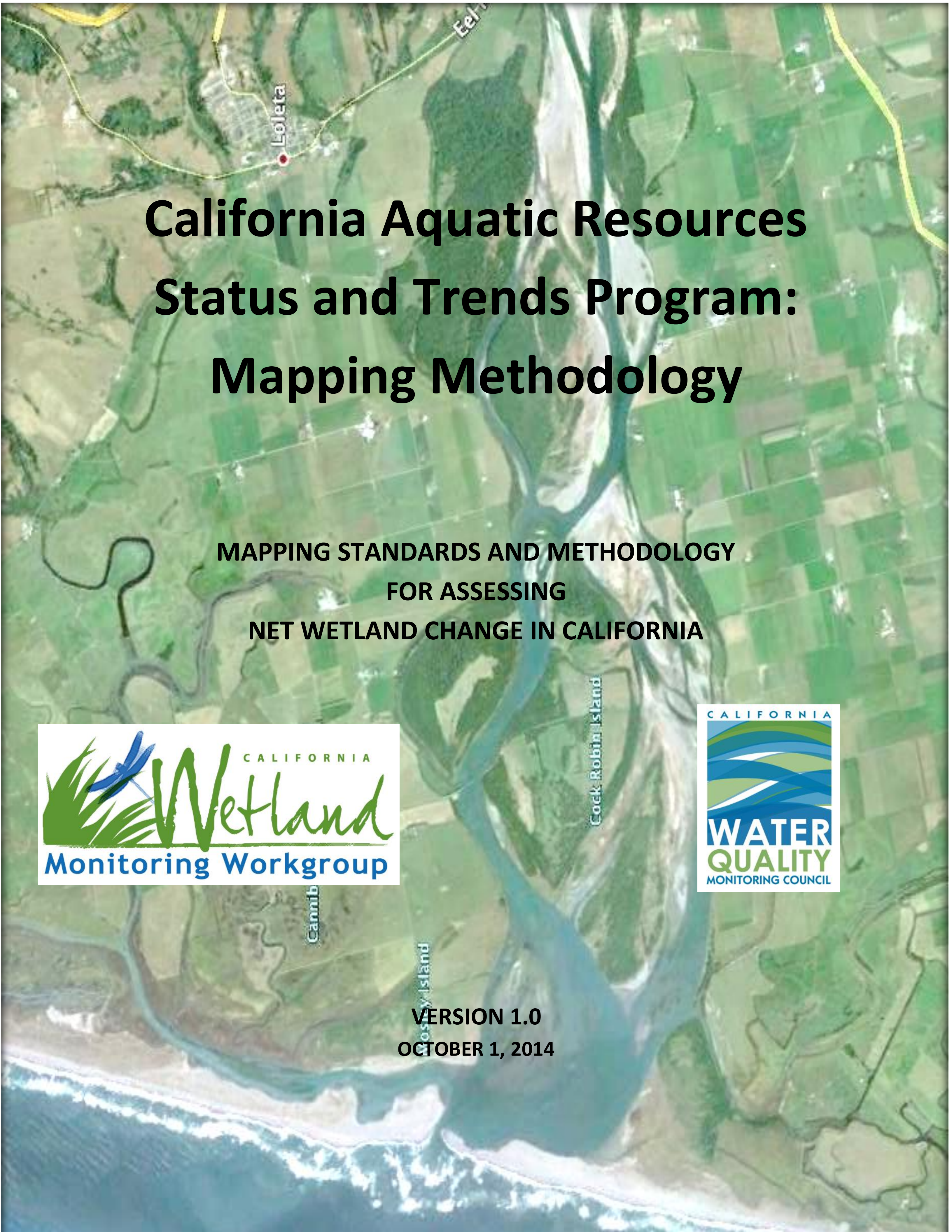

California Aquatic Resources Status and Trends Program: Mapping Methodology

MAPPING STANDARDS AND METHODOLOGY FOR ASSESSING NET WETLAND CHANGE IN CALIFORNIA

California Wetland Monitoring Workgroup

California Water Quality Monitoring Council

VERSION 1.0

OCTOBER 1, 2014

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PRODUCED BY SCCWRP, MLML, CSUN, AND SFEI-ASC[1]
FOR
THE CALIFORNIA WETLANDS MONITORING WORKGROUP

[1] Southern California Coastal Water Research Project (SCCWRP), Moss Landing Marine Laboratories (MLML), California State University, Northridge (CSUN), San Francisco Estuary Institute – Aquatic Science Center (SFEI-ASC)

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- Participating State Agencies
    - California Coastal Commission
    - California Department of Fish and Wildlife
    - California Department of Parks and Recreation
    - California Department of Water Resources
    - California Resources Agency
    - California State Lands Commission
    - Central Coast Regional Water Quality Control Board
    - Central Valley Regional Water Quality Control Board
    - Delta Conservancy
    - Los Angeles Regional Water Quality Control Board
    - San Diego Regional Water Quality Control Board
    - San Francisco Bay Regional Water Quality Control Board
    - Santa Ana Regional Water Quality Control Board
    - State Water Resources Control Board

- Participating Federal Agencies
    - National Oceanic and Atmospheric Administration, National Marine Fisheries Service
    - Natural Resources Conservation Service
    - US Army Corps of Engineers
    - US Environmental Protection Agency
    - US Fish and Wildlife Service
- Other Participating Agencies
    - Riparian Habitat Joint Venture
    - San Francisco Estuary Institute
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This report was funded wholly or in part by the US Environmental Protection Agency as part of a project under Grant Agreement # 00T83201 to the Southern California Coastal Water Research Project. The contents of this report do not necessarily reflect the views and policies of the US Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use

Please cite this document using the following citation:
California Wetland Monitoring Workgroup (CWMW) 2014. *California Aquatic Resources Status and Trends Program Mapping Methodology.*

LIST OF ACRONYMS

CARI – California Aquatic Resource Inventory
CDFW – California Department of Fish and Wildlife
CMECS – Coastal and Marine Ecological Classification Standard
CRAM – California Rapid Assessment Method
CSUN – California State University, Northridge
CUSP – Continually Updated Shoreline Product
CWMW - California Wetlands Monitoring Workgroup
DEM – Digital Elevation Model
DRG – Digital Raster Graphic
EPA – Environmental Protection Agency
FGDC – Federal Geographic Data Committee
GCS - Geographic Coordinate System
GIS – Geographic Information System
GRTS – Generalized Random Tessellation Stratified
LIDAR – Light Detection and Ranging
MLML – Moss Landing Marine Laboratories
NAIP – National Agriculture Imagery Program
NAD – North American 1983 Datum
NED – National Elevation Dataset
NOAA – National Oceanographic and Atmospheric Administration
NWI – National Wetland Inventory
OHW – Ordinary High Waterline
OW – Open Water (Hydrogeomorphology Major Class)
QA/QC – Quality Assurance/Quality Control
S&T – Wetland Status and Trends
SCCWRP – Southern California Coastal Water Research Project
SFEI-ASC – San Francisco Estuary Institute – Aquatic Science Center
SOP – Standard Operating Procedures
USDA – US Department of Agriculture
USEPA – US Environmental Protection Agency
USFWS – US Fish and Wildlife Service
USGS – US Geological Survey
VegCAMP – Vegetation Classification and Mapping Program
WRAMP – Wetland and Riparian Area Monitoring Plan

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1.0 BACKGROUND AND PURPOSE

The ability to track changes in wetland area is a foundational element of California's wetland monitoring and assessment programs. It not only provides the basic information to report on wetland status and trends over time, but is also crucial for accurately assessing the Federal and State "no net loss" policies in terms of wetland quantity and evaluating the effectiveness of current regulatory and management programs (e.g., Porter-Cologne Water Quality Control Act, Clean Water Act §401, CA Fish and Wildlife Code §1600). Furthermore, monitoring trends and tracking net change provide a foundation for monitoring the long-term effects of climate change and other natural disturbances (e.g., fires, floods, and droughts) on wetland resources, and the effect of these trends on habitat and species conservation efforts.

Developing an agreed upon approach for assessing wetland gains and losses using a combination of ambient surveys and project tracking is a necessary first step to better our capacity to answer fundamental management questions. Complete survey mapping of a state the size of California on a regular basis is cost prohibitive and logistically challenging. A cost estimate to update mapping of streams and other aquatic resources is $3,000 per USGS quadrangle, and California has 2,800 quadrangles (CWMW 2010)[2]. Not only does the state of California lack the $8.5 million for comprehensively mapping, but this cost would need to be incurred every 5 to 10 years in order to assess change over time. The National Wetland Status and Trends (S&T) Program (administered by US Fish and Wildlife Service (USFWS)) has addressed this challenge by adopting a probabilistic approach to wetland change assessment. Probabilistic mapping provides a method to produce extent and trend information in a practical, cost-effective manner. Because probability-based mapping requires significantly fewer resources, it allows for more frequent production of maps and extent and trend estimates. These probabilistically-selected maps will serve as updates to the California Aquatic Resources Inventory (CARI), a standardized statewide map of wetlands, streams, and riparian areas that is used for Level-1 landscape assessment. The maps can also serve as a sample frame to support Level-2 or -3 condition assessments if locations for condition assessment are selected from the status and trends plots.

Although sufficient for a national assessment, the National S&T plots by themselves are insufficient for assessing status and trends of California's wetland and riparian resources. The US Fish and Wildlife Service (USFWS) National S&T Program includes only 257 plots in California, covering approximately 0.6% of the land area, mostly concentrated along the coast. Furthermore the national program does not include streams, and is based on older vintage National Wetlands Inventory maps that omit many of the wetland and riparian areas of California.

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[2] http://www.mywaterquality.ca.gov/monitoring_council/wetland_workgroup/docs/2010/tenetsprogram.pdf.

Previous US Environmental Protection Agency (USEPA) funding supported development of the first phase of a status and trends program for California. That effort evaluated other Federal and State programs, identified key technical challenges for S&T implementation in California, and used a model-based approach to test various design alternatives. The Phase 1 effort produced a set of recommendations for optimum plot allocation, plot size, and stratification, and tested the design in a limited geographic area. These analysis conducted during Phase 1 of this project resulted in a recommendation that S&T plots be 4 km^2 in size (2 km x 2 km) and that mapping for each plot include all elements within sample plots, including aquatic resources and upland land use. This will provide information about proximal anthropogenic influences and impacts on wetlands and aquatic resources and allow other programs to take advantage of the plots to fulfill part of their programmatic needs.

Although all natural and anthropogenic resources within each plot will be mapped, the main focus and intensity will be devoted to the aquatic resources. Unlike other programs, ***the California S&T program includes wetlands and streams*** (regardless of whether or not the streams include wetland areas). Standard procedures and quality assurance measures will help minimize mapping and interpretation errors, which in turn will maximize the confidence and reliability of the mapping results.

The purpose of this document is to describe the mapping standards and methods[3] that should be applied when mapping ***wetlands and other aquatic resources*** (e.g., lakes, streams) within the California Status and Trends (S&T) plots. This document provides only minimal guidance pertaining to the upland and developed portions of the S&T plots, as they relate to interpreting changes in aquatic resources. Additional protocols would need to be developed, consulted and/or applied for programs that need detailed information about upland resources.

1.1 Status and Trends in Context of Other Mapping Programs

The Status and Trends program (S&T) is part of Level-1 or remote sensing/landscape-level assessment of wetland health. The main goal of Level 1 assessments is to answer the question "*Where are the wetlands?*" Level-1 assessments are foundational element of the state's overall Wetland and Riparian Areas Monitoring Plan (WRAMP)[4]. Other components of Level 1 include comprehensive mapping, wetland restoration project tracking, and riparian area modeling.

[3] S&T standards were adapted from CARI, the California Aquatic Resource Inventory.

[4] For more information on the Wetland and Riparian Areas Monitoring Plan please visit http://www.waterboards.ca.gov/water_issues/programs/cwa401/wrapp.shtml.

The S&T mapping methods are derived from the California Aquatic Resource Inventory (CARI) standard mapping protocols. Consistency with CARI standards and protocols facilitates integration of data developed through the S&T program back into the statewide comprehensive mapping effort. However, due to the requirements of the S&T program to maintain a statistically sound protocol some mapping procedures have deviated from the CARI SOP. In most cases these are minor changes and do not eliminate the ability of S&T mapping to be integrated into CARI. These limitations are laid out below.

1. The S&T program uses standardized datasets across mapping teams and spatial extents regardless of availability of additional data. This is to ensure the mapping product can be statistically compared across both mappers and extents. In contrast, the CARI SOP calls for using the most accurate data available to determine aquatic resource absence or presence and type in order to ensure the accuracy of each data feature. This is any data beyond the minimum requirements and can include light detection and ranging (LiDAR) imagery, higher-resolution or more recent imagery, or local data and/or knowledge. The use of additional data can increase variability among plots/locations and complicates the assessment of potential error across mappers. Low inter-mapper variability is necessary to maximize the ability to detect change and to increase the likelihood that changes in mapping over time are due to actual changes in aquatic resources and not due to differences in available information, data interpretation, or mapping procedures.

2. Due to the particular uses for each effort, the classification used by S&T is more general than what is available in CARI. The S&T's goal is to understand the change in extent of aquatic resources across the state using a probabilistic sample design; therefore, standardization of what these resources are called across ecoregions is necessary. Additionally, this program is meant to be a cost-savings approach to understanding statewide resource extent which requires the program to take a more general approach in classification so that it can be applied confidently statewide. Conversely, CARI is a comprehensive mapping effort that has more flexibility to focus on the regional needs of an aquatic resource map and can include more detailed classification of wetland types. Nevertheless, the CARI and S&T classifications are compatible and can be cross-walked or nested to allow assessments to occur across programs (see Appendix A).

2.0 STATUS AND TRENDS STUDY AREA AND SAMPLING DESIGN

The California S&T program covers the entire State of California (Figure 1). Approximately 2,000 4-km^2 plots will be selected using a spatially balanced, fully randomized method with no stratification and mapped over a five year rotating cycle. Offshore islands within State waters and interior open water bodies (e.g., San Francisco Bay, Salton Sea, and Lake Tahoe) will be included in the sample frame. Regional intensifications may result in additional plots being added to selected regions based on local priorities and available resources. Plots adjacent to the state boundaries or the coast will be clipped to the state border and may be less than 4 km^2 in size. These plots will be assigned a proportional weighting based on the area that is within California. All features within the plots should be mapped, including streams, wetlands, upland natural areas, upland developed, roads, and agriculture. For more information on plot size and selection see *study design* document (Stein and Lackey 2012)[5]

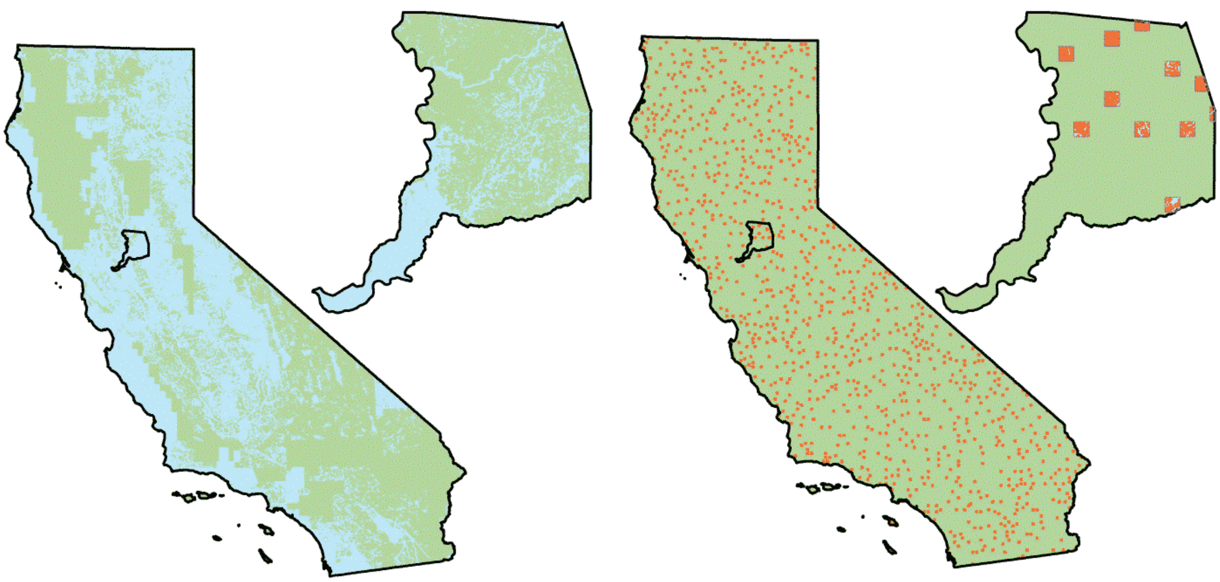

Figure 1. Examples of comprehensive (left, blue) and probabilistic mapping (right, orange) for California with a Sacramento county detail (from Stein and Lackey 2012).

[5] Stein, E.D. and L.G. Lackey. 2012. Technical Design for a Status & Trends Monitoring Program to Evaluate Extent and Distribution of Aquatic Resources in California. Southern California Coastal Water Research Project, Technical Report #706. (http://www.sccwrp.org/Documents/TechnicalReports.aspx)

3.0 Mapping Standards

Mapping standards were adapted from CARI methodologies. Procedures for line and polygon mapping are largely consistent between CARI and S&T; however, there are differences in data sources and classification (as described above). These adaptations were performed to ensure consistency across mappers, throughout the mapping extent, and in future mapping efforts. Mapping methods should have as little subjectivity as possible and be based on standard work flows and datasets. Any dataset used should be comparable and consistent across the state and potentially be available in an updated vintage for future mapping efforts.

3.1 Classification System

The S&T program is designed to produce estimates of extent and change in the overall area of aquatic resources and based on major class of aquatic resources. The classification system consists of required and optional elements and is divided into wetland classification and wetland modifiers (Table 1). Required elements describe the hydrogeomorphology of a polygon and are used to categorize areas as wetland, open water, or upland, and into primary CRAM classes (i.e., riverine, depressional, lacustrine, estuarine, slope). Optional elements provide more detail on the landscape setting and are used for locally intensive and detailed assessments. Modifiers are intended to provide additional information about features that may affect wetlands and be helpful in interpreting change over time.

Table1. Required vs. optional classification components and modifiers.

	Required	**Optional**
Classification	Major class Class Type	Subtype
Modifiers	*Anthropogenic Influence* *Vegetation*	*Hydrology*

The S&T classification system is consistent with CARI at the major class and class level, is hierarchical, and is based on the dominant hydrology of the system, rather than the vegetation community, although vegetation supports the classification decision (Table 2). Each classification category is mutually exclusive and polygons should be assigned to only one class, but may have many modifiers. Polygons can be classified using remote sensed information (as described in Section 3.4) with limited ground-truthing to ensure accuracy

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Table 2. Required and optional hydrogeomorphology and landscape connection classification categories.

Hydrogeomorphology		***Landscape Connection***	
Major Class (Required)	***Class (Required)***	***Type (Required)***	***Subtype (Optional)***
Open Water (O)	Lacustrine (L)		
	Riverine (R)	Confined (c)	
		Unconfined (u)	
	Estuarine (E)	Lagoon/Dune Strand (l)	
		Bar Built Estuary (r)	Tidal Channels (a)
		Open Embayment (b)	Tidal Basin (c)
	Marine (M)	Intertidal (i)	Embayment (e)
			Exposed Shoreline (s)
		Subtidal (s)	Embayment (e)
			Exposed Shoreline (s)
Wetland (W)	Depression (D)	Depression, Other (d)	Defined Outlet (d)
			Undefined Outlet (u)
		Vernal Pool Complex (v)	
		Playa (p)	
	Lacustrine (L)		
	Slope (S)	Wet Meadow (w)	
		Forested Slope (f)	
		Slope, Other (s)	
	Riverine (R)	Confined (c)	
		Unconfined (u)	
	Estuarine (E)	Lagoon/Dune Strand (l)	
		Bar Built Estuary (r)	
		Open Embayment (b)	
Upland (U)	See Upland Categories		

Modifiers should be assigned to polygons in order to describe factors that may influence condition or change over time (Tables 3 through 5). The anthropogenic influence and vegetation modifiers (Tables 3 and 4) can be applied remotely and are required for the S&T program. The final element, hydrology modifiers, is optional (Table 5). Hydrology modifiers can be applied based on remote data, but typically require field confirmation.

Table 3. Required anthropogenic influence modifiers.

Anthropogenic Influence (Required)	
Class	**Type**
Whole System	Natural/No Apparent Modification (0) Modified (1) Remnant (2) Restoration (3)
Water Source/Hydroperiod	Agricultural Runoff (a) Constrained/Impounded (b) Diked (c) Ditched/Drained (d) Diverted (e) Infiltration (f) Wastewater Treatment Pond (x) Treatment Wetland (y) Stormwater Control (g) Urban Runoff (h)
Substrate and Bank	Armored (i) Excavated (j) Filled/Graded (k) Marine Control Structures (l) Realigned (m)
Agriculture or Other Use	Agricultural Storage Ponds (sp) Aquaculture (n) Flooded Agriculture (o) Flood Irrigation (p) Harbors/Marinas/Ports (q) Orchards (r) Ranchland (s) Rangeland (t) Recreation (u) Row or Sown Agriculture (v) Managed Hunting (w) Silviculture (z)

Table 4. Required vegetation modifiers.

Vegetation Modifier (Required)	
Class	**Type**
Non-vegetated	Shallow Open Water (SOW) Unvegetated Channel Bed/Mud/Sand/Salt Flat (FLT)
Aquatic Vegetation	Algae (AL) Floating (FL) Submerged (SU) Emergent (EM)
Transitional Vegetation	Forested (FO) Scrub-shrub (SS) Herbaceous/Grass (HE) Mixed (MI)
Naturally Disturbed	Scour (NSC) Slides (NSL) Fire (NFR)

Table 5. Optional hydrology modifiers.

Hydrology Modifiers (Optional)	
Class	**Type**
Tidal	Regularly Tidal (T1) Seasonally Tidal (T2) Irregularly Tidal (T3)
Flowing	Perennially Flowing (F1) Seasonally Flowing (F2) Ephemeral (F3)
Inundation	Perennially Flooded (I1) Seasonally Flooded (I2) Temporarily Flooded (I3)
Saturation	Perennially Saturated (S1) Seasonally Saturated (S2) Temporarily Saturated (3S)

Upland portions of the S&T plots should be mapped and assigned basic categories based on land use or land cover (Table 6). These categories are based on the basic classification used by the US Geological Survey/US Environmental Protection Agency (USGS/USEPA) National Land Cover Database system (http://www.epa.gov/mrlc/definitions.html) and the NOAA Coastal Change Assessment Program (http://www.csc.noaa.gov/digitalcoast).

Table 6. Required upland categories.

Upland Categories (Required)
Class
Beach and dune (BD)
Developed (DEV)
Developed, Open Space/Recreation (DOS)
Cultivated Crops (CC)
Pasture, Rangeland, Ranchland (PRR)
Flooded agriculture (FLA)
Grassland/Herbaceous (GRS)
Forest (FST)
Rock Outcrop (RKO)
Ruderal/Barren (RUD)
Scrub/shrub (SSH)
Undeveloped Urban Open Space (UOS)
Roads (RDS)

The classification system can be cross-walked to Coastal and Marine Ecological Classification Standard (CMECS)[6] and the Cowardin (1979)[7] classification system at the higher levels. Although consistent with current and emerging wetland definitions, ***the mapping does not constitute a jurisdictional determination***.

3.1.1 Definitions of Hydrogeomorphology Major Class (Required)

Open Water (OW): Includes all marine systems and non-marine systems with area greater than 8 ha[8] and average depth greater than 2 m (estimated), during the growing season, or greater than the maximum depth from which rooted vascular vegetation grows to the water surface,

[6] www.csc.noaa.gov/digitalcoast/publications/cmecs

[7] www.npwrc.usgs.gov/resource/wetlands/classwet/index.htm

[8] The 8-ha depth limit is used mainly for lentic (ponded) water bodies, such as lagoons and lakes. For riverine systems, the emphasis is mainly on water depth and not on the accumulation of 8 ha of area along the linear axis of a river/stream.

whichever is deeper. Open water is characterized by a lack of vegetation. Areas that are temporarily inundated by deep water can be wetlands if such inundation does not persist throughout most of the growing season. Tidal channels and basins that are permanently inundated can be classified as *open water*.

Wetlands (W): Under normal circumstances, a wetland 1) is saturated by groundwater or inundated by shallow surface water for duration sufficient to cause anaerobic conditions within the upper substrate; 2) exhibits hydric substrate conditions indicative of such hydrology; and 3) either lacks vegetation or the vegetation is dominated by hydrophytes.

Upland (U): All developed and natural terrestrial areas that are not open water or wetland.

3.1.2 Definitions of Hydrogeomorphology Class (Required)

Depression (D): closed basin hydrology in topographic lows with no or variable inlets and outlets. System does not include a non-wetland open water portion (greater than 8 ha in area and 2 m in depth), and may lack outgoing surface drainage except during flood events or heavy rainfall. Dominant water sources include precipitation and groundwater discharge from shallow saturated zones, nearby streams, springs, or pumps. Wetland can fill via surface or subsurface routes. Main loss mechanisms are evapotranspiration and/or infiltration. Examples of depressional wetlands include vernal pools, stock ponds, wildlife enhancement ponds, duck ponds, golf course water features, and stormwater treatment ponds. Depressional wetlands also include playas, if they meet the size and depth criteria. Many are seasonal and some lack ponding or saturated conditions during dry years. This class designation is used for W major class.

Estuarine (E): defined by the physical mixing of saltwater and freshwater. Typically has a bidirectional flow (typically tidal) hydroperiod. Often involves wetting and drying during different phases of the hydroperiod, and may be saline or hypersaline, with minimal freshwater influence, or saline with a strong freshwater influence. System is fully or partially tidal for at least one month during most years. Tidal fluctuations may be fully natural or muted due to tide gates, weirs, etc., and includes sub-tidal and intertidal environments. The boundary between estuarine and marine is the mean high tide line as demarcated in the (NOAA) Continually Updated Shoreline (CUSP) Product. The boundary between estuarine and riverine should be demarcated based on observed changes in vegetation, topography or elevation, or apparent extent of ponding (e.g., inland limit of tidal vegetation or tidal flat areas). The presence of water control structures (e.g., levees or tide gates) that prevent tidal access from an area can cause it to longer be considered estuarine (for example, areas below mean tide level but isolated by levees may be depressional wetlands vs. estuarine). ***The entire San Francisco Bay Delta is estuarine up to the legal limits of the Delta boundary.*** For bar-built estuaries the typical high water line should be used to inform the location of the boundary of the estuary. Tidal channels that do not dewater at low tide or are wider than 30 m are not part of the estuarine wetland and would be classified as Open Water, Marine. This class designation is used for both OW and W major class.

Lacustrine (L): closed basin hydrology including a non-wetland open water portion (greater than 8 ha in area and 2 m in depth). Areas that are perennially inundated and appear to be greater than 2 m deep should be mapped as *Open Water Lacustrine,* while the adjacent areas should be mapped as *Wetland Lacustrine*. Lacustrine wetlands may or may not be prone to seasonal drying under natural hydrologic regime. The boundary of the lacustrine wetland should be considered the approximate ordinary high waterline (OHW). This class designation is used for both OW and W major class.

Marine (M): strongly influenced by bidirectional (typically tidal) hydroperiod. Involves wetting and drying during different phases of the hydroperiod. Saline without strong freshwater influence. Includes sub-tidal and intertidal environments. The boundary between estuarine and marine is the mean high tide line as demarcated in the (NOAA) Continually Updated Shoreline (CUSP) Product. This class designation is used for the OW major class.

Riverine (R): defined by unidirectional flow, but may be tidal (with bi-directional flow) in the lowest geographical reaches in a watershed; not subject to mixing of freshwater and saltwater. Includes channel, active floodplain, and portions of adjacent areas likely to be strongly linked to channel or floodplain through bank stabilization and allochthonous inputs. Active floodplain refers to periodically flooded area adjacent to and slightly above the active flow zone and can be vegetated or non-vegetated. This class designation is used for both OW and W major class.

Slope (S): form due to seasonal or perennial emergence of groundwater into root zone. Hydroperiod mainly controlled by unidirectional subsurface flow. Slope wetlands are distinguished from depressional wetlands by having predominantly flow-through hydrology vs. a closed basin. Slope wetlands often exhibit strong dominance by groundwater flow or discharge, although many slope wetlands demonstrate abundant over-surface flow. Wet meadows are examples of slope wetlands. If surface water moves through a well-defined channel within a slope wetland, classify it as a riverine wetland with slope wetlands adjacent to it. This class designation is used for the Wetland major class.

3.1.3 Definitions of Landscape Connection Type (Required)

The landscape connection categories are not used for statistical reporting of status and trends but are recommended when additional detail is needed on wetland typology. Landscape connection may also be important for local intensifications and for more detailed interpretation of wetland plots.

3.1.3.1 DEPRESSION

Vernal Pool Complex (v): a special kind of seasonal depressional wetland having bedrock or an impervious soil horizon close to the surface and supporting a unique vernal pool flora. These depressions fill with rainwater and runoff from small catchment areas during the winter and may remain inundated until spring or early summer, sometimes filling and emptying repeatedly during the wet season. Water can move between adjacent pools and swales through the thin soils above the underlying impervious substrate. Vernal pools often occur together with vernal swales as vernal pool systems or complexes that have many pools of various sizes and shapes.

Vernal pool complexes rather than individual vernal pools will be mapped. The maps of vernal pool complexes will therefore include the intervening non-wetland matrix that is an integral component of the overall system. Clues for identifying possible vernal pool complexes, include:

- Nearly horizontal and flat topographic slope or gently sloping undulating lands with multiple depressions of generally equal size and shape having no obvious or only partial hydrological connection as viewed in NAIP imagery (i.e., land surface resembles golf ball surface);
- Nearly horizontal and flat topographic slope or gently sloping undulating lands with multiple swales that are anastomosing (interconnected) or not, very shallow (seldom deeper than 1-2 feet), much wider than deep, and mostly vegetated from side-to-side and along their length during spring. These swales may comprise the headward reaches of riverine drainage networks but generally lack the capacity to transport bedload due to their very gradual slope, although water may flow through then during storm events (hence the vegetated condition during spring).

Playa (p): are nearly level, shallow, ephemeral (seasonal) or perennial, or saline water bodies with very fine grain sediments of clays and silts. Unlike vernal pools, playas have little or no vascular vegetation within the limits of the waterbody, though they often support sparse l vegetation along the margins. Playas can have open water/unvegetated areas and vegetated areas without standing water. Unlike lacustrine wetlands, playas are less than 2m deep during the dry season, although they can be hundreds of ha in size.

Depression, Other (d): all other depressional wetlands that do not meet the criteria as vernal pool complexes or playas should be mapped as Depression, other.

3.1.3.2 ESTUARINE

Lagoon/Dune strand (l): impoundments of water subject to at least occasional or sporadic connection to full or muted tidal action. They can occur naturally due to barrier beaches or dunes or due to modification through levees and tide gates. Typically they have limited fluvial input and may be cut off from a larger estuarine system for significant portions of the year. As a result, the water level may be above or below the adjacent estuary. Lagoons are not classified as Bar-Built Estuaries (which are subject to direct tidal action much more frequently and exhibit a much stronger fluvial influence).

Bar-built Estuary (r): are the terminus of coastal rivers and streams that are ecologically influenced by seasonal closures of their tidal inlets. The frequency and duration of inlet closure can be natural or managed. The tidal regime can be muted or not (i.e., the tidal range can be the same or less than that of the adjacent marine or estuarine system when the tidal inlet is open). The salinity regime of a bar-built estuary can be highly variable. It can be fresh throughout very wet years or hypersaline during extended droughts. The inland extent of Bar-built estuaries are mapped to the upstream (landward) limit of tidal vegetation or tidal flat combined with the downstream limit of the adjoining fluvial channel, as evidenced by a change in channel-side vegetation or channel plan-form (i.e., sudden increase or decrease in channel width and/or sinuosity).

Open Embayment (b): estuarine area formed by an indentation of the shoreline and/or located in a pre-existing valley or canyon. Typically these estuaries will be perennially or nearly-perennially open and exposed to the tides, differentiating them from lagoons or bar-built estuaries. The open and perennial tidal connection can be the result of either the natural structure of the system or anthropogenic structures such as jetties or hardened river mouth outlets. ***The San Francisco-Bay Delta is generally considered an open embayment***.

3.1.3.3 LACUSTRINE

No additional types have been identified for lacustrine systems.

3.1.3.4 MARINE

Intertidal (i): linear portion of shoreline covered by the great diurnal range (GT) as defined by the National Oceanic and Atmospheric Association (the difference in height between mean higher high water and mean lower low water, the averages for each tidal day observed over the National Tidal Datum Epoch or derived equivalent, created by comparison of simultaneous observations with a control tide station).

Subtidal (s): marine system below mean lower low water (see *intertidal*).

3.1.3.5 RIVERINE

Confined (c): width, across which the active channel within the system can migrate without encountering a hillside, terrace, man-made levee, or urban development, is less than twice channel width or the channel has artificial levees or urban development preventing its migration. Entrenchment is not a consideration. The entire system comprised of the active channel(s) and adjacent wetland or riparian habitat should be mapped as confined.

Unconfined (u): width across which the active channel can migrate (within the floodplain) without encountering a hillside, terrace, man-made levee, or urban development is more than twice the average bankfull width and unrelated to channel entrenchment. The entire system comprised of the active channel(s) and adjacent wetland or riparian habitat should be mapped as unconfined. *Alluvial fans* are specific type of Riverine, Unconfined aquatic resource identifiable as a triangle- or fan-shaped deposit of gravel, sand and sediment created as flowing water drains from mountainous terrain and emerges onto a flatter plain. Often found in deserts.

3.1.3.6 SLOPE

Wet Meadow (w): are non-forested slope wetlands greater than 0.2 ha in size that support less than 30% cover of tall woody shrubs or trees as evidenced in aerial imagery or any available vegetation dataset. Typically, they are dominated by herbaceous/grass cover or small shrubs. They can include small areas (inclusions) within the slope feature with greater than 30% cover of tall woody shrubs or trees that if they are smaller than 0.2 ha.

Forested Slope (f): are slope wetlands larger than 0.2 ha that form due to a seasonal or perennial emergence of groundwater into the root zone and in some cases onto the ground surface. Forested Slope Wetlands also support more than 30% cover of tall woody vegetation, as evidenced in aerial imagery, or any available vegetation dataset. These wetlands can adjoin non-forested slope wetlands (i.e., wet meadows). Forested Slope Wetlands can also include small areas (inclusions) within the slope feature with less than 30% woody cover (i.e., non-forested slope wetlands) if they are smaller than 0.2 ha.

Slope, Other (ss): all other slope wetlands that do not meet the criteria as wet meadow or forested slope should be mapped as Slope, other.

3.1.4 DEFINITIONS OF LANDSCAPE CONNECTION, SUBTYPE (Optional)

Optional subtype classes are only provided for estuarine, marine and depressional wetland classes.

3.1.4.1 DEPRESSION

Defined outlet (d): system has one or more apparent surface connections to other surface water features such as intermittent streams. Defined outlets function to limit system water level and residence time, particularly during or after precipitation events

Undefined outlet (u): system lacks apparent connections to surface stream channels that could limit water levels during or after precipitation events.

3.1.4.2 ESTUARINE

Tidal Basin (c): an estuarine subtidal open water feature nested in an intertidal wetland feature that is greater than 8 ha in size. These are features that do not drain at low tide within an intertidal environment and are primarily saltwater.

Tidal Channel (a): channel defined by bidirectional flow subject to mixing of freshwater and saltwater. Fully tidal for at least 11 month during most years. Includes all channelized area including areas which are open water during low tide. These channels must be greater than 30 m wide to be mapped.

3.1.4.3 MARINE

Embayment (e): concave portion of shoreline forming a semi-enclosed indentation, recess, or arm of the ocean into the land or be between two capes or headlands. The indentation must be greater than a 1 to 4 depth to width ratio. An embayment often appears as a crescent shaped coastal configuration of land.

Exposed shoreline (s): relatively straight or convex (bending seaward) shorelines that are fully exposed to the waves and currents of the open ocean. Could also include relatively straight portions of shoreline with a manmade structure, such as a breakwater or jetty, to artificially decrease wave action or erosion.

3.1.5 MODIFIERS

Modifiers provide additional information about the state of the resource being mapped. Can be applied to any aquatic support area, open water, or wetland. Vegetation and anthropogenic influence can be applied remotely while water regime and substrate should be applied based on field information. Vegetation can be expanded through use of the California Department of Fish and Wildlife Service (CDFW) Vegetation Classification and Mapping Program (VegCAMP) if the necessary information is available and mapping and classification expertise exists.

3.1.5.1 VEGETATION

Broadly classifies the dominant vegetation or lack of vegetation. Multiple modifiers can be used but each modifier should apply to at least 20% of the considered area before it can be included.

A. *Non-Vegetated*

   Shallow Open Water (SOW): less than 2 m deep less than 10% standing water contains apparent vegetation.

   Unvegetated Channel Bed/Mud/Sand/Salt Flat (FLT): less than 10% of the terrain is contains vascular vegetation and the area is not submerged. Includes channel beds with less than 10% vegetation cover.

B. *Aquatic Vegetation*

   Emergent (EM): vegetation is rooted below water surface and emerges above water level.

Floating (FL): vegetation is rooted below water surface, or is non-rooted, and is evident as a layer on water surface.

Submerged (SU): vegetation is rooted below water surface and does not emerge above water level.

Algal (AL): floating or submerged vegetation lacking true stems, roots, leaves and vascular tissue.

C. *Transitional vegetation*

Forested (FO): vegetation has at least 15% canopy cover of woody plant species greater than 3 m in height.

Scrub-shrub (SS): vegetation has at least 15% canopy cover of woody plant species less than 3 m in height, and not more than 15% canopy cover of trees > 3 m in height.

Herbaceous/Grass (HE): vegetation has a least 15% cover of non-woody vegetation, and not more than 10% cover of woody vegetation. Should not be used for *emergent* vegetation.

Mixed (MI): terrain is relatively even mix of vegetation types with greater than 15% cover of multiple vegetation types.

D. *Naturally Disturbed*

Scour (NSC): areas where vegetation and physical structure have been altered/removed due to apparent high flow events, such as floods or debris flows

Slides (NSL): areas where vegetation and physical structure have been altered/removed due to large, episodic land movements, such as landslides, sloughing, mass wasting, etc.

Fire (NSF): areas where vegetation has been altered/removed due to relatively recent wildfire.

3.1.5.2 ANTHROPOGENIC INFLUENCE

Use to describe an observed or apparent anthropogenic influence on the system due to land use or management actions. Influence can be intentional or unintentional, historical or current, etc., as long as the influence is still apparently visible on the imagery. This category includes a modifier for natural disturbances, such as floods or fires that may also affect the system.

A. *Influences on the Whole System:*

Natural (O): use this modifier if there are no anthropogenic influences or modifications to the system.

Modified (1): used when another modifier does not apply but there is obvious evidence of anthropogenic influence.

Remnant (2): the current aquatic resource existed prior to establishment of an immediately adjacent anthropogenic disturbance, such as urban development or agriculture. Present resource boundaries could be smaller than historical.

Restoration (3): wetland or stream has been altered to support deliberate restoration or enhancement activities, including recontouring, grading, or vegetation management.

B. *Influences on Water Source and Hydroperiod*

Agricultural Runoff (a): water source is dominated by an artificially increased input of agricultural runoff — typically escaped or unused irrigation water.

Constrained/Impounded (b): modified by a man-made barrier that obstructs the movement of water out of the system to adjacent areas.

Diked (c): modified by a man-made barrier that obstructs the inflow of water.

Ditched/drained (d): modified by a man-made structure that functions to drain (usually via subsurface route) the system, thereby altering its natural hydroperiod.

Diverted (e): anthropogenic modification to otherwise artificially lower the water level.

Infiltration (f): area receives artificially increased input of treated or untreated water. Water is held for infiltration into a subsurface aquifer.

Stormwater Control (g): water is held to attenuate flow or until infiltration or evaporation. Also includes systems designed to improve water quality, typically involving addition of permeable surfaces, filtration, or impoundment.

Wastewater Treatment Pond (x): open water areas for last stages of wastewater treatment/polishing prior to discharge

Treatment Wetland (y): An artificial wetland created to treat anthropogenic discharge from either stormwater or wastewater. May include both open water and emergent wetland areas.

Urban Runoff (h): water source is dominated by an artificially increased input of urban runoff.

C. *Influences on Substrate and Bank*

Armored (i): human actions have artificially consolidated banks and/or bottoms to prevent erosion through placement of concrete, large rocks or boulders, geotextiles, gabions, or other artificial stabilization.

Excavated (j): sediment or substrate has been removed to deepen and/or widen the area of inundation. This can also include excavation along the banks for widening purposes.

Filled/graded (k): area has had an artificial input of sediment, sand, rock, etc. due to human actions. May be performed to reduce topographic complexity and/or to change slope.

Marine Control Structures (l): breakwaters, jetties, groins, seawalls, etc. meant to control erosion, tidal influences, and wave action within an estuary or along a shoreline.

Realigned (m): channel has been relocated, straightened, or otherwise altered to flow in a different location or pathway and/or through a different type of substrate.

D. *Influences Related to Agriculture and other Uses*

Aquaculture (n): standing, flowing, or tidal water used for production of aquatic organisms such as fish, mollusks, algae, etc.

Flooded Wetland Agriculture (o): cultivation of crops such as rice, wild rice, or cranberries, which require inundated for at least one month during the growing season. If areas include other wetland characteristics, such as position in the landscape or defined topographic features, they are flooded wetland agriculture. Upland areas that are flooded for crops or migratory waterfowl are mapped as upland, flooded agriculture.

Flood Irrigation (p): cultivation of crops, often grassy forage crops for hay, by flooding fields to point of saturation or shallow inundation.

Harbors/Marinas/Ports (q): open water area where boats are regularly docked, maintained, loaded, or unloaded. Typically have significant modification, armoring, and excavation of the shoreline.

Orchards (r): includes vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Ranchland (s): area is used for livestock production. Includes hayfields, meadows, managed vegetated areas subject to herbivory by livestock, and non-vegetated areas potentially subject to soil compaction by livestock.

Rangeland (t): wildland area used for livestock grazing outside of cultivated ranch and farmland.

Recreation (u): area used by humans for activities such as birdwatching, hiking, camping, fishing, biking, recreational vehicles, etc.

Row or Sown Agriculture (v): soil surface has been mechanically or physically altered for production of crops.

Silviculture (z): natural or planted forest used for timber production.

Managed Hunting (w): habitat modified and managed for hunting (typically waterfowl).

Agricultural Storage Ponds (sp): open water ponds for confined animal wastewater runoff or storage of irrigation water.

3.1.5.3 HYDROLOGY (Optional)

This limited set of modifiers applies to duration of tidal, flooded, flowing, or saturated conditions. One system could have up to three modifiers.

A. *Tidal*

Regularly Tidal (T1): Bidirectional flow, once or twice daily, most days, for at least 11 months of the year.

Seasonally Tidal (T2): Bidirectional flow, once or twice daily, most days, for at least one month of the year. May result from seasonal closures of tidal inlets.

Irregularly Tidal (T3): Bidirectional flow during extreme tides caused by high water levels or high wind. May stay predominantly non-tidal in some years.

B. *Flowing*

Perennial Flow (F1): Unidirectional flow (typically in one or more channels) is present for the entire annual cycle; typically occurs in larger geographical areas because of a combination of precipitation and groundwater discharge.

Intermittent (Seasonal) Flow (F2): Flowing water is present for periods of weeks to months following the cessation of precipitation, but not throughout the annual cycle; typically occurs because of a combination of precipitation and groundwater discharge.

Ephemeral Flow (F3): Flowing water is present only during or immediately after precipitation events; typically occurs in small watershed areas as a direct response to precipitation.

C. *Inundation*

Perennially Flooded (I1): Standing water throughout year. Only dries completely under extreme drought conditions.

Seasonally Flooded (I2): Standing water for three to nine months of the year associated with seasonal precipitation patterns.

Temporarily Flooded (I3): Standing water less than three months of the year or not associated with seasonal precipitation patterns. May be completely dry in some years.

D. *Saturation*

Perennially Saturated (S1): Lacks standing water but water table is at or near surface throughout year. Only dries completely under extreme drought conditions.

Seasonally Saturated (S2): Lacks standing water but water table at or near surface for three to nine months of the year. Associated with seasonal precipitation patterns.

Temporarily Saturated (S3): Lacks standing water but water table at or near surface less than three months of the year; may or may not be associated with seasonal precipitation patterns.

3.1.6 Upland Categories

Beach/Dune: includes area dominated by sand or cobble.

Developed: any built up area that consists of greater than 50 percent constructed material and can include vegetated/unpaved yards or any other associated cover less than 5 ha.

Developed, Open Space/Recreation: any managed vegetated areas usually consisting of fertilized and irrigated grasses. This category should include any associated structure(s). This can include park lands, golf courses, and other sports fields.

Cultivated Crops: Includes herbaceous and woody cultivated lands with any indication of annual planting or tilling.

Pasture, Rangeland, Ranchland: any grassland or managed area that is open to the grazing of livestock. This can include areas of low intensity development for horse and cattle corrals and associated structures.

Flooded agriculture: areas of cultivation that are subject to seasonal-or perennial flooding. These areas may provide wildlife habitat, but are typically not considered wetlands.

Grassland/Herbaceous: Upland areas characterized by natural or semi-natural herbaceous non-grazed vegetation; herbaceous vegetation accounts for 75 - 100 percent of the cover.

Forest: Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 m tall); tree canopy accounts for 25 - 100 percent of the cover.

Rock outcrop: large boulders, rocks, bedrock, or other natural hard surfaces.

Ruderal/Barren: dominated by bare ground or "weedy" generalist grasses and forbs. These plants may be characteristic of periods following either natural or anthropogenic disturbance.

Scrub/shrub: Areas dominated by woody vegetation less than 6 m in height. This class includes true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

Undeveloped Urban Open Space: open space areas associated with developed areas, such as active use parks, golf course, ball fields, etc.

Roads: Where a road crosses a stream, divides a wetland, or lies immediately adjacent to a stream or wetland (i.e., borders a stream or wetland), the portion of the road which crosses/divides the feature, plus an additional 10 m of road on either side of the stream or wetland is mapped as a distinct polygon (Figure 2). Roads should be added in a separate layer, rather than added to a wetland layer, in order to maintain the integrity of the wetlands.

Figure 2. Illustration of mapping a road crossing over a stream, such as a bridge or culverted crossing. The stream (blue) is shown on top of the road (red) to indicate that it remains a contiguous feature that flows under the road. If the road was paved in the stream (e.g., a dip/Arizona crossing), the road (red) would be shown on top to indicate a break in the continuity of the stream.

3.2 Scale, Targeted Mapping Unit (TMU), and Topology

The S&T mapping scale and targeted mapping unit (TMU) varies based on general habitat type. The TMU is a desired minimum mapping unit but *slight* exception can be made on a case by case basis (within 50 m^2 for polygons or 25 m for lines). The goal is to maximize the detail of a dataset, capturing small but important wetland areas, such as springs and seeps, while producing a consistent dataset for the region. The consistent determination of the presence or absence of wetland areas depends on making this determination at a standard spatial scale.

Non-tidal wetlands are identified at a TMU scale of 1:5,000. However, after a wetland area has been identified and classified, a larger scale view (up to 1:1,000) can be used to map the boundary of the area. The targeted mapping area for non-tidal polygonal features is 100 m^2. Non-wetland open water features are open water areas greater than 8 ha and have an average depth of greater than 2 m during the growing season (see Non-wetland open water in section 3.1.1).

Upland/non-wetland categories should be mapped at a scale of 1:5,000 with a minimum mapping unit of 5 ha. Uplands should be kept as separate distinct layer so as to not truncate wetland polygons. If roads cross or are adjacent to wetland or stream polygons, they are mapped as distinct features (see above). Roads that are wider than 15 m or greater than two lanes (includes 2 lanes with wide center median) are mapped as distinct features, in a layer separate from the wetland layers. Smaller roads that run through uplands are subsumed within the upland polygon.

The final output should be a complete coverage of the entire sample plot. There should be no overlapping polygons, no multi-part features, or a polygon segment smaller than the minimum mapping unit for each category.

3.3 Projection and Datum

During creation, all S&T data were maintained in the California Teale Albers projection with a North American 1983 Datum (NAD). This provides a consistent projected dataset for the entire study area.

3.4 Database Schema

It is important to have a consistent database and attribute table. Wetlands and uplands should be digitized and subjected to QA/QC separately. The attribute tables should have six different attribute fields that mimic the structure of the Table 1 and Table 2: “MajorClass”, “Class”, “Type”, “Subtype”, “Anthropgenic”, and “Vegetation”. A template geodatabase (Figure 3) will be set up with necessary feature classes with attributes, topologies, and domains and distributed to each mapper prior to the start of a project (see Appendix B for more detail).

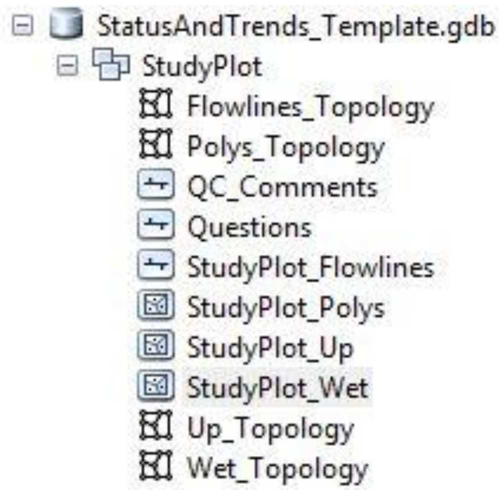

Figure 3: Example of a geodatabase template.

3.4 Data Sources

The dataset used to map each wetland should be noted in the "Source Primary" field. In general, sources should be available statewide in a consistent format and with consistent scale and quality.

3.4.1 Primary Data

National Agricultural Imagery Program (NAIP)

To establish consistency across the project, the National Agriculture Imagery Program (NAIP) available through the US Department of Agriculture (USDA) serves as the base imagery from which all features are mapped. The NAIP images are natural color and color infrared (CIR), 1-m pixel resolution, georectified digital aerial photographs. The choice to use NAIP was based on the spatial coverage, year flown and data availability. NAIP imagery is publicly available without cost from the USDA and covers the entire state of California, which is important to ensure state-wide consistency of these standards. NAIP datasets are flown periodically for California which helps ensure the aquatic resources inventory is current. For more information visit http://www.fsa.usda.gov/FSA/. All wetland areas mapped must be consistent with NAIP imagery. Images from a spring/summer timeframe are preferred, in order to use vegetation to support the classification decision.

National Elevation Dataset (NED) 1/3 arc second (10m)

The NED serves as the elevation layer of The National Map, and provides basic elevation information for earth science studies and mapping applications in the United States. The data are utilized by the scientific and resource management communities for global change research, hydrologic modeling, resource monitoring, mapping and visualization applications.

NED Modeled Flowlines

This dataset is an automated stream network generated from the NED using geographic information systems (GIS). Elevation, flow accumulation, and flow direction determine the initiation and location of a channel or channel network. A channel is initiated where the upstream basin is 10,000 m^2 or with a 100 cell accumulation threshold. The ArcHydro channel network should be used as a guide to determine the likely locations of first-order (headward) channels. Ancillary data should be consulted to confirm or deny the presence of a channel and to verify the extent of the channel.

National Oceanic and Atmospheric Administration (NOAA) Continually Updated Shoreline Product (CUSP)

This dataset is a vector shoreline representation based on an office interpretation of imagery or derived from LiDAR. This dataset should be used as a primary source to determine the boundary between estuarine and marine features, as well as backshore extent (excluding islands). Shoreline vectors were verified with contemporary imagery. This shoreline dataset represents the boundary between the land/water interface at the mean high water tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch (18.6 years). Sources of non-NOAA vector shoreline included US Fish and Wildlife Service, North Carolina Department of Environment and Natural Resources, and US Geological Survey. Non-NOAA imagery sources for interpreting shoreline included USDA-FSA Aerial Photography Field Office, ESRI Imagery World 2D (USGS, US Geological Survey, and US Department of Agriculture), Bing Maps Imagery Service, and Google Earth (TerraMetrics and DigitalGlobe).

3.4.2 Ancillary Data

Ancillary data are used where identification of aquatic resources using the primary data alone in insufficient, unclear, or ambiguous. In general, ancillary data are used to better understand topography, the effects of NAIP vintage on the visibility of aquatic resources in NAIP imagery, and to help detect subsurface drainage. The following specified ancillary data has been used for S&T.

National Wetlands Inventory (NWI)

NWI wetland maps are produced by the US Fish and Wildlife Service (USFWS). These data vary markedly in accuracy, in terms of omissions, boundaries, and misclassifications. The NWI data should only be used as a preliminary indication of the likely existence, location, and classification of major areas of aquatic resources.

Existing Vegetation Data (CALVEG)

Visible Ecological Groupings (CALVEG) comprise the only regional set of vegetation data for S&T and are derived from recently completed interpretation of 2005 1:24,000 scale LANDSAT imagery. The 2005 data are an update of the vintage 2000, 1:100,000 scale version originally done for the US National Forest Service administrative areas within the Basin, including private land inholdings. These data are mainly used in S&T to help identify wet meadows and forested slopes.

USGS Topographic Quadrangle Digital Raster Graphic (DRG)

The DRG is a scanned image of the 1:24,000 scale Topographic Quadrangle (7.5 minute quadrangle or "quad sheet") provided by the US Geological Survey (USGS). These data are used to help view major roads and buildings, as well as topography and major water bodies, including large channels. The contour lines provided with the DRG can be helpful for visualizing topography and estimating the flow directions of channels and channel networks.

Google Earth and Google Earth Pro

Google Earth (free) and Google Earth Pro (requires license fee) are publically accessible, online GIS tools. Google Earth provides access to high-resolution aerial imagery and topography, as well as local ground-based photography and local place names. Google Earth Pro provides non-georectified downloads of this same aerial imagery. Google Earth imagery is digitized in areas where it shows major landscape changes, such as large developments, fires, etc., that are more recent than the primary vintage imagery data or other ancillary data. Only Google Earth data that is available in a comparable form across the state should be used to ensure mapping consistency across plots.

National Land Cover Database (NLCD)

Then National Land Cover Database (NLCD) provides a nationally complete, current, consistent, and public domain information on the Nation's land cover. Data is derived from Landsat satellite imagery and other supplementary datasets. NLCD provides spatial reference and descriptive data for characteristics of the land surface such as thematic class (for example, urban, agriculture, and forest), percent impervious surface, and percent tree canopy cover. The overall NLCD layer is typically updated every five years. NLCD products are created by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of Federal agencies led by the US Geological Survey. All NLCD data products are available for download at no charge to the public from the MRLC Web site: http://www.mrlc.gov.

Land Use Survey Department of Water Resources Agricultural Land Use

This dataset should be used as an ancillary dataset to map flooded and other agriculture. The main emphasis of DWR's land use surveys is the mapping of agricultural land. Over 70 different crops or crop categories are included in our surveys. Irrigation methods and water sources have also been mapped in some, but not all surveys. Urban and native vegetation (undeveloped) areas are mapped but not in the detail of agricultural land. This data can range from 1986 to 2012 depending on the county.

http://www.water.ca.gov/landwateruse/lusrvymain.cfm

CalTRANS California Road System

This data layer provides statewide roads of different classes from Interstates to local roads. It may not be 100% comprehensive for all areas but serves as a consistent statewide layer of roads. Including this layer as a separate and distinct layer will support polygon delineations and assigning modifiers related to roads.

4.0 MAPPING PROCEDURES (FLOW CHARTS)

The following text describes the S&T mapping procedure in three basic steps. All mapping must follow this prescribed stepwise procedure. In order to accurately map using this methodology, the mapper should have an understanding of the system as a whole and mapping should be based on the overall structure and hydrology features. Note that if a plot does not contain any stream or wetland resources it should still be included and the other components of the plot (e.g., uplands, agriculture, roads) should be mapped.

Details on mapping procedures are provided in the sections below. Examples of channel and wetland polygon mapping are provided in Appendix C.

ArcGIS is the primary tool for all map production and classification. Use Geographic Coordinate System (GCS) NAD 83. California Teale Albers is recommended as a projection. Mapped features should be managed within a single file geodatabase with the following standardized attributes:

- OBJECTID: Automatically produced unique identifier for each feature.
- SHAPE: Automatically produced indicator of feature geometry.
- SHAPE_Length: Automatically produced perimeter length in meters.
- SHAPE_Area: Automatically produced area in square meters.
- Gridcode: Unique identifier of the PSU that contains the feature.
- Yearcode: Provides four-digit year of primary imagery. Additional information about imagery should be provided in metadata.

A more detailed geodatbase schema report that describes features, classes, topology, attributes, projection and other information is provided in Appendix B.

Other software (besides ArcGIS) can be used as long as the final products are compatible with ArcGIS. Additional attributes can be provided as necessary based on the specific needs of the individual project.

4.1 Channel Mapping

Channels (streams/riverine features) should be digitized as a line feature (Figure 4). These features will then get a standard buffer of 5 m (2.5 m on each side of the line). After buffering, these features can be adjusted if the banks are visible in the imagery. The downstream extent of the buffered line is where the stream becomes wide enough to be mapped as a polygon with clear banks. Channel length should be included in the mapping results.

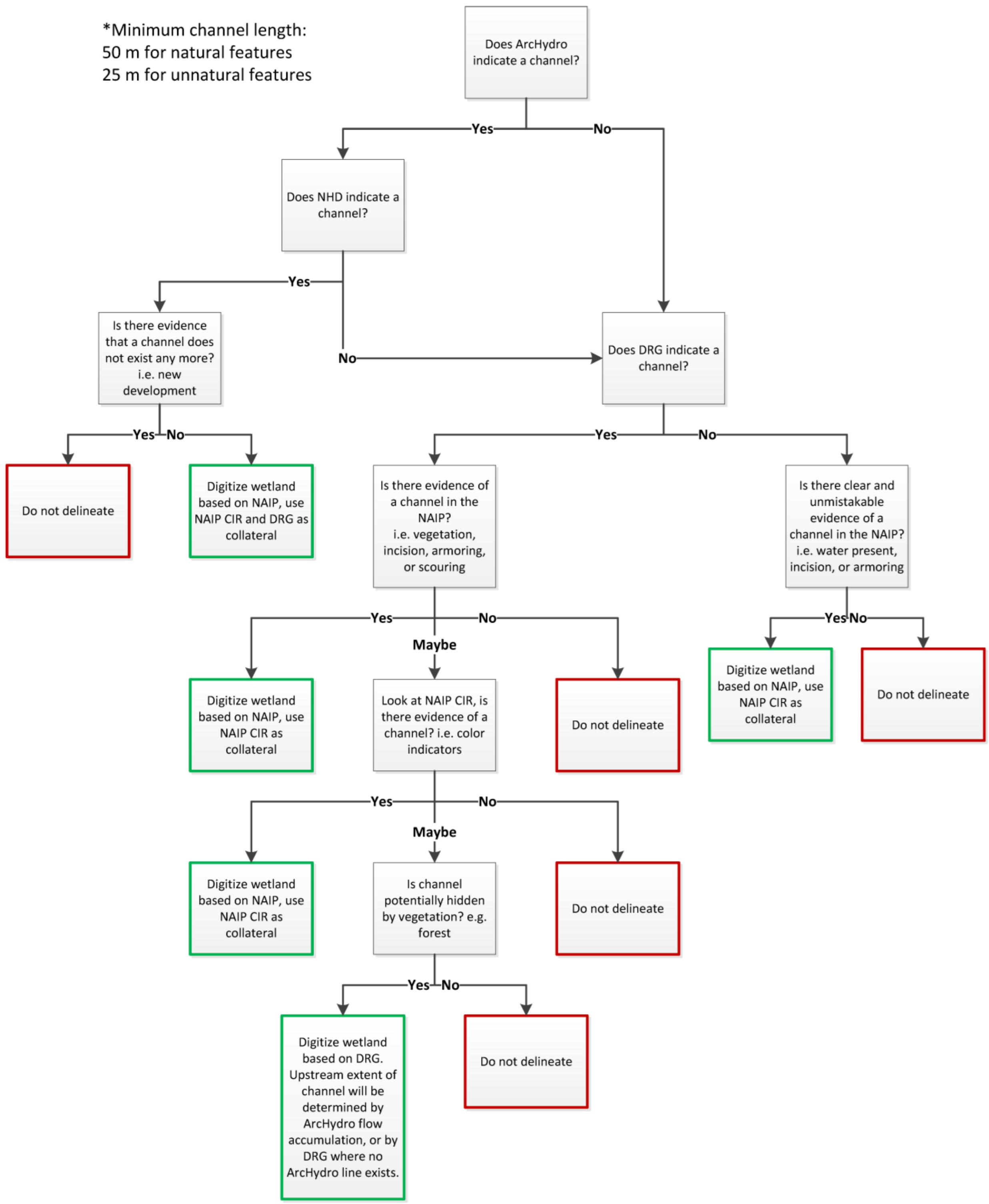

Figure 4. Channel mapping decision tree.

4.1.1 General considerations for mapping channels

- Begin with the ArcHydro analysis, but do not rely solely on the ArcHydro NED hillshade dataset when identifying and mapping channels. Channel mapping requires full use of all primary and ancillary data.
- Digitize channels from upstream to downstream. Always use “Snapping” to connect segments, particularly the “End” option.
- Natural channel features need to be at least 50 m in length. Modified or unnatural channels can be as small as 25 m in length. Channels shorter than this are likely erosional feature and should not be mapped.
- If channel is clearly visible, but appears to fade and fail to connect to another channel, wetland, or other waterbody, do not artificially connect it. Instead, digitize only the visually evident portion.
- Use Google Earth in cases where updated imagery is available for viewing, especially in areas subject to recent change, but use it only for reference. Attribute [Source_Ancillary] field as “GEyyyy” (Google Earth and imagery year).
- The boundary where a channel ends and another waterbody (such as a lake or depressional wetland) begins is mapped where the channel begins to flare or widen thereby transitioning to the other waterbody. This can be indicated by a change in vegetation.
- If there is a clear channel flowing through a wet meadow, then confirm that only the channel portion of the polygon is mapped as riverine, and the remainder mapped as slope. If the channel terminates within the wet meadow, map the feature as riverine until it is no longer visible on the imagery. Diffuse flow with little to no signs of defined channels typically indicates a slope wetland.
- For alluvial fans and other multi-thread channels, map flow lines off ArcHydro and main visible channels. Use a line down the approximate center of the flow path for calculating channel length in multi-thread or braided streams.

4.1.2 Landscape specific considerations for mapping channels

<u>In the upper-most areas of watersheds</u>

1. Using ArcHydro with a 100 cell accumulation (10,000 m^2 upstream watershed), compare channels to the primary imagery.
    a. If a channel is visible in the imagery, map of the imagery and classify.
    b. If there is no evidence of a channel in the imagery, consult the DRG or DEM.

2. Using the DRG, interpret the contour lines to determine whether or not a channel is likely to form, based on lateral hillslope, catchment size, longitudinal slope, etc.
    a. If topography indicates a channel would likely form, digitize using the DRG and classify.
    b. If there is no evidence in the DRG or NED of a channel, do not digitize.

In urban or agricultural landscapes

3. Using ArcHydro, compare channels to the primary imagery.
    a. If a channel can be identified in the imagery, digitize based on the imagery and classify.
    b. If there is no evidence of a channel (e.g., due to urbanization) in the imagery, the channel is likely subsurface and should not be digitized.
    c. Area between levees- If levees are present, include the area between levees if the wetland vegetation is similar to the riverine portion. If the area between levees has clearly been converted to non-wetland, then it should be excluded. The assumption is to include this area, with the burden of proof needed to exclude the area from the rest of the riverine wetland, if there is sufficient evidence to support this conclusion.

Braided Channels

If channel is braided, digitize the active flow area as defined by evidence of scour in imagery. The active low-flow path should also be digitized as apparent in the imagery. Do not include relic floodplain areas.

Alluvial Fans

Map active channels and alluvial fans. Lines can end at the distributary. The polygon should include all of the active alluvial fan.

Channels with Widening Riparian Areas

Map the riparian vegetation when the DRG contours indicate a widening of the channel. Map only in bank vegetation.

In-Channel Depressions/Pits

Do not digitize flow in channel pits that are predominately flow through systems separately from the riverine channel. However, in-channel stock ponds where a levee has created a pond should be classified as a depression.

Wide Channels

If a channel's banks are apparent in the imagery, digitize the stream from bank to bank as a polygon in the wetland layer and attribute with appropriate channel classification.

Artificial Channels and Ditches

Include all channels that contribute to the flow network; meaning channels that connect the upper watershed to the lower or drain upland areas and are tributary to larger streams. Fully channelized systems that have replaced natural streams and rivers should be mapped and given the appropriate modifiers (e.g., armored or realigned). Aqueducts canals or ditches that have been created in the uplands to drain developed or managed surfaces or to transfer water from one basin/watershed to another should not be included. Examples of these include the California Aqueduct, agricultural drainage ditches and roadside drainage ditches. More permanent ditches that have become naturalized and provide wetland functions or can support wildlife should be included.

4.2 Wetland Mapping

Wetlands should be mapped as polygonal features. Each polygon should represent a single wetland feature with based on all required attribution (hydrogeomorphology, landscape connection, anthropogenic influence, and vegetation modifier).

4.2.1 General Considerations for Mapping Wetlands

- Using the wetland mapping procedure flow charts (Figures 4 through 6), cleanly digitize wetland areas without any unnecessary vertices (i.e., small spikes, overlapping areas, etc.). When creating new wetland areas adjacent to existing ones, always use "Auto-complete Polygon" and "Snapping" to avoid topology errors, such as slivers or gaps between polygons.
- Ensure that there are no overlapping polygons when mapping. Use the editor clip tool to remove overlapping areas when digitizing an open water area in the center of a vegetated wetland.
- Overlay the channel layer on the imagery while digitizing wetland areas; the channel layer will provide flow direction and other indicators or clues about the locations of wetland areas.
- When assigning a wetland class, look at the system as a whole, defining the dominant hydrology and typology based on the contiguous components of the wetland that may not appear in the 2 km^2 plot. The wetland assumes the typology based on the system as a whole. For example, a wetland area that is <8 ha or <2 m deep within a plot would still be considered lacustrine (not depressional) if it is part of a larger contiguous lacustrine system that happens to not fit within the plot.

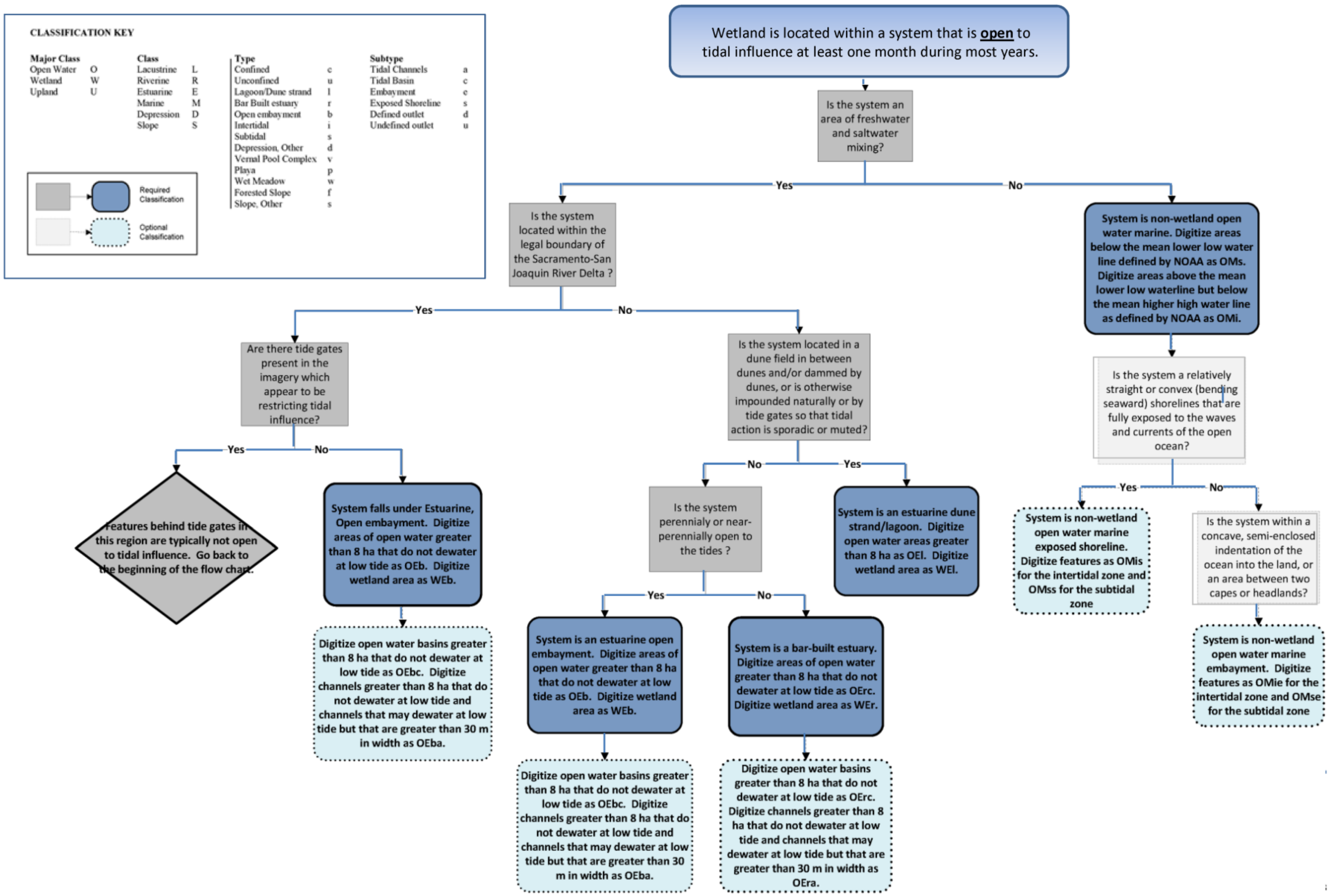

Figure 5. Wetland mapping decision tree for open systems.

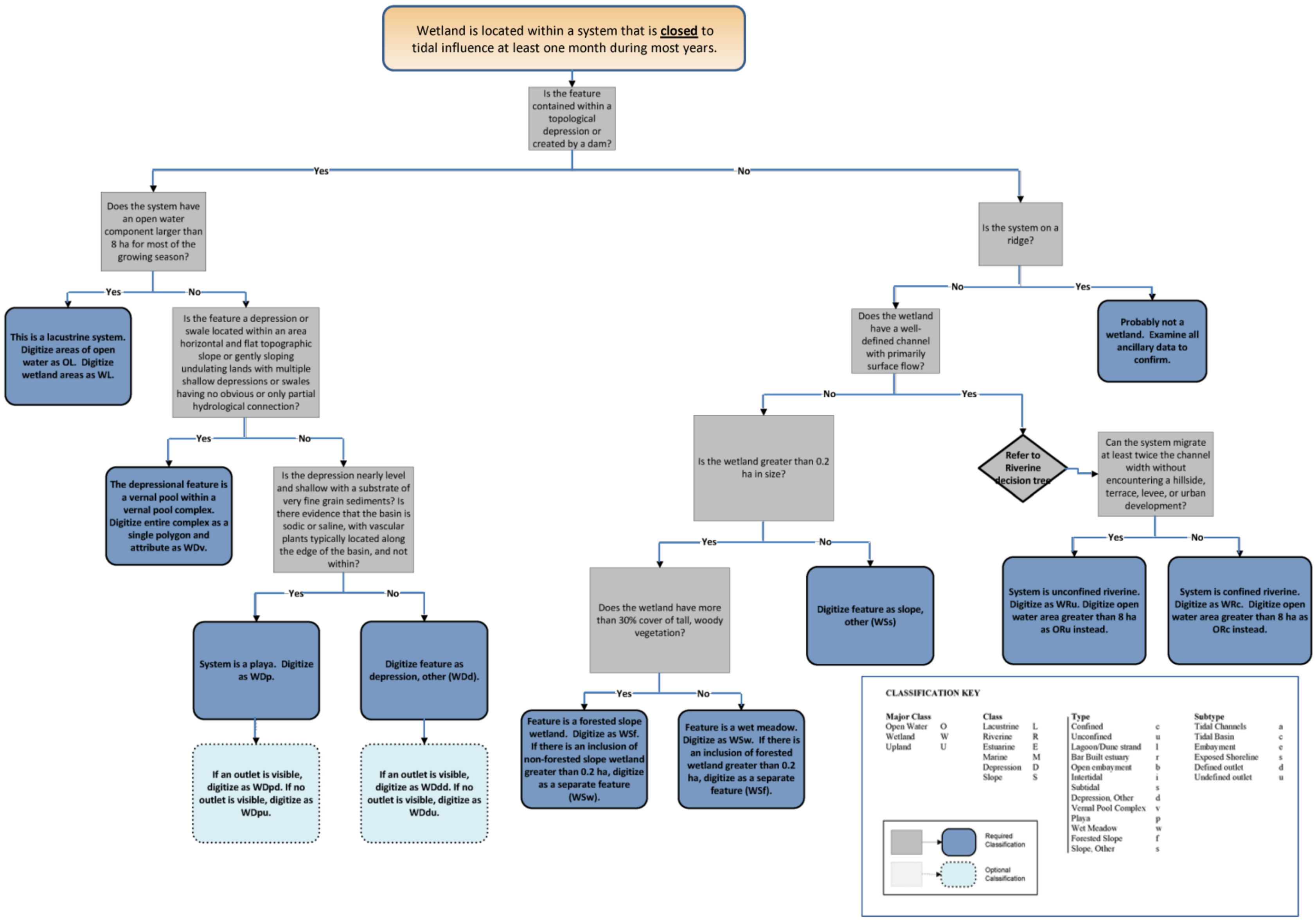

Figure 6. Wetland mapping decision tree for closed systems.

4.2.2 Specific considerations for wetland types

Depressional

- Natural depressional wetlands occupy topographic depressions – low areas where rainwater and surface runoff collect, and into which groundwater can rise. Look for natural depressional wetlands in the lowermost areas of valleys large and small, on broad floodplains, on saddles along broad ridge tops, between small hills, and behind beaches and dunes along lake shores.
- Depressional wetlands can be created by a road crossing that acts as an impoundment to a stream, causing water to pool. When this type of system is encountered, the assumption is that the road is creating a depressional wetland, and the burden of proof falls to demonstrate that the road is not affecting the hydrology and no depression exists.
- Oxbows that are separated from a river are considered depressional wetlands within the floodplain. The depression will be hydrologically distinct from the riverine portion, even if the vegetation is similar between the two wetlands.
- Depressional wetlands are common as stock ponds and irrigation ponds behind small dams and levees. Although they may be unnatural in origin, they are still considered depressional wetlands.
- Mapping the landward (upland) boundary between the vegetated areas for large depressional wetlands and adjoining slope wetlands can be very difficult. The general approach is to determine the likely ordinary high waterline (OHW) of the depressional wetland feature, and to assume that the boundary generally corresponds to the OHW. The OHW can be estimated based on the change in color signature or texture of the vegetation as evidenced in the primary imagery, as well as the elevation contours from the DRG and the topographic detail evident in the DEM. Local expertise can be very helpful to identify the boundary line.
- Questions to answer while identifying this boundary include:
  - What is the direction and pattern of surface runoff into the depressional or lacustrine wetland?
  - Is there a clear topographic boundary for the depression (this boundary can be used as surrogate for the wetland boundary)?
  - Based on vegetation color or texture, is there an obvious area of saturated land upslope from the apparent OHW (this would likely be an area of slope wetland)?
- Based on the answers to these questions, map the area primarily using the imagery and elevation contours as guides.

Lacustrine

- The criterion of a lacustrine wetland being >2 m deep only applies to the open water portion; the fringe of a lacustrine wetland may be <2 m. In other words, the portion of the lacustrine wetland that is <2 m deep is considered part of the lacustrine system, and not designated depressional wetland just because of the depth limit.
- The OHW of the lacustrine feature is used to determine the boundary between wetland and upland areas. The OHW can be estimated based on the change in color signature or texture of the vegetation as evidenced in the primary imagery, as well as the elevation contours from the DRG and the topographic detail evident in the DEM.

Slope

- Seeps and springs tend to occur uphill from where natural channels originate, on slopes where groundwater encounters an impervious geologic stratum, or at the base of slopes where groundwater emerges into the root zone of vegetation. Use topography to help identify whether a feature is a slope wetland (e.g., convex slope) or not. Always look for slope wetlands immediately above the upstream end of first-order channels (headwaters), and immediately above or below landslides on grassy hillsides. Check for saturated soils in the natural color NAIP imagery.
- Check the DRG for springs that may not be visible in the imagery. For these features look for a possible seep in the vicinity of the DRG icon. If such an area is not present digitize a circular polygon at the location indicated on the DRG. This circular feature should be 200 m^2 in size.

Estuarine Boundaries

- This dominant hydrology should be used to determine whether a feature is tidally dominated. This can be inferred by vegetation and soil signatures.
- To help determine the estuarine boundary, try to examine features during low tide to better observe channels, basins, etc.
- Identify portion of the tidal cycle when image was taken (e.g., flood vs. ebb tide)
- Review images from other portions of the tidal cycle, if available, in order to estimate maximum inundation area.
- Use evidence of scour or wrack lines to estimate extent of inundation or tidal flooding.
- Mean High Water is the boundary between Marine and Estuarine, as delimited by the CUSP data set. If the mouth of an estuary is open, extend the boundary line directly cross the estuary mouth.
- If the imagery shows progradation of the shoreline (growth of a river delta farther out into the sea over time), then extend the estuarine boundary based on the imagery.

- In seasonal or bar-built estuaries, if the mouth of the estuary is closed, the inundated area is generally considered Wetland (shallow open water) vs. Open Water. Open Water is assigned to deeper subtidal areas, when present. The boundary of the wetland can often be demarcated by the OHW of the estuarine feature. The OHW can be estimated based on the change in color signature or texture of the vegetation as evidenced in the primary imagery, as well as the elevation contours from the DRG and the topographic detail evident in the DEM.
- The entire San Francisco Bay-Delta is Estuarine, up to the limits of the legal Delta boundary. The San Francisco Bay-Delta is an open embayment. Permanent tidal channels are generally considered *Open Water*.

Marine Boundaries

- The boundary between marine and Estuarine is defined by the MHWL as defined from the NOAA CUSP dataset**.** If the mouth of an estuary is open to the tides, then the CUSP derived boundary is extended in a direct line across the estuary mouth. For channels that cross this boundary, if the feature is over 30 m wide, including in-channel flat, it should be classified as marine. Map the width of open channel including the flat. Note that this 30-m criterion for estuarine tidal channels does not apply to river mouth channels.
- Artificially constructed marinas with no appreciable freshwater input (marinas that only have local nuisance runoff) should be considered marine.
- For this program, the boundaries of the intertidal vs. the subtidal rocky or sandy are not delineated.

4.2.3 Considerations of Ambiguous Areas

Seasonal or Ephemeral Features

- Goal is to map polygons to the full extent of area that appears to be regularly included as part of the wetland/aquatic zone.
- Look for evidence of full extent of ponding or inundation, such as scoured areas or wrack line.
- Include additional index periods for photographs to improve understanding of maximum area of regular inundation or saturation.
- Temporal variability may become more apparent through the successive mapping cycles (i.e., once plot is mapped more than once).
- In tidally influenced areas, tide gates may be permanently open, allowing flooding of adjacent areas or may only be opened periodically, restricting water movement. If the tide gates appear to allow regular access to tidal flows, then the system is estuarine. If

however the tide gates appear to restrict flow, then the system is likely depressional. Certain parts of the State have a greater likelihood of one or the other type of flood gate. Gates in the Delta area (e.g., Suisan Bay) tend to be closed the majority of the time, while those in southern California (e.g., Ballona Creek and Bolsa Chica) tend to be open.

- The Delta also has systems that are subject to subsidence, and are hydrologically distinct from adjacent estuarine channels. If differences in elevation can be determined between a wetland and adjacent channels, then the area is likely not estuarine.

Flooded Agriculture

- Flooded fields may provide habitat for waterfowl even if they are not wetlands. Area should be mapped based on what it would normally be in the absence of the artificial flooding. For example, flooded upland fields are mapped as flooded agriculture vs. wetlands that are seasonally flooded and managed.
- Use adjacent areas to attempt to understand if flooded area would normally be upland or wetland. Look for topographic or vegetation clues, or positioning in the landscape to determine if these features are naturally uplands or wetlands.
- View aerial photographs from other time periods to assist in making a determination if area is wetland.
- Temporal patterns may become more apparent through the successive mapping cycles (i.e., once plot is mapped more than once).

Wetlands within an Agricultural Matrix (e.g., Vineyards)

- Natural or remnant wetland interspersed among agricultural lands should be mapped as distinct wetland features regardless of size.
- Agricultural matrix should be mapped as agriculture with appropriate modifiers

Forestry Land Use (Timber Harvest Plans)

- Same as wetlands within an agricultural matrix.

Areas that have been Recently Disturbed by Natural Events (e.g., Flood, Fires)

- Areas should be mapped as they exist/appear on the imagery.
- View aerial photographs from other time periods to assist in making a determination if area is wetland.
- Include a “natural disturbance” vegetation modifier.

Early Restoration or In-Process Conversion

- As long as site retains some original features map what it looks like at the time of the assessment, don’t try to predict the future.
- Add disturbance modifiers as appropriate.

Land Clearing

- Areas should be mapped as they exist/appear on the imagery.
- Adjacent areas can be used to provide insight into pre-disturbance condition.
- View aerial photographs from other time periods to assist in making a determination whether area is wetland.

5.0 CHANGE ASSESSMENT

A strength of the S&T program is that after all plots have been mapped once, subsequent iterations only map changes between successive time points. Once an area has been mapped in a previous S&T era, use the existing data as a starting point and map changes where necessary. That is the more recent imagery should be compared to the base year. The following general procedures should be used for change assessment:

1. Open existing S&T plot with polygons from previous mapping iteration.
2. Overlay new/current imagery and ancillary data layers.
3. If an imagery shift is detected greater than 3 m throughout the plot, the image should be re-georeferenced to the positioning of the base year's imagery:
    a. Zoom to a level in which the entire plot is viewable in data view. Turn on the more recent imagery and turn off plot shp.
    b. Export the map to jpeg, 300 dpi is good resolution.
    c. Add the jpeg back into the dataframe and georeference the jpeg to the base year imagery. Use fixed points near at least three corners of the plot.
    d. The more recent imagery should then be lined up with the base-year imagery with minimal loss in graphic resolution.
4. If a clear error is discovered on the base year imagery (original time period), then it should be corrected and the original geodatabase updated before the change assessment is conducted.
5. Digitize areas where there has been a change in the polygon or stream lines between the successive time periods using the mapping procedures described in this document. These may include changes in the size or location of the polygon/line, elimination of features, or creation of new wetlands or streams.
6. Attribute new or modified polygons using the classification system provided in Tables 2 through 5.
7. Where changes have occurred, assign one of the following change categories:
    - New stream or wetland where one did not previously exist.
    - Modified extent.
    - Modified wetland type/class.
    - Similar extent, but modified location/boundary.
    - Prior wetland eliminated and converted to developed land use.
    - Prior wetland eliminated and converted to upland habitat.

- Prior wetland converted to open water.
- Prior wetland converted to a facility or structure.
- Prior wetland converted to agriculture.

8. Reported changes to evaluate should include:
   - Change in area by wetland type.
   - Change in stream length by stream type.
   - Change in stream area.

6.0 Quality Assurance and Quality Control (QA/QC)

Application of the Generalized Random Tessellation Stratified (GRTS) probabilistic design according to the recommendations contained in Stein and Lackey (2012) will produce estimates of total wetland area that are within the 95% CI of the actual statewide wetland extent with +/- 10% error (assuming 2,000 plots are mapped). However, once one complete cycle of the probabilistic S&T design is implemented, it should be used as the baseline for future change assessment. If the protocols and quality control measures described in this document are followed, the following confidence levels can be obtained in the change assessment:

- Overall wetland area: ±5%
- Wetland class: ±20%

These rates are slightly below the Federal FGDC Standards of 98% producers' accuracy for overall area and 85% producers' accuracy for classification. However, our proposed rates are reasonable and achievable based on the results of an intermapper calibration exercise in California.

Error rates for wetland type and subtype (subcategories of class) are too high to establish target confidence levels. This information is valuable for analytical purposes; however, trends should not be reported at this level of resolution given the inherent variability in classification between individual mapping efforts.

Quality control measures and data quality objectives have been established based on analysis of variability between trained mapping teams (Table 7). To achieve these objectives map producers should utilize internal quality assurance and quality control procedures and should be fully trained in the SOPs outlined by this document.

Table 7. Quality control criteria and objectives.

Criterion	Quality Control Requirement	Objective
Representativeness	Use GRTS draw without substitutions	±10%
Comparability	Use of standard imagery, data sources and protocols	100%
Completeness	All area within all plots selected should be mapped	100%
Precision/Bias	10% of plots verified by an independent mapper	
Area		±5%
Classification		80%
Accuracy	Groundtruthing 5% of mapped plots	
Area		±5%
Classification		80%

6.1 Representativeness

Plots should be selected from the GRTS sample draw. Mapping of the designated plots will ensure that the statistical estimates are representative of actual wetland area within ±10%. No additional quality control measures are necessary as long as plots are not artificially eliminated or substituted.

6.2 Comparability

Use of standard imagery (e.g., NAIP) and other data sources will ensure comparable and consistent treatment of each plot during the mapping. No changes should be made to the protocols without review and approval of the oversight group (California Natural Resources Agency, CDFW, or State Water Resources Control Board). Any approved deviations from either imagery or mapping protocols must be documented.

6.3 Completeness

All (100%) plots selected should be mapped and all areas within the plots should be mapped. Since this is a remote sensing exercise, no plots should be excluded from mapping.

6.4 Precision/Bias

Independent mappers should map overall area within ±6%. At least 80% of the polygons mapped should be classified the same at the wetland class level. At least 10% of the plots from every mapper should be independently verified by a second senior, experienced mapper to ensure that this objective is being met.

6.5 Accuracy

Each year, approximately 5% of the mapped plots will be selected at random for groundtruthing. For each plot a team of two individuals will spend up to one day in the field verifying mapped resources on the ground. The data quality objective for accuracy is that total mapped area should be with ±6% of the field verified area. Classification accuracy should be 80%. Systematic errors may result in the need for selected remapping. Groundtruthing results may also inform future refinements of the mapping protocols

6.6 Corrective Measures

An independent quality control (QC) officer should be identified for each mapping team. The QC officer should verify that all data quality objectives have been met for each mapping effort. The following minimum standards and corrective measures should be applied.

- If 15% or less of the polygons tested for quality control fail to meet all data quality objectives, corrections should be made and the failure rate documented by objective. However the entire batch of maps can be *accepted*.

- If between 15% and 30% of the polygons tested for quality control fail to meet all data quality objectives, the entire set of maps should be *returned to the producer for revision* and resubmission. Upon resubmission, a different sample should be selected for QC review. The process should be repeated until the error rate is below 15%.

- If more than 30% of the polygons tested for quality control fail to meet all data quality objectives, the entire set of maps should be *rejected*. If the producer submits maps in the future, 25% of submitted maps should be selected for review instead of the standard 10%.

6.7 Data Review and Data Management

All maps will conform to Federal Geographic Data Committee (FGDC) standards (http://www.fgdc.gov/standards/projects/FGDC-standards-projects/wetlands-mapping/index_html) and to data and metadata standards established by CalEPA and/or the California Natural Resources Agency. As a check, 10% of the mapped plots are to be evaluated by a senior photo-interpreter, using the QA procedures outlined in this document. Issues with plots that fail this QA check will need to be reconciled with the senior photo-checker. Data products will be uploaded to the designated data management system (e.g., BIOS).

6.8 Reporting

Status and Trends reports should be issued at least once every five years and through the periodic *State of the State's Wetlands* report. Results should also be accessible through the My Water Quality Portals (http://www.mywaterquality.ca.gov/eco_health/wetlands/).

APPENDIX A: S&T CLASSIFICATIONS AND CARI CROSSWALKS

Hierarchical				**CARI Crosswalk**
Hydrogeomorphology		***Landscape Connection***		
Major Class (Required)	***Class (Required)***	***Type (Required)***	***Subtype (Optional)***	
Open Water (O)	Lacustrine (L)			LOW-
	Riverine (R)	Confined (c)		FC,FD
		Unconfined (u)		
	Estuarine (E)	Lagoon/Dune Strand (l)		GPOW-
		Bar Built Estuary (r)	Tidal Channels (a)	BS,BD
		Open Embayment (b)	Tidal Basin (c)	
	Marine (M)	Intertidal (i)	Embayment (e)	
			Exposed Shoreline (s)	
		Subtidal (s)	Embayment (e)	
			Exposed Shoreline (s)	
Wetland (W)	Depression (D)	Depression, Other (d)	Defined outlet (d)	DV-,DOW-
			Undefined outlet (u)	
		Vernal Pool Complex (v)		VPC,VP
		Playa (p)		PV-,POW-,PU-
	Lacustrine (L)			LV-
	Slope (S)	Wet Meadow (w)		WM
		Forested Slope (f)		FS
		Slope, Other (s)		S-
	Riverine (R)	Confined (c)		CUF,CV
		Unconfined (u)		
	Estuarine (E)	Lagoon/Dune Strand (l)		GPV-
		Bar Built Estuary (r)		TV,TNV,TBF,TMF,TC
		Open Embayment (b)		
Upland (U)	See Upland Categories			

APPENDIX B: DATABASE SCHEMA, TOPOLOGY, AND FEATURE ATTRIBUTION

Geodatabase Feature Classes

A description of required and optional feature classes and topologies follows. Schema details can be found in Table B2. Figure B1 shows the required and optional contents of the geodatabase used for mapping.

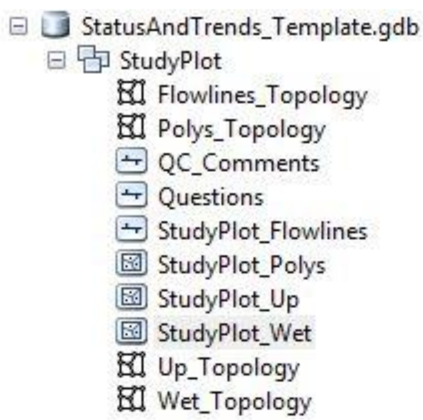

Figure B1: Geodatabase contents.

The mapping geodatabase must contain the following feature classes organized within a feature dataset:

- StudyPlot_Flowlines: digitized flowlines
- StudyPlot_Polys: digitized upland and wetland polygons, combined
- StudyPlot_Up: digitized upland polygons
- StudyPlot_Wet: digitized wetland polygons

The following feature classes are also recommended in addition to those listed above:

- QC_Comments: internal comments generated from QA/QC
- Questions: internal mapping questions

The mapping geodatabase must contain the following topologies:

- Flowlines_Topology: topological relationship rules for StudyPlot_Flowlines
- Polys_Topology: topological relationship rules for StudyPlot_Polys
- Up_Topology: topological relationship rules for StudyPlot_Up
- Wet_Topology: topological relationship rules for StudyPlot_Wet

Workflow

The following is a description of the suggested general workflow to show how the feature classes described above are intended to be utilized (Figure B2). This workflow may be modified to suit the internal organization and goals of any given project or mapping team. The goal of the workflow is to present a logical and efficient order of operations that minimizes technical error. It is also recommended that internal QA/QC procedures be incorporated into the workflow in a way that best fits the organization and goals of the given project or mapping team.

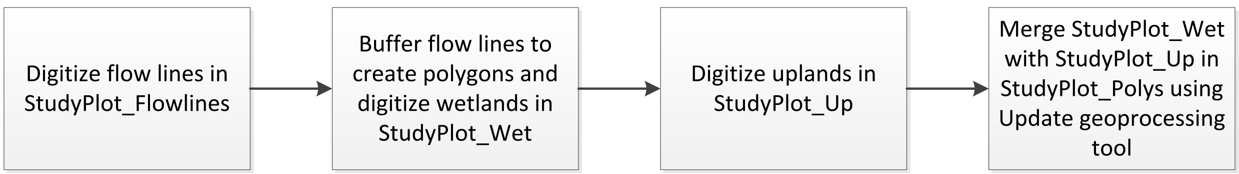

Figure B2: Suggested workflow.

1. Digitize and attribute flow lines in StudyPlot_Flowlines feature class, run Flowlines_Topology, and fix errors.

2. Buffer flow lines to create polygons and digitize and attribute wetlands in StudyPlot_Wet feature class, run Wet_Topology, and fix errors.

3. Digitize and attribute uplands in StudyPlot_Up feature class. Upland polygons should cover entire plot, or at least overlap into wetland polygons in the instance where there are very large wetland polygons within the plot for features such as lakes, ocean, or large floodplains. Run Up_Topology, and fix errors.

4. Merge StudyPlot_Wet with StudyPlot_Up feature classes into StudyPlot_Polys feature class. StudyPlot_Up polygons are clipped by StudyPlot_Wet polygons so there is no overlap. This can be accomplished by the following process:

    a. Go to ArcToolbox > Analysis Tools > Overlay > Update.

        i. Input: StudyPlot_Up.

        ii. Update: StudyPlot_Wet

        iii. "Borders" should be checked.

        iv. Output feature class: existing StudyPlot_Polys feature class in the StudyPlot GDB.

    b. Run Polys_Topology, fix errors.

5. Future edits should be made to the StudyPlot_Wet or StudyPlot_Up feature classes separately, then repeat step 4. This will ensure road features are preserved and reduce topology errors.

Field Attribution

Table B1 describes the fields contained within each of the required feature classes, whether it is required that the field be completely populated within the feature class, and notes related to the attribution within each field. Figure B3 is an example of a record within the StudyPlot_Wet feature class. Detailed schema information can be found in Table B2, Geodatabase schema details.

Table B1: Field attribution descriptions and guidelines.

StudyPlot_Flowlines			
Fields	**Description**	**Attribution Required**	**Attribution Notes**
STRAHLER_STREAMORDER	Strahler stream order	No	

StudyPlot_Wet			
Fields	**Description**	**Attribution Required**	**Attribution Notes**
MAJOR	"Major Class" classification	Yes	Filled out for wetland polygons
CLASS	"Class" classification	Yes	Filled out for wetland polygons
TYPE	"Type" classification	Yes	Filled out for wetland polygons
SUBTYPE	"Subtype" classification	No	Filled out for wetland polygons
ATTRIBUTE	Concatenation of coded values of polygon attribution	Yes	Filled out for wetland polygons. For wetland polygons, this is composed of the coded values for Major Class, Class, Type, and Subtype.
ANTHROPOGENIC	Anthropogenic modifier(s)	Yes	Filled out for wetland polygons. Only coded value(s) should be entered. All applicable codes should be entered and comma delimited
VEGETATION	Vegetation modifier	Yes	Filled out for wetland polygons
HYDROLOGY	Hydrology modifier	No	Filled out for wetland polygons
EXTENDS	Describes whether feature extends beyond plot boundary	No	Filled out for wetland polygons
BUFFERDIST	distance of buffer operation from a point or line	No	This field is required to be present when using the Buffer Wizard tool in ArcGIS. Auto-populated by tool.
COMMENTS	Mapper comments	No	Filled out for wetland polygons
ST_PLOT_NO	Status and Trends plot ID number	Yes	Filled out for wetland polygons
SOURCE_PRIMARY	Primary base imagery used to map the polygon	Yes	Filled out for wetland polygons
SOURCE_ANCILLARY	Ancillary imagery and other data used to map the polygon	No	Filled out for wetland polygons

CHANGE_ASSESS	Where changes have occurred, assign change category	Where change has occurred, Yes	Filled out for wetland polygons
CHANGE_YR_FROM	Where changes have occurred, assign the first year in the change comparison	Where change has occurred, Yes	Filled out for wetland polygons
CHANGE_YR_TO	Where changes have occurred, assign the second year in the change comparison	Where change has occurred, Yes	Filled out for wetland polygons
CHANGE_COMMENTS	Mapper comments related to change mapping and assessment. If "Other" is selected in CHANGE_ASSESS field, custom description of change is noted here	No	Filled out for wetland polygons

StudyPlot_Up			
Fields	**Description**	**Attribution Required**	**Attribution Notes**
MAJOR	"Major Class" classification	Yes	Filled out for upland polygons
CLASS	"Class" classification	Yes	Filled out for upland polygons
TYPE	"Type" classification	No	Not used for uplands
SUBTYPE	"Subtype" classification	No	Not used for uplands
ATTRIBUTE	Concatenation of coded values of polygon attribution	Yes	Filled out for upland polygons. For upland polygons, this is a concatenation of the coded values for Major Class and Class.
ANTHROPOGENIC	Anthropogenic modifier(s)	No	Not used for uplands
VEGETATION	Vegetation modifier	No	Filled out for upland polygons
HYDROLOGY	Hydrology modifier	No	Not used for uplands
EXTENDS	Describes whether feature extends beyond plot boundary	No	Filled out for upland polygons
BUFFERDIST	distance of buffer operation from a point or line	No	Not used for uplands
COMMENTS	Mapper comments	No	Filled out for upland polygons
ST_PLOT_NO	Status and Trends plot ID number	Yes	Filled out for upland polygons
SOURCE_PRIMARY	Primary base imagery used to map the polygon	Yes	Filled out for upland polygons
SOURCE_ANCILLARY	Ancillary imagery used to map the polygon	No	Filled out for upland polygons
CHANGE_ASSESS	Where changes have occurred, assign change category	No	Not used for uplands

CHANGE_YR_FROM	Where changes have occurred, assign the first year in the change comparison	No	Not used for uplands
CHANGE_YR_TO	Where changes have occurred, assign the second year in the change comparison	No	Not used for uplands
CHANGE_COMMENTS	Mapper comments related to change mapping and assessment. If “Other” is selected in CHANGE_ASSESS field, custom description of change is noted here	No	Not used for uplands

StudyPlot_Polys			
Fields	**Description**	**Attribution Required**	**Attribution Notes**
MAJOR	"Major Class" classification	Yes	Filled out for both wetland and upland polygons
CLASS	"Class" classification	Yes	Filled out for both wetland and upland polygons
TYPE	"Type" classification	No	Filled out for wetland polygons only
SUBTYPE	"Subtype" classification	No	Filled out for wetland polygons only
ATTRIBUTE	Concatenation of coded values of polygon attribution	Yes	Filled out for both wetland and upland polygons. For wetland polygons, this is composed of the coded values for Major Class, Class, Type, and Subtype. For upland Polygons, this is a concatenation of the coded values for Major Class and Class.
ANTHROPOGENIC	Anthropogenic modifier(s)	No	Filled out for wetland polygons only. Only coded value(s) should be entered. All applicable codes should be entered and comma delimited
VEGETATION	Vegetation modifier	No	Filled out for wetland polygons only
HYDROLOGY	Hydrology modifier	No	Filled out for wetland polygons only
EXTENDS	Describes whether feature extends beyond plot boundary	No	Filled out for both wetland and upland polygons
BUFFERDIST	distance of buffer operation from a point or line	No	This field is required to be present when using the Buffer Wizard tool in ArcGIS. Auto-populated by tool.
COMMENTS	Mapper comments	No	Filled out for both wetland and upland polygons

ST_PLOT_NO	Status and Trends plot ID number	Yes	Filled out for both wetland and upland polygons
SOURCE_PRIMARY	Primary base imagery used to map the polygon	Yes	Filled out for both wetland and upland polygons
SOURCE_ANCILLARY	Ancillary imagery used to map the polygon	No	Filled out for both wetland and upland polygons
CHANGE_ASSESS	Where changes have occurred, change category	No	Filled out for wetland polygons only
CHANGE_YR_FROM	Where changes have occurred, the first year in the change comparison	No	Filled out for wetland polygons only
CHANGE_YR_TO	Where changes have occurred, the second year in the change comparison	No	Filled out for wetland polygons only
CHANGE_COMMENTS	Mapper comments related to change mapping and assessment. If “Other” is selected in CHANGE_ASSESS field, custom description of change is noted here	No	Filled out for wetland polygons only

StudyPlot_Wet

Major	Class	Type	Subtype	Attribute	Anthropogenic	Vegetation	Extends	BufferDist	Comments	Source_Primary	Source_Ancillary
Wetland	Depression	Depression, Other	Defined Outlet	WDdd	i,j	Floating	No	<Null>	Confirmed OHW thro	NAIP 2010	NAIP 2005

Figure B3: Example of wetland polygon attribution

Geodatabase Schema Details

The following table (Table B2) outlines the details of the geodatabase structure, including domains, feature classes, topology rules, and spatial reference.

Table B2: Geodatabase schema detail.

ArcGIS Diagrammer

Report Creation	
Date	Tuesday, August 26, 2014
Author	pmp32374/CSUN on GEOGPENDLETON
System Information	
Operating System	Microsoft Windows NT 6.1.7601 Service Pack 1
.Net Framework	2.0.50727.5483
Diagrammer	10.0.1.0
Geodatabase	
Workspace Type	Personal Geodatabase
File	N:\Active\StatusandTrends\GIS\Template_GDB\STATUSANDTRENDS_TEMPLATE.XML

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Domains

Domain Name	Owner	Domain Type
Change		Coded Value
Class		Coded Value
Extends		Coded Value
Hydrology		Coded Value
Major		Coded Value
Subtype		Coded Value
Type		Coded Value
Vegetation		Coded Value
Yes/No		Coded Value

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Change

Owner	
Description	Change assessment
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
New stream or wetland where one did not previously exist	New stream or wetland where one did not previously exist
Modified extent	Modified extent
Modified wetland type/class	Modified wetland type/class
Similar extent, but modified location/boundary	Similar extent, but modified location/boundary
Prior wetland eliminated and converted to developed land use	Prior wetland eliminated and converted to developed land use
Prior wetland eliminated and converted to upland habitat	Prior wetland eliminated and converted to upland habitat
Prior wetland converted to open water	Prior wetland converted to open water
Prior wetland converted to a facility or structure	Prior wetland converted to a facility or structure
Prior wetland converted to agriculture	Prior wetland converted to agriculture
Other	Other

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Class

Owner	
Description	Hydrogeomorphology Class
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Depression	Depression
Estuarine	Estuarine
Lacustrine	Lacustrine

Marine	Marine
Riverine	Riverine
Slope	Slope
Undeveloped Urban Open Space	Undeveloped Urban Open Space
Beach/Dune	Beach/Dune
Rock Outcrop	Rock Outcrop
Ruderal/Baren	Ruderal/Baren
Grassland/Herbaceous	Grassland/Herbaceous
Forest	Forest
Scrub/Shrub	Scrub/Shrub
Developed	Developed
Developed, Open Space/Recreation	Developed, Open Space/Recreation
Cultivated Crops	Cultivated Crops
Pasture, Rangeland, Ranchland	Pasture, Rangeland, Ranchland
Flooded Agriculture	Flooded Agriculture
Roads	Roads

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Extends

Owner	
Description	Wetland does/does not extend beyond plot boundary
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Yes	Yes
No	No

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Hydrology

Owner	
Description	Hydrology modifier
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Regularly tidal	T1
Seasonally tidal	T2
Irregularly tidal	T3
Perennially flowing	F1
Seasonally flowing	F2
Ephemeral	F3
Perennially flooded	I1
Seasonally flooded	I2
Temporarily flooded	I3
Perennially saturated	S1
Seasonally saturated	S2
Temporarily saturated	S3

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Major

Owner	
Description	Hydrogeomorphology Major Class
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Wetland	Wetland
Upland	Upland
Open Water	Open Water

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Subtype

Owner	
Description	Landscape Connection Subtype
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Tidal Channel	Tidal Channel
Tidal Basin	Tidal Basin
Exposed Shoreline	Exposed Shoreline
Defined Outlet	Defined Outlet
Undefined Outlet	Undefined Outlet
Emabyment	Embayment

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Type

Owner	
Description	Landscape Connection Type
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Intertidal	Intertidal
Subtidal	Subtidal
Confined	Confined
Unconfined	Unconfined
Lagoon/Dune Strand	Lagoon/Dune Strand
Bar Built Estuary	Bar Built Estuary
Open Embayment	Open Embayment
Depression, Other	Depression, Other
Vernal Pool Complex	Vernal Pool Complex
Playa	Playa
Forested Slope	Forested Slope
Slope, Other	Slope, Other
Wet Meadow	Wet Meadow

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Vegetation

Owner	
Description	Vegetation modifier
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value
Domain Members	
Name	**Value**
Shallow Open Water	SOW
Algae	AL
Floating	FL
Submerged	SU
Emergent	EM
Forested	FO
Scrub-shrub	SS
Herbaceous/Grass	HE
Mixed	MI
Scour	NST
Slides	NSL
Unveg channel/mud/sand/salt flat	FLT
Fire	NFR

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Yes/No

Owner	
Description	Yes/No
Domain Type	Coded Value
Field Type	String
Merge Policy	Default Value
Split Policy	Default Value

Domain Members	
Name	**Value**
Yes	Yes
No	No

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ObjectClasses

ObjectClass Name	Type	Geometry	Subtype
StudyPlot_year			SR
QC_Comments	Simple FeatureClass	Polyline	-
Questions	Simple FeatureClass	Polyline	-
StudyPlot_Flowlines	Simple FeatureClass	Polyline	-
StudyPlot_Polys	Simple FeatureClass	Polygon	-
StudyPlot_Up	Simple FeatureClass	Polygon	-
StudyPlot_Wet	Simple FeatureClass	Polygon	-
Stand Alone ObjectClass(s)			

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QC_Comments

Alias	QC_Comments	**Geometry:**Polyline
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
COMMENTS	Comments	Comments	String	0	0	70	Yes
FIXED	Fixed	Fixed	String	0	0	3	Yes
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	Default Value	Domain
ObjectClass		
FIXED		Yes/No

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

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Questions

Alias	Questions	**Geometry:**Polyline
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
QUESTIONS	Questions	Questions	String	0	0	255	Yes
RESPONSE	Response	Response	String	0	0	255	Yes
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

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StudyPlot_Flowlines

Alias	StudyPlot_Flowlines	**Geometry:**Polyline
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
STRAHLER_STREAMORDER	Strahler_StreamOrder	Strahler_StreamOrder	Small Integer	0	0	2	Yes
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes

Subtype Name	Default Value	Domain

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

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StudyPlot_Polys

Alias	StudyPlot_Polys	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
MAJOR	Major	Major	String	0	0	50	Yes
CLASS	Class	Class	String	0	0	50	Yes
TYPE	Type	Type	String	0	0	50	Yes
SUBTYPE	Subtype	Subtype	String	0	0	50	Yes
ATTRIBUTE	Attribute	Attribute	String	0	0	10	Yes
ANTHROPOGENIC	Anthropogenic	Anthropogenic	String	0	0	10	Yes
VEGETATION	Vegetation	Vegetation	String	0	0	10	Yes
EXTENDS	Extends	Extends	String	0	0	3	Yes
BUFFERDIST	BufferDist	BufferDist	Double	0	0	8	Yes
COMMENTS	Comments	Comments	String	0	0	255	Yes
ST_PLOT_NO	ST_Plot_No	ST_Plot_No	Small Integer	0	0	2	Yes
SOURCE_PRIMARY	Source_Primary	Source_Primary	String	0	0	150	Yes
SOURCE_ANCILLARY	Source_Ancillary	Source_Ancillary	String	0	0	150	Yes
SHAPE	Shape	Shape	Geometry	0	0	0	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes
CHANGE_ASSESS	CHANGE_ASSESS	CHANGE_ASSESS	String	0	0	70	Yes
CHANGE_YR_FROM	CHANGE_YR_FROM	CHANGE_YR_FROM	String	0	0	4	Yes
CHANGE_YR_TO	CHANGE_YR_TO	CHANGE_YR_TO	String	0	0	4	Yes
CHANGE_COMMENTS	CHANGE_COMMENTS	CHANGE_COMMENTS	String	0	0	255	Yes

Subtype Name	Default Value	Domain
ObjectClass		
MAJOR		Major
CLASS		Class
TYPE		Type
SUBTYPE		Subtype
VEGETATION		Vegetation
EXTENDS		Extends
CHANGE_ASSESS		Change

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

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StudyPlot_Up

Alias	StudyPlot_Up	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
MAJOR	Major	Major	String	0	0	50	Yes
CLASS	Class	Class	String	0	0	50	Yes
TYPE	Type	Type	String	0	0	50	Yes
SUBTYPE	Subtype	Subtype	String	0	0	50	Yes
ATTRIBUTE	Attribute	Attribute	String	0	0	10	Yes
ANTHROPOGENIC	Anthropogenic	Anthropogenic	String	0	0	10	Yes
VEGETATION	Vegetation	Vegetation	String	0	0	10	Yes
EXTENDS	Extends	Extends	String	0	0	3	Yes
BUFFERDIST	BufferDist	BufferDist	Double	0	0	8	Yes
COMMENTS	Comments	Comments	String	0	0	255	Yes
SOURCE_PRIMARY	Source_Primary	Source_Primary	String	0	0	150	Yes
SOURCE_ANCILLARY	Source_Ancillary	Source_Ancillary	String	0	0	150	Yes
SHAPE	Shape	Shape	Geometry	0	0	0	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes
CHANGE_ASSESS	CHANGE_ASSESS	CHANGE_ASSESS	String	0	0	70	Yes
CHANGE_YR_FROM	CHANGE_YR_FROM	CHANGE_YR_FROM	String	0	0	4	Yes
CHANGE_YR_TO	CHANGE_YR_TO	CHANGE_YR_TO	String	0	0	4	Yes
CHANGE_COMMENTS	CHANGE_COMMENTS	CHANGE_COMMENTS	String	0	0	255	Yes

Subtype Name	Default Value	Domain
ObjectClass		
MAJOR		Major
CLASS		Class
TYPE		Type
SUBTYPE		Subtype
EXTENDS		Extends
CHANGE_ASSESS		Change

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

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StudyPlot_Wet

Alias	StudyPlot_Wet	**Geometry:**Polygon
Dataset Type	FeatureClass	**Average Number of Points:**0
		Has M: No
FeatureType	Simple	**Has Z:**No
		Grid Size:0

Field Name	Alias Name	Model Name	Type	Precn.	Scale	Length	Null
OBJECTID	OBJECTID	OBJECTID	OID	0	0	4	No
MAJOR	Major	Major	String	0	0	50	Yes
CLASS	Class	Class	String	0	0	50	Yes
TYPE	Type	Type	String	0	0	50	Yes
SUBTYPE	Subtype	Subtype	String	0	0	50	Yes
ATTRIBUTE	Attribute	Attribute	String	0	0	10	Yes
ANTHROPOGENIC	Anthropogenic	Anthropogenic	String	0	0	10	Yes
VEGETATION	Vegetation	Vegetation	String	0	0	10	Yes
EXTENDS	Extends	Extends	String	0	0	3	Yes
BUFFERDIST	BufferDist	BufferDist	Double	0	0	8	Yes
COMMENTS	Comments	Comments	String	0	0	255	Yes
SOURCE_PRIMARY	Source_Primary	Source_Primary	String	0	0	150	Yes
SOURCE_ANCILLARY	Source_Ancillary	Source_Ancillary	String	0	0	150	Yes
SHAPE	SHAPE	SHAPE	Geometry	0	0	0	Yes
SHAPE_Length	SHAPE_Length	SHAPE_Length	Double	0	0	8	Yes
SHAPE_Area	SHAPE_Area	SHAPE_Area	Double	0	0	8	Yes
CHANGE_ASSESS	CHANGE_ASSESS	CHANGE_ASSESS	String	0	0	70	Yes
CHANGE_YR_FROM	CHANGE_YR_FROM	CHANGE_YR_FROM	String	0	0	4	Yes
CHANGE_YR_TO	CHANGE_YR_TO	CHANGE_YR_TO	String	0	0	4	Yes
CHANGE_COMMENTS	CHANGE_COMMENTS	CHANGE_COMMENTS	String	0	0	255	Yes

Subtype Name	Default Value	Domain
ObjectClass		
MAJOR		Major
CLASS		Class
TYPE		Type
SUBTYPE		Subtype
VEGETATION		Vegetation
EXTENDS		Extends
CHANGE_ASSESS		Change

Index Name	Ascending	Unique	Fields
FDO_OBJECTID	Yes	Yes	OBJECTID
FDO_SHAPE	Yes	No	SHAPE

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Topologies

Name: Flowlines_Topology

Cluster Tolerance: 0.001
Maximum Generated Error Count: Undefined

Feature Class	Weight	XY Rank	Z Rank	Event Notification
StudyPlot_Flowlines	5	1	1	No

Topology Rules

Name	Origin (*FeatureClass::Subtype*)	Rule Type	Destination (*FeatureClass::Subtype*)	Trigger Events
	StudyPlot_Flowlines:: All Subtypes	Must not have dangles	StudyPlot_Flowlines:: All Subtypes	No

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Name: Polys_Topology

Cluster Tolerance: 0.001
Maximum Generated Error Count: Undefined

Feature Class	Weight	XY Rank	Z Rank	Event Notification
StudyPlot_Polys	5	1	1	No

Topology Rules

Name	Origin (*FeatureClass::Subtype*)	Rule Type	Destination (*FeatureClass::Subtype*)	Trigger Events
	StudyPlot_Polys:: All Subtypes	Must not have gaps	StudyPlot_Polys:: All Subtypes	No
	StudyPlot_Polys:: All Subtypes	Must not have overlaps	StudyPlot_Polys:: All Subtypes	No

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Name: Up_Topology

Cluster Tolerance: 0.001
Maximum Generated Error Count: Undefined

Feature Class	Weight	XY Rank	Z Rank	Event Notification
StudyPlot_Up	5	1	1	No

Topology Rules

Name	Origin (*FeatureClass::Subtype*)	Rule Type	Destination (*FeatureClass::Subtype*)	Trigger Events
	StudyPlot_Up:: All Subtypes	Must not have overlaps	StudyPlot_Up:: All Subtypes	No
	StudyPlot_Up:: All Subtypes	Must not have gaps	StudyPlot_Up:: All Subtypes	No

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Name: Wet_Topology

Cluster Tolerance: 0.001
Maximum Generated Error Count: Undefined

Feature Class	Weight	XY Rank	Z Rank	Event Notification
StudyPlot_Wet	5	1	1	No

Topology Rules

Name	Origin (*FeatureClass::Subtype*)	Rule Type	Destination (*FeatureClass::Subtype*)	Trigger Events
	StudyPlot_Wet:: All Subtypes	Must not have overlaps	StudyPlot_Wet:: All Subtypes	No

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Spatial References

Dimension	Minimum	Precision
StudyPlot_year		
X	-16909700	10000

Y	-8597000	
M	-100000	10000
Z	-100000	10000

Coordinate System Description

PROJCS["NAD_1983_California_Teale_Albers",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Albers"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",-4000000.0],PARAMETER["central_meridian",-120.0],PARAMETER["Standard_Parallel_1",34.0],PARAMETER["Standard_Parallel_2",40.5],PARAMETER["latitude_of_origin",0.0],UNIT["Meter",1.0],AUTHORITY["EPSG",3310]]

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Appendix C: Examples of Each Wetland Class to Assist in Mapping and Interpretation

Please note that the assigned attribute codes are current as of August 2014, but are subject to change.

List of Figures

Wetland - Depressional

Figure C1: Golf course ponds. Depressions (WD) with shallow open water and some areas of emergent vegetation. WDdd when a visible outlet was observed, WDdu when no visible outlet was observed.

Figure C2: Color-Infrared NAIP imagery showing emergent vegetation (EM) in a golf course pond as pink.

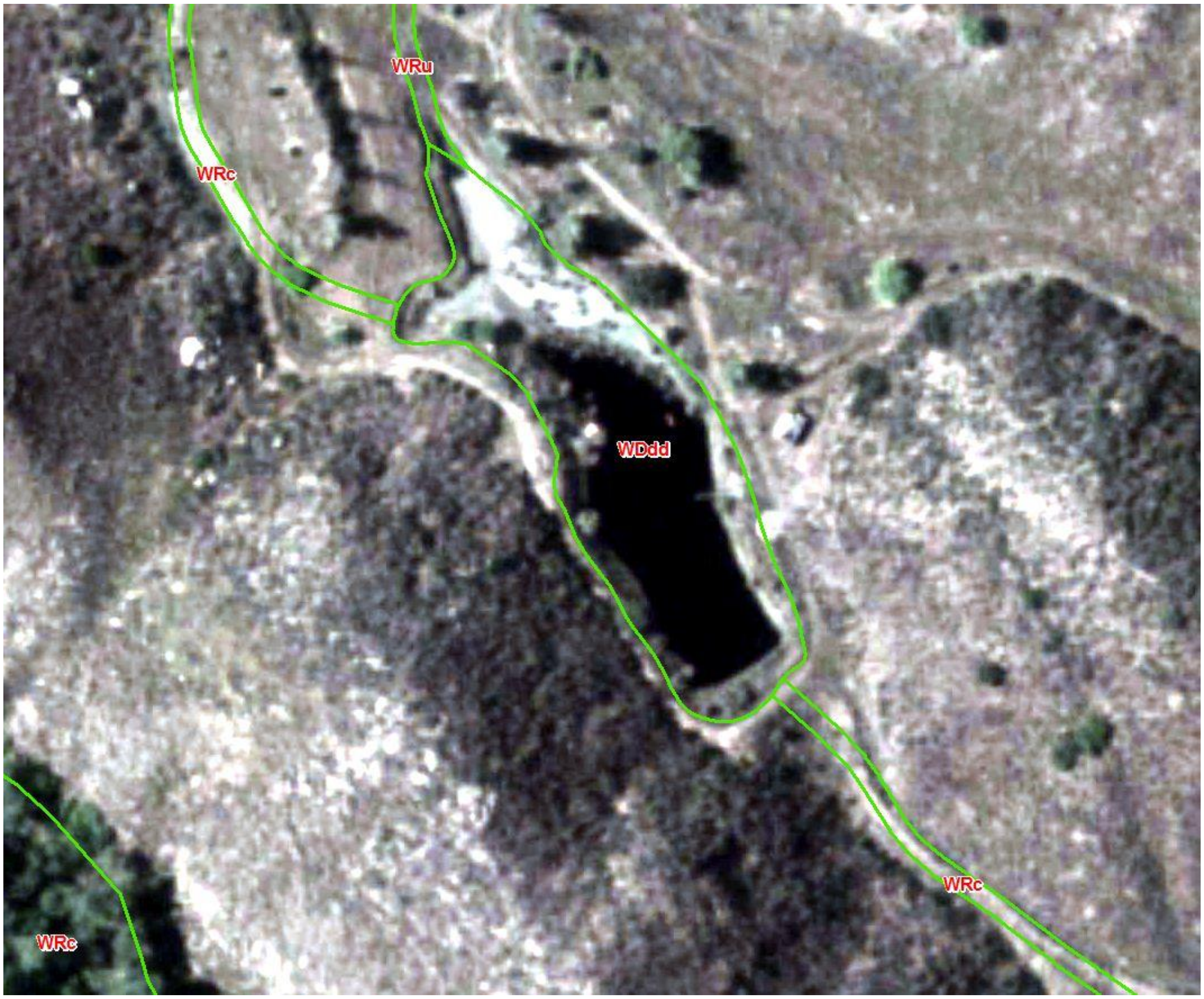


Figure C3: In-channel depressional wetland (WDdd) caused by stream impoundment.

Figure C4: In-channel depressional wetland (WDdd), created by impoundment.

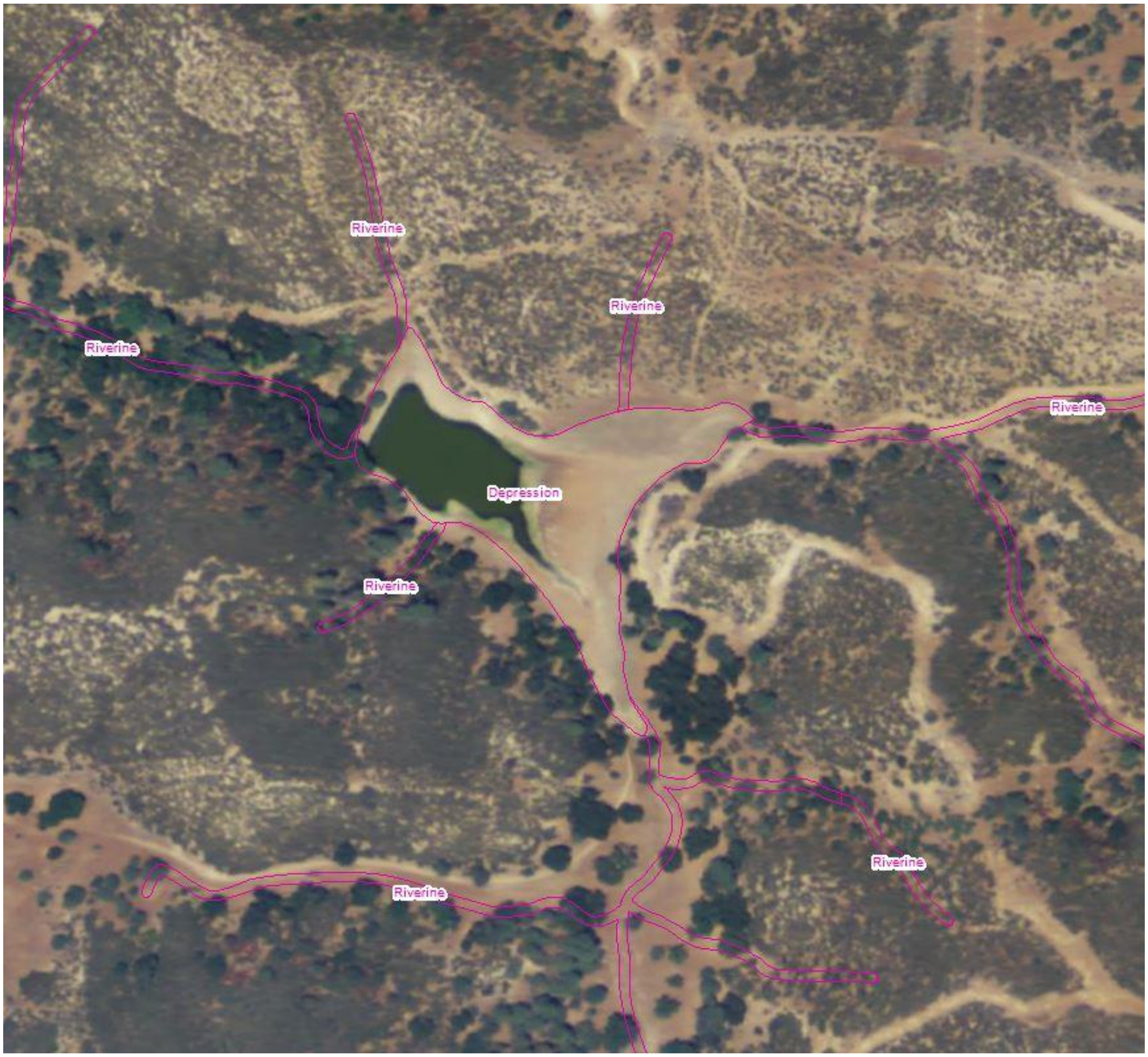


Figure C5: Delineate depressional wetlands (WD) to the visible outward extent of the draw-down zone, or OHW boundary.

Figure C6: When a riverine feature is flowing into a depression, delineate the depression to the outward extent of the apparent drawdown zone.

Figure C7: Where potential in-channel depressions are not impounded and have predominantly flow-through hydrology, they are to be classified as part of the riverine (WR) channel.

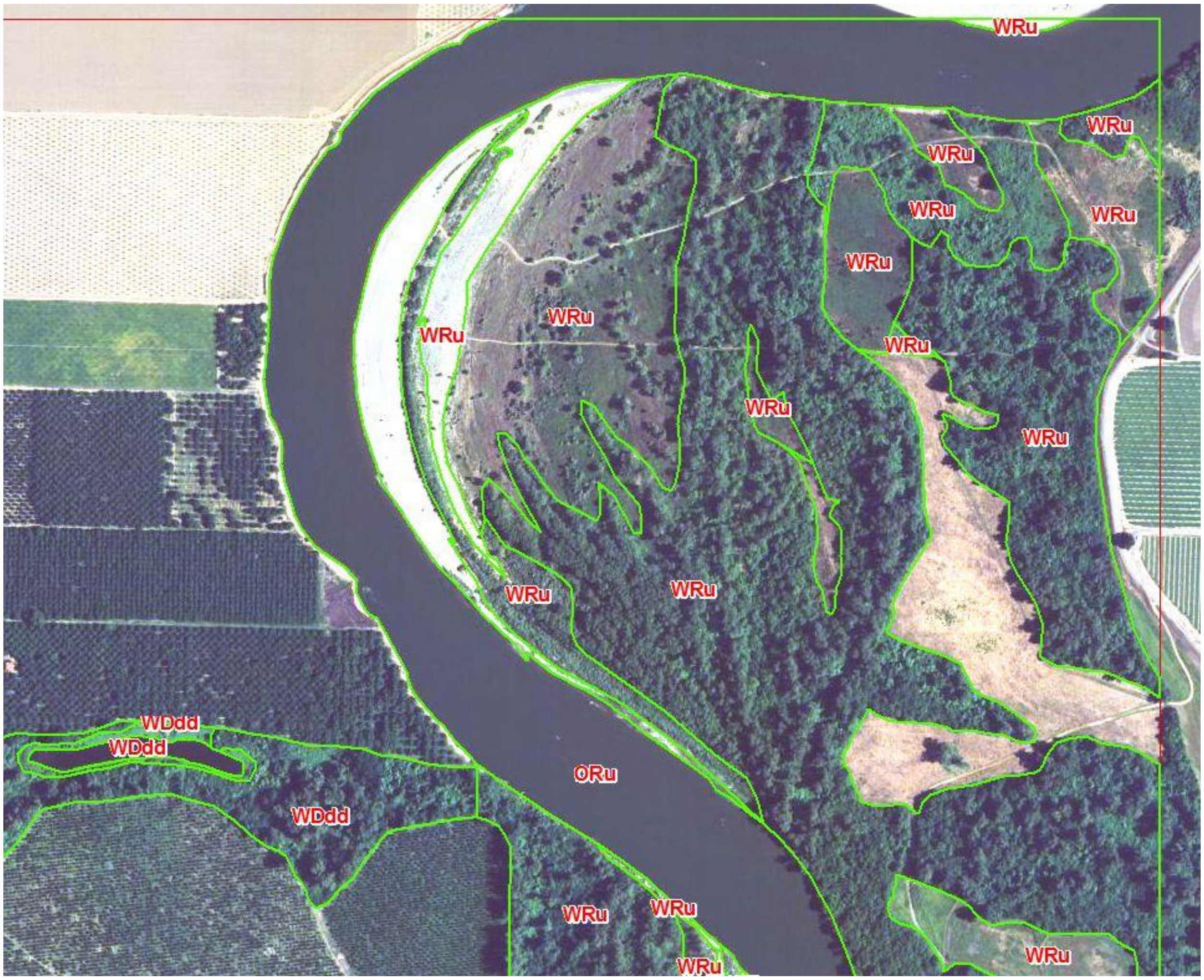


Figure C8: Example of river, floodplain, and oxbow depression.

Open Water/Wetland - Lacustrine

NAIP 2005

NAIP 2012

Figure C9: Approximate lacustrine OHW boundary line shown above in blue. Note the difference in extent between the 2005 and 2012 imagery. Multiple years of imagery should be used to determine the OHW line.

Wetland - Slope

Wetland – Slope

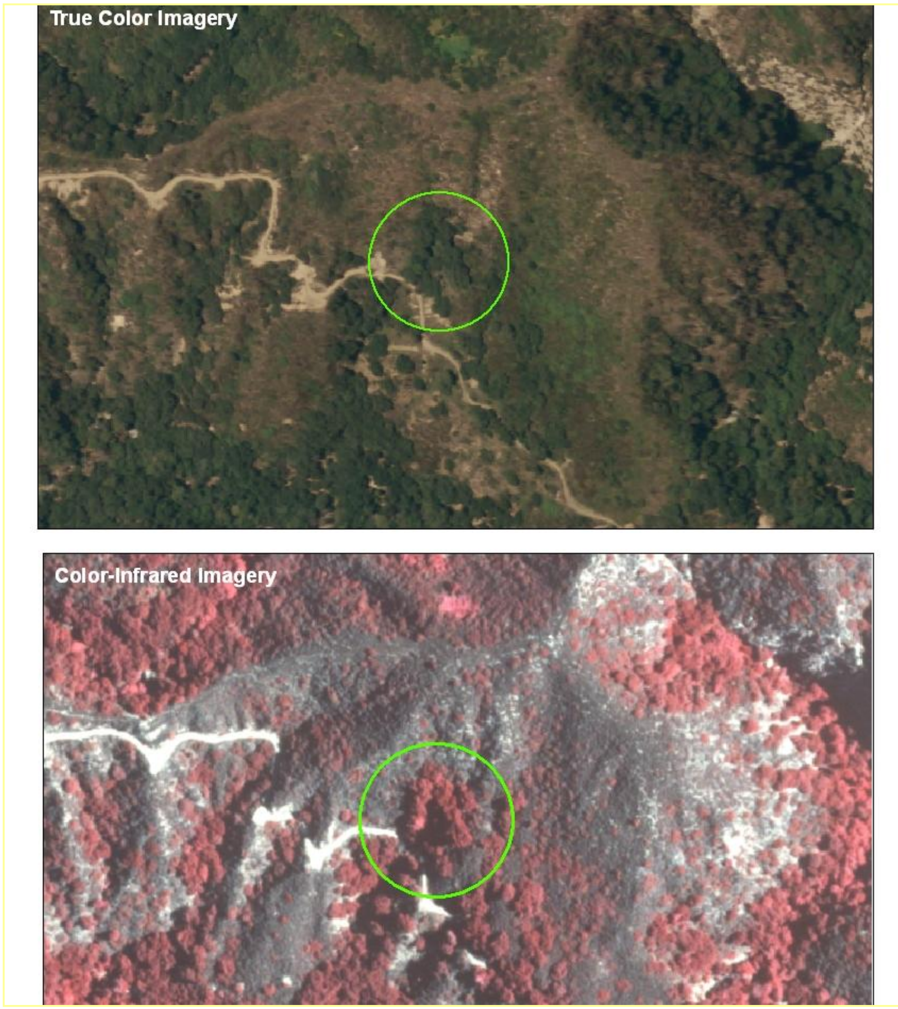


Figure C10: Color-Infrared imagery often shows a brighter pink for areas of slope wetlands (WS).


Bing bird's eye view

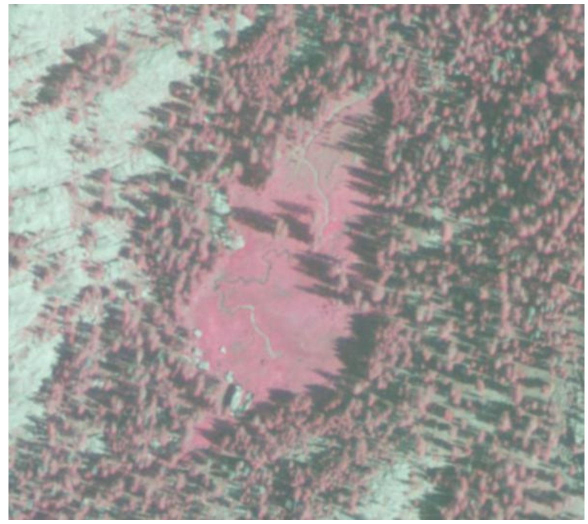
Figure C11: (Above 3 screenshots are of same location.) Downstream from the Millard Canyon Picnic Area, example of slope wetland (WS) in Southern California.

Springs

Figure C12: Check DRG and NHD datasets for springs that might not be visible on the imagery. If a spring exists in one of these two collateral datasets but is not visible in the imagery, buffer the point by 8 m and label as a slope wetland (WSs).

Wet Meadows

NAIP True-Color



NAIP CIR

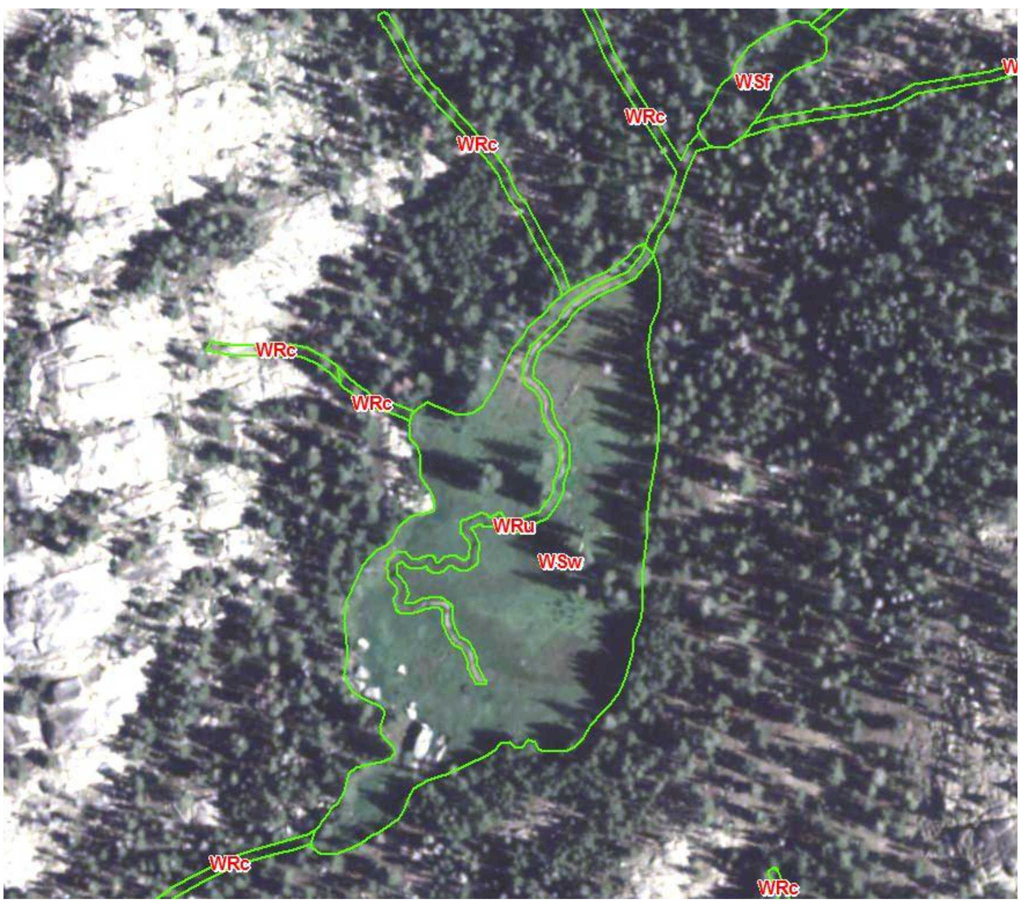
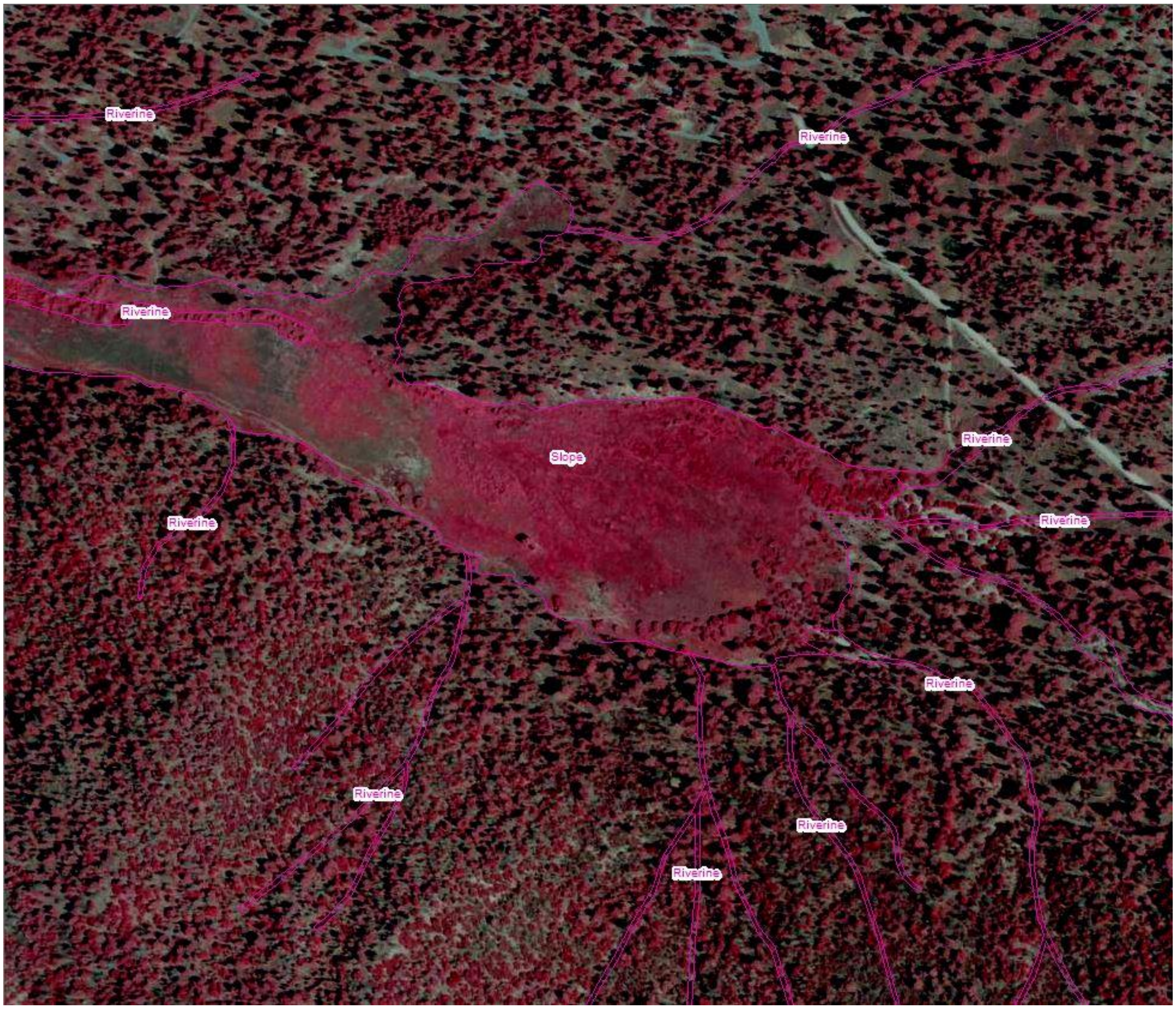


Figure C13: Examples of a wet meadow slope wetland (WSw). Visible surface stream channel classified as riverine within meadow as Wetland, Riverine, unconfined (WRu).



NAIP 2005 CIR

Figure C14: Wet meadow slope wetland (WSw),

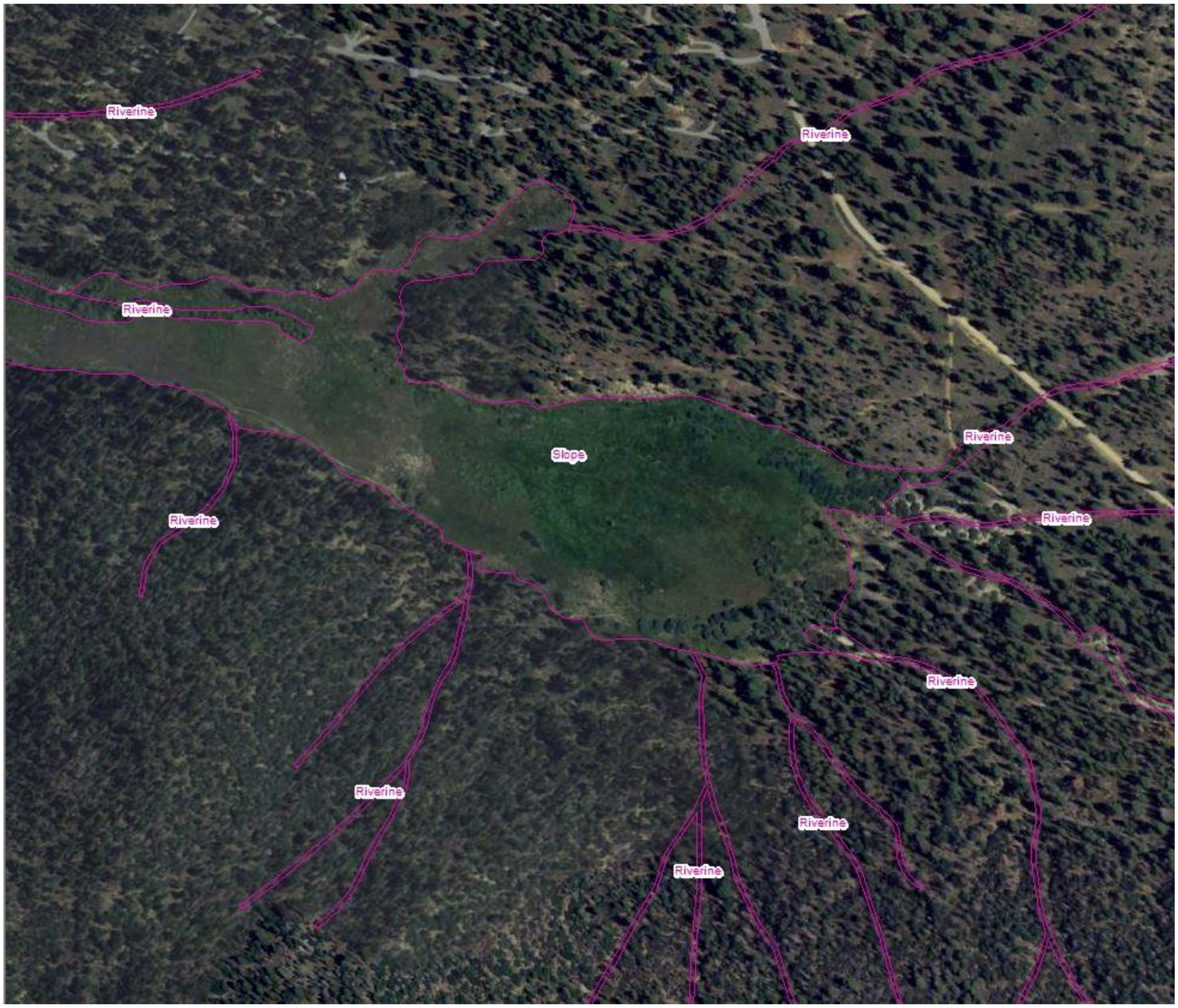


Figure C15: Wet meadow slope wetland (WSw), NAIP 2005 True Color. If a surface channel is clearly visible through a slope wetland, bisect the slope polygon; otherwise, slope wetland is not divided by riverine channels.

Open Water/Wetland - Estuarine

Figure C16: San Diego Bay – Estuarine open embayment (OEb and WEb).

Figure C17: Agua Hedionda – Estuarine open embayment (OEb and WEb).

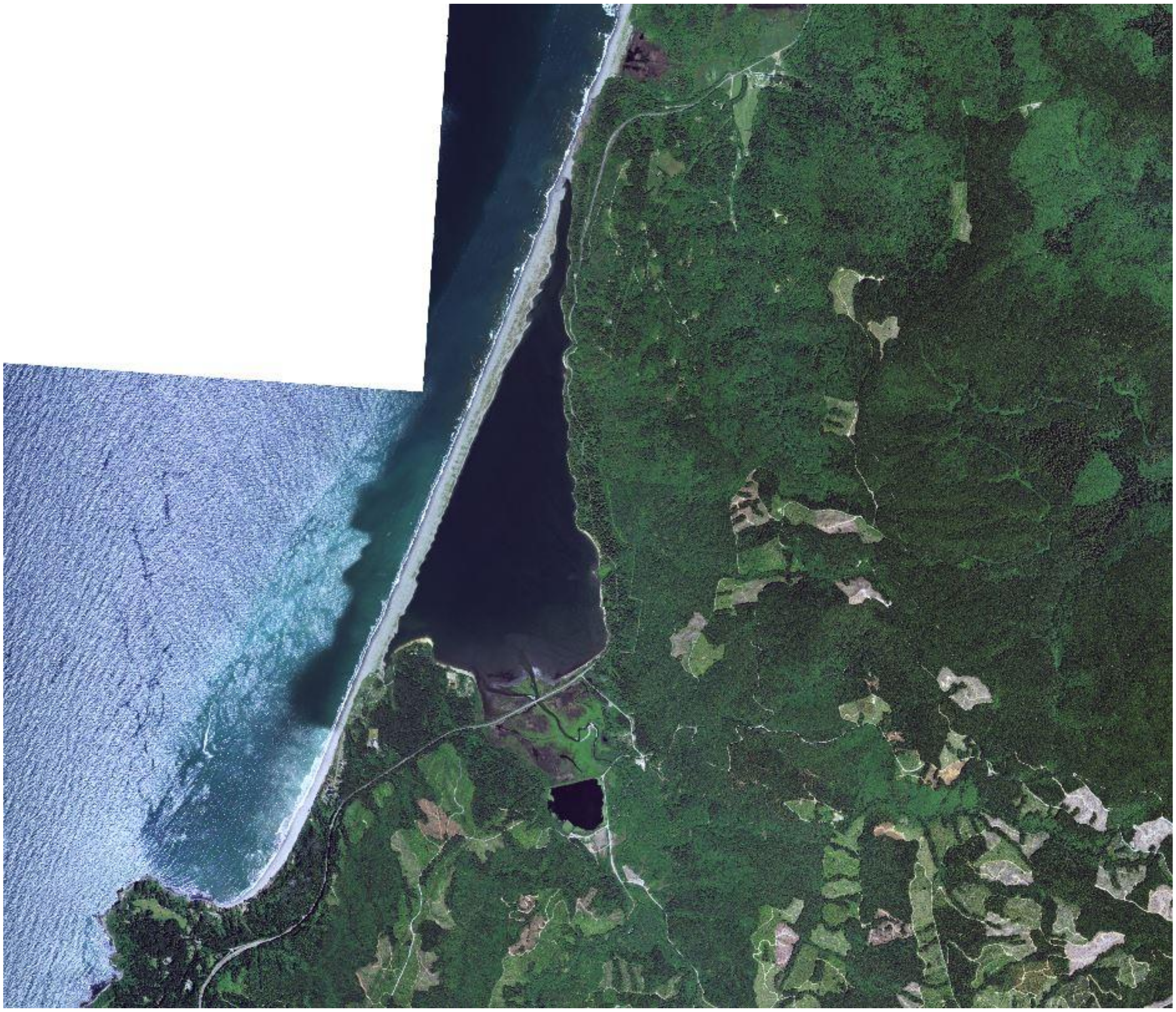


Figure C18: Big Lagoon – Estuarine lagoon/dune strand (OEl and WEl).

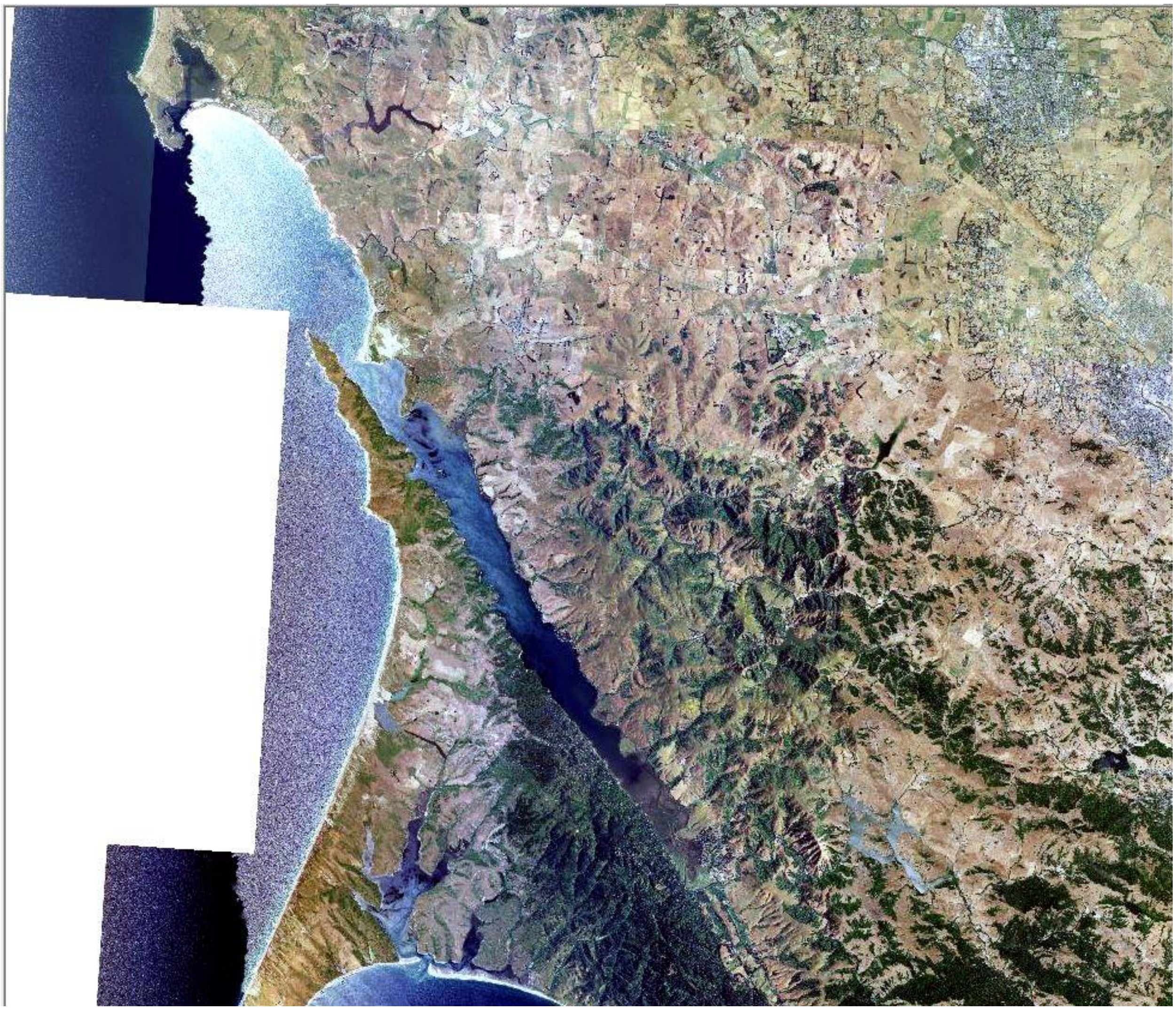


Figure C19: Tomales Bay – Estuarine open embayment (OEb and WEb).

Figure C20: Batiquitos Lagoon – Estuarine open embayment (OEb and WEb).

Figure C21: San Elijo – Estuarine open embayment (OEb and Web.

Figure C22: Santa Margarita River – Estuarine bar-built (WEr).

Figure C23: Mission Bay and San Diego River.

Figure C24: Coastal lagoons in San Diego county – lower feature is an estuarine lagoon/dune strand (WEl). Upper feature is estuarine bar -built (WEr).

Figure C25: Arroyo Hondo – Estuarine bar-built (WEr).

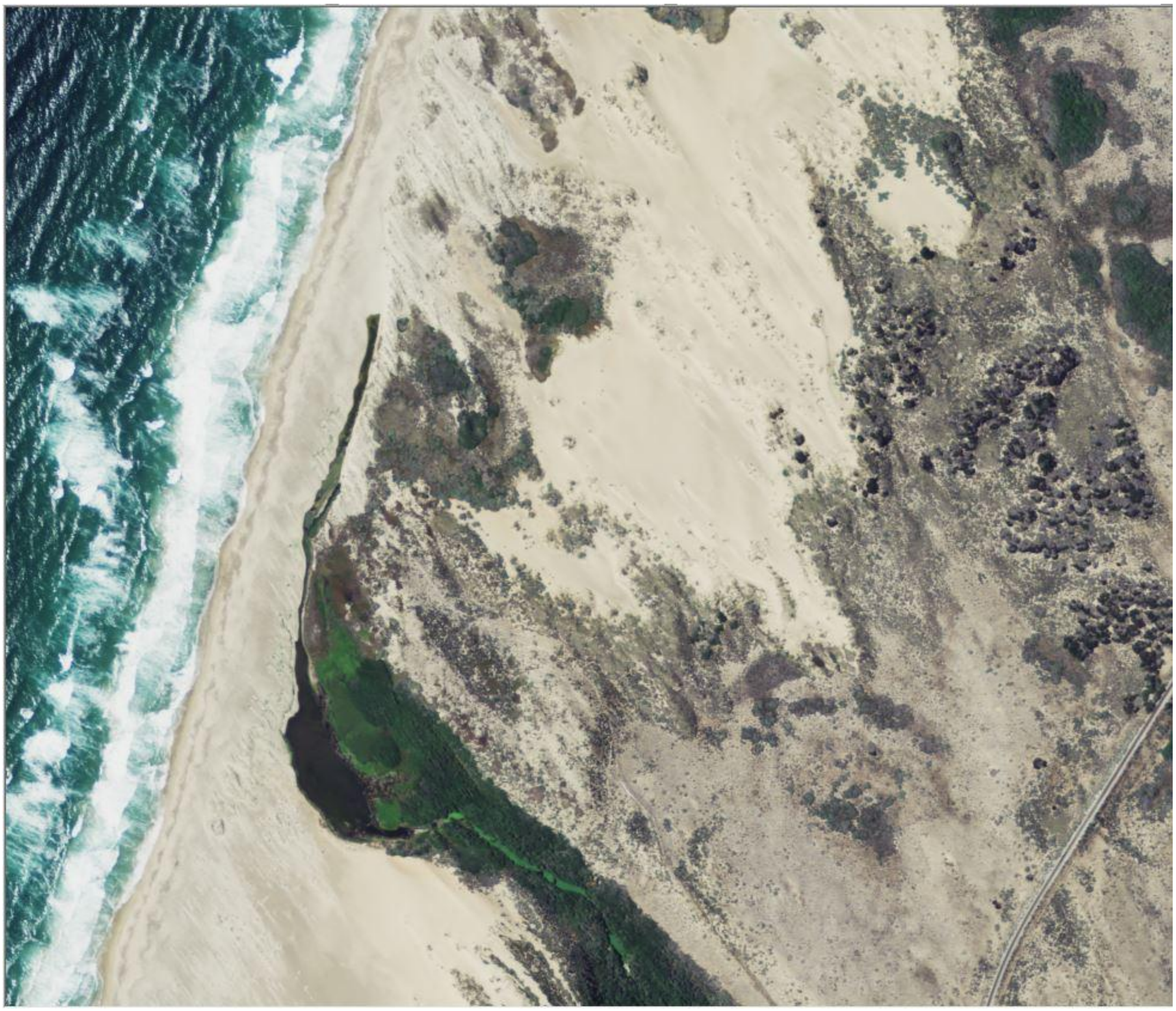


Figure C26: Vandenberg AFB dune field – Estuarine bar-built (WEr) and Estuarine lagoon/dune strand (WEl).

Figure C27: Oceano Dunes SRA – Oso Fluco Creek – Estuarine lagoon/dune strand (WEI).

Figure C28: Storm drain. Do not map.

Estuarine Mapping Considerations

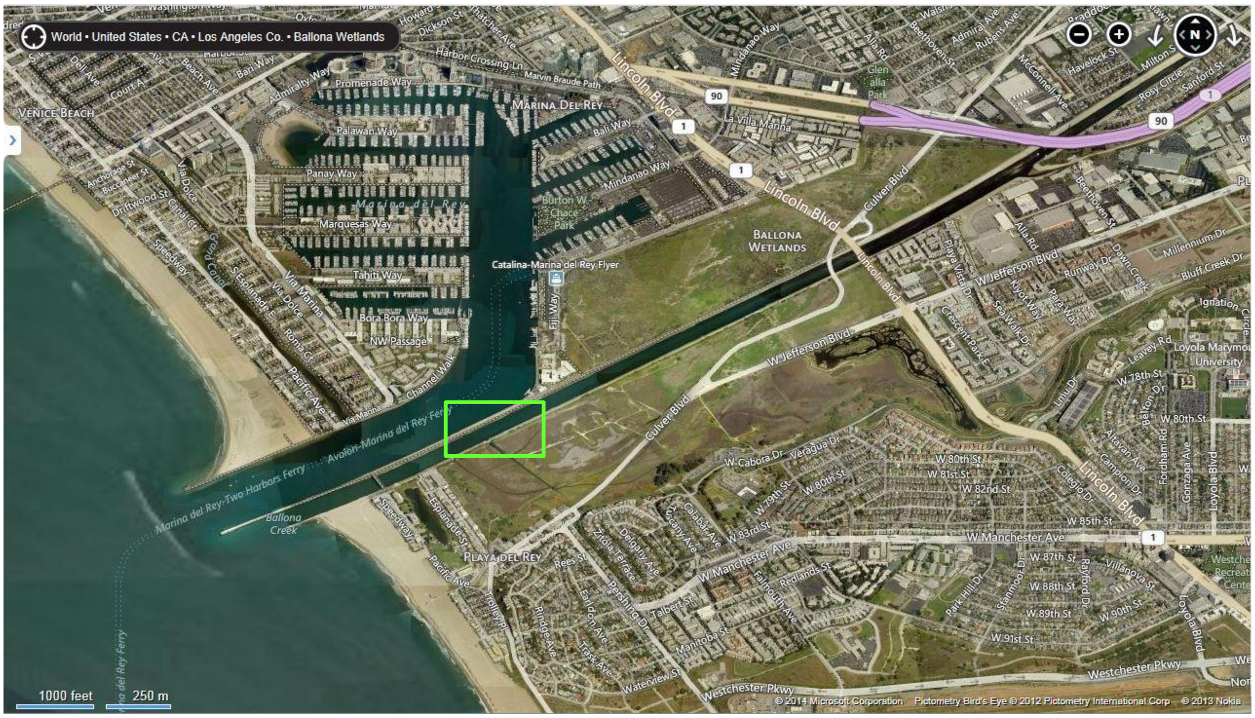


Figure C29: Ballona Wetlands, Southern California, example of estuary with muted tidal action (OE, WE). Culverts with flap gates allow limited amounts of sea water into the marsh via Ballona Creek (per CWIS). SoCal-specific.

Figure C30: San Dieguito with the NOAA CUSP dataset MHW line. Division between estuarine area and marine area is made at the continuation of the shoreline across the mouth of the estuary.

Figure C31: Because there is a surface channel visible upstream, this was digitized as a wetland. Had there been no channel visible upstream, only a storm drain emptying into the ocean, there would have been no wetlands digitized.

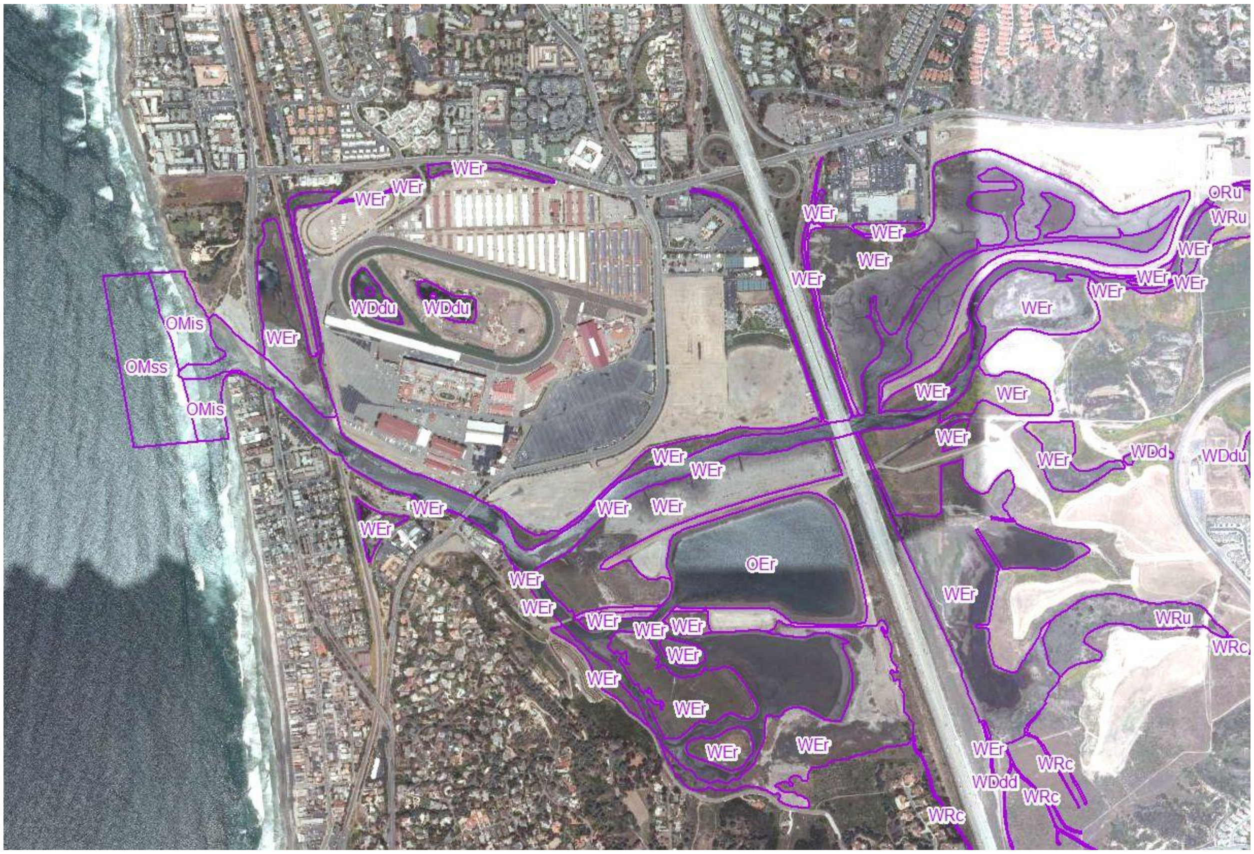


Figure C32: San Dieguito estuary: example classification of Bar-built Estuary.

Figure C33: Santa Ynez River, Bar-built estuary is open in 2005 NAIP imagery (above), but closed in 2010 NAIP imagery (below). Similar to the high water line for depressions, delineate bar-built estuary wetlands (WEr) to the visible outward extent of the draw-down zone, or OHW boundary.

Figure C34: Sant Clara River, Bar-built estuary in open vs. closed condition.

Riverine to Estuarine Transition

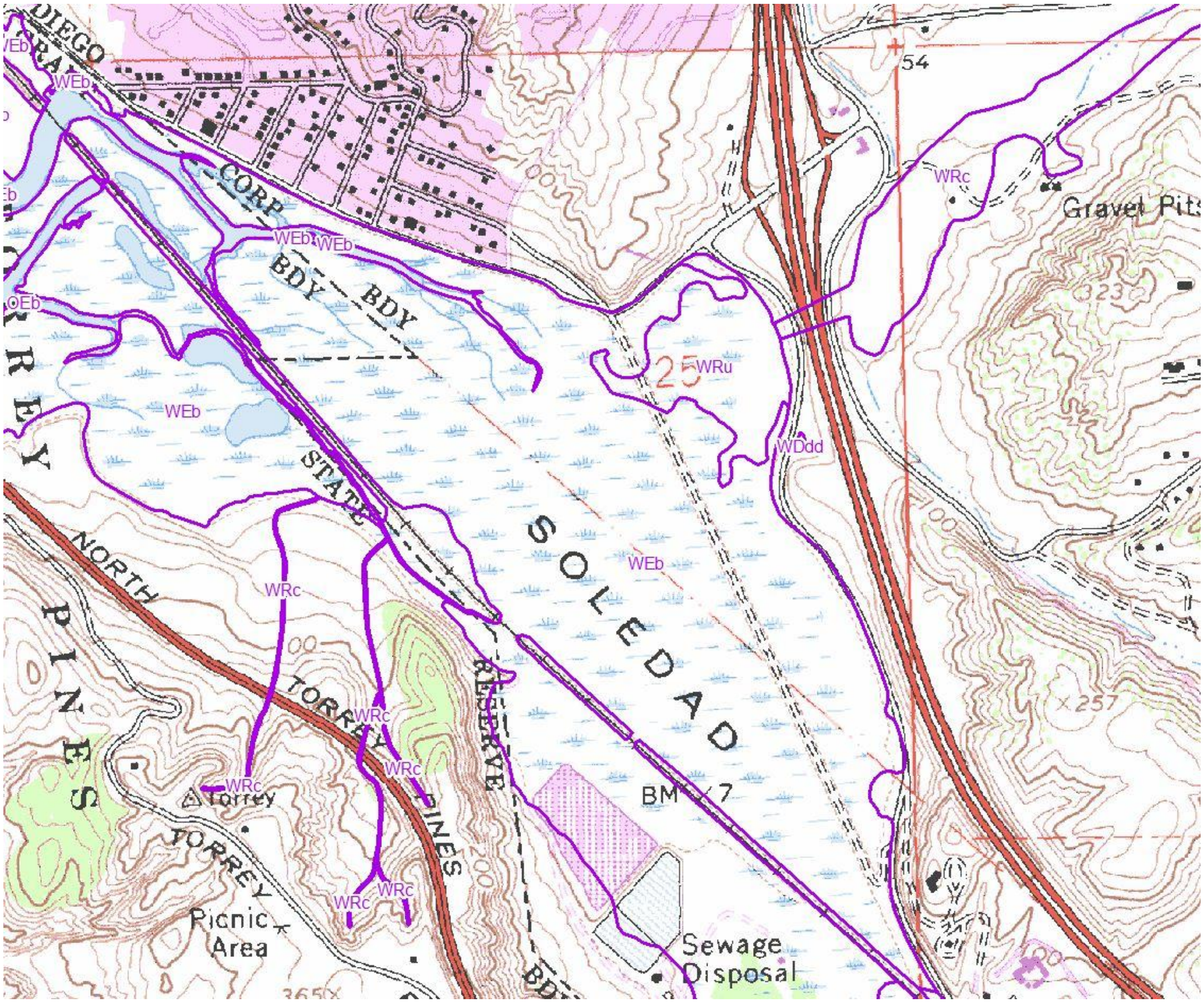


Figure C35: Transition from riverine to estuarine. Los Penasquitos Lagoon DRG. DRG indicates swampy area near river mouth; however, use imagery to determine dominant process and delineate in transition zone.

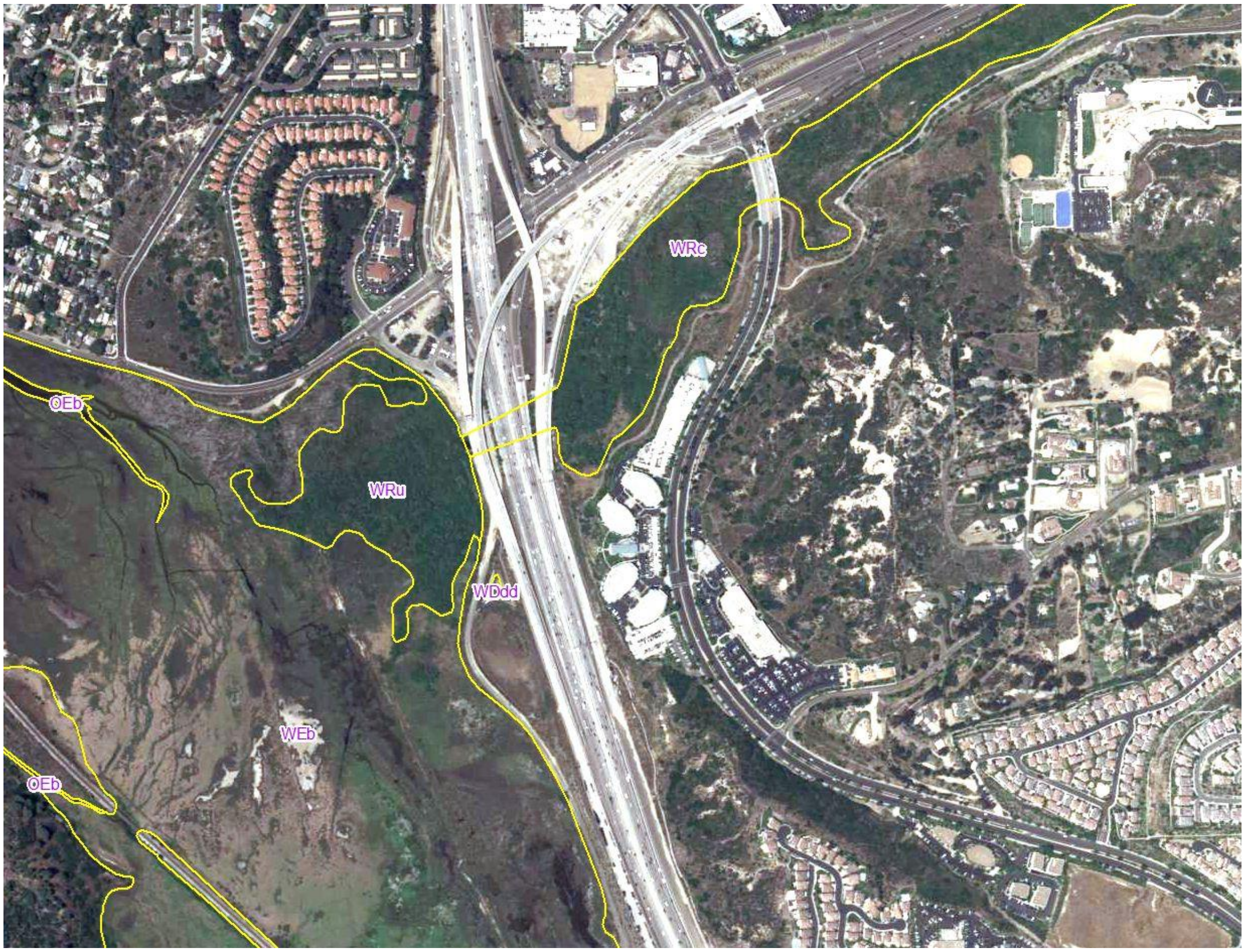


Figure C36: Transition from Riverine to Estuarine. Los Penasquitos Lagoon true-color NAIP. Use vegetation indicators.

Figure C37: Transition from Riverine to Estuarine. Los Penasquitos Lagoon CIR. Use vegetation indicators.

Figure C38: Transition from Riverine to Estuarine. Los Penasquitos Lagoon true-color NAIP. Use vegetation indicators.

Figure C39: Transition from Riverine to Estuarine. Los Penasquitos Lagoon CIR. Use vegetation indicators.

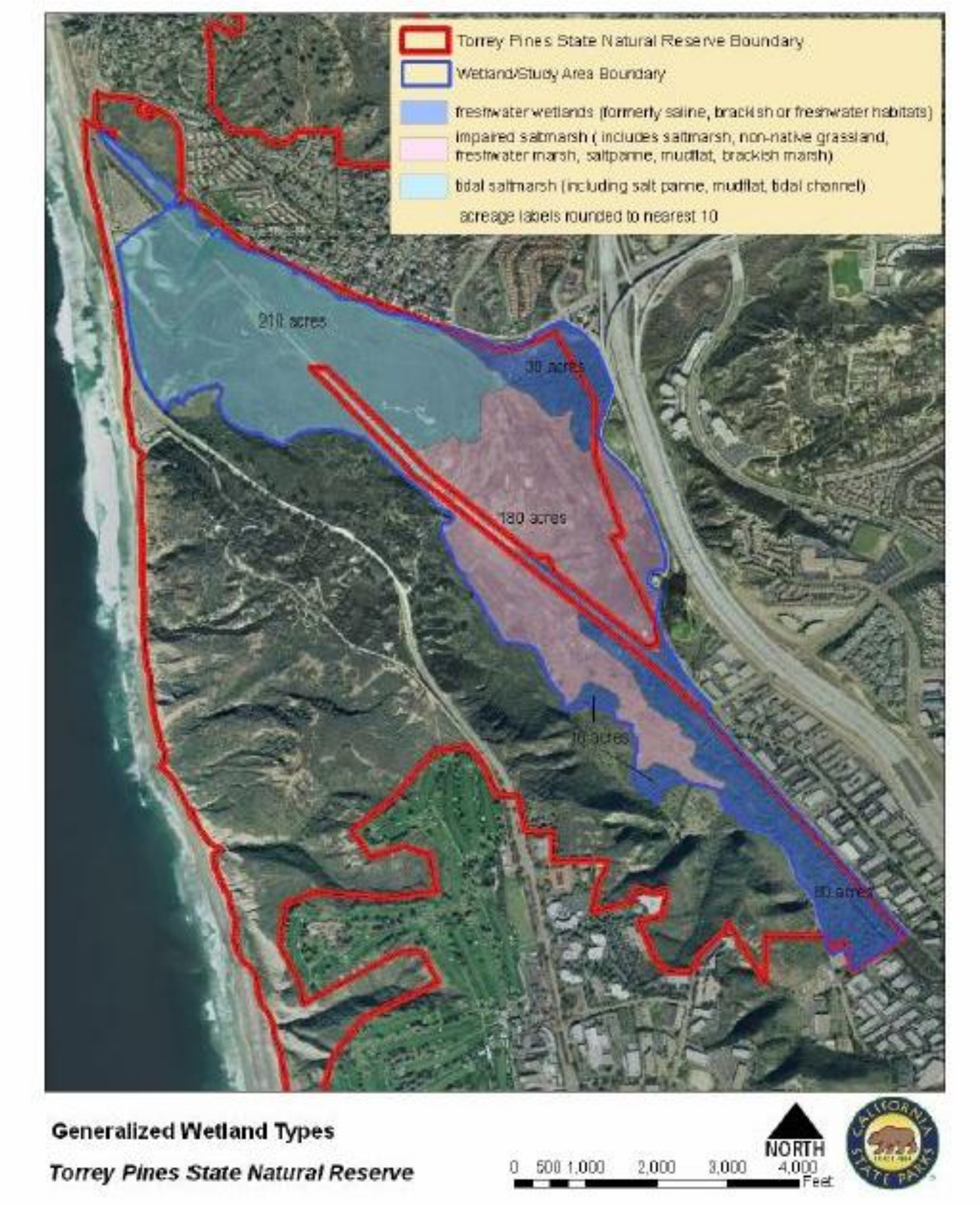


Figure C40: Wetland habitats within Los Peñasquitos Lagoon (California State Parks, 2010).

Open Water – Marine

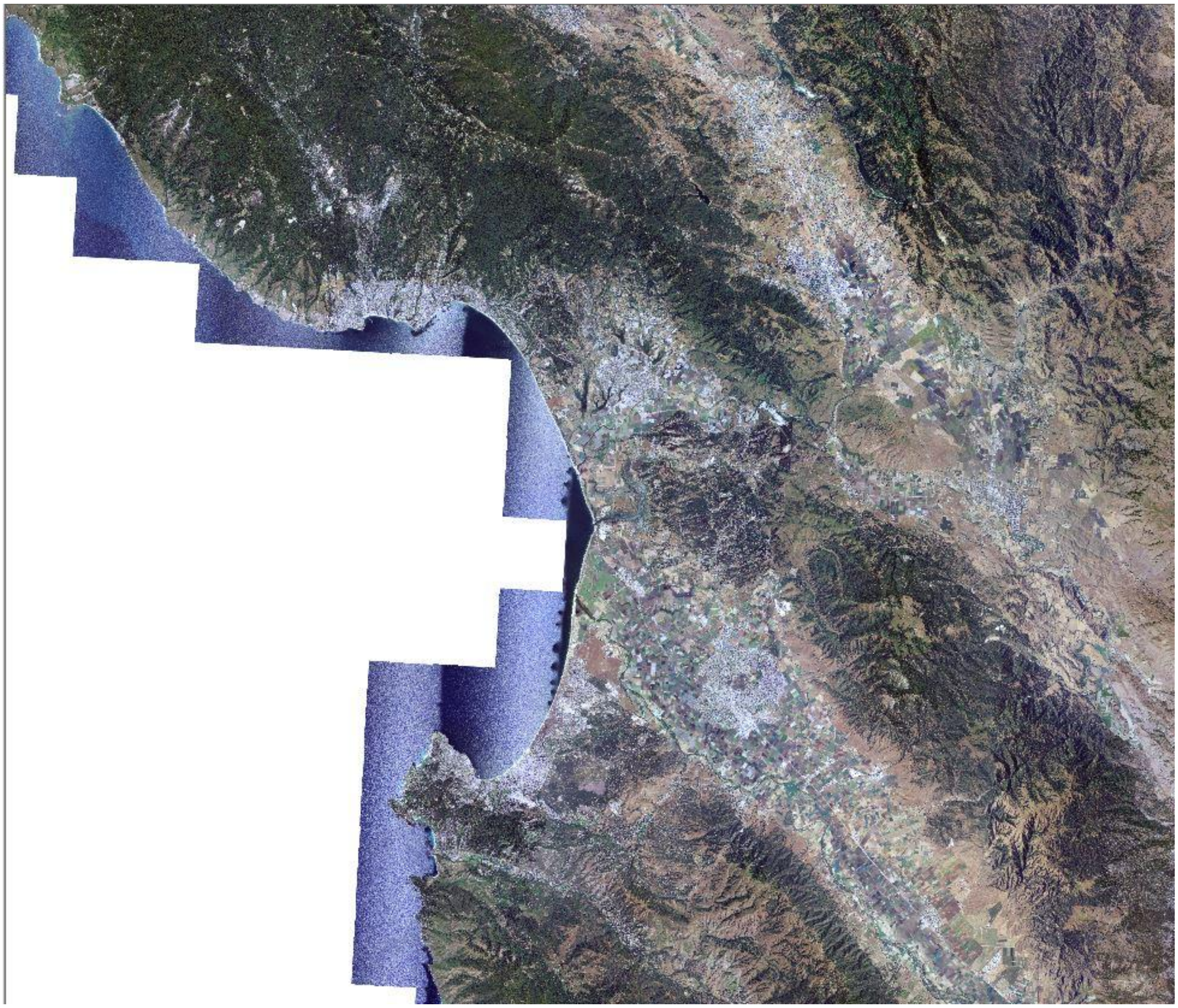


Figure C41: Monterey Bay – Open Water Marine Subtidal Embayment (OMse).

Figure C42: SoCal, Dana Point Harbor. Example of an artificially constructed marina with no appreciable freshwater input (except local nuisance runoff). Should be considered Open Water Marine (OM).

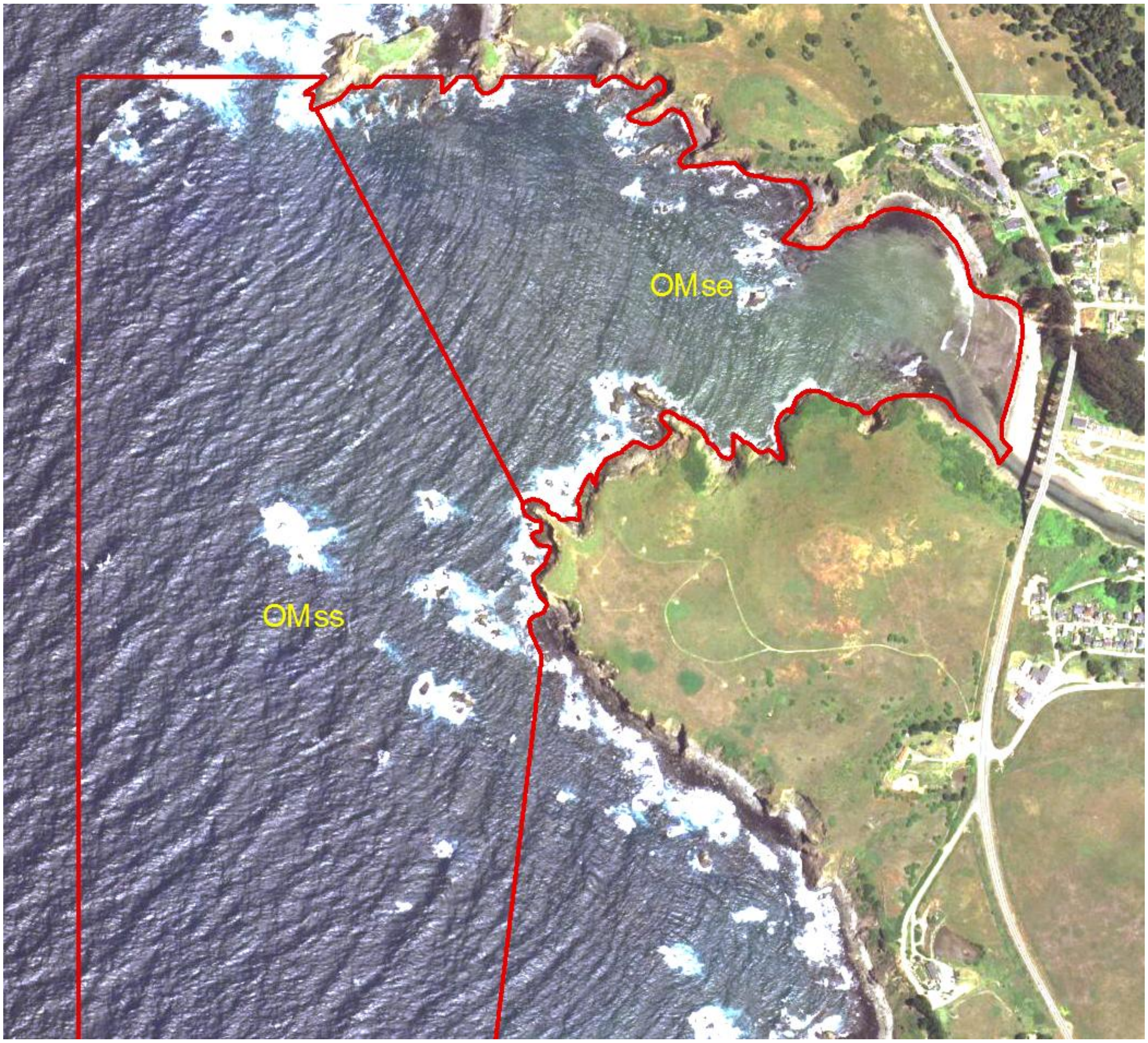


Figure C43: Estuary and marine boundary is the Mean high tide line (not shown). Example of a Marine Embayment (OMse) and Marine Exposed Shore (OMss).

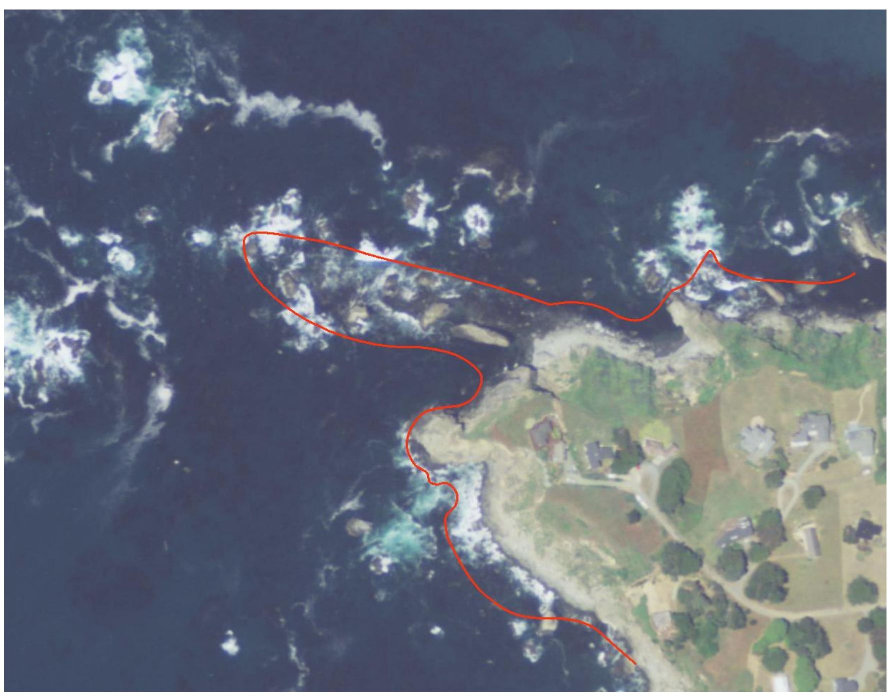


Figure C44: When mapping intertidal areas, it is helpful to scroll through all available imagery and compare water levels. Imagery above shows exposed rocky coast. Same area at different tidal stage shows significant inundation. Intertidal area classified as OMis, subtidal area classified as OMss.

Open Water/Wetland – Riverine

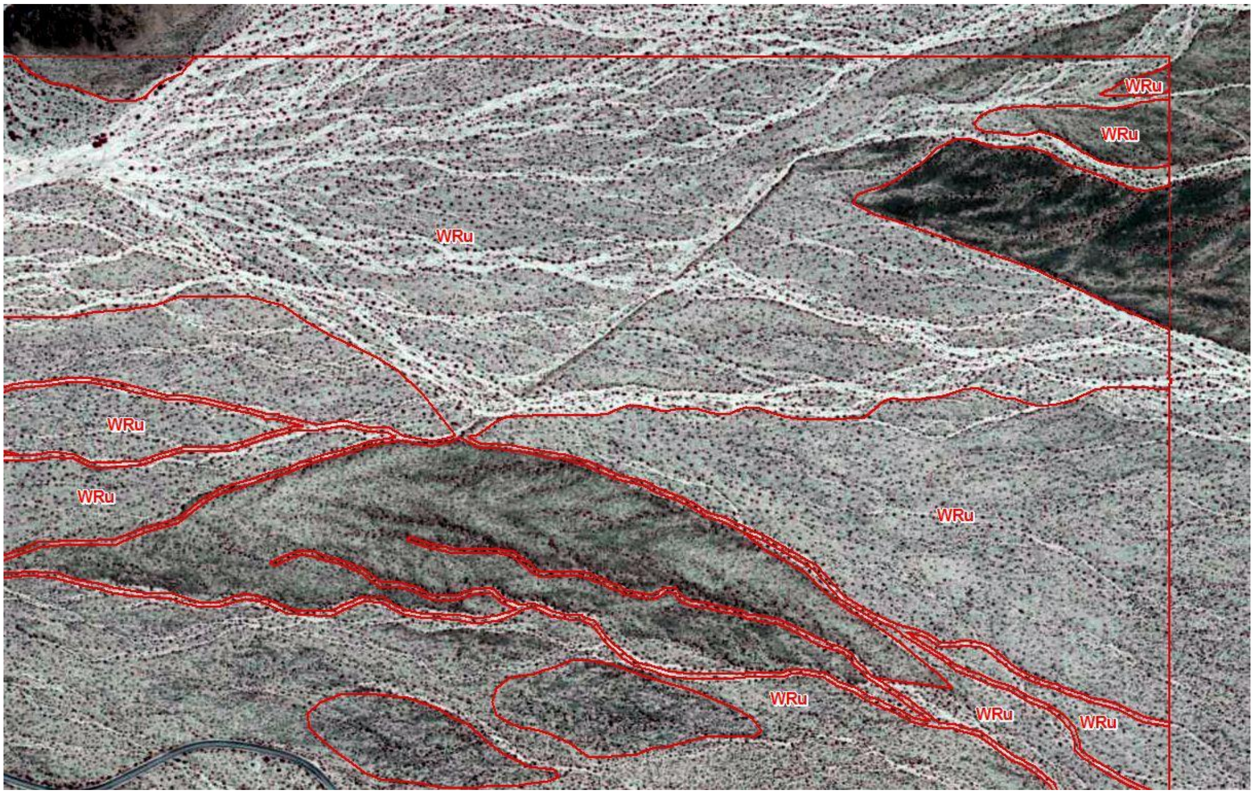


Figure C45: Example of riverine channel in desert area. Delineate areas of scour as active floodplain.

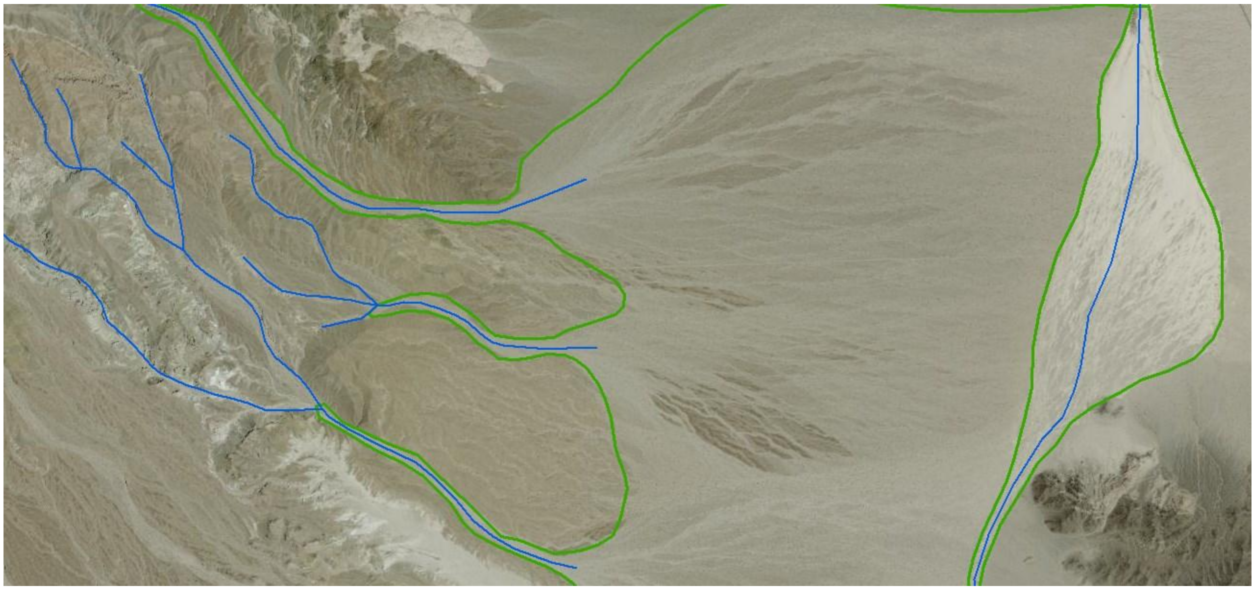


Figure C46: Example of an alluvial fan-- Map active channels and alluvial fans. Flow lines can end in at the distributary. The polygon should include all of the active alluvial fan.

Figure C47: Channels with widening riparian area - Map the riparian vegetation when the DRG contours indicate a widening of the channel. Map only vegetation inside the banks of the riverine wetland.

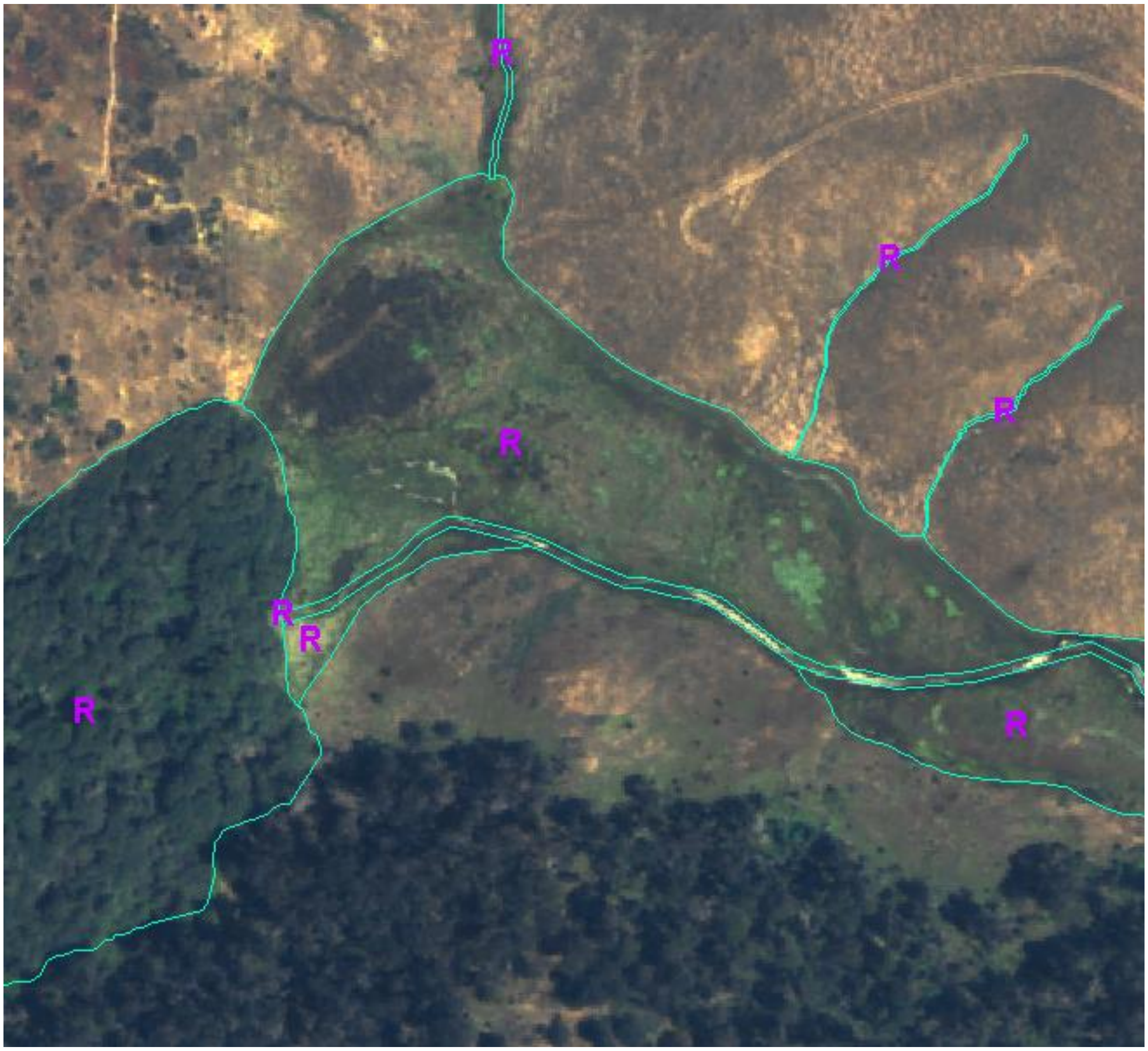


Figure C48: Channel with apparent channel and wide floodplain - If a channel's banks are apparent in the imagery, digitize the stream from bank to bank as a polygon in the wetland layer and attribute with appropriate channel classification.

Figure C49: Channels in a wide floodplain.

Figure C50: Example of a riverine system. Width of active floodplain in red (OR, WR).

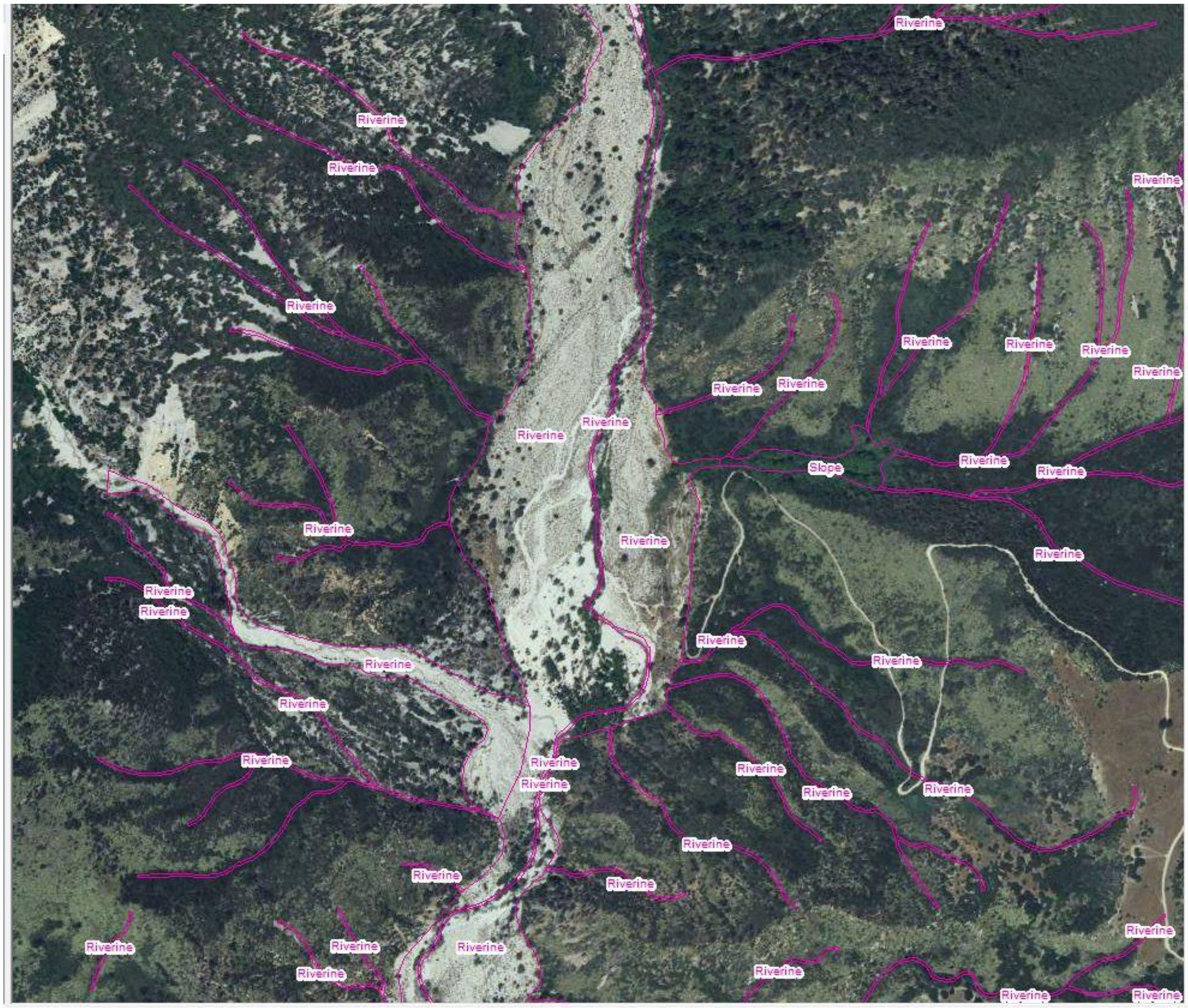


Figure C51: Floodplains: Delineate to the extent of active floodplain.

Figure C52: Riverine polygon delineation: True color imagery.

Figure C53: Riverine polygon delineation: color infrared (CIR) imagery.

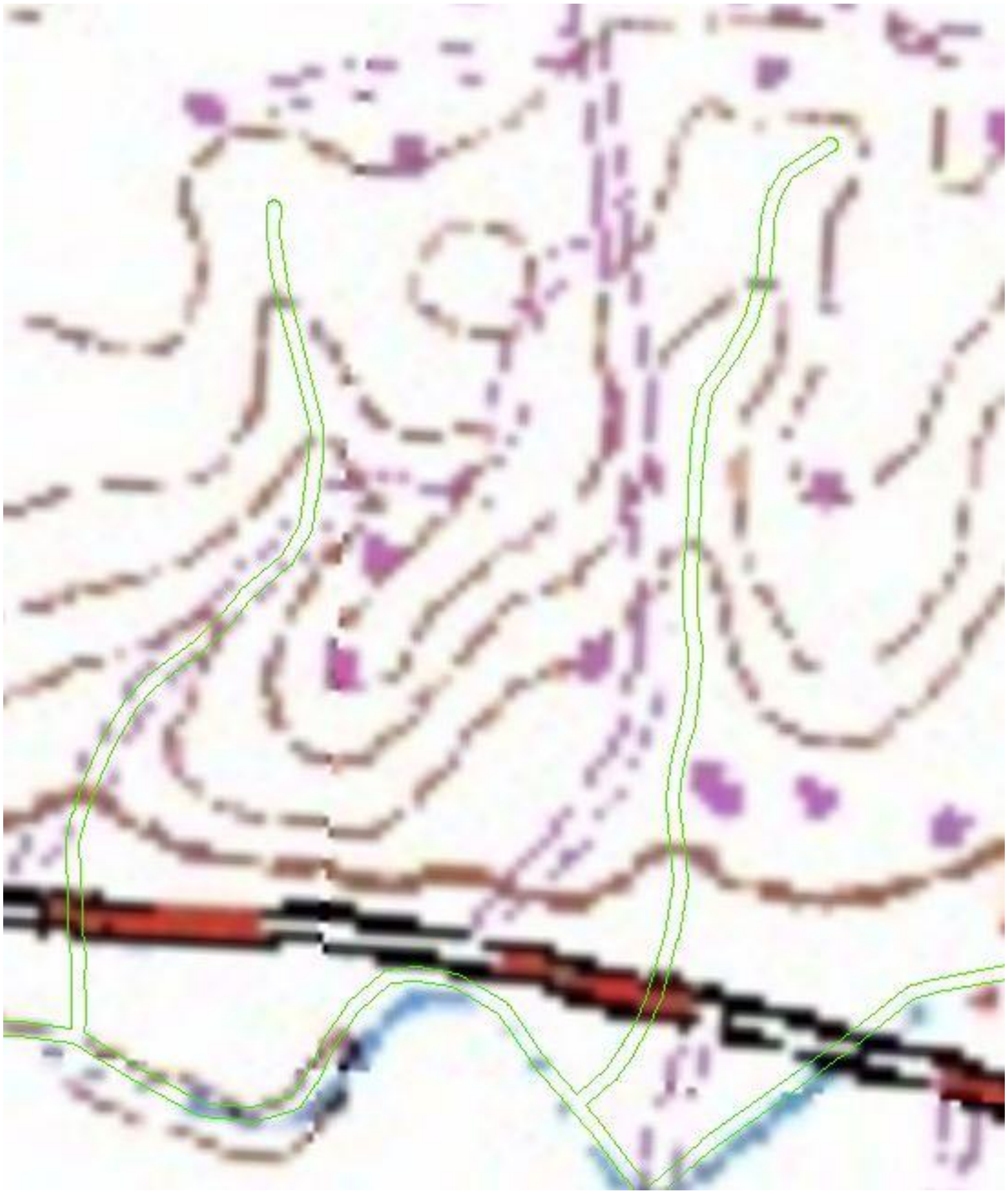


Figure C54: Riverine polygon delineation: DRG.

Figure C55: Riverine polygon delineation example: corrections.

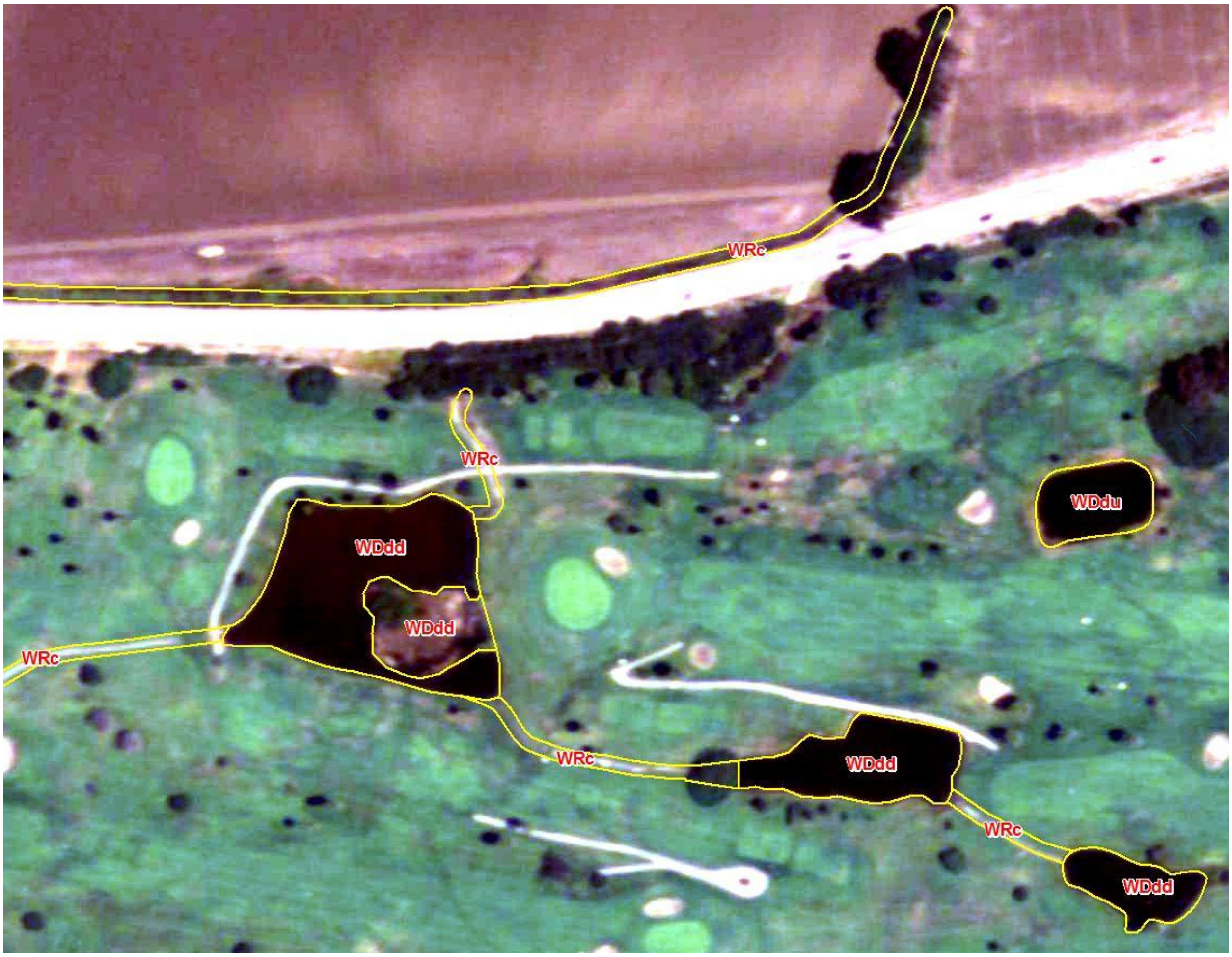


Figure C56: Excavated channel along farmland that appears to support wetland vegetation (WRc, vegetation modifier EM, anthropogenic modifiers a and j).