

**CALIFORNIA STATE PARKS – NORTH COAST REDWOODS DISTRICT - STREAM
CROSSING INVENTORY AND FISH PASSAGE EVALUATION**

FINAL REPORT

By

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INTRODUCTION

The inventory and fish passage evaluation of stream crossings within the properties of the North Coast Redwoods District of California State Parks was conducted between October of 2007 and March of 2009. The primary objective was to assess passage of juvenile and adult coastal rainbow trout/steelhead (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and coastal cutthroat trout (*O. clarki clarki*) and develop a project-scheduling document to prioritize corrective treatments to provide unimpeded fish passage at road/stream intersections and at other manmade impediments.

The North Coast Redwoods District of California State Parks is comprised of 22 distinct units which encompass approximately 135,000 acres. The major anadromous fish-bearing watersheds that flow through North Coast Redwoods District park units are the Smith River, Redwood Creek, and the Eel River.

Please note that for this report the term **stream crossing** is defined as any human-made structure, (used primarily for transportation purposes) that crosses over or through a stream channel, such as: a paved road, unpaved road, railroad track, biking or hiking trail, golf-cart path, or low-water ford. Stream crossings include culverts, bridges, and low-water crossings such as paved and unpaved fords. For the purpose of assessing fish passage, the distinction between types of stream crossings is not as important as the effect the structure has on the form and function of the stream flow. A stream crossing encompasses the structure employed to pass stream flow as well as associated fill material within the crossing prism.

The inventory and assessment process included:

1. Locating stream crossings within anadromous stream reaches.
2. Visiting each crossing on an initial site visit to determine the type of crossing and assessment of stream channel as suitable fish habitat.
3. At crossings with culverts - collecting information regarding culvert specifications and surveying a longitudinal profile.
4. Assessing fish passage using culvert specifications and passage criteria for juvenile and adult salmonids (state and federal criteria) by employing a first-phase evaluation filter and then using a computer software program (FishXing) on a subset of sites defined as partial/temporal barriers by the filter.
5. Assessing quality and quantity of stream habitat above and below each culvert.

The prioritization process ranked culvert sites by assigning numerical scores for the following criteria:

1. Presumed species diversity within stream reach of interest (and federal listing status).
2. Extent of barrier for each species and age-class over the range of estimated migration flows.
3. Quality and quantity of potential upstream habitat gains.
4. Hydraulic capacity of current stream crossing (risk of fill failure).
5. Condition of current crossing (life expectancy).

The initial ranking was not intended to provide an exact order of priority, rather produce a first-cut rank in which sites could be grouped as high, medium, or low priority. Professional judgment was a vital component of the ranking process. On a site-specific basis, some or all of these factors were considered in developing the final ranked list:

1. Tributaries that currently support runs of coho salmon, steelhead, Chinook salmon and/or coastal cutthroat trout. Treating migration barriers in these sections of the watershed should result in a high probability of immediate utilization of re-opened habitat.
2. Physical stress or danger to migrating salmonids at crossings where migration attempts were observed. Recent studies have revealed numerous sites in California where concentrations of migrating salmonids were subjected to decades of predation by birds and mammals or poaching by humans (Taylor 2000 and 2001). Observations of adult coho salmon injuring themselves on failed leap attempts have also been made (Taylor 2000 and 2001). Inability to enter cool-water tributaries to escape stressful/lethal mainstem water temperatures during summer months has also been observed. These factors should weigh heavily in priority ranking.
3. Amount of fill material. At stream crossings that were undersized and/or in poor condition, we assessed the volume of fill material within the crossing prism potentially deliverable to the stream channel if the crossing were to fail. Large, sudden contributions of sediment from crossing failures are often detrimental to salmonid spawning and rearing habitat.
4. Presence or absence of other stream crossings and other types of barriers. In some cases, a single stream was crossed by multiple roads under a variety of management or ownership. In these situations, close communication with other road managers, private property owners, and watershed coordinators was important. When multiple stream crossings were identified as migration barriers, a coordinated effort will be required to identify and treat them in a logical manner – generally in an upstream direction starting with the lowermost barrier or impediment.
5. Remediation project cost. The range of treatment options and associated costs should be examined when determining the order in which to proceed and what types of treatments should be implemented at specific sites. Long-term maintenance should be considered when estimating costs associated with retrofits. In cases where federal or state listed fish species are present, costs must also be weighed against the consequences of failing to comply with Endangered Species Acts by not providing unimpeded passage.
6. Scheduling of other road maintenance and repair projects. Road managers should consider upgrading all migration barriers during other activities they may perform to the roadway, such as repaving, chip-sealing, or widening. When undersized or older crossings fail during storms, road managers should be prepared to install properly-sized crossings that provide unimpeded passage for all species and age-classes of salmonids.

7. Other factors impacting salmon and steelhead. In many cases, other limiting factors besides migration barriers exist that impair salmonid productivity. On a watershed or sub-basin level, restoration decisions must be made after carefully reviewing potential limiting factors, the source of the impacts, and the range of restoration options available, and what restoration activities are actually feasible.

Additional physical, operational, social, and/or economic factors exist that may influence the final order of sites; but evaluating these are beyond the scope of this project.

Final Product of Stream Crossing Inventory

This final report includes:

1. A count and location of all stream crossings with culverts and other manmade structures located within fish-bearing stream reaches. Locations were identified by State Park Unit name; road name; stream name; watershed name; mile marker or distance to nearest named crossroad; USGS Quad name; Township, Range and Section coordinates; and lat/long coordinates (WGS84 datum). All location data were entered into a spreadsheet for potential database uses.
2. For each site with a culvert, crossing specifications were collected, including: length, dimensions, type, construction material, inlet and outlet configurations, position relative to flow and stream gradient, amount of fill material, depth of jump pool below crossing, height of leap required to enter crossing, and previous modifications (if any) to improve fish passage. All site-specific data were entered into a spreadsheet for potential database uses.
3. Information regarding crossing age, wear, and performance was collected, including: overall condition of the crossing (and associated road fill) and rust line height (applicable only to metal culverts). All crossing specifications were entered into a spreadsheet for potential database uses.
4. An evaluation of fish passage at each culvert location. Fish passage was evaluated by two methods. Initially, fish passage was assessed by employing a first-phase evaluation filter that was developed for Part IX of CDFG's *Salmonid Stream Habitat Restoration Manual* (Taylor and Love, 2003). The filter quickly determined if a crossing either met fish passage criteria for all species and life stages as defined by CDFG for the range of migration flows (**GREEN**); failed to meet passage criteria for all species and life stages (**RED**); or was a partial and/or temporal barrier (**GRAY**). Then FishXing (a computer software program) was used to conduct in-depth passage evaluations on the **GRAY** sites by modeling culvert hydraulics over the range of migration flows and comparing these values with leaping and swimming abilities of the species and age classes of interest. In some instances, FishXing was also utilized on crossings initially screened as **RED**.

5. Digital photo documentation of all crossings visited was taken to provide visual information regarding inlet and outlet configurations; as well as insertion in future reports, proposals, or presentations.
6. An evaluation of the quantity and quality of fish habitat above and below each culvert location. Most information was obtained from habitat typing and fisheries surveys previously conducted by various federal and state agencies, as well as watershed groups and private consultants. Where feasible, a first-hand inspection and evaluation of stream habitat occurred. Lengths of potential anadromous habitat were also estimated from USGS topographic maps. In situations where formal habitat typing surveys were not conducted professional judgment of biologists and/or watershed coordinators familiar with watershed conditions was utilized.
7. A ranked list of crossings with culverts that require treatment to provide unimpeded fish passage to spawning and rearing habitat. On a site-by-site basis, general recommendations for providing unimpeded fish passage were provided.

Project Justification

Migration Barrier Impacts to Salmonids

Fish passage through crossings (especially culverts) and over dams is an important factor in the recovery of depleted salmonid populations throughout the Pacific Northwest. Although most fish-bearing streams with culverts at stream crossings tend to be relatively small in size with only a couple of miles or less of upstream habitat, thousands of these exist and the cumulative effect of blocked habitat is probably quite significant. Recent research regarding watershed restoration considers the identification, prioritization, and treatment of migration barriers to restore ecological connectivity for salmonids a vital step towards recovering depressed populations (Roni et al. 2002).

Culverts often create temporal, partial or complete barriers for anadromous salmonids on their spawning migrations (Table 1) (adapted from Robison et al. 2000).

Typical passage problems created by culverts are:

- Excessive drop at outlet (too high of entry leap required);
- Excessive velocities within culvert;
- Lack of depth within culvert;
- Excessive velocity and/or turbulence at culvert inlet; and
- Debris accumulation at culvert inlet and/or within culvert.

Table 1. Definitions of barrier types and their potential impacts.

Barrier Category	Definition	Potential Impacts
Temporal	Impassable to all fish some of the time	Delay in movement beyond the barrier for some period of time
Partial	Impassable to some fish at all times	Exclusion of certain species and life stages from portions of a watershed
Total	Impassable to all fish at all times	Exclusion of all species from portions of a watershed

Even if culverts are eventually negotiated, excess energy expended by fish may result in their death prior to spawning or reductions in viability of eggs and offspring. Migrating fish concentrated in pools and stream reaches below stream crossings are also more vulnerable to predation by a variety of avian and mammalian species, as well as poaching by humans. Culverts which impede adult passage limit the distribution of spawning, often resulting in under seeded headwaters and superimposition of redds in lower stream reaches.

Current guidelines for new culvert installation aim to provide unimpeded passage for both adult and juvenile salmonids (CDFG 2002, NOAA 2001). However many existing culverts on federal, state, county, city, and private roads are barriers to anadromous adults, and more so to resident and juvenile salmonids whose smaller sizes significantly limit their leaping and swimming abilities to negotiate culverts. For decades, “legacy” culverts on established roads have effectively disrupted the spawning and rearing behavior of all four species of anadromous salmonids in California: Chinook salmon (*O. tshawytscha*), coho salmon, coastal rainbow trout (steelhead are anadromous coastal rainbow trout), and coastal cutthroat trout (*O. clarki clarki*).

In recent years, there has been a growing awareness of the disruption of in-stream migrations of resident and juvenile salmonids caused at road/stream intersections. In-stream movements of juvenile and resident salmonids are highly variable and still poorly understood by biologists. Juvenile coho salmon spend approximately one year in freshwater before migrating to the ocean, and juvenile steelhead may rear in freshwater for up to four years prior to out-migration (one to two years is most common in California). Thus, juveniles of both species are highly dependent on stream habitat. Many studies indicate that a common strategy for over-wintering juvenile coho salmon is to migrate out of larger river systems into smaller streams during late-fall and early-winter storms to seek refuge from possibly higher flows and potentially higher turbidity levels in mainstem channels (Skeesick 1970; Cederholm and Scarlett 1981; Tripp and McCart 1983; Tschaplinski and Hartman 1983; Scarlett and Cederholm 1984; Sandercock 1991; Nickelson et al. 1992). Recent research conducted in Pacific Northwest watersheds suggests that juvenile salmonids migrate into smaller tributaries in the fall and winter to feed on eggs deposited by spawning adults as well as flesh of spawned-out adults (Wipfli et al. 2003). This important source of protein leads to significant increases in growth and potentially higher survival rates of coho salmon smolts (Wipfli et al. 2003; Giannico et al. 2007). Direct observation at numerous culverts in northern California confirmed similar upstream movements of three year-classes of juvenile steelhead (young-of-year, 1-year old and 2-year old) (Taylor 2000; Taylor 2001).

The variable life history of resident coastal rainbow trout is exhibited by seasonal movements in and out of one or more tributaries within a watershed. These smaller tributaries are where most culverts are still located since larger channels tend to be spanned by bridges.

Undersized and poorly constructed stream crossings affect more than just the migrations of salmonids. Stream crossings disrupt the movements of other native fish species, such as scuplins, lampreys, and suckers. Many amphibian and mammal species also utilize the stream and riparian corridor for movement. Undersized and infrequently maintained crossings interrupt the movement of bedload and LWD during high flow events, exacerbate flooding, and cause damage to other infra-structure.

Planning Efforts to Address Migration Barriers

Anadromous salmonids will benefit from this planning effort because the final document provides the North Coast Redwoods District of CA State Parks with a prioritized list of stream crossing locations to fix that will provide unimpeded passage for all species (and age classes) of salmonids. Report information will assist in proposal development to seek State and Federal money to implement treatments. The inventory will also provide State Park managers with a comprehensive status evaluation of the overall condition and storm-flow capacities of crossings on fish-bearing stream reaches within their jurisdictions, providing vital information to assist each Park Unit's general planning and road maintenance needs.

METHODS AND MATERIALS

Methods for conducting the stream crossing inventory and fish passage evaluation included seven tasks; accomplished generally in the following order:

1. Location of stream crossings.
2. Initial site visits and data collection.
3. Estimation of tributary-specific hydrology and design flows for presumed migration period.
4. Data entry and passage analyses. Passage was first evaluated with a first-phase evaluation filter referred to as the “Green-Gray-Red” filter. Sites determined to be “Gray” and/or “Red” then required an in-depth evaluation with FishXing – a computer modeling software.
5. Collection and interpretation of existing habitat information.
6. Prioritization of sites for corrective treatment.
7. Development of site-specific recommendations for unimpeded passage of both juvenile and adult salmonids.

These methods were fairly consistent with the protocol recently developed for Part IX of the CDFG *California Salmonid Stream Habitat Restoration Manual* (Taylor and Love, 2003). These methods were developed to be consistent with current state and federal fish passage criteria for anadromous salmonids (CDFG 2002, NMFS 2001).

Two modifications to the original CDFG protocol were made during the North Coast Redwoods District of CA State Parks fish passage assessment project:

- Use of more rigorous criteria (decreased minimum water depths and increased swimming abilities) for assessing passage of adult salmonids (see page 19).
- A reduction of the weight of crossing sizing and condition in the ranking score (see page 26).

These two modifications to the original CDFG protocol were initiated in response to results generated by following the original methods during assessments completed prior to 2003. All protocol changes were discussed with CDFG and NOAA personnel prior to their use in assessment projects conducted by RTA since 2003. In-depth explanations to the rationale of modifying the methodology are provided at appropriate places within the Methods and Materials Section.

Location of Stream Crossings

Preliminary project scoping for stream crossings to survey included examination of State Parks road layers in their GIS system and identifying road and trail intersections within known (current and historic) anadromous stream reaches. The CalFish Passage Assessment Database (PAD) was also queried to determine the locations of potential barriers. Most of the preliminary scoping was conducted by Ross Taylor with the assistance of Jay Harris and Brian Merrill at State Parks. Additional sites were also investigated by RTA once the project started and initial site visits were conducted.

Access Permission

Because all of the sites were located on CA State Park property, no access permission was required to visit sites and complete surveys at crossings with culverts. RTA obtained a State Park permit to conduct biological investigations and coordinated timing of certain site visits with Park rangers when working on roads and trails where public vehicular access was not normally permitted.

Initial Site Visits

The objective of the initial site visits was to collect physical measurements at stream crossings to utilize with the first-phase evaluation filter and with the FishXing passage evaluation software. Notes describing the type and condition of each crossing, as well as qualitative comments describing stream habitat immediately above and below each crossing were also included. Site photographs taken included: upstream and downstream sides of the crossing, locations of cross-section tape, stream channel conditions, and/or crossing condition such as damage or unique features.

Stream Crossing Type

Potential sites were visited in the field and all crossings were first identified as either: culverts, bridges, dams, or weirs. Field measurements were collected at culverts, dams, and weirs; however during the initial field investigation we closely examined all crossings identified on maps as bridges because of the length of their span. Typically any structure with a combined span greater than 20 feet is defined by road managers as a bridge – yet from a fish passage perspective if these structures had a smooth concrete floor they were defined as concrete box culverts, surveyed, and evaluated for passage.

Crossing Location

The location of each stream crossing within a fish-bearing stream reach was described by: park unit; road name; stream name; watershed name; name of USGS quad map; Township, Range, and Section; latitude and longitude; and mile marker or distance to nearest named cross-road. If more than one stream crossing was present within a single tributary, a number was assigned to the stream name with the #1 crossing located farthest downstream (numbering then proceeded in an upstream direction). Lat/long coordinates were determined using Terrain Navigator (Version 3.01 by MapTech™), a geo-referenced mapping software program; or in the field with a handheld GPS unit. For data entry and analyses purposes, all lat/long coordinates were provided in the WGS84 datum.

Longitudinal Survey

A longitudinal survey was shot at each crossing to provide accurate elevation data for FishXing passage analyses. We utilized a total station (Topcon™ GTS-230W), a flat-head surveyor's tripod, and an 8.5' prism rod with a tilt single prism unit. The total station's data logger was used to store survey coordinates and all survey data were measured in feet to an accuracy of

1/100th of a foot. Survey notes and site information were written on water-proof data sheets and in a bound field notebook with a pencil. Data sheets and field notes were photocopied to provide back-ups in case of loss or destruction of originals.

Once a site was located in the field by the two-person survey crew, bright orange safety cones with signs marked “Survey Crew” were placed to warn oncoming traffic from both directions. Bright orange vests were also worn by the survey crew to increase one’s visibility to traffic. To start the survey, the total station was set in a location to eliminate or minimize the number of re-sections required to complete the survey. The person on the prism rod then selected locations along the thalweg (deepest point of channel cross-section at any given point along the center tape) at various locations along the channel, generally capturing visually noticeable breaks in slope along the stream channel. Longitudinal surveys were typically conducted in an upstream to downstream direction. Left-bank measurements were associated to the channel bank on one’s left when facing in a downstream direction. Extreme caution was used when wading through or over the crossings. A hardhat and flashlight were standard items used during the surveys.

At all sites, the minimum points required to run FishXing were measured (Figures 1 and 2):

1. crossing inlet (if culvert) or upstream edge of dam/weir,
2. crossing outlet (if culvert) or downstream edge of dam/weir,
3. maximum pool depth within five feet of the outlet,
4. outlet pool tail-water control,
5. at least one point downstream of the tail-water control, and
6. a cross-section at the tail-water control.

Each cross-section was comprised of approximately eight to 15 elevations from the left bank-full channel margin to the right bank-full margin. A tape was typically stretched across the cross-section to assist the rod person in accurately selecting points along the cross-section (Figure 2). These cross sections allowed for more accurate modeling of changes in tail-water elevations over varying stream discharges with the FishXing software.

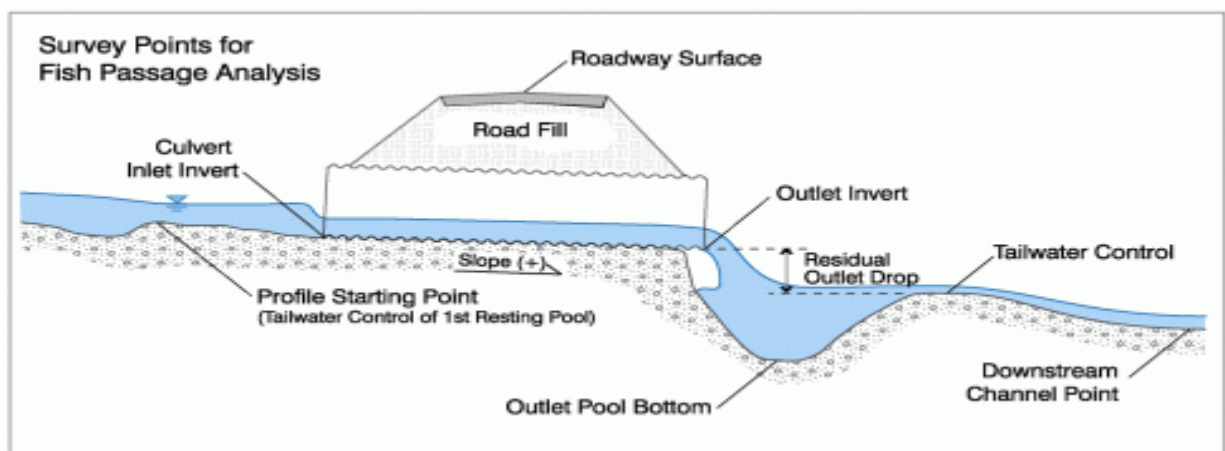


Figure 1. Diagram of required survey points through a culvert at a typical stream crossing.



Figure 2. Example of tape location for measuring the tail-water cross-section, Durphy Creek #1 in Richardson Grove.

On a site-specific basis, the following additional survey points provided useful information for evaluating fish passage with FishXing:

- Apparent breaks-in-slope within the crossing. Older culverts often sag when road fills slump, creating steeper sections within a culvert. If only inlet and outlet elevations are measured, the overall slope will predict average velocities less than actual velocities within steeper sections. These breaks-in-slope may act as velocity barriers, which are masked if only the overall slope of the culvert is measured. The total station was set within the culvert or channel to measure breaks-in-slope.
- Steep drops in the stream channel profile immediately upstream of the culvert inlet. The elevation at the tail-water control of the first upstream holding water was measured to estimate the channel slope leading into the culvert. In some cases, a fish may negotiate the culvert only to fail at passing through a velocity chute upstream of the inlet entrance. Inlet drops often create highly turbulent conditions during elevated flows.

- Multi-stage drops over dams and weirs. In some cases, dams were constructed on top of existing bed-rock outcrops that protruded farther downstream than the concrete face. These situations most likely create unfavorable hydraulic conditions for leap attempts by adult steelhead. Protruding outcrops also increase the horizontal distance required for successful leap attempts.
- Aprons are concrete structures extending upstream or downstream from a culvert at the channel culvert interface to control the flow transition into or out of the culvert. Aprons often have a different slope than the culvert itself. If the apron is much steeper than the culvert, then it may be the limiting factor preventing fish passage.

Channel widths

Where feasible, at least five measurements of the active channel width above the crossing (visually beyond any influence the crossing may have on channel width) were taken. Active channel is defined as the portion of channel commonly wetted during and above winter base flows and is identified by a break in rooted vegetation or moss growth on rocks along stream margins. Some stream crossing design guidelines utilize active channel widths in determining the appropriate widths of new culvert installations (CDFG 2002; NMFS 2001; Robison et al 2000; Bates et al. 1999).

Fill Estimate

The site survey data were also used to obtain an order of magnitude estimate of the fill volume. This rough estimate of fill volume was used in prioritization of site replacement or remediation and has two purposes. First, the replacement cost for a culvert site is highly influenced by the fill volume that must be moved and replaced to access the culvert. Second, the fill volume can also be an indication of potential consequences should a culvert fail due to plugging or being undersized allowing flow to overtop the road. The fill volume represents the potential volume of sediment delivered to the downstream channel when a crossing fails. Fill elevation can also be used to estimate the culvert flood capacity or the flow rate through the culvert when the culvert is submerged with an upstream water depth approaching the top of the fill. These uses of fill volume and elevation are most appropriate for small to moderate fill volumes (less than 10,000 cubic yards).

At minimum, 10 survey points were used to estimate the fill volume. The five points, FB₁, FB₂, FT₁, FT₂, and FT₃ (Figure 3) were measured on both the upstream and downstream fill slope. These ten points were then used to calculate the lengths (L_d, L_u, W_r, W_f, and W_c) and slopes (S_d and S_u) indicated in Figure 2.2. The fill volume was calculated using these values and equations 1 through 4 as outlined on page 12 of the *California Salmonid Stream Habitat Restoration Manual* (Taylor and Love, 2003). These fill estimates were an order of magnitude only and not meant to be used for design or construction purposes.

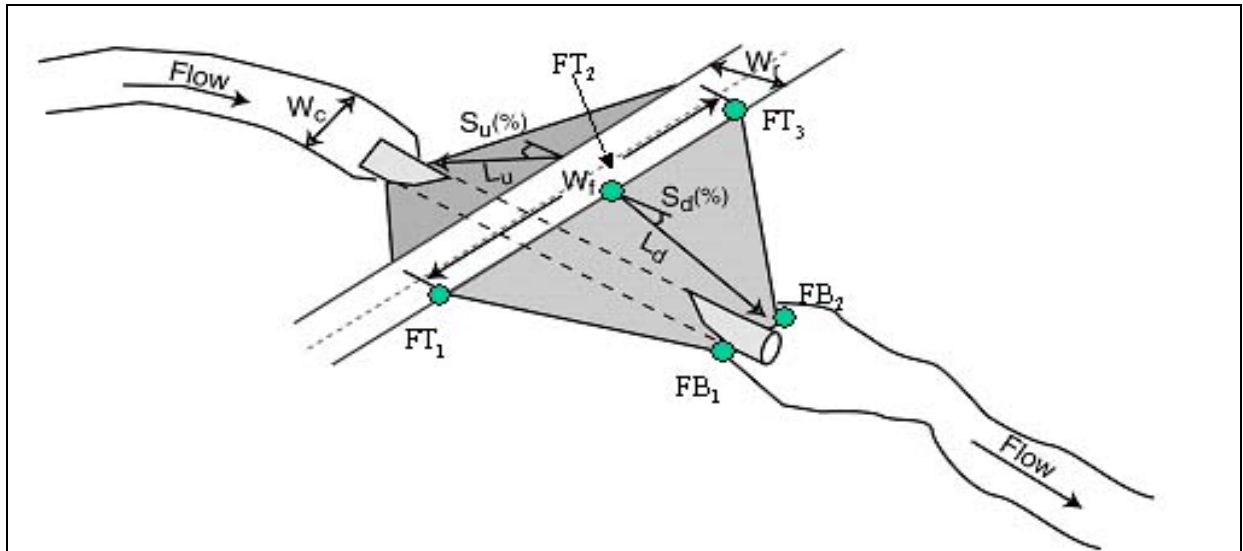


Figure 3. Road fill measurements (modified from Taylor and Love 2003).

For each crossing with a culvert, the following specifications were collected:

1. Length (to nearest 1/10 of foot);
2. Dimensions: diameter (circular), or height and width (box culverts), or span and rise (pipe arches and open-bottom arches);
3. Type: corrugated metal pipe (CSP), structural steel plate (SSP), concrete pipe, concrete box, open-bottom pipe arch, squashed pipe-arch, or a composite of materials;
4. Overall condition of pipe (good, fair, poor, extremely poor);
5. Height and width of rustline (if present);
6. Position relative to flow and stream gradient;
7. Depth of pool below culvert;
8. Height of jump required to enter culvert;
9. Previous modifications (if any) to improve fish passage; and
10. Condition of previous modifications.

For crossing that was a dam or weir, the following specifications were collected:

1. Length (to 1/10');)
2. Dimensions: width of structure, location and dimensions of any notches;
3. Construction material;
4. Overall condition (good, fair, poor, extremely poor);
5. Depth of pool below dam or weir;
6. Height of leap required to clear the structure;
7. Previous modifications (if any) to improve fish passage; and
8. Condition of previous modifications.

Qualitative notes describing stream habitat immediately upstream and downstream of each crossing were taken. Where feasible, variable lengths of the stream channel above and below crossings were walked to detect presence of salmonids, other fish species, and provide additional information regarding habitat conditions.

Data Entry and Passage Analyses

After return from the field, the total station files were downloaded to a computer. Each site was given a unique name and number with the preface SPNC (for State Parks North Coast) and then the downloaded survey data were converted into a usable format. The survey data were processed in Excel to calculate the physical characteristics needed to perform a fish passage assessment using the CDFG ranking filter and, if needed, hydraulic analysis with FishXing. All site characteristic data and information that were recorded on waterproof data sheets were also entered into an Excel spreadsheet.

First-phase Passage Evaluation Filter: GREEN-GRAY-RED

In collaboration with NOAA Fisheries, CDFG developed a ranking filter to quickly assess fish passage at stream crossings (Taylor and Love, 2003). The filtering process was used to assist in identifying sites which either met, or failed to meet, state and federal fish passage criteria for all fish species and life-stages (CDFG 2002; NMFS 2001). Using the field inventory data, the following values were calculated: average active channel width, crossing slope, residual inlet depth and drop at outlet (Figure 4). The first-phase passage evaluation filter was employed to reduce the number of crossings which required an in-depth passage evaluation with FishXing. The filter criteria were designed to quickly classify crossings into one of three categories:

- **GREEN:** Conditions assumed adequate for passage of all salmonids, including the weakest swimming life-stage.
- **GRAY:** Conditions may not be adequate for all salmonid species or life-stages presumed present. Additional analyses required to determine extent of barrier for each species and life-stage.
- **RED:** Conditions do not meet passage criteria at any flows for strongest swimming species presumed present. In some instances, assume “no passage” and move to analysis of habitat quantity and quality upstream of the barrier. A subset of “RED” sites required additional assessment with FishXing.

A spreadsheet macro was utilized that followed the CDFG flowchart to determine a stream crossing’s status as Green, Gray, or Red (Figure 5). Depending on geographic location within California, species of interest will vary. Within anadromous-bearing watersheds, CDFG has determined that crossings classified as “Green” must meet upstream passage criteria for both adult and over-wintering juvenile salmonids at all expected migration flows.

Many stream crossings have unique characteristics which may hinder fish passage, yet they are not recognized in the filtering process. For crossings meeting the “Green” criteria, a review of

the inventory data and field notes was necessary to ensure no unique passage problems existed before classifying the stream crossings as “100% passable”.

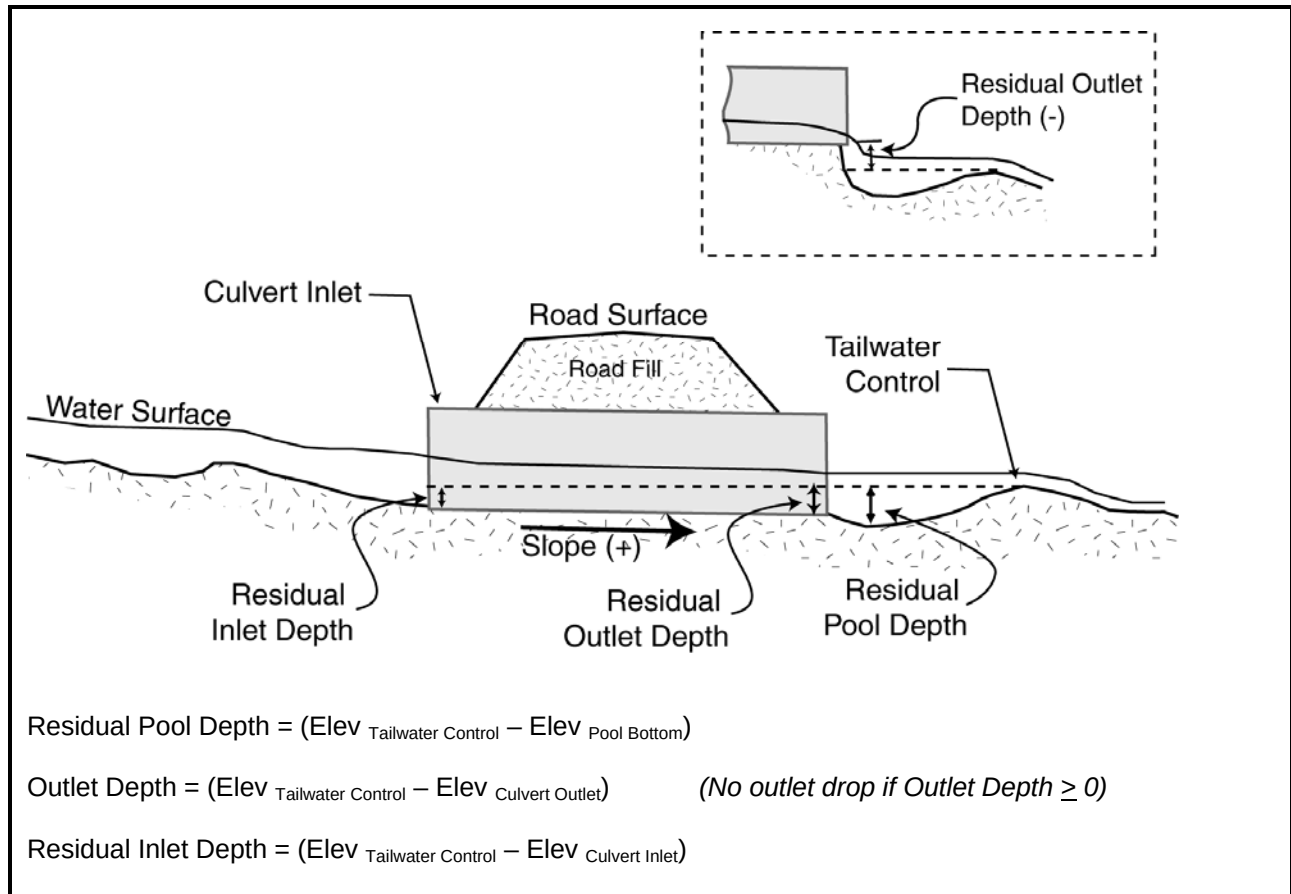


Figure 4. Measurements used in Green-Grey-Red filtering criteria.

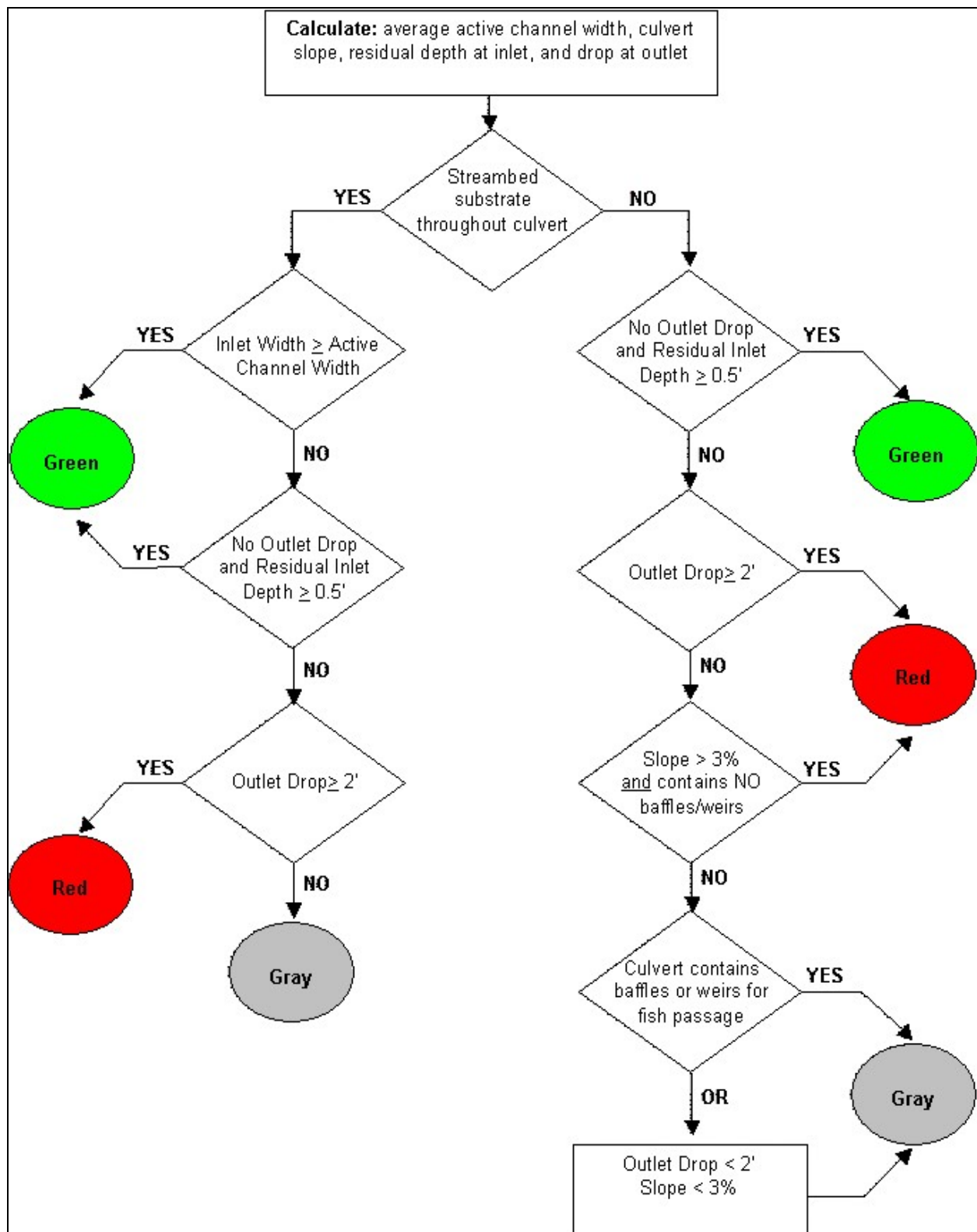


Figure 5. **GREEN-GRAY-RED** first-phase passage evaluation filter.

FishXing Overview

FishXing is a computer software program developed by Six Rivers National Forest's Watershed Interactions Team - a group of scientists with diverse backgrounds in engineering, hydrology, geomorphology, geology, and fisheries biology. Mike Furniss, a Forest Service hydrologist for Six Rivers, managed program development. The initial version of FishXing was released in March, 2000. FishXing has since undergone two revisions, with version 3.0 being the most current. In-depth information regarding FishXing (or a copy of the most-recent version) may be obtained at the FishXing homepage on the internet at www.stream.fs.fed.us/fishxing/.

FishXing is an interactive software package that integrates a culvert design and assessment model for fish passage nested within a multimedia educational setting. Culvert hydraulics are well understood and model output closely resembles reality. FishXing successfully models (predicts) hydraulic conditions throughout the culvert over a wide range of flows for numerous culvert shapes and sizes. The model incorporates fisheries inputs including fish species, age classes, body lengths, and leaping and swimming abilities. FishXing uses the swimming abilities to determine whether the culvert installation (current or proposed) will accommodate fish passage over a desired range of migration flows, and identify specific locations within the culvert that impede or prevent passage. Software outputs include water surface profiles and hydraulic variables such as water depths and average velocities displayed in both tabular and graphical formats.

Fish Passage Criteria – First Deviation from CDFG Passage Assessment Protocol

FishXing utilized survey elevation and crossing specifications to evaluate passage at sites defined as "GRAY" by the first-phase evaluation filter for each species and age class of salmonids known to currently or historically reside in coastal watersheds. The swimming abilities and passage criteria recommended in the original CDFG fish-passage protocol and the alternate values used in the North Coast Redwoods District of California State Parks project for each species and age class are listed Table 2.

The CDFG fish-passage protocol recommended using conservative values for assessment under the assumption that although many individual fish will have swimming abilities surpassing those listed, swim speeds and minimum water depths were selected to ensure stream crossings accommodated passage of weaker individuals within each age class. This assumption is better suited for the *design* of new crossings where being conservative hopefully allows for the passage of all fish. However, for *assessment* purposes, the use of conservative swimming values and minimum water depths generated many "RED" sites that, in fact, were allowing the passage of adult salmonids. This discrepancy was first noticed during RTA's Marin County assessment project (in 2002) where extensive spawning survey data confirmed adult coho salmon and steelhead consistently spawning upstream of crossings initially assessed as "RED".

If the objective of the passage assessment is to identify crossings that are truly barriers to adult migration, as well as, accurately estimate the percentage of temporal passage to allow a gradation in the scoring matrix; then using conservative values is not appropriate. The use of more rigorous passage criteria should reduce the number of "RED" sites and generate a wider range of "extent of barrier" scores for the "GRAY" sites.

Table 2. Fish species and age classes used in the fish passage along with associated swimming abilities and passage criteria. Values in parentheses are the conservative values recommended in the CDFG protocol. Passage flows are based on current adult salmonid criteria combined with observational data from northern California coastal streams.

Fish Species/Age Class	Adult Steelhead and Coho	Resident Trout	Juvenile Salmonids
Fish Length	500 mm	200 mm	80 mm
Prolonged Mode			
Swim Speed	(6 ft/sec) 8 ft/sec	4 ft/s	1.5 ft/s
Time to Exhaustion	30 min	30 min	30 min
Burst Mode			
Swim Speed	(10 ft/sec) 16 ft/sec	5.0 ft/s	3.0 ft/s
Time to Exhaustion	5 sec	5 s	5 s
Maximum Leaping Speed	(12.0 ft/sec) 16 ft/sec	6.0ft/s	3.0 ft/s
Velocity Reduction Factors for Corrugated Metal Culverts **	Inlet = 1.0 Barrel = 1.0 Outlet = 1.0	Inlet = 0.8 Barrel = 0.6 Outlet = 0.8	Inlet = 0.8 Barrel = 0.6 Outlet = 0.8
Minimum Required Water Depth	(0.8 ft) 0.5 ft	0.5 ft	0.3 ft
Minimum Passage Flow (Use the larger of the two flows)	50% exceedence flow or 3 cfs	90% exceedence flow or 2 cfs	95% exceedence flow or 1 cfs
Maximum Passage Flow	1% exceedence flow	5% exceedence flow	10% exceedence flow

** Velocity reduction factors only apply to culverts with corrugated walls, baffles, or natural substrate. All other culverts had reduction factors of 1.0 for all fish.

FishXing and other hydraulic models report the average cross-sectional water velocity, often failing to account for spatial variations. Stream crossings with natural substrate or corrugations will have regions of reduced velocities that can be utilized by migrating fish. These areas are often too small for larger fish to use, but can enhance juvenile passage success. FishXing allows the use of reduction factors that decrease the calculated water velocities proportionally. As shown in Table 2, velocity reduction factors were used in the passage analysis of resident fish and juveniles with specific types of stream crossing structures.

Using FishXing, the range of flows that met the depth, velocity, and leaping criteria for each age class were identified. The range of flows meeting the passage requirements were then compared to the entire range of fish passage flows to determine “percent passable”.

Hydrology and Design Flow

When examining stream crossings that require fish passage, three specific flows are considered: peak flow capacity of the stream crossing, the upper fish passage flow, and the lower fish passage flow. Because flow is not gauged on most small streams, it must be estimated using techniques that required hydrologic information about the stream crossing's contributing watershed, including:

- Drainage area;
- Mean annual precipitation;
- Mean annual potential evapotranspiration; and
- Average basin elevation.

Drainage area and basin elevations were calculated from a 1:24,000 USGS topographic map. For most projects, mean annual precipitation (MAP) and potential evapotranspiration (PET) are estimated from regional maps produced by Rantz (1968).

Peak Flow Capacity

Peak flows are typically defined in terms of a recurrence interval, but reported as a quantity; often as cubic feet per second (c.f.s.). Current guidelines recommend all stream crossings pass the flow associated with the 100-year flood without damage to the stream crossing (NOAA, 2001). Additionally, infrequently maintained crossings with culverts should accommodate the 100-year flood without overtopping the culvert's inlet.

Determination of a crossing's flood capacity assisted in ranking sites for remediation. Undersized crossings have a higher risk of catastrophic failure, which often results in the immediate delivery of sediment from the road-fill into the downstream channel. Depending on the amount of road-fill, this pulse of sediment may have a minor-to-catastrophic impact on downstream rearing and spawning habitat. Undersized crossings can also adversely affect sediment transport and downstream channel stability, creating conditions that hinder fish passage, degrade habitat, and may cause damage to other stream crossings or infrastructure..

The first step was to estimate hydraulic capacity of each inventoried stream crossing.

Capacity is generally a function of the shape and cross-sectional area of the inlet. Capacity was calculated for two different headwater elevations: water ponded to the top of the culvert inlet ($HW/D = 1$) and water ponded to top of the road/fill prism ($HW/F = 1$). Nomograph equations developed by Piehl et. al (1988) were used to calculate capacity of circular culverts. Federal Highways nomographs presented in Norman et al (1995) were used for pipe-arches, open bottom arches, oval pipes and box culverts. The FishXing program was also used to determine when backwatered culverts were flowing full due to outlet-controlled situations.

The second step was to estimate peak flows at each crossing. This required estimating the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year peak flows. Regional flood estimation equations developed by Waananen and Crippen (1977) were used to estimate peak flows for the

various recurrence intervals (Figure 6). The equations incorporate drainage area, MAP, and mean basin elevation as variables to predict peak flow in North Coast region California streams.

The third step was to compare the stream crossing capacity to peak flow estimates. Risk of failure was assessed by comparing a stream crossing's hydraulic capacity with the estimated peak flow for each recurrence interval. Each crossing was placed into one of six "sizing" categories:

1. equal to or greater than the 100-year flow,
2. between the 50-year and 100-year flows,
3. between the 25-year and 50-year flows,
4. between the 10-year and 25-year flows,
5. between the 10-year and 5-year flows,
6. less than the 5-year storm flow.

These six categories were utilized in the stream crossing ranking matrix.

Fish Passage Flows

It is widely agreed that designing stream crossings to pass fish at all flows is impractical (CDFG 2002; NOAA 2001; Robison et al. 2000; SSHEAR 1998). Although anadromous salmonids typically migrate upstream during higher flows triggered by hydrologic events, it is presumed that migration is naturally delayed during larger flood events. Conversely, during low flow periods on many smaller streams, water depths within the channel are often impassable for both adult and juvenile salmonids. To identify the range of flows that stream crossings should accommodate for fish passage, lower and upper flow limits have been defined specifically for streams within California (CDFG 2002; NOAA 2001).

To evaluate the extent to which a crossing is a barrier, passage was assessed between the lower and upper passage flows for each fish species and age class of concern. Typically, passage flows were determined by calculating the exceedence flows with average daily stream flow data from gauged streams available from the USGS. The methods for calculating exceedence flows were fully described in Section XI of the CDFG Restoration manual (Taylor and Love 2003).

However; for the North Coast Redwoods District of California State Parks project we found that small drainage areas above many crossings lead to extremely small values for adult high-passage flows when using the exceedence flow methodology. Thus, we utilized 50% of the two-year recurrence interval discharge as the alternate means to determine adult high-passage flow as recommended by CDFG since this method results in higher flows and a wider range of migration flows for passage assessment (CDFG 2002). For assessing resident trout/2+ juvenile high-passage we used 30% of the two-year flow and for 1+/young-of-year juveniles we used 10% of the two-year flow (CDFG 2002). Results using both methods (exceedence flows and percentages of the two-year recurrence discharge) are available for comparison in Appendix C.

When analyzing fish passage with FishXing, these flows were used to determine the extent to which the crossing was failing to meet passage criteria. The stream crossing must meet water velocity, leap height and depth criteria between Q_{lp} and Q_{hp} to be considered 100% passable (NOAA 2001). For the ranking matrix, at each stream crossing, the extent of the migration barrier was determined for each salmonid species and age class presumed present.

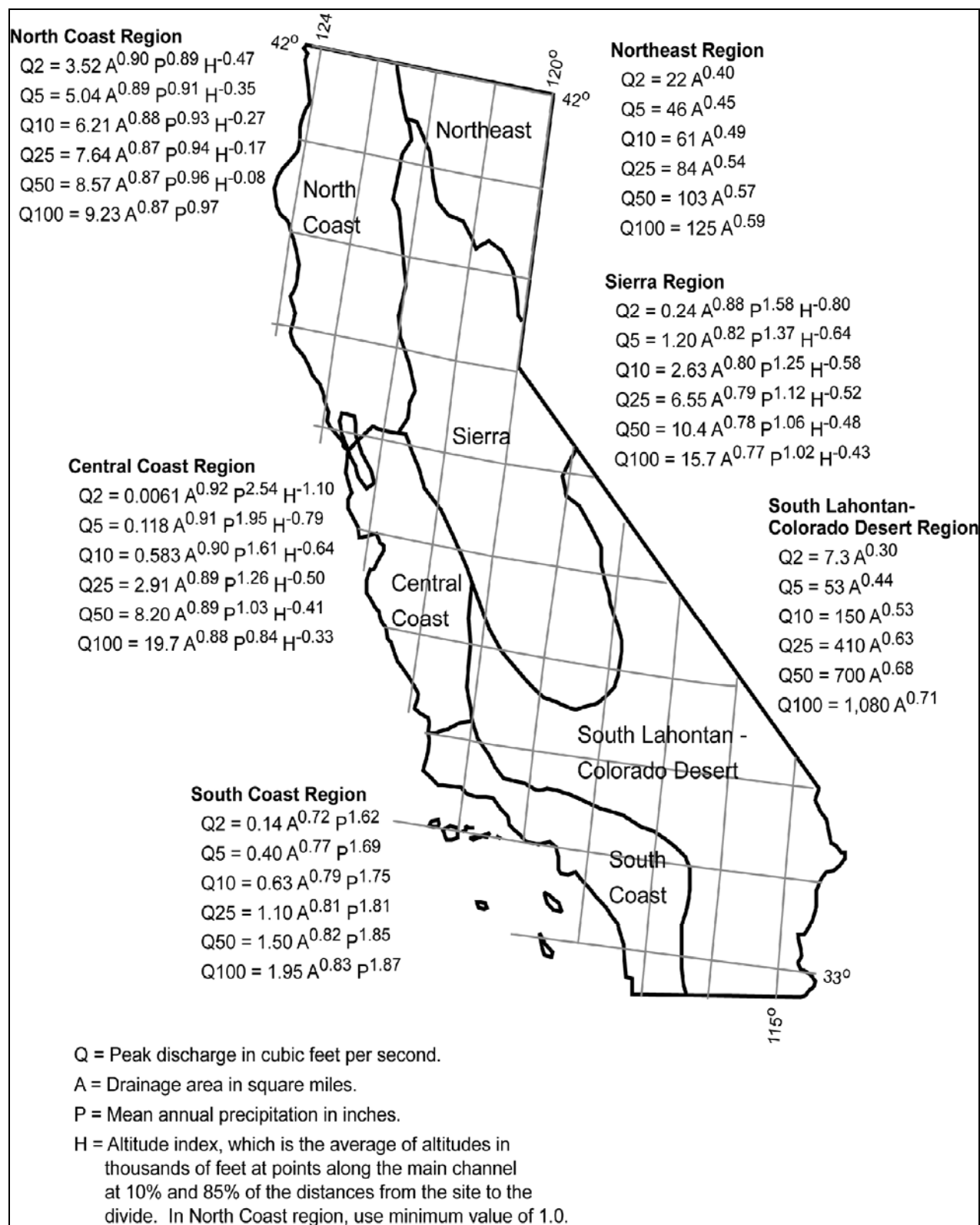


Figure 6. California regional regression equations for estimating peak flows associated with a 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year recurrence interval (Waananen and Crippen, 1977).

Habitat Information

Because this project addressed fish passage in numerous tributaries along the Northern California coast, the assessment of stream habitat conditions associated with the surveyed stream crossings was based primarily on previously completed surveys and reports, as well as the professional judgment of biologists, State Park staff or restoration groups familiar with the watersheds. Additional CDFG reports and memos also provided information on past, present, and future land uses within watersheds where stream crossings were located.

Professional judgment from on-site inspection of stream crossings and stream habitat also aided habitat assessment and evaluation. Longer reaches of stream-channel were walked to better assess quantity and quality of habitat above several crossings that were of potential high-priority for treatment. We also field checked several streams where the lengths of habitat measured off of USGS maps seemed questionable.

Habitat Quantity

Lengths of potential anadromous salmonid habitat upstream of each crossing were estimated by two methods:

1. Lengths measured in the field during previously conducted habitat typing or fisheries surveys. If access was permitted, these surveys were terminated where the field crews thought the limit of anadromy was located. The surveys were often terminated at obvious features such as natural waterfalls, extremely steep-sloped boulder cascades, or at permanent human-made structures such as dams.
2. Measured off of digitized USGS 7.5 Minute Series topographic maps (Terrain Navigator, Version 3.01 by MapTech). The upper limit of anadromous habitat was considered when the channel exceeded an eight percent slope for at least a 300-foot channel reach.

The habitat quantity value used in the ranking matrix varied, but usually if a habitat typing survey identified an obvious feature where anadromy was terminated – this was the value used. In other instances, the eight-percent slope was used only if on-the-ground survey information was unavailable.

The presence of previously assessed stream crossings above and below each site included in this project was also considered when evaluating potential habitat gains. The location (and status) of these previously assessed crossings were considered when developing the final ranking matrix for the purpose of selecting sites for treatment scheduling.

Initial Ranking of Stream Crossings for Treatment

The ranking objective was to arrange the sites in an order from high to low priority using a suite of site-specific information. However, the “scores” generated were not intended to be absolute in deciding the exact order of scheduling treatments. Once the first-cut ranking was completed, professional judgment played an important part in deciding the order of treatment. As noted by

Robison et al. (2000), numerous social and economic factors influenced the exact order of treated sites.

Because the North Coast Redwoods District of California State Parks intends on treating stream crossings identified as “high-priority” by submitting proposals to various fisheries restoration funding sources, additional opportunities for re-evaluating the biological merit of potential projects will occur through proposal review committees composed of biologists from CDFG and other agencies. The methodology for ranking migration barriers at stream crossings is a developing process and will undoubtedly require refinement as additional information is obtained.

This report also acknowledges (but makes no attempt to quantify or prioritize) that other potentially high-priority restoration projects exist throughout California, and these must all be considered when deciding where and how to best spend limited restoration funds. However, recent research regarding watershed restoration considers the identification, prioritization, and treatment of human-made migration barriers to restore ecological connectivity for salmonids a vital (and often initial) step towards recovering depressed populations (Roni et al. 2002).

Ranking Criteria

The criteria and scoring for ranking stream crossings were relatively consistent with those developed for Part IX of CDFG’s *Salmonid Stream Habitat Restoration Manual* (Taylor and Love, 2003), except for two aspects. The second deviation from the CDFG protocol entailed reducing the weight of the current crossing’s sizing and condition scores on the site’s total score. Again, this modification to the CDFG protocol resulted from carefully analyzing data sets from previously completed assessment projects. The ranking matrix developed for the *Restoration Manual* can generate a maximum possible score of 41 points, with a maximum of 10 points (24.4%) associated with crossing condition and sizing. In some instances, crossings with very little upstream habitat (<1,000’) and/or met the adult passage criteria on 70-100% of the range of migration flows were ranking near the top due primarily to poor condition and under-sizing.

Undersized crossings that are in poor condition should be of concern to road managers. However, if the primary purpose of the ranking matrix is to identify sites to treat with fisheries restoration funding, then more weight should be put on the biological-related criteria so that crossings which are serious impediments to migration with significant reaches of potential upstream habitat rank higher than crossings in need of replacement with maintenance funds.

The weight of the sizing and condition criteria score was reduced by utilizing the average of the two values. This resulted in a maximum possible total score of 36 points, with sizing and condition criteria comprising no more than 13.8% of the maximum total score. This adjustment in scoring crossing capacity and condition has already occurred on the following projects completed by RTA: Corte Madera Creek watershed, San Mateo County, Marin County, Russian River, Santa Cruz County, the Morro Bay watershed, Hopland Band of Pomo Indians and the Mendocino District of State Parks fish passage assessment projects.

The method utilized for the North Coast Redwoods District of California State Parks assessment assigned a score or value for the following criteria at each crossing location. The total score was

the sum of four criteria: species diversity, extent of barrier, average value of crossing sizing and current condition, and total habitat score.

1. **Species diversity:** number of salmonid species known to occur (or historically occurred) within the stream reach at the crossing location. **Score:** CA. ESA listing status as endangered: Coho salmon = 4 points; Federal ESA listing status as threatened south of the Klamath River: Steelhead = 2 points; Federal ESA listing status as threatened south of the Klamath River: Chinook Salmon = 2 points; CDFG species of special concern: Coastal Cutthroat Trout = 1 point. **Maximum score = 9 points.**
2. **Extent of barrier:** for three age classes of salmonids (adults, resident trout/2+ and 1+/young-of-year), over the range of estimated migration flows, assign one of the following values. **Score:** 0 = 80-100% passable; 1 = 60-80% passable; 2 = 40-60% passable; 3 = 20-40% passable; 4 = less than 20% passable; 5 = 0% passable (RED by first-phase evaluation filter). For a total score, sum scores given for adults and each year-class of juveniles. **Maximum score = 15 points.**
3. **Sizing (risk of failure):** for each crossing, assign one of the following values as related to flow capacity. **Score:** 0 = sized to NMFS standards of passing 100-year flow at less than inlet height. 1 = sized for at least a 50-year flow, low risk. 2 = sized for at least a 25-year flow, moderate risk. 3 = sized for less than a 25-year flow, moderate to high risk of failure. 4 = sized for less than a 10-year event, high risk of failure. 5 = sized for less than a five-year event, high risk of failure.
4. **Current condition:** for each crossing, assign one of the following values. **Score:** 0 = good condition. 1 = fair, showing signs of wear. 3 = poor, floor rusting through, crushed by road-base, etc. 5 = extremely poor, floor rotted-out, severely crushed, damaged inlets, collapsing wing-walls, slumping road-base, etc.
5. **Crossing Score:** for each crossing, combine the sizing and condition values and compute the average value. **Maximum score = 5 points.**
6. **Habitat quantity:** above each crossing, length in feet to sustained 8% gradient. **Score:** Starting at a 500' minimum; 0.5 points for each 500' length class (**example:** 0 points for <500'; 1 point for 1,000'; 2 points for 2,000'; 3.5 points for 3,500'; and so on). **Maximum score = 10 points.**
7. **Habitat quality:** for each stream reach within the vicinity of the crossing, assign a "multiplier" of quality (relative to other streams and stream-reaches in inventory) after reviewing available habitat information.
 - **Score: 1.0 = Excellent-** Relatively undeveloped, "pristine" watershed conditions. Habitat features include dense riparian zones with mix of mature native species, frequent pools, high-quality spawning areas, cool summer water temperatures, complex in-channel habitat, and/or channel floodplain relatively intact. High likelihood of no future human development. Presence of migration barrier(s) is obviously the watershed's limiting factor.

- **0.75 = Good-** Habitat is fairly intact, but human activities have altered the watershed with likelihood of continued activities. Habitat still includes dense riparian zones of native species, frequent pools, spawning gravels, cool summer water temperatures, complex in-channel habitat, and/or channel floodplain relatively intact. Presence of migration barrier(s) is most likely one of the watershed's primary limiting factors.
 - **0.5 = Fair-** Human activities have altered the watershed with likelihood of continued (or increased) activities, with apparent effects to watershed processes and features. Habitat impacts include riparian zone present but lack of mature conifers and/or presence of non-native species, infrequent pools, sedimentation evident in spawning areas (pool tails and riffle crests), summer water temperatures periodically exceed stressful levels for salmonids, sparse in-channel complex habitat, floodplain intact or slightly modified). Presence of migration barrier(s) may be one of the watershed's limiting factors (out of several factors).
 - **0.25 = Poor-** Human activities have drastically altered the watershed with high likelihood of continued (or increased) activities, with apparent effects to watershed processes. Habitat impacts include riparian zones absent or severely degraded, little or no pool formations, excessive sedimentation evident in spawning areas (pool tails and riffle crests), stressful to lethal summer water temperatures common, lack of in-channel habitat, floodplain severely modified with levees, riprap, and/or residential or commercial development. Other limiting factors within watershed are most likely of a higher priority for restoration than remediation of migration barriers. NOTE: a "poor" habitat rating was also assigned to stream reaches that were either too small and/or too steep immediately upstream of the crossing to provide adequate habitat for anadromous salmonids even though the stream reach was potentially available for fish utilization.
8. **Total habitat score:** Multiply #5 by #6 for habitat "score". A multiplier assigned for habitat quality, weighs the final score more on quality than sheer quantity of upstream habitat. **Maximum score = 10 points.**

For each culvert, the five ranking criteria were entered into a spreadsheet and total scores computed. Then the list was sorted by "Total Score" in a descending order to determine an initial ranking. On closer review of the rank, some professional judgment was used to slightly adjust the rank of several sites. The list was then divided subjectively into groups defined as "high", "medium", or "low" priority.

The high-priority sites were generally characterized as serious impediments to migration with significant amounts of upstream spawning and rearing habitat for salmon and steelhead. Medium-priority sites were characterized as limited in upstream habitat gains and/or were only significant impediments to juvenile migration. Low-priority sites were either limited in upstream habitat, habitat condition was poor, and/or the site allowed passage of adults and most juveniles.

Remediation of crossings identified as "high-priority" should be accomplished by submitting proposals to various fisheries restoration funding sources. The information provided in this report should be used to document the logical process employed to identify, evaluate, and rank these migration barriers.

State Parks resource managers should consider ranking medium and low-priority sites a second time focusing mainly on crossing condition, sizing, and amount of fill material within the road prism. A risk assessment may be conducted to determine the consequence of potential sediment delivery to the downstream channel if or when a crossing failed. Most medium and low-priority sites should not be considered candidates for treatment via limited restoration funding sources, unless an imminent site failure would deliver a significant amount of sediment to downstream salmonid habitat. However, this information will provide road managers a list of sites in need of future replacement with road maintenance funds. When these replacements are implemented, this report should provide guidance on treatments with properly-sized crossings conducive to adequate flow conveyance and unimpeded fish passage.

Additional Considerations for Final Ranking

On a site-specific basis, some or all of these factors were considered in rearranging the first-cut ranking to develop a final list for project scheduling:

1. Fish observations at crossings. Sites where fish were observed during migration periods were given higher priority in the final ranking. The species of salmonids observed, the number of fish, frequency of attempts, and the number of failed versus successful passage attempts were important variables considered. Sites with fish present are areas where immediate re-colonization of upstream habitat is likely to occur. Many streams in northern California have experienced immediate re-colonization after migration barriers were treated.
2. Stocks of fish presumed present. Streams currently supporting runs of anadromous fish were given a higher priority over streams that historically supported anadromous fish populations.
3. Amount of road fill. At stream crossings that were undersized and/or in poor condition, we examined the volume of fill material within the road prism potentially deliverable to the stream channel if the culvert were to fail.
4. Presence, location, and barrier status of other stream crossings. In some cases, an individual stream was crossed by multiple roads under a variety of management or ownership. In these situations, close communication amongst road managers will be important in project selection and implementation. If multiple crossings are migration barriers, a coordinated effort is required to identify and treat them in a logical manner – generally in an upstream direction starting with the lowermost crossing.
5. Remediation project cost. In some cases, sites were raised in priority if cost-effective retrofits were feasible treatment options. Conversely, some sites were lowered in priority because the only feasible treatments were full replacements of culverts underneath large amounts of fill and/or buildings.
6. Scheduling of other road maintenance and improvement projects. The upgrading of migration barriers during other scheduled maintenance and/or improvement activities was considered. When undersized or older crossings fail during storms, road managers should be prepared to install properly-sized crossings that provide unimpeded passage for all species and life-stages of fish.

RESULTS

Initial Site Visits

Initial site visits were conducted at 53 stream crossings and 29 crossings were included in the full assessment and ranking process (Table 3). Organizationally, sites were ordered by basins in a north-to-south direction and within basin in a downstream-to-upstream direction (Table 3). Reasons for excluding 24 sites from the full evaluation varied and are listed in the right-hand column of Table 3.

The 29 assessed stream crossings were each given a unique ID number starting with the prefix SPNC (State Parks North Coast) (Table 4). A table of the 29 fully-assessed stream crossings and their location information and characteristics is provided in Appendix A. More detailed summaries of location information, site-specific characteristics, FishXing results, site photographs, maps and habitat descriptions for the 29 stream crossings were assembled in a separate document titled *Site Catalog of Stream Crossings Located on Fish-bearing Stream Reaches within the North Coast Redwoods District of CA State Parks*.

The following list is an overview of the crossings inventoried:

1. During the initial site visits a variety of crossing types and materials were discovered. Fully-spanning bridges were present at 17 sites. Corrugated metal pipes (CMP) and structural-plate metal pipes (SSP) were encountered at 17 sites (Table 4). Concrete box culverts were common structures on tributaries to Prairie Creek along the Newton B. Drury Parkway; a total of 11 crossings had box culverts dating from the late 1920s (Table 4).
2. Twelve of the 29 fully assessed crossings were in good condition (41% of the sites). Another eight crossings (28% of the sites) were described as in “fair” condition, and were starting to show signs of deterioration. The remaining nine fully-assessed crossings were classified as being in either “poor” or “extremely poor” condition (31% of the sites) and are in need of replacement. These nine poor-condition sites were SPNC-01, SPNC-02, SPNC-03, SPNC-04 on Howland Hill Road; SPNC-07 and SPNC-08 on Redwood National Park’s Southern Operations Road; SPNC-11 on Davison Road; and SPNC-24 and SPNC-26 on the Mattole Road. These last two sites were on a Humboldt County-maintained road, and this information will be passed on to the County’s Public Works Department.
3. Only a single crossing (SPNC-27, Harper Creek/Mattole Road) was properly sized for flow conveyance when compared to NMFS guidelines that recommend stream crossings pass the 100-year storm flow at less than 100% of inlet height (Table 5). Two crossings (SPNC-12 and SPNC-23) were determined to pass between the 50 and 100-year storm at 100% of inlet height (Table 5). Twenty of the 29 fully-assessed crossings were significantly undersized, all unable to pass a 10-year storm flow at 100% of inlet height (Table 5). Fourteen of these crossings were considered severely undersized because they were at 100% of inlet height on less than a 5-year storm flow (Table 5). These 14 crossings should be of concern to road managers due to their limited capacity to convey storm flows, as well as the poor condition of nine of these crossings (SPNC-01, SPNC-02, SPNC-03, SPNC-04, SPNC-07, SPNC-08, SPNC-11, SPNC-24 and SPNC-26).

Table 3. Status of initial site visits for the North Coast Redwoods District of CA State Parks stream crossing inventory and fish passage evaluation project. Sites are listed by basin name in a north-to-south direction and from downstream-to-upstream direction within basins.

BASIN	STREAM	ROAD NAME OR #	STATE PARK UNIT	LAT/LONG	STATUS OF INITIAL SITE VISIT
Smith River	Mill Creek	Howland Hill Road	Jedediah Smith Redwoods	N41.77413 W124.09988	Bridge
Smith River	Unnamed Trib to Mill Creek	Howland Hill Road	Jedediah Smith Redwoods	N41.76881 W124.10592	Survey Completed
Smith River	Unnamed Trib #1 to Nickerson Ck	Howland Hill Road	Jedediah Smith Redwoods	N41.76628 W124.11741	Survey Completed
Smith River	Unnamed Trib #2 to Nickerson Ck	Howland Hill Road	Jedediah Smith Redwoods	N41.76765 W124.11131	Survey Completed
Smith River	Metcalf Creek; trib to Nickerson Ck	Howland Hill Road	Jedediah Smith Redwoods	N41.652728 W124.1295531	Survey Completed
Smith River	Nickerson Creek	Nickerson Ranch Trail	Jedediah Smith Redwoods	N41.76529 W124.11136	Foot Bridge
Smith River	Mill Creek	Nickerson Ranch Trail	Jedediah Smith Redwoods	N41.76110 W124.10834	No crossing present. The USGS topographic map indicated a crossing.
Smith River	West Branch Mill Creek	Hamilton Road	Mill Creek Acquisition	N41.72998 W124.05768	Bridge – near Park offices.
Smith River	Trib to West Branch Mill Ck	Picnic Road	Mill Creek Acquisition	N41.72860 W124.10879	Survey Completed
Smith River	West Branch Mill Creek	Picnic Road	Mill Creek Acquisition	N41.70914 W124.10713	No crossing present. The USGS topographic map had indicated a crossing.
Smith River	West Branch Mill Creek	Mill Creek Campground Road	Mill Creek Acquisition	N 39.33227 W123.79223	Bridge – Alder Campground.
Smith River	West Branch Mill Creek	West Branch Road	Mill Creek Acquisition	N41.68632 W124.06680	Bridge
Smith River	Unnamed trib to East Fork Mill Ck	Hamilton Road	Mill Creek Acquisition	N41.73091 W124.08873	Bridge

Table 3 (continued). Status of initial site visits for the North Coast Redwoods District of CA State Parks stream crossing inventory and fish passage evaluation project. Sites are listed by basin name in a north-to-south direction and from downstream-to-upstream direction within basins.

BASIN	STREAM	ROAD NAME OR #	STATE PARK UNIT	LAT/LONG	STATUS OF INITIAL SITE VISIT
Smith River	East Fork Mill Creek #1	Low Water Crossing Rd	Mill Creek Acquisition	N41.72538 W124.07634	Low water ford crossing
Smith River	East Fork Mill Creek #2	Rock Creek Road	Mill Creek Acquisition	N41.72598 W124.07322	Bridge
Smith River	Bummer Lake Creek	Child's Hill Road	Mill Creek Acquisition	N41.72741 W124.06790	Bridge
Smith River	East Fork Mill Creek #3	Child's Hill Road	Mill Creek Acquisition	N41.72214 W124.05221	Bridge
Coastal Stream	Espa Creek	Davison Road	Prairie Creek State Park	N 41.35098 W 124.06984	Survey Completed
Redwood Creek	West Fork Strawberry Creek	Southern Operations Rd	Redwood National Park	N41.27640 W124.07382	Survey Completed
Redwood Creek	Strawberry Creek	Southern Operations Rd	Redwood National Park	N41.27475 W124.07243	Survey Completed
Redwood Creek	Trillium Falls Creek	Davison Trail	Prairie Creek State Park	N41.32040 W124.04527	Survey Completed
Redwood Creek	Unnamed Tributary #1	Davison Trail	Prairie Creek State Park	N41.32189 W124.04499	Survey Completed
Redwood Creek	Unnamed Tributary	Davison Trail	Prairie Creek State Park	N 41.32424 W 124.04354	Upstream channel too steep for fish.
Redwood Creek	Lost Man Creek #1	Lost Man Creek Road	Prairie Creek State Park	N 41.32759 W 124.01574	Bridge
Redwood Creek	Lost Man Creek #2	Lost Man Creek Road	Prairie Creek State Park	N 41.32433 W 124.01204	Bridge
Redwood Creek	Lost Man Creek #3	Lost Man Creek Road	Prairie Creek State Park	N 41.32445 W 124.01143	Bridge

Table 3 (continued). Status of initial site visits for the North Coast Redwoods District of CA State Parks stream crossing inventory and fish passage evaluation project. Sites are listed by basin name in a north-to-south direction and from downstream-to-upstream direction within basins.

BASIN	STREAM	ROAD NAME OR #	STATE PARK UNIT	LAT/LONG	STATUS OF INITIAL SITE VISIT
Redwood Creek	North Fork Lost Man Creek	Lost Man Creek Road	Prairie Creek State Park	N 41.32360 W 124.99869	Two SSP culverts, but bridge to be installed in summer of 2009.
Redwood Creek	Streelow Creek	Davison Trail	Prairie Creek State Park	N 41.34466 W 124.03229	Bridge
Redwood Creek	North Fork Streelow Creek	Streelow Creek Trail	Prairie Creek State Park	N 41.34585 W 124.04599	New bridge on trail.
Redwood Creek	Unnamed Trib to Streelow Creek	Streelow Creek Trail	Prairie Creek State Park	N 41.34492 W 124.05444	Failing Humboldt crossing – active erosion source that should be treated.
Redwood Creek	Upper Streelow Creek	Davison Road	Prairie Creek State Park	N 41.34097 W 124.05962	Survey Completed
Redwood Creek	Boyes Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.36446 W 124.02029	Survey Completed
Redwood Creek	Big Tree Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.37716 W 124.01425	Survey Completed
Redwood Creek	Unnamed Tributary at Corkscrew Tree	N. B. Drury Parkway	Prairie Creek State Park	N 41.38204 W 124.01495	Upstream channel too steep for fish.
Redwood Creek	Browns Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.38839 W 124.01739	Survey Completed
Redwood Creek	Good Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.40255 W 124.02867	Survey Completed
Redwood Creek	Unnamed Tributary #2	N. B. Drury Parkway	Prairie Creek State Park	N 41.40586 W 124.02967	Survey Completed
Redwood Creek	Unnamed Tributary #3	N. B. Drury Parkway	Prairie Creek State Park	N 41.40803 W 124.03020	Survey Completed
Redwood Creek	Sweet Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.41397 W 124.03145	Survey Completed

Table 3 (continued). Status of initial site visits for the North Coast Redwoods District of CA State Parks stream crossing inventory and fish passage evaluation project. Sites are listed by basin name in a north-to-south direction and from downstream-to-upstream direction within basins.

BASIN	STREAM	ROAD NAME OR #	STATE PARK UNIT	LAT/LONG	STATUS OF INITIAL SITE VISIT
Redwood Creek	Unnamed Tributary #4	N. B. Drury Parkway	Prairie Creek State Park	N 41.42054 W 124.03429	Survey Completed
Redwood Creek	Little Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.42691 W 124.03678	Survey Completed
Redwood Creek	Ten Taypo Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.43365 W 124.03899	Survey Completed
Redwood Creek	Hope Creek	N. B. Drury Parkway	Prairie Creek State Park	N 41.43878 W 124.04053	Survey Completed
Redwood Creek	Prairie Creek	N. B. Drury Parkway	Prairie Creek State Park	N 44.44090 W 124.04106	Survey Completed
Eel River	Cabin Creek	Mattole Road	Humboldt Redwoods	N40.34989 W123.93138	Survey Completed
Eel River	Cow Creek	Mattole Road	Humboldt Redwoods	N40.35079 W123.96347	Survey Completed
Eel River	Calf Creek	Mattole Road	Humboldt Redwoods	N40.35289 W123.97589	Survey Completed
Eel River	Harper Creek	Mattole Road	Humboldt Redwoods	N40.35109 W123.98799	Survey Completed
Eel River	Cuneo Creek	Mattole Road	Humboldt Redwoods	N 40.33316 W 124.02739	Bridge
Eel River	Durphy Creek #1	Oak Flat Campground	Richardson Grove	N40.02171 W123.79215	Survey Completed
Eel River	Durphy Creek #2	Madrone Campground	Richardson Grove	N40.02073 W123.79388	Survey Completed
Eel River	Mill Creek	Page and Gates Road	Standish Hickey	N 39.88543 W 123.74463	Bridge

Table 4. Site ID numbers for the 29 stream crossings fully assessed for the North Coast Redwoods District of CA State Parks.

SITE ID #	STREAM NAME	ROAD NAME or LOCATION	CROSSING TYPE
SPNC-01	Unnamed Tributary to Mill Creek	Howland Hill Road	Circular CSP Culvert
SPNC-02	Unnamed Tributary #1 to Nickerson Creek	Howland Hill Road	Circular CSP Culvert
SPNC-03	Unnamed Tributary #3 to Nickerson Creek	Howland Hill Road	Circular SSP Culvert
SPNC-04	Metcalf Grove Creek	Howland Hill Road	Circular CSP Culvert
SPNC-05	Unnamed Tributary to West Fork Mill Creek	Picnic Road	Circular CSP Culvert
SPNC-06	Espa Creek	Davison Road	Circular SSP Culvert
SPNC-07	West Fork Strawberry Creek	Southern Operations Road	Circular CSP Culvert
SPNC-08	Strawberry Creek	Southern Operations Road	Circular CSP Culvert
SPNC-09	Trillium Falls Creek	Davison Trail	Circular Aluminum Culvert
SPNC-10	Unnamed tributary #1 to Prairie Creek	Davison Trail	CSP Pipe-arch
SPNC-11	Streelow Creek	Davison Road	Oval CSP Culvert
SPNC-12	Boyes Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-13	Big Tree Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-14	Browns Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-15	Good Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-16	Unnamed tributary #2 to Prairie Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-17	Unnamed Tributary #3 to Prairie Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-18	Sweet Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-19	Unnamed tributary #4 to Prairie Creek	Newton B. Drury Parkway	Concrete Box Culvert

Table 4 (continued). Site ID numbers for the 29 stream crossings fully assessed for the North Coast Redwoods District of CA State Parks.

SITE ID #	STREAM NAME	ROAD NAME or LOCATION	CROSSING TYPE
SPNC-20	Little Creek	Newton B. Drury Parkway	Concrete Box Culvert with circular concrete pipe at outlet
SPNC-21	Ten Taypo Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-22	Hope Creek	Newton B. Drury Parkway	Concrete Box Culvert with circular concrete pipe at outlet
SPNC-23	Prairie Creek	Newton B. Drury Parkway	Concrete Box Culvert
SPNC-24	Cabin Creek	Mattole Road	Circular SSP Culvert
SPNC-25	Cow Creek	Mattole Road	Circular CSP Culvert w/spiral corrugations
SPNC-26	Calf Creek	Mattole Road	Circular SSP Culvert
SPNC-27	Harper Creek	Mattole Road	Two-bay Concrete Box Culvert
SPNC-28	Durphy Creek #1	Oak Flat Campground Road	Circular SSP Culvert
SPNC-29	Durphy Creek #2	Madrone Campground Road	Circular SSP Culvert

Table 5. Hydraulic capacities of the 29 fully-assessed stream crossings maintained by the North Coast Redwoods District of CA State Parks. Capacity is expressed as both a discharge (c.f.s.) and a recurrence-interval (years) for flows overtopping culvert inlet (HW/D=1).

SITE ID #	STREAM NAME	ROAD NAME or LOCATION	Capacity (c.f.s.) at HW/D = 1	Capacity – Recurrence Interval
SPNC-01	Unnamed Tributary to Mill Creek	Howland Hill Road	20	3-year
SPNC-02	Unnamed Tributary #1 to Nickerson Ck	Howland Hill Road	46	2-year
SPNC-03	Unnamed Tributary #2 to Nickerson Ck	Howland Hill Road	46	3-year
SPNC-04	Metcalf Grove Creek	Howland Hill Road	31	2-year
SPNC-05	Unnamed Tributary to West Fork Mill Creek	Picnic Road	363	5-year
SPNC-06	Espa Creek	Davison Road	112	3-year
SPNC-07	West Fork Strawberry Creek	Southern Operations Road	6	1-year
SPNC-08	Strawberry Creek	Southern Operations Road	31	1-year
SPNC-09	Trillium Falls Creek	Davison Trail	135	40-year
SPNC-10	Unnamed tributary #1 to Prairie Creek	Davison Trail	240	15-year
SPNC-11	Streelow Creek	Davison Road	60	2-year
SPNC-12	Boyes Creek	Newton B. Drury Parkway	930	60-year
SPNC-13	Big Tree Creek	Newton B. Drury Parkway	198	11-year
SPNC-14	Browns Creek	Newton B. Drury Parkway	710	29-year
SPNC-15	Good Creek	Newton B. Drury Parkway	100	30-year
SPNC-16	Unnamed tributary #2 to Prairie Creek	Newton B. Drury Parkway	100	21-year
SPNC-17	Unnamed Tributary #3 to Prairie Creek	Newton B. Drury Parkway	56	3-year
SPNC-18	Sweet Creek	Newton B. Drury Parkway	100	5-year
SPNC-19	Unnamed tributary #4 to Prairie Creek	Newton B. Drury Parkway	115	9-year

Table 5 (continued). Hydraulic capacities of the 29 fully-assessed stream crossings maintained by the North Coast Redwoods District of CA State Parks. Capacity is expressed as both a discharge (c.f.s.) and a recurrence-interval (years) for flows overtopping culvert inlet (HW/D=1).

SITE ID #	STREAM NAME	ROAD NAME or LOCATION	Capacity (c.f.s.) at HW/D = 1	Capacity – Recurrence Interval
SPNC-20	Little Creek	Newton B. Drury Parkway	104	7-year
SPNC-21	Ten Taypo Creek	Newton B. Drury Parkway	80	3-year
SPNC-22	Hope Creek	Newton B. Drury Parkway	7.5	1-year
SPNC-23	Prairie Creek	Newton B. Drury Parkway	165	94-year
SPNC-24	Cabin Creek	Mattole Road	71	1-year
SPNC-25	Cow Creek	Mattole Road	363	3-year
SPNC-26	Calf Creek	Mattole Road	64	2-year
SPNC-27	Harper Creek	Mattole Road	1,620	>100-year
SPNC-28	Durphy Creek #1	Oak Flat Campground	537	5-year
SPNC-29	Durphy Creek #2	Madrone Campground	670	10-year

Passage Analyses

The **GREEN-GRAY-RED** first-phase evaluation filter reduced the number of sites requiring in-depth analyses with FishXing. The initial use of the first-phase filter was followed by passage evaluations with FishXing on all **GRAY** and three **RED** sites (Table 6). Passage for adult anadromous salmonids was assessed with the more rigorous swimming abilities of 8ft/sec for prolonged swimming mode, 16 ft/sec for burst speed swimming mode and exit velocity, and a minimum water depth of 0.5 feet.

Crossings which failed to meet the more rigorous criteria may still actually provide partial or temporal passage during certain flow conditions. The values used for the passage evaluations were more rigorous than CDFG's recommended criteria, yet were still less than the maximum values recorded for adult coho salmon and steelhead. Some passage probably also occurs at sites where FishXing identified the only violation of the passage criteria as a lack-of-depth. However, **RED** sites were given a "total barrier" score in the ranking matrix unless a FishXing assessment confirmed some passage for adults.

Table 6. GREEN-GRAY-RED first-phase evaluation filter results for the 29 fully-assessed stream crossings maintained by the North Coast Redwoods District of CA State Parks.

SITE ID #	STREAM NAME	ROAD NAME or LOCATION	FILTER RESULT	FISHXING RUN?
SPNC-01	Unnamed Tributary to Mill Creek	Howland Hill Road	RED	YES
SPNC-02	Unnamed Tributary #1 to Nickerson Ck	Howland Hill Road	GRAY	YES
SPNC-03	Unnamed Tributary #2 to Nickerson Ck	Howland Hill Road	RED	YES
SPNC-04	Metcalf Grove Creek	Howland Hill Road	RED	NO
SPNC-05	Unnamed Tributary to West Fork Mill Creek	Picnic Road	RED	NO
SPNC-06	Espa Creek	Davison Road	RED	YES
SPNC-07	West Fork Strawberry Creek	Southern Operations Road	GRAY	YES
SPNC-08	Strawberry Creek	Southern Operations Road	GREEN	NO
SPNC-09	Trillium Falls Creek	Davison Trail	GREEN	NO
SPNC-10	Unnamed tributary #1 to Prairie Creek	Davison Trail	GREEN	NO
SPNC-11	Streelow Creek	Davison Road	GRAY	YES
SPNC-12	Boyes Creek	Newton B. Drury Parkway	GREEN	NO
SPNC-13	Big Tree Creek	Newton B. Drury Parkway	RED	YES
SPNC-14	Browns Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-15	Good Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-16	Unnamed tributary #2 to Prairie Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-17	Unnamed Tributary #3 to Prairie Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-18	Sweet Creek	Newton B. Drury Parkway	RED	NO
SPNC-19	Unnamed tributary #4 to Prairie Creek	Newton B. Drury Parkway	GRAY	YES

Table 6 (continued). **GREEN-GRAY-RED** first-phase evaluation filter results for the 29 fully-assessed stream crossings maintained by the North Coast Redwoods District of CA State Parks.

SITE ID #	STREAM NAME	ROAD NAME or LOCATION	FILTER RESULT	FISHXING RUN?
SPNC-20	Little Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-21	Ten Taypo Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-22	Hope Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-23	Prairie Creek	Newton B. Drury Parkway	GRAY	YES
SPNC-24	Cabin Creek	Mattole Road	RED	NO
SPNC-25	Cow Creek	Mattole Road	GRAY	YES
SPNC-26	Calf Creek	Mattole Road	GREEN	NO
SPNC-27	Harper Creek	Mattole Road	GRAY	YES
SPNC-28	Durphy Creek #1	Oak Flat Campground	GRAY	YES
SPNC-29	Durphy Creek #2	Madrone Campground	GRAY	YES

FishXing proved an extremely useful tool in estimating the extent of passage at all 16 **GRAY** and identifying the probable causes of blockages. Three **RED** sites were also assessed with FishXing to evaluate whether adult salmonids could pass through two culverts with slopes greater than four percent (SPNC-01 and SPNC-06) and one culvert with an outlet perched more than two feet (SPNC-03).

However, like most models which attempt to predict complex physical and biological processes with mathematics, there were limitations and assumptions that must be acknowledged when using FishXing. Many stream crossings have site-specific characteristics that may influence hydraulics in a way that the software cannot account for, such as a box culvert outlet with an irregularly-poured concrete edge. In other cases, varying materials (and condition) within the crossing and at the tail-water control rendered the selection of a proper roughness coefficient difficult.

Biological considerations are probably more difficult to account for than the physical attributes of the stream crossings in interpreting FishXing results. Over the past 10 winters, repeated visits to numerous crossings with culverts in northern California during migration flows revealed some confounding results generated by FishXing:

1. Adult salmonids having great difficulties entering perched culverts which FishXing suggested were easily within the species' leaping and swimming capabilities.
2. Adult salmonids successfully migrating through water depths defined as "too shallow" by current fish passage assessment and design criteria.

The behavior and abilities of fish are too varied and complex to be summed up with an equation or a number taken from a published article. Even a single fishes' leaping and swimming abilities at a culvert may change as numerous attempts are made. Extensive winter-time observations at culverts in northern California have documented individual fish become fatigued over repetitive attempts, and conversely documented other fish gaining access to culverts after numerous failed attempts (Taylor 2000-03; Love pers. comm.).

Due to these factors, passage evaluation results generated by FishXing were used conservatively in the ranking matrix by lumping "percent passable" into large (20%) categories. Adult steelhead and coho salmon were grouped in the "adult" run, resident coastal rainbow trout and two-year old (2+) steelhead were grouped as the "resident trout" run, and one-year old (1+) and young-of-the-year (y-o-y) steelhead and coho salmon were grouped as the "juvenile" run (Table 7).

For each site, by age-class, FishXing evaluation results are provided in Table 7. The hydrologic data and information utilized to calculate peak flows and range of fish passage flows at each crossing are provided in Appendix B. The detailed FishXing results are also located in Appendix B.

Table 7. FishXing results for seven 19 crossings maintained by the North Coast Redwoods District of CA State Parks. Q_{lp} = low fish passage flow; Q_{hp} = high fish passage flow.

SITE ID #	Stream Name	Age Class Assessed	Range of Migration Flows (cfs)	Percent Passable	Barrier Codes at Q_{lp}	Barrier Codes at Q_{hp}
SPNC-01	Mill Creek – Unnamed Trib	Adult	3 – 7.6	74.7%	Depth	NONE
SPNC-02	Nickerson Ck – Unnamed Trib #1	Adult	3 – 30.2	97.6%	Depth	NONE
SPNC-02	Nickerson Ck – Unnamed Trib #1	Resident trout	2 – 18.1	0.0%	Depth	V
SPNC-02	Nickerson Ck – Unnamed Trib #1	Juvenile	1 – 6.0	5.6%	NONE	EB
SPNC-03	Nickerson Ck – Unnamed Trib #2	Adult	3 – 20.8	91.7%	Depth	NONE
SPNC-06	Espa Creek	Adult	3 – 46.8	11.0%	Depth	V
SPNC-07	West Fork Strawberry Creek	Adult	3 – 18.6	92.8%	Depth	NONE
SPNC-07	West Fork Strawberry Creek	Resident trout	2 – 11.1	0.0%	Depth	V
SPNC-07	West Fork Strawberry Creek	Juvenile	1 – 3.7	0.0%	EB	V
SPNC-11	Streelov Creek	Adult	3 – 35.4	100.0%	NONE	NONE
SPNC-11	Streelov Creek	Resident trout	2 – 21.3	100.0%	NONE	NONE
SPNC-11	Streelov Creek	Juvenile	1 – 7.1	65.0%	NONE	EB
SPNC-14	Browns Creek	Adult	3 – 127.1	100.0%	NONE	NONE
SPNC-14	Browns Creek	Resident trout	2 – 76.2	86.7%	NONE	EB
SPNC-14	Browns Creek	Juvenile	1 – 25.4	59.60%	NONE	EB
SPNC-15	Good Creek	Adult	3 – 21.6	63.0%	Depth	NONE
SPNC-15	Good Creek	Resident trout	2 – 13.0	19.3%	Depth	EB
SPNC-15	Good Creek	Juvenile	1 – 4.3	0.0%	Depth; EB	Depth; V

Barrier Code Key: Leap = too high; Pool = outlet pool too shallow; Depth = culvert too shallow; V = excessive velocities within culvert; EB = fish swims to exhaustion in burst mode.

Table 7 (continued). FishXing results for 19 stream crossings maintained by the North Coast Redwoods District of CA State Parks. Q_{lp} = low fish passage flow; Q_{hp} = high fish passage flow.

SITE ID #	Stream Name	Age Class Assessed	Range of Migration Flows (cfs)	Percent Passable	Barrier Codes at Q_{lp}	Barrier Codes at Q_{hp}
SPNC -16	Prairie Creek – Unnamed Trib #2	Adult	3 – 18.5	4.5%	Depth	NONE
SPNC -16	Prairie Creek – Unnamed Trib #2	Resident trout	2 – 11.1	0.0%	Depth	Depth; V
SPNC -16	Prairie Creek – Unnamed Trib #2	Juvenile	1 – 3.7	0.0%	Depth; EB	Depth; V
SPNC -17	Prairie Creek – Unnamed Trib #3	Adult	3 – 22.4	0.0%	Depth	Depth
SPNC -17	Prairie Creek – Unnamed Trib #3	Resident trout	2 – 13.4	0.0%	Depth	Depth; V
SPNC -17	Prairie Creek – Unnamed Trib #3	Juvenile	1 – 4.5	0.0%	Depth	Depth; V
SPNC -19	Prairie Creek – Unnamed Trib #4	Adult	3 – 27.7	89.9%	Depth	NONE
SPNC -19	Prairie Creek – Unnamed Trib #4	Resident trout	2 – 16.6	76.1%	Depth	NONE
SPNC -19	Prairie Creek – Unnamed Trib #4	Juvenile	1 – 5.5	0.0%	Depth	EB
SPNC -20	Little Creek	Adult	3 – 28.5	88.0%	Depth	NONE
SPNC -20	Little Creek	Resident trout	2 – 17.1	24.0%	Depth	V
SPNC -20	Little Creek	Juvenile	1 – 5.7	0.0%	Depth	V
SPNC -21	Ten Taypo Creek	Adult	3 – 33.7	86.4%	Depth	NONE
SPNC -21	Ten Taypo Creek	Resident trout	2 – 20.2	71.6%	Depth; EB	NONE
SPNC -21	Ten Taypo Creek	Juvenile	1 – 6.7	71.6%	Depth; V	V
SPNC -22	Hope Creek	Adult	3 – 11.2	13.9%	Depth	NONE
SPNC -22	Hope Creek	Resident trout	2 – 6.7	0.0%	Depth	Depth; V
SPNC -22	Hope Creek	Juvenile	1 – 2.2	0.0%	Depth; V	Depth; V

Barrier Code Key: Leap = too high; Pool = outlet pool too shallow; Depth = culvert too shallow; V = excessive velocities within culvert; EB = fish swims to exhaustion in burst mode.

Table 7 (continued). FishXing results for 19 stream crossings maintained by the North Coast Redwoods District of CA State Parks. Q_{lp} = low fish passage flow; Q_{hp} = high fish passage flow.

SITE ID #	Stream Name	Age Class Assessed	Range of Migration Flows (cfs)	Percent Passable	Barrier Codes at Q_{lp}	Barrier Codes at Q_{hp}
SPNC-23	Prairie Creek	Adult	3 – 21.6	100.0%	NONE	NONE
SPNC-23	Prairie Creek	Resident trout	2 – 13.0	100.0%	NONE	NONE
SPNC-23	Prairie Creek	Juvenile	1 – 4.3	100.0%	NONE	NONE
SPNC-25	Cow Creek	Adult	3 – 142.4	58.9%	Depth	EB
SPNC-25	Cow Creek	Resident trout	2 – 85.5	0.9%	Depth	V
SPNC-25	Cow Creek	Juvenile	1 – 28.5	7.1%	NONE	EB
SPNC-27	Harper Creek	Adult	3 – 98.7	78.0%	Depth	NONE
SPNC-27	Harper Creek	Resident trout	2 – 59.2	0.0%	Depth	EB
SPNC-27	Harper Creek	Juvenile	1 – 19.7	0.0%	Depth	V
SPNC-28	Durphy Creek #1	Adult	3 – 168.5	98.7%	Depth	NONE
SPNC-28	Durphy Creek #1	Resident trout	2 – 101.1	5.9%	Depth	V
SPNC-28	Durphy Creek #1	Juvenile	1 – 33.7	0.0%	Depth; EB	V
SPNC-29	Durphy Creek #2	Adult	3 – 164.8	100.0%	NONE	NONE
SPNC-29	Durphy Creek #2	Resident trout	2 – 98.9	23.9%	NONE	V
SPNC-29	Durphy Creek #2	Juvenile	1 – 33.0	11.0%	NONE	V

Barrier Code Key: Leap = too high; Pool = outlet pool too shallow; Depth = culvert too shallow; V = excessive velocities within culvert; EB = fish swims to exhaustion in burst mode.

Ranking Matrix

The 29 evaluated stream crossing locations were sorted by “Total Score”, the sum of the four ranking criteria (Appendix C). The right-hand column of the final ranking matrix provides information on the passage analyses, general recommendations for treatment and suggested changes in treatment order due to professional judgment and other factors (Table 8).

As previously mentioned in the Methods section, the primary purpose of the ranking matrix developed for the CDFG protocol was to roughly sort the sites into a descending order of scores where sites could be grouped as high, medium, or low priority. There are many other factors to consider when selecting sites to treat that were not feasible to capture in a discrete scoring matrix. On a site-specific basis, one or more of the following factors were considered when recommending that a site be either raised or lowered in the ranking for project scheduling:

- Additional migration barriers above or below a site that would limit the amount of re-opened habitat by treating just this crossing – lower in ranking.
- Criteria other than “extent of barrier” accounting for large percentage of a site’s final score – lower in ranking.
- FishXing flagged “lack-of-depth” as the only passage criteria violation – lower in ranking.
- Expensive replacement is only feasible treatment option – lower in rank.
- Cost-effective retrofit versus expensive replacement – raise in ranking.
- Site with limited reach of upstream habitat, but of good-quality and currently utilized by coho salmon (or coho known to occur immediately downstream of crossing) – raise in ranking.
- Limited upstream habitat benefit, but high likelihood of crossing failure and potential for significant sediment release to good-quality downstream habitat – raise in ranking.
- Instances where two streams’ culverts meet at a common confluence and the two sites could be addressed as a single project – raise in ranking.
- In streams with multiple crossings, re-arranging sites so that treatment proceeds in an upstream direction – either raise or lower in ranking.

Adjustments to the suggested order of treatment scheduling in this final report were made after drafts of the ranking matrix and of Table 8 were circulated for review by North Coast Redwoods District of State Parks personnel, CDFG biologists and the contract manager; all who were familiar with these watersheds. However, as new information becomes available after the completion of this report, the exact order of treatment will probably continue to change.

Table 8. Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA. State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
High	SPNC-05	Unnamed Tributary to West Fork Mill Creek	Picnic Road	15	8,900'	30.2	Highest-Priority due to: severity of the barrier and extensive amount of good-quality upstream habitat. The crossing fails to meet the passage criteria for all age classes of salmon and steelhead due to the outlet drop (residual outlet depth = -3.77') and insufficient depth in the outlet pool for leap attempts. Rip rap immediately below the outlet also contributes to poor passage conditions. No habitat typing or fisheries reports were found for this creek; however juvenile salmonids were observed downstream of the culvert during the site survey. Recommend replacement with a fully-spanning bridge as the best option for long-term unimpeded passage and storm flow conveyance. An estimated 3,700 cubic yards of fill material are associated with this crossing; however ample room to temporarily store this material is close to this crossing. Site also has good access for heavy equipment.
High	SPNC-02	Unnamed Trib #1 to Nickerson Creek	Howland Hill Road	9	3,200'	20.6	High-Priority due to: culvert is a nearly complete barrier to resident coastal cutthroat trout and all juveniles, is severely undersized for storm flow conveyance, and is in poor condition. The invert on the culvert is rusted through in several locations with some stream flow running underneath the pipe. Elevated in ranking because: the undersized crossing has created a debris jam with a three-foot drop immediately upstream of Howland Hill Road that would prevent fish migration to the upstream habitat. RTA walked approximately 2,300' of the channel above the culvert and observed excellent spawning and rearing habitat for coho salmon, steelhead, and coastal cutthroat trout. Numerous pools were present, mostly formed by complex LWD jams of old-growth redwood. Resident trout and juvenile salmonids were observed in pools up to 2,000' upstream of the crossing. Recommend a replacement with a properly-sized embedded pipe-arch or circular culvert that is at least eight feet in width; or a bridge. Also recommend re-grading upstream channel or consider using grade-control structures to minimize channel head-cutting.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
High	SPNC-03	Unnamed Trib #2 to Nickerson Creek	Howland Hill Road	10	2,400'	22.3	High-Priority due to: culvert is a complete barrier to resident coastal cutthroat trout and all juveniles, is severely undersized for storm flow conveyance (<2-year storm flow), and is in extremely poor condition. The culvert invert is rusted-through with flow seeping through the fill prism underneath the culvert. The culvert also appears to be slightly crushed. The site has a large outlet pool with numerous fish present, mostly juveniles; however several 8"-10" trout were observed. RTA walked approximately 2,000' of the channel above the culvert and observed excellent spawning habitat for coastal cutthroat trout; rearing habitat would support juvenile coho salmon and steelhead as well. Numerous pools were present, mostly formed by complex LWD jams of old-growth redwood. Resident trout and juvenile salmonids were observed in pools up to 1,700' upstream of the crossing. Recommend a replacement with an embedded circular or pipe-arch culvert that is at least 8.0 feet in diameter or span. A bridge would also be a suitable crossing for this location.
Med	SPNC-28	Durphy Creek #1	Oak Flat Camp-ground Road	9	10,570'	22.5	Medium-Priority and dropped slightly ranking due to: the crossing provides unimpeded passage for adult salmon and steelhead and the CalTrans Highway 101 crossing upstream is a more serious impediment to passage. A comprehensive fish passage improvement project for Durphy Creek should upgrade all three crossings (two State Parks and the Highway 101) to provide unimpeded passage and adequate storm flow conveyance. The best treatment option at all three sites are fully-spanning bridges.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Med	SPNC-07	West Fork of Strawberry Creek	S.O.C Road	10	800'	21.6	Medium-Priority due to: culvert is a complete barrier to resident coastal cutthroat trout and all juveniles, is severely undersized for storm flow conveyance, and is in poor condition. Juvenile coho salmon were recently sampled near the Hilton Road culvert and were assumed to be non-natal fish rearing in Strawberry Creek. Replacement should be considered as part of an overall restoration plan for Strawberry Creek that is impacted by non-native reed canary grass, channelization, and livestock grazing. Currently the downstream channel is too choked with reed canary grass for fish to access the West Fork crossing. Culvert replacement limited by low elevation of the road fill-prism; however a 6'9" x 4'11" pipe arch is wide enough and conveys more than the 100-yr storm flow.
Med	SPNC-01	Unnamed Trib to Mill Creek	Howland Hill Road	11	450'	21.2	Medium-Priority due to: culvert is a complete barrier to resident coastal cutthroat trout and all juveniles, is severely undersized for storm flow conveyance, and is in poor condition. Limited upstream habitat renders this a lower priority for treatment with fisheries restoration funds; however crossing should be upgraded for flow capacity. Replace with an embedded circular or pipe-arch culvert with at least a six-foot diameter or span. Grade control structures may be required because of the 3.5' elevation difference in the site's longitudinal profile.
Med	SPNC-13	Big Tree Creek	Newton B. Drury Scenic Parkway	15	650'	20.5	Medium-Priority due to: assessed as "RED" by the first-phase evaluation filter because of the large drop at the outlet. The box culvert built in 1927 is sized to pass the 11-year storm flow and is in fair condition. Dropped in ranking due to: the limited amount of upstream habitat and the large cost of replacing this crossing render this a lower priority site to address with fisheries restoration funds.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Med	SPNC-06	Espa Creek	Davison Road	10	3,100'	16.3	Medium-Priority due to: culvert fails to meet passage criteria on all flows for resident coastal cutthroat trout and all juveniles, is severely undersized for storm flow conveyance, and is in fair condition. Elevated in ranking due to: adult salmon and steelhead passage was not assessed with FishXing, thus the extent of barrier score of 10 is the maximum score for this site. Recommend replacement with an embedded pipe-arch or circular culvert that is at least ten feet in diameter; and properly sized for storm flow conveyance.
Med.	SPNC-17	Unnamed Trib #3 to Prairie Creek	Newton B. Drury Scenic Parkway	11	600'	21.0	Medium-Priority due to: diversity of juvenile fish species sampled downstream of this crossings and that this crossing fails to meet passage criteria for resident trout and all age-classes of juvenile salmonids. This two-bay box culvert is severely aggraded with sediment (2.6'-2.8' deep), which is the main cause for the limited flow capacity (100% of inlet height on a 3-year storm flow).
Med	SPNC-04	Metcalf Grove Creek	Howland Hill Road	10	400'	15.2	Medium-Priority and raised in ranking due to: culvert fails to meet passage criteria on all flows for resident coastal cutthroat trout and all juveniles, is severely undersized for storm flow conveyance, and is in poor condition. Because adult salmon and steelhead passage was not assessed with FishXing, the extent of barrier score of 10 is the maximum score for this site. The invert on the culvert is rusted through in several locations with some stream flow running underneath the pipe. Recommend a replacement with a properly-sized embedded pipe-arch or circular culvert that is at least six feet in width.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Med.	SPNC-27	Harper Creek	Mattole Road	11	3,800'	14.9	Medium-Priority and raised in ranking due to: significant amount of upstream spawning and rearing habitat for steelhead; and relatively inexpensive treatment option. This site was assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing met adult steelhead passage criteria for 78% of the migration flows, but failed to meet criteria for resident trout and all age classes of juveniles. The right-bay of this crossing is aggraded with boulders and cobbles and doesn't carry water until the left-bay is two feet deep. The recommended treatment is installing downstream grade-control weirs to raise tail-water elevation. Cautiously consider installation of corner baffles because of high-energy flow and substantial bedload movement.
Low	SPNC-16	Unnamed Trib #2 to Prairie Creek	Newton B. Drury Scenic Parkway	14	500'	22.9	Low-Priority and dropped in ranking due to: although the culvert has a high extent of barrier score, the only criteria violation for adult salmon and steelhead was a lack-of-depth; also there is limited upstream habitat available for salmon and steelhead. RNP has no fish data for this creek; however in 1989-1991 RTA observed coastal cutthroat trout and juvenile coho salmon upstream of the crossing. The box culvert was considered in good condition and is sized to pass the 21-year storm flow.
Low	SPNC-22	Hope Creek	Newton B. Drury Scenic Parkway	11	250'	21.1	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides nearly unimpeded passage for all age-classes of salmonids. The crossing is severely undersized for storm flow conveyance due to significant aggradation of sediment. Dropped in ranking due to: limited amount of potential upstream habitat renders this site a low-priority site to treat with fisheries restoration grant funds.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Low	SPNC-29	Durphy Creek #2	Madrone Camp-ground Road	7	10,000'	20.5	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently meets adult steelhead passage criteria for the entire range of migration flows and provides partial passage for resident trout and juvenile salmonids. Dropped in ranking due to: the current crossing was estimated to pass a 10-year storm flow; however the site has four 48" overflow pipes that can pass an additional 280 cfs, raising the total capacity to about the 50-year storm flow. Also, Highway 101 culvert was also assessed as "RED" by HSU during the CalTrans District 1 inventory.
Low	SPNC-18	Sweet Creek	Newton B. Drury Scenic Parkway	15	350'	20.4	Low-Priority and dropped in ranking due to: although the crossing was assessed as "RED" by the first-phase evaluation filter, the limited amount of upstream habitat and the probable high cost to treat this site render it a poor candidate to treat with fisheries restoration funds. Because the box culvert is undersized (at 100% of inlet height on a 5-year storm flow), a retrofit with corner baffles or weirs is not recommended. State and Redwood National Parks did not have any fish data for Sweet Creek.
Low	SPNC-25	Cow Creek	Mattole Road	10	3,100'	16.6	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently meets passage criteria for adult steelhead only. CDFG surveys indicate that the accessible upstream habitat is approximately 1,000' due to a large hillslope failure and associated debris jam in the channel. The current crossing is undersized and the over-steepened channel just upstream of the inlet (15%).
Low	SPNC-19	Unnamed Trib #4 to Prairie Creek	Newton B. Drury Scenic Parkway	6	900'	15.7	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides nearly unimpeded adult passage, good resident trout passage (meets criteria for 76% of migration flows), but fails to meet juvenile passage criteria. RNP had no fish data for this unnamed tributary to Prairie Creek. The crossing is in good condition, but passes approximately the 9-year storm flow.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Low	SPNC-21	Ten Taypo Creek	Newton B. Drury Scenic Parkway	6	350'	15.9	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides unimpeded adult passage, good resident trout passage (meets criteria for 70% of migration flows), but fails to meet juvenile passage criteria. There is limited fisheries habitat available upstream due to steep channel slope and RNP has no fish data for this creek. The crossing is in good condition, but passes less than a 5-year storm flow.
Low	SPNC-20	Little Creek	Newton B. Drury Scenic Parkway	8	200'	17.1	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing meets adult passage criteria for 90% of migration flows, 30% of resident trout passage criteria, and fails to meet juvenile salmonid criteria. There is limited fisheries habitat available upstream due to steep channel slope and RNP has no fish data for this creek. The crossing is in good condition, but passes less than a 10-year storm flow.
Low	SPNC-15	Good Creek	Newton B. Drury Scenic Parkway	9	150'	15.7	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides ample adult passage (meets criteria on 69% of migration flows), some resident trout passage (meets criteria for 30% of migration flows), but fails to meet juvenile passage criteria. There is limited fisheries habitat available upstream due to steep channel slope; however RNP has sampled juvenile steelhead and coastal cutthroat trout upstream of the crossing. Downstream of the crossing RNP has sampled juvenile Chinook salmon in addition to steelhead and coastal cutthroat trout. The crossing is in good condition, but passes approximately a 13-year storm flow.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Low	SPNC-11	Streelow Creek	Davison Road	1	1,600'	12.4	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides nearly unimpeded passage for all age-classes of salmonids. However; the current culvert is in poor condition and is severely undersized for storm flow conveyance. The undersized pipe has also interrupted the transport of wood and bedload. Replacement with a properly-sized culvert is a road maintenance project, not a fisheries enhancement project. This site also has an associated ditch-relief culvert that is over-burdened with fine sediment.
Low	SPNC-08	Strawberry Creek	S.O.C Road	0	950'	11.2	Low-Priority due to: assessed as "GREEN" by the first-phase evaluation filter and the crossing currently provides unimpeded passage of all age-classes of salmonids; however the current crossing is severely under-sized and is in poor condition. Juvenile coho salmon were recently sampled near the Hilton Road culvert and were assumed to be non-natal fish rearing in Strawberry Creek. Replacement should be considered as part of an overall restoration plan for Strawberry Creek that is impacted by non-native reed canary grass, channelization, and livestock grazing.
Low	SPNC-26	Calf Creek	Mattole Road	0	350'	6.3	Low-Priority due to: assessed as "GREEN" by the first-phase evaluation filter and the crossing currently provides unimpeded passage of all age-classes of salmonids. There is also minimal upstream habitat for steelhead and CDFG surveys suggest Calf Creek is not a fish-bearing stream due to a large drop near the confluence with Bull Creek. However this crossing is severely undersized and in poor condition. Replacement with a properly-sized culvert is a road maintenance project, not a fisheries enhancement project.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Low	SPNC-24	Cabin Creek	Mattole Road	15	450'	21.1	Low-Priority and dropped in ranking due to: although this crossing was assessed as “RED” by the first-phase evaluation filter, information from CDFG and first-hand inspection of the confluence with the South Fork Eel River suggest that Cabin Creek is not a fish-bearing stream. The current culvert is in poor condition and is severely undersized; however the length of the culvert and the large amount of fill volume (7,400 cubic yards) render replacement of this crossing solely for flow conveyance purposes cost-prohibitive. The large road fill prism appears able to pond substantial amounts of storm flow on the upstream side of the crossing; however the inlet is severely clogged with woody debris and should be cleared by Humboldt County roads personnel.
Low	SPNC-09	Trillium Falls Creek	Davison Trail	0	500'	8.9	Low-Priority due to: assessed as “GREEN” and the crossing currently provides unimpeded passage for all age-classes of salmonids. The culvert is in fair condition and currently passes a 40-year storm flow. This crossing was assessed as “GREEN” due to the back-water effect of a downstream beaver dam – if this dam were to fail, the culvert may become a partial or temporal migration barrier. RNP has sampled all four native anadromous fish species in Trillium Creek upstream of the culvert, as well as stickleback. The downstream beaver pond supports the above mentioned species, as well as lamprey ammocetes and sculpin.
Low	SPNC-10	Unnamed Trib #1 to Prairie Creek	Davison Trail	0	1,100'	9.6	Low-Priority due to: assessed as “GREEN” and the crossing currently provides unimpeded passage for all age-classes of salmonids. The culvert is in fair condition, but moderately undersized for storm flow conveyance and passes a 15-year storm flow at 100% of inlet height. This crossing was assessed as “GREEN” due to the back-water effect of a downstream beaver dam – if this dam were to fail, the culvert may become a partial or temporal migration barrier. RNP has sampled juvenile steelhead and coastal cutthroat trout in this creek upstream of Davison trail.

Table 8 (continued). Ranked list of 29 crossings located in anadromous-bearing stream reaches within the North Coast Redwoods District of CA State Parks.

Rank	Site ID#	Stream Name	Road Name	Barrier Score (15 pts max)	Length Upstream Habitat (ft)	TOTAL SCORE	Comments Regarding Site and any Adjustments made to Final Rank
Low	SPNC-14	Browns Creek	Newton B. Drury Scenic Parkway	1	4,700'	13.7	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides nearly unimpeded passage for all age-classes of salmonids. RNP has sampled coho salmon, steelhead, coastal cutthroat, prickly sculpin and stickleback both above and below this crossing. The box culvert is in good condition and currently passes nearly a 30-year storm flow.
Low	SPNC-12	Boyces Creek	Newton B. Drury Scenic Parkway	0	6,040'	13.5	Low-Priority due to: assessed as "GREEN" and the crossing currently provides unimpeded passage for all age-classes of salmonids. RNP has sampled coho salmon, steelhead, coastal cutthroat and stickleback both above and below this crossing. The box culvert is in good condition and currently passes a 60-year storm flow.
Low	SPNC-23	Prairie Creek	Newton B. Drury Scenic Parkway	0	1,500'	8.6	Low-Priority due to: assessed as "GRAY" by the first-phase evaluation filter and the FishXing analysis determined that the crossing currently provides unimpeded passage of all age-classes of salmonids. The box culvert is in good condition and currently passes nearly a 100-year storm flow.

Scheduling of Site-Specific Treatments

High-Priority Sites

At site # SPNC-05, Tributary to West Fork Mill Creek, RTA recommends that State Parks submit proposals to state and federal restoration in 2009 to install a fully spanning bridge. A licensed engineer with experience in designing fish passage projects should be utilized since channel head-cutting and the use of grade-control structures must be considered in designing a functional replacement. Besides restoring passage, project components should include pre and post-project monitoring, a water management plan, and relocating fish and amphibians.

Site SPNC-03, Tributary #2 to Nickerson Creek on Howland Hill Road was the second site ranked as high-priority. There were three other sites on Howland Hill Road SPNC-01, 02 and 04; all which were ranked as medium-priority sites. RTA recommends that State Parks considers replacing all four of these crossings as part of an upgrade to Howland Hill Road. All four crossings are severely undersized for flow capacity and are in poor condition; thus are overdue for replacement based solely on proper road management. Collectively, upstream of these four sites there is more than one mile of potential fish-bearing habitat. Most of the habitat is probably more suitable for juvenile salmonid rearing; however some reaches also appear suitable for coastal cutthroat trout spawning. All four stream channels appear to support suitable amphibian habitat too, and it is unknown how these four culverts affect movement and distribution of native amphibians.

Medium-Priority Sites

The exact scheduling for treating of the remaining “medium-priority” sites is unknown at the time because:

1. State Parks resource managers have a large task of completing the scheduling, contracting, permitting, and implementation required to treat high-priority locations identified by this assessment. The focus should be on completing these higher priority projects with properly designed and constructed treatments before addressing the next tier of sites.
2. When addressing the “medium-priority” tier of crossings, the current biological condition and/or importance (such as quantity) of the streams start to diminish. Thus, these sites may not rank well compared to other types of projects proposed to state and federal funding sources that are focused on listed anadromous salmonids. However, other sources of funding, such as sediment reductions programs should be considered.

Espa Creek on Davison Road (SPNC-06) ranked as medium priority based on only supporting one (non-ESA listed) salmonid species, the coastal cutthroat trout. This culvert fails to meet passage criteria for resident trout and all age classes of juveniles, is severely undersized for flow capacity and is in fair condition. There is also a substantial amount of potential upstream habitat based on channel slopes measured off of the USGS topographic map. RTA recommends that Park fisheries biologists conducted a more thorough investigation of the upstream habitat, and possibly conduct some electro-fishing sampling to confirm species diversity and assess distribution. Depending on the biological and habitat assessments, treating this site may have

significant benefits to Espa Creek's coastal cutthroat trout population, as well as reducing flooding and erosion potential.

Durphy Creek #1 in Richardson Grove State Park (SPNC-28) ranked as medium priority based on being a temporal barrier to adult salmon and steelhead and failing to meet resident trout and juvenile salmonid passage criteria. Less than 300' upstream the Highway 101 crossing was assessed as "RED" during the HSU 2001 inventory of CalTrans District 1 crossings (Lang 2005). Any treatment of the two State Park crossings should only be pursued in conjunction with CalTrans addressing the Highway 101 crossing. Due to the relatively large upstream drainage area and historically large storm events, all three sites should be upgraded with fully-spanning bridges. A possible nexus to treating these sites may be mitigation requirements for CalTrans' plans to widen Highway 101 through Richardson Grove.

West Fork Strawberry Creek (SPNC-07) was ranked as medium priority based on failing to meet passage criteria for resident trout and juveniles, as well as being in poor condition and severely undersized for storm flow conveyance. Both RNP crossings on Strawberry Creek (SPNC-08 too) should be treated as part of a more comprehensive plan to restore the watershed. Currently the main channel of Strawberry Creek is too choked with non-native reed canary grass to allow fish access up to the West Fork crossing or the upper main channel crossing (SPNC-08). Restoration activities to remove reed canary grass from the stream channel, re-establish a riparian corridor, and upgrade several downstream crossings should occur prior to addressing the two uppermost crossings, SPNC-07 and SPNC-08.

Harper Creek on the Mattole Road (SPNC-27) is a Humboldt County-maintained crossing and all information pertaining to this site will be passed to the Public Works Department. This site was ranked as medium priority based on the nearly 4,000' of upstream habitat and a relatively inexpensive treatment cost. A series of downstream grade control weirs would improve passage through this two-bay box culvert.

Two crossings (SPNC-13 and SPNC-17) along Newton B. Drury Scenic Parkway were ranked as medium priority based on extent of barrier scores and limited storm flow capacity. Unfortunately the limited amount of upstream habitat (1,200' combined) renders replacing the two box culverts cost-prohibitive. Neither site is recommended for retrofits due to limited flow capacity, as well as the perched outlet at the Big Tree Creek crossing (SPNC-13).

Low-Priority Sites

Generally low-priority sites either allowed fish passage, or have minimal biological benefit if treated. However, these sites should be examined for "consequence-of-risk" as to current condition, sizing, and quantity of fill within the road prism. All future replacements with maintenance funds should include properly sized crossings that permit unimpeded passage of adult and juvenile salmonids.

Limited fisheries restoration dollars should probably not be spent on improving fish passage in these streams, unless significant improvements occur to impacts of other land management activities. However, road managers should carefully examine the entire list of crossings and determine which locations may be treated with existing maintenance funds.

Design Options for Improving Fish Passage

All stream crossing replacement projects should follow recently developed state criteria and federal guidelines for facilitating adult and juvenile fish passage (CDFG 2002; NMFS 2001). However, site-specific characteristics of the crossing's location should always be carefully reviewed prior to selecting the type of crossing to install. These characteristics include local geology, slope of natural channel, channel confinement, and extent of channel incision likely from removal of a perched culvert. For additional information, Bates et al. (1999) is recommended as an excellent reference to use when considering fish-friendly culvert installation options and Robinson et al. (2000) provides a comprehensive review of the advantages and disadvantages of the various treatment alternatives as related to site-specific conditions.

CDFG Allowable Design Options

Active Channel Design Option is a simplified design method that is intended to size a crossing sufficiently large and embedded deep enough into the channel to allow the natural movement of bed load and formation of a stable bed inside the culvert. Determination of the high and low fish passage design flows, water velocity, and water depth is not required for this option since the stream hydraulic characteristics within the culvert are intended to mimic the stream conditions upstream and downstream of the crossing.

The Active Channel Design Option is suitable for the following conditions:

- New and replacement culvert installations
- Simple installations with channel slopes of less than 3%.
- Short culvert lengths (less than 100 feet).
- Passage is required for all fish species and life-stages.

Culvert Setting and Dimensions

Culvert Width – the minimum culvert width shall be equal to, or greater than, 1.5 times the active channel width.

Culvert Slope – the culvert shall be placed level (0% slope).

Embedment – the bottom of the culvert shall be buried into the streambed not less than 20% of the culvert height at the outlet and not more than 40% of the culvert height at the inlet. Embedment does not apply to bottomless culverts.

Stream Simulation Design Option

The Stream Simulation Design Option is a design process that is intended to mimic the natural stream processes within a culvert. Fish passage, sediment transport, flood and debris conveyance within the crossing are intended to function as they would in a natural channel. Determination of the high and low fish passage flows, water velocity, and water depth is not required for this

option since the stream hydraulic characteristics within the culvert are designed to mimic the stream conditions upstream and downstream of the culvert.

Stream simulation crossings are sized as wide, or wider than, the bankfull channel and the bed inside the culvert is sloped at a gradient similar to that of the adjacent stream reach. These crossings are filled with a streambed mixture that is resistant to erosion and is unlikely to change grade, unless specifically designed to do so. Stream simulation crossings require a greater level of information on hydrology and topography and a higher level of engineering expertise than the Active Channel Design Option.

The Stream Simulation Design Option is suitable for the following conditions:

- New and replacement culvert installations.
- Complex installations with channel slopes less than 6%.
- Moderate to long culvert length (greater than 100 feet).
- Passage required for all fish species and lifestages.
- Ecological connectivity is required.

Culvert Setting and Dimensions

Culvert Width – the minimum culvert width shall be equal to, or greater than, the bankfull channel width. The minimum culvert width shall not be less than six feet.

Culvert Slope - the culvert slope shall approximate the slope of the stream through the reach in which it is being placed. The maximum slope shall not exceed 6%.

Embedment – the bottom of the culvert shall be buried into the streambed, not less than 30% and not more than 50% of the culvert height. Embedment does not apply to bottomless culverts.

Substrate Configuration and Stability

- Culverts with slopes greater than 3% shall have the bed inside the culvert arranged into a series of step-pools with the drop at each step not exceeding 0.5 feet for juvenile salmonids.
- Smooth walled culverts with slopes greater than 3% may require bed retention sills within the culvert to maintain the bed stability under elevated flows.
- The gradation of the native streambed material or engineered fill within the culvert shall address stability at high flows and shall be well graded to minimize interstitial flow through it.

Hydraulic Design Option

The Hydraulic Design Option is a design process that matches the hydraulic performance of a culvert with the swimming abilities of a target species and age class of fish. The method targets specific species of fish and therefore does not account for ecosystem requirements of non-target species. There can be significant errors associated with estimation of hydrology and fish swimming speeds that are mitigated by making conservative assumptions in the design process. Determination of the high and low fish passage design flows, water velocity, and water depth are required for this option.

The Hydraulic Design Option requires hydrologic data analysis, open channel flow hydraulic calculations and information on the swimming ability and behavior of the target group of fish. This design option can be applied to the design of new and replacement culverts, and can be used to evaluate the effectiveness of retrofits for existing culverts.

The Hydraulic Design option is suitable for the following conditions:

- New, replacement, and retrofit culvert installations.
- Low to moderate channel slopes (less than 3%).
- Situation where either Active Channel Design or Stream Simulation Options are not physically feasible.
- Swimming ability and behavior of target fish species is known.
- Ecological connectivity is not required.
- Evaluation of proposed improvements to existing culverts.

For more information regarding the Hydraulic Design, obtain the most recent copy of the CDFG *Culvert Criteria for Fish Passage*, available on the Department's website.

NMFS Order of Preferred Alternatives

1. *No crossing* - relocate or decommission the road.
2. *Bridge* - spanning the stream to allow for long-term dynamic channel stability.
3. *Streambed simulation strategies* – bottomless arch, embedded culvert design, or ford.
4. *Non-embedded culvert* – this often referred to as a hydraulic design, associated with more traditional culvert design approaches limited to low slopes for fish passage.
5. *Baffled culvert or structure designed with a fish way* – for steeper slopes.

For more information, or to obtain a copy of the NMFS *Guidelines for Salmonid Passage at Stream Crossings* go to the Southwest Region website at: <http://swr.nmfs.noaa.gov>

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PERSONAL COMMUNICATIONS

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APPENDIX A:

**STREAM CROSSING LOCATION INFORMATION
AND SURVEY DATA**

Site ID #	Stream Name	Road Name	State Park Unit	USGS Quad	Township, Range, Section	Latitude and Longitude Coordinates	Milemarker or Name and Distance to nearest Crossroad	Type of Crossing	Construction Material	Corrugation Dimensions	Crossing Length (ft)	Culvert Dimensions: Diameter, height/width, or rise/span (ft)	% Slope thru Crossing	Rustline Height (ft)	Inlet Type
SPNC-01	Unnamed Tributary to Mill Creek	Howland Hill Road	Jedediah Smith State Park	Hiouchi	T16N, R1E, S19	N41.77037 W124.11042	3.3 miles to Humboldt Road	Circular	CSP	2-2/3" x 1/2"	66.4	2.5	4.55%	1.1	Projecting
SPNC-02	Unnamed Tributary #1 to Nickerson Creek (trib to Mill Creek)	Howland Hill Road	Jedediah Smith State Park	Hiouchi	T16N, R1E, S19	N41.76875 W124.11034	3.0 miles to Humboldt Road	Circular	CSP	2-2/3" x 1/2"	65.8	3.5	2.46%	2.0	Projecting
SPNC-03	Unnamed Tributary #2 to Nickerson Creek (trib to Mill Creek)	Howland Hill Road	Jedediah Smith State Park	Hiouchi	T16N, R1E, S19	N41.76634 W124.11786	2.5 miles to Humboldt Road	Circular	SSP	2-2/3" x 1/2"	53.1	3.5	1.22%	2.0	Projecting
SPNC-04	Metcalf Grove Creek	Howland Hill Road	Jedediah Smith State Park	Crescent City	T16N, R1W, S24	N41.76529 W124.12945	1.9 miles to Humboldt Road	Circular	CSP	2-2/3" x 1/2"	42.1	3.0	4.93%	1.5	Projecting
SPNC-05	Unnamed Tributary to West Fork Mill Creek	Picnic Road	Mill Creek Acquisition	Childs Hill	T15N, R1E, S6	N41.72902 W124.10961	350' to Hamilton Road	Circular	CSP	2-2/3" x 1/2"	54.5	8.0	2.63%	1.2'	Projecting
SPNC-06	Espa Creek	Davison Road	Prairie Creek State Park	Orick	T11N, R1E, S9	N 41.35098 W 124.06984	3.1 miles to Highway 101	Circular	SSP	2-2/3" x 1/2"	31.4	5.0	5.58%	1.7	Projecting
SPNC-07	West Fork Strawberry Creek (tributary to Strawberry Creek)	SOC Road	Redwood National Park	Orick	T10N, R1E, S4	N41.27640 W124.07382	0.5 miles to Hilton Road	Circular	CSP	2-2/3" x 1/2"	40.3	1.5	1.02%	All	Projecting
SPNC-08	Strawberry Creek (tributary to Redwood Creek)	SOC Road	Redwood National Park	Orick	T10N, R1E, S4	N41.27475 W124.07243	0.7 miles to Hilton Road	Circular	CSP	2-2/3" x 1/2"	28.3	3.0	-3.11%	All	Projecting
SPNC-09	Trillium Falls Creek (tributary to Prairie Creek)	Davison Trail	Prairie Creek State Park	Orick	T11N, R1E, S22	N41.32040 W124.04527	Crossroad Davidson Rd	Circular	Aluminum	2-2/3" x 1/2"	60.5	5.0	-0.15%	N/A	Wingwall
SPNC-10	Unnamed tributary #1 to Prairie Creek	Davison Trail	Prairie Creek State Park	Orick	T11N, R1E, S22	N41.32189 W124.04499	Crossroad Davidson Rd	Pipe Arch	CSP	2-2/3" x 1/2"	41.6	(2.7)5.75 x 8.2	6.44%	All	Projecting
SPNC-11	Streelow Creek (tributary to Prairie Creek)	Davison Road	Prairie Creek State Park	Orick	T11N, R1E, S16	N41.34097 W124.05962	2.02 miles to Hwy 101	Oval	CSP	2-2/3" x 1/2"	40.8	4 x 4.5	0.81%	2.9'	Projecting

Site ID #	Inlet Alignment to Channel	Inlet Apron	Outlet Configuration	Outlet Apron	Culvert Embedded?	Crossing-Culvert Condition	Average Active Channel Width (ft)	Estimated Road fill (cubic yards)	Previous Fish Passage Modifications to Crossing	Additional Comments from Initial Site Visit
SPNC-01	<30°	No	At stream grade	No	No	Poor - rusted through invert	3.9	1,836	No	Site was surveyed on 12/9/08. The culvert's invert at both the inlet and outlet were rusted-through. No fish were observed. Upstream channel has limited rearing habitat and no spawning habitat. Upstream channel also has numerous drops >1.0' over LWD jams.
SPNC-02	30°-45°	No	At stream grade	No	No	Poor - rusted through invert	5.3	1,812	No	Site was surveyed on 12/9/08. Most of culvert length was back-watered at low flow conditions. The culvert's invert at both the inlet and outlet were rusted-through. Extensive debris jam at inlet should be cleared. No fish were observed. Channel has limited rearing habitat and large drop just u.s. of inlet would impede juvenile migration to u.s. habitat. Approx. 100' d.s. to Nickerson Creek = good habitat.
SPNC-03	<30°	No	Freefall into Pool	No	No	Extremely poor - rusted through invert	5.5	1,817	No	Site was surveyed on 12/9/08. Drop at outlet was approximately 2.0' into a large outlet pool with a maximum depth of at least six feet. The culvert's invert at both the inlet and outlet were rusted-through and the pipe was slightly crushed too. A moderate number of juvenile salmonids and a few larger (6-10") trout were observed in the outlet pool. Channel has good rearing and spawning habitat.
SPNC-04	<30°	No	Freefall into Pool	No	No	Poor - rusted through invert	4.4	526	No	Site was surveyed on 11/18/08. Drop at outlet is less than one foot, but rusted through invert probably increases difficulty for a fish to enter the culvert. Habitat was rated as "fair" due to small size of channel - seems more appropriate for resident trout and juvenile rearing, limited spawning habitat. Dense old-growth redwood forest. At 15:00 air temp = 60f and water temp = 52F.
SPNC-05	<30°	No	Freefall into Pool	No	No	Fair	12.1	3,730	No	Site was surveyed on 11/18/08. Drop at outlet falls onto riprap - poor leap conditions for migrating fish. Upstream habitat was considered good with a mix of pools and riffles, large wood in channel, dense riparian and ample spawning substrate. Juvenile salmonids were observed downstream of the crossing only. Close to confluence with West Fork Mill Creek. At 11:50 air temp = 58 F and water temp = 55 F.
SPNC-06	<30°	No	At stream grade	No	No	Fair - invert abraded, but not rusted-through	5.0	289	No	Site was surveyed on 12/9/08. The culvert has one break-in-slope that creates a steeper section towards the outlet. No fish were observed. Upstream channel has good potential for rearing habitat and spawning habitat, probably for coastal cutthroat trout only due to poor access at beach for coho or steelhead.
SPNC-07	<30°	No	At stream grade	No	Yes	Poor	4.0	300	No	Site was surveyed on 1/29/09. Barely embedded, overgrown upstream with brush, alders and canary grass, gravels, lots of fines; good spawning and good rearing for cutthroat. No fish were observed. Two red legged frogs upstream, 1 adult, 1 juvenile. Upstream of USCH2 is a well defined channel. DS is broken up with no defined channel.
SPNC-08	<30°	No	At stream grade	No	Yes	Poor	8.0	252	No	Site was surveyed on 1/29/09. Culvert highly embedded; canary grass filling in channel, trapping sediment. Culvert almost completely buried. No well defined DS channel. Fish habitat is very poor in its current state. Creek may improve 1/4 mile upstream when it gets into the hills. Several juvenile fish (3"-6") were observed upstream. 12-ft bankfull width according to MLA report.
SPNC-09	<30°	Yes	At stream grade	No	Yes	Fair	---	1,584	No	Site was surveyed on 1/21/09. Creek is pretty stagnant at this point, influenced by the beaver dam downstream. Marshy upstream, could not make it up from the inlet for widths or to assess habitat quality. Good rearing habitat. Substrate is silt. Several fish were observed downstream.
SPNC-10	<30°	No	At stream grade	No	Yes	Fair	6.4	945	No	Site was surveyed on 1/21/09. Creek flows into large beaver pond, very good for fish rearing. Creek is small and has some cascades, but slope decreases approx. 300' u.s. Creek has fair/poor fish habitat - mostly riffles, gravel and sand substrate near parking area (old mill site?). There is oily seepage from banks. No fish were observed. Beaver dam approx 3-4' drop to d.s. channel.
SPNC-11	30-45°	No	At stream grade	No	Yes	Poor - rusted through invert	7.1	418	No	Site was surveyed on 1/21/09. Fish habitat is poor. The downstream reach is highly sediment impaired. Good rearing habitat, not sure about spawning - most of the channel bottom is fines and clay. Log jam (lots of fines, too). Flow goes sub surface under debris jam - pipe is too small to pass logs. A single juvenile fish was observed downstream.

Site ID #	Stream Name	Road Name	State Park Unit	USGS Quad	Township, Range, Section	Latitude and Longitude Coordinates	Milemarker or Name and Distance to nearest Crossroad	Type of Crossing	Construction Material	Corrugation Dimensions	Crossing Length (ft)	Culvert Dimensions: Diameter, height/width, or rise/span (ft)	% Slope thru Crossing	Rustline Height (ft)	Inlet Type
SPNC-12	Boyes Creek (tributary to Prairie Creek)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Orick	T11N, R1E, S2	N41.36446 W124.02029	at park headquarters road	Box	Concrete	N/A	60.3	10 x 10	-0.67%	N/A	Wingwall
SPNC-13	Big Tree Creek (tributary to Prairie Creek)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S36	N41.37716 W124.01425	128.20	Box	Concrete	N/A	41.2	5 x 6	1.20%	N/A	Wingwall
SPNC-14	Browns Creek (tributary to Prairie Creek)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S35	N41.38839 W124.01739	129.01	Box	Concrete	N/A	39.3	8.5 x 10	0.13%	N/A	Wingwall
SPNC-15	Good Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S26	N 41.40255 W 124.02867	130.17	Box	Concrete	N/A	40.7	4.0 x 5.0	1.83%	N/A	Headwall
SPNC-16	Unnamed tributary #2 to Prairie Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S23	N 41.40586 W 124.02967	130.36	Box	Concrete	N/A	39.2	4.0 x 5.0	1.44%	N/A	Headwall
SPNC-17	Unnamed Tributary #3 to Prairie Creek (1of2)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S23	N 41.40803 W 124.03020	130.54	Box	Concrete	N/A	40.6	1.4 x 4.0	1.18%	N/A	Headwall
SPNC-17	Unnamed Tributary #3 to Prairie Creek (2of2)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S23	N 41.40803 W 124.03020	130.54	Box	Concrete	N/A	40.6	1.2 x 4.0	0.32%	N/A	Headwall
SPNC-18	Sweet Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S23	N 41.41397 W 124.03145	130.96	Box	Concrete	N/A	49.0	4.0 x 5.0	4.42%	N/A	Headwall
SPNC-19	Unnamed tributary #4 to Prairie Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S15	N 41.42054 W 124.03429	131.43	Box	Concrete	N/A	47.0	4.0 x 5.0	0.70%	N/A	Wingwall
SPNC-20	Little Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S15	N 41.42691 W 124.03678	131.90	Box at inlet Circular at outlet	Concrete	N/A	48.1	Inlet: 4.0 x 4.0 Outlet: 4.5	-2.11%	N/A	Headwall
SPNC-21	Ten Taypo Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S15	N 41.43365 W 124.03899	132.36	Box	Concrete	N/A	44.0	4.0 x 4.0	2.23%	N/A	Headwall
SPNC-22	Hope Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S10	N 41.43878 W 124.04053	132.74	Box at inlet Circular at outlet	Concrete	N/A	44.3	Inlet: 0.95 x 3.0 Outlet: 3.5	2.00%	N/A	Headwall
SPNC-23	Prairie Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	Fern Canyon	T12N, R1E, S10	N 44.44090 W 124.04106	132.83	Box	Concrete	N/A	53.1	5.0 x 5.0	-0.67%	N/A	Wingwall

Site ID #	Inlet Alignment to Channel	Inlet Apron	Outlet Configuration	Outlet Apron	Culvert Embedded?	Crossing-Culvert Condition	Average Active Channel Width (ft)	Estimated Road fill (cubic yards)	Previous Fish Passage Modifications to Crossing	Additional Comments from Initial Site Visit
SPNC-12	<30°	No	At stream grade	No	Yes	Good	14.3	2,471	No	Site was surveyed on 1/29/09. Concrete floor with 2.5 x 3.0 walkway. Excellent fish habitat, numerous pools. Alder log spanning channel. Cobbles and gravel substrate. Moderate amount of trout observed upstream and downstream of various sizes.
SPNC-13	<30°	No	Freefall into Pool	No	No	Fair	7.5	1,614	No	Site was surveyed on 1/29/09. Upstream habitat - good spawning substrate, small pools for rearing. Lots of LWD and dense old growth riparian. Scour on downstream side has undermined footings of the wingwalls. Date on headwall: 1927. Huge redwood suspended over channel, and redwood log spanning channel on the other side of the outlet. There is lots of LWD that would affect TW elevation. No fish were observed.
SPNC-14	<30°	No	At stream grade	No	Yes	Good	13.9	2,631	No	Site was surveyed on 1/29/09. Excellent fish habitat. Several adult fish were observed upstream and downstream. Substrate is cobbles.
SPNC-15	>45°	No	At stream grade	No	Yes	Good	6.9	1,003	No	Site was surveyed on 10/3/07. Crossing constructed in 1928. Very good habitat with mixed substrate. Small creek. Only the first few feet of the culvert are not completely embedded. Crossing should not be much of a barrier. At 15:40 Air = 14 C and Water = 10 C
SPNC-16	>45°	No	Freefall into Pool	No	No	Good	6.5	988	No	Site was surveyed on 10/3/07. Crossing constructed in 1927. Old rearing site used during highway 101 relocation. Fair to good quality habitat with the quality being diminished by the size of the creek. Substrate is predominately cobble. Steep channel upstream of inlet due to aggradation of material. At 14:40 Air = 14 C and Water = 10 C
SPNC-17	<30°	No	At stream grade	No	Yes	Good	6.9	1,211	No	Site was surveyed on 10/3/07. Possible cutthroat trout in first pool upstream of inlet. Both bays of the crossing are very embedded with less than 1.5 feet of height open for flow. Fair to good quality habitat with the quality being diminished by the size of the creek. Substrate is predominately cobble. Downstream of outlet the right bank is very steep. At 13:15 Air = 14 C and Water = 10 C
SPNC-17	30°-45°	No	At stream grade	No	Yes	Good	6.9	1,211	No	Site was surveyed on 10/3/07. Possible cutthroat trout in first pool upstream of inlet. Both bays of the crossing are very embedded with less than 1.5 feet of height open for flow. Fair to good quality habitat with the quality being diminished by the size of the creek. Substrate is predominately cobble. Downstream of outlet the right bank is very steep. At 13:15 Air = 14 C and Water = 10 C
SPNC-18	<30°	No	Freefall into Pool	No	No	Good	8.0	1,918	No	Site was surveyed on 10/3/07. Culvert constructed in 1928. Small creek with good to excellent fish habitat consisting of pools, riffles and substrate composed of cobbles and small boulders. Outlet has a one foot long step/ledge off of it. At 11:50 Air = 14 C and Water = 9 C
SPNC-19	30°-45°	No	At stream grade	No	Yes	Good	6.1	1,305	No	Site was surveyed on 10/3/07. Culvert is fully embedded and does not appear to pose a problem for fish passage. Creek is small with good fish habitat. Cobbles are predominant substrate. Inlet has some aggraded material upstream of it and the upstream left bank is undercut. At 10:25 Air = 15 C and Water = 10 C
SPNC-20	<30°	No	At stream grade	No	Yes	Good	6.8	1,267	No	Site was surveyed on 9/26/07. Pipe is embedded 0.7 feet at the outlet and the embeddedness starts 2 feet from the inlet. The creek is small but has good habitat with pools and adequate spawning gravels. The box culvert runs about three quarters of the length then a circular pipe runs the rest. Channel has a steep left bank going upstream of the inlet. At 16:45 Air = 17 C and Water = 11 C
SPNC-21	<30°	Yes	At stream grade	No	Yes	Good	8.9	1,198	No	Site was surveyed on 9/26/07. Substrate accumulating upstream of inlet, most likely due to undersized pipe. Very good fish habitat. Fish observed in outlet pool. Downstream channel right bank is very steep and actively delivering material to channel. At 15:00 Air = 17 C and Water = 10 C
SPNC-22	<30°	No	At stream grade	No	Yes	Fair	5.1	972	No	Site was surveyed on 9/26/07. Fair to poor fish habitat based on the size of the creek and the limited features. The box culvert runs about three quarters of the length then a circular pipe runs the rest. Crossing is highly embedded thus reducing the hydraulic capacity. At 13:30 Air = 17 C and Water = 10 C.
SPNC-23	>45°	No	At stream grade	No	Yes	Good	6.8	650	No	Site was surveyed on 9/26/07. Small channel in old growth redwood forest. Channel has a dense canopy with good habitat. The pipe is more embedded at the outlet than the inlet. At 11:50 Air = 18 C and Water = 10 C

Site ID #	Stream Name	Road Name	State Park Unit	USGS Quad	Township, Range, Section	Latitude and Longitude Coordinates	Milemarker or Name and Distance to nearest Crossroad	Type of Crossing	Construction Material	Corrugation Dimensions	Crossing Length (ft)	Culvert Dimensions: Diameter, height/width, or rise/span (ft)	% Slope thru Crossing	Rustline Height (ft)	Inlet Type
SPNC-24	Cabin Creek	Mattole Road	Humboldt Redwoods State Park	Weott	T1S, R2E, S27	N40.34989 W123.93138	0.7 miles to Hwy 101	Circular	SSP	2-2/3" x 1/2"	182.7	4.0	3.33%	2.8	Mitered
SPNC-25	Cow Creek	Mattole Road	Humboldt Redwoods State Park	Weott	T1S, R2E, S28	N40.35079 W123.96347	2.8 miles to Hwy 101	Circular	CSP - Spiral	2-2/3" x 1/2"	42.2	8.0	0.77%	4.0	Projecting
SPNC-26	Calf Creek	Mattole Road	Humboldt Redwoods State Park	Weott	T1S, R2E, S29	N40.35289 W123.97589	3.5 miles to Hwy 101	Circular	SSP	2-2/3" x 1/2"	37.5	4.0	0.53%	2.2	Projecting
SPNC-27	Harper Creek - LB	Mattole Road	Humboldt Redwoods State Park	Weott	T1S, R2E, S29	N40.35109 W123.98799	4.3 miles to Hwy 101	Box	Concrete	N/A	27.2	10 x 10	0.52%	N/A	Headwall
SPNC-27	Harper Creek - RB	Mattole Road	Humboldt Redwoods State Park	Weott	T1S, R2E, S29	N40.35109 W123.98799	4.3 miles to Hwy 101	Box	Concrete	N/A	29.0	10 x 10	0.53%	N/A	Headwall
SPNC-28	Durphy Creek #1	Oak Flat Campground Road	Richardson Grove State Park	Garberville	T5S, R3E, S13	N40.02171 W123.79215	0.3 miles to Hwy 101	Circular	SSP	6" x 2"	60.5	9.0	1.48%	2.4	Mitered
SPNC-29	Durphy Creek #2	Madrone Campground Road	Richardson Grove State Park	Garberville	T5S, R3E, S13	N40.02073 W123.79388	0.2 miles to Hwy 101	Circular	SSP	6" x 2"	50.6	9.5	0.16%	7.0	Wingwall

Site ID #	Inlet Alignment to Channel	Inlet Apron	Outlet Configuration	Outlet Apron	Culvert Embedded?	Crossing-Culvert Condition	Average Active Channel Width (ft)	Estimated Road fill (cubic yards)	Previous Fish Passage Modifications to Crossing	Additional Comments from Initial Site Visit
SPNC-24	<30°	No	Cascade Over Riprap	No	No	Poor	9.0	7,412	No	Site was surveyed on 2/25/09. Large debris jam at inlet. Outlet is very perched above the South Fork Eel River. Two old growth redwoods on road fill. Channel very aggraded upstream of inlet.
SPNC-25	<30°	No	At stream grade	No	Partial	Fair	16.0	1,032	No	Site was surveyed on 2/26/09. Drop at inlet due to undersized pipe. Pipe appears very undersized. Excellent fish habitat, pools-riffles and nice spawning gravels. Pipe most likely does not block fish but the inlet could be very problematic.
SPNC-26	<30°	No	At stream grade	No	Yes	Poor	8.2	253	No	Site was surveyed on 2/26/09. Inlet is scoured due to undersized pipe. Inlet is damaged on top. Pipe is slumping in the middle on top from the road. Pipe is backwatered. Nice small creek with limited pools. Bedload deposited at inlet. Appears to be one long riffle with a moderate gradient. Mostly cobble substrate. Several hundred feet upstream there are several pools formed by redwood LWD and roots of live redwoods. Gradient makes it probably more a steelhead than a coho creek.
SPNC-27	<30°	No	Freefall into Pool	No	No	Good	12.4	---	No	Site was surveyed on 2/24/09. Upstream habitat: narrow, confined, relatively steep channel. Mostly high gradient riffles. One pool in approximately 300-ft of channel. Dense riparian of hardwoods and small conifers. Check CDFG for more habitat info. Looks more suitable for steelhead than coho.
SPNC-27	<30°	No	Freefall into Pool	No	Partial	Good	12.4	---	No	Site was surveyed on 2/24/09. Upstream habitat: narrow, confined, relatively steep channel. Mostly high gradient riffles. One pool in approximately 300-ft of channel. Dense riparian of hardwoods and small conifers. Check CDFG for more habitat info. Looks more suitable for steelhead than coho.
SPNC-28	<30°	No	At stream grade	No	Yes	Poor - culvert broken at inlet	21.6	2,966	No	Site was surveyed on 2/24/09. Stream reach from confluence up to second park crossing is steep, confined, straight channel with little, if any habitat value. Channel appears recently downcut through aggraded bedload. Spoils on right bank from excavating. Banks appear feathered from grading/excavating.
SPNC-29	30-45°	No	At stream grade	No	No	Fair	21.6	4,229	No	Site was surveyed on 2/24/09. Large amounts of sediment deposited upstream of site, huge terraces created from bedload. Creek is largely channelized from deposited sediments decreasing viable fish habitat. May improve upstream (check CDFG for HSU/Caltrans study and habitat info). Two foot falls a few hundred feet upstream. Four overflow culverts above main creek culvert.

SPNC-01 UNNAMED TRIBUTARY TO MILL CREEK - HOWLAND HILL ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	41.99	-28.39	87.16	USCH1		0.00	87.16
3	34.12	-24.52	87.19	INLINV		8.77	87.19
14	-22.42	10.36	84.16	OUTINV		75.20	84.16
15	-26.08	13.23	83.39	POOLD	max d w/in 5' = 1.0'	79.85	83.39
19	-40.71	21.32	84.17	TWXS1	Thalweg d = 0.25'	96.56	84.17
25	-65.95	26.04	83.71	DSCH1		122.24	83.71

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	-40.47	22.85	86.34	TWXS1	LB	0.00	86.34
18	-40.48	21.67	85.27	TWXS1		1.18	85.27
19	-40.71	21.32	84.17	TWXS1	Thalweg d = 0.25'	1.60	84.17
20	-40.75	19.76	84.17	TWXS1		3.15	84.17
21	-40.68	18.71	84.35	TWXS1		4.21	84.35
22	-40.58	16.25	84.78	TWXS1		6.67	84.78
23	-40.53	12.46	85.24	TWXS1		10.46	85.24
24	-41.01	10.57	87.64	TWXS1	RB	12.41	87.64

Calculations for R-G-G Filter

us channel slope =	-0.0029
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0455
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	66.4
ds channel slope =	0.0177
residual inlet depth(ft) =	-3.02
residual outlet depth(ft) =	0.01
residual pool depth(ft) =	0.78

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
5	35.58	-23.14	87.05	FILINBOT1		0.00	87.05
4	33.58	-26.79	87.14	FILINBOT2		4.16	87.14
8	32.15	-2.40	99.64	FILINTOP1		0.00	99.64
7	19.63	-12.24	99.14	FILINTOP2		15.93	99.14
6	9.88	-25.10	98.49	FILINTOP3		32.06	98.49
9	11.03	16.67	99.94	FILOUTTOP1		0.00	99.94
10	-8.97	-1.52	99.64	FILOUTTOP2		27.03	99.64
11	-22.60	-11.36	100.11	FILOUTTOP3		43.84	100.11
12	-22.15	12.39	84.16	FILOUTBOT1		0.00	84.16
13	-24.03	9.73	83.93	FILOUTBOT2		3.25	83.93

Culvert shape = Circular 30" diameter
Culvert xs area (ft^2) = 4.9

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
65.9	18.6	64.2	25.0	100.2	32.1	43.8	4.2	3.3	12.0	15.6	7063	11430	31405	1,848	12	1,836

SPNC-02 UNNAMED TRIBUTARY #1 TO NICKERSON CREEK - HOWLAND HILL ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	30.87	-49.27	87.94	USCH1	Drop above inlet	0.00	87.94
3	17.39	-38.67	85.95	INLINV		17.15	85.95
12	20.96	27.05	84.33	OUTINV	d = 1.1'	82.96	84.33
15	21.03	30.30	84.43	POOLD	max d w/in 5' = 1.0'	86.22	84.43
19	22.83	41.66	86.10	TWXS1	Thalweg = dry	97.72	86.10
22	28.44	55.82	85.49	DSCH1		112.95	85.49

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
16	26.56	41.67	87.82	TWXS1	LB	0.00	87.82
17	25.80	41.69	87.25	TWXS1		0.76	87.25
18	25.08	41.62	86.35	TWXS1		1.48	86.35
19	22.83	41.66	86.10	TWXS1	Thalweg = dry	3.73	86.10
20	20.91	41.67	86.39	TWXS1		5.65	86.39
21	19.64	41.87	87.87	TWXS1	RB	6.93	87.87

Calculations for R-G-G Filter

us channel slope =	0.1163
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0246
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	65.8
ds channel slope =	0.0397
residual inlet depth(ft) =	0.15
residual outlet depth(ft) =	1.77
residual pool depth(ft) =	1.67

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	21.30	-39.37	86.58	FILINBOT1		0.00	86.58
5	15.38	-39.35	85.65	FILINBOT2		5.92	85.65
6	30.59	-17.17	99.68	FILINTOP1		0.00	99.68
7	14.62	-16.85	99.25	FILINTOP2		15.97	99.25
8	-15.21	-16.24	99.46	FILINTOP3		45.80	99.46
9	35.73	3.71	99.90	FILOUTTOP1		0.00	99.90
10	18.42	4.72	99.71	FILOUTTOP2		17.34	99.71
11	-0.01	8.06	99.64	FILOUTTOP3		36.06	99.64
13	22.66	27.42	84.55	FILOUTBOT1		0.00	84.55
14	19.21	27.44	84.64	FILOUTBOT2		3.45	84.64

Culvert shape = Circular 42" diameter
Culvert xs area (ft^2) = 9.6

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V yd^3	Culvert V yd^3	Fill V yd^3
76.6	17.4	76.7	20.1	71.8	45.8	36.1	5.9	3.5	13.1	15.1	12818	11225	25522	1,836	23	1,812

SPNC-03 UNNAMED TRIBUTARY #2 TO NICKERSON CREEK - HOWLAND HILL ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	42.46	-32.29	90.25	USCH1	d = 0.7'	0.00	90.25
3	31.40	-21.21	90.95	INLINV		15.65	90.95
12	-8.96	13.31	90.30	OUTINV		68.75	90.30
13	-9.84	14.69	83.24	POOLD	d = 6.0'	70.39	83.24
21	-31.23	17.65	88.22	TWXS1	Thalweg d = 1.0'	91.99	88.22
23	-24.19	48.96	88.75	DSCH1		124.08	88.75

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
16	-23.80	32.66	91.25	TWXS1	LB	0.00	91.25
17	-24.00	32.07	89.14	TWXS1		0.62	89.14
18	-25.21	29.60	89.46	TWXS1		3.37	89.46
19	-27.85	24.34	89.42	TWXS1		9.25	89.42
20	-29.29	21.52	89.54	TWXS1		12.42	89.54
21	-31.23	17.65	88.22	TWXS1	Thalweg d = 1.0'	16.75	88.22
22	-31.55	17.03	90.21	TWXS1	RB	17.45	90.21

Calculations for R-G-G Filter

us channel slope =	-0.0450
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0122
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	53.1
ds channel slope =	-0.0165
residual inlet depth(ft) =	-2.74
residual outlet depth(ft) =	-2.08
residual pool depth(ft) =	4.98

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	21.30	-39.37	86.58	FILINBOT1		0.00	86.58
5	15.38	-39.35	85.65	FILINBOT2		5.92	85.65
6	30.59	-17.17	99.68	FILINTOP1		0.00	99.68
7	14.62	-16.85	99.25	FILINTOP2		15.97	99.25
8	-15.21	-16.24	99.46	FILINTOP3		45.80	99.46
9	35.73	3.71	99.90	FILOUTTOP1		0.00	99.90
10	18.42	4.72	99.71	FILOUTTOP2		17.34	99.71
11	-0.01	8.06	99.64	FILOUTTOP3		36.06	99.64
13	22.66	27.42	84.55	FILOUTBOT1		0.00	84.55
14	19.21	27.44	84.64	FILOUTBOT2		3.45	84.64

Culvert shape = Circular 42" diameter
Culvert xs area (ft^2) = 9.6

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
76.6	17.4	76.7	20.1	71.8	45.8	36.1	5.9	3.5	13.1	15.1	12818	11225	25522	1,836	19	1,817

SPNC-04 METCALF GROVE CREEK - HOWLAND HILL ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	40.70	-16.25	94.16	USCH1	TWC of 1st pool d=0.12'	0.00	94.16
3	30.32	-7.02	94.15	INLINV		13.89	94.15
14	-8.04	10.32	92.08	OUTINV	Thalweg d=0.20'	55.98	92.08
15	-10.03	13.97	91.25	POOLD	d=0.32	60.14	91.25
22	-27.23	17.12	91.48	TWXS1	Thalweg d=0.17'	77.62	91.48
25	-22.94	45.09	91.28	DSCH1	d=0.18'	105.92	91.28

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	-19.36	24.94	93.27	TWXS1	LB	0.00	93.27
18	-20.22	24.07	92.81	TWXS1		1.23	92.81
19	-20.58	23.82	91.91	TWXS1		1.67	91.91
20	-23.81	20.67	91.89	TWXS1	Thalweg d=0.17'	6.18	91.89
21	-26.54	17.87	91.77	TWXS1		10.09	91.77
22	-27.23	17.12	91.48	TWXS1		11.10	91.48
23	-27.86	16.51	93.47	TWXS1	RB	11.98	93.47
24	-29.43	14.98	94.07	TWXS1		14.18	94.07

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	33.07	-2.91	94.15	FILINBOT1		0.00	94.15
5	29.98	-8.67	94.24	FILINBOT2		6.53	94.24
6	28.40	11.32	100.66	FILINTOP1		0.00	100.66
7	19.91	-3.20	101.02	FILINTOP2		16.81	101.02
8	11.98	-13.44	101.49	FILINTOP3		29.76	101.49
9	5.78	22.30	99.64	FILOUTTOP1		0.00	99.64
10	1.83	7.04	99.68	FILOUTTOP2		15.76	99.68
11	-10.71	-8.26	99.99	FILOUTTOP3		35.53	99.99
12	-6.06	11.30	92.58	FILOUTBOT1		0.00	92.58
13	-5.87	13.13	92.13	FILOUTBOT2		1.84	92.13

Calculations for R-G-G Filter

us channel slope =	0.0004
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0493
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	42.1
ds channel slope =	0.0071
residual inlet depth(ft) =	-2.68
residual outlet depth(ft) =	-0.60
residual pool depth(ft) =	0.22

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Circular 36" diameter

Culvert xs area (ft^2) = 7.1

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V yd^3	Culvert V yd^3	Fill V yd^3
41.0	16.9	31.6	23.8	68.2	29.8	35.5	6.5	1.8	6.8	7.3	2503	2108	9896	537	11	526

SPNC-05 UNNAMED TRIBUTARY TO WEST FOR MILL CREEK - PICNIC ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	-9.29	-108.70	105.85	USCH1		0.00	105.85
3	-9.57	-89.69	104.76	INLINV		19.01	104.76
4	-2.78	-35.66	103.33	OUTINV		73.46	103.33
5	-1.67	-31.29	98.90	POOLD	max d w/in 5' = 1.6'	77.97	98.90
10	3.37	-7.16	99.56	TWXS1		102.62	99.56
16	-16.68	47.11	98.27	DSCH1		160.47	98.27

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
7	12.36	-4.91	102.06	TWXS1	LB	0.00	102.06
8	8.09	-6.44	100.44	TWXS1		4.54	100.44
9	5.21	-6.13	100.66	TWXS1		7.44	100.66
10	3.37	-7.16	99.56	TWXS1	Thalweg d = 0.95'	9.54	99.56
11	0.14	-8.58	100.26	TWXS1		13.07	100.26
12	-1.04	-8.94	100.70	TWXS1		14.30	100.70
13	-4.05	-9.73	100.71	TWXS1		17.42	100.71
14	-6.22	-10.45	101.01	TWXS1		19.70	101.01
15	-8.78	-11.17	102.47	TWXS1	RB	22.36	102.47

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
106	-7.00	-94.32	104.88	FILINBOT1		0.00	104.88
107	-13.83	-91.98	104.45	FILINBOT2		7.22	104.45
103	17.86	-81.88	120.19	FILINTOP1		0.00	120.19
104	-7.62	-74.16	119.98	FILINTOP2		26.61	119.98
105	-35.05	-69.68	120.49	FILINTOP3		54.41	120.49
102	24.30	-60.36	120.58	FILOUTTOP1		0.00	120.58
20	-15.58	-49.21	120.01	FILOUTTOP2		41.41	120.01
19	-32.10	-40.57	120.30	FILOUTTOP3		60.05	120.30
17	5.28	-28.71	100.51	FILOUTBOT1		0.00	100.51
18	-7.27	-27.25	100.50	FILOUTBOT2		12.64	100.50

Calculations for R-G-G Filter

us channel slope =	0.0571
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0263
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	54.5
ds channel slope =	0.0224
residual inlet depth(ft) =	-5.20
residual outlet depth(ft) =	-3.77
residual pool depth(ft) =	0.67

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Circular 96" diameter
Culvert xs area (ft^2) = 50.3

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
65.8	23.9	88.7	22.6	85.9	54.4	60.1	7.2	12.6	15.3	19.5	15117	30655	57681	3,832	101	3,730

SPNC-06 ESPA CREEK - DAVISON ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	19.37	-9.80	95.42	USCH1	d = 0.2'	0.00	95.42
3	7.25	-13.38	95.02	INLINV		12.64	95.02
12	-22.92	-22.03	93.27	OUTINV		44.02	93.27
15	-25.64	-23.41	91.90	POOLD	w/in 5' d = 1.5'	47.07	91.90
19	-49.60	-19.57	93.25	TWXS1	Thalweg	71.34	93.25
24	-63.17	-19.21	93.19	DSCH1		84.91	93.19

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	-49.37	-18.63	94.72	TWXS1	LB	0.00	94.72
18	-49.56	-19.15	94.35	TWXS1		0.56	94.35
19	-49.60	-19.57	93.25	TWXS1	Thalweg	0.98	93.25
20	-49.88	-21.53	93.33	TWXS1		2.95	93.33
21	-50.36	-24.40	93.29	TWXS1		5.87	93.29
22	-50.54	-24.73	94.82	TWXS1		6.24	94.82
23	-50.99	-26.81	95.17	TWXS1	RB	8.37	95.17

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	7.10	-11.69	94.88	FILINBOT1		0.00	94.88
5	8.34	-14.52	95.12	FILINBOT2		3.09	95.12
6	3.37	-2.25	99.63	FILINTOP1		0.00	99.63
7	4.66	-12.23	100.01	FILINTOP2		10.06	100.01
8	6.99	-22.91	100.10	FILINTOP3		20.99	100.10
9	-20.85	-9.33	98.64	FILOUTTOP1		0.00	98.64
10	-21.40	-20.64	98.72	FILOUTTOP2		11.32	98.72
11	-23.07	-31.70	98.91	FILOUTTOP3		22.51	98.91
13	-24.07	-19.89	92.37	FILOUTBOT1		0.00	92.37
14	-23.35	-24.32	92.10	FILOUTBOT2		4.49	92.10

Calculations for R-G-G Filter

us channel slope =	0.0320
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0558
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	31.4
ds channel slope =	0.0041
residual inlet depth(ft) =	-1.77
residual outlet depth(ft) =	-0.02
residual pool depth(ft) =	1.35

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Circular 60" diameter
Culvert xs area (ft^2) = 19.6

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
12.3	44.8	13.1	56.9	89.8	21.0	22.5	3.1	4.5	5.0	6.5	338	498	7571	311	23	289

SPNC-07 WEST FORK STRAWBERRY CREEK - SOC ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	-175.62	2.90	98.93	USCH2		0.00	98.93
2	-18.46	-21.69	94.54	INLINV		159.07	94.54
14	-1.39	14.82	94.13	OUTINV		199.37	94.13
16	-2.64	30.13	94.52	DSCH1		214.73	94.52
18	-175.00	59.17	95.68	USCH3	at presumed culvert, could not find this culvert downstream of presumed culvert	0.00	95.68
19	-158.46	94.88	95.50	DSCH2		39.35	95.50

Tailwater Cross Section Raw Data

No tailwater cross section done

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	-17.41	-22.08	94.34	FILINBOT1		0.00	94.34
5	-19.17	-21.69	94.74	FILINBOT2		1.80	94.74
6	-3.17	-19.33	100.10	FILINTOP1		0.00	100.10
7	-14.79	-13.32	99.99	FILINTOP2		13.08	99.99
8	-22.93	-9.41	99.91	FILINTOP3		22.11	99.91
9	7.23	-0.40	99.56	FILOUTTOP1		0.00	99.56
10	-9.17	5.95	99.78	FILOUTTOP2		17.58	99.78
11	-19.24	11.46	99.66	FILOUTTOP3		29.06	99.66
12	-0.50	15.07	93.93	FILOUTBOT1		0.00	93.93
13	-1.56	15.72	93.82	FILOUTBOT2		1.24	93.82

Calculations for R-G-G Filter

us channel slope =	0.0276
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0102
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	40.3
ds channel slope =	-0.0251
residual inlet depth(ft) =	-0.03
residual outlet depth(ft) =	0.39
residual pool depth(ft) =	N/A

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Circular 18" diameter
Culvert xs area (ft^2) = 1.77

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
31.0	17.9	41.4	14.4	65.8	22.1	29.1	1.8	1.2	5.5	5.9	994	1830	5350	303	3	300

SPNC-08 STRAWBERRY CREEK - SOC ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	-27.92	-24.02	97.02	USCH1	TWC of 1st pool d=0.12'	0.00	97.02
3	-7.99	-20.92	95.06	INLINV		20.17	95.06
15	17.17	-7.91	95.94	OUTINV	Thalweg d=0.20'	48.49	95.94
17	25.94	-6.31	96.72	TWC	Thalweg d=0.17'	57.41	96.72
18	92.73	-55.18	92.66	DSCH1	d=0.18'	140.17	92.66

Tailwater Cross Section Raw Data

No tailwater cross section data collected

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
5	-7.49	-22.09	94.49	FILINBOT1		0.00	94.49
6	-9.68	-18.01	95.25	FILINBOT2		4.63	95.25
7	2.71	-25.30	100.15	FILINTOP1		0.00	100.15
8	-4.97	-15.77	99.85	FILINTOP2		12.24	99.85
9	-13.20	-8.89	99.78	FILINTOP3		22.96	99.78
10	20.88	-19.29	100.33	FILOUTTOP1		0.00	100.33
11	14.71	-13.53	100.13	FILOUTTOP2		8.43	100.13
12	7.39	-3.16	99.72	FILOUTTOP3		21.13	99.72
13	18.76	-10.03	94.37	FILOUTBOT1		0.00	94.37
14	16.50	-5.69	94.40	FILOUTBOT2		4.89	94.40

Calculations for R-G-G Filter

us channel slope =	0.0974
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	-0.0311
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	28.3
ds channel slope =	0.0491
residual inlet depth(ft) =	1.66
residual outlet depth(ft) =	0.78
residual pool depth(ft) =	N/A

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Circular 36" diameter

Culvert xs area (ft²) = 7.1

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
20.3	25.3	22.7	26.1	65.0	23.0	21.1	4.6	4.9	5.0	5.7	678	820	5499	259	7	252

SPNC-09 TRILLIUM FALLS CREEK - DAVISON TRAIL

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
				USCH1		0.00	0.00
2	-16.485	-17.55	86.58	INLINV		24.08	86.58
13	30.845	20.06	86.67	OUTINV		84.53	86.67
14	30.935	19.98	90.25	WSE	Beaver pond = use as TWC	84.65	90.25

Tailwater Cross Section Raw Data

no tailwater X-section, pipe is fully submerged by a downstream beaver dam

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
3	-18.435	-25.705	87.23	FILINBOT1		0.00	87.23
4	-24.25	-18.745	87.385	FILINBOT2		9.07	87.39
5	7.64	-21.9	99.18	FILINTOP1		0.00	99.18
6	-3.76	-7.59	99.56	FILINTOP2		18.30	99.56
7	-17.38	10.815	100.08	FILINTOP3		41.19	100.08
8	21.825	-12.63	99.17	FILOUTTOP1		0.00	99.17
9	8.295	2.94	99.555	FILOUTTOP2		20.63	99.56
10	-2.38	18.605	100.41	FILOUTTOP3		39.58	100.41
11	32.545	18.46	86.665	FILOUTBOT1		0.00	86.67
12	29.495	22.47	85.995	FILOUTBOT2		5.04	86.00

Calculations for R-G-G Filter

us channel slope =	-3.596
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	-0.0015
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	60.5
ds channel slope =	N/A
residual inlet depth(ft) =	3.67
residual outlet depth(ft) =	3.58
residual pool depth(ft) =	N/A

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Circular 5-ft
Culvert xs area (ft^2) = 19.63

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
77.5	16.0	95.4	14.0	52.5	41.2	39.6	9.1	5.0	12.3	13.2	11780	13944	18228	1,628	44	1,584

SPNC-10 UNNAMED TRIBUTARY #1 TO PRAIRIE CREEK - DAVISON TRAIL

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	6.55	-54.57	92.45	USCH1	Top of cascade	0.00	92.45
3	3.33	-42.05	90.91	USCH2	Bottom of cascade d = 0.2'	12.92	90.91
4	3.08	-40.57	89.09	USCH3	Pool d = 1.8'	14.42	89.09
5	0.38	-31.77	89.80	USCH4	Pool d = 1.25'	23.63	89.80
6	-2.24	-16.84	89.93	INLINV	On top of sediment	38.79	89.93
18	-13.13	23.35	87.25	OUTINV		80.43	87.25
19	-13.13	23.29	90.97	WSE			90.97

Tailwater Cross Section Raw Data

No Cross Section Data recorded, Beaver Dam downstream

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
8	-1.86	-17.01	88.05	FILINBOT1		0.00	88.05
9	-8.22	-18.74	88.13	FILINBOT2		6.59	88.13
10	14.42	-5.88	99.90	FILINTOP1		0.00	99.90
11	-8.34	-5.96	100.05	FILINTOP2		22.76	100.05
12	-22.56	-7.01	100.34	FILINTOP3		37.02	100.34
13	16.89	11.20	99.50	FILOUTTOP1		0.00	99.50
14	-11.53	8.37	99.24	FILOUTTOP2		28.56	99.24
15	-25.52	8.01	99.22	FILOUTTOP3		42.55	99.22
16	-11.14	23.91	87.23	FILOUTBOT1		0.00	87.23
17	-15.81	24.06	88.05	FILOUTBOT2		4.67	88.05

Calculations for R-G-G Filter

us channel slope =	0.065
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0644
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	41.6
ds channel slope =	0.000
residual inlet depth(ft) =	1.05
residual outlet depth(ft) =	3.72
residual pool depth(ft) =	N/A

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 5.75x8.2 pipe arch
Culvert xs area (ft^2) = 38

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
43.7	28.5	53.4	22.2	48.2	37.0	42.5	6.6	4.7	12.0	11.6	5477	7140	14478	1,004	59	945

SPNC-11 STREELOW CREEK - DAVISON ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	-1.33	-11.06	94.49	USCH1		0.00	0.00
14	35.79	5.86	94.16	INLINV		11.13	94.49
15	38.05	7.22	94.13	OUTINV	d = 1.70'	51.92	94.16
20	51.48	12.51	94.41	POOLD	max d = 1.70'	54.55	94.13
23	92.70	4.88	94.89	TWXS1	Thalweg d = 1.5'	68.99	94.41
				DSCH1	d = 1.0'	110.91	94.89

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
16	52.07	7.62	96.65	TWXS1		0.00	96.65
17	51.77	8.24	95.04	TWXS1		0.69	95.04
18	51.73	10.01	94.90	TWXS1		2.46	94.90
19	51.59	11.63	94.63	TWXS1		4.09	94.63
20	51.48	12.51	94.41	TWXS1	Thalweg d = 1.5'	4.97	94.41
21	51.46	12.95	96.34	TWXS1		5.42	96.34
22	51.31	14.59	96.63	TWXS1	RB	7.06	96.63

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
3	-0.63	-13.04	94.21	FILINBOT1		0.00	94.21
5	-2.65	-9.09	94.42	FILINBOT2		4.44	94.42
6	16.69	-15.26	99.48	FILINTOP1		0.00	99.48
7	4.59	-7.70	99.57	FILINTOP2		14.26	99.57
8	-10.43	3.10	99.94	FILINTOP3		32.76	99.94
9	48.98	-7.13	98.73	FILOUTTOP1		0.00	98.73
10	31.94	2.80	99.04	FILOUTTOP2		19.72	99.04
11	20.14	11.62	99.58	FILOUTTOP3		34.45	99.58
12	36.99	4.70	94.66	FILOUTBOT1		0.00	94.66
13	36.07	8.07	94.24	FILOUTBOT2		3.49	94.24

Calculations for R-G-G Filter

us channel slope =	-8.487
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0081
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	40.8
ds channel slope =	-0.011
residual inlet depth(ft) =	-0.08
residual outlet depth(ft) =	0.25
residual pool depth(ft) =	0.28

scope and field notes: TDG
rod: RNT
spreadsheet: RNT/TDG

Culvert shape = 4x4.5 Oval
Culvert xs area (ft^2) = 14.52

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
24.9	21.6	20.4	23.1	96.1	32.8	34.4	4.4	3.5	5.3	4.6	1190	864	9823	440	22	418

SPNC-12 BOYES CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	-16.57	98.98	100.96	USCH1		0.00	100.96
3	-16.47	84.01	99.61	INLINV		14.97	99.61
4	-13.20	69.24	99.65	CLVBOT1		30.09	99.65
5	-3.11	25.18	100.02	OUTINV		75.29	100.02
6	-1.74	20.93	100.18	POOLD		79.76	100.18
16	19.31	-0.40	100.53	TWXS1	REW, thalweg	109.72	100.53
19	57.37	-1.09	99.22	DSCH1		147.79	99.22

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
10	31.22	-19.67	102.08	TWXS1		0.00	102.08
11	29.37	-16.47	101.37	TWXS1		3.70	101.37
12	28.91	-15.76	100.87	TWXS1	LEW	4.54	100.87
13	26.39	-11.58	100.65	TWXS1		9.43	100.65
14	23.65	-6.91	100.56	TWXS1	d = 0.35'	14.84	100.56
15	21.16	-2.84	100.65	TWXS1		19.61	100.65
16	19.31	-0.40	100.53	TWXS1	REW, thalweg	22.67	100.53
17	19.25	-0.10	101.32	TWXS1		22.97	101.32
18	18.92	0.99	102.03	TWXS1		24.11	102.03

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
104	-22.77	92.37	101.22	FILINBOT1		0.00	101.22
105	-12.60	95.63	100.99	FILINBOT2		10.67	100.99
101	-39.51	77.78	111.96	FILINTOP1		0.00	111.96
102	-15.47	82.29	112.24	FILINTOP2		24.45	112.24
103	-0.73	85.23	111.91	FILINTOP3		39.49	111.91
20	-25.17	24.77	113.10	FILOUTTOP1		0.00	113.10
21	-5.28	29.59	113.11	FILOUTTOP2		20.46	113.11
22	9.28	33.82	112.93	FILOUTTOP3		35.62	112.93
7	-6.15	14.35	100.63	FILOUTBOT1		0.00	100.63
8	2.59	17.85	100.58	FILOUTBOT2		9.41	100.58

Calculations for R-G-G Filter

us channel slope =	0.0902
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	-0.0067
non-embedded segment Slope =	-0.0026
embedded segment length (ft)=	-0.0081
non-embedded segment length (ft)=	15.1
embedded segment length (ft)=	45.2
total culvert length(ft) =	60.3
ds channel slope =	0.0345
residual inlet depth(ft) =	0.92
residual outlet depth(ft) =	0.52
residual pool depth(ft) =	0.35

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 10x10 Box
Culvert xs area (ft^2) = 100

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
44.2	26.0	49.8	25.9	176.1	39.5	35.6	10.7	9.4	11.1	12.5	5977	6791	59986	2,695	223	2,471

SPNC-13 BIG TREE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
				USCH1		0.00	0.00
2	-8.76	1.57	100.02	INLINV		8.89	100.02
3	-49.90	3.93	99.53	OUTINV		50.11	99.53
5	-53.44	4.27	93.48	POOLD		53.66	93.48
6	-65.58	7.83	95.58	POOL TWC		66.31	95.58

Tailwater Cross Section Raw Data

Not able to do tailwater crosssection due to logs across TWC

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
7	-2.58	4.23	100.08	FILINBOT1		0.00	100.08
8	-2.80	-2.76	100.12	FILINBOT2		6.99	100.12
9	-10.99	16.66	109.67	FILINTOP1		0.00	109.67
10	-11.93	0.49	109.72	FILINTOP2		16.20	109.72
11	-12.85	-13.57	109.68	FILINTOP3		30.29	109.68
101	-40.18	19.35	109.92	FILOUTTOP1		0.00	109.92
102	-40.70	4.48	110.09	FILOUTTOP2		14.88	110.09
103	-41.66	-14.30	110.12	FILOUTTOP3		33.68	110.12
104	-56.85	9.65	94.20	FILOUTBOT1		0.00	94.20
105	-58.74	-3.04	94.85	FILOUTBOT2		12.82	94.85

Calculations for R-G-G Filter

us channel slope =	N/A
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0120
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	41.2
ds channel slope =	N/A
residual inlet depth(ft) =	-4.44
residual outlet depth(ft) =	-3.95
residual pool depth(ft) =	2.10

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 5x6 box
Culvert xs area (ft^2) = 30

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
33.8	29.7	61.9	26.0	95.3	30.3	33.7	7.0	12.8	9.6	15.6	2907	10831	31076	1,660	46	1,614

SPNC-14 BROWNS CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	94.18	47.17	99.61	USCH1	d = 0.85'	0.00	99.61
3	62.86	27.49	99.48	INLINV	d = 0.90'	36.99	99.48
4	26.96	11.61	99.43	OUTINV	d = 0.95'	76.24	99.43
5	23.27	8.74	99.61	POOLD	d = 0.80'	80.92	99.61
13	9.30	1.87	99.74	TWXS1	Thalweg d = 0.60'	96.48	99.74
18	-42.85	-25.22	98.72	DSCH1	d = 0.35'	155.24	98.72

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
8	2.66	12.04	102.21	TWXS1		0.00	102.21
9	3.66	10.51	101.51	TWXS1		1.82	101.51
10	4.41	9.43	100.83	TWXS1		3.14	100.83
11	7.21	4.80	100.32	TWXS1	LEW	8.55	100.32
12	8.57	3.07	99.88	TWXS1		10.75	99.88
13	9.30	1.87	99.74	TWXS1	Thalweg d = 0.60'	12.15	99.74
14	11.16	-0.84	99.92	TWXS1		15.44	99.92
15	12.54	-2.88	100.37	TWXS1	REW	17.90	100.37
16	13.71	-4.89	101.30	TWXS1		20.23	101.30
17	14.73	-6.39	103.05	TWXS1		22.04	103.05

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
104	66.62	38.35	100.36	FILINBOT1		0.00	100.36
105	75.56	31.88	99.41	FILINBOT2		11.03	99.41
101	38.09	42.57	112.70	FILINTOP1		0.00	112.70
102	55.47	28.26	113.07	FILINTOP2		22.51	113.07
103	77.41	10.46	113.48	FILINTOP3		50.77	113.48
19	10.96	28.72	112.37	FILOUTTOP1		0.00	112.37
20	28.02	13.96	112.72	FILOUTTOP2		22.56	112.72
21	50.55	-5.64	112.83	FILOUTTOP3		52.42	112.83
6	9.68	10.88	100.50	FILOUTBOT1		0.00	100.50
7	22.56	1.39	100.00	FILOUTBOT2		16.00	100.00

Calculations for R-G-G Filter

us channel slope =	0.0034
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0013
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	39.3
ds channel slope =	0.0174
residual inlet depth(ft) =	0.25
residual outlet depth(ft) =	0.30
residual pool depth(ft) =	0.13

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 8.5x10 Box
Culvert xs area (ft^2) = 85

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
yd^3														yd^3	yd^3	yd^3
59.6	22.7	54.4	23.5	101.6	50.8	52.4	11.0	16.0	13.2	12.5	11851	11302	51228	2,755	124	2,631

SPNC-15 GOOD CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	-11.13	55.74	94.27	USCH1	TWC of 1st pool d=0.12'	0.00	94.27
3	7.44	35.50	92.99	INLINV		27.46	92.99
15	8.69	-5.21	92.24	OUTINVXS	Thalweg d=0.20'	68.19	92.24
18	8.77	-8.70	92.04	POOLD	d=0.32	71.68	92.04
22	8.93	-11.53	92.13	TWXS1	Thalweg d=0.17'	74.51	92.13
26	15.90	-28.84	91.82	DSCH1	d=0.18'	93.17	91.82

Outlet XS

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
14	7.24	-5.36	92.38	OUTINVXS	LB	0.00	92.38
15	8.69	-5.21	92.24	OUTINVXS	Thalweg d=0.20'	1.46	92.24
16	10.63	-5.13	92.44	OUTINVXS		3.40	92.44
17	12.08	-5.20	92.51	OUTINVXS	RB	4.85	92.51

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
19	6.00	-11.48	93.88	TWXS1	LB	0.00	93.88
20	6.67	-11.48	93.58	TWXS1		0.67	93.58
21	7.07	-11.49	92.16	TWXSLEW		1.07	92.16
22	8.93	-11.53	92.13	TWXS1	Thalweg d=0.17'	2.93	92.13
23	11.60	-11.56	92.25	TWXSREW		5.60	92.25
24	12.95	-11.34	92.58	TWXS1		6.97	92.58
25	16.20	-10.70	93.76	TWXS1	RB	10.28	93.76

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	-0.11	38.72	93.35	--FILINLBOT1		0.00	93.35
5	9.28	39.00	93.10	--FILINLBOT2		9.39	93.10
6	-16.19	34.36	98.85	--FILINLTOP1		0.00	98.85
7	5.89	32.92	99.91	--FILINLTOP2		22.12	99.91
8	22.96	32.13	100.36	--FILINLTOP3		39.22	100.36
9	-15.85	-2.61	99.54	--FILOUTTOP1		0.00	99.54
10	10.25	-2.68	99.69	--FILOUTTOP2		26.10	99.69
11	26.81	-0.89	100.52	--FILOUTTOP3		42.75	100.52
12	7.21	-11.81	92.13	--FILOUTBOT1		0.00	92.13
13	12.09	-11.04	92.13	--FILOUTBOT2		4.94	92.13

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
26.0	26.6	30.8	25.3	117.6	39.2	42.8	9.4	4.9	6.7	7.6	2040	2690	23177	1,034	30	1,003

Calculations for R-G-G Filter

us channel slope =	0.0468
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0183
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outletxs ds slope =	0.0587
outlet apron length(ft) =	N/A
total culvert length(ft) =	40.7
ds channel slope =	0.0166
residual inlet depth(ft) =	-0.86
residual outlet depth(ft) =	-0.11
residual pool depth(ft) =	0.09

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Box
Culvert xs area (ft^2) = 20

SPNC-16 UNNAMED TRIBUTARY #2 TO PRAIRIE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	19.08	51.05	94.21	USCH1	d=0.15	0.00	94.21
3	5.29	34.35	92.40	INLINV		21.65	92.40
12	4.05	-4.81	91.83	OUTINV		60.82	91.83
13	3.09	-5.47	91.17	POOLD	d=0.23	61.99	91.17
18	3.64	-9.66	91.15	TWXS1	Thalweg d=0.31'	66.22	91.15
23	3.31	-35.65	90.51	DSCH1		92.21	90.51

Calculations for R-G-G Filter

us channel slope =	0.0838
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0144
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	39.2
ds channel slope =	0.0244
residual inlet depth(ft) =	-1.25
residual outlet depth(ft) =	-0.69
residual pool depth(ft) =	-0.02

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
14	-0.73	-9.22	92.73	TWXS1	LB	0.00	92.73
15	-0.22	-9.19	91.80	TWXS1		0.52	91.80
16	0.58	-9.28	91.70	TWXS1	LB ACM	1.32	91.70
17	2.25	-9.59	91.43	TWXSLEW		3.01	91.43
18	3.64	-9.66	91.15	TWXS1	Thalweg d=0.31'	4.40	91.15
19	5.25	-9.77	91.47	TWXSREW		6.02	91.47
20	6.73	-9.98	92.50	TWXS1	RB	7.51	92.50

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	2.43	37.30	93.32	--FILINLBOT1		0.00	93.32
5	11.60	38.91	93.19	--FILINLBOT2		9.31	93.19
6	-11.46	31.01	99.90	--FILINLTOP1		0.00	99.90
7	8.36	32.70	99.72	--FILINLTOP2		19.89	99.72
8	27.36	32.25	100.00	--FILINLTOP3		38.89	100.00
9	-16.47	-2.92	99.62	--FILOUTTOP1		0.00	99.62
10	6.14	-1.99	99.95	--FILOUTTOP2		22.62	99.95
11	23.84	-2.14	100.02	--FILOUTTOP3		40.32	100.02
21	0.49	-9.19	91.58	--FILOUTBOT1		0.00	91.58
22	5.96	-9.50	91.60	--FILOUTBOT2		5.48	91.60

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wtr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
24.7	27.1	28.6	30.6	114.0	38.9	40.3	9.3	5.5	6.5	8.4	1853	2618	22994	1,017	29	988

Culvert shape = Box
Culvert xs area (ft^2) = 20

SPNC-17 UNNAMED TRIBUTARY #3 TO PRAIRIE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data - Left Bay Culvert 1 of 2

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	24.37	55.28	94.49	USCH1	TWC of 1st US pool d=0.10'	0.00	94.49
3	11.92	33.66	92.79	INLINV1	Left Bay d=0.10'	24.95	92.79
15	6.49	-6.56	92.31	OUTINV1	d=0.20'	65.53	92.31
17	7.42	-8.44	92.18	POOLD	d=0.30'	67.62	92.18
21	10.88	-14.58	91.86	TWXS1	d=0.28'	74.67	91.86
23	-0.24	-22.85	91.53	DSCH1	d=0.15	88.53	91.53

Longitudinal Profile Raw Data - Right Bay Culvert 2 of 2

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	24.37	55.28	94.49	USCH1	TWC of 1st US pool d=0.10'	0.00	94.49
4	17.67	33.50	92.77	INLINV2	Right Bay	22.78	92.77
16	10.90	-6.56	92.64	OUTINV2	dry	63.41	92.64
17	7.42	-8.44	92.18	POOLD	d=0.30'	67.36	92.18
21	10.88	-14.58	91.86	TWXS1	d=0.28'	74.41	91.86
23	-0.24	-22.85	91.53	DSCH1	d=0.15	88.27	91.53

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
18	0.27	-13.31	92.91	TWXS1		0.00	92.91
19	4.06	-13.82	92.43	TWXSLEW		3.82	92.43
20	7.16	-14.66	92.15	TWXS1	d=0.13'	7.03	92.15
21	10.88	-14.58	91.86	TWXS1	d=0.28'	10.76	91.86
22	11.58	-14.60	93.01	TWXS1	RB	11.46	93.01

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
5	7.94	36.42	93.09	--FILINLBOT1		0.00	93.09
6	22.09	35.10	93.26	--FILINLBOT2		14.21	93.26
7	-9.60	30.42	99.50	--FILINLTOP1		0.00	99.50
8	16.09	30.06	99.92	--FILINLTOP2		25.68	99.92
9	35.48	29.93	100.27	--FILINLTOP3		45.08	100.27
10	-14.81	-3.90	99.60	--FILOUTTOP1		0.00	99.60
11	9.78	-1.33	100.15	--FILOUTTOP2		24.72	100.15
12	31.03	-0.96	100.46	--FILOUTTOP3		45.98	100.46
13	3.57	-9.81	92.40	--FILOUTBOT1		0.00	92.40
14	12.79	-10.40	91.88	--FILOUTBOT2		9.24	91.88

Calculations for R-G-G Filter - Left Bay Culvert 1 of 2

us channel slope =	0.0679
inlet apron slope =	N/A
inlet apron length(ft)=	N/A
culvert slope =	0.0118
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	40.6
ds channel slope =	0.0235
residual inlet depth(ft) =	-0.94
residual outlet depth(ft) =	-0.45
residual pool depth(ft) =	-0.33

Calculations for R-G-G Filter - Right Bay Culvert 2 of 2

us channel slope =	0.0753
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0032
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	40.6
ds channel slope =	0.0235
residual inlet depth(ft) =	-0.91
residual outlet depth(ft) =	-0.78
residual pool depth(ft) =	-0.33

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Box
Culvert xs area (ft^2) = 16

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wtr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
30.6	22.6	33.9	24.3	105.0	45.1	46.0	14.2	9.2	6.7	8.0	2981	3640	26727	1,235	24	1,211

SPNC-18 SWEET CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	52.55	57.65	96.63	USCH1	d=0.26' TWC of US pool	0.00	96.63
3	44.43	45.07	96.22	INLINV		14.98	96.22
12	21.71	1.69	94.06	OUTINV		63.94	94.06
13	21.53	1.80	93.46	OUTEDGE	US edge	64.15	93.46
14	21.40	1.49	93.43	OUTEDGE	DS edge	64.49	93.43
15	22.00	1.24	91.88	OUTEDGE	off edge d=0.88'	65.14	91.88
16	20.78	-2.02	90.94	POOLD	d=1.85'	68.61	90.94
22	7.98	-12.99	92.58	TWXS1	Thalweg d=0.27'	85.47	92.58
29	5.39	-27.29	92.23	DSCH1	d=0.20'	100.01	92.23

Calculations for R-G-G Filter

us channel slope =	0.027
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0442
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	49.0
ds channel slope =	0.0237
residual inlet depth(ft) =	-3.65
residual outlet depth(ft) =	-1.48
residual pool depth(ft) =	1.64

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
19	4.89	-10.83	94.37	TWXS1	LB	0.00	94.37
20	5.77	-11.35	93.14	TWXS1		1.03	93.14
21	6.50	-11.60	92.82	TWXSLEW		1.80	92.82
22	7.98	-12.99	92.58	TWXS1	Thalweg d=0.27'	3.82	92.58
23	10.00	-14.82	92.90	TWXSREW		6.55	92.90
24	10.95	-15.80	93.13	TWXS1	RB ACM	7.92	93.13
25	13.54	-17.72	93.44	TWXS1		11.14	93.44
26	14.40	-18.77	93.50	TWXS1		12.50	93.50
27	17.18	-21.40	93.71	TWXS1		16.33	93.71
28	19.08	-21.93	94.98	TWXS1	Top of RB	18.30	94.98

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	44.45	48.28	95.62	--FILINLBOT1		0.00	95.62
5	49.23	48.44	96.56	--FILINLBOT2		4.78	96.56
6	19.16	42.35	103.11	--FILINLTOP1		0.00	103.11
7	43.70	41.99	103.38	--FILINLTOP2		24.55	103.38
8	64.08	41.80	103.69	--FILINLTOP3		44.92	103.69
9	-11.71	5.56	102.87	--FILOUTTOP1		0.00	102.87
10	20.47	5.69	102.85	--FILOUTTOP2		32.17	102.85
11	46.03	4.59	103.00	--FILOUTTOP3		57.76	103.00
17	10.99	-3.17	92.08	--FILOUTBOT1		0.00	92.08
18	20.46	-6.44	91.54	--FILOUTBOT2		10.02	91.54

Culvert shape = Box
Culvert xs area (ft^2) = 20

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
25.4	30.0	42.6	26.8	141.4	44.9	57.8	4.8	10.0	7.3	11.0	2203	7701	42867	1,954	36	1,918

SPNC-19 UNNAMED TRIBUTARY #4 TO PRAIRIE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	36.38	43.78	93.60	USCH1		0.00	93.60
3	33.34	37.14	93.00	INLINVXS	LB d=0.40'	7.30	93.00
20	12.24	-4.88	92.67	OUTINVXS	d=0.29'	54.32	92.67
22	10.21	-6.19	92.69	POOLD	d=0.31	56.73	92.69
27	9.73	-12.71	92.79	TWXS1	Thalweg d=0.16'	63.27	92.79
30	-15.85	-16.19	92.33	DSCH1	d=0.11	89.09	92.33

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
23	3.83	-7.17	93.85	TWXS1	on LB	0.00	93.85
24	5.09	-8.60	92.93	TWXSLEW		1.91	92.93
25	6.23	-9.76	92.91	TWXS1		3.54	92.91
26	7.92	-11.09	93.01	TWXS1		5.69	93.01
27	9.73	-12.71	92.79	TWXS1	Thalweg d=0.16'	8.12	92.79
28	10.42	-13.56	92.97	TWXSREW		9.21	92.97
29	10.84	-13.91	94.65	TWXS1	RB	9.75	94.65

Calculations for R-G-G Filter

us channel slope =	0.0829
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0070
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	47.0
ds channel slope =	0.0176
residual inlet depth(ft) =	-0.21
residual outlet depth(ft) =	0.12
residual pool depth(ft) =	0.09

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
8	33.31	43.81	93.66	--FILINLBOT1		0.00	93.66
9	42.82	39.02	93.93	--FILINLBOT2		10.65	93.93
10	16.79	33.82	100.38	--FILINLTOP1		0.00	100.38
11	37.96	35.85	100.09	--FILINLTOP2		21.27	100.09
12	57.27	34.46	100.81	--FILINLTOP3		40.63	100.81
13	-16.64	-2.11	99.65	--FILOUTTOP1		0.00	99.65
14	10.89	-0.85	99.92	--FILOUTTOP2		27.56	99.92
15	31.31	-0.58	100.31	--FILOUTTOP3		47.98	100.31
16	4.65	-8.67	93.02	--FILOUTBOT1		0.00	93.02
17	12.12	-10.10	92.84	--FILOUTBOT2		7.61	92.84

Culvert shape = Box
Culvert xs area (ft^2) = 20

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
25.4	25.6	32.5	22.0	149.6	40.6	48.0	10.6	7.6	6.3	7.0	1988	3082	31093	1,339	35	1,305

SPNC-20 LITTLE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	35.78	34.05	93.44	USCH1		0.00	93.44
3	31.17	29.38	92.91	USCH2	DS edge of riffle before pool at inlet	6.57	92.91
101	31.22	25.48	91.41	USCH3	Pool before inlet d=1.51	10.46	91.41
102	32.56	24.29	91.83	INLINV		12.26	91.83
4	5.47	-15.41	92.84	OUTINV		60.32	92.84
7	5.43	-17.71	92.77	POOLD	d=0.20'	62.62	92.77
11	-0.92	-23.54	92.69	TWXS4	Thalweg d=0.10'	71.24	92.69
14	-18.00	-26.09	92.22	DSCH1		88.51	92.22

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
8	-3.76	-17.94	93.66	TWXS1	on LB	0.00	93.66
9	-2.38	-21.04	93.15	TWXS2	ACM LB	3.40	93.15
10	-1.87	-21.97	92.92	TWXS3	LEW	4.46	92.92
11	-0.92	-23.54	92.69	TWXS4	Thalweg d=0.10'	6.30	92.69
12	0.01	-25.60	92.90	TWXS5	REW	8.55	92.90
13	-0.01	-27.22	94.30	TWXS6	RB	10.17	94.30

Calculations for R-G-G Filter

us channel slope =	0.1313
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	-0.0211
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	48.1
ds channel slope =	0.0269
residual inlet depth(ft) =	0.86
residual outlet depth(ft) =	-0.16
residual pool depth(ft) =	-0.08

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
103	29.16	29.91	92.96	--FILINLBOT1		0.00	92.96
104	38.63	22.88	92.88	--FILINLBOT2		11.80	92.88
15	13.48	35.08	100.47	--FILINLTOP1		0.00	100.47
16	32.68	20.66	100.54	--FILINLTOP2		24.01	100.54
17	49.66	7.11	101.09	--FILINLTOP3		45.73	101.09
18	-16.08	10.44	99.46	--FILOUTTOP1		0.00	99.46
19	5.95	-5.75	99.86	--FILOUTTOP2		27.33	99.86
20	22.44	-16.00	100.57	--FILOUTTOP3		46.75	100.57
5	2.65	-14.94	93.03	--FILOUTBOT1		0.00	93.03
6	6.83	-18.87	92.80	--FILOUTBOT2		5.74	92.80

Culvert shape = Box
Culvert xs area (ft^2) = 16

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
27.7	28.6	38.2	18.5	123.3	45.7	46.7	11.8	5.7	7.6	6.9	2922	3424	28622	1,295	28	1,267

SPNC-21 TEN TAYPO CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	18.57	48.98	93.70	USCH1	d=0.3	0.00	93.70
3	14.63	44.67	93.70	USCH2	top edge before inlet d=0.15'	5.84	93.70
4	11.94	40.66	93.16	USCH3	on apron d=0.15'	10.67	93.16
5	13.14	35.93	92.51	USCH4	Pool before inlet d=0.70'	15.55	92.51
6	15.12	34.75	93.10	INLINV		17.86	93.10
15	-3.86	-4.99	92.12	OUTINV		61.89	92.12
16	-7.15	-7.55	90.96	POOLD	w/in 5-ft d=0.95	66.06	90.96
17	-9.99	-10.40	90.55	POOLD	d=1.50'	70.09	90.55
24	-15.77	-21.78	91.79	TWXS5	d=0.30'	82.85	91.79
28	-30.86	-22.03	91.79	DSCH1	d=0.12'	97.95	91.79

Calculations for R-G-G Filter

us channel slope =	0.0333
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0223
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	44.0
ds channel slope =	0.0000
residual inlet depth(ft) =	-1.32
residual outlet depth(ft) =	-0.34
residual pool depth(ft) =	0.83

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
20	-19.70	-14.32	93.32	TWXS1	on LB gravel bar	0.00	93.32
21	-19.05	-15.64	92.74	TWXS2	on LB gravel bar	1.47	92.74
22	-18.15	-18.17	92.40	TWXS3	ACM LB	4.16	92.40
23	-16.32	-20.71	92.08	TWXS4	LEW	7.29	92.08
24	-15.77	-21.78	91.79	TWXS5	Thalweg d=0.30'	8.49	91.79
25	-15.58	-22.16	92.18	TWXS6	on clay	8.92	92.18
26	-15.14	-23.49	92.08	TWXS7	target on side, bottom of RB	10.32	92.08
27	-14.66	-22.91	96.81	TWXS8	Top of RB	11.07	96.81

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
7	8.60	39.40	92.71	--FILINLBOT1		0.00	92.71
8	18.50	34.65	93.37	--FILINLBOT2		10.98	93.37
9	-8.75	42.83	100.18	--FILINLTOP1		0.00	100.18
10	12.06	30.62	100.80	--FILINLTOP2		24.12	100.80
11	25.58	23.05	101.17	--FILINLTOP3		39.62	101.17
12	-26.36	7.73	99.31	--FILOUTTOP1		0.00	99.31
13	-4.35	-3.30	99.40	--FILOUTTOP2		24.61	99.40
14	11.09	-10.02	99.87	--FILOUTTOP3		41.45	99.87
18	-9.58	-6.08	91.35	--FILOUTBOT1		0.00	91.35
19	-3.11	-9.66	91.81	--FILOUTBOT2		7.40	91.81

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
29.0	27.8	21.8	38.5	123.6	39.6	41.5	11.0	7.4	7.8	7.8	2743	1945	28368	1,224	26	1,198

Culvert shape = Box
Culvert xs area (ft^2) = 16

SPNC-22 HOPE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	23.825	44.405	95.41	USCH1		0.00	95.41
3	23.63	27.58	94.37	INLINV		16.83	94.37
12	1.595	-10.89	93.485	OUTINV		61.16	93.49
15	1.43	-12.145	93.45	POOLD		62.43	93.45
19	0.11	-17.23	93.455	TWXS4	REW/Thalweg	67.68	93.46
22	-8.075	-23.07	92.675	DSCH1		77.73	92.68

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
16	-5.09	-13.425	93.905	TWXS1	on LB	0.00	93.91
17	-2.545	-15.15	93.605	TWXS2	LEW	3.07	93.61
18	-1.09	-16.28	93.475	TWXS3		4.92	93.48
19	0.11	-17.23	93.455	TWXS4	REW/Thalweg	6.45	93.46
20	0.905	-17.685	94.275	TWXS5		7.36	94.28
21	2.205	-18.545	95.305	TWXS6	on RB	8.92	95.31

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	17.625	34.18	94.645	--FILINLBOT1		0.00	94.65
5	28.515	28.77	94.965	--FILINLBOT2		12.16	94.97
6	1.23	38.905	100.555	--FILINLTOP1		0.00	100.56
7	22.495	26.74	101.15	--FILINLTOP2		24.50	101.15
8	38.14	19.555	101.515	--FILINLTOP3		41.71	101.52
9	-21.2	3.12	98.92	--FILOUTTOP1		0.00	98.92
10	1.38	-4.535	99.58	--FILOUTTOP2		23.84	99.58
11	13.88	-15.565	99.955	--FILOUTTOP3		40.51	99.96
13	-2.23	-10.795	93.85	--FILOUTBOT1		0.00	93.85
14	1.645	-14.885	93.565	--FILOUTBOT2		5.63	93.57

Calculations for R-G-G Filter

us channel slope =	0.0618
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0200
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	44.3
ds channel slope =	0.0776
residual inlet depth(ft) =	-0.92
residual outlet depth(ft) =	-0.03
residual pool depth(ft) =	0.00

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = Box
Culvert xs area (ft^2) = 3

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
25.8	25.4	29.4	20.4	123.8	41.7	40.5	12.2	5.6	6.3	5.9	2137	1954	22276	977	5	972

SPNC-23 PRAIRIE CREEK - NEWTON B. DRURY SCENIC PARKWAY

Longitudinal Profile Raw Data

Pt #	N(m)	E(m)	Z(m)	pcode	notes	Dist (ft)	Elev (ft)
2	5.18	2.50	27.41	USCH1		0.00	89.92
3	1.65	2.55	26.95	INXS1		11.56	88.41
104	-8.76	-9.84	27.06	OUTINVXS2		64.65	88.77
107	-9.57	-11.03	27.02	POOLD		69.38	88.64
109	-13.10	-12.68	26.98	TWXS2		82.17	88.53
115	-16.15	-16.06	27.02	DSCH1		97.12	88.64

Tailwater Cross Section Raw Data

Pt #	N(m)	E(m)	Z(m)	pcode	notes	Dist (ft)	Elev (ft)
108	-13.38	-12.50	27.48	TWXS1	top LB	0.00	90.15
109	-13.10	-12.68	26.98	TWXS2	TWC	1.09	88.53
110	-12.81	-13.02	27.05	TWXS3		2.57	88.75
111	-12.27	-13.47	27.08	TWXS3		4.86	88.85
112	-11.97	-13.81	27.07	TWXS4		6.36	88.81
113	-11.84	-14.20	27.10	TWXS4		7.69	88.92
114	-11.70	-14.55	27.58	TWXS5		8.93	90.50

Calculations for R-G-G Filter

us channel slope =	0.1308
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	-0.0067
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	53.1
ds channel slope =	-0.0075
residual inlet depth(ft) =	0.12
residual outlet depth(ft) =	-0.24
residual pool depth(ft) =	-0.10

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Volume Raw Data

Pt #	N(m)	E(m)	Z(m)	pcode	notes	Dist (ft)	Elev (ft)
8	3.15	4.26	27.54	FILINBOT1		0.00	90.35
9	6.33	1.19	27.35	FILINBOT2		14.53	89.72
10	-6.08	2.75	30.22	FILINTOP1		0.00	99.13
11	1.13	-0.49	30.56	FILINTOP1		25.95	100.25
12	5.30	-2.45	30.68	FILINTOP3		41.06	100.66
13	-14.45	-4.19	30.41	FILOUTTOP1		0.00	99.75
14	-7.78	-7.62	30.72	FILOUTTOP2		24.59	100.79
15	-1.33	-10.49	30.99	FILOUTTOP3		47.77	101.68
101	-11.76	-11.50	27.12	FILOUTBOT1		0.00	88.99
102	-9.60	-12.35	27.24	FILOUTBOT2		7.61	89.35

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
20.2	58.6	21.0	66.7	37.4	41.1	47.8	14.5	7.6	10.2	11.6	2473	2805	13604	699	49	650

Culvert shape = Box
Culvert xs area (ft^2) = 25

SPNC-24 CABIN CREEK - MATTOLE ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
110	34.43	-162.35	96.36	USCH1	d = 1.55'	0.00	96.36
111	56.37	-207.22	97.21	USCH2		49.95	97.21
107	34.78	-156.66	94.46	INLINV		104.93	94.46
2	-4.05	21.84	88.37	OUTINV	d = 1.3'	287.59	88.37
5	-1.13	35.77	81.51	DSCH1	On rip rap past outfall	301.82	81.51
6	4.54	36.82	80.45	DSCH2	WSE of South Fk Eel River	307.58	80.45

Tailwater Cross Section Raw Data

Downstream control in South Fork Eel River

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
108	37.49	-156.72	94.23	FILINBOT1		0.00	94.23
109	31.67	-158.34	95.70	FILINBOT2		6.04	95.70
104	51.30	-122.84	116.10	FILINTOP1		0.00	116.10
105	30.08	-126.12	115.97	FILINTOP2		21.48	115.97
106	8.63	-129.89	116.13	FILINTOP3		43.25	116.13
101	48.41	-100.92	115.97	FILOUTTOP1		0.00	115.97
102	26.50	-105.18	116.10	FILOUTTOP2		22.31	116.10
103	9.11	-108.59	116.34	FILOUTTOP3		40.04	116.34
3	-1.59	21.55	87.59	FILOUTBOT1		0.00	87.59
4	-4.60	21.59	87.38	FILOUTBOT2		3.01	87.38

Calculations for R-G-G Filter

us channel slope =	-0.0169
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0333
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	182.7
ds channel slope =	0.1841
residual inlet depth(ft) =	-14.01
residual outlet depth(ft) =	-7.93
residual pool depth(ft) =	N/A

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 4-ft circular
Culvert xs area (ft^2) = 12.6

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
106.7	20.1	428.0	6.7	69.7	43.3	40.0	6.0	3.0	21.0	28.6	27074	131517	43834	7,497	85	7,412

SPNC-25 COW CREEK - MATTOLE ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	77.36	32.55	94.68	USCH1	d = 0.7'	0.00	94.68
3	45.29	11.17	93.34	USCH2	d = 0.75'	38.55	93.34
4	36.66	7.96	91.96	INLINV	d = 1.6'	47.76	91.96
101	7.75	-0.62	90.79	CLVBOT1	At start of embeddedness	77.91	90.79
7	-4.17	-2.54	91.63	OUTINV	on embedded material	89.98	91.63
10	-8.74	-4.49	91.37	POOLD1	w/in 5' d = 1.85'	94.94	91.37
11	-16.19	-7.97	90.95	POOLD2	Max d = 2.3'	103.17	90.95
15	-45.64	-6.00	92.08	TWXS1	Thalweg d = 1.1'	132.69	92.08
22	-137.73	-52.12	91.20	DSCH1	d= 0.8'	235.68	91.20

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
12	-47.57	-2.60	95.04	TWXS1	LEW	0.00	95.04
13	-47.12	-3.88	92.83	TWXS1		1.36	92.83
14	-46.14	-5.53	93.51	TWXS1		3.28	93.51
15	-45.64	-6.00	92.08	TWXS1	Thalweg d = 1.1'	3.96	92.08
16	-43.05	-10.42	92.33	TWXS1		9.09	92.33
17	-38.58	-17.94	92.78	TWXS1		17.83	92.78
18	-34.81	-24.27	93.11	TWXS1	REW	25.20	93.11
19	-34.09	-25.57	94.51	TWXS1		26.69	94.51
20	-32.43	-28.52	95.66	TWXS1	RB	30.07	95.66
21	-31.58	-30.17	95.68	TWXS1	RB	31.93	95.68

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
5	37.84	10.17	92.27	FILINBOT1		0.00	92.27
6	38.59	3.69	92.22	FILINBOT2		6.52	92.22
23	31.97	24.35	100.62	FILINTOP1		0.00	100.62
24	31.47	5.54	100.97	FILINTOP2		18.82	100.97
25	32.45	-9.19	100.81	FILINTOP3		33.57	100.81
26	-3.99	20.33	99.54	FILOUTTOP1		0.00	99.54
27	-1.23	-3.99	99.84	FILOUTTOP2		24.47	99.84
28	2.31	-25.30	100.15	FILOUTTOP3		46.07	100.15
8	-8.41	-0.34	92.03	FILOUTBOT1		0.00	92.03
9	-6.85	-7.95	91.78	FILOUTBOT2		7.77	91.78

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
26.5	35.0	25.8	32.4	111.7	33.6	46.1	6.5	7.8	8.7	7.9	2186	2617	25186	1,111	79	1,032

Calculations for R-G-G Filter

us channel slope =	0.0348
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
Overall culvert slope =	0.0077
non-embedded segment length (ft)=	30.1
embedded segment length (ft)=	12.1
non-embedded segment slope =	0.0386
embedded segment slope =	-0.0696
total culvert length(ft) =	42.2
ds channel slope =	0.0085
residual inlet depth(ft) =	0.13
residual outlet depth(ft) =	0.45
residual pool depth =	0.72

scope and field notes: TDG
rod: RNT
spreadsheet: RNT/TDG

Culvert shape = 8-ft circular
Culvert xs area (ft^2) = 50.3

SPNC-26 CALF CREEK - MATTOLE ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	37.99	-39.66	99.53	USCH1	d = 0.5'	0.00	99.53
3	6.93	-17.67	98.13	USCH2	d = 0.4'	38.06	98.13
4	-10.01	-14.05	95.80	INLINV		55.37	95.80
15	-46.77	-6.57	95.60	OUTINV	d = 1.35'	92.89	95.60
16	-48.15	-5.78	95.93	POOLD	d = 1.1'	94.48	95.93
21	-53.75	-5.15	96.12	TWXS1	Thalweg d = 0.75'	100.11	96.12
26	-104.61	-23.39	94.61	DSCH1	d = 0.7'	154.14	94.61

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	-55.39	4.37	99.47	TWXS1	LB	0.00	99.47
18	-54.56	-0.49	98.32	TWXS1		4.92	98.32
19	-54.51	-1.52	96.90	TWXS1	LEW	5.96	96.90
20	-53.91	-3.45	96.43	TWXS1		7.98	96.43
21	-53.75	-5.15	96.12	TWXS1	Thalweg d = 0.75'	9.69	96.12
22	-52.66	-9.97	96.88	TWXS1	REW	14.63	96.88
23	-52.77	-10.66	97.25	TWXS1		15.33	97.25
24	-52.42	-13.73	100.98	TWXS1	RB	18.42	100.98
25	-52.09	-15.68	101.27	TWXS1		20.40	101.27

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
5	-8.63	-12.95	96.20	FILINBOT1		0.00	96.20
6	-10.05	-16.35	96.75	FILINBOT2		3.68	96.75
7	-7.04	-3.14	100.54	FILINTOP1		0.00	100.54
8	-15.19	-11.68	101.15	FILINTOP2		11.81	101.15
9	-21.68	-19.68	101.47	FILINTOP3		22.11	101.47
10	-42.48	2.98	100.20	FILOUTTOP1		0.00	100.20
11	-44.97	-7.07	100.32	FILOUTTOP2		10.35	100.32
12	-49.39	-15.90	100.59	FILOUTTOP3		20.23	100.59
13	-46.67	-4.33	96.08	FILOUTBOT1		0.00	96.08
14	-47.68	-8.38	96.20	FILOUTBOT2		4.17	96.20

Calculations for R-G-G Filter

us channel slope =	0.037
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0053
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	37.5
ds channel slope =	0.028
residual inlet depth(ft) =	0.33
residual outlet depth(ft) =	0.53
residual pool depth =	0.20

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 4 ft circular
Culvert xs area (ft^2) = 12.6

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
22.8	20.9	11.0	40.9	98.9	22.1	20.2	3.7	4.2	4.7	4.2	674	261	6356	270	17	253

SPNC-27 HARPER CREEK - MATTOLE ROAD

Longitudinal Profile Raw Data - Left Bay Culvert 1 of 2

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	74.20	-106.43	103.27	USCH1		0.00	103.27
16	48.77	-59.68	98.89	INLINV1	Left bay	53.21	98.89
15	33.37	-37.32	98.75	OUTINV1	Left bay, d = 0.7'	80.36	98.75
14	30.57	-37.88	96.14	POOLD2	depth w/in 5' d = 1.70'	83.22	96.14
13	18.12	-24.34	95.70	POOLD1	max d = 2.30'	101.61	95.70
8	6.82	-17.00	96.93	TWXS1	Thalweg d = 1.05'	115.09	96.93
2	-31.85	26.10	94.81	DSCH1	d = 1.15'	172.99	94.81

Longitudinal Profile Raw Data - Right Bay Culvert 2 of 2

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
17	74.20	-106.43	103.27	USCH1		0.00	103.27
20	45.50	-69.55	98.87	INLINV2	RB	46.73	98.87
19	34.86	-56.75	101.13	CULVBOT1	ave depth of embedded	63.38	101.13
18	30.76	-45.07	98.72	OUTINV2	Dry right bay	75.75	98.72
14	30.57	-37.88	96.14	POOLD2	depth w/in 5' d = 1.70'	82.95	96.14
13	18.12	-24.34	95.70	POOLD1	max d = 2.30'	101.34	95.70
8	6.82	-17.00	96.93	TWXS1	Thalweg d = 1.05'	114.82	96.93
2	-31.85	26.10	94.81	DSCH1	d = 1.15'	172.71	94.81

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
3	5.93	-5.94	100.27	TWXS1		0.00	100.27
4	6.09	-7.23	100.29	TWXS1	Rod was slipping	1.30	100.29
5	6.18	-7.83	97.37	TWXS1		1.91	97.37
6	6.80	-13.12	97.17	TWXS1		7.24	97.17
7	6.56	-16.02	97.72	TWXS1		10.14	97.72
8	6.82	-17.00	96.93	TWXS1	Thalweg d = 1.05'	11.16	96.93
9	6.71	-20.98	97.07	TWXS1		15.14	97.07
10	7.29	-27.09	97.61	TWXS1		21.28	97.61
11	7.30	-27.74	100.75	TWXS1		21.93	100.75
12	7.44	-29.20	101.09	TWXS1		23.39	101.09

Calculations for R-G-G Filter - Left Bay Culvert 1 of 2

us channel slope =	0.0823
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0052
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	27.2
ds channel slope =	0.0366
residual inlet depth(ft) =	-1.96
residual outlet depth(ft) =	-1.82
residual pool depth(ft) =	0.80

Calculations for R-G-G Filter - Right Bay Culvert 2 of 2

us channel slope =	0.0942
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0053
Inlet to break length (ft)=	16.6
Inlet to break slope =	-0.1357
break to outlet length (ft)=	12.4
break to outlet slope =	0.1952
total culvert length(ft) =	29.0
ds channel slope =	0.0366
residual inlet depth(ft) =	-1.94
residual outlet depth(ft) =	-1.79
residual pool depth(ft) =	0.80

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

No fill points surveyed due to minimal road fill

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
														yd^3	yd^3	yd^3

SPNC-28 DURPHY CREEK #1 - OAK FLAT CAMPGROUND ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
104	-139.55	-53.71	87.81	USCH1	d = 1.2'	0.00	87.81
101	-60.10	-16.34	85.47	INLINV	d = 1.15'	87.80	85.47
2	-19.72	28.78	84.57	OUTINV	d = 1.3'	148.35	84.57
5	-17.15	32.37	84.68	POOLD1	d = 1.25'	152.76	84.68
11	-1.99	51.55	84.75	TWXS1	Thalweg d = 0.95'	177.21	84.75
16	31.70	85.50	83.87	DSCH1	above 1st riffle d = 0.5'	225.03	83.87
17	150.01	120.71	81.59	DSCH2	Conflu w/SFk Eel d = 0.85'	348.47	81.59

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
6	11.68	40.17	90.36	TWXS1	LB	0.00	90.36
7	9.07	42.33	87.73	TWXS1		3.39	87.73
8	6.49	44.38	86.32	TWXS1		6.69	86.32
9	5.40	45.34	85.73	TWXS1	LEW	8.14	85.73
10	2.04	48.22	84.93	TWXS1		12.57	84.93
11	-1.99	51.55	84.75	TWXS1	Thalweg d = 0.95'	17.79	84.75
12	-6.66	55.52	85.07	TWXS1		23.92	85.07
13	-9.22	57.77	85.63	TWXS1	REW	27.33	85.63
14	-11.92	60.30	87.38	TWXS1		31.02	87.38
15	-14.91	62.79	90.21	TWXS1	RB	34.92	90.21

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
102	-57.49	-20.24	84.89	FILINBOT1		0.00	84.89
103	-62.30	-12.66	86.09	FILINBOT2		8.98	86.09
21	-27.96	-32.57	98.64	FILINTOP1		0.00	98.64
22	-45.62	-10.16	97.42	FILINTOP2		28.53	97.42
23	-71.99	22.27	98.61	FILINTOP3		70.32	98.61
18	-4.49	-14.20	98.09	FILOUTTOP1		0.00	98.09
19	-29.68	16.98	97.30	FILOUTTOP2		40.08	97.30
20	-50.63	41.11	98.39	FILOUTTOP3		72.04	98.39
3	-14.99	27.96	84.98	FILOUTBOT1		0.00	84.98
4	-20.75	34.44	84.83	FILOUTBOT2		8.67	84.83

Calculations for R-G-G Filter

us channel slope =	0.0267
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0148
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	60.5
ds channel slope =	0.0184
residual inlet depth(ft) =	-0.72
residual outlet depth(ft) =	0.18
residual pool depth(ft) =	0.07

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Culvert shape = 9-ft circular
Culvert xs area (ft^2) = 63.6

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
54.5	22.4	63.5	19.9	103.2	70.3	72.0	9.0	8.7	11.9	12.4	12586	15569	55769	3,108	143	2,966

SPNC-29 DURPHY CREEK #2 - MADRONE CAMPGROUND ROAD

Longitudinal Profile Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
2	-60.81	20.97	83.36	USCH1	d = 1.7'	0.00	83.36
3	6.52	-29.81	80.86	INLINV	d = 1.9'	84.32	80.86
101	56.71	-36.20	80.78	OUTINV		134.92	80.78
104	60.74	-36.30	81.12	POOLD		138.95	81.12
109	78.32	-38.65	81.14	TWXS1	Thalweg d = 1.20'	156.69	81.14
113	205.66	-44.32	77.54	DSCH1	d = 1.2'	284.15	77.54

Tailwater Cross Section Raw Data

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
105	78.25	-17.90	84.80	TWXS1	RB	0.00	84.80
106	78.08	-19.66	84.64	TWXS1		1.76	84.64
107	78.02	-24.46	82.43	TWXS1	REW	6.56	82.43
108	78.13	-34.71	81.80	TWXS1		16.81	81.80
109	78.32	-38.65	81.14	TWXS1	Thalweg d = 1.20'	20.76	81.14
110	78.54	-43.88	81.60	TWXS1		26.00	81.60
111	78.98	-49.45	82.32	TWXS1	LEW	31.59	82.32
112	79.36	-51.66	84.02	TWXS1	LB	33.83	84.02

Calculations for R-G-G Filter

us channel slope =	0.0296
inlet apron slope =	N/A
inlet apron length(ft) =	N/A
culvert slope =	0.0016
non-embedded segment length (ft)=	N/A
embedded segment length (ft)=	N/A
outlet apron slope =	N/A
outlet apron length(ft) =	N/A
total culvert length(ft) =	50.6
ds channel slope =	0.0282
residual inlet depth(ft) =	0.28
residual outlet depth(ft) =	0.36
residual pool depth(ft) =	0.02

scope and field notes:	TDG
rod:	RNT
spreadsheet:	RNT/TDG

Fill Survey Points

Pt #	N(ft)	E(ft)	Z(ft)	pcode	notes	Dist (ft)	Elev (ft)
4	0.17	-38.54	83.61	FILINBOT1		0.00	83.61
5	-1.04	-18.64	82.28	FILINBOT2		19.94	82.28
6	23.05	-59.70	98.55	FILINTOP1		0.00	98.55
7	15.19	-29.11	98.96	FILINTOP2		31.58	98.96
8	4.57	-2.32	99.70	FILINTOP3		60.40	99.70
9	54.81	-59.32	97.96	FILOUTTOP1		0.00	97.96
10	43.11	-38.17	98.43	FILOUTTOP2		24.17	98.43
11	32.92	0.13	99.53	FILOUTTOP3		63.80	99.53
102	64.28	-44.95	82.19	FILOUTBOT1		0.00	82.19
103	62.05	-30.78	81.52	FILOUTBOT2		14.34	81.52

Fill Volume Calculation

Lu(ft)	Ou (%)	Ld(ft)	Od (%)	Wr(ft)	Wtopu(ft)	Wtopd(ft)	Wbotu(ft)	Wbotd(ft)	Hu(ft)	Hd(ft)	Vu	Vd	Vr	Fill + Culvert V	Culvert V	Fill V
62.8	26.4	71.8	23.7	96.3	60.4	63.8	19.9	14.3	16.0	16.6	19540	22610	75611	4,362	133	4,229

Culvert shape = 9.5-ft circular
Culvert xs area (ft^2) = 70.9

APPENDIX B:

**HYDROLOGIC DATA FOR PASSAGE
ASSESSMENTS AND FISHING RESULTS**

Site ID #	Stream Name	Road Name	State Park Unit	Drainage Area (mi. ²)	Length of Anadromy (ft)	Mean Annual Precipitation (in/yr)	H Altitude Index (Thousand ft)	Potential Evapotranspiration rate (in/yr)	Avg Annual Runoff (in/yr)	Qave (cfs)
SPNC-01	Unnamed Tributary to Mill Creek	Howland Hill Road	Jedediah State Park	0.07	450	80	1.0	28	59.7	0.3
SPNC-02	Unnamed Tributary #1 to Nickerson Creek (trib to Mill Creek)	Howland Hill Road	Jedediah State Park	0.31	3,200	80	1.0	28	59.7	1.4
SPNC-03	Unnamed Tributary #2 to Nickerson Creek (trib to Mill Creek)	Howland Hill Road	Jedediah State Park	0.20	2,400	80	1.0	28	59.7	0.9
SPNC-04	Metcalf Grove Creek	Howland Hill Road	Jedediah State Park	0.16	400	80	1.0	28	59.7	0.7
SPNC-05	Unnamed Tributary to West Fork Mill Creek	Picnic Road	Mill Creek Acquisition	1.34	8,976	80	1.0	28	59.7	5.9
SPNC-06	Espa Creek	Davison Road	Prairie Creek State Park	0.59	3,100	68	1.0	30	46.9	2.0
SPNC-07	West Fork Strawberry Creek (tributary to Strawberry Creek)	Soc Road	Redwood National Park	0.21	820	68	1.0	30	46.9	0.7
SPNC-08	Strawberry Creek (tributary to Redwood Creek)	Soc Road	Redwood National Park	0.36	950	68	1.0	30	46.9	1.2
SPNC-09	Trillium Falls Creek (tributary to Prairie Creek)	Davison Trail	Prairie Creek State Park	0.28	500	60	1.0	30	38.9	0.8
SPNC-10	Unnamed tributary #1 to Prairie Creek	Davison Trail	Prairie Creek State Park	0.72	1,100	60	1.0	30	38.9	2.1
SPNC-11	Streelaw Creek (tributary to Prairie Creek)	Davison Road	Prairie Creek State Park	0.45	1,600	65	1.0	30	43.9	1.5
SPNC-12	Boyes Creek (tributary to Prairie Creek)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	2.03	6,040	68	1.0	30	46.9	7.0
SPNC-13	Big Tree Creek (tributary to Prairie Creek)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.57	650	68	1.0	30	46.9	2.0
SPNC-14	Browns Creek (tributary to Prairie Creek)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	1.79	960	68	1.0	30	46.9	6.2
SPNC-15	Good Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.25	150	68	1.0	30	46.9	0.9
SPNC-16	Unnamed tributary #2 to Prairie Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.21	500	68	1.0	30	46.9	0.7
SPNC-17	Unnamed Tributary #3 to Prairie Creek (1of2)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.26	600	68	1.0	30	46.9	0.9
SPNC-17	Unnamed Tributary #3 to Prairie Creek (2of2)	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.26	600	68	1.0	30	46.9	0.9
SPNC-18	Sweet Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.37	350	68	1.0	30	46.9	1.3
SPNC-19	Unnamed tributary #4 to Prairie Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.33	900	68	1.0	30	46.9	1.1

Site ID #	Adult High Flow Passage Qave Method (cfs)	Adult High Flow Passage Unit Area Method (cfs)	Resident High Flow Passage Unit Area Method (cfs)	Juvenile High Flow Passage Unit Area Method (cfs)	Design Flood 50% 2yr High Flow Passage Adult (cfs)	Design Flood 30% 2yr High Flow Passage Resident (cfs)	Design Flood 10% 2yr High Flow Passage Juvenile (cfs)	2-year Recurrence Interval (cfs)	5-year Recurrence Interval (cfs)	10-year Recurrence Interval (cfs)	25-year Recurrence Interval (cfs)	50-year Recurrence Interval (cfs)	100-year Recurrence Interval (cfs)
SPNC-01	2.7	2.6	1.3	0.8	7.6	4.5	1.5	15	24	34	44	54	61
SPNC-02	12.5	12.1	6.0	3.6	30.2	18.1	6.0	60	96	130	169	207	233
SPNC-03	8.2	8.0	3.9	2.4	20.8	12.5	4.2	42	66	90	118	145	163
SPNC-04	6.6	6.4	3.1	1.9	17.0	10.2	3.4	34	54	74	97	119	134
SPNC-05	54.0	52.6	25.8	15.5	113.2	67.9	22.6	226	353	473	606	742	835
SPNC-06	18.7	23.1	11.4	6.8	46.8	28.1	9.4	94	147	198	255	311	349
SPNC-07	6.7	8.3	4.1	2.4	18.6	11.1	3.7	37	59	80	104	127	143
SPNC-08	11.4	14.1	6.9	4.2	30.0	18.0	6.0	60	95	128	166	203	228
SPNC-09	7.4	11.0	5.4	3.2	21.5	12.9	4.3	43	68	92	119	145	162
SPNC-10	19.0	28.4	13.9	8.4	50.4	30.2	10.1	101	157	211	271	330	370
SPNC-11	13.4	17.8	8.7	5.2	35.4	21.3	7.1	71	111	150	194	237	266
SPNC-12	64.2	79.6	39.1	23.4	142.3	85.4	28.5	285	440	586	747	911	1024
SPNC-13	18.1	22.5	11.0	6.6	45.6	27.3	9.1	91	143	193	248	303	341
SPNC-14	56.6	70.2	34.4	20.7	127.1	76.2	25.4	254	394	525	669	817	918
SPNC-15	7.9	9.8	4.8	2.9	21.6	13.0	4.3	43	68	93	121	147	166
SPNC-16	6.6	8.2	4.0	2.4	18.5	11.1	3.7	37	58	80	104	127	142
SPNC-17	8.2	10.2	5.0	3.0	22.4	13.4	4.5	45	71	96	125	152	171
SPNC-17	8.2	10.2	5.0	3.0	22.4	13.4	4.5	45	71	96	125	152	171
SPNC-18	11.7	14.5	7.1	4.3	30.7	18.4	6.1	61	97	131	170	207	233
SPNC-19	10.4	12.9	6.4	3.8	27.7	16.6	5.5	55	87	118	154	188	211

Site ID #	Stream Name	Road Name	State Park Unit	Drainage Area (mi. ²)	Length of Anadromy (ft)	Mean Annual Precipitation (in/yr)	H Altitude Index (Thousand ft)	Potential Evapotranspiration rate (in/yr)	Avg Annual Runoff (in/yr)	Qave (cfs)
SPNC-20	Little Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.34	180	68	1.0	30	46.9	1.2
SPNC-21	Ten Taypo Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.41	350	68	1.0	30	46.9	1.4
SPNC-22	Hope Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.12	250	68	1.0	30	46.9	0.4
SPNC-23	Prairie Creek	Newton B. Drury Scenic Parkway	Prairie Creek State Park	0.25	1,500	68	1.0	30	46.9	0.9
SPNC-24	Cabin Creek	Mattole Road	Humboldt Redwoods State Park	0.73	440	60	1.0	35	36.9	2.0
SPNC-25	Cow Creek	Mattole Road	Humboldt Redwoods State Park	2.30	3,110	60	1.0	35	36.9	6.2
SPNC-26	Calf Creek	Mattole Road	Humboldt Redwoods State Park	0.48	350	60	1.0	35	36.9	1.3
SPNC-27	Harper Creek - LB	Mattole Road	Humboldt Redwoods State Park	1.53	3,800	60	1.0	35	36.9	4.2
SPNC-27	Harper Creek - RB	Mattole Road	Humboldt Redwoods State Park	1.53	3,800	60	1.0	35	36.9	4.2
SPNC-28	Durphy Creek #1	Oak Flat Campground Road	Richardson Grove	2.45	10,570	68	1.0	37	44.1	8.0
SPNC-29	Durphy Creek #2	Madrone Campground Road	Richardson Grove	2.39	9,960	68	1.0	37	44.1	7.8

Site ID #	Adult High Flow Passage Qave Method (cfs)	Adult High Flow Passage Unit Area Method (cfs)	Resident High Flow Passage Unit Area Method (cfs)	Juvenile High Flow Passage Unit Area Method (cfs)	Design Flood 50% 2yr High Flow Passage Adult (cfs)	Design Flood 30% 2yr High Flow Passage Resident (cfs)	Design Flood 10% 2yr High Flow Passage Juvenile (cfs)	2-year Recurrence Interval (cfs)	5-year Recurrence Interval (cfs)	10-year Recurrence Interval (cfs)	25-year Recurrence Interval (cfs)	50-year Recurrence Interval (cfs)	100-year Recurrence Interval (cfs)
SPNC-20	10.8	13.3	6.5	3.9	28.5	17.1	5.7	57	90	122	158	193	216
SPNC-21	13.0	16.1	7.9	4.7	33.7	20.2	6.7	67	106	143	186	227	255
SPNC-22	3.8	4.7	2.3	1.4	11.2	6.7	2.2	22	36	49	64	78	87
SPNC-23	7.9	9.8	4.8	2.9	21.6	13.0	4.3	43	68	93	121	147	166
SPNC-24	21.4	24.8	10.3	5.7	51.0	30.6	10.2	102	159	213	274	334	374
SPNC-25	66.9	77.8	32.3	17.7	142.4	85.5	28.5	285	439	582	740	901	1011
SPNC-26	14.0	16.2	6.7	3.7	34.8	20.9	7.0	70	109	147	189	230	259
SPNC-27	44.5	51.8	21.5	11.8	98.7	59.2	19.7	197	305	407	519	632	709
SPNC-27	44.5	51.8	21.5	11.8	98.7	59.2	19.7	197	305	407	519	632	709
SPNC-28	85.2	82.9	34.4	18.9	168.5	101.1	33.7	337	520	691	879	1073	1206
SPNC-29	83.1	80.9	33.5	18.4	164.8	98.9	33.0	330	509	677	861	1050	1180

Flow Duration Table for Richardson Grove and Humboldt Redwoods State Parks: Q/DA (cfs/mi²)

Percent Time Flow is Equalled or Exceeded	Bull Creek (cfs/mi ²)	North Fork Mattole (cfs/mi ²)	Mill Creek (cfs/mi ²)	Little Van Duzen River (cfs/mi ²)	Jacoby Creek (cfs/mi ²)	Elk River (cfs/mi ²)	Chamise Creek (cfs/mi ²)	Median Flow (cfs/mi ²)	Minimum Flow (cfs/mi ²)	Maximum Flow (cfs/mi ²)
1%	46.48	48.21	15.42	55.80	29.14	22.96	33.83	33.83	15.42	55.80
2%	34.20	33.87	11.23	36.54	19.18	17.78	23.57	23.57	11.23	36.54
5%	19.40	21.16	7.07	18.98	11.32	9.90	14.03	14.03	7.07	21.16
10%	11.25	12.41	4.18	11.44	6.55	5.11	7.70	7.70	4.18	12.41
15%	7.51	8.69	2.89	7.35	4.48	3.02	4.56	4.56	2.89	8.69
20%	5.27	5.98	2.25	5.41	3.10	1.88	3.19	3.19	1.88	5.98
25%	3.88	4.41	1.70	4.25	2.24	1.31	2.12	2.24	1.31	4.41
30%	2.88	3.40	1.25	3.20	1.72	0.95	1.37	1.72	0.95	3.40
35%	2.10	2.71	1.03	2.51	1.33	0.68	0.93	1.33	0.68	2.71
40%	1.57	2.05	0.84	1.96	1.05	0.52	0.66	1.05	0.52	2.05
45%	1.14	1.54	0.71	1.52	0.83	0.38	0.44	0.83	0.38	1.54
50%	0.78	1.09	0.45	1.16	0.67	0.27	0.33	0.67	0.27	1.16
55%	0.53	0.82	0.30	0.83	0.55	0.20	0.25	0.53	0.20	0.83
60%	0.39	0.64	0.18	0.55	0.43	0.14	0.16	0.39	0.14	0.64
65%	0.28	0.53	0.08	0.36	0.36	0.10	0.11	0.28	0.08	0.53
70%	0.21	0.40	0.03	0.25	0.29	0.07	0.08	0.21	0.03	0.40
75%	0.16	0.32	0.01	0.18	0.22	0.05	0.06	0.16	0.01	0.32
80%	0.12	0.27	0.00	0.15	0.21	0.04	0.05	0.12	0.00	0.27
85%	0.09	0.23	0.00	0.14	0.19	0.03	0.04	0.09	0.00	0.23
90%	0.07	0.19	0.00	0.12	0.17	0.03	0.04	0.07	0.00	0.19
95%	0.04	0.14	0.00	0.10	0.16	0.02	0.03	0.04	0.00	0.16
98%	0.02	0.11	0.00	0.10	0.14	0.02	0.02	0.02	0.00	0.14
99.5%	0.01	0.09	0.00	0.08	0.14	0.01	0.02	0.02	0.00	0.14

Flow Duration Table for Richardson Grove and Humboldt Redwoods State Parks: Q/Qavg (cfs/cfs)

Percent Time Flow is Equalled or Exceeded	Bull Creek (cfs/cfs)	North Fork Mattole (cfs/cfs)	Mill Creek (cfs/cfs)	Little Van Duzen River (cfs/cfs)	Jacoby Creek (cfs/cfs)	Elk River (cfs/cfs)	Chamise Creek (cfs/cfs)	Median Flow (cfs/cfs)	Minimum Flow (cfs/cfs)	Maximum Flow (cfs/cfs)
1%	12.55	11.97	5.53	19.19	8.30	8.41	10.71	10.71	5.53	19.19
2%	9.24	8.41	4.02	12.57	5.46	6.51	7.46	7.46	4.02	12.57
5%	5.24	5.26	2.54	6.53	3.22	3.62	4.44	4.44	2.54	6.53
10%	3.04	3.08	1.50	3.93	1.87	1.87	2.44	2.44	1.50	3.93
15%	2.03	2.16	1.04	2.53	1.28	1.10	1.44	1.44	1.04	2.53
20%	1.42	1.49	0.81	1.86	0.88	0.69	1.01	1.01	0.69	1.86
25%	1.05	1.10	0.61	1.46	0.64	0.48	0.67	0.67	0.48	1.46
30%	0.78	0.85	0.45	1.10	0.49	0.35	0.43	0.49	0.35	1.10
35%	0.57	0.67	0.37	0.86	0.38	0.25	0.29	0.38	0.25	0.86
40%	0.42	0.51	0.30	0.67	0.30	0.19	0.21	0.30	0.19	0.67
45%	0.31	0.38	0.25	0.52	0.24	0.14	0.14	0.25	0.14	0.52
50%	0.21	0.27	0.16	0.40	0.19	0.10	0.10	0.19	0.10	0.40
55%	0.14	0.20	0.11	0.28	0.16	0.07	0.08	0.14	0.07	0.28
60%	0.11	0.16	0.06	0.19	0.12	0.05	0.05	0.11	0.05	0.19
65%	0.08	0.13	0.03	0.12	0.10	0.03	0.04	0.08	0.03	0.13
70%	0.06	0.10	0.01	0.09	0.08	0.02	0.03	0.06	0.01	0.10
75%	0.04	0.08	0.00	0.06	0.06	0.02	0.02	0.04	0.00	0.08
80%	0.03	0.07	0.00	0.05	0.06	0.01	0.02	0.03	0.00	0.07
85%	0.02	0.06	0.00	0.05	0.05	0.01	0.01	0.02	0.00	0.06
90%	0.02	0.05	0.00	0.04	0.05	0.01	0.01	0.02	0.00	0.05
95%	0.01	0.03	0.00	0.04	0.04	0.01	0.01	0.01	0.00	0.04
98%	0.01	0.03	0.00	0.03	0.04	0.01	0.01	0.01	0.00	0.04
99.5%	0.00	0.02	0.00	0.03	0.04	0.00	0.01	0.01	0.00	0.04

Flow Duration Table for Prairie Creek and Jedidiah Smith State Parks and the Mill Creek Acquisition: Q/DA (cfs/mi²)

Percent Time Flow is Equalled or Exceeded	Mill Creek (cfs/mi²)	Panther Creek (cfs/mi²)	Little Lost Man Creek (cfs/mi²)	Lacks Creek (cfs/mi²)	Coyote Creek (cfs/mi²)	Lopez Creek (cfs/mi²)	Rowdy Creek (cfs/mi²)	Median Flow (cfs/mi²)	Minimum Flow (cfs/mi²)	Maximum Flow (cfs/mi²)
1%	39.23	29.74	27.32	38.75	50.55	53.80	47.37	39.23	27.32	53.80
2%	29.35	23.29	20.81	28.19	37.96	39.67	38.29	29.35	20.81	39.67
5%	16.41	14.83	13.29	19.24	24.55	23.91	23.90	19.24	13.29	24.55
10%	10.71	10.35	8.38	11.54	13.15	14.67	13.54	11.54	8.38	14.67
15%	7.45	7.74	5.49	7.55	8.99	9.78	10.23	7.74	5.49	10.23
20%	5.70	6.10	4.05	5.27	5.91	7.61	7.48	5.91	4.05	7.61
25%	4.48	4.94	2.89	3.61	4.11	6.09	5.79	4.48	2.89	6.09
30%	3.67	4.12	2.28	2.66	2.83	4.78	4.65	3.67	2.28	4.78
35%	2.97	3.29	1.79	1.89	2.06	3.91	3.73	2.97	1.79	3.91
40%	2.34	2.47	1.36	1.42	1.54	3.04	2.91	2.34	1.36	3.04
45%	1.78	1.98	1.04	1.07	1.13	2.39	2.28	1.78	1.04	2.39
50%	1.33	1.48	0.78	0.77	0.86	1.85	1.83	1.33	0.77	1.85
55%	1.01	1.19	0.58	0.58	0.66	1.41	1.32	1.01	0.58	1.41
60%	0.73	0.96	0.43	0.42	0.49	0.87	0.90	0.73	0.42	0.96
65%	0.56	0.74	0.32	0.30	0.30	0.65	0.63	0.56	0.30	0.74
70%	0.42	0.58	0.23	0.20	0.19	0.43	0.42	0.42	0.19	0.58
75%	0.33	0.44	0.18	0.14	0.12	0.33	0.29	0.29	0.12	0.44
80%	0.26	0.35	0.14	0.11	0.08	0.22	0.18	0.18	0.08	0.35
85%	0.21	0.25	0.12	0.08	0.05	0.11	0.08	0.11	0.05	0.25
90%	0.17	0.18	0.09	0.06	0.04	0.11	0.00	0.09	0.00	0.18
95%	0.14	0.12	0.06	0.03	0.03	0.00	0.00	0.03	0.00	0.14
98%	0.12	0.08	0.04	0.02	0.02	0.00	0.00	0.02	0.00	0.12
99.5%	0.09	0.05	0.03	0.01	0.02	0.00	0.00	0.02	0.00	0.09

Flow Duration Table for Prairie Creek and Jedidiah Smith State Parks and the Mill Creek Acquisition: Q/Qavg (cfs/cfs)

Percent Time Flow is Equalled or Exceeded	Mill Creek (cfs/cfs)	Panther Creek (cfs/cfs)	Little Lost Man Creek (cfs/cfs)	Lacks Creek (cfs/cfs)	Coyote Creek (cfs/cfs)	Lopez Creek (cfs/cfs)	Rowdy Creek (cfs/cfs)	Median Flow (cfs/cfs)	Minimum Flow (cfs/cfs)	Maximum Flow (cfs/cfs)
1%	8.04	9.16	7.29	10.07	13.99	11.30	8.55	9.16	7.29	13.99
2%	6.01	7.17	5.55	7.32	10.50	8.33	6.91	7.17	5.55	10.50
5%	3.36	4.57	3.55	5.00	6.79	5.02	4.31	4.57	3.36	6.79
10%	2.19	3.19	2.24	3.00	3.64	3.08	2.44	3.00	2.19	3.64
15%	1.53	2.38	1.47	1.96	2.49	2.05	1.84	1.96	1.47	2.49
20%	1.17	1.88	1.08	1.37	1.64	1.60	1.35	1.37	1.08	1.88
25%	0.92	1.52	0.77	0.94	1.14	1.28	1.04	1.04	0.77	1.52
30%	0.75	1.27	0.61	0.69	0.78	1.00	0.84	0.78	0.61	1.27
35%	0.61	1.01	0.48	0.49	0.57	0.82	0.67	0.61	0.48	1.01
40%	0.48	0.76	0.36	0.37	0.43	0.64	0.53	0.48	0.36	0.76
45%	0.37	0.61	0.28	0.28	0.31	0.50	0.41	0.37	0.28	0.61
50%	0.27	0.46	0.21	0.20	0.24	0.39	0.33	0.27	0.20	0.46
55%	0.21	0.37	0.15	0.15	0.18	0.30	0.24	0.21	0.15	0.37
60%	0.15	0.29	0.12	0.11	0.14	0.18	0.16	0.15	0.11	0.29
65%	0.11	0.23	0.08	0.08	0.08	0.14	0.11	0.11	0.08	0.23
70%	0.09	0.18	0.06	0.05	0.05	0.09	0.08	0.08	0.05	0.18
75%	0.07	0.14	0.05	0.04	0.03	0.07	0.05	0.05	0.03	0.14
80%	0.05	0.11	0.04	0.03	0.02	0.05	0.03	0.04	0.02	0.11
85%	0.04	0.08	0.03	0.02	0.01	0.02	0.01	0.02	0.01	0.08
90%	0.04	0.06	0.02	0.01	0.01	0.02	0.00	0.02	0.00	0.06
95%	0.03	0.04	0.02	0.01	0.01	0.00	0.00	0.01	0.00	0.04
98%	0.02	0.03	0.01	0.01	0.01	0.00	0.00	0.01	0.00	0.03
99.5%	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02

North Coast Redwoods District CA State Parks - Fish Passage Analysis
Results of Existing Passage Conditions

Hydrology Information					Adult Salmon and Steelhead Barriers							Resident Trout Barriers				
Site ID #	Stream Name	Length of Anadromy (ft)	Drainage Area (mi. ²)	Conclusion from Filter Output	Passage Flows (cfs)			Leap		Depth		Velocity		Passage Flows (cfs)		
					Lower (cfs)	Upper (cfs)	% Passable	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower (cfs)	Upper (cfs)	% Passable		
SPNC-01	Unnamed Tributary to Mill Creek	450	0.07	RED	3.0	7.6	75%	0.0	None	4.2	11.6	2.0	4.5	0%		
SPNC-02	Unnamed Tributary #1 to Nickerson Creek (trib to Mill Creek)	3,200	0.31	GRAY	3.0	30.2	97%	0.0	None	3.7	40.0	2.0	18.1	0%		
SPNC-03	Unnamed Tributary #2 to Nickerson Creek (trib to Mill Creek)	2,400	0.20	RED	3.0	20.8	92%	0.0	None	4.5	70.0	2.0	12.5	0%		
SPNC-04	Metcalf Grove Creek	400	0.16	RED	3.0	17.0	86%	0.0	None	4.9	18.2	2.0	10.2	0%		
SPNC-05	Unnamed Tributary to West Fork Mill Creek	8,976	1.34	RED	3.0	113.2	0%	---	---	---	---	2.0	67.9	0%		
SPNC-06	Espa Creek	3,100	0.59	RED	3.0	46.8	0%	---	---	---	---	2.0	28.1	0%		
SPNC-07	West Fork Strawberry Creek (tributary to Strawberry Creek)	820	0.21	GRAY	3.0	18.6	93%	0.0	None	4.1	>50	2.0	11.1	0%		
SPNC-08	Strawberry Creek (tributary to Redwood Creek)	950	0.36	GREEN	3.0	30.0	100%	0.0	None	None	---	2.0	18.0	100%		
SPNC-09	Trillium Falls Creek (tributary to Prairie Creek)	500	0.28	GREEN	3.0	21.5	100%	0.0	None	None	---	2.0	12.9	100%		
SPNC-10	Unnamed tributary #1 to Prairie Creek	1,100	0.72	GREEN	3.0	50.4	100%	0.0	None	None	---	2.0	30.2	100%		

				Young of the Year Barriers							Comments		
Leap		Depth		Passage Flows (cfs)			Leap		Depth			Velocity	
Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower (cfs)	Upper (cfs)	% Passable	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)	Lower Limit barrier<Q (cfs)	Upper Limit barrier>Q (cfs)			
---	---	---	---	1.0	1.5	0%	---	---	---	---	Small creek. Sized < 5 yr flow. Steep slope pipe 4.5% Limited marginal habitat upstream ~450 ft. Ran crossing for adults, site can pass adults at some flows. No other lifestage passes.		
0.0	None	3.7	2.1	1.0	6.0	6%	0.0	None	None	1.3	Not a passage issue for adults. Velocity main concern for juvenile and resident fish. Debris jam at inlet will impede passage reducing model results. Pipe severely undersized <2 yr flow and is in poor condition. ~3,200 ft of habitat upstream which needs to be observed for quality. Habitat quality immediately upstream of pipe was fair. ~1,800 yd^3 of fill.		
---	---	---	---	1.0	4.2	0%	---	---	---	---	Pipe severely undersized <2 yr flow and in extremely poor condition. ~2,400 ft of good fish habitat upstream. ~1,800 yd^3 of fill. Fish observed in outlet pool. US channel and DS channel ~1.5 ft difference in elevation. Pipe run for adults since outlet was perched just over 2 ft.		
---	---	---	---	1.0	3.4	0%	---	---	---	---	Small creek with very limited habitat for adults. Steep slope pipe (~5%) very undersized <5-yr flow. Limited amount of upstream habitat ~400 ft. Low amount of road fill ~500 yd^3.		
---	---	---	---	1.0	22.6	0%	---	---	---	---	Outlet perched 3.8 ft. Pipe undersized ~5yr flow. Ample amount of good upstream habitat ~9,000 ft. Relatively fair amount of road fill ~3,700 yd^3.		
---	---	---	---	1.0	9.4	0%	---	---	---	---	Short steep sloped pipe (5.5%) Small coastal creek. Culvert undersized <5 yr flow. ~3,100 ft potential habitat. Very small amount of road fill ~290 yd^3.		
0.0	None	4.1	3.3	1.0	3.7	0%	0.0	None	0.8	0.3	No defined downstream channel making it difficult for fish to find crossing. Pipe severely undersized <1 yr flow. ~800 ft of good cutthroat habitat. Low amount of road fill ~300 yd^3.		
0.0	None	None	---	1.0	6.0	100%	0.0	None	None	---	Pipe severely undersized <2 yr flow. No defined channel downstream.		
0.0	None	None	---	1.0	4.3	100%	0.0	None	None	---	Pipe is backwatered over 3 ft, making it a swim through for all life stage. However, due to the extreme outlet control the hydraulic capacity is diminished from being built to pass 135 cfs (~40 yr flow) under current conditions only passing 52 cfs (~3 yr flow)		
0.0	None	None	---	1.0	10.1	100%	0.0	None	None	---	Pipe is backwatered over 3 ft, making it a swim through for all life stage. However, due to the extreme outlet control the hydraulic capacity is diminished from being built to pass 240 cfs (~15 yr flow) under current conditions only passing 57 cfs (~1 yr flow)		

SPNC-11	Steelelow Creek (tributary to Prairie Creek)	1,600	0.45	GRAY	3.0	35.4	100%	0.0	None	1.3	>100	2.0	21.3	100%
SPNC-12	Boyes Creek (tributary to Prairie Creek)	6,040	2.03	GREEN	3.0	142.3	100%	0.0	None	None	---	2.0	85.4	100%
SPNC-13	Big Tree Creek (tributary to Prairie Creek)	650	0.57	RED	3.0	45.6	0%	---	---	---	---	2.0	27.3	0%
SPNC-14	Browns Creek (tributary to Prairie Creek)	960	1.79	GRAY	3.0	127.1	100%	0.0	None	1.2	>200	2.0	76.2	88%
SPNC-15	Good Creek	150	0.25	GRAY	3.0	21.6	69%	0.0	None	8.7	>50	2.0	13.0	30%
SPNC-16	Unnamed tributary #2 to Prairie Creek	500	0.21	GRAY	3.0	18.5	4%	0.0	None	17.8	>50	2.0	11.1	0%
SPNC-17	Unnamed Tributary #3 to Prairie Creek (1of2)	600	0.26	GRAY	3.0	22.4	54%	0.0	None	12.0	>50	2.0	13.4	0%
SPNC-17	Unnamed Tributary #3 to Prairie Creek (2of2)	600	0.26	GRAY	3.0	22.4	55%	0.0	None	11.7	>50	2.0	13.4	3%
SPNC-18	Sweet Creek	350	0.37	RED	3.0	30.7	0%	---	---	---	---	2.0	18.4	0%
SPNC-19	Unnamed tributary #4 to Prairie Creek	900	0.33	GRAY	3.0	27.7	90%	0.0	None	5.5	>100	2.0	16.6	76%

0.0	None	1.3	25.5	1.0	7.1	65%	0.0	None	0.5	5.0	Pipe very undersize <3 yr flow. Is not an issue for fish passage. Sediment from Davidson Road is severely impacting fish habitat downstream. Poor fish habitat.
0.0	None	None	---	1.0	28.5	100%	0.0	None	None	---	Culvert sized for 60 yr flow and road overtops on a 95 yr flow.
---	---	---	---	1.0	9.1	0%	---	---	---	---	Culvert sized for <15 yr flow. ~1,600 yd^3 of road fill. Outlet perched 4 ft.
0.0	None	1.3	67.0	1.0	25.4	60%	0.0	None	0.0	15.5	Culvert constrains channel width. Crossing built to pass 930 cfs (>100 yr flow) but due to embedded condition can currently pass ~30 yr flow. Channel goes to 12% for 700 ft about 960 ft above the culvert then slope decreases below 5% for the next 4,700 ft.
0.0	None	8.7	12.0	1.0	4.3	0%	0.0	None	3.8	1.0	Low fish passage barrier of 9.9 cfs reduced to 8.7 cfs due to first 3 ft being the only part of culvert <0.5 ft at 9.9 cfs. For juveniles a flow of 3.8 cfs was used for a depth of 0.3 ft. Temporal barrier to adults and residents and a total barrier to juveniles. Pipe sized <15 yr flow. Limited habitat ~150 ft.
0.0	None	17.8	3.3	1.0	3.7	0%	0.0	None	8.0	0.3	Pipe sized ~20 yr flow. Small creek with fair to good fish habitat. Upstream habitat ~500 ft. Deposition at inlet.
0.0	None	12.0	10.3	1.0	4.5	0%	0.0	None	6.8	2.0	Assumed height of 4.0 for both bays with embedded depth of LB=2.6' RB=2.8'. Assumed lack of depth at inlet not enough to block fish. Used minimum depth requirement for pipe with exception to inlet depth. Hydraulic capacity is extremely impaired under current conditions only passing <5 yr flow. Upstream habitat ~600 ft.
0.0	None	11.7	12.0	1.0	4.5	0%	0.0	None	8.0	2.7	Assumed height of 4.0 for both bays with embedded depth of LB=2.6' RB=2.8'. Assumed lack of depth at inlet not enough to block fish. Used minimum depth requirement for pipe with exception to inlet depth. Hydraulic capacity is extremely impaired under current conditions only passing <5 yr flow. Upstream habitat ~600 ft.
---	---	---	---	1.0	6.1	0%	---	---	---	---	Good to excellent habitat but very limited amount ~350 ft. Undersized ~5 yr flow. ~1,900 yd^3 road fill. Steep sloped culvert ~4.4% and perched 1.5 ft. 4.5 ft elevation difference between upstream and downstream.
0.0	None	5.5	19.5	1.0	5.5	0%	0.0	None	2.3	2.3	Provides adequate passage for adults and residents. Undersized ~10 yr flow. Small creek with good fish habitat. Material aggraded at inlet and scour is occurring.

SPNC-20	Little Creek	180	0.34	GRAY	3.0	28.5	88%	0.0	None	6.0	>100	2.0	17.1	24%
SPNC-21	Ten Taypo Creek	350	0.41	GRAY	3.0	33.7	87%	0.0	None	7.1	>100	2.0	20.2	71%
SPNC-22	Hope Creek	250	0.12	GRAY	3.0	11.2	63%	0.0	None	6.0	22.0	2.0	6.7	0%
SPNC-23	Prairie Creek	1,500	0.25	GRAY	3.0	21.6	100%	0.0	None	0.0	>100	2.0	13.0	100%
SPNC-24	Cabin Creek	440	0.73	RED	3.0	51.0	0%	---	---	---	---	2.0	30.6	0%
SPNC-25	Cow Creek	3,110	2.30	GRAY	3.0	142.4	59%	0.0	None	6.9	89.3	2.0	85.5	0%
SPNC-26	Calf Creek	350	0.48	GREEN	3.0	34.8	100%	---	---	---	---	2.0	20.9	100%
SPNC-27	Harper Creek - LB	3,800	1.53	GRAY	3.0	98.7	78%	0.0	None	24.2	>200	2.0	59.2	0%
SPNC-27	Harper Creek - RB	3,800	1.53	GRAY	3.0	98.7	0%	0.0	None	160.0	>200	2.0	59.2	0%
SPNC-28	Durphy Creek #1	10,570	2.45	GRAY	3.0	168.5	99%	0.0	None	5.1	172.0	2.0	101.1	6%
SPNC-29	Durphy Creek #2	9,960	2.39	GRAY	3.0	164.8	100%	0.0	None	0.6	>200	2.0	98.9	24%

0.0	None	6.0	9.6	1.0	5.7	0%	0.0	None	4.6	1.2	FishXing unable to model the combination of a box culvert at the inlet and a circular pipe at the outlet. Had to model independently. Assumed depth immediately at outlet not a barrier. For resident fish FishXing predicts outlet velocity as the only barrier until 15.5 cfs. Used outlet velocity of 5 ft/s to determine velocity barrier for residents. Good adult passage. Undersized <10 yr flow. Limited habitat ~180 ft. Permits fair fish passage.
0.0	None	7.2	>50	1.0	6.7	0%	0.0	None	6.1	0.2	Crossing extremely undersized <5 yr flow. Limited upstream habitat ~350 ft. Very good fish habitat, fish in outlet pool. Aggrading material at inlet. Provides adequate resident and adult passage.
0.0	None	6.0	4.2	1.0	2.2	0%	0.0	None	4.5	1.0	Hydraulic capacity severely diminished in current embedded state. Assumed lack of outlet depth was not a barrier. Fair to poor fish habitat. FishXing unable to model the combination of a box culvert at the inlet and a circular pipe at the outlet. Modeled independently.
0.0	None	0.0	>50	1.0	4.3	100%	0.0	None	0.0	>20	Crossing properly sized ~100 yr flow. Passes all lifestages of fish.
---	---	---	---	1.0	10.2	0%	---	---	---	---	Culvert extremely undersized <2 yr flow. Large amount of road fill ~7,400 yd ³ . Outlet severely perched.
0.0	None	6.9	3.0	1.0	28.5	7%	0.0	None	0.0	3.0	Due to break in slope from last 10 ft being embedded and since the tailwater conditions backwater the culvert the culvert was modeled as an unembedded 30 ft long pipe. Excellent fish habitat (~3,100 ft). Undersized <5 yr flow. ~1,000 yd ³ road fill. Deposition at inlet creates a 15% slope over 9 ft.
---	---	---	---	1.0	7.0	100%	---	---	---	---	Culvert extremely undersized <3 yr flow. Low amount of road fill ~250 yd ³ .
0.0	None	24.2	14.6	1.0	19.7	0%	0.0	None	10.6	1.2	Crossing is properly sized >100 yr flow. The right bay culvert does not receive flow until 84 cfs.
---	---	---	---	1.0	19.7	0%	---	---	---	---	Crossing is properly sized >100 yr flow. Added depth of embeddedness of 2.3 ft to the inlet and outlet elevations to create no flow conditions until the embedded part of the culvert is surpassed. The right bay culvert does not receive flow until 84 cfs.
0.0	None	5.1	11.0	1.0	33.7	0%	0.0	None	2.0	1.0	Two crossings within 500 ft upstream of crossing. Undersized ~5 yr flow. Crossing width is 40% of active channel width. 3,000 yd ³ of road fill. Ample amount of habitat upstream ~10,570 ft. Permits almost 100% adult fish passage. No real resting pools between this culvert, the HWY 101 culvert and the upstream culvert (SPNC-29).
0.0	None	0.6	25.1	1.0	33.0	11%	0.0	None	0.0	4.5	Inlet turbulence may create difficulties for fish and the first pool is 100 ft upstream. Culvert flat and backwatered. Crossing moderately undersized (~10 yr flow) not including capacity of four overflow pipes. Large amount of road fill ~4,200 yd ³ . Enormous amount of bedload retained upstream.

APPENDIX C:
RANKING MATRIX

INITIAL RANK	SITE ID #	Stream Name	State Park Unit	Road Name	Presumed Species Diversity	Species Diversity Score	Extent of Barrier Score	Current Sizing Score	Current Condition Score	Culvert Score (ave of sizing and condition scores)	Length of habitat for scoring	Habitat Length score	Habitat Quality Modifier	Total Habitat Score	TOTAL SCORE	Comments and/or Considerations for the Final Ranking
#1	SPNC-05	Unnamed Tributary to West Fork Mill Creek	Jedidah State Park	Picnic Road	Coho, Steelhead, Cutthroat	6	15	4	1	2.5	8,976	8.98	0.75	6.73	30.2	
#2	SPNC-16	Unnamed tributary #2 to Prairie Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	14	3	0	1.5	500	0.50	0.75	0.38	22.9	
#3	SPNC-28	Durphy Creek #1	Richardson Grove	Oak Flat Campground Road	Steelhead, Coho	6	9	4	1	2.5	10,570	10	0.50	5.00	22.5	CalTrans crossing just upstream was assessed as "RED" during the District 1 project conducted by HSU.
#4	SPNC-03	Unnamed Tributary #2 to Nickerson Creek (trib to Mill Creek)	Jedidah State Park	Howland Hill Road	Coho, Steelhead, Cutthroat	6	10	5	4	4.5	2,400	2.40	0.75	1.80	22.3	
#5	SPNC-07	West Fork Strawberry Creek (tributary to Strawberry Creek)	Redwood National Park	Soc Road	Coho, Steelhead, Cutthroat	7	10	5	3	4.0	820	0.82	0.75	0.62	21.6	
#6	SPNC-02	Unnamed Tributary #1 to Nickerson Creek (trib to Mill Creek)	Jedidah State Park	Howland Hill Road	Coho, Steelhead, Cutthroat	6	9	5	3	4.0	2,500	2.50	1.00	2.50	21.5	
#7	SPNC-01	Unnamed Tributary to Mill Creek	Jedidah State Park	Howland Hill Road	Coho, Steelhead, Cutthroat	6	11	5	3	4.0	450	0.45	0.50	0.23	21.2	Limited amount of upstream habitat
#8	SPNC-22	Hope Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	11	5	1	3.0	250	0.25	0.50	0.13	21.1	
#9	SPNC-24	Cabin Creek	Humboldt Redwoods State Park	Mattolie Road	Steelhead	2	15	5	3	4.0	440	0.44	0.25	0.11	21.1	Drop in ranking because CDFG considers Cabin Creek not a fish-bearing stream due to steep drop at confluence with the South Fork Eel River.
#10	SPNC-17	Unnamed Tributary #3 to Prairie Creek (2of2)	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	11	5	0	2.5	600	0.60	0.75	0.45	21.0	
#11	SPNC-13	Big Tree Creek (tributary to Prairie Creek)	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Steelhead, Cutthroat	3	15	3	1	2.0	650	0.65	0.75	0.49	20.5	
#12	SPNC-29	Durphy Creek #2	Richardson Grove	Madrone Campground Road	Steelhead, Coho	6	7	4	1	2.5	9,960	9.96	0.50	4.98	20.5	CalTrans crossing just downstream was assessed as "RED" during the District 1 project conducted by HSU.
#13	SPNC-18	Sweet Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Steelhead, Cutthroat	3	15	4	0	2.0	350	0.35	1.00	0.35	20.4	Limited amount of upstream habitat
#14	SPNC-20	Little Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	8	4	0	2.0	180	0.18	0.75	0.14	17.1	Limited amount of upstream habitat
#15	SPNC-25	Cow Creek	Humboldt Redwoods State Park	Mattolie Road	Steelhead	2	10	5	1	3.0	3,110	3.11	0.50	1.56	16.6	According to CDFG, the effective length of anadromy is probably 1,000' due to land slide and associated debris jam.
#16	SPNC-06	Espa Creek	Prairie Creek State Park	Davison Road	Cutthroat Trout	1	10	5	1	3.0	3,100	3.10	0.75	2.33	16.3	
#17	SPNC-21	Ten Taypo Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	6	5	0	2.5	350	0.35	1.00	0.35	15.9	Limited amount of upstream habitat
#18	SPNC-19	Unnamed tributary #4 to Prairie Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	6	4	0	2.0	900	0.90	0.75	0.68	15.7	
#19	SPNC-15	Good Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Chinook, Steelhead, Cutthroat	5	9	3	0	1.5	150	0.15	1.00	0.15	15.7	Limited amount of upstream habitat
#20	SPNC-04	Metcalf Grove Creek	Jedidah State Park	Howland Hill Road	Cutthroat	1	10	5	3	4.0	400	0.40	0.50	0.20	15.2	Limited amount of upstream habitat
#21	SPNC-27	Harper Creek - LB	Humboldt Redwoods State Park	Mattolie Road	Steelhead	2	11	0	0	0.0	3,800	3.8	0.50	1.90	14.9	
#22	SPNC-14	Browns Creek (tributary to Prairie Creek)	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	1	2	0	1.0	4,700	4.70	1.00	4.70	13.7	
#23	SPNC-12	Boyes Creek (tributary to Prairie Creek)	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	0	1	0	0.5	6,040	6.04	1.00	6.04	13.5	
#24	SPNC-11	Steele Creek (tributary to Prairie Creek)	Prairie Creek State Park	Davison Road	Coho, Steelhead, Cutthroat	7	1	5	3	4.0	1,600	1.60	0.25	0.40	12.4	
#25	SPNC-08	Strawberry Creek (tributary to Redwood Creek)	Redwood National Park	Soc Road	Coho, Steelhead, Cutthroat	7	0	5	3	4.0	950	0.95	0.50	0.48	11.5	
#26	SPNC-10	Unnamed tributary #1 to Prairie Creek	Prairie Creek State Park	Davison Trail	Coho, Steelhead, Cutthroat	7	0	3	1	2.0	1,100	1.10	0.50	0.55	9.6	Downstream beaver dam creates back-watering effect and good passage at this site. If dam were to fail culvert could become a migration barrier.
#27	SPNC-09	Trillium Falls Creek (tributary to Prairie Creek)	Prairie Creek State Park	Davison Trail	Coho, Steelhead, Cutthroat	7	0	2	1	1.5	500	0.50	0.75	0.38	8.9	Downstream beaver dam creates back-watering effect and good passage at this site. If dam were to fail culvert could become a migration barrier.
#28	SPNC-23	Prairie Creek	Prairie Creek State Park	Newton B. Drury Scenic Parkway	Coho, Steelhead, Cutthroat	7	0	1	0	0.5	1,500	1.50	0.75	1.13	8.6	
#29	SPNC-26	Call Creek	Humboldt Redwoods State Park	Mattolie Road	Steelhead	2	0	5	3	4.0	350	0.35	0.75	0.26	6.3	CDFG biologists do not consider Call Creek to be fish-bearing due to vertical drop at confluence with Bull Creek.