Caltrans

2014–2015 Detailed Fish Passage Assessment Evaluations

Districts 1 and 2 – Mendocino, Trinity, and Humboldt Counties

May 2015
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Prepared For:
California Department of Transportation
Division of Environmental Analysis
Office of Biology and Technical Assistance
Sacramento, CA USA

HDR

2015 Fish Passage Survey Results

Supplemental Report for Selected Sites in District 1 and 2

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1. Reconnaissance Fish Passage Surveys

During May 2015, five highway-stream crossings in District 1 and District 2 were identified as requiring a fish passage evaluation. Reconnaissance Fish Passage Surveys were conducted at five sites (**Table 1**; **Figure 1**).

Table 1. Reconnaissance Fish Passage Surveys conducted in District 1 and District 2.

County	Route	Postmile	Stream
Mendocino	253	0.54	Anderson Creek
Mendocino	1	17.67	Hathaway Creek
Humboldt	101	23.9	Salmon Creek
Trinity	299	51.2	Sidney Gulch
Trinity	299	51.41	Garden Gulch

The Reconnaissance Surveys were performed in accordance with the California Department of Transportation's (Caltrans) 2007 Reconnaissance Fish Passage Assessment Instructions and Procedures manual.

The primary objective of the Reconnaissance Survey is to determine whether any given highway-stream crossing may potentially be an anadromous fish-bearing stream based on characteristics of the stream and the crossing. The Reconnaissance Survey includes both field and office activities. Field activities include documenting whether a natural stream channel is present, whether the site is primarily used for conveying stormwater and/or is a concrete-lined floodway, and evaluating basic stream channel width and gradient criteria. In addition to documenting characteristics of the crossing and the stream channel at each survey site, aerial imagery also is reviewed and a literature review is conducted to identify streams that may currently support or historically supported anadromous fish, in order to support a determination on whether further surveying effort is required, and to assist in prioritization of future survey efforts.

Reconnaissance Survey sites that do not meet the basic criteria for potentially being an anadromous fish-bearing stream or are known to have not historically supported anadromous salmonids (e.g., due to a natural migration barrier downstream of the site) are identified as not needing a Detailed Survey, as defined in Caltrans' (2007a) Detailed Fish Passage Assessment Data Collection Instructions and Procedures manual. Sites identified as needing a Detailed Survey require additional information to be collected during the Reconnaissance Survey, including information on: (1) land ownership upstream and downstream of the site (to the extent possible); (2) whether the site is accessible via the highway for conducting a Detailed Survey; (3) whether vegetation removal is required to conduct a Detailed Survey; and (4) whether the crossing is classified as a confined space. Up to four photographs are taken at each surveyed site, to the extent possible, including: (1) upstream of the crossing looking upstream; (2) upstream of the crossing looking downstream; (3) downstream of the crossing looking upstream; and (4) downstream of the crossing looking downstream.

The results of the Reconnaissance Surveys addressed in this report are summarized by county, route and postmile (**Appendix A**). For each surveyed site, the information collected during the Reconnaissance Survey is displayed, in addition to basic hydrologic unit classifications for the site, the stream name, whether the site historically supported anadromous salmonids, and photographs of the site. If a determination was made that a site requires a Detailed Survey, additional information is displayed, including land ownership information, site accessibility for conducting a Detailed Survey, whether vegetation removal is needed to conduct a Detailed Survey, and whether the site may be a confined space. Site-specific photographs taken during the Reconnaissance Surveys are provided in **Appendix B**.

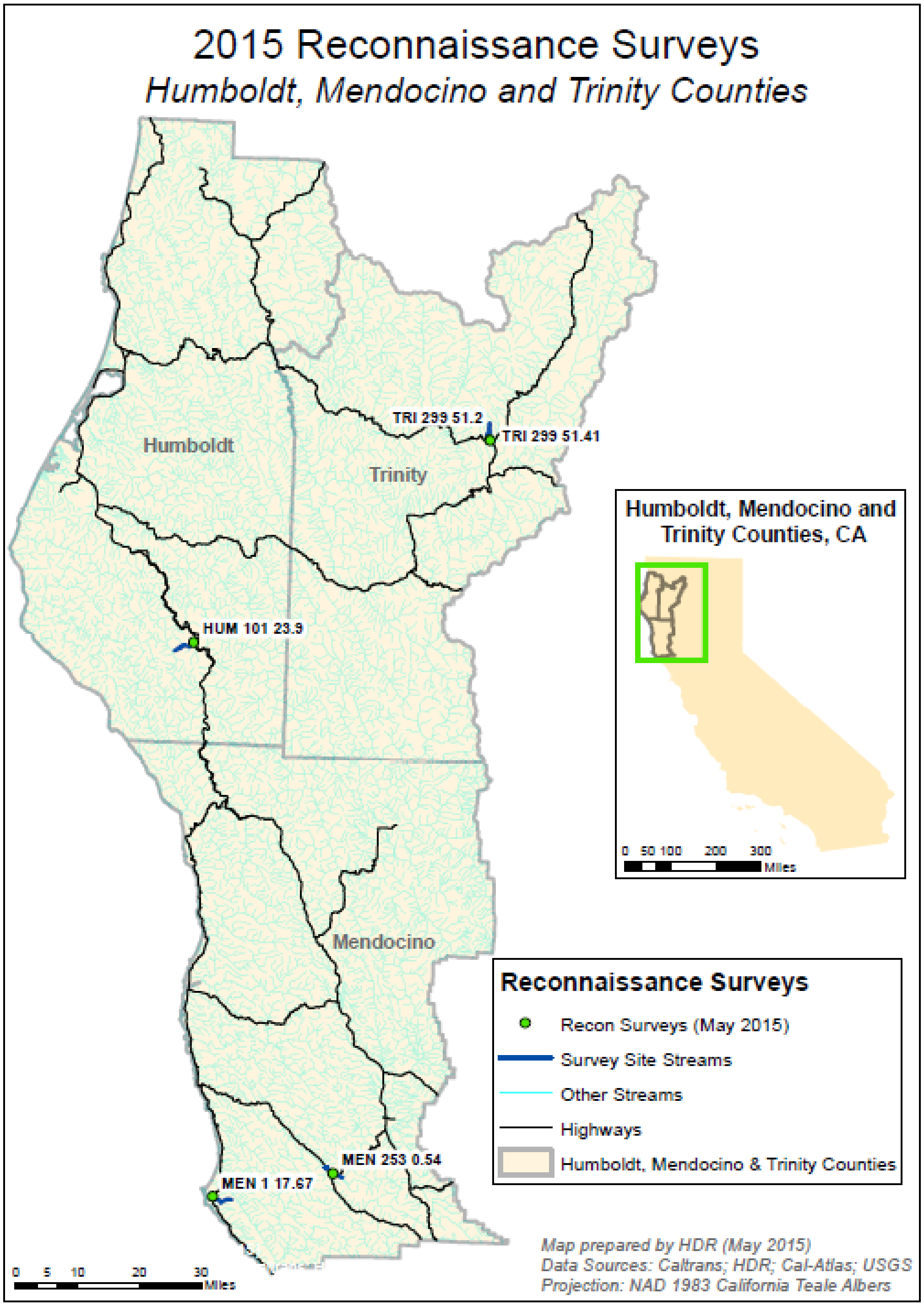

Figure 1. Reconnaissance Fish Passage Surveys conducted in District 1 and District 2.

Surveyed sites that: (1) meet the basic channel width and gradient criteria according to Caltrans' Reconnaissance Fish Passage Assessment Instructions and Procedures manual; (2) potentially constrain fish passage (i.e., not a channel-spanning bridge); and (3) have the potential to have historically or currently support anadromous salmonids, are identified as requiring a Detailed Survey during field and office activities associated with the Reconnaissance Survey.

As described in Caltrans' (2007a) Detailed Fish Passage Assessment Data Collection Instructions and Procedures manual, the Detailed Survey primarily consists of a longitudinal profile of the stream channel upstream and downstream of the crossing, a tailwater control (TWC) cross-section downstream of the crossing, and survey locations used to estimate road fill volume at the crossing. The Detailed Survey also may include surveying additional crossing features to the extent that they are present, such as weirs, fishways, aprons, headwalls and wingwalls. Additional quantitative and qualitative data are collected via manual measurements and observations, such as characteristics and dimensions of the culvert and associated features, culvert substrate embeddedness, alignment of the culvert inlet and outlet to the channel, channel width, and substrate size.

Two of the five sites were identified as requiring a Detailed Fish Passage Survey – TRI 299 51.41 (i.e., Trinity County, State Route 299, Postmile 51.41) and TRI 299 51.2 (**Figure 2**). The other three sites were identified as not requiring a Detailed Survey because they consisted of bridges without potential fish passage constraints. The streams associated with both sites identified as requiring a Detailed Survey support anadromous salmonids (Taylor et al. 2002; USFS 2004; NMFS 2014).

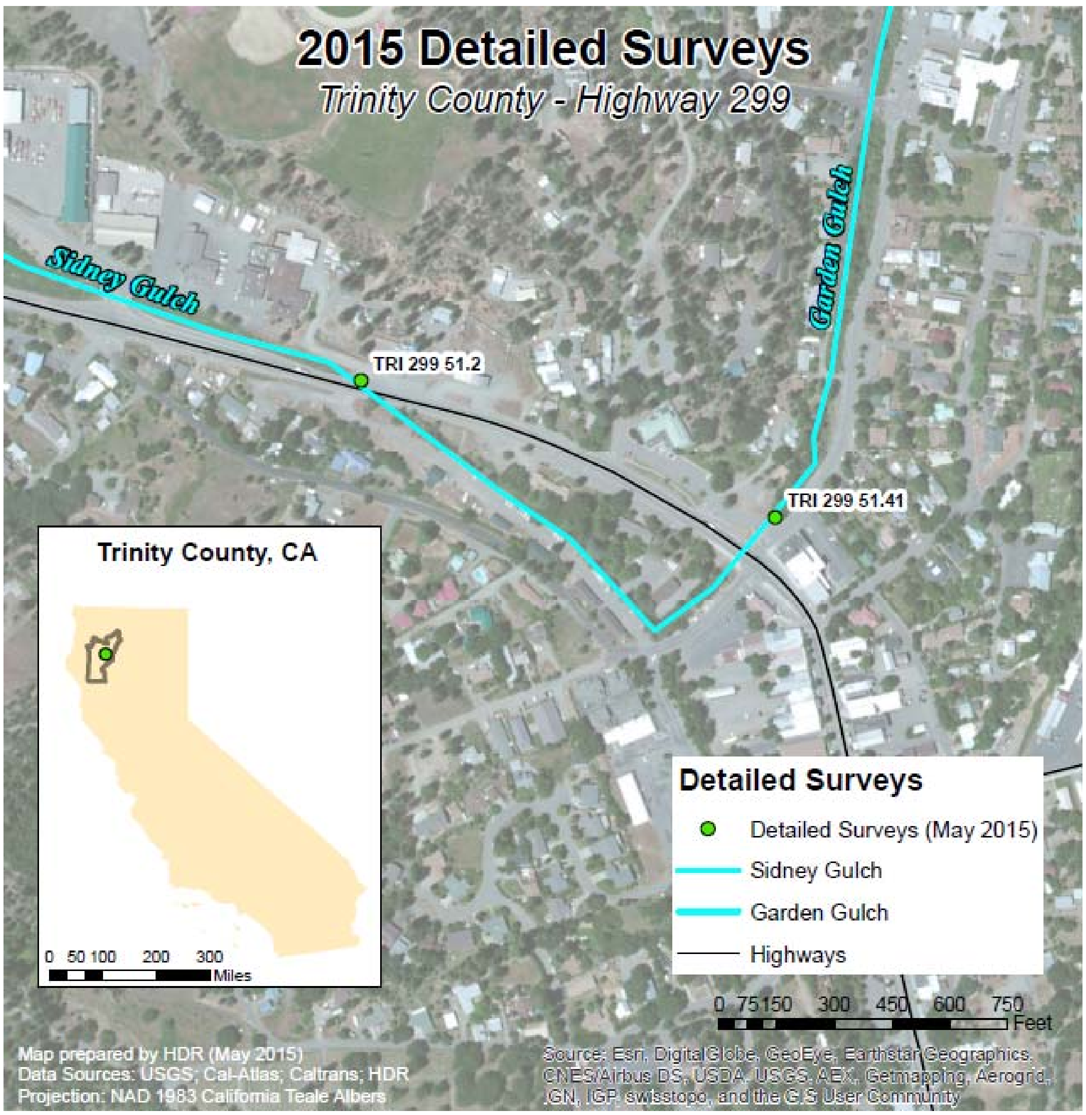

Figure 2. Detailed Surveys conducted in Trinity County.

2. Detailed Fish Passage Survey Data Collection and Post-Processing

In order to evaluate fish passage at the crossings where a Detailed Survey was conducted, the raw survey data collected are first post-processed. As previously mentioned, the survey data primarily include the longitudinal stream profile (i.e., based on survey locations along the stream bottom from upstream of the crossing to downstream of the crossing), the TWC cross-section (i.e., based on survey locations perpendicular to the stream along the downstream TWC), and road fill survey points.

The survey data collected at each site for the longitudinal stream profile, the TWC cross-section, and road fill volume consists of an X, Y and Z (elevation) coordinate for each survey point. The survey point coordinates for each site were converted into relative distance and elevation in Excel, in order to allow for calculation of the following site parameters:

- Upstream channel slope
- Inlet apron slope and length, if applicable
- Culvert slope
- Outlet apron slope and length, if applicable
- Total culvert length
- Downstream channel slope
- Residual inlet depth
- Residual outlet depth
- Road fill volume estimate

If a site includes more than one culvert, then culvert slope and length, and residual inlet and outlet depths are calculated separately for each culvert, to the extent feasible.

Resulting site-specific parameters for each Detailed Survey site are shown in two tables below. **Table 2** displays parameters that are specific to an entire site, while **Table 3** displays parameters that can vary at each site with more than one culvert.

Table 2. Site parameters – upstream channel slope, downstream channel slope, and road fill volume-related calculations.

County	Route	Postmile	Upstream Channel Slope (%)	Downstream Channel Slope (%)	Inlet Fill Volume (ft^3)	Outlet Fill Volume (yd^3)	Road Width (ft)	Road Fill Volume (ft^3)	Total Fill Volume (yd^3)	Elevation of Road Prism (ft)
TRI	299	51.2	-0.4	1.3	1,209	2,728	147	31,067	1,296	5
TRI	299	51.41	3.3	5.8	2,770	11,775	154	52,661	2,489	9

Table 3. Site parameters – culvert slope and length, and residual inlet and outlet depths.

County	Route	Postmile	Culvert #	Culvert Slope (%)	Residual Inlet Depth (ft)	Residual Outlet Depth (ft)	Total Culvert Length (ft)	Inlet Apron Slope (%)	Inlet Apron Length (ft)	Outlet Apron Slope (%)	Outlet Apron Length (ft)
TRI	299	51.2	1	1.4	-2.09	-0.18	134.4	n/a	n/a	n/a	n/a
TRI	299	51.41	1	3.7	-6.58	-0.17	174.1	n/a	n/a	n/a	n/a

3. Initial Evaluation of Detailed Survey Sites

The first step in evaluating fish passage at each highway-stream crossing consists of applying the California Department of Fish and Wildlife (CDFW) Passage Evaluation Filter based on the survey calculations described above. The CDFW Passage Evaluation Filter allows for an initial evaluation of whether a crossing likely provides fish passage at all potential flows (identified as "green"), likely does not provide passage (identified as "red"), or may provide passage at some flows (identified as "gray") (Taylor and Love 2003).

As described by Taylor and Love (2003), in general:

1. If the site provides unrestricted flow, there is no drop at the outlet, and water depth is at least 0.5 feet throughout the facility, then fish passage is provided (Green).
2. If the site restricts flow, there is a drop of > 2 feet or the gradient along the facility is > 3 % (depth < 0.5 feet), the site does not provide fish passage (Red).
3. If the outlet drop is < 2 feet, but the depth is less than 0.5 feet or baffles or weirs are present, the site needs further evaluation (Gray).

Results of applying the CDFW Passage Evaluation Filter, as well as the reason for each site's filter determination, are provided in **Table 4**. After identifying the filter result for each evaluated site, site photos were examined to confirm the filter results.

Based on simply applying the filter, the TRI 299 51.2 site was identified as "gray", and the TRI 299 51.41 site was identified as "red". The TRI 299 51.2 site was identified as "gray" due to insufficient residual inlet and outlet depths. The TRI 299 51.41 site was identified as "red" due to insufficient residual and outlet depths, and due to a culvert slope of greater than 3%. Because the TRI 299 51.41 site was identified as "red", and because the site has previously been identified as undersized for fish passage (Taylor et al. 2002), this site was not further evaluated for fish passage. Both the Garden Gulch crossing (TRI 299 51.41) and the Sidney Gulch crossing (TRI 299 51.2) have been identified by Caltrans (2014) as priority fish passage barriers.

Table 4. CDFW Fish Passage Evaluation Filter Results

County	Route	PM	Fully Embedded?	Inlet Width > ACW	Residual inlet/outlet depths ≥ .5'	Outlet drop ≥ 2'	Culvert Slope > 3 %	Filter Result	Reason for Filter Result
TRI	299	51.2	No	Yes	No	No	No	Gray	Insufficient residual inlet/outlet depths
TRI	299	51.41	No	Yes	No	No	Yes	Red	Insufficient residual inlet/outlet depths; Culvert slope > 3%

4. FishXing Evaluation

As previously described, sites ranking as "gray" by the CDFW Passage Evaluation Filter require further evaluation by using FishXing software. Before running the FishXing software, additional analyses were required in order to develop the inputs to the software, particularly related to hydrologic information pertaining to the drainage upstream of each crossing.

Methodology

Because FishXing requires particular flow values in order to evaluate passage of fish at a range of flows at each stream crossing, and because flow gage data was not readily available for nearby unregulated streams, flood estimator equations developed by the USGS were used to estimate 2-year peak flows (i.e., 50% exceedance flows). The resulting 50% exceedance flows were then multiplied by a particular factor to estimate upper fish passage flows for adult coho salmon and steelhead, and for juvenile salmonids. As identified by CDFG (2002), upper fish passage flows for adult coho salmon and steelhead are calculated by multiplying the 50% exceedance flow by 0.5, and upper fish passage flows for juvenile salmonids are calculated by multiplying the 50% exceedance flow by 0.1. Lower fish passage flows were taken from CDFG (2002) – 3 cfs for adults, and 1 cfs for juveniles.

The USGS flood estimator equations reported by geographic region in California in Taylor and Love (2003) are sourced from Waananen and Crippen (1977). However, updated flood estimation equations for California have since been developed by the USGS and are presented in Gotvald et al. (2012). The updated flood estimator equations require watershed-specific drainage area and mean annual precipitation. For the stream crossing being evaluated, the USGS StreamStats web application[1] was used to retrieve watershed area above the crossing and mean annual precipitation within the delineated watershed. However, the formulas for calculating flood flows had not yet been updated in the StreamStats web application at the time of developing this report. Therefore, the 2-year flood flow (i.e., 50% exceedance flow) was manually calculated in Excel (**Table 5**).

Table 5. Calculation of upper fish passage flows for FishXing.

County	Route	PM	Stream	Drainage Area (mi^2)	Mean Annual Precip (in)	50% Exceedance Flow	.5*50% Exceedance Probability (Upper Flow for Adults)	.1*50% Exceedance Probability (Upper Flow for Juveniles)
TRI	299	51.2	Sidney Gulch	2.7	42.3	177.3	88.7	17.7

Additional inputs required for running FishXing included characteristics of the culvert, culvert embeddedness, downstream channel slope, downstream maximum depth, and results from the TWC cross-section survey. The swimming ability criteria for prolonged and burst swimming for both adult and juvenile salmonids, and minimum depth requirements, were taken from Marin County (2003), which provided refined swimming ability criteria based on a combination of CDFW criteria and their observations of fish passage at stream crossings in northern California streams.

Results

Results of the FishXing evaluation for each site are displayed in terms of the percent of flows passable by lifestage (**Table 6**). As shown in the table, types of barriers identified by FishXing for adult salmonid passage was insufficient water depth in the culvert ("Depth") at lower flows, and swimming to exhaustion during burst mode ("EB") at higher flows. The types of barriers identified for juvenile salmonid passage were excessive height to enter culvert ("Leap"), insufficient water depth in the culvert ("Depth"), and swimming to exhaustion in burst mode ("EB") at lower flows, and excessive velocities in the culvert ("V") at higher flows. However, there are some known potential limitations associated with FishXing that must be acknowledged, as reported by Marin County (2003) and Ross Taylor and Associates (2009), who reported that after their numerous site visits to culverts during migration flows, the following confounding results were generated by FishXing:

[1] http://water.usgs.gov/osw/streamstats/california.html

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

Therefore, to the extent feasible, site-specific observations should be made during the upstream migration periods to assist in evaluating the reliability FishXing results, where such information is not already available or known by local fisheries biologists.

Despite FishXing identifying this site as a total barrier to adult salmonids due to insufficient water depth in the culvert, adult salmonids likely are able to pass upstream during some flow conditions because coho salmon and steelhead spawning has been documented upstream of the State Route 299 crossing (USFS 2004; Taylor et al. 2002). However, modification of the crossing at State Route 299 may not necessarily substantively improve fish passage conditions without other modifications to the channel downstream of the crossing. USFS (2004) reported that the section of concrete channel passing through the Weaverville Ranger District compound (just downstream of the State Route 299 crossing) prevents fish migration in all but "optimal" flows.

Table 6. Summary of FishXing results for evaluated crossings.

Crossing	Species/ Lifestage	Stream	Low Passage Flow (Q_{LP})	High Passage Flow (Q_{HP})	% of Flows Passable	Barriers at Q_{LP}	Barriers at Q_{HP}
TRI 299 51.2	Adult Steelhead and Coho Salmon	Sidney Gulch	3 cfs	88.7 cfs	0.0%	Depth	EB
TRI 299 51.2	Juvenile Salmonids	Sidney Gulch	1 cfs	17.7 cfs	0.0%	Leap; Depth; EB	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.

5. Upstream Habitat Availability Evaluation

Sites identified as "gray" and "red" by the CDFW Passage Evaluation Filter (i.e., TRI 299 51.2 and TRI 299 51.41) were further evaluated in terms of the potential quantity of habitat that could be recovered upstream of a crossing if the crossing was remediated to allow unimpaired fish passage. Information to conduct this evaluation included site-specific habitat information collected during the Reconnaissance and Detailed surveys, quality and quantity of potential habitat upstream of a crossing based on GIS analyses, a literature review of fisheries habitat surveys, previously-conducted fish passage assessments, and priority fish passage barriers for remediation identified by Caltrans and/or CDFW.

Methodology

Previously conducted road-stream crossing fish passage evaluations estimated the length of habitat potentially available upstream of a crossing based on stream gradient (e.g., Lang 2005; Marin County 2003). Based on a literature review of stream gradient and upstream habitat limits of steelhead, R2 Resource Consultants (2007) reported that a slope of approximately 12%, as discernable over 100 m using digital elevation models (DEMs), would likely limit upstream passage of steelhead (and coho salmon) in northern California coastal streams. This criterion reportedly corresponds to the limiting value used to define intrinsic habitat potential for steelhead in northern California streams by NMFS (Agrawal et al. 2005, as cited in R2 Resource Consultants 2007). Because of the specific application of this recommendation to GIS analysis, the 12% gradient over 100 m was applied in this report.

The steps summarized below describe the GIS methods employed to calculate stream gradient of individual segments for each evaluated stream and its tributaries upstream of a crossing, in order to estimate potential length of anadromous fish habitat upstream of each evaluated crossing.

- Downloaded USGS digital elevation model (DEM) layers (NHD Plus) covering Trinity County. All layers were converted to the NAD 1983 California (Teale) Albers projection. A personal geodatabase was created to store all datasets used for this exercise.
- The DEM layer was clipped to the spatial extent of the region surrounding the watersheds upstream of the crossings at TRI 299 51.2 and 51.41.
- The following processing functions within the Hydrology toolset (located in the Spatial Analyst toolbox) were applied to the DEM layer in order to identify natural stream pathways, and delineate an upstream watershed for each site evaluated. For all processes, the cell size of the output raster was set to equal the cell size (i.e., 30 m) of the respective input raster.
    - The Fill tool was run to remove any potential "sinks" in the DEM (i.e., cells that do not have a defined drainage value, and need to be removed from the dataset prior to delineating watersheds and streams).
    - The Flow Direction tool was run on the DEM in order to develop a flow direction grid (i.e., a grid that assigns a value to each cell that indicates the direction of flow).
    - The Flow Accumulation tool was run on the DEM which calculates the accumulated flow into each cell by summing the cells that flow into each downslope cell. The resulting Flow Accumulation raster was symbolized in order to display streams that generally corresponded with the streams from the National Hydrography Dataset (NHD), and set to display cells that received flow from 200 cells or more. The threshold of 200 cells was determined based on: (1) general consistency with the streams displayed in the NHD; and (2) to delineate potential streams not shown in the NHD that represented drainages of the highway-stream crossings being evaluated.
    - Prior to running the next tool required to delineate individual watersheds, "outlet pour points" needed to be specified in order to define the lowermost boundary of each watershed associated with each evaluated crossing. For the purposes of this analysis, the pour points are represented by the highway stream crossing for each site being evaluated.
    - Ran the Snap Pour Point tool using the pour points created in the previous step and the Flow Accumulation raster, to produce an outlet pour point raster, which represents the "outlet" or downstream extent of each watershed being evaluated.
    - Ran the Watershed tool, which utilizes the Flow Direction raster and the Pour Point raster, to delineate an upstream watershed for each of the evaluated sites. The watersheds raster was converted to a polygon feature class in order to further process and display individual watersheds. **Figures 2** displays each delineated watershed with the NHD streams layer.
- Within the Terrain Preprocessing toolset of the Arc Hydro toolbox, ran Stream Definition tool using 200 cells as a threshold for converting the Flow Accumulation raster into a stream "grid" to delineate streams for further processing. The stream grid was then processed with the Stream Segmentation tool to create a stream segments raster (i.e., Stream Link Grid). The Stream Link Grid raster was then converted to features representing the stream network using the Stream to Feature Tool in the Spatial Analyst toolbox. The creation of a stream features layer that is based on the DEM that will be used to calculate stream gradient ensures that the streams layer and the DEM are properly registered (e.g., streams are not flowing uphill).

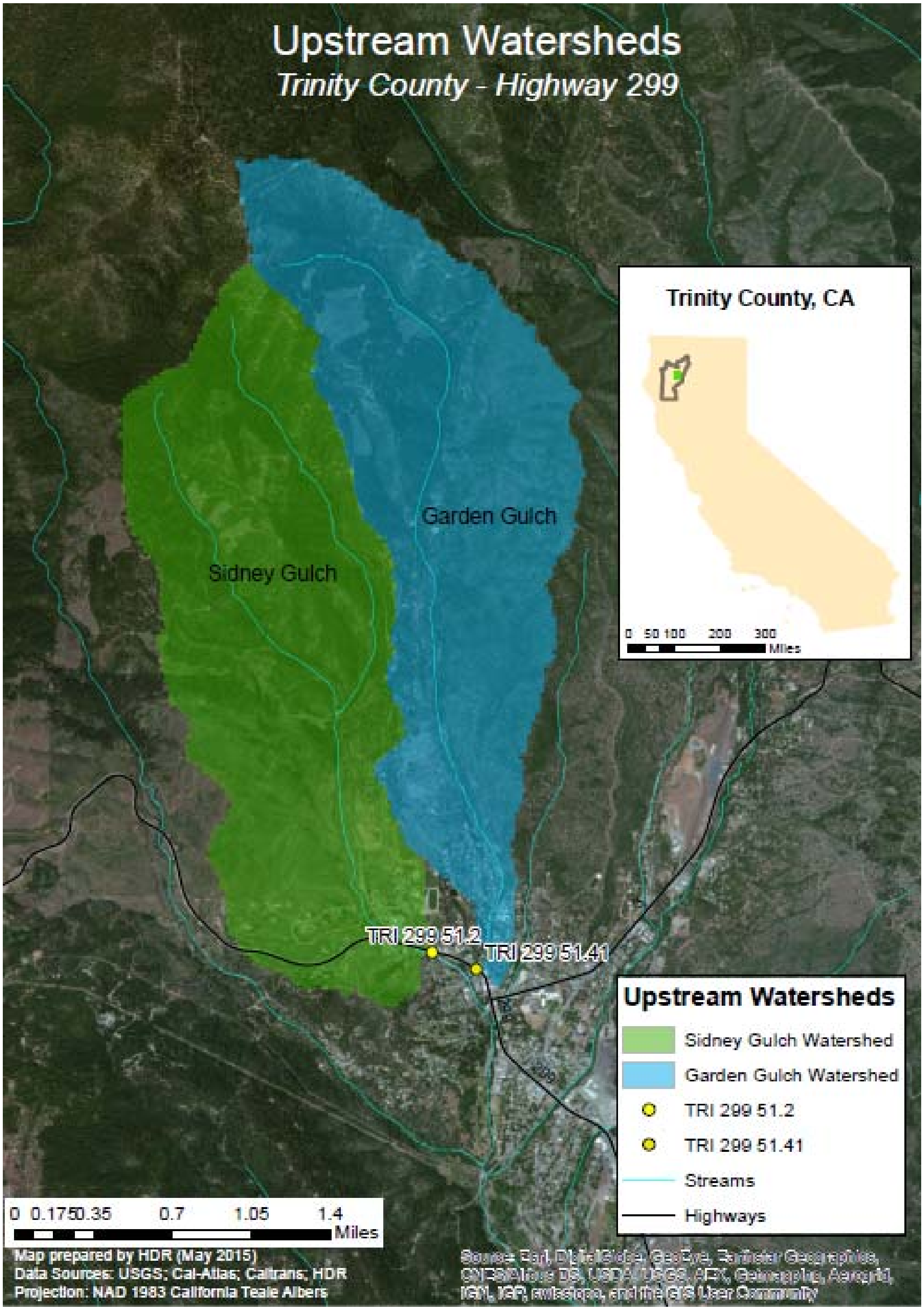

Figure 3. Overview of delineated watersheds upstream of evaluated crossings.

- Clipped the stream feature class to each individual watershed in order to individually process stream layers within each watershed.
- Stream segments residing within each watershed being evaluated were clipped to their respective watersheds such that the downstream extent of each stream feature generally corresponds with the highway-stream crossing. Ran the Densify tool (Editing toolbox) on the stream features layer to create vertices at a maximum of 100 m intervals.
- Ran the Split Line at Vertices tool (Data Management toolbox) for each stream feature class associated with each watershed to segment each stream reach between vertices in order to eventually calculate slope along each individual segment.
- Ran the Add Surface Information Tool (3D Analyst Toolbox) to generate elevations, slopes and surface lengths for individual stream segments for each stream feature class. Due to the discrepancy between the units in the DEM raster (cm) and the length units of the streams (m), the *z factor* parameter was inputted as .01 to correct for the difference in XY and Z units.
- Each stream segment within each stream feature class associated with each watershed was symbolized based on its average slope.

Based on the threshold of a 12% or greater slope occurring over approximately 100 m or more of stream length, the length of each evaluated stream reach was calculated to estimate potential length of anadromous fish habitat within each evaluated crossing's upstream watershed. It should be emphasized that the lengths of potential upstream habitat discussed below are only estimates, and do not take into account the potential for very short reaches that could be excessively steep, or potential instream barriers other than stream gradient. The estimates also are limited by the accuracy of the representation of the respective stream reaches based on a DEM, which can result in discrepancies between the DEM-generated streams and the actual streams. Site-specific discussions regarding potential habitat upstream of each crossing, including previously reported fish passage barriers upstream of each crossing, are provided below.

Results

TRI 299 51.2 (Sidney Gulch)

Potential upstream habitat available in Sidney Gulch and its tributaries upstream of the State Route 299 crossing was estimated to be approximately 2.5 miles, based on the 12% gradient criterion (**Figure 3**). This is generally consistent with the estimate of approximately 2.1 miles of potential fish-bearing habitat upstream of Memorial Drive (located just upstream of the State Route 299 crossing) reported by Taylor et al. (2002). FishXing analysis indicated that the site is a barrier at all evaluated flows for adult and juvenile anadromous salmonids. However, as previously discussed, steelhead and coho salmon spawning has been reported upstream of the State Route 299 crossing, indicating that adult anadromous salmonids are able to pass through the crossing at certain flows. Further, NMFS (2014) reported that the State Route 299 crossing at Sidney Gulch is a "partial" fish passage barrier. Also as previously discussed, USFS (2004) reported that the concrete channel just downstream of the State Route 299 crossing also is a barrier to upstream fish migration during most flow conditions, potentially limiting the fish passage benefits of remediating only the State Route 299 crossing and not the concrete channel downstream. USFS (2004) noted that observations of Sidney Gulch during spawning surveys suggests that Sidney Gulch has similar habitat deficiencies as other local streams, with a lack of large wood, shallow pools and an unstable channel. However, Taylor et al. (2002) reported that upstream reaches of Sidney Gulch contain pools for juvenile rearing and suitable spawning gravels.

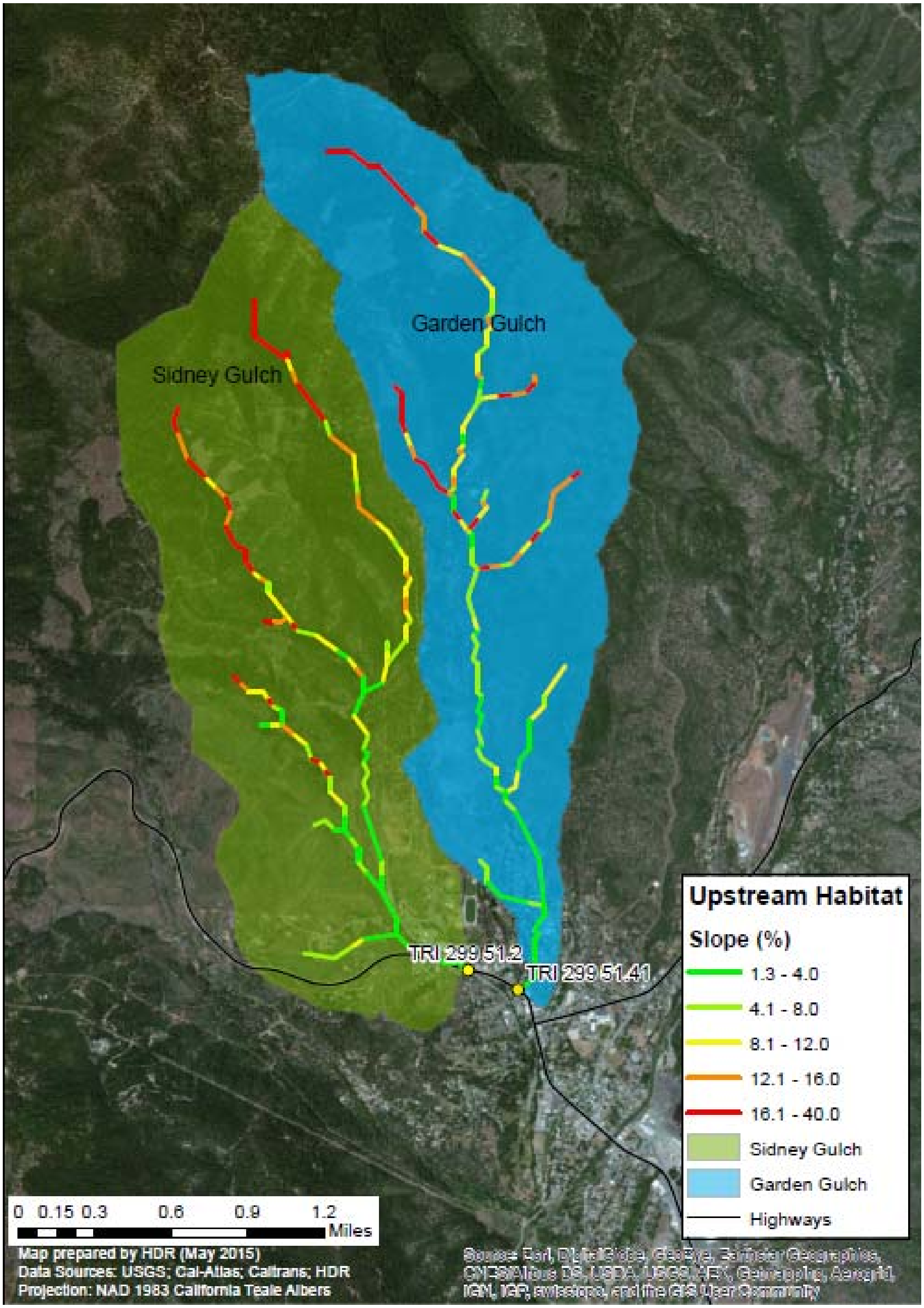

Figure 4. Stream gradient upstream of TRI 299 51.2 (Sidney Gulch) and TRI 299 51.41 (Garden Gulch).

TRI 299 51.41 (Garden Gulch)

Potential upstream habitat available in Garden Gulch and its tributaries upstream of the State Route 299 crossing was estimated at approximately 3 miles based on the 12% gradient criterion (Figure 3). This is generally consistent with an estimated 2.3 miles of potential fish-bearing habitat on Garden Gulch upstream of the Easter Avenue crossing (located approximately .25 miles upstream of the State Route 299 crossing) reported by Taylor et al. (2002). Similar to the channel downstream of the Sidney Gulch crossing at State Route 299, Garden Gulch flows through a concrete channel for approximately 500 feet downstream of State Route 299 before it’s confluence with Sidney Gulch’s concrete channel (Taylor et al. 2002). However, habitat conditions reportedly are substantially improved upstream of the channelized reach in downtown Weaverville (Taylor et al. 2002). As previously discussed, the Garden Gulch crossing has previously been identified as a fish passage barrier by others (Taylor et al. 2002; Caltrans 2013).

6. References

California Department of Transportation (Caltrans). 2014. Coastal Anadromous Fish Passage Assessment and Remediation Progress Report. Annual Report to the Legislature for Calendar Year 2013.

______. 2007. Reconnaissance Fish Passage Assessment Instructions and Procedures. Prepared by HDR Engineering, Inc.

______. 2007a. Detailed Fish Passage Assessment Data Collection Instructions and Procedures. Prepared by HDR Engineering, Inc.

California Department of Fish and Game (CDFG). 2002. Culvert Criteria for Fish Passage.

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles, 2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p. Available at http://pubs.usgs.gov/sir/2012/5113/

Marin County. 2003. Marin County Stream Crossing Inventory and Fish Passage Evaluation. Final Report. Prepared by Ross Taylor and Associates.

National Marine Fisheries Service (NMFS). 2014. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon.

R2 Resource Consultants. 2007. SWRCB Instream Flow Policy: GIS-Analysis Criteria for Upstream Limit of Steelhead. Technical Memorandum to State Water Resources Control Board.

Ross Taylor and Associates (RTA). 2009. Jackson State Forest Stream Crossing Inventory and Fish Passage Evaluation Report.

Taylor, R. and M. Love. 2003. Part IX. Fish Passage Evaluation at Stream Crossings. California Stream Habitat Restoration Manual. California Department of Fish and Game.

Taylor, R.N., M. Love, T.D. Grey, and A.L. Knoche. 2002. Final Report: Trinity County Culvert Inventory and Fish Passage Evaluation. Ross Taylor and Associates. McKinleyville, CA.

U.S. Forest Service (USFS). 2004. Weaverville Watershed Analysis. Shasta-Trinity National Forest, Trinity River Management Unit.

Waananen, A.O. and J.R. Crippen. Magnitude and Frequency of Floods in California. U.S. Geological Survey. Water Resources Investigations 77-21. Prepared in cooperation with California Department of Water Resources, California Department of Transportation, Federal Highway Administration, and U.S. Forest Service.

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Appendix A –Reconnaissance Survey Results

RECONNAISSANCE SURVEY INFORMATION

County: MEN | **Route: 253** | **PM: 0.54**

Survey Information

Date	**5/4/2015**	**Time**	**16:00** (24 hr. clock)
Data Recorder	no		
Agency Performing Survey	**HDR**	Survey Team	no, jv, jvm

Site Information

GPS Data

Longitude	-123.34877424	Latitude	39.00016864
GPS HDOP	1	Loc. of GPS Point	above inlet PM

Hydrologic Information

Stream Name	Anderson Creek	Source:	sign at site
Basin	Anderson Creek	Quad Name (7.5')	BOONVILLE
USGS Hydrologic Unit	BIG-NAVARRO-GARCIA	CalWater Unit HA	Navarro River
CalWater Unit HU	MENDOCINO COAST	CalWater Unit HSA	Navarro River

Natural Stream Channel?

Is there a definable channel upstream of culvert? Yes

Is the primary function for storm water runoff or road drainage?: No

Is the waterway a concrete-lined flood control channel?

Potential Fish Bearing Stream?

Does the site contain an active channel width >2 feet? Yes

Is the stream gradient < 20%? Yes

Salmonid ESU/DPS

ESU (Chinook and Coho Salmon) or DPS (Steelhead)

Northern California Steelhead

Historic Anadromous Reach?

Has the stream reach upstream of the crossing supported an anadromous fish population? Yes

Source: Navarro Watershed Restoration Plan (1998)

Crossing Type

Crossing Type: Bridge w/ potential passage constraints | ID: 10-0225

General Description: concrete bridge with no instream support structures and natural substrate bottom

Photos

3.1 Upstream Looking Upstream - Photo I	Mendocino_County_SR253_PM0.54_3.1
3.2 Upstream Looking Downstream - Photo I	Mendocino_County_SR253_PM0.54_3.2
3.3 Downstream Looking Upstream - Photo ID	Mendocino_County_SR253_PM0.54_3.2
3.4 Downstream Looking Downstream - Photo ID	Mendocino_County_SR253_PM0.54_3.4

Detailed Survey Required?

Detailed Survey Required?: **No**

Report Date 05-26-2015

RECONNAISSANCE SURVEY INFORMATION

County: MEN **Route: 1** **PM: 17.67**

Survey Information

Date	**5/1/2015**	**Time**	**14:25**	**Agency Performing Survey**	**HDR**
Data Recorder	JV		(24 hr. clock)	Survey Team	JV, NO, MA

Site Information

GPS Data

Longitude	-123.708468	Latitude	38.936004	
GPS HDOP	1.1	Loc. of GPS Point	above inlet	PM

Hydrologic Information

Stream Name	Hathaway Creek	Source:	USGS
Basin	Hathaway Creek	Quad Name (7.5')	POINT ARENA
USGS Hydrologic Unit	BIG-NAVARRO-GARCIA	CalWater Unit HA	Garcia River
CalWater Unit HU	MENDOCINO COAST	CalWater Unit HSA	Garcia River

Natural Stream Channel?

Is there a definable channel upstream of culvert?	Yes
Is the primary function for storm water runoff or road drainage?:	No
Is the waterway a concrete-lined flood control channel?	No

Potential Fish Bearing Stream?

Does the site contain an active channel width >2 feet?	Yes
Is the stream gradient < 20%?	Yes

Salmonid ESU/DPS

ESU (Chinook and Coho Salmon) or DPS (Steelhead)

- California Coastal Chinook Salmon
- Central California Coast Coho Salmon
- Northern California Steelhead

Historic Anadromous Reach?

Has the stream reach upstream of the crossing supported an anadromous fish population? Yes

Source: NMFS 2012 (Central California Coast Coho Salmon Recovery Plan)

Crossing Type

Crossing Type: bridge w/o potential passage constraints ID

General Description: concrete bridge with no instream support stuctures and natural substrate bootom

Photos

3.1 Upstream Looking Upstream - Photo I	Mendocino_County_SR1_PM17.67_3.1
3.2 Upstream Looking Downstream - Photo I	Mendocino_County_SR1_PM17.67_3.2
3.3 Downstream Looking Upstream - Photo ID	Mendocino_County_SR1_PM17.67_3.3
3.4 Downstream Looking Downstream - Photo ID	Mendocino_County_SR1_PM17.67_3.4

Detailed Survey Required?

Detailed Survey Required?: **No**

Report Date 05-26-2015

RECONNAISSANCE SURVEY INFORMATION

County: HUM | **Route: 101** | **PM: 23.90**

Survey Information

Date	**5/5/2015**	**Time**	**13:29** (24 hr. clock)
Data Recorder	no		
Agency Performing Survey	**HDR**	Survey Team	no, jvm, ma

Site Information

GPS Data

Longitude	-123.83300692	Latitude	40.23502689	
GPS HDOP	6	Loc. of GPS Point	above outlet	PM

Hydrologic Information

Stream Name	Salmon Creek	Source:	USGS
Basin	Canoe Creek	Quad Name (7.5')	MIRANDA
USGS Hydrologic Unit	SOUTH_FORK_EEL	CalWater Unit HA	South Fork Eel River
CalWater Unit HU	EEL RIVER	CalWater Unit HSA	Weott

Natural Stream Channel?

Is there a definable channel upstream of culvert?	Yes
Is the primary function for storm water runoff or road drainage?:	No
Is the waterway a concrete-lined flood control channel?	No

Potential Fish Bearing Stream?

Does the site contain an active channel width >2 feet?	Yes
Is the stream gradient < 20%?	Yes

Salmonid ESU/DPS

ESU (Chinook and Coho Salmon) or DPS (Steelhead)

Historic Anadromous Reach?

Has the stream reach upstream of the crossing supported an anadromous fish population?	Yes
Source	Becker and Reining 2009 (Steelhead/Rainbow Trout Resources of the Eel River Watershed, California)

Crossing Type

Crossing Type	bridge w/o potential passage constraints	ID
General Description:	concrete bridge with no instream support structures and natural substrate bottom	

Photos

3.1 Upstream Looking Upstream - Photo I	Humboldt_County_SR101_PM23.9_3.1
3.2 Upstream Looking Downstream - Photo I	Humboldt_County_SR101_PM23.9_3.2
3.3 Downstream Looking Upstream - Photo ID	Humboldt_County_SR101_PM23.9_3.3
3.4 Downstream Looking Downstream - Photo ID	Humboldt_County_SR101_PM23.9_3.4

Detailed Survey Required?

Detailed Survey Required?:	**No**

Report Date 05-26-2015

RECONNAISSANCE SURVEY INFORMATION

County: TRI **Route: 299** **PM: 51.20**

Survey Information

Date	**5/6/2015**	**Time**	**13:18** (24 hr. clock)
Data Recorder	NO		
Agency Performing Survey	**HDR**	Survey Team	NO, JVM, MA

Site Information

GPS Data

Longitude	-122.945301	Latitude	40.735766
GPS HDOP	1	Loc. of GPS Point	above inlet

PM

Hydrologic Information

Stream Name	Sidney Gulch	Source:	USGS
Basin	West Weaver Creek	Quad Name (7.5')	WEAVERVILLE
USGS Hydrologic Unit	TRINITY	CalWater Unit HA	Middle Trinity River
CalWater Unit HU	TRINITY RIVER	CalWater Unit HSA	Weaver Creek

Natural Stream Channel?

Is there a definable channel upstream of culvert?	Yes
Is the primary function for storm water runoff or road drainage?:	No
Is the waterway a concrete-lined flood control channel?	No

Potential Fish Bearing Stream?

Does the site contain an active channel width >2 feet?	Yes
Is the stream gradient < 20%?	Yes

Salmonid ESU/DPS

ESU (Chinook and Coho Salmon) or DPS (Steelhead)

- Upper Klamath - Trinity Chinook Salmon
- Southern Oregon - Northern California Coho Salmon
- Klamath Mountains Province Steelhead

Historic Anadromous Reach?

Has the stream reach upstream of the crossing supported an anadromous fish population? Yes

Source: NMFS 2014 SONCC Recovery Plan

Crossing Type

Crossing Type: Culvert ID

General Description: Concrete box culvert; concrete lined.

Photos

3.1 Upstream Looking Upstream - Photo I	Trinity_County_SR299_PM51.2_3.1
3.2 Upstream Looking Downstream - Photo I	Trinity_County_SR299_PM51.2_3.2
3.3 Downstream Looking Upstream - Photo ID	Trinity_County_SR299_PM51.2_3.3
3.4 Downstream Looking Downstream - Photo ID	Trinity_County_SR299_PM51.2_3.4

Detailed Survey Required?

Detailed Survey Required?: **Yes**

Report Date 05-26-2015

RECONNAISSANCE SURVEY INFORMATION

County: TRI **Route: 299** **PM: 51.41**

Survey Information

Date	**5/6/2015**	**Time**	**9:00** (24 hr. clock)
Agency Performing Survey	**HDR**		
Data Recorder	JV	Survey Team	JV, MA, NO

Site Information

GPS Data

Longitude	-122.94138061	Latitude	40.73487655
GPS HDOP	1	Loc. of GPS Point	above inlet

PM

Hydrologic Information

Stream Name: unknown

Source:

Basin	West Weaver Creek	Quad Name (7.5')	WEAVERVILLE
USGS Hydrologic Unit	TRINITY	CalWater Unit HA	Middle Trinity River
CalWater Unit HU	TRINITY RIVER	CalWater Unit HSA	Weaver Creek

Natural Stream Channel?

Is there a definable channel upstream of culvert?	Yes
Is the primary function for storm water runoff or road drainage?:	No
Is the waterway a concrete-lined flood control channel?	Yes

Potential Fish Bearing Stream?

Does the site contain an active channel width >2 feet?	Yes
Is the stream gradient < 20%?	Yes

Salmonid ESU/DPS

ESU (Chinook and Coho Salmon) or DPS (Steelhead)

- Upper Klamath - Trinity Chinook Salmon
- Klamath Mountains Province Steelhead
- Southern Oregon - Northern California Coho Salmon

Historic Anadromous Reach?

Has the stream reach upstream of the crossing supported an anadromous fish population? Yes

Source: Taylor et al. 2002; personal observation (YOY salmonids were observed in the stream downstream of the culvert 5/6/15)

Crossing Type

Crossing Type: Culvert

ID

General Description: Concrete box culvert (1939) with a 6' CSP culvert fit into the center; wing walls present at both inlet and outlet.

Photos

3.1 Upstream Looking Upstream - Photo I	Tririny_County_SR299_PM51.41_3.1
3.2 Upstream Looking Downstream - Photo I	Tririny_County_SR299_PM51.41_3.2
3.3 Downstream Looking Upstream - Photo ID	Tririny_County_SR299_PM51.41_3.3
3.4 Downstream Looking Downstream - Photo ID	Tririny_County_SR299_PM51.41_3.4

Detailed Survey Required?

Detailed Survey Required?: **Yes**

Report Date 05-26-2015

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Appendix B –Fish Passage Assessment Photographs – Reconnaissance Surveys

County: Mendocino Route: 253 Postmile : 0.54 Survey Date: 05/04/2015

Upstream Looking Upstream	Upstream Looking Downstream
	
Downstream Looking Upstream	Downstream Looking Downstream
	

County: Mendocino Route: 1 Postmile : 17.67 Survey Date: 05/04/2015

Upstream Looking Upstream	Upstream Looking Downstream
	
Downstream Looking Upstream	**Downstream Looking Downstream**
	

County: Humboldt Route: 101 Postmile : 23.9 Survey Date: 05/20/2015

Upstream Looking Upstream	Upstream Looking Downstream
	
Downstream Looking Upstream	Downstream Looking Downstream
	

County: Trinity Route: 299 Postmile : 51.2 Survey Date: 05/06/2015

Upstream Looking Upstream	Upstream Looking Downstream
	
Downstream Looking Upstream	Downstream Looking Downstream
	

County: Trinity Route: 299 Postmile : 51.41 Survey Date: 05/06/2015

Upstream Looking Upstream	Upstream Looking Downstream
	
Downstream Looking Upstream	Downstream Looking Downstream
	

Appendix C - Fish Passage Assessment Photographs – Detailed Surveys

Figure 5. TRI 299 51.2 (Downstream looking upstream at TWC)

Figure 6. TRI 299 51.41 (Downstream looking upstream at TWC)

Appendix D - Detailed Fish Passage Assessment Site Sketches

TRI-299-51.20

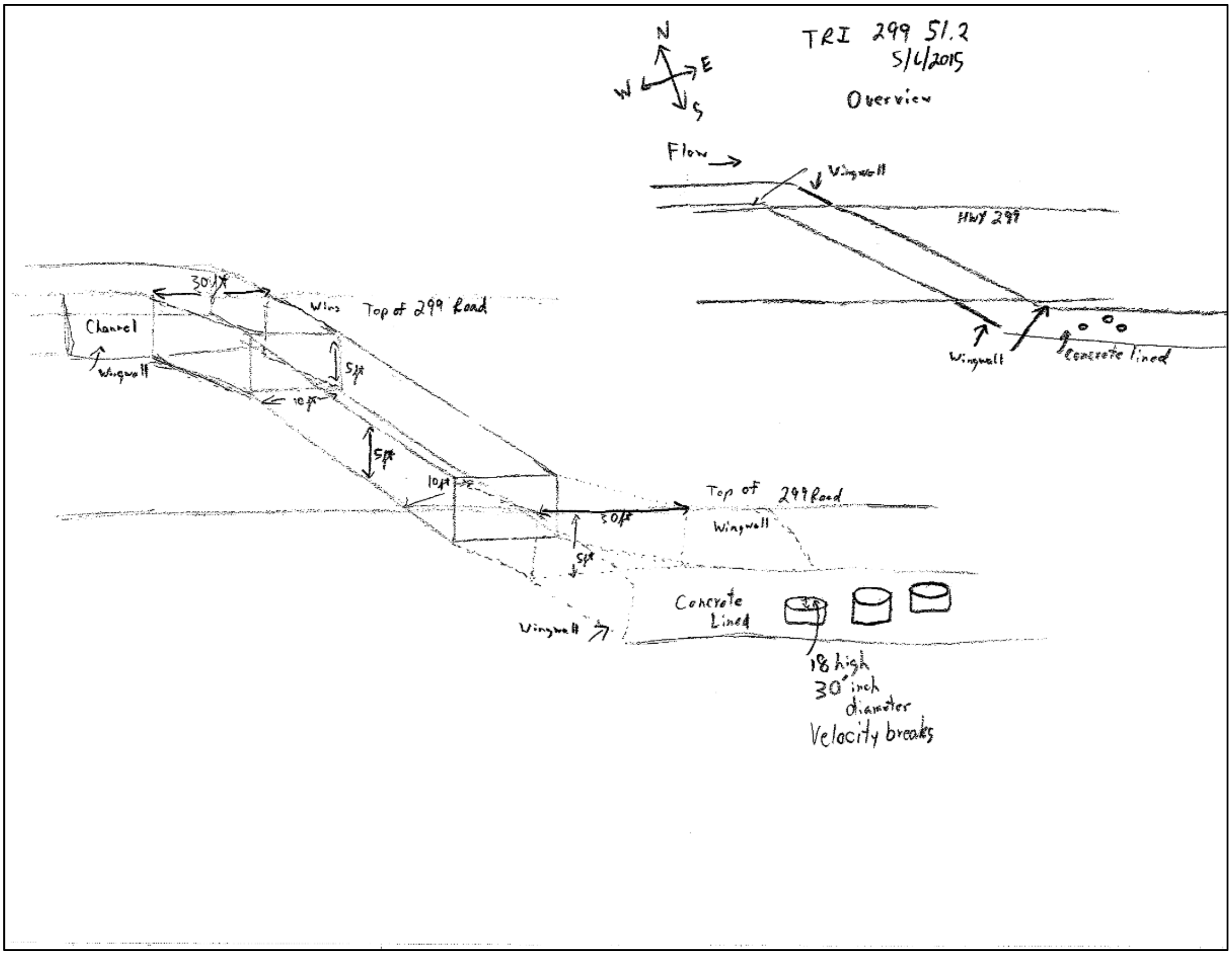

Figure B-38. Site sketch for TRI-299-51.20

TRI-299-51.41

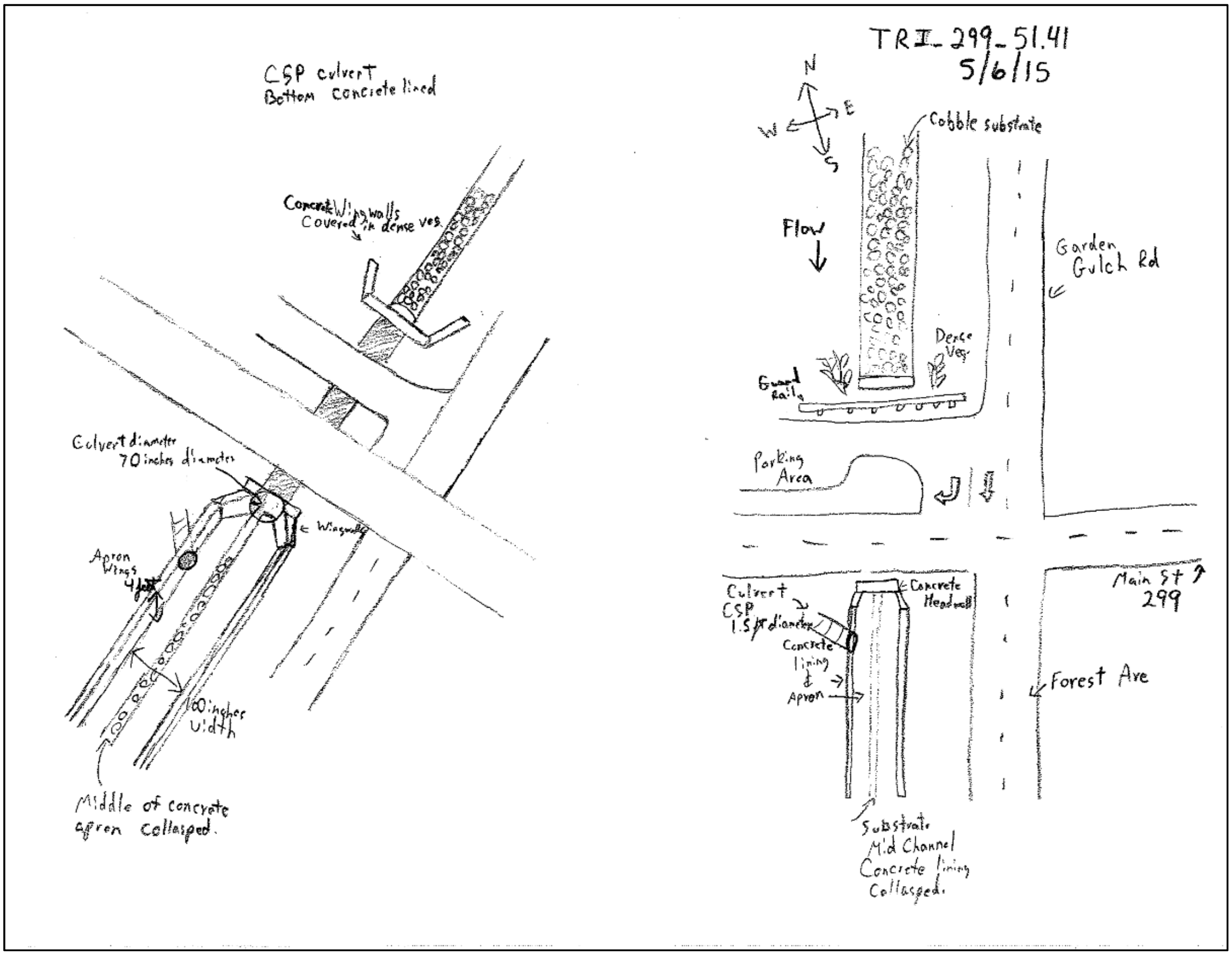

Figure B-39. Site sketch for TRI-299-51.41

Appendix E - Detailed Fish Passage Assessment Datasheets

Detailed Survey Information

GIS Number	**TRI**	**299**	**51.20**

7 Surveyor Information

7.1 Date **5/6/2015** **Time** **13:26** **7.2 Agency** **HDR**

7.3 Scope JVM 7.4 Rod MA 7.5 Data NO

8 Crossing Information

Crossing Type Culvert No. of Culverts or Bays 1 No.of Segments 1 Type per Log

9 Active Channel Width

9.1 Upstream Channel Widths: (1) 4 (2) 3 (3) 3.25
(4) 3.17 (5) 5.25

10 Trash Rack

10.1 Is there a trash rack present at the site? No

10.2 What is the distance upstream of trash rack from crossing?

10.3 Rack condition during survey

10.4 Flows at which trash rack is being bypassed

10.5 Elevation of the road prism
(assumes culvert inlet invert at 0.0 ft.)

10.6 Road fill volume

11 Tailwater Control Information

11.1 Natural Tailwater Control (downstream of weirs if present) No Control Point

11.2 Tailwater Substrate Bedrock

12 Weir Presence and Description

12.1 Downstream weirs? ☐ 12.2 Number of weirs:

Weir Description

16 Site Pictures

Picture ID TRI_299_51.2 Comment Type TWEC Transect (required)

Detailed Survey Information

GIS Number	TRI	299	51.20

Culverts

Culvert Number 1

17 Embedded culvert (not including open arched culverts)

17.1 Is the culvert embedded? No

17.2 If YES, is it embedded:

17.3 Downstream End Depth (ft.)

17.3 Upstream End Depth (ft.)

17.4 Dominant Substrate

Detailed Survey Information

GIS Number | **TRI** | **299** | **51.20**

Segments

Segment Number: 1

20 SEGMENT DESCRIPTION (describe any unique features of the segment)

Concrete box culvert. Wingwalls on upstream and downstream end. Velocity breaks (3) downstream of culvert.

21 SEGMENTShape Information

21.1 Segment Shape: Box
21.2 Diameter (ft)
21.3 Height/Rise (ft): 5
21.4 Width/Span (ft): 10
21.5 Length (ft)
21.6 Culvert segment shape description (describe uniqueness of shape)

22 Mean Low Flow Indicator

22.1 Stain (rust) Line Height (ft)

23 Inlet information

23.1 Type: Wingwall
23.2 Alignment (Inlet to Channel): > 45 Deg
23.3 Inlet description (describe apron type, shape, material and other features influencing fish passage):

Concrete lining that is degraded.

23.4 Inlet Apron:
23.5 Inlet Apron Upstream Width (ft)
23.6 Inlet Apron Downstream Width (ft)
23.7 Inlet Apron Length (ft)
23.8 Inlet Apron Slope (%)

24 Outlet information

24.1 Type: Wingwall
24.2 Alignment (Outlet to Channel): > 45 Deg
24.3 Outlet description (describe apron type, shape, material and other features influencing fish passage):

Velocity breaks 18 inches high, with a diameter of 30 inches.

24.4 Outlet Configuration: At stream grade
24.5 Fish ladder: no
24.6 Outlet Apron: No
24.7 Outlet Apron Upstream Width (ft)
24.8 Outlet Apron Downstream Width (ft)
24.9 Outlet Apron Length (ft)
24.10 Outlet Apron Slope

25 Segment side materials

25.1 Condition: Poor
25.2 Condition Description: Concrete Wingwalls are degraded.
25.3 Side Material Description: Concrete
specify "other" side material:

26 Segment bottom/lining material

26.1 Condition: poor
26.2 Condition description: Concrete lining is degraded and broken.
26.3 Bottom/lining material description: Concrete
specify "other" bottom material:

27 Culvert segment retrofit

Detailed Survey Information

GIS Number	TRI	299	51.20

27.1 Retrofit Type
.
27.2 Condition:

27.2 Outlet Sill?:

Survey Results

CDFG Matrix Site Ranking

Active Channel Width (ft.)	3.734	(mean of 5 field measurements)
Maximum Slope (%)		(max. of collected data)
Baffles/Weirs?	0	

Residual Input/Output

Residual Inlet Depth (ft.)	
Residual Outlet Ddepth (ft.)	
Culvert #	1
Substrate Throughout?	No

Passage Evaluation For Site

Fish Crossing Results for Site

Detailed Survey Information

GIS Number | **TRI** | **299** | **51.41**

7 Surveyor Information

7.1 Date 5/6/2015 **Time** 11:12 **7.2 Agency** HDR

7.3 Scope JVM 7.4 Rod MA 7.5 Data NO

8 Crossing Information

Crossing Type: Culvert | No. of Culverts or Bays: 1 | No.of Segments: 1 | Type per Log

9 Active Channel Width

9.1 Upstream Channel Widths: (1) 5.5 (2) 3.4 (3) 3.7 (4) 5.3 (5) 4

10 Trash Rack

10.1 Is there a trash rack present at the site? No

10.2 What is the distance upstream of trash rack from crossing?

10.3 Rack condition during survey

10.4 Flows at which trash rack is being bypassed

10.5 Elevation of the road prism
(assumes culvert inlet invert at 0.0 ft.)

10.6 Road fill volume 1800

11 Tailwater Control Information

11.1 Natural Tailwater Control (downstream of weirs if present) Pool tail out

11.2 Tailwater Substrate Cobble (2.5-10")

12 Weir Presence and Description

12.1 Downstream weirs? ☐ 12.2 Number of weirs:

Weir Description

16 Site Pictures

Picture ID TNR_299_51.41 Comment Type TWEC Transect (required)

Detailed Survey Information

GIS Number	TRI	299	51.41

Culverts

Culvert Number 1

17 Embedded culvert (not including open arched culverts)

17.1 Is the culvert embedded? No

17.2 If YES, is it embedded:

17.3 Downstream End Depth (ft.)

17.3 Upstream End Depth (ft.)

17.4 Dominant Substrate

Detailed Survey Information

GIS Number	**TRI**	**299**	**51.41**

Segments

Segment Number: 1

20 SEGMENT DESCRIPTION (describe any unique features of the segment)

CSP culvert with concrete lining. Natural substrate upstream; concrete lining downstream of culvert.

21 SEGMENTShape Information

21.1 Segment Shape: Circular Pipe

21.2 Diameter (ft): 5.8

21.3 Height/Rise (ft)

21.4 Width/Span (ft)

21.5 Length (ft)

21.6 Culvert segment shape description (describe uniqueness of shape)

22 Mean Low Flow Indicator

22.1 Stain (rust) Line Height (ft)

23 Inlet information

23.1 Type: Wingwall

23.2 Alignment (Inlet to Channel): < 30 Deg

23.3 Inlet description (describe apron type, shape, material and other features influencing fish passage):

23.4 Inlet Apron: No

23.5 Inlet Apron Upstream Width (ft)

23.6 Inlet Apron Downstream Width (ft)

23.7 Inlet Apron Length (ft)

23.8 Inlet Apron Slope (%)

24 Outlet information

24.1 Type: Wingwall

24.2 Alignment (Outlet to Channel): < 30 Deg

24.3 Outlet description (describe apron type, shape, material and other features influencing fish passage):

Concrete lining the length of the channel. Concrete broken in middle of channel.

24.4 Outlet Configuration: At stream grade

24.5 Fish ladder: no

24.6 Outlet Apron: No

24.7 Outlet Apron Upstream Width (ft)

24.8 Outlet Apron Downstream Width (ft)

24.9 Outlet Apron Length (ft)

24.10 Outlet Apron Slope

25 Segment side materials

25.1 Condition: Fair

25.2 Condition Description: Concrete segement material.

25.3 Side Material Description: Annular and Helical (152 mm x 51 mm)

specify "other" side material:

26 Segment bottom/lining material

26.1 Condition: poor

26.2 Condition description: Concrete bottom has eroded away

26.3 Bottom/lining material description: Concrete

specify "other" bottom material:

27 Culvert segment retrofit

27.1 Retrofit Type: None

Detailed Survey Information

GIS Number	TRI	299	51.41

27.2 Condition:

27.2 Outlet Sill?: No

Survey Results

CDFG Matrix Site Ranking

Active Channel Width (ft.)	4.380	(mean of 5 field measurements)
Maximum Slope (%)		(max. of collected data)
Baffles/Weirs?	0	

Residual Input/Output

Residual Inlet Depth (ft.)	
Residual Outlet Ddepth (ft.)	
Culvert #	1
Substrate Throughout?	No

Passage Evaluation For Site

Filter Result:	red	Reason for Filter Result:	Slope > 3%
Filter Results Adjusted?	No	Describe Adjustment:	

Fish Crossing Results for Site

	QLP (cfs)	QHP (cfs)	Leap lower limit: (cfs)	Leap upper limit: (cfs)	Depth lower limit (cfs):	Velocity upper limit: (cfs)	range passable flows:	percent passable flows:
Adult Anadromous:	3	16						0
Adult Resident:	2	7.5						0
Juvenile salmonids:	1	4.9						0