	max depth 44", LWD submerged-scour pools forming, Sa/Si bottom
	3	3	glide	40.9	40.0	52.8	3.7	3.2	1.9	0	0	15.0	10:37 AM	4	European starling	Max depth 40"

Date	Cross-section (X-S) location	Photo point	Habitat Unit	Wetted width (ft)	Wetted depth (in)	Bankfull Width (ft)	Bankfull Depth (ft)			Percent Embeddedness	Stream Bank Instability (ft)	Water Temperature		Canopy cover (%)	Wildlife	Structures/comments
	4	4	glide	30.6	36.0	38.6	2.9	1.9	1.6	0	0	16.5	10:54 AM	26	Black capped chickadees, Belted king fisher, beaver signs	Max depth 36" -- riparian plantings doing well— Salix sitchensis,
Averages				**37.6**	**42**	**45.7**	**3.5**	**3.3**	**2**.0			**15.38**		**14.25**		
10/2/2007	1	1	glide	25.6	33.0	29.3	2.6	3.33	2.41	sandy bottom-n/a	0	14.0	11:00 AM	25		; At first meander bend-minor scour pools forming around LWD
	2	2	glide	32.8	31.0	39.4	2.3	2.8	1.4	sandy bottom-n/a	0	14.0	11:20 AM	8	Dark eyed juncos	Minor scour pools forming around LWD
	3	3	glide	30	27.0	36.6	2.5	2.5	1.1	sandy bottom-n/a	0	14.0	11:35 AM	12		Minor scour pools forming at LWD
	4	4	glide	16.7	23.0	22.8	1.8	2.3	0.58	sandy bottom-n/a	0	14.0	11:45 AM	35	Bald eagle overhead; black capped chickadees	Minor scour pools forming around LWD
Averages				**26.28**	**28.5**	**32.0**	**2.3**	**2.7**	**1.4**			**14**.0		**20**		
Baseline	1		glide	27.7	2.9	27.7	2.6	2.9	2.6	silt bottom-n/a	0	14.0	12:23 PM	88		Glide at head of meander bend, just upstream of new channel alignment; Lat/Long: N 40 59 min 17.4 sec, W 122 15 min 53.1 sec
Baseline	2		glide	25.9	3.7	25.9	2.9	3.7	2.65	silt bottom-n/a	0	14.0	12:45 PM	84	Northern flicker	Riparian cover and banks armored by vegetation; submerged LWD
Baseline	3		Glide	22.5	4.1	22.5	2.05	4.1	3.4	silt bottom-n/a	0	14.5	1:35 PM	65	Red tailed hawk, song sparrow, American crow	Lat/Long:N48 59 min, 14.5 sec; W122 16 min 0.4 sec
Averages				**25.37**	**3.57**	**25.37**	**2.48**	**3.55**	**2.88**			**14.17**		**79**		

Reference Reach/Baseline Data

All stream habitat prior to the stream channel realignment was recorded as *glide*. The baseline monitoring stream measurements for *wetted width* and *wetted depth* average 25.37 feet and 3.57 feet, respectively, and indicate an average *bankfull width* and *depth* of 25.37 feet and 2.48 feet, respectively. This puts the *wetted width/depth ratio* at 7.1 and the *bankfull width/depth ratio* at 8.54. The success standard requires maintaining the wetted width/depth ratio and bankfull width/depth ratio within 80% of the reference reach. Accordingly, 80% of the wetted width/depth ratio would be 5.68 and 6.83 for the bankfull width/depth ratio. Substrate was dominated by fines (< 2 mm) such as silt and sand; therefore substrate embeddedness was 0%. *Canopy cover* for the baseline cross-sections averaged 79%. Stream temperatures averaged 14.16°C during baseline monitoring. A small amount of bank instability, two to three feet on the west stream bank, was observed during the baseline monitoring. In the new channel all 51 pieces of LWD were installed and within the OHWM of the stream. An undetermined number of submerged LWD were observed during the baseline monitoring in cross-section two (Table 1).

Year 1

Stream measurements for *wetted width* and *wetted depth* during year-one monitoring showed an average of 26.28 feet and 3.57 feet, respectively, with an average *bankfull width* and *depth* of 32.01 feet and 2.13 feet, respectively. This puts the year-one wetted width/depth ratio at 7.36 and the bankfull width/depth ratio at 15.0, well above 80% of the reference reach data. Due to the nature of the streambed substrate as primarily fines, the year-one result for *substrate embeddedness* was 0% at all cross-sections. *Canopy cover* in the new stream section was lower with an average of 20%. At year-one, cross-sections one and four, located closer to the original alignment, had the highest canopy cover estimates at 25% and 35%. Stream temperatures averaged 14.0°C during the year-one monitoring sessions. No evidence of bank instability was observed during year-one monitoring. Three of the proposed engineered log jams (EJL), labeled as ELJ 7, 9, and 10 were placed as single pieces of wood due to the steepness of the stream banks (Appendix C). Minor scour pools were forming around the LWD structures at the time of year-one monitoring. During year-one monitoring, feeding flocks of dark eyed juncos (*Junco hyemalis*) and black-capped chickadees (*Poecile atricapillus*) were observed as well as a bald eagle (*Haliaeetus leucocephalus*). No fish were observed during year-one monitoring (Table 1).

Year 2

Stream measurements for *wetted width* and *wetted depth* during year-two monitoring showed an average of 37.6 feet and 3.5 feet, respectively, with an average *bankfull width* and *depth* of 45.7 feet and 2.93 feet, respectively. This puts the year-two wetted width/depth ratio at 10.74 and the bankfull width/depth ratio at 15.6, well above 80% of the reference reach data. Due to the nature of the streambed substrate as primarily fines the year-two results for *substrate embeddedness* was 0% at all cross-sections. *Canopy cover* for year-two averaged 14.25% with the highest canopy cover in cross-sections one and four at 22 and 26%, respectively. Stream temperatures averaged 15.38°C during the year-two monitoring session. No evidence of bank instability was observed during year-two monitoring. Scour pools were also evident around the

LWD structures at the time of year-two monitoring. Wildlife species observed during year-two monitoring include feeding flocks of dark eyed juncos (*Junco hyemalis*) and black-capped chickadees (*Poecile atricapillus*). Other birds observed include European starlings (*Sturnus vulgaris*), American crows (*Corvus brachyrhynchos*), and a belted king fisher (*Megaceryle alcyon*). Signs of beaver activity were evident. No fish were observed during year-two monitoring (Table 1).

Year 3

Stream measurements for *wetted width* and *wetted depth* during year-three monitoring showed an average of 6.2 feet and 0.36 feet, respectively, with an average *bankfull width* and *depth* of 32.0 feet and 2.1 feet, respectively. This puts the year-three wetted width/depth ratio at 17.22 and the bankfull width/depth ratio at 15.23, well above 80% of the reference reach data. Extreme low flows were observed during year-three monitoring with an absence of water at cross-section three. Due to the nature of the streambed substrate as primarily fines, the year-three results for *substrate embeddedness* was 0% at all cross-sections. *Canopy cover* for year-three averaged 20% with the highest canopy cover in cross-sections one and four at 16 and 36%, respectively. Stream temperatures averaged 14.3°C during the year-three monitoring session. No evidence of bank instability was observed during year-three monitoring. Scour pools were also evident around the LWD structures at the time of year-three monitoring. Wildlife species observed during year-three monitoring include cedar waxwings (*Bombycilla cedrorum*), American robin (*Turdus migratorius*), black capped chickadees (*Poecile atricapillus*), and swallows (*Tachycineta* spp.). Signs of beaver activity were evident. No fish were observed during year-three monitoring as stream flow was extremely low or not even present in all cross-sections (Table 1).

Year 4

Stream measurements for *wetted width* and *wetted depth* during year-three monitoring showed an average of 31.0 feet and 2.8 feet, respectively, with an average *bankfull width* and *depth* of 37.9 feet and 2.4 feet, respectively. This puts the year-four wetted width/depth ratio at 11.07 and the bankfull width/depth ratio at 15.79, well above 80% of the reference reach data. High flows were observed during year-four monitoring. Due to the nature of the streambed substrate as primarily fines, the year-four results for *substrate embeddedness* was 0% at all cross-sections. *Canopy cover* for year-four averaged 41% with the highest canopy cover in cross-sections three and four at 49 and 56%, respectively. Stream temperatures averaged 11.8°C during the year-four monitoring session. No evidence of bank instability was observed during year-four monitoring. Scour pools were also evident around the LWD structures at the time of year-four monitoring. Wildlife species observed during year-four monitoring include American crow (*Corvus brachyrhynchos*), cedar waxwings, house sparrow, spotted towhee, American robin (*Turdus migratorius*), black capped chickadees (*Poecile atricapillus*), European starling (*Sturnus vulgaris*), and California gull (*Larus californicus*). Signs of beaver activity were evident and a den in the bank at cross-section three was observed. No fish were observed during year-four monitoring as stream flow was high and visibility low (Table 1).

Chapter 5. Conclusions/Recommendations

Stream channel characteristics at Bone Creek such as bankfull width/depth ratio and wetted width/depth ratio will be compared over a five-year monitoring period for significant changes with the goal of maintaining the new channel within 80% of the reference reach data. Year-four stream flows were high; however, comparing the reference reach data to the year-one, year-two, year-three, and year-four monitoring data indicates the new channel is well above the 80% ratios for wetted width/depth and bankfull width/depth. This indicates an absence of vertical channel movement (incision); therefore, the channel is performing as expected. In addition, the new channel is not showing any signs of lateral movement as evidenced by the stable stream banks.

The goal for substrate composition is to maintain substrate within 90% of the D_{50}. Since sampling at all cross-sections indicate the stream bed is 100% fines (< 2 mm) the substrate composition easily meets the criteria for years one and two. Streambed embeddedness also is not a concern at this location since the dominant substrate is fines.

At year-four, average canopy cover was higher (41%) than year-three (20%), year-two (14.25%), and year-one (20%). Riparian plantings (generally shrubs) appear to be thriving (Appendix A) and are contributing to stream shade. Beaver activity was evident throughout the planting area; however, plantings (especially willows) appear unaffected. Riparian plantings are providing stream bank stability as evidenced by the absence of eroding banks.

Stream structures at the monitoring site appear to be in stable condition and functioning as designed to provide habitat, bank stability, and detrital input. Overall, habitat features such as scour pools were evident and deepening at LWD structures.

Chapter 6. References

WSDOT. 2005. Final Wetland and Stream Mitigation Report for the SR 9 Nooksack Road Vicinity To Cherry Street All Weather Rehabilitation (MP 93.0-MP 97.5). August 2005.

Appendix A Photo Points

A.1. Photo monitoring of Cross-section 1

Figure 2. Photo facing northwest from mid-channel of cross-section 1 showing riparian and stream conditions and LWD.

Figure 3. Photo facing southeast from mid-channel of cross-section 1 showing mostly submerged LWD and stream conditions.

Figure 4. Photo facing southwest across channel showing benchmark 1 and riparian conditions.

Figure 5. Photo facing northeast from mid-channel (looking at benchmark 2) showing riparian conditions.

A.2. Photo monitoring of Cross-section 2

Figure 6. Photo facing northwest from cross-section 2 showing channel and riparian conditions.

Figure 7. Photo facing southeast from mid-channel of cross-section 2 showing riparian and stream conditions.

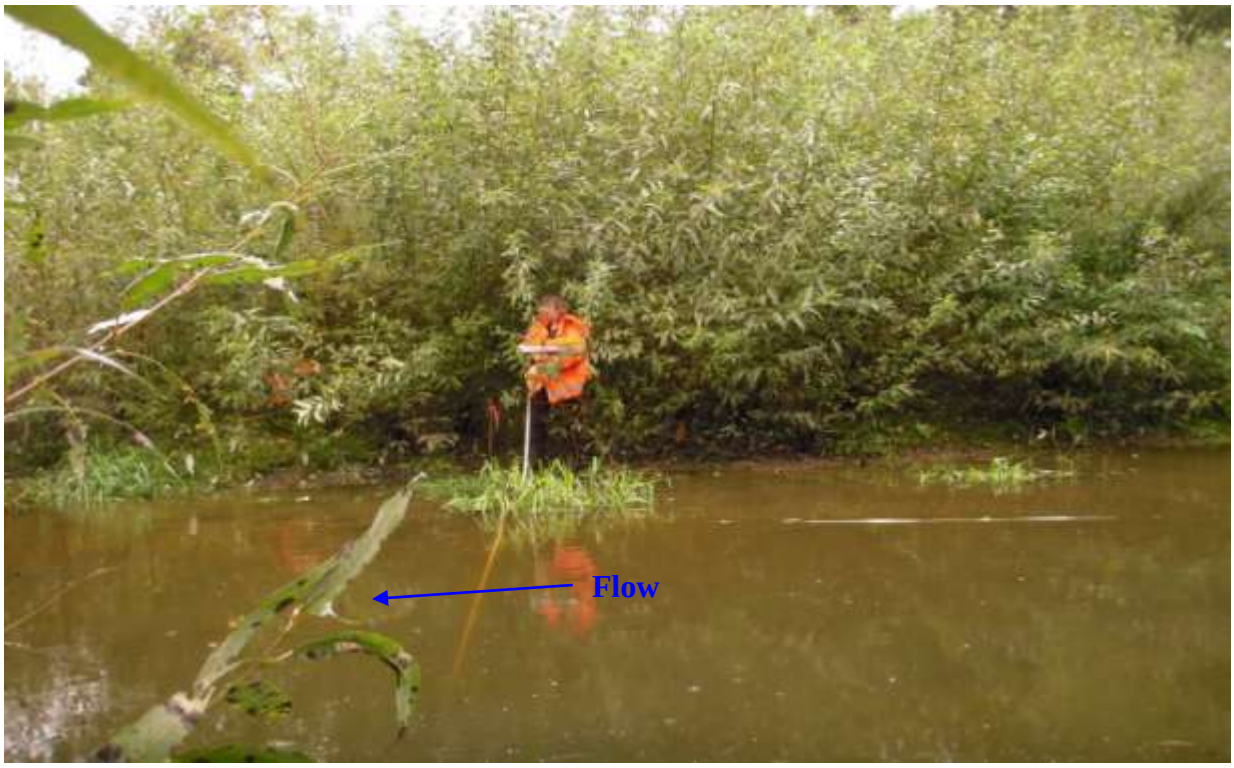


Figure 8. Photo facing northeast of benchmark 4, showing stream and riparian conditions.

Figure 9. Photo facing southwest of benchmark 3, showing stream/riparian conditions.

A.3. Photo monitoring of Cross-section 3

Figure 10. Photo facing northeasterly from mid-channel of cross-section 3, showing stream and riparian conditions.

Figure 11. Photo facing southwest from mid-channel at cross-section 3, showing stream and riparian conditions.

Figure 12. Photo facing benchmark 6 from mid-channel, showing riparian conditions.

Figure 13. Photo from mid-channel facing benchmark 5 showing riparian conditions.

A.4. Photo monitoring of Cross-section 4

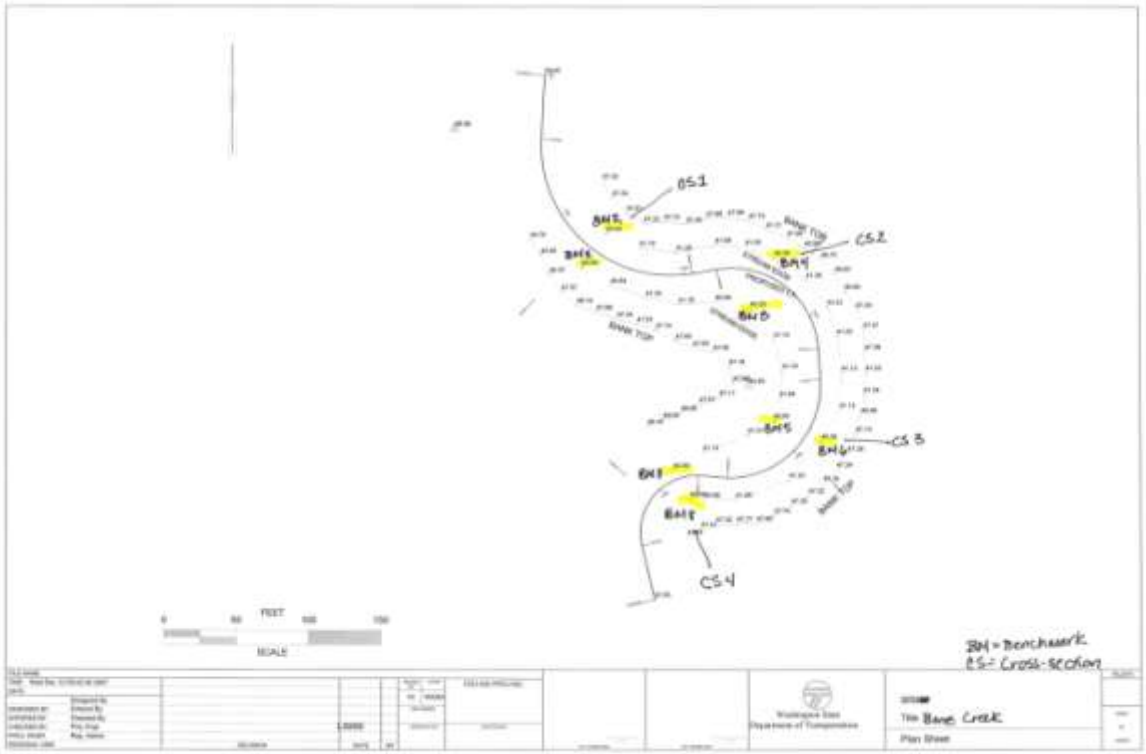
Figure 14. Photo facing westerly at cross-section 4 showing tips of LWD and stream conditions.

Figure 15. Photo facing easterly from mid-channel of cross-section 4 showing tips of LWD and stream conditions.

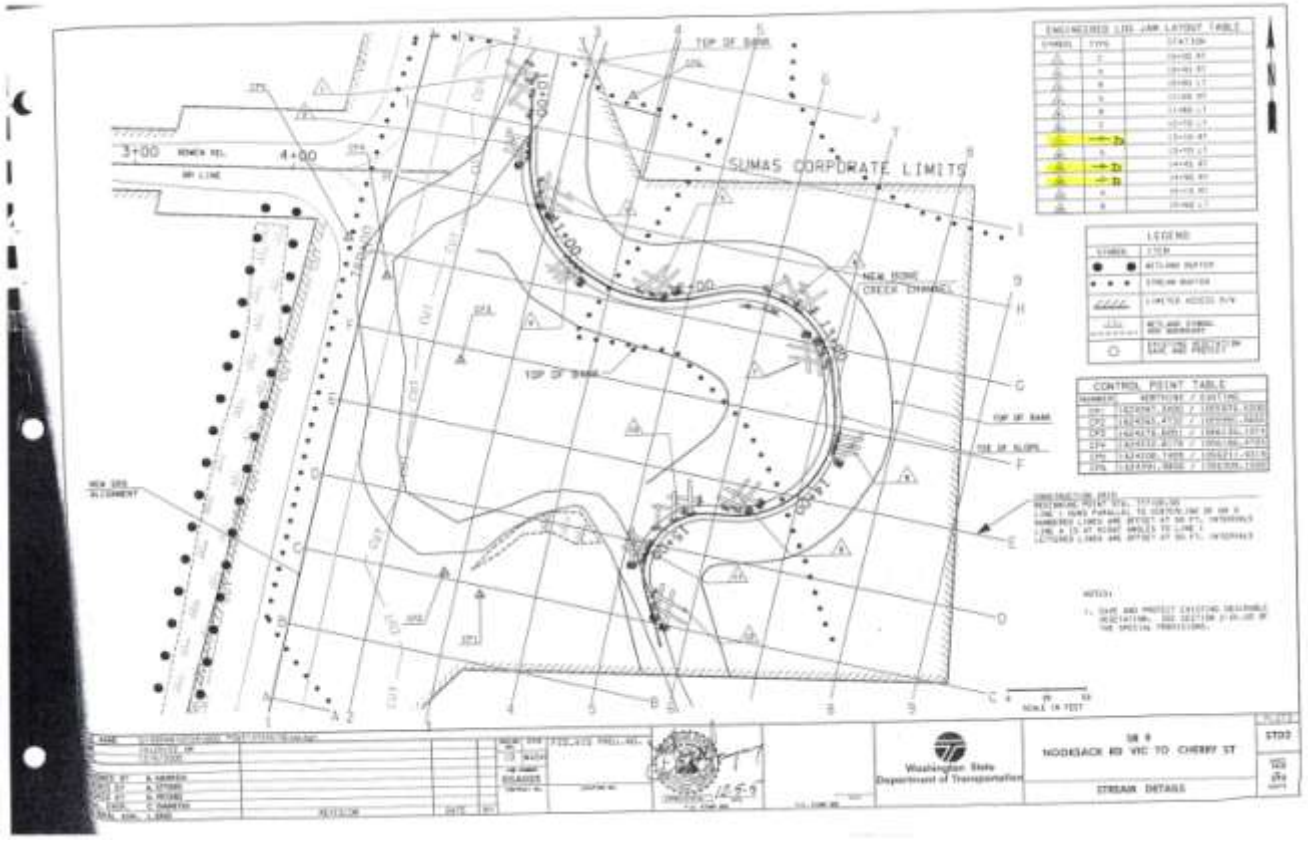
Figure 16. Photo facing southerly of benchmark 8 showing riparian conditions.

Figure 17. Photo facing northerly of benchmark 7 showing riparian conditions.

Appendix B Stream Realignment Benchmark Plan Sheet



Appendix C LWD Placement Plan Sheet with Modifications



Appendix C – Cont.