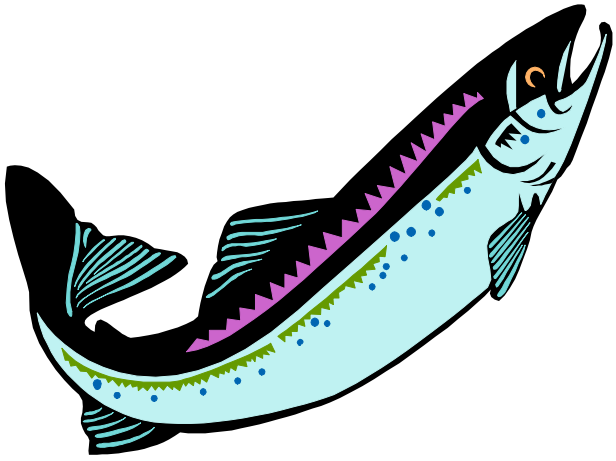
Documenting Salmonid Habitat Restoration Project Locations

Final Report



Prepared for:

California Department of Fish and Game
Salmon and Steelhead Trout Restoration Account Agreement No. P0210566

Prepared by:

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INTRODUCTION

A fundamental requirement for successful monitoring is the ability to re-locate restoration project areas and individual features. Documentation of locations must be sufficient to facilitate a person unfamiliar with the project to find the area and all features within the area ten or more years in the future. Relying on the contractor, land-owner or contract manager to remember exact locations of project features is not sufficient (Frissell and Nawa 1992). This report provides standardized procedures for documenting restoration project locations. Although designed for monitoring, this report may be used for any task that requires relocating points in the field such as spawner surveys, macroinvertebrate sampling reaches, thermograph deployments, etc.

The location of project features must be described in relation to permanent landmarks, rather than relying on the existence of the feature itself as a navigation tool. This is because it may be necessary to re-locate the site where a feature was installed, even if the feature is no longer present (Frissell and Nawa 1992). Bank stabilization and in-stream structures may be washed out or buried, riparian plantings may be overtopped by competing vegetation, rolling dips may be graded out after installation, but it is still important to be able to find the original installation location of every project feature and assess what happened.

This report should be used by project contractors and DFG staff while planning and evaluating restoration projects. Since contractors are intimately familiar with proposed work sites it would be most efficient to require them to accurately describe project area and feature locations after receiving funding. That would eliminate the need for DFG contract managers to generate detailed information on sites they are unfamiliar with. DFG contract managers could then just use the location data provided by the contractors during site reviews and verify its accuracy.

Documentation should be done after project feature locations have been marked or flagged in the field, but before construction begins. This allows for data collection during pre-treatment conditions using photographic monitoring, pre-treatment checklists or quantitative methods. Changes in project feature locations that occur during implementation should be used to amend location data to reflect as-built conditions.

Users of this report are expected to have basic navigation skills and know how to select and use appropriate tools. Ferguson (1999) covers use of tools (GPS units, compasses, altimeters), maps and coordinate systems. Navigation courses are periodically offered through the DFG (K. Hunting personal communication). Required basic skills include:

- Taking a bearing using a compass,
- Setting declination on a compass,
- Locating points in the field using bearing and distance descriptions,
- Converting between slope distance (used in the field) and horizontal distance (derived from maps),
- Interpreting topography and location from maps
- Deriving coordinates from a mapped location and plotting locations on a map using coordinates while in the field,
- Recording waypoints in a GPS unit and downloading them to a computer and uploading waypoints from a computer into a GPS unit to find locations in the field,

- Determining the appropriate datum to use based on the map and setting the datum in a GPS unit.

This report has two sections, one on procedures and one on tools. It is necessary to understand the use of tools in order to conduct the procedures. A description of the procedures and forms used to document project locations is presented below, followed by descriptions and guidance on use of appropriate tools. The tools used in this report include: maps, site sketches, GPS units, narrative descriptions, compasses, distance measuring devices and permanent monuments.

DOCUMENTING LOCATIONS OF PROJECT AREAS, FEATURES AND POINTS

Three things are needed to document the location of restoration projects:

1. Driving directions to the project area.
2. Delineation of the extent (boundaries) of the project area.
3. Description of the location of individual project features and other points within the project area.

Most information will be collected in the field using the tools described below. Logistical information such as contract number and name, gate combinations or key locations, restrictions on access, contact information for relevant parties (e.g., landowner, contractor, etc.) must be obtained from the proposal or contract. Information describing site locations and logistics should be collected at the pre-treatment stage and made available to monitoring staff, along with other project background, e.g., proposal, contract, etc.

Driving Directions

Below the standard header information on the Site Access Form there is a section titled Access Information for the Site that contains information on site logistics. Contact information for the landowner, lead agency, contractor and previous monitoring crews is provided so that crews can safely gain access to the site and learn relevant details about the project. There is also information on access limitations and gate combinations. All of this information should be filled out prior to the first site visit using the proposal package and additional contacts if necessary.

SITE ACCESS FORM

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Contract #: P9985082 **Contract name:** Indian Creek Restoration Prj. Phase II

Stream/Road: Indian Creek **Date:** 11/09/04 & 11/10/04 **Evaluation crew:** B. Budnick, D. Resnik

Drainage: Klamath R. **USGS Quad(s):** Deadmen Point **Legal Description:** T 18N R 06E S 25

ACCESS INFORMATION FOR SITE

Contact Information for Project

Entity	Name	Affiliation	Phone	Email
Landowner	Marble Mt. Wilderness	USFS	"	"
Lead Agency	John Schwabe	CDFG	707.441-2006	jschwabe@dfg.ca.gov
Contractor	Scott Bauer	CCC	707.725-7195	sbauer@ccc.ca.gov
Cons't crew	A			
Eval crew	Brooke Budnick	PSMFC / DFG	707-725-1076	bbudnick@dfg.ca.gov

Gates and Access

Landowner permission required?	No	Written or Verbal	Gate combo or key required? No
Comments:			

DIRECTIONS TO SITE

Driving Directions to Parking Site and/or Departure Point (include landmarks, roads and distances)

good place to eat

Hwy 101 to Hwy 299 E to Hwy 96 N to Happy Camp. After the pizza place take a left on Davis St which becomes Indian Creek Rd (also known as Greyback Rd), travel 10.8 mi to the bridge over Indian Creek. Park on side of road before of after bridge, walk to reaches 1 & 2. (DP001)

To access reach 3, continue 0.8 mi further to West Fork Campground turnoff (RD 18N31) on the right side of road, continue to or through gate (DP002)

Parking Site and/or Departure Point Location

Point name	Waypoint	Latitude	Longitude	Description of point
DP001	17	41.91639°N	123.46686°W	Bridge @ 10.8 mi (Reach 1&2)
DP002	16	41.92797°N	123.47578°W	1st gate on road 18N31 (Reach 3)

Photo of Parking Site and/or Departure Point, if necessary

Frame #	Photo Bearing	Scene Description

Sketch of Parking Site Relative to Work Site(s) and Major Roads

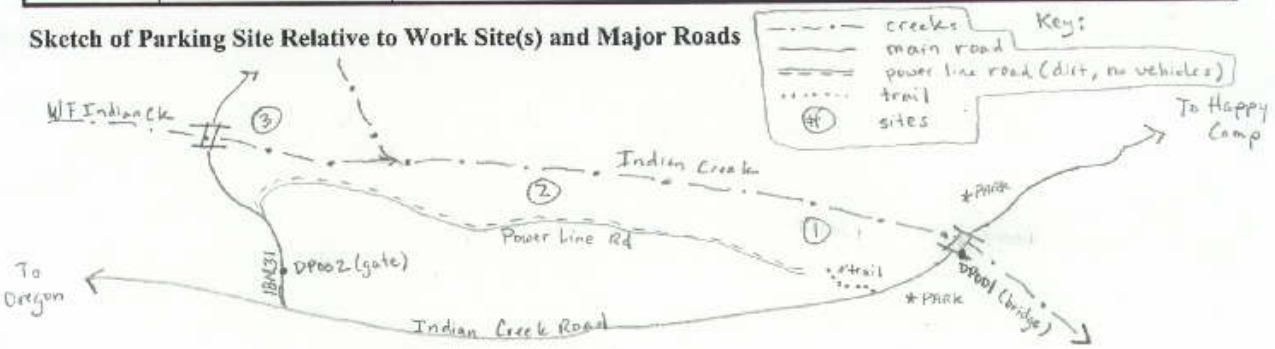
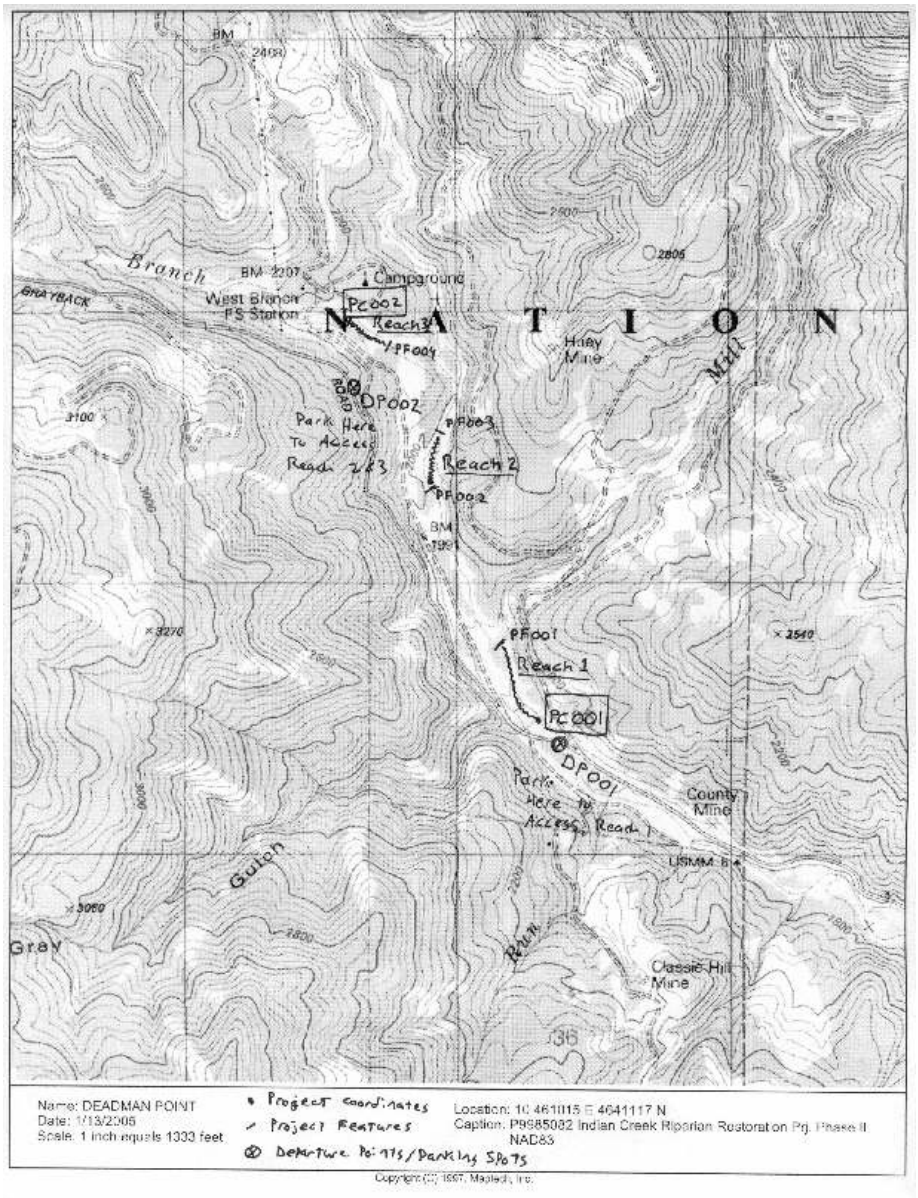


Figure 1. Example of Filled Out Site Access and Location Data Forms for Project on Indian Creek.

The next section is titled **Directions To Site**; this is where a narrative description of the driving directions is recorded. Driving directions should begin at the nearest major road or highway that would be commonly used to access the site (e.g. Highway 101). The description should include the names of all roads, landmarks and turnoffs on the way to the project site and distance between each as recorded using the vehicle odometer to the nearest tenth of a mile. The final parking spot should be described as accurately as possible including distance from nearest landmark or mile marker, which side of the road it is on, size of the area and distinguishing landmarks such as gates, rock outcrops, etc. Optional information that may be useful in finding the parking area includes a photograph of the site and latitude/longitude coordinates.



Location of the parking site and project area should be plotted on a 7.5 minute USGS topographic map (or GIS equivalent) and attached to the Site Access Form. The topographic map should be of sufficient size to include nearby landmarks and named roads, usually 8.5 by 11 inch maps projected between 1:12,000 (200 percent) and 1:24,000 (100 percent) scale are suitable. There is also space on the data form to provide a site sketch showing the parking site relative to the project area if additional detail is needed. The site sketch may include paths used to access the site, notable landmarks, individual project features, or other relevant points. All points should be labeled and a key provided.

Figure 2. Example of Project Area Map for Indian Creek. Locations of relevant points were plotted in the field, however maps with digitized features are also acceptable. Refer to the Indian Creek example Site Access and Location Data Form and the Onsite Navigation Form to see meta-data for points plotted on the maps.

The convention for naming all points is a two letter code followed by a three number code. For example "PS001" would be the code for the first parking site used to access the project area, if there were two parking sites the second would be named "PS002." A listing of the appropriate two letter code type abbreviations is located on the bottom of the Onsite Navigation Form. Additional two letter codes may be made up as needed and recorded with definitions on the bottom of the Onsite Navigation Form.

If the parking site is large and open it may be necessary to define a single landmark near the parking site as the "departure point" (DP###) from which other points within the project area are referenced. Bearing and distance to project coordinates (PC###), or a main reference point (RP###) near project features (PF###) should be defined relative to the specific departure point, rather than a large parking site area. Gates, monumented trees, bridges, interpretive signs, etc. all make good departure points.

Project Areas

A restoration project area includes all individual features, such as in-stream structures, culverts, etc. They can be described using points, lines or polygons:

- Points are applicable to projects that have a single discrete feature such as a fish passage project or an individual in-stream structure.
- Lines may be used to describe linear projects with multiple features along a stream or road. On the example provided (Figure 2), the boundaries of the project would be the upstream end of Reach 3 (PC002) and the downstream end of Reach 1 (PC001).
- Polygons occupy a land area rather than a line or point, such as a tree planting or conservation easements

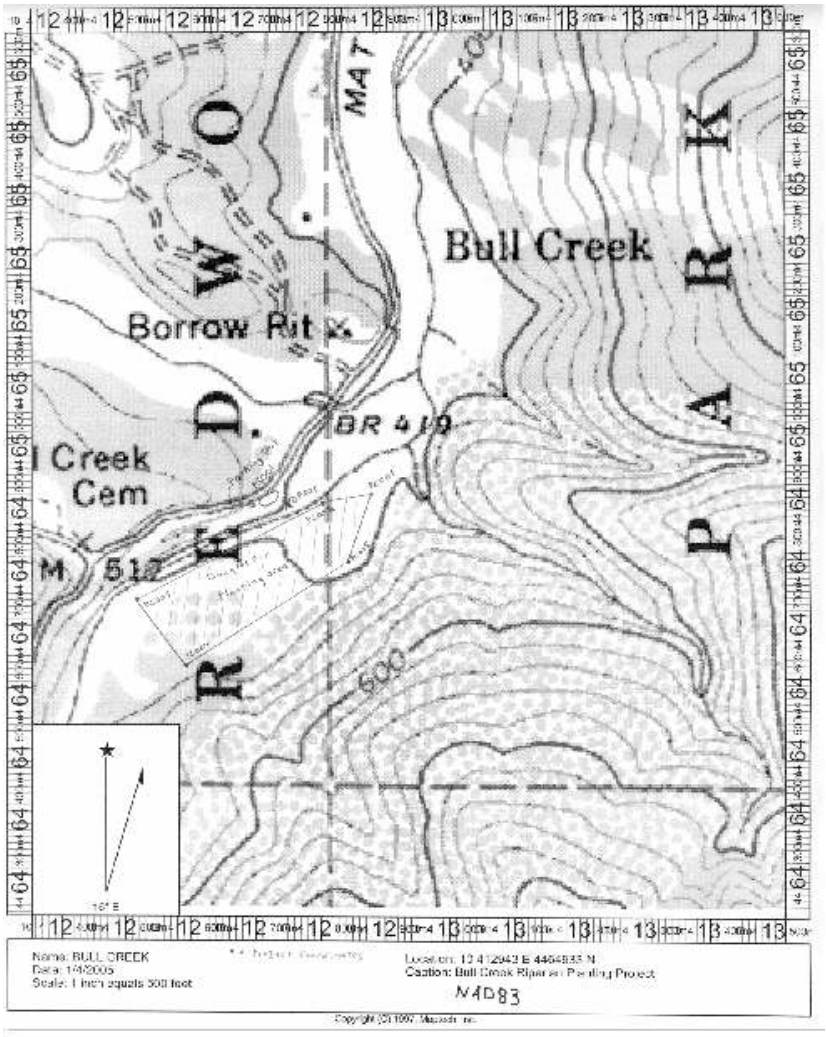


Figure 3. Example of Polygon Shaped Project Area on Bull Creek. Map has been enlarged 400 percent to highlight location of project. UTM Grid coordinates have printed on edges of maps to aid in plotting coordinates.

The point or set of points used to define the project area are known as the project coordinates (PC001, PC002, etc.). Coordinates for single point projects are the locations of that point. Coordinates for linear projects are the beginning and end point of that line. Coordinates for polygons are the locations of corner points. While it is acceptable to have multiple points, lines or polygons in a project area, a single set of coordinates should be used to define it. For example, a long, complex in-stream restoration project should be defined by the coordinates of upstream and downstream most features only, rather than individual reaches.

Coordinates are documented by recording latitude and longitude in decimal degrees (noting datum used[1]) for each point on the Onsite Navigation Form. Determining the latitude and longitude may be done using a GPS unit or by plotting the positions of each point (manually or electronically) on a 7.5 minute USGS quadrangle and measuring the latitude and longitude from the map scales. In either case the project coordinates need to be plotted onto a 7.5 minute USGS quadrangle (or equivalent GIS map) for inclusion in the project file. If location information has been digitized or stored in a spatial database (GIS), the files containing the geo-referenced information/coordinates (e.g. "shape" files or waypoint files) may be submitted to DFG along with paper maps. Waypoint lists and other electronic location data should be included with final products delivered to DFG.

In addition to describing project coordinates using latitude and longitude it is useful to provide a narrative description of the project coordinate markers themselves as well as directions to them using bearing and distance. For projects located on streams or actively used roads, the project location should be described using distance (in miles and tenths or feet depending on scale) from a fixed reference point.

Establish permanent monuments at project coordinates in areas that are not likely to be disturbed (above the 100-year floodplain for stream related sites and out of the way of graders and brushing machines on roads). If landmarks such as gates, bridges, buildings, unique trees, etc. are available these may be described and used instead of establishing separate markers.

Project Features

The location of individual project features is documented using the Onsite Navigation Form and associated maps and site sketches. Examples of project features include a stream crossing culvert, boulder weir, outsloped road reach, riparian planting area, etc. Project features are named according to the structured code system described above; two letters followed by three numbers (PF001, PF002, etc.). ID numbers are assigned sequentially from downstream to upstream for in-stream projects or from beginning to end for road projects. Latitude and longitude (decimal degree format) are required for the downstream most project feature for in-stream projects and the beginning feature for road projects.

Polygonal features e.g., planting areas, should also be assigned unique IDs. Large areas that have been segmented into smaller polygons for convenience of monitoring or other reasons should have sequential numbers.

[1] Coordinates ultimately need to be converted to the NAD83 datum for entry into the DFG database. However a different datum may be used in the field that is compatible with available maps.

For project features along roads or streams the linear distance to each feature from the reference point is the best tool for documenting location. For extensive projects such as plantings, vegetation removal, landslide stabilization, fences, etc. coordinates of the project corners should be recorded using bearing and distance from a fixed point and/or GPS points. Location information for project features should be recorded on the Onsite Navigation Form. Given these general guidelines the user must decide which combinations of tools are required to document each feature's location relative to the established reference points. Only a subset of tools would be used in most cases. See Appendix A for guidance on tool selection.

If using permanent markers or monuments, all features, even those that are less than 15 feet apart, should be separately located. New features should be distinguished from features of past projects. Markers for stream related features should be placed on the left or right stream bank above the 100-year floodplain and clearly visible to observers standing in the channel. Markers for road-related features should be visible from the road surface. For polygonal features, markers should be established at the corners.

For very large projects, such as road projects with many rolling dips and drains on the same section of road, affixing a permanent marker at each feature may not be feasible. In these cases it may be sufficient to place permanent markers intermittently. While permanent markers are not required for every feature, the location of every feature must be described relative to established reference points or nearby permanent markers. The presence of even a few permanent markers will be useful when trying to relocate all features during future monitoring efforts, especially ones that have deteriorated or no longer exist.

The location of all project features, photo-points and other relevant points should be recorded on map and/or site sketch at a sufficient scale to encompass the entire project area. Digitized data points entered into a GIS should be submitted electronically and as paper maps.

Monitoring Locations

Photo-points, cross-section endpoints, benchmarks, temperature logger locations, survey reaches, redds, etc., and other spatial information related to monitoring can be documented and relocated using this report. These should also be named according to the structured code of two letters followed by three numbers. The first two letters describe the point type and the three numbers sequentially number the points of each type. For example, XP003 would be used to describe the third cross section end point in a survey. To document locations of relevant points:

- Identify and record coordinates of these points using the mapping methods described above.
- Establish a location marker for each permanent point, where feasible, using methods described above.
- Record the location of the marker on the Onsite Navigation Form.

TOOLS

The procedures described above require use of one or more of the following tools:

- Maps
- Site sketches

- GPS units
- Narrative descriptions
- Compasses and distance measuring devices (tape measures, string boxes, odometers, etc.)
- Permanent monuments or markers

While there is flexibility in deciding which combination of tools should be used at each site, the user should keep in mind that the standard of quality is enabling someone else to relocate the site(s) 10 years in the future using only the information recorded on the data sheets and maps. The determining factor in deciding which tools to use should be the ability of others to find the sites as described, not how much time is required to record the information initially. Monitoring is impossible if project features cannot be relocated to assess their condition. The location tools should be used in combination to compensate for the inherent weaknesses in each (see Table 1).

Maps

Maps are a useful and required element of every site location description. The recommended base map is the 7.5 minute USGS topographic map. Electronic versions are commonly available in desk top computer applications. One advantage of the electronic map base is the ability to print out an 8.5 x 11 inch map of the project area, without having to include a standard size topographic map in the project file. Additionally, electronic maps may be printed out with the scale enlarged (typically at 200 or 400 percent) to facilitate more detailed notations in the project

Table 1. Recommendations on Tools for Restoration Project Location Documentation.

Navigation Tools	When to Use	Details	Include	Datasheet
Mapping	**Required** for all projects	USGS 7.5 minute topographic map or GIS map of known scale	Map scale, datum, north arrow, date of production, title of project, legend, and locations of relevant points	Waterproof paper or laminated
Site Sketches	**As needed** to supplement maps, usually for details of project features	Hand drawn in field notebook	Title of project, date produced, legend, location of relevant points	Waterproof field notebook and bottom of Site Access Form
GPS Unit	**As needed**, best suited to wide open areas with good satellite coverage.	Accuracy +/- 100-300 feet. Field check accuracy to determine suitability.	Waypoint numbers, datum used and unit ID number should be recorded on data sheets.	Site Access Form and Onsite Navigation Form
Narrative Description	**Required for driving directions**	Use detailed landmark descriptions- "green metal bridge" rather than "bridge".	Names of all roads, intersections, landmarks and description of parking site. Use odometer to record distances to nearest 1/10 mile.	Site Access Form
Narrative Description	**As needed**, for onsite navigation	Best for trails and abandoned roads or supplement to other tools	Junctions of trails and roads, landmarks, uphill/downhill, feature locations, etc. Use detailed descriptions	Onsite Navigation Form
Bearing and Distance	**Useful in most locations**	Need obvious landmarks to navigate from (reference points)	Record compass type: true north or magnetic north. Use azimuth scale (0-360°). Upstream/downstream may be used instead of azimuth in streams.	Site Access Form and Onsite Navigation Form
Permanent Monuments	**Required** for survey markers, reference points and project coordinates. **Recommended** for as many feature locations as possible.	Check with landowner for approved types and locations. "Two pin" method may be used for unstable areas.	Inscribe point name, organization and date on monument marker. Record description of marker and location on data sheet.	Site Access Form and Onsite Navigation Form

area. Maps intended for field use should be printed on waterproof paper with a laser printer to prevent smearing. Plastic lamination of maps may be necessary for very wet conditions.

Maps produced from GIS are also acceptable and may be preferable in some cases. Large project areas with large amounts of digitized information are better suited to GIS maps and larger map sizes. Elimination of the topographic lines may be necessary to produce clearly readable maps. In all cases, the following elements are required: map scale, datum, north arrow, date of production, legend/key explaining symbols and a title with the contract name. Maps should include plotted locations of all relevant points described on data sheets, such as project features, project coordinates, parking sites, photo-points, etc.

Topographic maps may be used to both record and derive information, especially if a GIS is used. In the first instance symbols, points, lines and text are noted on the map in the field based on estimates of their locations made by the user. If the notations are accurately placed on the map it is possible to derive the following types of information for use in location descriptions: horizontal distance and bearing between points, area of polygons, differences in elevation between points and latitude/longitude of coordinate positions. Map based calculations may have lower precision than field based measurements and may not be accurate if the user has erred in locating points or if the map itself is not accurate. For example, low gradient unconfined streams may have moved across the valley floor since the map was originally drafted, which would make calculating reach lengths inaccurate using map measurements.

A standard symbol set should be used for notating topographic maps and site sketches. Standard USGS symbols for topographic maps and their meanings are included in Ferguson (1999). A special symbol set for road related restoration projects has been included in Chapter 10 of the California Salmonid Stream Habitat Restoration Manual. A symbol set for other types of restoration projects (instream, riparian, etc.) should be developed by DFG.

Site Sketches

Site sketches are a useful supplement to topographic maps and may be used as needed. Their most common use is to provide additional detail about project features. Typically, site sketches are not drawn to scale and thus are not suitable for making calculations of area or distances. A space to record a site sketch showing the location of the parking site relative to the project area and major roads is located on the bottom of the Site Access Form. Supplementary site sketches should be recorded in a separate waterproof notebook, with copies included in the project file.

GPS Units

Handheld GPS units that typically cost less than $250 are widely used by contractors and DFG staff. They are commonly used to record “waypoints” at desired locations, rather than writing down the coordinates displayed on the unit or deriving them from map locations. The waypoints can then be downloaded to a computer mapping application, database or simply transcribed back at the office. Waypoints or coordinates can also be uploaded to the GPS unit before going into the field so that the GPS unit can be used in the “Go-To” mode to navigate to points in the field.

While GPS units can be very useful, it is essential to understand their limitations. They are most accurate in open areas with clear views of the horizon. They are less reliable and accurate and sometimes unable to obtain locations in deep canyons, on north facing slopes or under dense tree

cover. Even in wide open areas with good satellite coverage, accuracy is likely to be only 100 to 300 feet- despite the stated accuracy on the GPS unit (Ferguson 1999, C. Brooks personal communication). Because accuracy is variable and usually unknown when using GPS units, other navigational tools such as maps, compasses and altimeters should also be used to assess and improve accuracy while in the field.

The accuracy of GPS coordinates (100-300 feet) must be considered for each application. Generally, this means that GPS coordinates are sufficient to relocate large, easily recognizable features such as culverts, bridges or fish ladders, or smaller points that are in plain sight. GPS alone may not be suitable for relocating small features such as rebar cross section endpoints, benchmarks, photo-points or project area boundaries, especially in dense vegetation. Due to the relative inaccuracy of GPS coordinates, they should not be used to measure the dimensions of project features. For example, a bank stabilization treatment using boulders and willow plantings that is 750 feet long should be measured out using tape measures or a stringbox rather than using a GPS to estimate the distance between points.

To determine the usefulness of a coordinate position derived from a GPS unit an assessment of its accuracy should be conducted. The first step in obtaining accurate readings from a GPS unit is to set the datum used by the GPS to be the same as the map you are using in the field and then record the datum on the data sheet[1]. After setting the GPS to the appropriate datum, there are two ways to determine accuracy of GPS readings in the field. The preferred method is to:

1. Go to a known location on the topographic map such as a bridge or tributary junction
2. Obtain a GPS coordinate reading for that site
3. Plot the coordinates from the GPS unit on the map[2]
4. Measure the distance between the location of the plotted coordinates and the known location on the map, to obtain an estimate of the error.

[1]In order to use a GPS unit to plot coordinates on a topographic map, the GPS unit must use the same datum that the topographic map was created with. Topographic maps list the appropriate datum on the collar of the map, typically it is NAD27 or NAD83. The latter is the convention used by DFG.

[2] Methods used to plot coordinate locations on maps are described in Ferguson 1999.

Figure 4. Use of "Roamer" Scale on Compass and UTM Grid on Map to Determine Coordinates of Water Tank.
Note UTM grid printed onto map using the "print grid option" in the MapTech computer program. The "roamer" scale on the compass indicates that the water tank is 590 meters east of the 412000 grid line and 290 meters north of the 4466000 grid line, these values are added to the grid line values. The UTM coordinates of the water tank then are 412590mE and 4466290mN.

Another way to assess the relative accuracy of GPS coordinates without a map is to:

1. Record a waypoint at a recognizable feature
2. Navigate to the waypoint a short while later using the GPS unit's "Go-To" feature
3. Measure the distance between the waypoint location you navigated to and the feature's actual location as an estimate of the error

For either field check method, the distance between the re-located coordinate and the intended location should be evaluated relative to the accuracy needed in that application, i.e., can the GPS get someone else close enough to find the subject in the future? Also be aware that as satellite coverage changes throughout the day accuracy also changes. C. Brooks (personal communication) recommends using the "point averaging" function available in most GPS units to increase accuracy. That requires leaving the GPS unit in one place for 30 seconds or more so the GPS unit can average location estimates as satellite coverage changes.

When using a GPS to document the location of small or indistinct features the recommended method is to combine the GPS coordinates with compass and distance measurements (Ferguson 1999). The GPS unit should be used to record the location (waypoint) of a recognizable feature within 300 feet of the smaller target feature. The exact location of the target feature may then be recorded relative to the larger feature using a compass direction and distance from the larger feature. When relocating the target feature the GPS unit would be used to find the recognizable feature and then a compass and distance measuring device would be used to navigate to the target feature from the recognizable feature. Use of compasses and distance measuring devices is described below.

The coordinate system currently used by the Department of Fish and Game is latitude and longitude expressed in decimal degrees, e.g. 43.3564°. All coordinates should be recorded using decimal degrees with a maximum of 7 decimal places. Each degree of latitude spans approximately 69 miles, the first decimal gives a resolution of 6.9 miles, the second decimal 0.69 miles, the third decimal 364 feet, the fourth decimal 36 feet, and so on (Ferguson 1999). The distance spanned by a degree of longitude changes depending on the latitude of the location according to the following formula: distance per degree= 69 x cosine (latitude). At the equator a degree of longitude spans 69 miles, however, in Northern California at 40 degrees latitude a degree of longitude spans only 52.9 miles.

Although all location coordinates must eventually be recorded in decimal degrees for entry into the DFG database, users may find it easier to work with the Universal Transverse Mercator (UTM) system in the field to plot locations. The UTM system is easier to work with because:

- It is a grid system with a consistent scale (meters) in both the Northing and Easting directions, unlike latitude/longitude which is variable as described above.
- The UTM grid network has tighter spacing between reference lines when printed out on USGS topographic maps, making it easier to measure out coordinate locations on maps.
- Most mirrored compasses come with a UTM "roamer" scale that can be used to plot coordinate positions on 7.5 minute USGS topographic maps. "Roamers" of different scales are also available at survey supply stores.

A complete description of the various coordinate systems and how to plot locations using them is included in Ferguson (1999).

Use of a GPS unit is not required but it is a quick and convenient way to derive and find coordinate locations *if the accuracy has been verified in the field and is suitable for the particular task*.

Narrative Descriptions

Narrative descriptions are only required on the Site Access Form to provide driving directions to the project area. However, a verbal explanation of how to find a particular location may be a useful addition for complicated sites and may substitute for other methods in simple cases. Narrative descriptions should be concise as possible, but should include useful details. For example, if a tree is part of the description, include the species and diameter rather than just calling it a tree. Use cardinal directions (north, south, etc.) rather than right or left, to avoid confusion. In streams, the terms right bank, left bank, upstream and downstream are more easily interpreted than cardinal directions and should be used. A good example of a use for narrative directions would be for a foot trail to a restoration site, "follow foot trail downhill from DP001, at fork near 40 inch diameter madrone tree go right, project begins on south side of trail after crossing wooden footbridge."

Compasses and Distance Measuring Devices

Compasses and distance measuring devices are reliable tools that should be used in most location descriptions. The basic principle is to determine the distance and direction of travel between two points, known as "dead reckoning." The location of one of the points needs to be known, this is

called the reference point (RP). Any point that has already been described and has a high probability of being re-located can be used as a reference point. Multiple reference points may be used in a single project area.

A compass is used to determine the horizontal direction between the reference point and the point being navigated to. The direction between the two points is commonly called the "bearing" and is read off the compass after sighting between the two points. The azimuth system is used to record directions; these are the numbers between 0 and 360° that are printed on the rotating compass ring. The azimuth is recorded on the Onsite Navigation Form under the "Direction" column.

To obtain an accurate bearing the user must correctly set the declination on the compass. The correct declination is noted on each 7.5 minute USGS topographic map. If using a compass that does not allow for declination adjustment the readings obtained will be for "Magnetic North" rather than "True North."

A compass will normally be used to determine bearings between points on polygonal project features or to define project area boundaries. In some cases, it may be used to assist in navigating to project features that are isolated or not associated with a stream or road. As discussed below, it may also be used to define locations of permanent markers.

Distance between points can be measured using a variety of tools and should typically measure slope distance rather than horizontal distance. A tape measure is commonly used for relatively short distances, i.e., <300 feet. Rangefinders are better suited for long distances or to measure across un-wadeable streams (e.g. in winter). Rangefinders may use laser, ultrasonic, infrared or optical technology. Distance along a stream is best measured using a stringbox, while distance along a road can be measured using an odometer. The distance recorded for each feature along a road or stream should be the cumulative distance from the initial reference point, not the distance between features. As previously mentioned, distances may also be measured from a map of *accurately plotted sites*, however these horizontal distances will have to be slope corrected for use in the field.

Permanent Monuments

Affixing permanent monuments greatly increases the chances of correctly re-locating points in the field that are nondescript, small, or obscured by vegetation (now or in the future). Survey benchmarks, project coordinates, cross section endpoints, photo-points and reference points should all be monumented (Harrelson et al. 1994). Re-locating these points is essential to finding all of the other points and individual features in the project area. If it is not feasible to monument all individual project features, monument at least every fifth or tenth feature (two monumented features minimum) throughout the project area so that surveyors in the future can use these known points to re-locate the rest of the features. It is not necessary to monument large, obvious and unique points like buildings or concrete bridges on major roads, just describe them and record location coordinates.

During the pre-treatment phase when projects are being laid out for construction, flagging and/or wooden stakes are typically used to document project feature locations. Flagging and wooden stakes are sufficient to facilitate collection of pre-treatment data and photographs, but are not

considered permanent monuments, as they can only be expected to last 1-2 years. Permanent monuments should be installed after implementation when final locations are known. During return visits, the condition of permanent monuments should be noted and monuments should be replaced if necessary. Aluminum tags may corrode, rebar may be bent over, monuments may be vandalized or stolen, etc. Be prepared to replace missing or damaged components.

There are many methods used to establish permanent monuments. Landowners often have preferences or requirements regarding placement or types of monuments. For example in state parks brightly colored flagging or paint may not be used. Livestock owners typically do not like rebar driven in the ground, etc. Landowners should always be consulted regarding their preferences for use and placement of monuments. Where suitable, the following techniques are recommended for permanently marking sites:

- Affixing an aluminum tag to an existing, durable feature such as a large tree (>12 inches diameter), boulder, rock outcrop, etc. Epoxy should be used for rocks, aluminum nails for trees. Tags should not be nailed tightly to trees, 2-3 inches of nail should be exposed to allow for growth and nails should point slightly downward so the tag slides to head of nail.
- Driving a 3 foot length of 1/2 inch outside diameter rebar into the ground 2 to 2.5 feet deep. Cover the exposed rebar with a six foot length of white PVC pipe (1/2 inch inside diameter). Affix an aluminum tag. Alternately, (especially if livestock are present) a metal "t-post" should be driven into the ground upside down (so that its use as a marker is obvious).
- Tying brightly colored flagging to the marker and on nearby vegetation to aid in relocation. Aluminum tags, flagging, and PVC pipes should be inscribed with at least the point name, date installed and organization responsible. Other information may be added if necessary.

Provide a detailed description of each permanent marker including the type of marker and characteristics of the marker (diameter of tree and species, size of boulder, color of fencepost, etc.) on the Onsite Navigation Form. Provide information on the proximity of each permanent marker to permanent reference points. Record the distance and bearing of each permanent marker from one of these reference points so that reference markers affected by disturbances can be re-located in the future.

If it is not possible to place a permanent marker because of a high probability of disturbance (i.e., in-stream or landslide projects), relative locations should be documented using the "two-pin method" described in the DFG Restoration Manual (Flosi et al. 1998, Appendix L). This standard surveying technique establishes the feature location by triangulation from two monumented reference points that are out of the potential disturbance zone.

Site Access Form Instructions

General Information- section 1

1) **Contract #-** Enter in the contract number assigned to this project by the Department of Fish and Game.
2) **Contract Name-** Enter the name of the contract as written on the proposal.
3) **Page ___ of ____**- Number the page. For example, if this is page 2 out of 3 total pages, enter: Page 2 of 3.
4) **Stream/Road -** Enter in the name of the stream or road being treated. If unnamed, use the nearest named stream/road that it connects to. If site is not on a road or stream enter the name of the watershed as it is commonly known.
5) **Date-** Enter the date: *mm/dd/yy*
6) **Evaluation Crew-** Enter the names of the survey crew in the following format: *first initial*, *last name.* J. Doe
7) **Drainage -** Enter the name of the main drainage basin that the stream is a tributary to.
8) **USGS Quad(s):** Enter the name(s) of the 7.5 minute USGS quadrangles where the project is located.
9) **Legal Description:** Enter the Townships (T), Ranges (R), and Sections (S) where the project is located.

Contact Information for Project- section 2

1) **Name-** Enter the name of a contact person for each entity. (Landowner refers to the person or organization that owns the land on which the project is located. Lead agency refers to the agency providing funding or technical leadership for the project. Contractor refers to the person or organization that received the grant from the lead agency to carry out the work. Cons't crew refers to the operators and laborers that actually implemented the contract on the ground and Eval crew refers to the team of surveyors that conducted monitoring or assessment work at this location.)
2) **Affiliation-** Enter the name of the organization that each contact person works for or represents.
3) **Address-** Enter the address of the organization that each contact person works for or represents.
4) **Phone-** Enter the business telephone or cell phone number for each contact person.
5) **Email-** Enter the email address for each contact person.

Gates and Access- section 3

6) **Landowner permission required? -** Enter whether or not prior permission from the landowner (or road owners leading to the project) is required to access the project. If permission is needed from someone other than the landowner, enter the contact information for that person.
7) **Written or Verbal-** Circle whether written or verbal permission is required.
8) **Gate combo or key required? -** Enter the combination to any gates on the access road for this project, or note that a key is required and provide information on how to acquire the key.
9) **Comments-** Include any other logistical details regarding access to the site. For example, enter the hours that the road leading to project or the project area itself is open to access,

whether there are hostile neighbors or dogs, a significant walk in is required due to poor road condition, etc.

Driving Directions to Parking Site- section 4

9) **Driving Directions-** Record detailed driving directions to the parking site from which the project is accessed. Start driving directions at the nearest highway or major marked road, include: exit names, street names, directions to turn, distances in miles and tenths from the odometer in the vehicle, useful landmark descriptions, and a detailed description of the parking spot.

Parking Site Location – section 6

10) **Point Name-** Enter the name of the point using the two letter, three number naming convention. This will typically be a Departure Point e.g. DP001
11) **Waypoint -** Enter the waypoint name or number used in the GPS unit to mark this location.
12) **Latitude-** Enter the latitude displayed on the GPS unit in decimal degrees. If no GPS unit is available or unit does not function, measure the latitude on a map. In either case, record the method used.
13) **Longitude-** Enter the longitude displayed on the GPS unit in decimal degrees. If no GPS unit is available or unit does not function, measure the longitude on a map. In either case, record the method used.
14) **Description of Point-** Describe what the point is such as parking lot, dirt pull out, access to reach 3, etc. If a photo of the area would help in relocation, record photo information on PHOTO DESCRIPTION FORM.

Site Sketch- section 7

16) **Site Sketch-** Draw an overview of the entire project location if possible, including the parking spot (departure point), nearest named roads and project area. Include project features and other relevant points if possible. If the project is too large to sketch in this space attach a map showing relevant points, and just use the site sketch area to show the parking spot relative to the reference points used to access the rest of the project. The location of photo points should also be included on this sketch or attached map.

SITE ACCESS FORM

Page ___ of ___

Contract #: **Contract name:**

Stream/Road: **Date:** **Evaluation crew:**

Drainage: **USGS Quad(s):** **Legal Description: T R S**

ACCESS INFORMATION FOR SITE

Contact Information for Project

Entity	Name	Affiliation	Phone	Email
Landowner				
Lead Agency				
Contractor				
Cons't crew				
Eval crew				

Gates and Access

Landowner permission required?	Written or Verbal	Gate combo or key required?
Comments:		

DIRECTIONS TO SITE

Driving Directions to Parking Site and/or Departure Point (include landmarks, roads and distances)

Parking Site and/or Departure Point Location

Point name	Waypoint	Latitude	Longitude	Description of point

Sketch of Parking Site Relative to Work Site(s) and Major Roads

Onsite Navigation Form

General Information- section 1

1) **Contract #-** Enter in the contract number assigned to this project by the Department of Fish and Game.
2) **Contract Name-** Enter the name of the contract as written on the proposal.
3) **Page ___ of ____**- Number the page. For example, if this is page 2 out of 3 total pages, enter: Page 2 of 3.
4) **Stream/Road -** Enter in the name of the stream or road being treated. If unnamed, use the nearest named stream/road that it connects to. If site is not on a road or stream enter the name of the watershed as it is commonly known.
5) **Date-** Enter the date: *mm/dd/yy*
6) **Evaluation Crew-** Enter the names of the survey crew in the following format: *last name, first initial*.
7) **Compass Type-** Record whether your compass provides bearings based on "True North" or "Magnetic North" by circling the appropriate category. If your compass has the declination set use "True North," if your compass does not have a declination setting, use "Magnetic North."
8) **GPS Unit ID-** Enter the serial number or other identifying number for the GPS unit being used to determine locations on this project.
9) **Datum-** Record the datum used by the GPS unit you are using, e.g., NAD83 that corresponds to the map you are using in the field.

Point or Feature?- section 2

11) **Point Name-** Enter the name of the point used to denote this location as type followed by the point number (*letter letter # # #).* Assign point numbers sequentially *within* each point type category (e.g. DP001 (Departure Point 1); then PC001 (Project Coordinate 1); PC002 (Project Coordinate 2); and BM001 (Benchmark 1). Additional point types may be defined by the user as needed (e.g. location of redds could be recorded as RD001, RD002) and defined at the bottom of the data form.

12) **Project Feature #-** Assign individual project features numbers sequentially from downstream to upstream for in-stream projects and from beginning to endpoint on road projects. Use the *letter, letter # # #* naming convention (e.g. PF001, PF002, etc.). If unique numbers have already been assigned to extensive projects (e.g. large road road projects) those existing numbers could be used.

    To record the location of a project feature, record only Feature Number and leave Point Name blank. For points associated with particular features (for example, a cross section survey through an in-stream feature) the Point Name and Feature Number should both be filled in. For points not associated with a feature (such as the departure point) record Point Name but leave the Feature Number blank.

Directions to Point or Feature-section 3

14) **Reference Point-** The point name or feature number being used as the starting point for navigation to the subject point or feature. Typically an obvious landmark such as a

bridge, old growth tree, signpost, etc. Different reference points can be used throughout project as long as they are obvious, unmistakable and well marked.

15) **Distance to Point or Feature-** Enter the distance from the reference point to the current point or feature.
16) **Distance Units-** Record the units used in the distance measurement in either feet or miles. Generally, road projects will be recorded in miles and most other projects will use feet.
17) **Bearing to Point-** Enter the bearing to the current point from the reference point using the azimuth scale (0-360°). Note if your compass reads Magnetic North or True North at the top of the page.
18) **Narrative Directions-** If necessary and not redundant with bearing and distance, record directions to the point or feature using concise, specific written descriptions. Use cardinal directions (North, Northwest, etc.) rather than "right and left" in descriptions.

Description of Point or Feature-section 4

19) **Description of Point or Feature-** Describe the physical setting of the point and type of marker used with specific detail, such as tree species, rock size, fencepost color and type, slope angle, aspect, or nearby landmarks, (e.g. red metal fencepost, 15 inch dbh spruce, 4' diameter rock with rebar). Record GPS waypoint name assigned if applicable, and/or Latitude and Longitude readings in decimal degree format (D.DDDDDD).
20) **WP-** Record waypoint ID numbers in this space, it is easiest and least confusing to use the numbers assigned by the GPS unit.
21) **Photo of Site (frame number)-** If a photograph of the point or feature is taken to help future crews in relocation, record the frame number displayed on the camera for each photograph. Additional information for the photo, including the frame number, will still need to be recorded on the PHOTO DESCRIPTION FORM. Use of this column is intended to make correlating data between the two data forms easier.

ONSITE NAVIGATION FORM

Page ___ of ___

Contract #: **Contract name:**

Stream/Road: **Date:** **Evaluation crew:**

Compass Type (*circle***): True North** or **Magnetic North** **GPS Unit Number:** **Datum:**

Point OR Feature?		**Directions to Point or Feature**					**Description of Point or Feature**		Photo(s) taken **at** a point or **of** a feature? Frame #
		From	*Go*						
Point name (PT###)	Project Feature #	Reference Point	**Distance** to point or feature	Units: **ft** or **mi**	**Direction** to point or feature	Narrative Directions	Description of point or feature (include Lat/Long if no waypoint)	WP	

Point Types : PS Parking Site, **PC** Project Coordinate, **PF** Project Feature, **PP** Photo Point, **RP** Reference Point, **DP** Departure Point, **BA** Begin Access, **EA** End Access, **SR** Sample Reach, **EF** Electro Fish Reach, **TL** Temperature Logger**, BM** Benchmark, **XP** Cross section end point, **BS** Beginning of Survey, **ES** End Survey, - *Define other point types as needed:*

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