California Department of Fish and Game
East Marin County
San Francisco Bay Watersheds
Stream Habitat Assessment Reports

Miller Creek

Surveyed 2009

Report Complete Feb. 2011

STREAM INVENTORY REPORT

Miller Creek

INTRODUCTION

A stream inventory was conducted during 7/17/2009 to 7/22/2009 on Miller Creek. The survey began at the confluence with San Pablo Bay and extended upstream 7.2 miles.

The Miller Creek inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Miller Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions and recommend options for the potential enhancement of habitat for steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Miller Creek is a tributary to San Pablo Bay, located in Marin County, California (Map 1). Miller Creek's legal description at the confluence with San Pablo Bay is T02N R06W S11. Its location is 38°01'53.1" north latitude and 122°29'54.3" west longitude, LLID number 1224972380314. Miller Creek is a second order stream and has approximately 26.9 miles of blue line stream according to the USGS National Hydrography Dataset (NHD). Miller Creek drains a watershed of approximately 12 square miles. Elevations range from about sea level feet at the mouth of the creek to 1,890 feet in the headwater areas. Mixed hardwood forest dominates the watershed. The watershed is primarily privately owned which accounts for 71.5% of the land area. Fourteen percent of the land is urban, 13% is agricultural and 65% is considered natural. Vehicle access exists via HWY 101 to St. Vincents Drive.

METHODS

The habitat inventory conducted in Miller Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a two-person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are fully measured. All other habitat unit types encountered for the first time in each reach are measured for all the parameters and

characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Miller Creek to record measurements and observations. There are eleven components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) near the bottom of the stream survey reach using a Marsh-McBirney Model 2000 flow meter.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity. Channel characteristics are measured using a clinometer, hand level, hip chain, tape measure, and a stadia rod.

3. Temperatures:

Both water and air temperatures are measured and recorded at every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1990). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Miller Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All measurements are in feet to the nearest tenth. Habitat characteristics are measured using a clinometer, hip chain, and stadia rod.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out areas is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Miller Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3) and 76 - 100% (value 4). Additionally, a value of 5 was

assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate like bedrock, log sills, boulders or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide juvenile salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition for prey. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Miller Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully-described habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes and recorded as a one and two, respectively. In addition, the dominant substrate composing the pool tail-outs is recorded for each pool.

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densiometers as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Miller Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or hardwood trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Miller Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation (including downed trees, logs, and rootwads) was estimated and recorded.

10. Large Woody Debris Count:

Large woody debris (LWD) is an important component of fish habitat and an element in channel forming processes. In each habitat unit all pieces of LWD partially or entirely below the elevation of bankfull discharge are counted and recorded. The minimum size to be considered is

twelve inches in diameter and six feet in length. The LWD count is presented by reach and is expressed as an average per 100 feet.

11. Average Bankfull Width:

Bankfull width can vary greatly in the course of a channel type stream reach. This is especially true in very long reaches. Bankfull width can be a factor in habitat components like canopy density, water temperature, and pool depths. Frequent measurements taken at riffle crests (velocity crossovers) are needed to accurately describe reach widths. At the first appropriate velocity crossover that occurs after the beginning of a new stream survey page (ten habitat units), bankfull width is measured and recorded in the appropriate header block of the page. These widths are presented as an average for the channel type reach.

BIOLOGICAL INVENTORY

Biological sampling during the stream inventory is used to determine fish species and their distribution in the stream. Fish presence was observed from the stream banks in Miller Creek. In addition, two sites were electrofished using a Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Stream Habitat 2.0.18, a Visual Basic data entry program developed by Karen Wilson, Pacific States Marine Fisheries Commission in conjunction with the California Department of Fish and Game. This program processes and summarizes the data, and produces the following ten tables:

- Riffle, Flatwater, and Pool Habitat Types
- Habitat Types and Measured Parameters
- Pool Types
- Maximum Residual Pool Depths by Habitat Types
- Mean Percent Cover by Habitat Type
- Dominant Substrates by Habitat Type
- Mean Percent Vegetative Cover for Entire Stream
- Fish Habitat Inventory Data Summary by Stream Reach (Table 8)
- Mean Percent Dominant Substrate / Dominant Vegetation Type for Entire Stream
- Mean Percent Shelter Cover Types for Entire Stream

Graphics are produced from the tables using Microsoft Excel. Graphics developed for Miller Creek include:

- Riffle, Flatwater, Pool Habitat Types by Percent Occurrence

- Riffle, Flatwater, Pool Habitat Types by Total Length
- Total Habitat Types by Percent Occurrence
- Pool Types by Percent Occurrence
- Maximum Residual Depth in Pools
- Percent Embeddedness
- Mean Percent Cover Types in Pools
- Substrate Composition in Pool Tail-outs
- Mean Percent Canopy
- Dominant Bank Composition by Composition Type
- Dominant Bank Vegetation by Vegetation Type

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED AT THE END OF THE REPORT *

The habitat inventory of 7/17/2009 to 7/22/2009 was conducted by C. Bell, T. Macias and A. Villalobos (WSP). The total length of the stream surveyed was 37,872 feet with an additional 127 feet of side channel.

Stream flow was not measured on Miller Creek.

Miller Creek is an F4 channel type for 34,470 feet of the stream surveyed (Reach 1), a B4 channel type for the next 2,564 feet of the stream surveyed (Reach 2), and an A3 channel type for the remaining 965 feet of the stream surveyed (Reach 3).

F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. B4 channels are moderately entrenched riffle dominated channels with infrequently spaced pools, very stable plan and profile, stable banks on moderate gradients with low width /depth ratios and gravel dominant substrates. A3 channels are steep, narrow, cascading, step-pool streams with high energy and debris transport associated with depositional soils and cobble-dominant substrate.

Water temperatures taken during the survey period ranged from 56 to 66 degrees Fahrenheit. Air temperatures ranged from 55 to 76 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 38% flatwater units, 27% pool units, 16% riffle units, 12% dry units, 6% culvert units and 1% no survey units (Graph 1). Based on total length of Level II habitat types there were 45% dry units, 32% flatwater units, 13% pool units, 7% riffle units, 2% culvert units and 1% no survey units (Graph 2).

Fifteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 16% Low Gradient Riffle units, 13% Run units and 13% Glide units (Graph 3). Based on percent total length, there were 45% Dry units, 14% Step Run units, 10% Run units and 5% Mid-channel pool units.

A total of 80 pools were identified (Table 3). Scour pools were the most frequently encountered, at 61%, and comprised 61% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Fifty-six of the 80 pools (70%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 80 pool tail-outs measured, 7 had a value of 1 (8.8%); 13 had a value of 2 (16.2%); 21 had a value of 3 (26.2%); 39 had a value of 4 (48.8%) (Graph 6). On this scale, a value of 1 indicates the best spawning conditions and a value of 4 the worst. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other considerations.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 7, flatwater habitat types had a mean shelter rating of 15, and pool habitats had a mean shelter rating of 37 (Table 1). Of the pool types, the Main Channel pools had a mean shelter rating of 30, Scour pools had a mean shelter rating of 41 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Terrestrial vegetation is the dominant cover types in Miller Creek. Graph 7 describes the pool cover in Miller Creek. Root mass is the dominant pool cover type followed by terrestrial vegetation.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel dominance was observed in 58% of pool tail-outs and sand dominance was observed in 22% of pool tail-outs (Graph 8).

The mean percent canopy density for the surveyed length of Miller Creek was 85%. The mean percentages of hardwood and coniferous trees were 100% and 0%, respectively. Fifteen percent of the canopy was open. Graph 9 describes the mean percent canopy in Miller Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 63%. The mean percent left bank vegetated was 59%. The dominant elements composing the structure of the stream banks consisted of 4% bedrock, 7% boulder, 1% cobble/gravel and 88% sand/silt/clay (Graph 10). Hardwood trees were the dominant vegetation type observed in 78% of the units surveyed. Additionally, 16% of the units surveyed had brush as the dominant vegetation type and 5% had grass as the dominant vegetation (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Two sites were electrofished for species composition and distribution in Miller Creek on October 27, 2009. Water temperatures taken during the electrofishing period ranged from 59 to 60 degrees Fahrenheit. Air temperatures ranged from 63 to 70 degrees Fahrenheit. The sites were sampled by T. Macias, A. Villalobos (WSP) and D. Acomb, D. Resnik (DFG).

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In reach 1, which comprised the first 34,343 feet of stream, two sites were sampled. The reach sites yielded sixteen young-of-the-year steelhead/rainbow trout (SH/RT), nine age 1+ SH/RT and four age 2+ SH/RT.

The following chart displays the information yielded from these sites:

2009 Miller Creek e-fish observations

Date	Site #	Reference Point	Distance From Reference Point (ft.)	Steelhead/ Rainbow Trout			Non Salmonids Name species
				0+	1+	2+	
10/27/2009	746	Lassen rd. bridge	100 downstream	14	7	3	8 Stickleback, 13 Roach, 3 Suckers
10/27/2009	747	Marinwood Park	500 upstream, 500 downstream	2	2	1	14 Stickleback, 65 Roach, 3 Suckers

DISCUSSION

Miller Creek is an F4 channel type for the first 34,470 feet of stream surveyed and a B4 channel type for the next 2,564 feet and an A3 channel type for the remaining 965 feet. The suitability of F4/B4/A3 channel types for fish habitat improvement structures is as follows: F4 channels are good for bank-placed boulders. They are fair for plunge weirs, single and opposing wing-deflectors, channel constrictors and log cover. They are poor for boulder clusters. B4 channels are excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing deflectors and log cover. A3 channels are good for bank placed boulders. They are fair for plunge weirs, opposing wing-deflectors and log cover. They are poor for boulder clusters and single wing-deflectors.

The water temperatures recorded on the survey days 7/17/2009 to 7/22/2009, ranged from 56 to 66 degrees Fahrenheit. Air temperatures ranged from 55 to 76 degrees Fahrenheit. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 32% of the total length of this survey, riffles 7%, and pools 13%. The pools are relatively deep, with 56 of the 80 (70%) pools having a maximum residual depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum residual depth of at least two feet, occupy

at least half the width of the low flow channel, and be as long as the low flow channel width. Installing structures that will increase or deepen pool habitat is recommended for locations where their installation will not be threatened by high stream energy, or where their installation will not conflict with the modification of any log debris accumulations (LDA's) in the stream.

Twenty of the 80 pool tail-outs measured had embeddedness ratings of 1 or 2. Sixty of the pool tail-outs had embeddedness ratings of 3 or 4. None of the pool tail-outs had a rating of 5, which is considered unsuitable for spawning. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. Sediment sources in Miller Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Fifty two of the 80 pool tail-outs measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools was 37. The shelter rating in the flatwater habitats was 15. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by Terrestrial vegetation in Miller Creek. Root mass is the dominant cover type in pools followed by terrestrial vegetation. Log and root wad cover structures in the pool and flatwater habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

The mean percent canopy density for the stream was 85%. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was 63% and 59%, respectively. In areas of stream bank erosion or where bank vegetation is sparse, planting endemic species of coniferous and hardwood trees, in conjunction with bank stabilization, is recommended.

GENERAL RECOMMENDATIONS

Miller Creek should be managed as an anadromous, natural production stream.

Winter storms often bring down large trees and other woody debris into the stream, which increases the number and quality of pools. This woody debris, if left undisturbed, will provide fish shelter and rearing habitat, and offset channel incision. Landowners should be sensitive about the natural and positive role woody debris plays in the system, and encouraged not to remove woody debris from the stream, except under extreme buildup and only under guidance by a fishery professional.

RECOMMENDATIONS

1) Access for migrating salmonids should be assessed at all Dams and road crossings. All fish passage assessments should be done according to Part 9 of the California Salmonid Stream Habitat Restoration Manual (Flosi et al, 1998). Where needed, crossings should be replaced or modified to improve fish passage.

2) There are several reaches where the stream is being impacted from livestock in the riparian zone. Livestock in streams generally inhibit the growth of new trees, exasperate erosion, and reduce summertime survival of juvenile fish by negatively impacting water quality. Alternatives to limit cattle access, control erosion and increase canopy, should be explored with the landowner, and developed if possible.

3) Inventory and map sources of stream bank erosion and active or potential sediment sources related to the road system. These sites should be identified, mapped, prioritized and treated according to their potential to reduce the amount of fine sediments entering the stream and its tributaries.

4) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover in the pools is from Boulders. Adding high quality complexity with woody cover in the pools is desirable.

5) Increase the canopy on Miller Creek by planting appropriate native vegetation like willow, alder, redwood, and Douglas fir along the stream where shade canopy is not at acceptable levels. The reaches above this survey section should be inventoried and treated as well, since the water flowing here is affected from upstream. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.

6) Miller Creek would benefit from utilizing bio-technical vegetative techniques to re-establish floodplain benches and a defined low flow channel. This would discourage lateral migration of the base flow channel and decrease bank erosion.

7) The limited water temperature data available suggest that maximum temperatures are within/above the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

Position (ft.)	Habitat Unit #	Comments:
0	0001.00	Start of Survey: Out of tidal influence at coordinates N38.03426 W122.52058
139	0002.00	Structures: Bridge #1. North Pacific Railroad Bridge. Dry with natural bottom. W=51' H=5' L=12'. Made of wood. No downcutting and not retaining gravel. Not likely a barrier.

Position (ft.)	Habitat Unit #	Comments:
2,617	0011.00	Bio Sample: (Other) minnows observed
3,117	0017.00	General Comment: Channel almost completely choked with blackberries, grasses, and aquatic vegetation.
3,959	0023.00	General Comment: Cows accessing stream.
4,716	0036.00	Bio Sample: (Other) California Roach observed
5,481	0046.00	Structures: Bridge #2. Road crossing with natural bottom W=75' H=10' L=19'. Made of cement. Not retaining gravel and no downcutting. Not likely a barrier. N38.03051 W122.53677
5,641	0048.00	Structures: Bridge #3. Hwy 101 Bridge. Made of cement. W=78' H=14' L=158' It is retaining gravel but no downcutting. Natural bottom. Not likely a barrier. N38.03031 W122.53777
8,006	0080.00	Tributaries: LB Trib #1. Unnamed stream enters Miller Creek dry. Water temps downstream: 66F, upstream: 65F & trib: dry. It is accessible to fish. Checked 100' up trib. No fish observed. N38.03025 W122.54460
8,356	0084.00	Structures: Bridge #4. Las Gallinas Rd. Road crossing. Not retaining gravel with a natural bottom. W=46' H=8'L=90'. Made of cement. No downcutting present. Not likely a barrier. N38.03059 W122.54542
9,225	0098.00	Structures: Bridge #5. Park footpath. W=82' H=11' L=14'. Made of wood and steel Not retaining gravel and no downcutting with a natural bottom. Not likely a barrier. N38.03087 W122.54720
11,090	0116.00	Structures: Bridge #6. Private. W=68' H=16' L=6'. Made of wood. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.02977 W122.55122
11,661	0124.00	General Comment: Bedrock in channel
12,290	0130.00	Structures: Bridge #7. Lucas Valley Rd. W=98' H=20' L=62'. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.02697 W122.55208
12,409	0132.00	General Comment: Bedrock in channel
12,545	0134.00	General Comment: RB concrete wall falling into stream.
13,603	0152.00	General Comment: dry RB culvert falling away from bank
13,603	0152.00	Bio Sample: (Other) Possible Young of the year salmonids (YOY) observed
14,247	0160.00	General Comment: RB rip rap
14,297	0161.00	General Comment: LB 12" diameter pipe with cement
14,870	0169.00	General Comment: RB rip rap falling in creek
14,915	0170.00	Bio Sample: (Other) Possible YOY observed

Position (ft.)	Habitat Unit #	Comments:
16,935	0194.00	Bio Sample: (Other) Salmonid observed, approx. 6" long
17,842	0207.00	Structures: Bridge #8. Lucas Valley Road. W=124' H=16' L=55'. Made of cement. No downcutting present. Not likely a barrier. N38.02541 W122.56733
17,894	0208.00	Structures: Dam #1. L=36' H=3' W(0)=na W(d)=11'. No flashboards present. Composed of boulders, pipe, and step weir. 2 feet of downcutting present. Possible barrier to both juvenile and adult salmonids
18,142	0212.00	Bio Sample: (Other) Possible salmonid YOY observed
18,359	0216.00	Structures: Bridge #9. Lassen Drive. W=70' H=14' L=77'. Made of cement. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.02625 W122.56894
18,606	0219.00	Tributaries: LB Trib #2. Unnamed creek enters Miller Creek with discharge of <1cfs. Water temps downstream: 64F, upstream: 64F & of tributary: 62F. Not accessible to fish. No fish observed. N38.02665 W122.56957
19,560	0231.00	General Comment: Pump in stream.
21,188	0245.00	Tributaries: Unnamed LB trib#3 enters Miller Creek with no discharge. It is accessible to fish/ No fish observed. N38.02948 W122.57622
21,217	0246.00	Structures: Bridge #10. Mt Shasta Drive. W=87' H=14' L=54'. Made of cement. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier.
22,155	0256.00	Tributaries: LB Trib #4. Unnamed enters Miller Creek with no discharge. Water temps: 60F. Not accessible to fish. No fish observed. N38.02948 W122.57622
23,104	0267.00	Structures: LB wood retaining wall
23,387	0271.00	Tributaries: RB Trib #1. Unnamed enters Miller Creek with no discharge. Not accessible to fish, checked 5' up tributary. No fish observed. N38.03172 W122.58311
24,056	0272.00	Structures: Bridge #11. Mt McKinley Road. W=62' H=16' L=48'. Made of cement. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.03242 W122.58366
25,495	0280.00	Structures: Bridge #12. Bridgegate Drive. W=67' H=12' L=49'. Made of cement. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.03498 W122.58720
26,382	0282.00	Structures: Bridge #13. Neighborhood bridge. W=106' H=10' L=6'. Made of wood. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.03535 W122.59000

Position (ft.)	Habitat Unit #	Comments:
28,894	0284.00	Structures: Bridge #14. Westgate Drive. W=105' H=19' L=39'. Made of cement Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.03791 W122.59719
28,933	0285.00	Tributaries: RB Trib #2. Unnamed tributary enters Miller Creek with no discharge. Water temps: 60F. It is accessible to fish. No fish observed. N38.03752 W122.59819
29,436	0286.00	Structures: Bridge #15. Private driveway W=unk' H=9' L=18'. Made of steel, wood, Stone and cement. Not retaining gravel and no downcutting with natural bottom. Not a barrier. N38.03761 W122.59879
29,454	0287.00	General Comment: LB and RB, Bank stabilization project using 3' diameter logs and large boulders.
29,454	0287.00	Tributaries: RB Trib #3. Unnamed tributary enters Miller Creek with no discharge. It is accessible to fish. No fish observed. N38.03861 W122.60148
30,835	0288.00	Structures: Bridge #16. Private road. W=21' H=9' L=14'. Made of cement. Not retaining gravel but 7 feet of downcutting is present. Possibly a barrier. N38.03962 W122.60258
30,849	0289.00	General Comment: LB Trib #5. Unnamed tributary enters Miller Creek with no discharge It is accessible to fish. Checked 100' up trib. No fish observed. N38.04129 W122.60498
30,849	0289.00	Tributary: LB Trib #6. Unnamed tributary enters Miller Creek with no discharge. It is accessible to fish. No fish observed. N38.04276 W122.60898
30,849	0289.00	Tributaries: RB Trib #4. Unnamed tributary enters Miller Creek with no discharge. It is accessible to fish. No fish observed. N38.04054 W122.60426
34,333	0290.00	Structures: Bridge #17. Private ford crossing. W=22' H=0' L=10'. Made of natural streambed. Not retaining gravel and no downcutting with natural bottom. Not likely a barrier. N38.04354 W122.61082
34,343	0291.00	Tributaries: LB Trib #7. Unnamed tributary enters Miller Creek with no discharge. It is accessible to fish. No fish observed. N38.04543 W122.61570
34,343	0291.00	Channel type change. Reach 1 to reach 2. F4 to B4
36,907	0292.00	Tributaries: RB Trib #5. Unnamed tributary enters Miller Creek with no discharge. It is not accessible to fish. No fish observed. N38.04836 W122.61524
36,907	0292.00	Channel type change. Reach 2 to reach 3. B4 to A3
37,872	0292.00	End of Survey: Steep, unstable banks; channel filled with brush, boulders, logs. Unable to continue surveying upstream due to hazardous conditions. WP#087 N38.04913 W122.61527

REFERENCES

Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and Collins, B. 1998. *California Salmonid Stream Habitat Restoration Manual*, 3rd edition. California Department of Fish and Game, Sacramento, California.

McCain, M., D. Fuller, L. Decker and K. Overton. 1990. Stream habitat classification and inventory procedures for northern California. FHC Currents. No.1. U.S. Department of Agriculture. Forest Service, Pacific Southwest Region.

Rosgen, D.L., 1994. A Classification of Natural Rivers. Catena, Vol 22: 169-199, Elsevier Science, B. V. Amsterdam.

LEVEL III and LEVEL IV HABITAT TYPES

RIFFLE			
Low Gradient Riffle	(LGR)	[1.1]	{ 1}
High Gradient Riffle	(HGR)	[1.2]	{ 2}
CASCADE			
Cascade	(CAS)	[2.1]	{ 3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
MAIN CHANNEL POOLS			
Trench Pool	(TRP)	[4.1]	{ 8 }
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOLS			
Corner Pool	(CRP)	[5.1]	{22}
Lateral Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
Lateral Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
Lateral Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
Lateral Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{ 9 }
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{ 4 }
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{ 5 }
Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{ 6 }
Backwater Pool - Log Formed	(BPL)	[6.4]	{ 7 }
Dammed Pool	(DPL)	[6.5]	{13}
ADDITIONAL UNIT DESIGNATIONS			
Dry	(DRY)	[7.0]	
Culvert	(CUL)	[8.0]	
Not Surveyed	(NS)	[9.0]	
Not Surveyed due to a marsh	(MAR)	[9.1]	

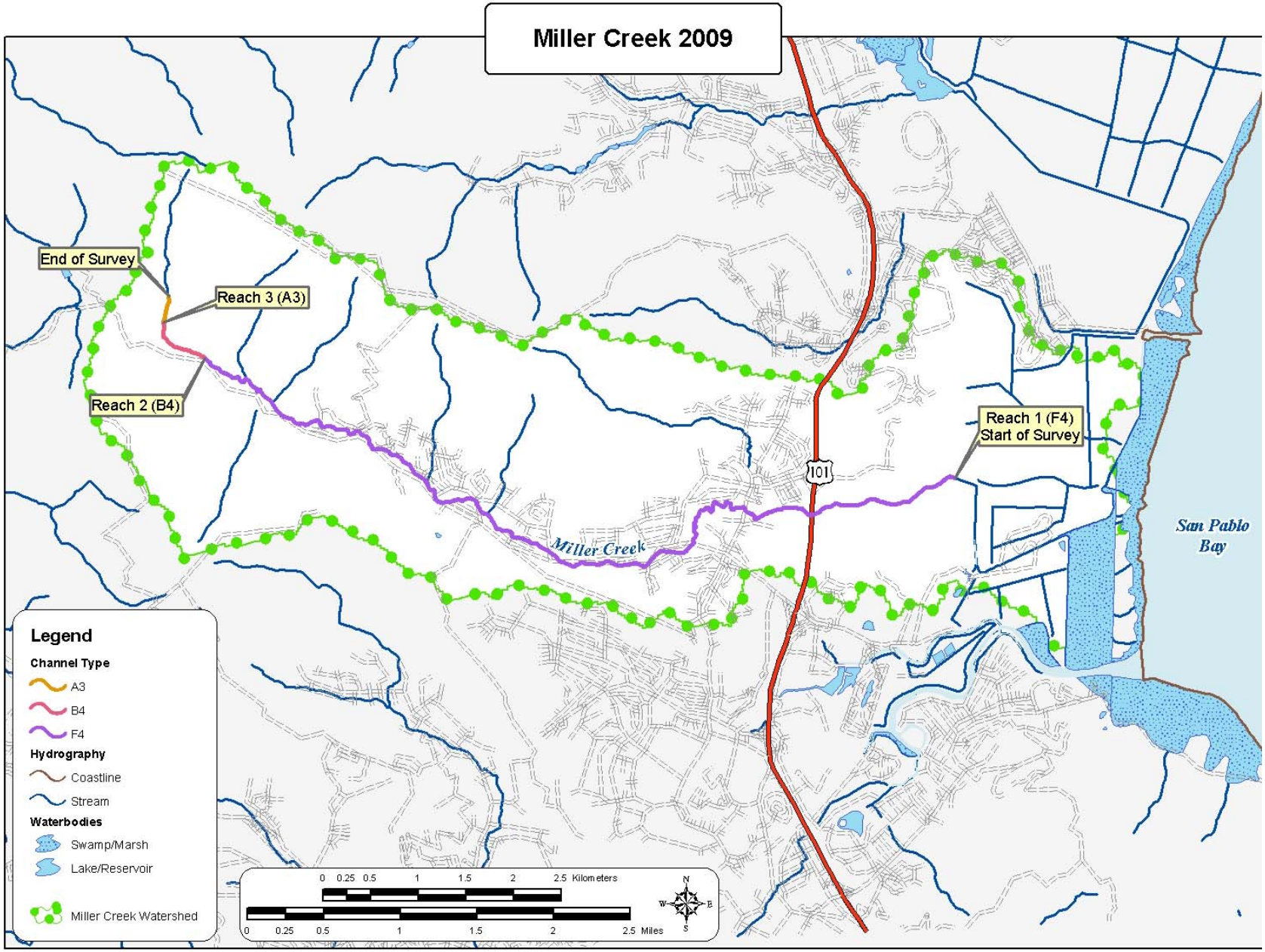

Miller Creek 2009
End of Survey
Reach 3 (A3)
Reach 2 (B4)
Reach 1 (F4)
Start of Survey
101
Miller Creek
San Pablo
Bay
Legend
Channel Type
A3
B4
F4
Hydrography
Coastline
Stream
Waterbodies
Swamp/Marsh
Lake/Reservoir
Miller Creek Watershed
0 0.25 0.5 1 1.5 2 2.5 Kilometers
0 0.25 0.5 1 1.5 2 2.5 Miles
N
W
E
S
\\DFG\Watershed_Overview\San_Pablo\2009\MillerCreek_2009.mxd
Prepared by: Scott Webb, May 2010

Table 1 - Summary of Riffle, Flatwater, and Pool Habitat Types

Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: Quad: NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating
18	0	CULVERT	6.1	42	764	2.0									
34	0	DRY	11.6	505	17159	45.2									
112	112	FLATWATER	38.1	109	12179	32.1	7.6	0.5	1.2	801	89755	412	46117		15
2	0	NOSURVEY	0.7	165	330	0.9									
80	80	POOL	27.2	61	4917	12.9	10.5	1.0	2.4	663	53005	816	65271	707	37
48	48	RIFFLE	16.3	55	2650	7.0	5.7	0.2	0.5	309	14844	86	4151		7

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
294	240	37999	157604	115538

Table 2 - Summary of Habitat Types and Measured Parameters

Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: Quad: NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Depth (ft.)	Mean Max Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Volume (cu.ft.)	Estimated Total Volume (cu.ft.)	Mean Residual Pool Vol (cu.ft.)	Mean Shelter Rating	Mean Canopy (%)
47	47	LGR	16.0	55	2571	6.8	6.0	0.2	1.8	313	14702	86	4037		1	90
1	1	HGR	0.3	79	79	0.2	6.0	0.8	2.0	142	142	114	114		140	90
38	38	GLD	12.9	77	2934	7.7	9.0	0.6	3.0	698	26538	514	19522		23	79
39	39	RUN	13.3	98	3832	10.1	7.0	0.4	2.8	734	28618	311	12119		12	86
35	35	SRN	11.9	155	5413	14.2	7.0	0.4	2.3	989	34599	414	14475		3	91
1	1	TRP	0.3	44	44	0.1	10.0	1.2	2.0	440	440	572	572	528	5	96
30	30	MCP	10.2	63	1883	5.0	11.0	1.0	4.8	695	20836	1001	30039	868	31	83
4	4	CRP	1.4	69	277	0.7	8.0	1.0	4.2	577	2308	594	2375	469	30	89
7	7	LSL	2.4	51	357	0.9	9.0	0.9	3.3	462	3235	475	3327	425	92	81
28	28	LSR	9.5	62	1735	4.6	11.0	1.0	4.8	712	19924	794	22223	690	35	90
5	5	LSBk	1.7	67	335	0.9	9.0	0.8	2.4	601	3003	592	2959	480	11	88
4	4	LSBo	1.4	51	204	0.5	11.0	1.2	3.1	548	2193	704	2816	638	48	90
1	1	PLP	0.3	82	82	0.2	13.0	0.8	2.2	1066	1066	959	959	853	0	98
34	0	DRY	11.6	505	17159	45.2										40
18	0	CUL	6.1	42	764	2.0										
2	0	NS	0.7	165	330	0.9										

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume
294	240	37999	157604	115538

Table 3 - Summary of Pool Habitat Types

Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: **Quad:** NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Habitat Units	Units Fully Measured	Habitat Type	Habitat Occurrence (%)	Mean Length (ft.)	Total Length (ft.)	Total Length (%)	Mean Width (ft.)	Mean Residual Depth (ft.)	Mean Area (sq.ft.)	Estimated Total Area (sq.ft.)	Mean Residual Pool Vol (cu.ft.)	Estimated Total Resid. Vol (cu.ft.)	Mean Shelter Rating
31	31	MAIN	39	62	1927	39	10.8	1.0	686	21276	857	26564	30
49	49	SCOUR	61	61	2990	61	10.3	1.0	648	31729	612	29979	41

Total Units	Total Units Fully Measured	Total Length (ft.)	Total Area (sq.ft.)	Total Volume (cu.ft.)
80	80	4917	53005	56543

Table 4 - Summary of Maximum Residual Pool Depths By Pool Habitat Types

Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: Quad: NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Habitat Units	Habitat Type	Habitat Occurrence (%)	< 1 Foot Maximum Residual Depth	< 1 Foot Percent Occurrence	1 < 2 Feet Maximum Residual Depth	1 < 2 Feet Percent Occurrence	2 < 3 Feet Maximum Residual Depth	2 < 3 Feet Percent Occurence	3 < 4 Feet Maximum Residual Depth	3 < 4 Feet Percent Occurrence	>= 4 Feet Maximum Residual Depth	>= 4 Feet Percent Occurrence
1	TRP	1	0	0	0	0	1	100	0	0	0	0
30	MCP	38	0	0	12	40	10	33	6	20	2	7
4	CRP	5	0	0	1	25	2	50	0	0	1	25
7	LSL	9	0	0	4	57	2	29	1	14	0	0
28	LSR	35	1	4	3	11	19	68	4	14	1	4
5	LSBk	6	0	0	2	40	3	60	0	0	0	0
4	LSBo	5	0	0	1	25	2	50	1	25	0	0
1	PLP	1	0	0	0	0	1	100	0	0	0	0

Total Units	Total < 1 Foot Max Resid. Depth	Total < 1 Foot % Occurrence	Total 1< 2 Feet Max Resid. Depth	Total 1< 2 Feet % Occurrence	Total 2< 3 Feet Max Resid. Depth	Total 2< 3 Feet % Occurrence	Total 3< 4 Feet Max Resid. Depth	Total 3< 4 Feet % Occurrence	Total >= 4 Feet Max Resid. Depth	Total >= 4 Feet % Occurrence
80	1	1	23	29	40	50	12	15	4	5

Mean Maximum Residual Pool Depth (ft.): 2

Table 5 - Summary of Mean Percent Cover By Habitat Type

Stream Name: Miller Creek **Dry Units:** 34 **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: Quad: NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Habitat Units	Units Fully Measured	Habitat Type	Mean % Undercut Banks	Mean % SWD	Mean % LWD	Mean % Root Mass	Mean % Terr. Vegetation	Mean % Aquatic Vegetation	Mean % White Water	Mean % Boulders	Mean % Bedrock Ledges
47	25	LGR	0	0	4	0	0	0	0	4	0
1	1	HGR	0	0	0	0	0	0	0	100	0
48	26	TOTAL RIFFLE	0	0	4	0	0	0	0	8	0
38	25	GLD	13	6	2	6	24	10	0	0	0
39	21	RUN	3	1	1	0	13	4	0	7	0
35	11	SRN	14	5	0	7	1	0	0	9	0
112	57	TOTAL FLAT	9	4	1	4	15	6	0	4	0
1	1	TRP	0	0	0	0	100	0	0	0	0
30	30	MCP	8	13	2	11	28	14	0	11	0
4	4	CRP	9	0	0	9	20	13	0	0	0
7	7	LSL	0	42	26	20	7	4	0	0	0
28	28	LSR	33	11	5	37	9	1	0	1	0
5	5	LSBk	10	0	0	10	0	9	0	31	0
4	4	LSBo	13	35	0	0	0	8	0	38	8
1	1	PLP	0	0	0	0	0	0	0	0	0
80	80	TOTAL POOL	16	14	5	20	16	8	0	8	0
18	0	CUL									
2	0	NS									
294	163	TOTAL	11	8	3	11	13	6	0	7	0

Table 6 - Summary of Dominant Substrates By Habitat Type

Stream Name: Miller Creek **Dry Units:** 34 **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: **Quad:** NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Habitat Units	Units Fully Measured	Habitat Type	% Total Silt/Clay Dominant	% Total Sand Dominant	% Total Gravel Dominant	% Total Small Cobble Dominant	% Total Large Cobble Dominant	% Total Boulder Dominant	% Total Bedrock Dominant
47	22	LGR	0	55	32	5	5	5	0
1	1	HGR	0	0	0	0	0	100	0
38	28	GLD	14	61	25	0	0	0	0
39	24	RUN	8	46	46	0	0	0	0
35	16	SRN	6	56	25	6	0	0	6
1	1	TRP	0	0	100	0	0	0	0
30	30	MCP	23	57	20	0	0	0	0
4	4	CRP	0	75	25	0	0	0	0
7	7	LSL	29	57	14	0	0	0	0
28	28	LSR	7	75	18	0	0	0	0
5	5	LSBk	0	80	20	0	0	0	0
4	4	LSBo	25	25	50	0	0	0	0
1	1	PLP	0	0	0	0	0	0	100
18	0	CUL	0	0	0	0	0	0	0
2	0	NS	0	0	0	0	0	0	0

Table 7 - Summary of Mean Percent Canopy for Entire Stream

Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: **Quad:** NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Mean Percent Canopy	Mean Percent Conifer	Mean Percent Hardwood	Mean Percent Open Units	Mean Right Bank % Cover	Mean Left Bank % Cover
85	0	100	0	63	59

Note: Mean percent conifer and hardwood for the entire reach are means of canopy components from units with canopy values greater than zero.

Open units represent habitat units with zero canopy cover.

Table 8 - Fish Habitat Inventory Data Summary

Stream Miller Creek LLID: 1224972380314 Drainage Novato

Survey Dates: 7/17/2009 to 7/22/2009 Survey Length (ft.): 37999 Main Channel (ft.): 37872 Side Channel (ft.): 127

Confluence Location: Quad NOVATO Legal Description: T02NR06WS11 Latitude: 38:01:53.1N Longitude: 122:29:54.3W

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 1

Channel Type: F4
Reach Length (ft.): 34343
Riffle/Flatwater Mean Width (ft.): 7.0
BFW:
Range (ft.): 16.00 to 38.00
Mean (ft.): 27.46
Std. Dev.: 6.47
Base Flow (cfs): NA
Water (F): 56 - 66 Air (F): 55 - 76
Dry Channel (ft.): 13630

Canopy Density (%): 85.4
Coniferous Component (%): 0.4
Hardwood Component 99.6
Dominant Bank Hardwood Trees
Vegetative Cover (%): 61.3
Dominant Terrestrial Veg.
Dominant Bank Substrate Sand/Silt/Clay
Occurrence of LWD (%): 3.3
LWD per 100 ft.:
Riffles: 1
Pools: 1
Flat: 0

Pools by Stream Length 14.3
Pool Frequency (%): 27.4
Residual Pool Depth (%):
< 2 Feet Deep: 30.0
2 to 2.9 Feet Deep: 50.0
3 to 3.9 Feet Deep: 15.0
>= 4 Feet Deep: 5.0
Mean Max Residual Pool Depth 2.39
Mean Pool Shelter 37

Pool Tail Substrate (%): Silt/Clay: 12.5 Sand: 22.5 Gravel: 57.5 Sm Cobble: 7.5 Lg Cobble: 0.0 Boulder 0.0 Bedrock: 0.0
Embeddedness Values (%): 1. 8.8 2. 16.3 3. 26.3 4. 48.8 5. 0.0

STREAM REACH: 2

Channel Type: B4
Reach Length (ft.): 2564
Riffle/Flatwater Mean Width (ft.):
BFW:
Range (ft.): to
Mean (ft.):
Std. Dev.:
Base Flow (cfs): NA
Water (F): 55 - 66 Air (F): 74 - 74
Dry Channel (ft.): 2564

Canopy Density (%):
Coniferous Component (%):
Hardwood Component
Dominant Bank
Vegetative Cover (%):
Dominant
Dominant Bank Substrate
Occurrence of LWD (%):
LWD per 100 ft.:
Riffles:
Pools:
Flat:

Pools by Stream Length
Pool Frequency (%):
Residual Pool Depth (%):
< 2 Feet Deep:
2 to 2.9 Feet Deep:
3 to 3.9 Feet Deep:
>= 4 Feet Deep:
Mean Max Residual Pool Depth
Mean Pool Shelter

Pool Tail Substrate (%): Silt/Clay: Sand: Gravel: Sm Cobble: Lg Cobble: Boulder Bedrock:
Embeddedness Values (%): 1. 2. 3. 4. 5.

Summary of Fish Habitat Elements By Stream Reach

STREAM REACH: 3

Channel Type: A3	Canopy Density (%):	Pools by Stream Length
Reach Length (ft.): 965	Coniferous Component (%):	Pool Frequency (%):
Riffle/Flatwater Mean Width (ft.):	Hardwood Component	Residual Pool Depth (%):
BFW:	Dominant Bank	< 2 Feet Deep:
Range (ft.): to	Vegetative Cover (%):	2 to 2.9 Feet Deep:
Mean (ft.):	Dominant	3 to 3.9 Feet Deep:
Std. Dev.:	Dominant Bank Substrate	>= 4 Feet Deep:
Base Flow (cfs):	Occurrence of LWD (%):	Mean Max Residual Pool Depth
Water (F): NA Air (F): 74 - 74	LWD per 100 ft.:	Mean Pool Shelter
Dry Channel (ft.): 965	Riffles:	
	Pools:	
	Flat:	

Pool Tail Substrate (%): Silt/Clay: Sand: Gravel: Sm Cobble: Lg Cobble: Boulder Bedrock:

Embeddedness Values (%): 1. 2. 3. 4. 5.

Table 9 -Mean Percentage of Dominant Substrate and Vegetation

Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: **Quad:** NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

Mean Percentage of Dominant Stream Bank Substrate

Dominant Class of Substrate	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage (%)
Bedrock	10	0	3.6
Boulder	8	11	6.9
Cobble/Gravel	3	1	1.5
Sand/Silt/Clay	116	125	88.0

Mean Percentage of Dominant Stream Bank Vegetation

Dominant Class of Vegetation	Number of Units Right Bank	Number of Units Left Bank	Total Mean Percentage
Grass	7	7	5.1
Brush	25	20	16.4
Hardwood	105	108	77.7
Coniferous	0	0	0.0
No Vegetation	0	2	0.7

Total Stream Cobble Embeddedness Values: 3

Table 10 - Mean Percent of Shelter Cover Types For Entire Stream

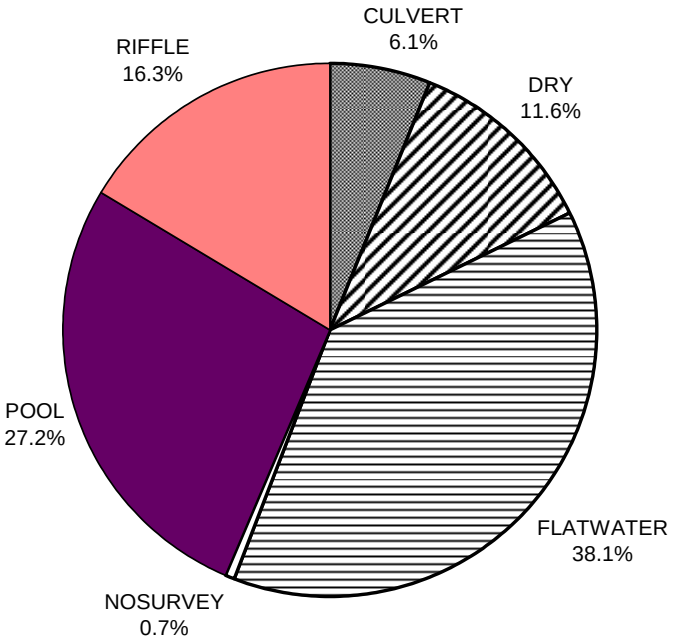
Stream Name: Miller Creek **LLID:** 1224972380314 **Drainage:** Novato

Survey 7/17/2009 to 7/22/2009

Confluence Location: **Quad:** NOVATO **Legal Description:** T02NR06WS11 **Latitude:** 38:01:53.1N **Longitude:** 122:29:54.3W

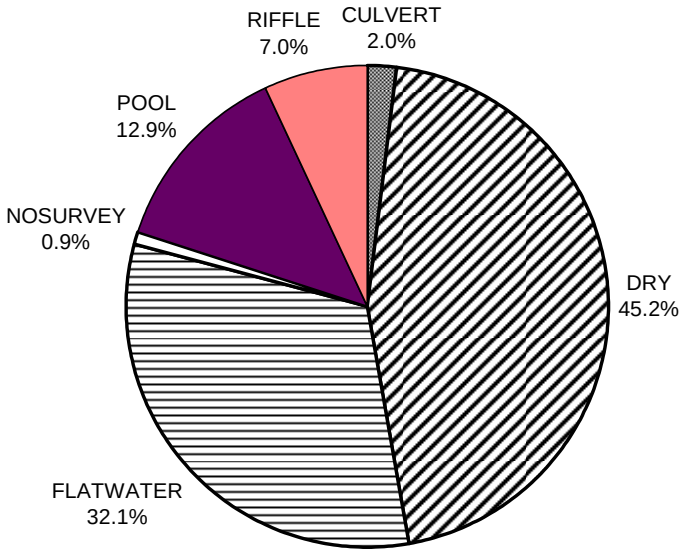
	Riffles	Flatwater	Pools
UNDERCUT BANKS (%)	0	9	16
SMALL WOODY DEBRIS (%)	0	4	14
LARGE WOODY DEBRIS (%)	4	1	5
ROOT MASS (%)	0	4	20
TERRESTRIAL VEGETATION	0	15	16
AQUATIC VEGETATION (%)	0	6	8
WHITEWATER (%)	0	0	0
BOULDERS (%)	8	4	8
BEDROCK LEDGES (%)	0	0	0

MILLER CREEK 2009
HABITAT TYPES BY PERCENT OCCURRENCE



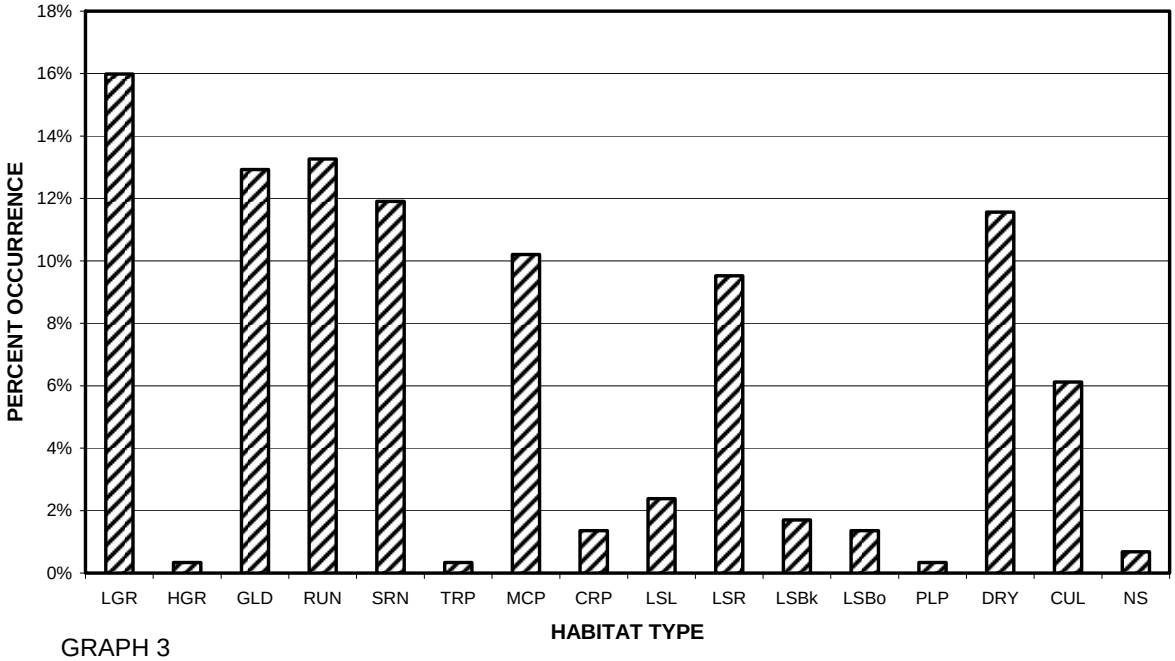
GRAPH 1

MILLER CREEK 2009
HABITAT TYPES BY PERCENT TOTAL LENGTH



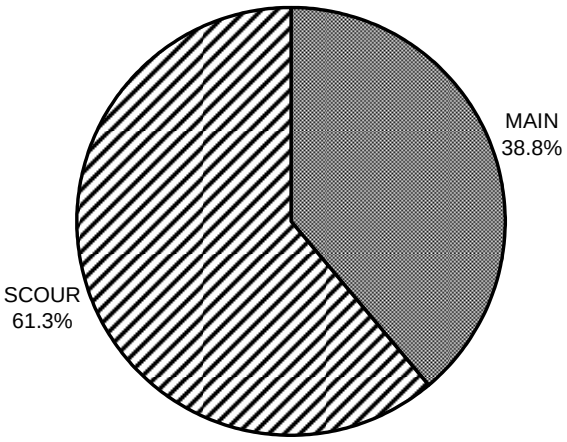
GRAPH 2

MILLER CREEK 2009
HABITAT TYPES BY PERCENT OCCURRENCE



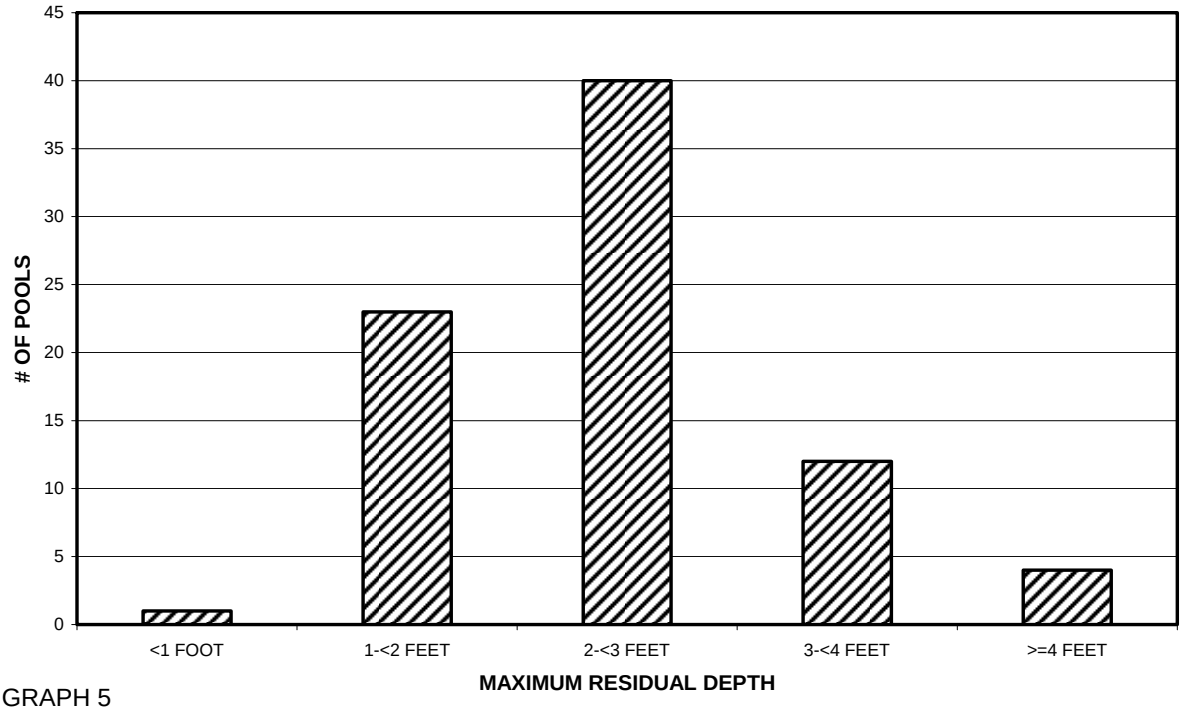
GRAPH 3

MILLER CREEK 2009
POOL TYPES BY PERCENT OCCURRENCE



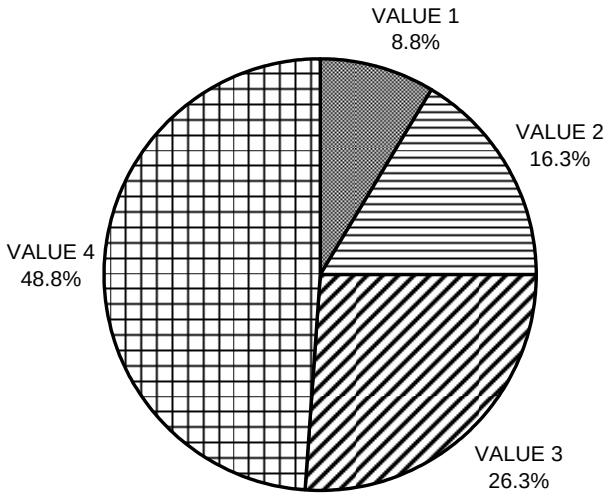
GRAPH 4

MILLER CREEK 2009
MAXIMUM DEPTH IN POOLS



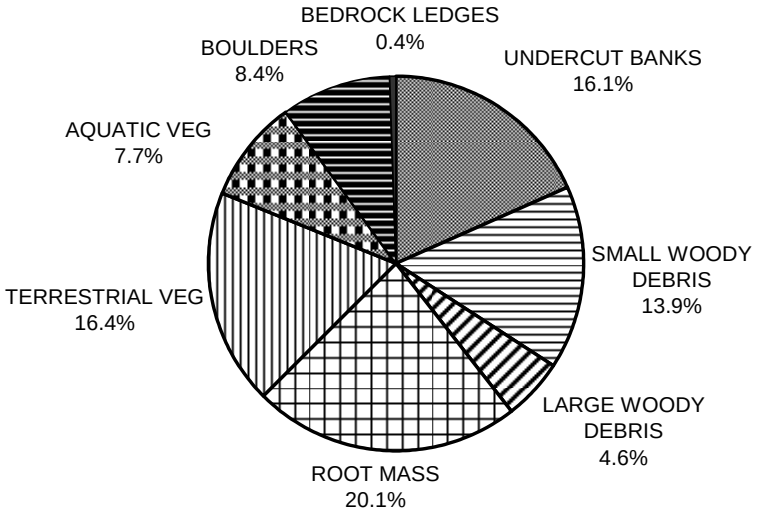
GRAPH 5

MILLER CREEK 2009
PERCENT EMBEDDEDNESS



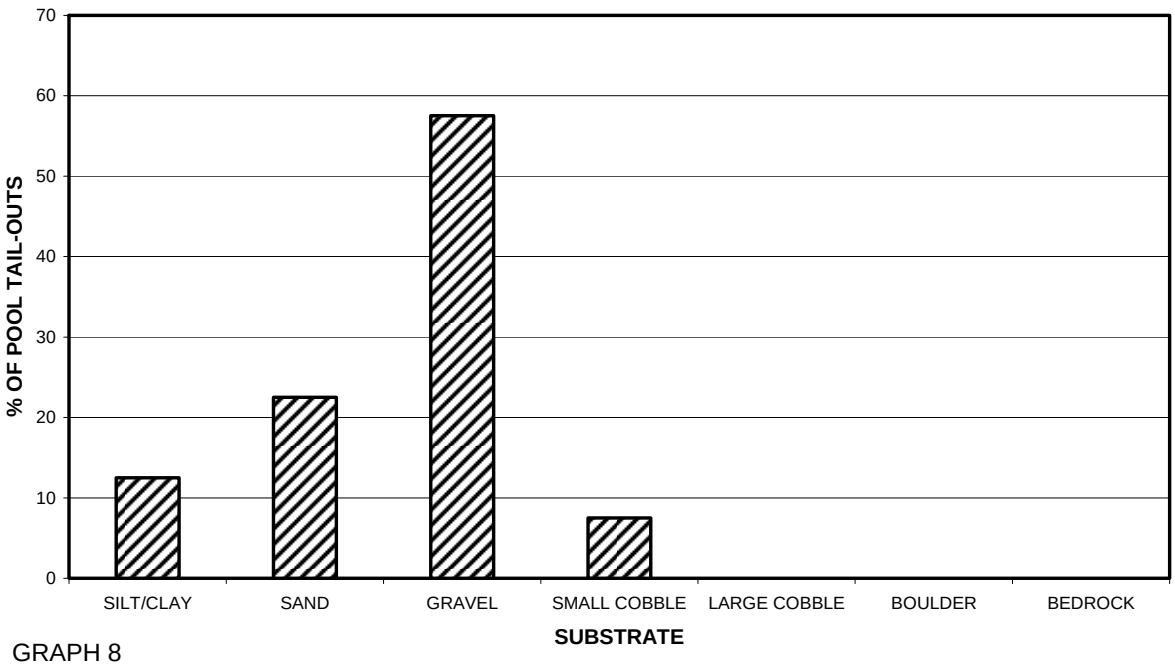
GRAPH 6

MILLER CREEK 2009
MEAN PERCENT COVER TYPES IN POOLS



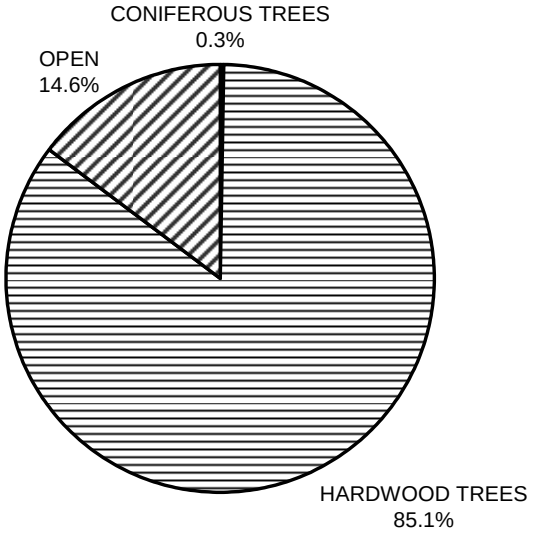
GRAPH 7

MILLER CREEK 2009
SUBSTRATE COMPOSITION IN POOL TAIL-OUTS



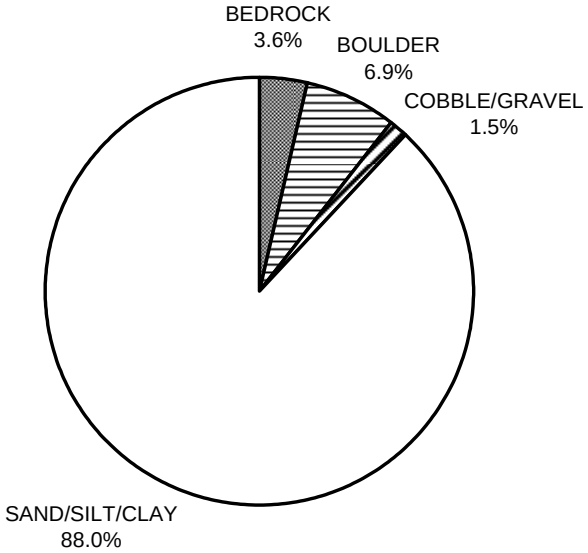
GRAPH 8

MILLER CREEK 2009
MEAN PERCENT CANOPY



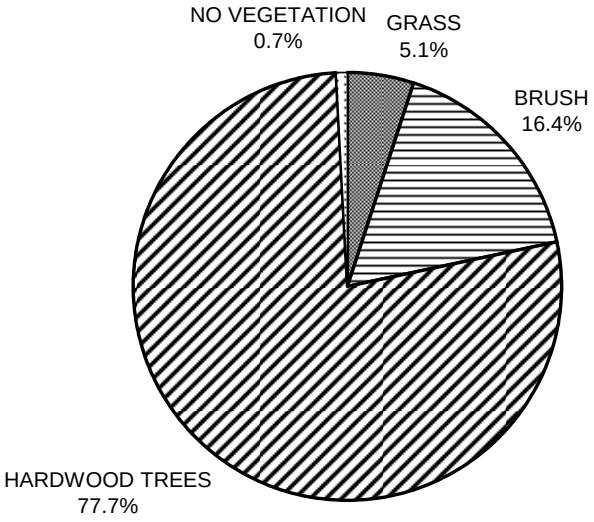
GRAPH 9

MILLER CREEK 2009
DOMINANT BANK COMPOSITION IN SURVEY REACH



GRAPH 10

MILLER CREEK 2009
DOMINANT BANK VEGETATION IN SURVEY REACH



GRAPH 11