



**California Department of Fish and Wildlife  
Sonoma County  
Russian River Watershed  
Stream Habitat Assessment Reports**

# **Mill Creek**

*Surveyed 2012*

*Report Completed in 2013*



## Mill Creek (Mark West tributary)

# STREAM INVENTORY REPORT

## Mill Creek

### INTRODUCTION

A stream inventory was conducted 9/10/2012 to 9/14/2012 on Mill Creek. The survey began at the confluence with Mark West Creek and extended upstream 2 miles.

The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Mill Creek.

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

### WATERSHED OVERVIEW

Mill Creek is located in Sonoma County, California (Map 1). It is a tributary to Mark West Creek, which flows into Russian River, which flows into Pacific Ocean. Mill Creek's legal description at the confluence with Mark West Creek is T08N R08W Sec.13. Its location is (38:32:49.0N) 38.547 north latitude and (122:41:50.0W) 122.6973 west longitude, LLID number 1226973385470. Mill Creek is a second order stream and has approximately 2.2 miles of blue line stream according to the USGS National Hydrology Dataset (NHD). Mill Creek drains a watershed of approximately 1.9 square miles. Elevations range from about 472 feet at the mouth of the creek to 1,549 feet in the headwater areas (average elevation of headwaters, not highest point). Evergreen forest dominates the watershed. The watershed is entirely privately owned, which accounts for 100% of the land area. One hundred percent of the land is considered natural. Vehicle access exists via Cresta Rd. and further access exists off of Foot Hill Ranch Road in Santa Rosa, CA.

### METHODS

The habitat inventory conducted in Mill Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). The Watershed Stewards Project/AmeriCorps (WSP) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Wildlife (CDFW). 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

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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 Mill 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". Mill 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.

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### 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 Mill 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 such as 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 Mill 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 densimeters as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Mill 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 Mill 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.

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### 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 Mill Creek.

## **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 Wildlife. 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 Mill Creek include:

- Riffle, Flatwater, Pool Habitat Types by Percent Occurrence

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- 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 9/10/2012 to 9/14/2012, was conducted by D. Dela Vega, C. Neill (WSP). The total length of the stream surveyed was 10,436 feet with an additional 0 feet of side channel.

Stream flow was not measured on Mill Creek.

Mill Creek is a B4 channel type for 4,508 feet of the stream surveyed (Reach 1), a A2 channel type for 1,228 feet of the stream surveyed (Reach 2), a B4 channel type for 813 feet of the stream surveyed (Reach 3), a NA channel type for 1,640 feet of the stream surveyed (Reach 4), a B3 channel type for 2,247 feet of the stream surveyed (Reach 5). B4 channels are moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile, stable banks, and gravel-dominant substrates. A2 channels are steep, narrow, cascading, step-pool, high energy debris transporting channels associated with depositional soils, and boulder-dominant substrates. B3 channels are moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools, very stable plan and profile, stable banks, and cobble-dominant substrates. NA channels had no access.

Water temperatures taken during the survey period ranged from 53 to 58 degrees Fahrenheit. Air temperatures ranged from 58 to 74 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of occurrence there were 30% pool units, 27% flatwater units, 22% riffle units, 17% dry units, 3% culvert units and 1% not surveyed units, (Graph 1). Based on total length of Level II habitat types, there were 42% dry units, 22% flatwater units, 16% not surveyed units, 11% pool units, 9% riffle units and 1% culvert units (Graph 2).

Thirteen Level IV habitat types were identified (Table 2). The most frequent habitat types by percent occurrence were 20% mid-channel pool units, 19% step run units and 17% dry units (Graph 3). Based on percent total length, 42% dry units, 20% step run units and 16% not surveyed units.

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A total of 28 pools were identified (Table 3). Main channel pools were the most frequently encountered at 89% (Graph 4), and comprised 92% of the total length of all pools (Table 3).

Table 4 is a summary of maximum residual pool depths by pool habitat types. Pool quality for salmonids increases with depth. Four of the 28 pools (14%) had a residual depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 28 pool tail-outs measured, 14 had a value of 1 (50%) and 14 had a value of 2 (50%) (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 4, flatwater habitat types had a mean shelter rating of 8, and pool habitats had a mean shelter rating of 28 (Table 1). Of the pool types, the main channel pools had a mean shelter rating of 24 and scour pools had a mean shelter rating of 62 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Boulders are the dominant cover type in Mill Creek. Graph 7 describes the pool cover in Mill Creek. Boulders are the dominant pool cover type, followed by root masses.

Table 6 summarizes the dominant substrate by habitat type. Graph 8 depicts the dominant substrate observed in pool tail-outs. Gravel substrate was observed in 46% of pool tail-outs; and small cobble substrate was observed in 39% of pool tail-outs.

The mean percent canopy density for the surveyed length of Mill Creek was 93%. Of the canopy present, the mean percentages of hardwood and coniferous trees were 50% and 50%, respectively. Seven percent of the canopy was open. Graph 9 describes the mean percent canopy in Mill Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 85%. The mean percent left bank vegetated was 82% (Table 7). The dominant elements composing the structure of the stream banks consisted of 45% boulder, 29% cobble/gravel, 16% bedrock and 10% sand/silt/clay (Graph 10). Deciduous trees were the dominant vegetation type observed in 49% of the units surveyed. Additionally, 48% of the units surveyed had coniferous trees as the dominant vegetation type, and 4% had brush as the dominant vegetation type (Graph 11).

## **DISCUSSION**

Mill Creek is a B4 channel type for 4,508 feet of the stream surveyed, an A2 channel type for 1,228 feet of the stream surveyed, a B4 channel type for 813 feet of the stream surveyed, a NA channel type for 1,640 feet of the stream surveyed, and a B3 channel type for 2,247 feet of the stream surveyed. The suitability of B4, A2, NA, and B3 channel types for fish habitat

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improvement structures is/are as follows: B4 channel types are excellent for low-stage plunge weirs, boulder clusters, bank placed boulders, single and opposing wing-deflectors, and log cover; A2 channels are generally not suitable for fish habitat improvement projects; NA channel types were not surveyed and suitability cannot be assessed; and B3 channel types are excellent for plunge weirs, boulder clusters and bank-placed boulders, single and opposing wing-deflectors, and log cover.

The water temperatures recorded on the survey days 9/10/2012 to 9/14/2012, ranged from 53 to 58 degrees Fahrenheit. Air temperatures ranged from 58 to 74 degrees Fahrenheit. This is a good water temperature range for salmonids. 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 22% of the total length of this survey, riffles 9%, and pools 11% (30% pool units, 27% flatwater units, 22% riffle units, 17% dry units, 3% culvert units and 1% not surveyed units). The pools are relatively shallow/deep, with 4 of the 28 (14%) pools having a maximum residual depth greater than two 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 the numerous log debris accumulations (LDA's) in the stream.

Twenty-eight of the 28 pool tail-outs measured had embeddedness ratings of 1 or 2. Zero of the pool tail-outs had embeddedness ratings of 3 or 4. Zero 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 Mill Creek should be mapped and rated according to their potential sediment yields, and control measures should be taken.

Twenty-four of the 28 pool tail-outs measured had gravel and small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean shelter rating for pools is 28. The shelter rating in the flatwater habitats is 8. A pool shelter rating of approximately 100 is desirable. The amount of cover that now exists is being provided primarily by boulders in Mill Creek. Boulders are the dominant cover type in pools, followed by root masses. 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 93%. Reach 1 had a canopy density of 94.3%, Reach 2 had a canopy density of 93%, Reach 3 had a canopy density of 83%, Reach 4



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had a canopy density of N/A, and Reach 5 had a canopy density of 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 85% and 82%, 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

Mill 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) 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.
- 2) Suitable size spawning substrate on Mill Creek is limited to relatively few reaches. Projects should be designed at suitable sites to trap and sort spawning gravel.
- 3) Access for migrating salmonids should be assessed at all road crossings and dams. Sites of particular concern include the Cresta Road Bridge and the associated upstream trash rack as well as all the identified ford crossings throughout Reaches 1 and 2. A Dam site is located at the end of the private access road which extends farther southeast off Cresta Road, was also identified as a fish barrier. 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.
- 4) Reaches 1, 2, and 3 are 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 defecating in the water. Alternatives to limit cattle access, control erosion and increase canopy, should be explored with the landowner, and developed if possible.
- 5) Increase the canopy on Mill Creek particularly throughout Reaches 3, 4, and 5, 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

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here is affected from upstream. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.

- 6) Mill 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) Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

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.

| <b>Position</b> | <b>Habitat Unit #</b> | <b>Memo</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0               | 0001.00               | Start of Survey at the confluence of Mill Creek and Mark West Creek.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 0               | 0001.00               | 600' into the unit is a parking pull-out on the left bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 785             | 0002.00               | Bridge # 1 is Cresta Rd. It is made of wood, concrete, and steel with length = 37', height = 7', width = 11', and the height from the water to sill = N/A. The bridge is retaining gravel, it is downcutting, and it is a possible barrier to salmonids. The width of the upstream wing-wall = 14'. The sill is made of concrete fill and is creating a 3' plunge on the downstream end. The sill is not level and is creating downcutting. There is a gate on the bottom of the bridge, which is a debris catch. WP# 2 N38.54575 W122.69449 |
| 822             | 0003.00               | 85' into the unit is an old ford crossing on the right bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1,059           | 0006.00               | Water temperature was taken. There are dry units and there are 2' plunges between each pool.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 1,143           | 0007.00               | One young of the year salmonid, two 1+ salmonids, and one bullfrog were observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1,440           | 0012.00               | 50' into the habitat unit there is a fence that spans the creek channel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1,679           | 0014.00               | 53' into the habitat unit is a spring on the left bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 1,819           | 0016.00               | One 1+ salmonid observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1,938           | 0020.00               | One pacific treefrog observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1,992           | 0021.00               | Cattle have access to the creek channel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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| <b>Position</b> | <b>Habitat Unit #</b> | <b>Memo</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1,992           | 0021.00               | One young of the year salmoind observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2,527           | 0031.00               | One 1+ salmonid observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 2,750           | 0035.00               | Three Pacific treefrogs are observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2,793           | 0036.00               | At the top of the habitat unit is a right bank tributary that is unnamed on stream reach #1. It is wet with a flow = 0.1-0.5 cfs. It contributes approximately 100% to the downstream flow of the receiving stream. It is accessible to fish. The crew checked up the tributary 200'. The water temperature upstream = N/A, downstream = 57F, and in the tributary = 57F. The slope was approximately 3-6%. There were no fish observed. There is an entrenched channel about 1-2' wide. 75' in is a ford crossing. The substrate of the tributary is silt and small cobble. WP #6 N38.54170 W122.69152 |
| 2,989           | 0042.00               | One Pacific treefrog was observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 3,013           | 0043.00               | One unidentified newt observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 3,068           | 0045.00               | Three Pacific treefrogs observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3,210           | 0048.00               | California newts observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3,449           | 0051.00               | An ATV trail follows the creek along the right bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 3,476           | 0052.00               | 50' into the habitat unit is a ford crossing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 3,642           | 0054.00               | There is an ATV trail following along the creek on the left bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3,803           | 0055.00               | Cattle still have access to the creek bed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4,164           | 0061.00               | 100' into the habitat unit is a spring on the right bank.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4,164           | 0061.00               | 2 salmonid young of the year observed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4,425           | 0063.00               | At bottom of the habitat unit is a ford crossing/ ATV trail on the left bank                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 4,508           | 0065.00               | 100' into the unit is a Left bank tributary #2. It is unnamed and dry, with discharge = 0 cfs. The water temperatures = N/A. The crew checked 50' up and found that it is accessible to fish for the first 50'. 60' into the tributary is a right bank drainage. 70' into the tributary the slope becomes steeper. The slope measured with a clinometer = 25-30%. The dominant substrate is boulders and there are multiple 3' plunges throughout the tributary. WP # 10 N38.53807 W122.68964                                                                                                           |
| 4,508           | 0065.00               | Pacific Tree Frog Observed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4,715           | 0069.00               | There is a 2.5' plunge into the pool from the upstream end of the unit. The slope of the channel is beginning to steepen.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4,808           | 0071.00               | Two functioning 2" pvc pipes extend along the right bank and continue upstream into the next habitat units.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 4,826           | 0072.00               | 45' into the habitat unit is a ford crossing where the ATV trail is crossing to the right bank. The pvc pipe continues along the right                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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| <b>Position</b> | <b>Habitat Unit #</b> | <b>Memo</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |                       | bank upslope of the creek channel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 5,135           | 0073.00               | There is a 3' plunge into the pool from the upstream unit. It is a rusty, unused metal pipe spanning the creek at the top of the unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5,233           | 0076.00               | The old metal pipe and new pvc pipes continue through the creek.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 5,233           | 0076.00               | Left bank tributary # 3 is 160' into the unit. It is unnamed and dry with discharge = 0 cfs. The water temperatures = N/A. The crew checked 100' up and found that it is not accessible to fish. The slope measured with a clinometer = 25%. There is a 5-6' plunge at the mouth of the tributary. The dominant substrate is cobble and boulder. WP 12 N38.53642 W122.68833                                                                                                                                                                                                              |
| 5,405           | 0077.00               | There is a 3' plunge into the unit from the upstream unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 5,442           | 0078.00               | There is a cable spanning the channel, which is suspended approximately 20' in the air. The pvc pipes continue upstream on both the right and left bank.                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 5,505           | 0080.00               | The pvc pipe spans the channel approximately 15' above the creek.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5,576           | 0082.00               | Three rough skinned newts and a yellow legged frog observed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 5,638           | 0083.00               | The pvc pipe crosses from the left bank to the right bank. There is water running in the pipe.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 5,682           | 0085.00               | There is a spring on the left bank near the top of the unit, approximately 43' into the unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 5,735           | 0086.00               | Dam #1 has length = 1', height = 5', width (o) = 17', width (d) = N/A, and the height from the water to sill = 5'. There are no flashboards and no associated downcutting. There is a bedrock sheet directly below the dam. The flashboard outlet is 3' wide. The dam is retaining gravel to the height of the outlet and it is a possible barrier to adults and juveniles. The left bank side of the dam wall is broken off. The pvc pipe that has been following the creek connects to the dam wall on the left bank side. This is the end of the pvc line. WP 14 N38.53599 W122.68767 |
| 5,736           | 0087.00               | There are algae in the water near the top of the unit.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5,804           | 0088.00               | Algae is covering the pool surface, 52' into the unit is a left bank spring. 10-15 pacific giant salamanders observed in the pool.                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 5,889           | 0089.00               | 250' into the unit is a ford crossing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5,889           | 0089.00               | Right bank tributary #4 is 161' into the unit. It is unnamed and dry, with discharge = 0 cfs. The crew checked 300' up and found that it is not accessible to fish. The water temperatures = N/A. The slope measured with a clinometer = 10-15%. The first 20' is a steep drainage, and then there is a road crossing through the tributary. The natural channel is filled with debris. The dominant                                                                                                                                                                                     |

**Mill Creek (Mark West tributary)**

| <b>Position</b> | <b>Habitat Unit #</b> | <b>Memo</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |                       | <p>substrate is gravel and cobble. The natural tributary confluence is 60' upstream, but the road is pushing the water to the downstream outlet. WP # 15 N38.53558 W122.68673</p> <p>Left bank tributary # 5 is 364' into the unit. It is unnamed and dry, with discharge = 0 cfs. The water temperatures = N/A. The crew checked 200' up and found that it is not accessible to fish. The slope measure with a clinometer = 15-20%. The channel is not entrenched. The dominant substrate is gravel and boulder. There is a steady slope with 1-2' plunges. The tributary crosses a ford near the mouth. The mouth of the tributary is eroding away. WP# 16 N38.53509 W122.68623</p> <p>Left bank tributary #6 is 151' into the unit. It is unnamed and dry with discharge = 0 cfs. The crew checked 200' up and found that it is accessible to fish. The water temperatures = N/A. The estimated slope = 4-6%. The channel is not entrenched. The dominant substrate is gravel and cobble. There is a 3' plunge at the confluence. WP# 17 N38.53449 W122.68539</p> |
| 6,549           | 0090.00               | Start of no access section WP # 18 38.5346 122.6848                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 8,189           | 0091.00               | Begin access, survey continued. WP #19 38.5343 122.6833                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 8,204           | 0092.00               | <p>Culvert #1 is under Foothill Ranch Rd. It is made of steel and is an old boiler. The length= 32', height =7.5', width = 7.5', diameter = 7.5'. The plunge height, from the lip to sill = .5'. The maximum depth within 5 ft= N/A. The slope of the culvert &lt;1 %.</p> <p>The culvert is in good condition, and is a little rusty on the bottom. It is not a possible barrier to juvenile or adult salmonids. There is concrete fill in the creek bed within 15' from the outlet. WP# 19 N38.53430 W122.68328</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8,236           | 0093.00               | <p>325' into the unit is a small temporary wooden footbridge. 550' into the unit is a small temporary wooden footbridge. 950' into the unit the channel becomes overgrown with grass and brush. The entire unit has very little to no canopy. 1600' into the unit there is more of a canopy.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 8,236           | 0093.00               | <p>Left bank tributary #7 is 1767' into the unit. It is unnamed and dry with discharge = 0 cfs. The crew checked 125' up and found that it is accessible to fish. The water temperatures = N/A. The estimated slope = 6-10%, The channel is extremely overgrown and is not very entrenched. There is lots of debris in the channel. The dominant substrate is bedrock and gravel.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 10,436          | 0093.00               | End of survey due to lack of access in the upstream properties. WP# 22 N38.53102 W122.67797                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Mill Creek (Mark West tributary)

### 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.

## Mill Creek (Mark West tributary)

### 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 } |

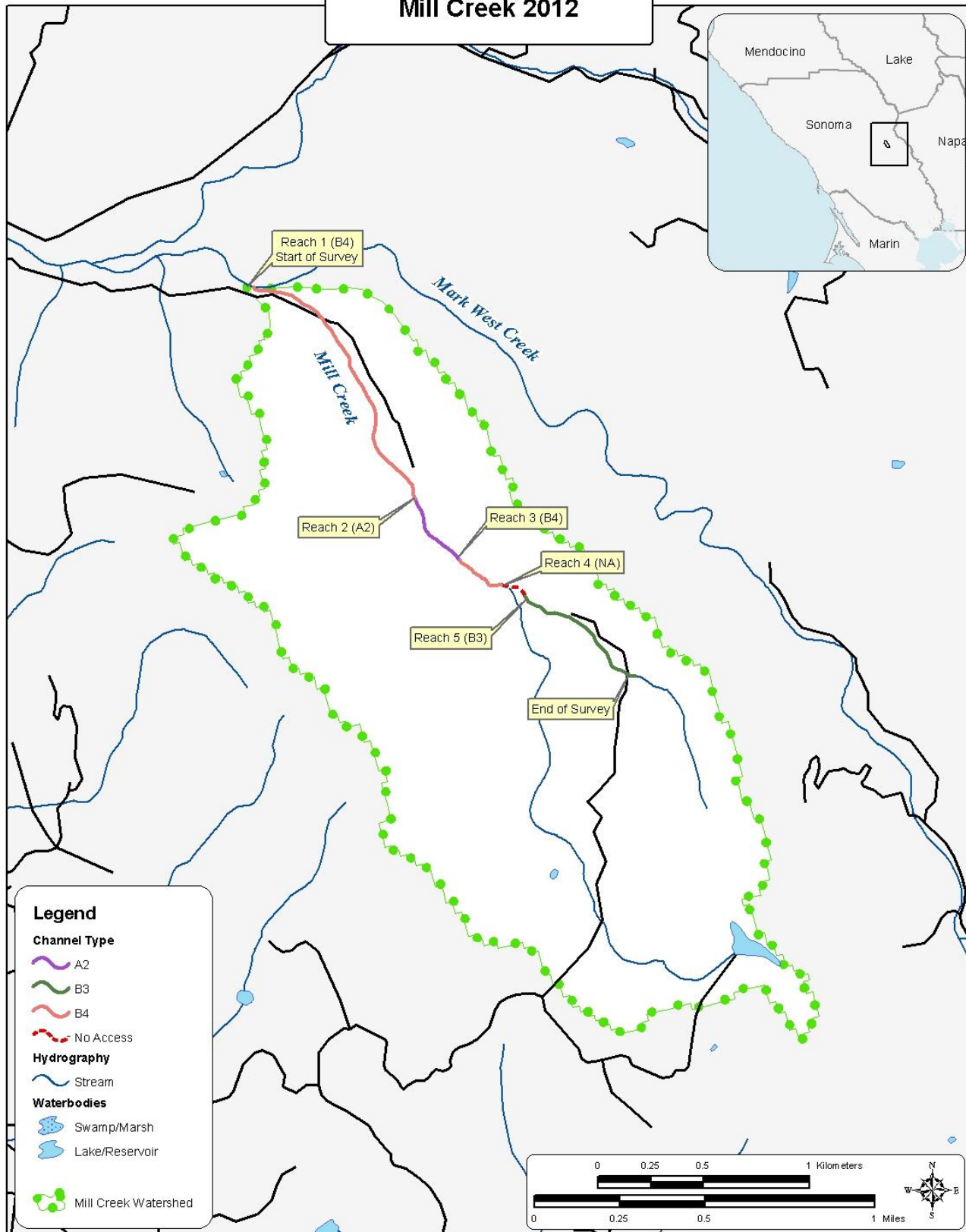
#### BACKWATER POOLS

|                                  |       |       |       |
|----------------------------------|-------|-------|-------|
| 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 marsh | (MAR) | [9.1] |  |

# Mill Creek 2012





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

**Stream Name:** Mill Creek

**LLID:** 1226973385470

**Drainage:** Russian River - Middle

**Survey** 9/10/2012 to 9/14/2012

**Confluence Location: Quad:** MARK WEST SPRINGS

**Legal Description:** T08NR08WS13

**Latitude:** 38:32:49.0N

**Longitude:** 122:41:50.0W

| 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 |
|--------------------|-----------------------------------|--------------|------------------------|-------------------|---------------------------|------------------|------------------|------------------|----------------------|--------------------|-------------------------------|----------------------|---------------------------------|---------------------------------|---------------------|
| 20                 | 7                                 | RIFFLE       | 21.5                   | 44                | 889                       | 8.5              | 2.4              | 0.2              | 0.4                  | 74                 | 1482                          | 12                   | 241                             |                                 | 4                   |
| 25                 | 5                                 | FLATWATER    | 26.9                   | 93                | 2317                      | 22.2             | 2.4              | 0.3              | 0.6                  | 288                | 7204                          | 99                   | 2465                            |                                 | 8                   |
| 28                 | 28                                | POOL         | 30.1                   | 40                | 1113                      | 10.7             | 6.6              | 0.6              | 1.4                  | 230                | 6446                          | 160                  | 4467                            | 138                             | 28                  |
| 16                 | 0                                 | DRY          | 17.2                   | 275               | 4407                      | 42.2             |                  |                  |                      |                    |                               |                      |                                 |                                 |                     |
| 3                  | 0                                 | CULVERT      | 3.2                    | 23                | 70                        | 0.7              |                  |                  |                      |                    |                               |                      |                                 |                                 |                     |
| 1                  | 0                                 | NOSURVEY     | 1.1                    | 1640              | 1640                      | 15.7             |                  |                  |                      |                    |                               |                      |                                 |                                 |                     |
| <b>Total Units</b> | <b>Total Units Fully Measured</b> |              |                        |                   | <b>Total Length (ft.)</b> |                  |                  |                  |                      |                    | <b>Total Area (sq.ft.)</b>    |                      | <b>Total Volume (cu.ft.)</b>    |                                 |                     |
| 93                 | 40                                |              |                        |                   | 10436                     |                  |                  |                  |                      |                    | 15132                         |                      | 7174                            |                                 |                     |

**Table 2 - Summary of Habitat Types and Measured Parameters**

**Stream Name:** Mill Creek

**LLID:** 1226973385470

**Drainage:** Russian River - Middle

**Survey** 9/10/2012 to 9/14/2012

**Confluence Location: Quad:** MARK WEST SPRINGS

**Legal Description:** T08NR08WS13

**Latitude:** 38:32:49.0N

**Longitude:** 122:41:50.0W

| 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 (%) |
|--------------------|-----------------------------------|--------------|------------------------|-------------------|---------------------------|------------------|------------------|------------------|----------------------|--------------------|-------------------------------|----------------------|---------------------------------|---------------------------------|---------------------|-----------------|
| 13                 | 4                                 | LGR          | 14.0                   | 52                | 674                       | 6.5              | 2.0              | 0.1              | 0.8                  | 88                 | 1141                          | 11                   | 142                             |                                 | 4                   | 94              |
| 4                  | 2                                 | HGR          | 4.3                    | 40                | 158                       | 1.5              | 2.0              | 0.2              | 0.5                  | 70                 | 281                           | 16                   | 65                              |                                 | 5                   | 93              |
| 3                  | 1                                 | BRS          | 3.2                    | 19                | 57                        | 0.5              | 2.0              | 0.3              | 0.5                  | 27                 | 82                            | 8                    | 25                              |                                 | 5                   | 100             |
| 7                  | 1                                 | RUN          | 7.5                    | 30                | 207                       | 2.0              | 2.0              | 0.2              | 0.2                  | 32                 | 227                           | 6                    | 45                              |                                 | 10                  | 90              |
| 18                 | 4                                 | SRN          | 19.4                   | 117               | 2110                      | 20.2             | 2.0              | 0.3              | 1.0                  | 352                | 6338                          | 122                  | 2189                            |                                 | 8                   | 95              |
| 19                 | 19                                | MCP          | 20.4                   | 32                | 615                       | 5.9              | 7.0              | 0.6              | 2.2                  | 229                | 4353                          | 170                  | 3226                            | 146                             | 27                  | 94              |
| 6                  | 6                                 | STP          | 6.5                    | 68                | 408                       | 3.9              | 5.0              | 0.6              | 1.6                  | 273                | 1640                          | 157                  | 939                             | 146                             | 17                  | 89              |
| 1                  | 1                                 | LSL          | 1.1                    | 41                | 41                        | 0.4              | 5.0              | 0.4              | 1.8                  | 205                | 205                           | 144                  | 144                             | 82                              | 60                  | 92              |
| 1                  | 1                                 | LSR          | 1.1                    | 25                | 25                        | 0.2              | 5.0              | 0.8              | 1.3                  | 119                | 119                           | 107                  | 107                             | 95                              | 120                 | 100             |
| 1                  | 1                                 | PLP          | 1.1                    | 24                | 24                        | 0.2              | 6.0              | 0.3              | 0.7                  | 130                | 130                           | 52                   | 52                              | 39                              | 5                   | 93              |
| 16                 | 0                                 | DRY          | 17.2                   | 275               | 4407                      | 42.2             |                  |                  |                      |                    |                               |                      |                                 |                                 |                     | 93              |
| 3                  | 0                                 | CUL          | 3.2                    | 23                | 70                        | 0.7              |                  |                  |                      |                    |                               |                      |                                 |                                 |                     |                 |
| 1                  | 0                                 | NS           | 1.1                    | 1640              | 1640                      | 15.7             |                  |                  |                      |                    |                               |                      |                                 |                                 |                     |                 |
| <b>Total Units</b> | <b>Total Units Fully Measured</b> |              |                        |                   | <b>Total Length (ft.)</b> |                  |                  |                  |                      |                    | <b>Total Area (sq.ft.)</b>    |                      | <b>Total Volume</b>             |                                 |                     |                 |
| 93                 | 40                                |              |                        |                   | 10436                     |                  |                  |                  |                      |                    | 14515                         |                      | 6934(cu.ft.)                    |                                 |                     |                 |

**Table 3 - Summary of Pool Habitat Types**

**Stream Name:** Mill Creek

**LLID:** 1226973385470

**Drainage:** Russian River - Middle

**Survey** 9/10/2012 to 9/14/2012

**Confluence Location: Quad:** MARK WEST SPRINGS

**Legal Description:** T08NR08WS13

**Latitude:** 38:32:49.0N

**Longitude:** 122:41:50.0W

| 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 |
|--------------------|-----------------------------------|--------------|------------------------|-------------------|---------------------------|------------------|------------------|---------------------------|--------------------|-------------------------------|---------------------------------|-------------------------------------|---------------------|
| 25                 | 25                                | MAIN         | 89                     | 41                | 1023                      | 92               | 6.8              | 0.6                       | 240                | 5993                          | 146                             | 3661                                | 24                  |
| 3                  | 3                                 | SCOUR        | 11                     | 30                | 90                        | 8                | 5.3              | 0.5                       | 151                | 453                           | 72                              | 216                                 | 62                  |
| <b>Total Units</b> | <b>Total Units Fully Measured</b> |              |                        |                   | <b>Total Length (ft.)</b> |                  |                  |                           |                    | <b>Total Area (sq.ft.)</b>    |                                 | <b>Total Volume (cu.ft.)</b>        |                     |
| 28                 | 28                                |              |                        |                   | 1113                      |                  |                  |                           |                    | 6446                          |                                 | 3877                                |                     |

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

**Stream Name:** Mill Creek **LLID:** 1226973385470 **Drainage:** Russian River - Middle  
**Survey:** 9/10/2012 to 9/14/2012

**Confluence Location:** **Quad:** MARK WEST SPRINGS **Legal Description:** T08NR08WS13 **Latitude:** 38:32:49.0N **Longitude:** 122:41:50.0W

| 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 Occurrence           | 3 < 4 Feet Maximum Residual Depth           | 3 < 4 Feet Percent Occurrence           | >= 4 Feet Maximum Residual Depth           | >= 4 Feet Percent Occurrence           |
|-----------------------------------------|--------------|------------------------|-------------------------------------------|---------------------------------------|---------------------------------------------|-----------------------------------------|---------------------------------------------|-----------------------------------------|---------------------------------------------|-----------------------------------------|--------------------------------------------|----------------------------------------|
| 19                                      | MCP          | 68                     | 1                                         | 5                                     | 14                                          | 74                                      | 4                                           | 21                                      | 0                                           | 0                                       | 0                                          | 0                                      |
| 6                                       | STP          | 21                     | 2                                         | 33                                    | 4                                           | 67                                      | 0                                           | 0                                       | 0                                           | 0                                       | 0                                          | 0                                      |
| 1                                       | LSL          | 4                      | 0                                         | 0                                     | 1                                           | 100                                     | 0                                           | 0                                       | 0                                           | 0                                       | 0                                          | 0                                      |
| 1                                       | LSR          | 4                      | 0                                         | 0                                     | 1                                           | 100                                     | 0                                           | 0                                       | 0                                           | 0                                       | 0                                          | 0                                      |
| 1                                       | PLP          | 4                      | 1                                         | 100                                   | 0                                           | 0                                       | 0                                           | 0                                       | 0                                           | 0                                       | 0                                          | 0                                      |
| <b>Total Units</b>                      |              |                        | <b>Total &lt; 1 Foot Max Resid. Depth</b> | <b>Total &lt; 1 Foot % Occurrence</b> | <b>Total 1 &lt; 2 Feet Max Resid. Depth</b> | <b>Total 1 &lt; 2 Feet % Occurrence</b> | <b>Total 2 &lt; 3 Feet Max Resid. Depth</b> | <b>Total 2 &lt; 3 Feet % Occurrence</b> | <b>Total 3 &lt; 4 Feet Max Resid. Depth</b> | <b>Total 3 &lt; 4 Feet % Occurrence</b> | <b>Total &gt;= 4 Feet Max Resid. Depth</b> | <b>Total &gt;= 4 Feet % Occurrence</b> |
| 28                                      |              |                        | 4                                         | 14                                    | 20                                          | 71                                      | 4                                           | 14                                      | 0                                           | 0                                       | 0                                          | 0                                      |
| Mean Maximum Residual Pool Depth (ft.): |              |                        | 1                                         |                                       |                                             |                                         |                                             |                                         |                                             |                                         |                                            |                                        |

**Table 5 - Summary of Mean Percent Cover By Habitat**

**Stream Name:** Mill Creek      **Dry Units:** 16      **LLID:** 1226973385470      **Drainage:** Russian River - Middle  
**Survey** 9/10/2012 to 9/14/2012

**Confluence Location:** Quad: MARK WEST SPRINGS      **Legal Description:** T08NR08WS13      **Latitude:** 38:32:49.0N      **Longitude:** 122:41:50.0W

| 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 |
|---------------|----------------------|--------------|-----------------------|------------|------------|------------------|-------------------------|---------------------------|--------------------|-----------------|-----------------------|
| 13            | 4                    | LGR          | 0                     | 0          | 0          | 0                | 0                       | 0                         | 0                  | 75              | 0                     |
| 4             | 2                    | HGR          | 0                     | 0          | 0          | 0                | 0                       | 0                         | 0                  | 100             | 0                     |
| 3             | 1                    | BRS          | 0                     | 0          | 0          | 0                | 0                       | 0                         | 0                  | 100             | 0                     |
| 20            | 7                    | TOTAL RIFFLE | 0                     | 0          | 0          | 0                | 0                       | 0                         | 0                  | 86              | 0                     |
| 7             | 1                    | RUN          | 0                     | 0          | 0          | 50               | 0                       | 0                         | 0                  | 50              | 0                     |
| 18            | 4                    | SRN          | 15                    | 0          | 0          | 15               | 0                       | 0                         | 0                  | 45              | 0                     |
| 25            | 5                    | TOTAL FLAT   | 12                    | 0          | 0          | 22               | 0                       | 0                         | 0                  | 46              | 0                     |
| 19            | 19                   | MCP          | 24                    | 4          | 1          | 24               | 0                       | 0                         | 0                  | 39              | 3                     |
| 6             | 6                    | STP          | 14                    | 14         | 0          | 23               | 0                       | 0                         | 0                  | 41              | 8                     |
| 1             | 1                    | LSL          | 40                    | 10         | 10         | 40               | 0                       | 0                         | 0                  | 0               | 0                     |
| 1             | 1                    | LSR          | 45                    | 10         | 0          | 45               | 0                       | 0                         | 0                  | 0               | 0                     |
| 1             | 1                    | PLP          | 0                     | 0          | 0          | 0                | 0                       | 0                         | 0                  | 100             | 0                     |
| 28            | 28                   | TOTAL POOL   | 22                    | 7          | 1          | 24               | 0                       | 0                         | 0                  | 39              | 4                     |
| 3             | 0                    | CUL          |                       |            |            |                  |                         |                           |                    |                 |                       |
| 1             | 0                    | NS           |                       |            |            |                  |                         |                           |                    |                 |                       |
| 93            | 40                   | TOTAL        | 17                    | 5          | 1          | 20               | 0                       | 0                         | 0                  | 48              | 3                     |

**Table 6 - Summary of Dominant Substrates By Habitat Type**

**Stream Name:** Mill Creek      **Dry Units:** 16      **LLID:** 1226973385470      **Drainage:** Russian River - Middle  
**Survey** 9/10/2012 to 9/14/2012

**Confluence Location: Quad:** MARK WEST SPRINGS      **Legal Description:** T08NR08WS13      **Latitude:** 38:32:49.0N      **Longitude:** 122:41:50.0W

| 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 |
|---------------|----------------------|--------------|----------------------------|-----------------------|-------------------------|-------------------------------|-------------------------------|--------------------------|--------------------------|
| 13            | 4                    | LGR          | 0                          | 0                     | 50                      | 50                            | 0                             | 0                        | 0                        |
| 4             | 2                    | HGR          | 0                          | 0                     | 0                       | 0                             | 0                             | 50                       | 50                       |
| 3             | 1                    | BRS          | 0                          | 0                     | 0                       | 100                           | 0                             | 0                        | 0                        |
| 7             | 1                    | RUN          | 0                          | 0                     | 100                     | 0                             | 0                             | 0                        | 0                        |
| 18            | 4                    | SRN          | 0                          | 0                     | 25                      | 50                            | 25                            | 0                        | 0                        |
| 19            | 19                   | MCP          | 0                          | 0                     | 58                      | 26                            | 16                            | 0                        | 0                        |
| 6             | 6                    | STP          | 0                          | 0                     | 0                       | 50                            | 33                            | 17                       | 0                        |
| 1             | 1                    | LSL          | 0                          | 0                     | 100                     | 0                             | 0                             | 0                        | 0                        |
| 1             | 1                    | LSR          | 0                          | 0                     | 100                     | 0                             | 0                             | 0                        | 0                        |
| 1             | 1                    | PLP          | 0                          | 0                     | 0                       | 0                             | 100                           | 0                        | 0                        |
| 3             | 0                    | CUL          | 0                          | 0                     | 0                       | 0                             | 0                             | 0                        | 0                        |
| 1             | 0                    | NS           | 0                          | 0                     | 0                       | 0                             | 0                             | 0                        | 0                        |

**Table 7 - Summary of Mean Percent Canopy for Entire Stream**

**Stream Name:** Mill Creek

**LLID:** 1226973385470

**Drainage:** Russian River - Middle

**Survey** 9/10/2012 to 9/14/2012

**Confluence Location:** **Quad:** MARK WEST SPRINGS **Legal Description:** T08NR08WS13 **Latitude:** 38:32:49.0N **Longitude:** 122:41:50.0W

| Mean<br>Percent<br>Canopy | Mean<br>Percent<br>Conifer | Mean<br>Percent<br>Hardwood | Mean<br>Percent<br>Open Units | Mean<br>Right Bank<br>% Cover | Mean<br>Left Bank<br>% Cover |
|---------------------------|----------------------------|-----------------------------|-------------------------------|-------------------------------|------------------------------|
| 93                        | 50                         | 50                          | 0                             | 85                            | 82                           |

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 Mill Creek LLID: 1226973385470 Drainage Russian River - Middle  
 Survey Dates: 9/10/2012 to 9/14/2012 Survey Length (ft.): 10436 Main Channel (ft.): 10436 Side Channel (ft.): 0  
 Confluence Location: Quad MARK WEST Legal Description: T08NR08WS13 Latitude: 38:32:49.0N Longitude: 122:41:50.0W

**Summary of Fish Habitat Elements By Stream Reach**

**STREAM REACH: 1**

|                                                                                                                         |                                |                              |                          |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------|------------------------------|--------------------------|
| Channel Type: B4                                                                                                        | Canopy Density (%): 94.3       | Pools by Stream Length       | 17.1                     |
| Reach Length (ft.): 4508                                                                                                | Coniferous Component (%): 52.6 | Pool Frequency (%):          | 29.7                     |
| Riffle/Flatwater Mean Width (ft.): 2.1                                                                                  | Hardwood Component             | 47.4                         | Residual Pool Depth (%): |
| BFW:                                                                                                                    | Dominant Bank                  | Hardwood Trees               | < 2 Feet Deep: 84.2      |
| Range (ft.): 11.00 to 22.00                                                                                             | Vegetative Cover (%): 87.3     |                              | 2 to 2.9 Feet Deep: 15.8 |
| Mean (ft.): 16.69                                                                                                       | Dominant                       | Boulders                     | 3 to 3.9 Feet Deep: 0.0  |
| Std. Dev.: 3.98                                                                                                         | Dominant Bank Substrate        | Boulder                      | >= 4 Feet Deep: 0.0      |
| Base Flow (cfs): 0                                                                                                      | Occurrence of LWD (%): 1.3     | Mean Max Residual Pool Depth | 1.39                     |
| Water (F): 56 - 58 Air (F): 67 - 74                                                                                     | LWD per 100 ft.:               | Mean Pool Shelter            | 38                       |
| Dry Channel (ft.): 1485                                                                                                 | Riffles: 1                     |                              |                          |
|                                                                                                                         | Pools: 1                       |                              |                          |
|                                                                                                                         | Flat: 0                        |                              |                          |
| Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 0.0 Gravel: 52.6 Sm Cobble: 36.8 Lg Cobble: 10.5 Boulder 0.0 Bedrock: 0.0 |                                |                              |                          |
| Embeddedness Values (%): 1. 47.4 2. 52.6 3. 0.0 4. 0.0 5. 0.0                                                           |                                |                              |                          |

**STREAM REACH: 2**

|                                                                                                                          |                                |                              |                          |
|--------------------------------------------------------------------------------------------------------------------------|--------------------------------|------------------------------|--------------------------|
| Channel Type: A2                                                                                                         | Canopy Density (%): 93.0       | Pools by Stream Length       | 20.9                     |
| Reach Length (ft.): 1228                                                                                                 | Coniferous Component (%): 50.0 | Pool Frequency (%):          | 36.4                     |
| Riffle/Flatwater Mean Width (ft.): 3.0                                                                                   | Hardwood Component             | 50.0                         | Residual Pool Depth (%): |
| BFW:                                                                                                                     | Dominant Bank                  | Hardwood Trees               | < 2 Feet Deep: 87.5      |
| Range (ft.): 12.00 to 24.00                                                                                              | Vegetative Cover (%): 73.5     |                              | 2 to 2.9 Feet Deep: 12.5 |
| Mean (ft.): 16.18                                                                                                        | Dominant                       | Boulders                     | 3 to 3.9 Feet Deep: 0.0  |
| Std. Dev.: 4.86                                                                                                          | Dominant Bank Substrate        | Boulder                      | >= 4 Feet Deep: 0.0      |
| Base Flow (cfs): 0                                                                                                       | Occurrence of LWD (%): 0.0     | Mean Max Residual Pool Depth | 1.33                     |
| Water (F): 53 - 56 Air (F): 58 - 73                                                                                      | LWD per 100 ft.:               | Mean Pool Shelter            | 8                        |
| Dry Channel (ft.): 47                                                                                                    | Riffles: 0                     |                              |                          |
|                                                                                                                          | Pools: 0                       |                              |                          |
|                                                                                                                          | Flat: 0                        |                              |                          |
| Pool Tail Substrate (%): Silt/Clay: 0.0 Sand: 0.0 Gravel: 25.0 Sm Cobble: 50.0 Lg Cobble: 12.5 Boulder 12.5 Bedrock: 0.0 |                                |                              |                          |
| Embeddedness Values (%): 1. 50.0 2. 50.0 3. 0.0 4. 0.0 5. 0.0                                                            |                                |                              |                          |



## Mill Creek (Mark West tributary)

### Summary of Fish Habitat Elements By Stream Reach

#### STREAM REACH: 3

|                                         |                                |                              |                          |
|-----------------------------------------|--------------------------------|------------------------------|--------------------------|
| Channel Type: B4                        | Canopy Density (%): 83.0       | Pools by Stream Length       | 10.5                     |
| Reach Length (ft.): 813                 | Coniferous Component (%): 20.0 | Pool Frequency (%):          | 33.3                     |
| Riffle/Flatwater Mean Width (ft.): 2.0  | Hardwood Component             | 80.0                         | Residual Pool Depth (%): |
| BFW:                                    | Dominant Bank                  | Coniferous Trees             | < 2 Feet Deep: 100.0     |
| Range (ft.): 24.00 to 24.00             | Vegetative Cover (%): 100.0    |                              | 2 to 2.9 Feet Deep: 0.0  |
| Mean (ft.): 24.00                       | Dominant                       | Undercut Banks               | 3 to 3.9 Feet Deep: 0.0  |
| Std. Dev.: 0.00                         | Dominant Bank Substrate        | Cobble/Gravel                | >= 4 Feet Deep: 0.0      |
| Base Flow (cfs): 0                      | Occurrence of LWD (%): 0.0     | Mean Max Residual Pool Depth | 0.9                      |
| Water (F): 53 - 53                      | Air (F): 58 - 58               | LWD per 100 ft.:             | Mean Pool Shelter        |
| Dry Channel (ft.): 660                  | Riffles: 0                     |                              | 10                       |
|                                         | Pools: 1                       |                              |                          |
|                                         | Flat:                          |                              |                          |
| Pool Tail Substrate (%): Silt/Clay: 0.0 | Sand: 0.0                      | Gravel: 100.                 | Sm Cobble: 0.0           |
| Embeddedness Values (%):                | 1. 100.0                       | 2. 0.0                       | 3. 0.0                   |
|                                         |                                | 4. 0.0                       | 5. 0.0                   |

#### STREAM REACH: 4

|                                     |                           |                              |                   |
|-------------------------------------|---------------------------|------------------------------|-------------------|
| Channel Type: NA                    | Canopy Density (%):       | Pools by Stream Length       | 0.0               |
| Reach Length (ft.): 1640            | Coniferous Component (%): | Pool Frequency (%):          | 0.0               |
| Riffle/Flatwater Mean Width (ft.):  | Hardwood Component        | Residual Pool Depth (%):     |                   |
| BFW:                                | Dominant Bank             | < 2 Feet Deep:               |                   |
| Range (ft.): 24.00 to 24.00         | Vegetative Cover (%): 0.0 | 2 to 2.9 Feet Deep:          |                   |
| Mean (ft.): 24.00                   | Dominant                  | 3 to 3.9 Feet Deep:          |                   |
| Std. Dev.: 0.00                     | Dominant Bank Substrate   | >= 4 Feet Deep:              |                   |
| Base Flow (cfs): 0                  | Occurrence of LWD (%):    | Mean Max Residual Pool Depth |                   |
| Water (F): 53 - 53                  | Air (F): 58 - 58          | LWD per 100 ft.:             | Mean Pool Shelter |
| Dry Channel (ft.): 0                | Riffles:                  |                              |                   |
|                                     | Pools:                    |                              |                   |
|                                     | Flat:                     |                              |                   |
| Pool Tail Substrate (%): Silt/Clay: | Sand:                     | Gravel:                      | Sm Cobble:        |
| Embeddedness Values (%):            | 1.                        | 2.                           | 3.                |
|                                     |                           | 4.                           | 5. 0.0            |

**Mill Creek (Mark West tributary)**

**Summary of Fish Habitat Elements By Stream Reach**

**STREAM REACH: 5**

|                                                                                                            |                               |                               |
|------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------|
| Channel Type: B3                                                                                           | Canopy Density (%): 85.0      | Pools by Stream Length: 0.0   |
| Reach Length (ft.): 2247                                                                                   | Coniferous Component (%): 0.0 | Pool Frequency (%): 0.0       |
| Riffle/Flatwater Mean Width (ft.):                                                                         | Hardwood Component: 100.0     | Residual Pool Depth (%):      |
| BFW:                                                                                                       | Dominant Bank:                | < 2 Feet Deep:                |
| Range (ft.): to                                                                                            | Vegetative Cover (%): 0.0     | 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): 0 - 0    Air (F): 66 - 66                                                                       | LWD per 100 ft.:              | Mean Pool Shelter:            |
| Dry Channel (ft.): 2215                                                                                    | Riffles:                      |                               |
|                                                                                                            | Pools:                        |                               |
|                                                                                                            | Flat:                         |                               |
| Pool Tail Substrate (%): Silt/Clay:    Sand:    Gravel:    Sm Cobble:    Lg Cobble:    Boulder    Bedrock: |                               |                               |
| Embeddedness Values (%):    1.    2.    3.    4.    5. 0.0                                                 |                               |                               |

### Table 9 -Mean Percentage of Dominant Substrate and Vegetation

**Stream Name:** Mill Creek **LLID:** 1226973385470 **Drainage:** Russian River - Middle  
**Survey** 9/10/2012 to 9/14/2012  
**Confluence Location:** **Quad:** MARK WEST SPRINGS **Legal Description:** T08NR08WS13 **Latitude:** 38:32:49.0N **Longitude:** 122:41:50.0W

#### 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                     | 5                          | 8                         | 16.3                      |
| Boulder                     | 21                         | 15                        | 45.0                      |
| Cobble/Gravel               | 11                         | 12                        | 28.8                      |
| Sand/Silt/Clay              | 3                          | 5                         | 10.0                      |

#### 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                        | 0                          | 0                         | 0.0                   |
| Brush                        | 0                          | 3                         | 3.8                   |
| Hardwood                     | 20                         | 19                        | 48.8                  |
| Coniferous                   | 20                         | 18                        | 47.5                  |
| No Vegetation                | 0                          | 0                         | 0.0                   |

**Total Stream Cobble Embeddedness Values:** 2

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

**Stream Name:** Mill Creek

**LLID:** 1226973385470

**Drainage:** Russian River - Middle

**Survey** 9/10/2012 to 9/14/2012

**Confluence Location:** **Quad:** MARK WEST SPRINGS

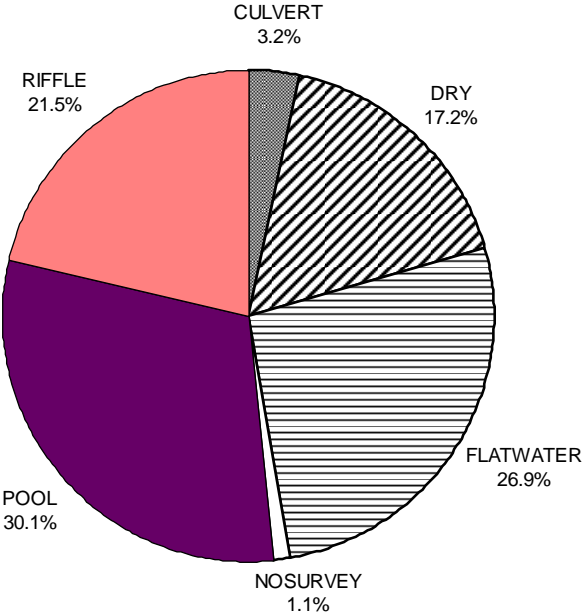
**Legal Description:** T08NR08WS13

**Latitude:** 38:32:49.0N

**Longitude:** 122:41:50.0W

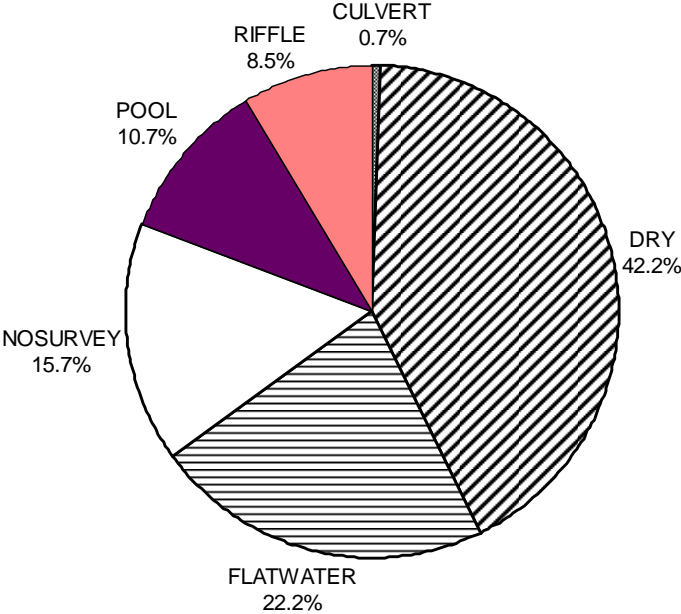
|                        | Riffles | Flatwater | Pools |
|------------------------|---------|-----------|-------|
| UNDERCUT BANKS (%)     | 0       | 12        | 22    |
| SMALL WOODY DEBRIS (%) | 0       | 0         | 7     |
| LARGE WOODY DEBRIS (%) | 0       | 0         | 1     |
| ROOT MASS (%)          | 0       | 22        | 24    |
| TERRESTRIAL VEGETATION | 0       | 0         | 0     |
| AQUATIC VEGETATION (%) | 0       | 0         | 0     |
| WHITEWATER (%)         | 0       | 0         | 0     |
| BOULDERS (%)           | 86      | 46        | 39    |
| BEDROCK LEDGES (%)     | 0       | 0         | 4     |

**MILL CREEK 2012  
HABITAT TYPES BY PERCENT OCCURRENCE**



GRAPH 1

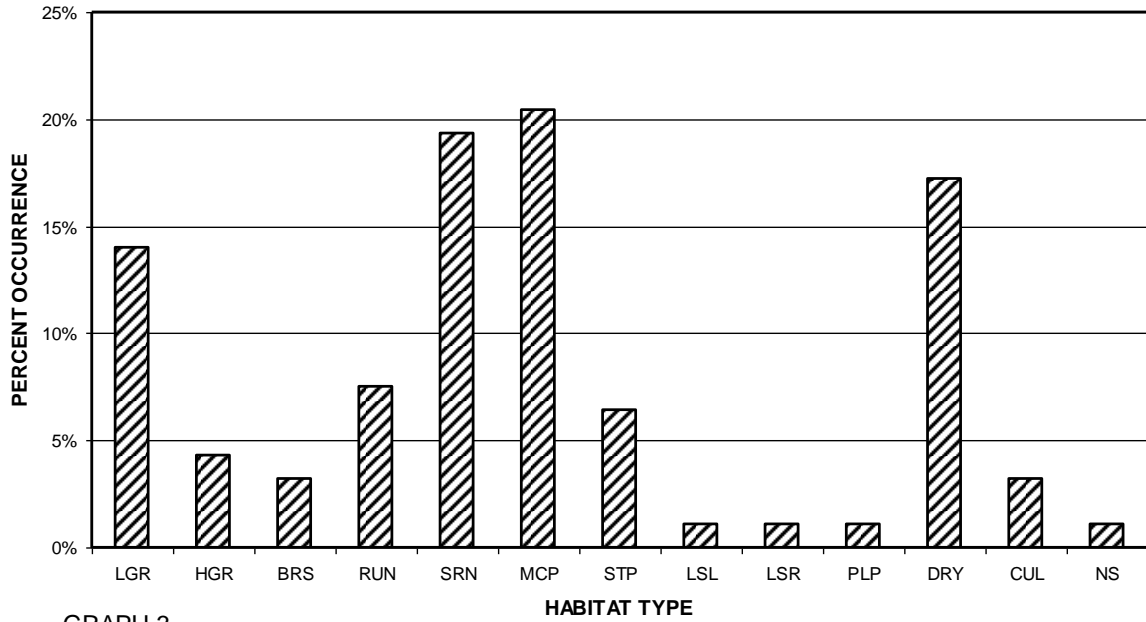
**MILL CREEK 2012  
HABITAT TYPES BY PERCENT TOTAL LENGTH**



GRAPH 2

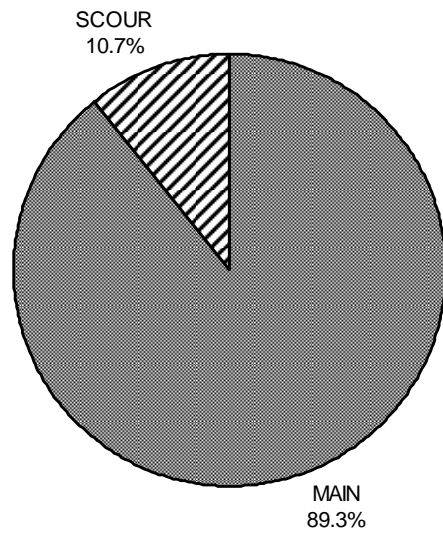
Mill Creek (Mark West tributary)

**MILL CREEK 2012  
HABITAT TYPES BY PERCENT OCCURRENCE**



GRAPH 3

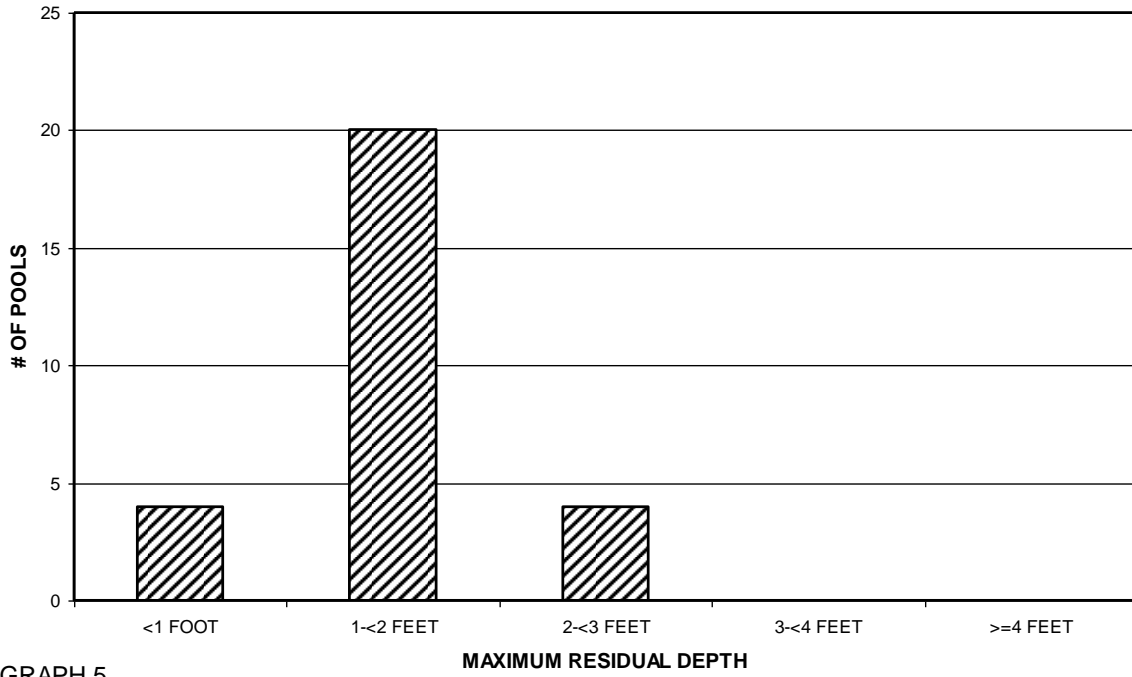
**MILL CREEK 2012  
POOL TYPES BY PERCENT OCCURRENCE**



GRAPH 4

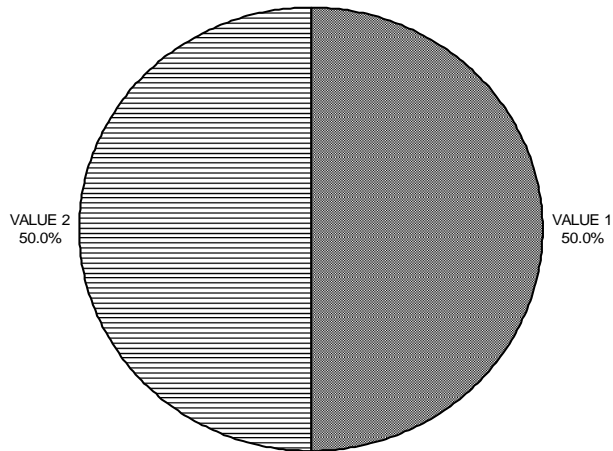
Mill Creek (Mark West tributary)

MILL CREEK 2012  
MAXIMUM DEPTH IN POOLS



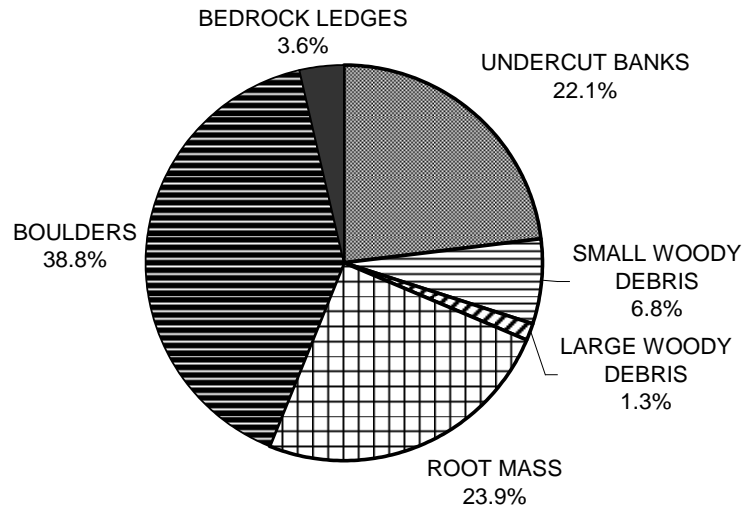
GRAPH 5

MILL CREEK 2012  
PERCENT EMBEDDEDNESS



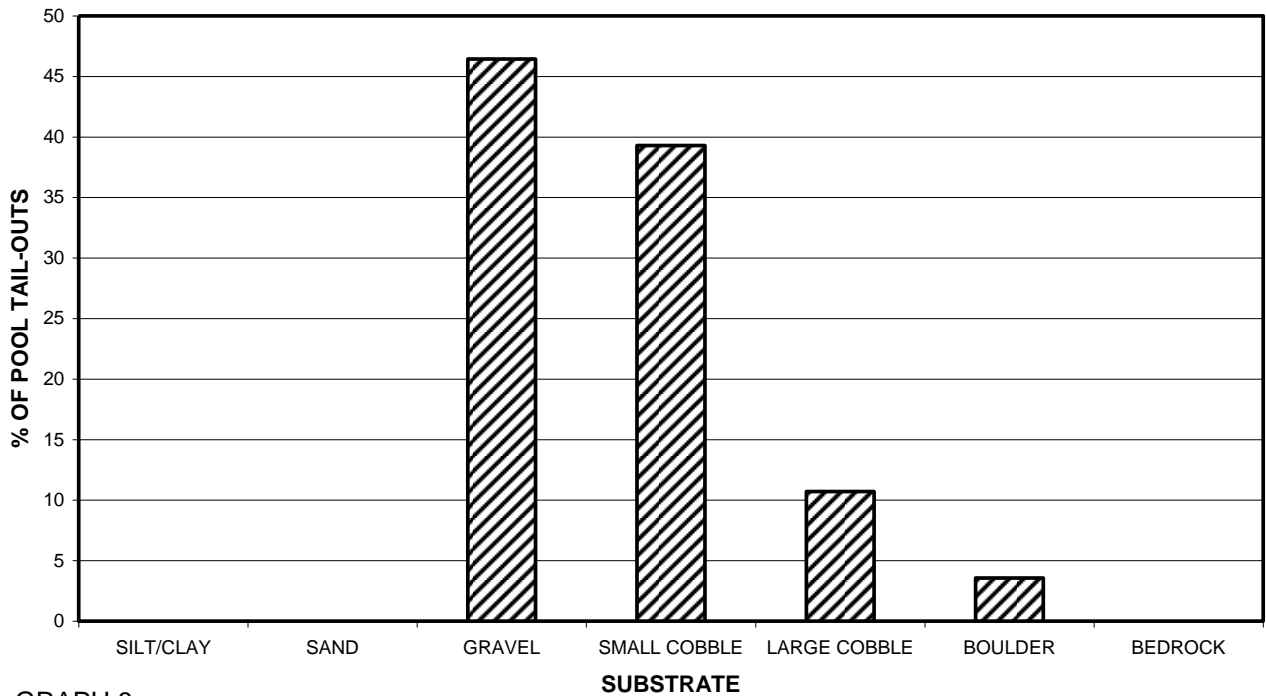
GRAPH 6

### MILL CREEK 2012 MEAN PERCENT COVER TYPES IN POOLS



GRAPH 7

### MILL CREEK 2012 SUBSTRATE COMPOSITION IN POOL TAIL-OUTS

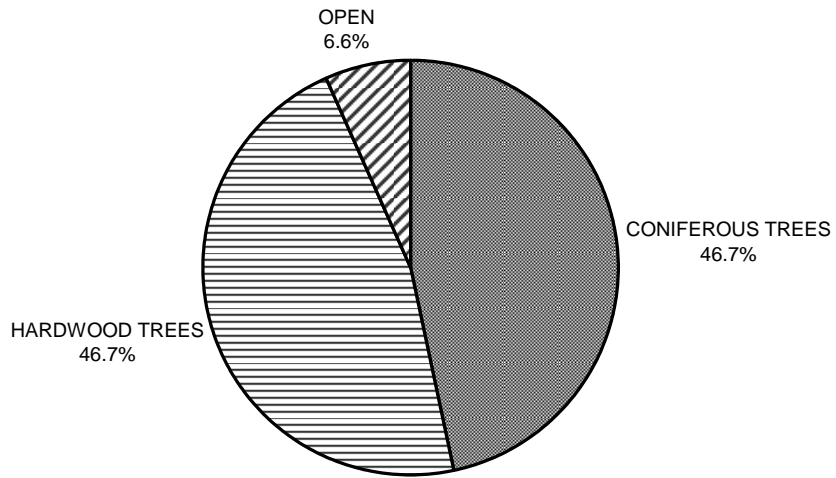


GRAPH 8



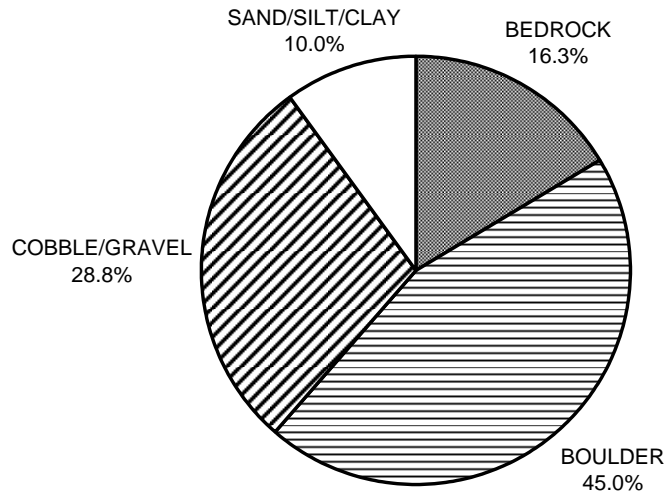
Mill Creek (Mark West tributary)

**MILL CREEK 2012  
MEAN PERCENT CANOPY**



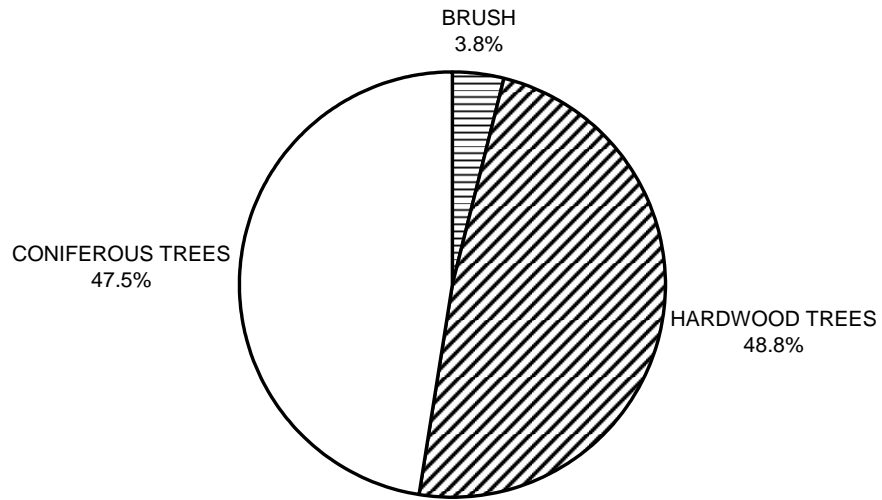
GRAPH 9

**MILL CREEK 2012  
DOMINANT BANK COMPOSITION IN SURVEY REACH**



GRAPH 10

**MILL CREEK 2012  
DOMINANT BANK VEGETATION IN SURVEY REACH**



GRAPH 11

