NORTH COAST INSTREAM FLOW POLICY

POTENTIAL INDIRECT ENVIRONMENTAL IMPACTS OF MODIFICATION OR REMOVAL OF EXISTING UNAUTHORIZED DAMS

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Division of Water Rights

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POTENTIAL INDIRECT ENVIRONMENTAL IMPACTS OF MODIFICATION OR REMOVAL OF EXISTING UNAUTHORIZED DAMS

The North Coast Instream Flow Policy (Policy) may contain permitting requirements for onstream dams. These proposed requirements are needed to prevent negative impacts on anadromous salmonids and their habitat. If the State Water Board adopts a Policy with these requirements, dam owners may have to modify or remove existing unauthorized dams to comply with the Policy. These actions by dam owners could give rise to environmental impacts. These potential environmental impacts are referred to as 'indirect' impacts because they are not immediately related to adoption of the Policy but may occur as a result of the Policy being adopted.

This report estimates the number, onstream storage volume, and onstream surface area of estimated existing unauthorized dams that might be affected by the proposed Policy and estimates the potential indirect environmental impacts that might be caused by owners removing or modifying these dams.

In this study, existing unauthorized dams with pending water right applications are estimated using data from the State Water Board's Water Rights Information Management System (WRIMS) database. Existing unauthorized dams that have no water right application on file at the State Water Board are estimated using a geographic information system (GIS) analysis based on available data. Table ES.1 summarizes the estimated number, onstream storage volume, and onstream surface area of estimated existing unauthorized dams that might be affected by the proposed Policy.

Table ES.2 summarizes the potential actions that owners of the estimated existing unauthorized dams could take in response to the requirements of the Policy and the potential indirect environmental impacts that could result from these actions. These estimates provide the upper limit of potential indirect environmental impacts resulting from the modification or removal of all the estimated existing unauthorized dams based on the conservative assumption that the potential action that creates the highest potential indirect environmental impacts would occur.

Table ES.1. Summary of Estimated Existing Unauthorized Dams

Estimated Stream Class	County					Total
	Humboldt	**Marin**	**Mendocino**	**Napa**	**Sonoma**	
Estimated Number of Regulatory Dams						
I	0	0	64	3	29	96
II and III	0	0	45	6	55	106
Total	**0**	**0**	**109**	**9**	**84**	**202**
Estimated Number of Impoundment Dams						
I	0	39	50	72	51	212
II and III	0	141	337	229	650	1,357
Total	**0**	**180**	**387**	**301**	**701**	**1,569**
Total Number of Estimated Existing Unauthorized Dams						
I	0	39	114	75	80	308
II and III	0	141	382	235	705	1,463
Total	**0**	**180**	**496**	**310**	**785**	**1,771**
Estimated Onstream Storage Volume (AF)						
I	0	14,561	1,589	3,244	3,307	22,701
II and III	0	3,472	5,924	7,534	18,843	35,774
Total	**0**	**18,033**	**7,513**	**10,778**	**22,150**	**58,474**
Estimated Onstream Surface Area (acres)						
I	0	971	106	216	220	1,513
II and III	0	231	395	502	1,256	2,385
Total	**0**	**1,202**	**501**	**719**	**1,477**	**3,898**

Table ES.2. Estimated Potential Indirect Environmental Impacts of Policy Restrictions on Estimated Existing Unauthorized Dams

Potential Actions in Response to Policy Requirements	Environmental Issue Area	Potential Indirect Environmental Impact	Potential Secondary Indirect Environmental Impact
Short term construction activities at up to 1,771 dams; relocate up to 58,474 AF of onstream storage to offstream storage reservoirs	Aesthetics	Temporary visual disturbance, long-term changes to aesthetics	
Short term construction activities at up to 1,771 dams	Air Quality	Higher PM10, ozone or other pollutant levels	
Relocate up to 3,898 acres of onstream surface water to offstream storage reservoirs	Agricultural Resources	Loss of up to 3,898 acres of potentially irrigable land	
Remove up to 3,898 acres of onstream surface water	Biological Resources	Loss of up to 3,508 acres of open water and 390 acres of wetland; benefits to habitat due to gain in riparian habitat	
Short term construction activities at up to 1,771 dams	Cultural Resources	Ground disturbances that could impact cultural resources	
Short term construction activities at up to 1,771 dams	Geology and Soil	Short-term exposure of people or structures to potential geologic hazards; erosion and loss of topsoil	
Short term construction activities at up to 1,771 dams	Hazards and Hazardous	Short-term exposure to hazardous materials	

Potential Actions in Response to Policy Requirements	Environmental Issue Area	Potential Indirect Environmental Impact	Potential Secondary Indirect Environmental Impact
	Materials	associated with construction equipment and materials	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Hydrology and Water Quality – Short-term sedimentation and water quality	Potential short-term release of up to 29,237 AF of sediment (2,924 AF bedload and 26,313 suspended load)	Impacts to riparian habitat due to suspended load or hazardous material carried by released sediment; benefits to habitat due to release of bedload
Removal of up to 1,771 dams and 58,474 AF of onstream storage	Hydrology and Water Quality – Long-term sedimentation and water quality	Benefit to habitat due to continued release of sediment and high flows that allow for channel maintenance	Benefit to habitat due to reduced hydraulic residence times and lower water temperatures
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Hydrology and Water Quality – Flooding	Loss of up to 58,474 AF of potential flood storage	
Removal of up to 1,771 dams and 58,474 AF of onstream storage	Land Use and Planning	Conflict with local planning policy to protect onstream habitat	
Short term construction activities at up to 1,771 dams	Noise	Short-term increases in noise	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Public Services	Loss of up to 269 dams and 25,639 AF of fire protection storage	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Recreation	Loss of up to 3,898 acres of water-related recreational area	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Utilities and Service Systems	Construction of new water storage facilities to replace up to 58,474 AF of onstream storage	Various impacts related to construction and operation of new water storage facilities

1 Purpose of this Report

The North Coast Instream Flow Policy (Policy) may contain permitting requirements for onstream dams. These proposed requirements are needed to prevent negative impacts on anadromous salmonids and their habitat. If the State Water Board adopts a Policy with these requirements, dam owners may have to modify or remove existing unauthorized dams to comply with the Policy. These actions by dam owners could give rise to environmental impacts. These potential environmental impacts are referred to as 'indirect' impacts because they are not immediately related to adoption of the Policy but may occur as a result of the Policy being adopted.

The purpose of this report is to estimate the potential indirect environmental impacts that might be caused by dam owners removing or modifying existing unauthorized dams. Existing unauthorized dams could be either unauthorized dams that have pending water right applications (unauthorized pending dams), or unauthorized dams that have no water right applications on file (unauthorized non-filer dams). The following approach is used:

1. The number of unauthorized pending dams and the volume and surface area of onstream storage behind these dams are estimated using data from the State Water Board's Water Rights Information Management System (WRIMS) database (Section 3);
2. The number of unauthorized non-filer dams and the volume and surface area of water stored behind these dams are estimated using a geographic information system (GIS) analysis (Section 4); and
3. The maximum potential indirect environmental impacts that may result from the potential modification or removal of estimated existing unauthorized dams are estimated in terms of construction impacts, and the loss of onstream storage volume and onstream surface area (Section 5).

2 Background

For purposes of CEQA, the proposed project is adoption of the Policy by the California State Water Resources Control Board (State Water Board). The State Water Board will not approve or disapprove any particular water diversion project through the adoption of the Policy; instead, the State Water Board will evaluate water right applications and other water right matters on a case-by-case basis, in conjunction with applicable law and the Policy, if adopted by the State Water Board.

The Policy will operate to protect the threatened and endangered anadromous salmonid species and their habitat in the Policy area by ensuring that water rights are administered in a manner designed to maintain instream flows. The Policy area includes all coastal streams from the mouth of the Mattole River southward to San Francisco and coastal streams entering northern San Pablo Bay.

2.1 Policy Applicability

The proposed Policy may contain permitting requirements for onstream dams. These requirements will apply to both impoundment dams that provide onstream storage and regulatory dams that enable direct diversions or diversions to offstream storage but provide an insignificant amount of onstream storage. These requirements may affect existing unauthorized dams that were diverting water prior to the issuance of a water right, and new dams that have not been built yet.

In response to the proposed Policy requirements, owners of existing unauthorized dams may choose to modify or remove their dams. Since these dams have already been constructed, compliance with the Policy may result in indirect environmental impacts. These potential impacts are identified and estimated in this report.

New dams that may be built in the future have not yet been constructed; therefore, the Policy will not result in new dam owners removing or modifying existing onstream storage or onstream surface area, and no impacts to the environment need to be analyzed in this report.

Existing water right permits are subject to the continuing authority of the State Water Board to protect public trust uses and to prevent the waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of waters in the state. The State Water Board's exercise of these authorities may require notice and an opportunity for hearing. Possible impacts to the environment caused by modification or removal of existing permitted dams are not analyzed in this report.

Existing unauthorized dams may have one of two water right statuses: (1) pending - a water right application has been filed but has not been permitted by the State Water Board (unauthorized pending dams); or (2) non-filer - no application has been filed at the State Water Board

(unauthorized non-filer dams). Existing unauthorized dams under both types of water right status are evaluated in this report.

Table 1 summarizes the different categories of dam construction and water right status, and whether this report estimates the potential indirect impacts of the removal or modification of dams in these categories.

Table 1. Policy Applicability and Potential Indirect Environmental Impacts

Dam Construction Status	Water Right Status		Policy Requirements Specified?	Potential Indirect Environmental Impacts Identified and Estimated in this Report?
Existing	Permitted		No	No
	Unauthorized	Pending	Yes	Yes
		Non-filer	Yes	Yes
New	Unauthorized	Pending	Yes	No
		Non-filer	Yes	No

2.2 Stream Classification and Policy Alternatives

The proposed Policy may classify streams using a system similar to the stream classifications developed by the California Department of Forestry (CDF; Cal. Code Regs., tit. 14, section 916.5, Table 1) which are as follows:

- Class I - Fish always or seasonally present, includes habitat to sustain fish migration and spawning;
- Class II – Fish always or seasonally present offsite within 1,000 feet downstream and/or aquatic habitat for non-fish species; excludes Class III waters tributary to Class I waters; and
- Class III – No aquatic life present, water course showing evidence of being capable of sediment transport downstream to Class I or Class II waters under normal high water flow conditions.

The proposed requirements for permitting onstream dams differ depending on the classification of the stream on which a dam is located. Table 2 summarizes the proposed Policy alternatives for permitting of onstream dams, organized by stream class. These alternatives provide different levels of protectiveness for anadromous salmonids, and could give rise to different levels of potential indirect environmental impacts.

Table 2. Policy Alternatives for Permitting Onstream Dams

Stream Class	Policy Alternative
Class I	**DP1.1** Onstream dams may not be issued water right permits.
	DP1.2 New onstream dams may not be issued water right permits. A water right permit may be considered for an existing, unauthorized onstream dam that was built prior to 7/19/2006 if the following criteria are met: 1. Fish passage and screening is provided; 2. A passive bypass system is used to meet the minimum bypass flow and maximum rate of diversion requirements; 3. A non-native species eradication plan is implemented; 4. A gravel and wood augmentation plan or bypass system is implemented; and 5. A riparian habitat replacement plan is implemented.
Class II	**DP2.1** Onstream dams may not be issued water right permits.
	DP2.2 New onstream dams may not be issued water right permits. A water right permit may be considered for an existing, unauthorized onstream dam that was built prior to 7/19/2006 if the following criteria are met: 1. A passive bypass system is used to meet the minimum bypass flow and maximum rate of diversion requirements; 2. A non-native species eradication plan is implemented; 3. A gravel and wood augmentation plan or bypass system is implemented; and 4. A riparian habitat replacement plan is implemented.
	DP2.3 A water right permit may be considered for an onstream dam if the following criteria are met: 1. A passive bypass system is used to meet the minimum bypass flow and maximum rate of diversion requirements; 2. A non-native species eradication plan is implemented; 3. A gravel and wood augmentation plan or bypass system is implemented; and 4. A riparian habitat replacement plan is implemented.
Class III	**DP3.1** A water right permit may be considered for an onstream dam if the following criteria are met: 1. The onstream dam will not dewater a Class II stream; and 2. The onstream dam will cause less than 10% cumulative instantaneous impairment at locations where fish are seasonally present.
	DP3.2 A water right permit may be considered for an onstream dam if the following criteria are met: 1. A passive bypass system is used to meet the minimum bypass flow and maximum rate of diversion requirements; 2. A non-native species eradication plan is implemented; and 3. A gravel and wood augmentation plan or bypass system is implemented.
	DP3.3 A water right permit may be considered for an onstream dam.

The California Department of Fish and Game (DFG) has the authority to condition the State Water Board's registrations of small domestic use and livestock stockpond use to be consistent with some or all of the terms of the Policy. These conditions could be applied to new registrations or added to existing registrations during the 5-year certification of registration renewal process. For the purposes of this analysis, it is assumed that the DFG would exert its authority to condition registrations for existing unauthorized dams with the same terms and restrictions as the Policy would require for appropriative water right permits.

2.3 Potential Indirect Environmental Impacts

The proposed Policy may contain permitting requirements for onstream dams that could potentially result in dam owners modifying or removing existing unauthorized dams. These actions by others could give rise to indirect environmental impacts. Table 3 lists these potential indirect environmental impacts.

Table 3. Potential Indirect Environmental Impacts of Policy Restrictions on Onstream Dams

Environmental Issue Area	Potential Actions in Response to Policy Giving Rise to Potential Indirect Environmental Impact	Potential Indirect Environmental Impact
Aesthetics	Modify or remove dams; construct new offstream storage	Short-term or longer term visual disturbances to scenic areas
Air Quality	Modify or remove dams; construct new offstream storage	Short-term contribution to higher PM10, ozone, or other pollutant levels
Agricultural Resources	Construct new offstream storage	Inundation of irrigable lands
Biological Resources	Remove dams	Loss of wetland features and elimination, removal, or other harm to sensitive plant species, which may also degrade habitat for sensitive aquatic, riparian, and terrestrial wildlife; changes in channel processes and sedimentation that may harm riparian vegetation or degrade habitat for sensitive riparian and aquatic wildlife
Cultural Resources	Modify or remove dams; construct new offstream storage	Ground disturbance activities that could affect cultural resources
Geology/Soils	Modify or remove dams; construct new offstream storage	Exposure of people or structures to potential fault rupture, seismic ground shaking, or landslide, or other geologic hazard; erosion or loss of topsoil
Hazards & Hazardous Materials	Modify or remove dams; construct new offstream storage	Increased use of hazardous materials associated with construction, operation, and maintenance of new reservoirs and appurtenant facilities
Hydrology/Water Quality	Modify or remove dams	Changes in channel processes and sedimentation; reduction in detention of storm flows and increased potential flooding; short-term increased water quality siltation
Land Use/Planning	Remove dams	Conflict with local planning policy to protect natural resources, such as HCPs and NCCPs.
Noise	Modify or remove dams; construct new offstream storage	Short-term increased noise from construction, operation, and maintenance activities
Public Services	Remove dams	Loss of onstream storage used for fire

Environmental Issue Area	Potential Actions in Response to Policy Giving Rise to Potential Indirect Environmental Impact	Potential Indirect Environmental Impact
		protection water
Recreation	Remove dams	Loss of recreational opportunities, such as swimming, fishing, and boating
Utilities/Service Systems	Remove dams	Disturbance or disruption of utilities and service systems; construction of storm water drainage systems

In addition to the indirect impacts summarized in Table 3, water diverters may seek alternative water supply sources to replace removed onstream storage if existing onstream storage cannot be modified to comply with the Policy or replaced with offstream storage. Development of alternative water supply sources could give rise to indirect environmental impacts; these potential impacts are addressed in a separate report, North Coast Instream Flow Policy, Restrictions on Flow Diversions and Storage: Potential Indirect Impacts on Municipal, Industrial and Agricultural Water Use and Related Indirect Impacts on Other Environmental Resources (Stetson 2007).

3 Existing Unauthorized Dams with Pending Water Right Applications

This section describes how existing unauthorized dams with pending water right applications (unauthorized pending dams) are estimated using data from the State Water Board's Water Rights Information Management System (WRIMS) database.

3.1 Estimated Number of Unauthorized Pending Dams

3.1.1 Pending water right applications and points of diversion

The WRIMS database stores information on permitted and pending water right applications. There are 3,351 permitted and 284 pending water right applications in the Policy area, as of December 20, 2006. Table 4 summarizes the number of permitted and pending water right applications, grouped by water right status and county. Permitted water right applications are not included in the analysis of potential indirect environmental impacts of the Policy; their numbers are shown here for comparison with the number of pending water right applications.

Table 4. Number of Water Right Applications in the Policy Area

Water Right Status	Water Right Record Type	County					Total
		Humboldt	Marin	Mendocino	Napa	Sonoma	
Permitted	Appropriative	36	160	537	492	919	2,144
	Pre-1969 StockPond Certificates	0	12	21	52	56	141
	Small Domestic Use Registration	3	2	92	27	61	185
	Livestock Stockpond Registration	0	1	15	0	4	20
	Riparian or Pre-1914 Statements of Diversion and Use	10	71	253	169	358	861
Total Permitted Applications		**49**	**246**	**918**	**740**	**1398**	**3,351**
Pending	Appropriative	0	2	136	28	108	274
	Small Domestic Use Registration	0	0	2	1	4	7
	Livestock Stockpond Registration	0	0	0	0	3	3
Total Pending Applications		**0**	**2**	**138**	**29**	**115**	**284**
Total Water Right Applications							**3,631**

Each water right application has one or more points of diversion (POD). A POD is the location where water is stored onstream, diverted for direct use, or diverted to storage in an offstream reservoir.

The number, onstream storage volume, and onstream surface area of unauthorized pending dams are estimated using the following WRIMS database information for the 284 pending water right applications:

- POD coordinates and zone - the location of each point of diversion (POD) in state plane coordinates and state plane zone;
- POD storage - the volume of onstream or offstream storage in acre-feet;
- Application maximum storage - the total volume of onstream and offstream storage in acre-feet for the water right application; and
- POD code - the location of storage: O is onstream; F is offstream; B is both on and offstream.

For this analysis, the maximum number of unauthorized pending dams is estimated by assuming that either a regulatory dam or an impoundment dam has already been constructed at every pending water right application POD, with the exclusion of PODs at dam locations that were already permitted in an earlier water right application and PODs that are known to not yet be constructed.

In the Policy area, there are 518 POD locations listed in the 284 pending water right applications that could be at existing unauthorized dams. These numbers include all PODs in all pending water right applications except for the 9 PODs in the two pending applications by Redwood Valley County Water District for new offstream storage that has not yet been constructed (Water right applications A031495 and A031505), the 25 pending PODs for onstream storage with the same location (WRIMS POD coordinates and zone) as a permitted or earlier pending water right application for onstream storage, the 20 pending PODs for offstream storage or direct diversion at a location with a pending or permitted POD for onstream storage, and the 34 pending PODs for offstream storage or direct diversion already counted in an earlier application for offstream storage or direct diversion.

Table 5 summarizes the number of estimated unauthorized pending dams, grouped by storage location, as indicated by the POD code, and county. 'Unknown' storage location indicates that no information or invalid information was provided in the water right application for the POD code. 'No Storage' indicates that there is neither onstream nor offstream storage at this location as indicated by the POD storage and application maximum storage, i.e. direct diversion only.

Table 5. Estimated Number of Unauthorized Pending Dams by Storage Location

Storage Location	County					
	Humboldt	Marin	Mendocino	Napa	Sonoma	Total
Onstream	0	0	92	26	109	227
Both onstream and offstream	0	0	25	0	37	62
Off-stream	0	0	64	9	46	119
Unknown	0	0	15	6	6	27
No storage	0	0	45	0	38	83
Total	**0**	**0**	**241**	**41**	**236**	**518**

3.1.2 Regulatory Dams and Impoundment Dams

The number of estimated unauthorized pending dams includes both regulatory dams and impoundment dams. The number of regulatory dams is estimated as the total number of unauthorized pending dams with no storage (determined from POD storage and application maximum storage) and with only offstream storage (POD code F). The number of impoundment dams is estimated as the sum of the number of unauthorized pending dams with onstream storage (POD code O), with both onstream and offstream storage (POD code B), and with an unknown storage location (no information or invalid information was provided in the application for the POD code; storage is assumed to be onstream).

The proposed Policy alternatives for permitting onstream dams were developed in consideration of the mitigation measures needed to protect anadromous salmonids. These alternatives are a function of stream class. The extent to which existing unauthorized dams might be affected by the proposed Policy will depend on which proposed Policy alternatives are adopted by the State Water Board, and the stream class at the location of the dam.

To help with estimating the magnitude of potential indirect environmental impacts, the numbers of unauthorized pending dams are grouped as either on Class I streams (anadromous fish presence) or on Class II or Class III streams (upstream of anadromous fish presence) by the estimated stream class at the dam location. The classification of streams in the Policy area is estimated according to procedures detailed in Appendix B. There are 30 unauthorized pending dams for applications known to be in the Policy area but lacking exact location information. These dams could not be assigned a stream class based on their location and are instead assumed to be on Class I streams.

Table 6 summarizes the estimated number of unauthorized pending dams, grouped by dam type, estimated stream class, and county. Figure A.1 shows the locations of these unauthorized pending dams in the Policy area, colored by dam type.

Table 6. Estimated Number of Unauthorized Pending Dams by Dam Type and Stream Class

Dam Type	Estimated Stream Class	County					Total
		Humboldt	Marin	Mendocino	Napa	Sonoma	
Regulatory Dams	I	0	0	64	3	29	96
	II and III	0	0	45	6	55	106
	Sub-Total	**0**	**0**	**109**	**9**	**84**	**202**
Impoundment Dams	I	0	0	15	4	16	35
	II and III	0	0	117	28	136	281
	Sub-Total	**0**	**0**	**132**	**32**	**152**	**316**
Unauthorized Pending Dams	I	0	0	79	7	45	131
	II and III	0	0	162	34	191	387
	Total	**0**	**0**	**241**	**41**	**236**	**518**

3.2 Estimated Volume and Surface Areas at Unauthorized Pending Dams

Regulatory dams have no significant onstream storage or onstream surface area. Onstream storage volume and onstream surface area is estimated only at the impoundment dams.

The onstream storage volume at unauthorized pending dams is estimated as the sum of the pending onstream POD storage at each impoundment dam. It is assumed that 25% of the diversion to storage at PODs with POD code B (both onstream and offstream) is onstream and that the remaining storage is offstream and that 100% of the storage at PODs with unknown POD codes is onstream. For some water right applications, the sum of the WRIMS POD storage volumes does not equal the WRIMS application maximum storage volume. In these cases, storage at each POD is multiplied by the ratio of the application maximum storage divided by total POD storage to force the POD storage to sum to the WRIMS application maximum storage

A complete list of pending applications, including the estimated number of existing unauthorized regulatory and impoundment dams and onstream storage volume requested in each application, is attached as Appendix D.

The onstream surface area at unauthorized pending dams is estimated from the onstream storage volume, assuming an average depth of 15 feet. This average depth is based on jurisdictional dam information obtained from the California Department of Water Resources Division of Dam Safety (2007). Figure 1 shows reported water depths and surface areas of reservoirs at jurisdictional dams that are located in the Policy area. These reservoirs have average depths ranging from 10 to 40 feet, with a mean average depth of approximately 15 feet.

Figure 1. Reported Water Depths and Surface Areas at Jurisdictional Dams in the Policy Area

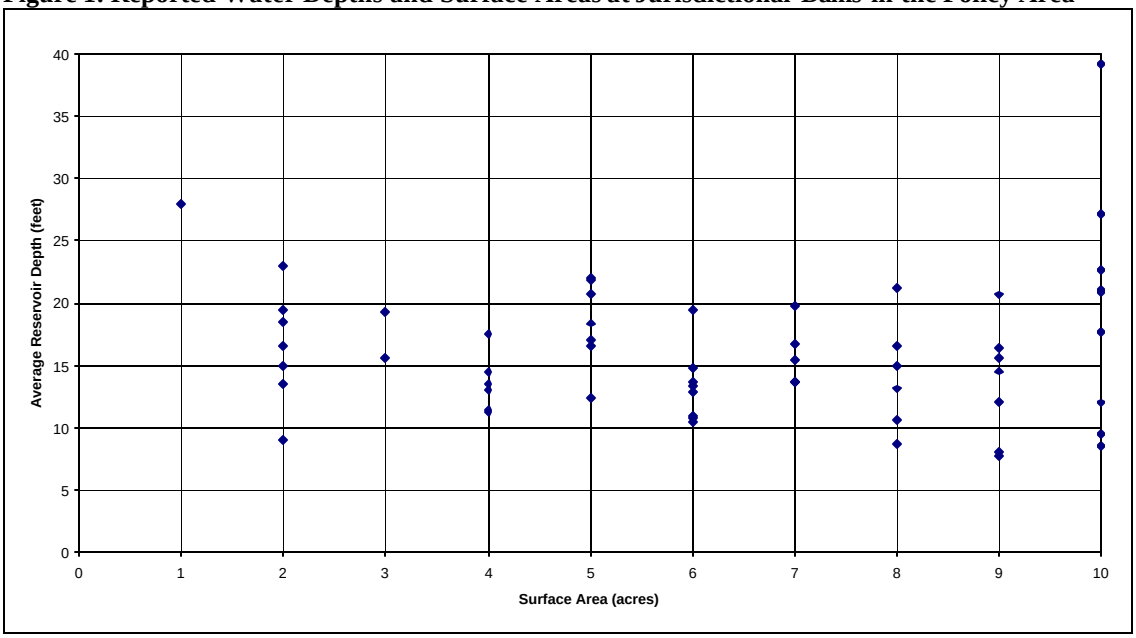


Table 7 summarizes the estimated number, onstream storage volumes, and onstream surface area of estimated unauthorized pending dams, grouped by estimated stream class and county.

Table 7. Summary of Estimated Existing Unauthorized Dams with Pending Water Right Applications

Estimated Stream Class	County					Total
	Humboldt	Marin	Mendocino	Napa	Sonoma	
Estimated Number of Regulatory Dams						
I	0	0	64	3	29	96
II and III	0	0	45	6	55	106
Total	**0**	**0**	**109**	**9**	**84**	**202**
Estimated Number of Impoundment Dams						
I	0	0	15	4	16	35
II and III	0	0	117	28	136	281
Total	**0**	**0**	**132**	**32**	**152**	**316**
Total Number of Estimated Unauthorized Pending Dams						
I	0	0	79	7	45	131
II and III	0	0	162	34	191	387
Total	**0**	**0**	**241**	**41**	**236**	**518**
Estimated Onstream Storage Volume (AF)						
I	0	0	215	24	1,483	1,721
II and III	0	0	2,012	595	5,630	8,238
Total	**0**	**0**	**2,227**	**619**	**7,113**	**9,959**
Estimated Onstream Surface Area (acres)						
I	0	0	14	2	99	115
II and III	0	0	134	40	375	549
Total	**0**	**0**	**148**	**41**	**474**	**664**

These estimates are based on the following assumptions:

- Pending water right applications are assumed to be requests for diversion at existing dams rather than at new dams except for the two Redwood Valley County Water District applications where it is known that reservoir storage has not already been constructed;
- All diversions for direct use or diversions to offstream storage are assumed to be at regulatory dams that block passage;
- All diversions to storage of unknown location (POD code U) are assumed to be at impoundment dams with 100% of the storage onstream;
- All diversions to both onstream and offstream storage (POD code B) are assumed to be at impoundment dams with 25% of the storage onstream; and
- All diversions at unknown locations (insufficient POD location information) are assumed to be on Class I streams.

4 Existing Unauthorized Dams with No Water Right Application on File

This section describes how existing unauthorized dams that have no water right application on file as of December 20, 2006 (unauthorized non-filer dams) are estimated using the results of a geographic information system (GIS) analysis.

4.1 Estimated Number of Unauthorized Non-filer Dams

Two Geographic Information System (GIS) studies were completed to estimate the unauthorized non-filer dams. An unauthorized non-filer dam is estimated at each possible reservoir location identified in the available digital data that is not located near a permitted or pending POD with onstream storage. Regulatory dams that do not have significant onstream storage could not be estimated in the GIS.

GIS Study #1 covered Napa County, and used existing digitized data available only for the Napa River watershed. GIS study #2 covered the entire Policy area, and used digital elevation data. Results of GIS Study #1 are used to estimate the number, onstream storage volume, and onstream surface area of estimated unauthorized non-filer dams in Napa County; results of GIS Study #2 are used to estimate the number, onstream storage volume, and onstream surface area of estimated unauthorized non-filer dams in the remainder of the Policy area. This section provides a summary of the studies. Appendix D provides a detailed description of the methods and assumptions used in the two GIS studies.

The GIS studies used the following digital data sets:

- Napa River watershed reservoirs digital GIS shapefile (Napa digitized reservoirs)
- USGS 10-m digital elevation data for the Policy area (10-m DEM[1])
- National Hydrography Database (NHD) GIS coverage of lakes, reservoirs, ponds, and wide streams (NHD water bodies)
- WRIMS database of permitted and pending water right applications and PODs
- National Agriculture Imagery Program 1-m aerial photography

In GIS Study #1, unauthorized non-filer dams are estimated at each of the Napa digitized reservoirs that were determined to be onstream, are not located near a permitted or pending POD with onstream storage and are estimated to be on a Class I, II or III stream. Aerial photos were used to determine whether a reservoir was onstream. WRIMS database information was used to determine whether a water right application was on file for the reservoir. Figure A.2 displays the results of GIS Study #1, showing the Napa digitized reservoirs that were determined to be onstream, colored by estimated water right status (permitted, pending, or non-filer).

Because a digitized reservoir coverage was not available for the entire Policy area, GIS Study #2 used the 10-m DEM and the NHD water bodies to identify possible locations of onstream

[1] A digital elevation model (DEM) is a digital map of the elevation of the land surface. Elevations are provided on a grid at a set interval. A 10-m DEM is a grid of elevation points at 10 meter intervals.

reservoirs (GIS onstream reservoirs) for the entire Policy area. Aerial photos were used to verify whether a feature was an onstream reservoir. WRIMS database information was used to determine whether a water right application was on file for the reservoir. Unauthorized non-filer dams are estimated at each of the GIS onstream reservoirs that are not located near a permitted or pending POD with onstream storage and are on an estimated Class I, II or III stream. Figure A.3 displays the results of GIS Study #2, showing the GIS onstream reservoirs, colored by estimated water right status.

Table 8 summarizes the number of unauthorized non-filer dams estimated by the two GIS studies, grouped by study, digital data source, and county. GIS Study #1 results are given only for Napa County because the study covered only this area. Figure A.4 compares the spatial results, showing the locations of the unauthorized non-filer dams in Napa County estimated by each GIS study.

Table 8. Estimated Number of Unauthorized Non-filer Dams by Study and Data Source

Study	Data Source	County					Total
		Humboldt	Marin	Mendocino	Napa	Sonoma	
GIS Study #1	Napa Digitized Reservoirs				**269**		
GIS Study #2	10-m DEM	0	19	36	3	28	86
	NHD water bodies	0	161	219	123	521	1,024
	GIS Study #2 Total	**0**	**180**	**255**	**126**	**549**	**1,110**

GIS Study #1 estimated a larger number of unauthorized non-filer dams in Napa County than GIS Study #2. To provide the most conservative (highest) estimate of indirect environmental impacts, the results of GIS Study #1 are used to estimate the unauthorized non-filer dams in Napa County.

Table 9 summarizes the number of estimated unauthorized non-filer dams, grouped by estimated stream class and county. Figure A.5 shows the locations of these estimated unauthorized non-filer dams colored by digital data source.

Table 9. Estimated Number of Unauthorized Non-filer Dams by Estimated Stream Class

Estimated Stream Class	County					Total
	Humboldt	Marin	Mendocino	Napa	Sonoma	
I	0	39	35	68	35	177
II and III	0	141	220	201	514	1,076
Total	**0**	**180**	**255**	**269**	**549**	**1,253**

4.2 Estimated Volume and Surface Area at Unauthorized Non-filer Dams

The onstream surface areas of the estimated unauthorized non-filer dams are estimated by measuring the corresponding Napa digitized reservoirs and GIS onstream reservoirs using standard GIS methods. Onstream storage volume is estimated from onstream surface area assuming an average depth of 15 feet, using the same calculation used for unauthorized pending dams. Table 10 summarizes the estimated number, onstream storage volume, and onstream surface area of estimated unauthorized non-filer dams, grouped by estimated stream class and county.

Table 10. Summary of Estimated Existing Unauthorized Dams with No Water Right Application on File

Estimated Stream Class	County					Total
	Humboldt	**Marin**	**Mendocino**	**Napa**	**Sonoma**	
Number of Estimated Unauthorized Non-filer Dams						
I	0	39	35	68	35	177
II and III	0	141	220	201	514	1,076
Total	**0**	**180**	**255**	**269**	**549**	**1,253**
Estimated Onstream Storage Volume (AF)						
I	0	14,561	1,374	3,220	1,824	20,979
II and III	0	3,472	3,912	6,939	13,213	27,536
Total	**0**	**18,033**	**5,286**	**10,159**	**15,037**	**48,515**
Estimated Onstream Surface Area (acres)						
I	0	971	92	215	122	1,399
II and III	0	231	261	463	881	1,836
Total	**0**	**1,202**	**352**	**677**	**1,002**	**3,234**

These estimates are based on the following assumptions:

- Unauthorized non-filer dams are estimated at the reservoirs that could be identified in the existing digital data. Regulatory dams and impoundment dams whose reservoirs could not be located in the digital data are not included in the estimates.
- All onstream reservoirs that are not near a permitted or pending POD with onstream storage are assumed to not have a water right application on file. However, these reservoirs might have a water right application on file with inaccurate or incomplete POD location information.
- All onstream reservoirs that are found to not have a water right application on file are assumed to be at existing unauthorized dams. Some of these impoundments might actually have a basis of right (e.g. filled by sheet flow, pumped groundwater, or purchased water) or be a natural water body (e.g. lakes, wetlands and swamps) that are outside of the permitting authority of the State Water Board.

5 Assessment of Potential Indirect Environmental Impacts

This section estimates the potential indirect environmental impacts of the proposed Policy that might be caused by dam owners removing or modifying existing unauthorized dams. The possible actions owners of existing unauthorized dams could take in response to the proposed Policy and the associated indirect impacts are:

1. Modify dam to provide required operational criteria – short-term construction activities;
2. Remove dam and move onstream storage to offstream – short-term construction activities, release of sediment held behind the dam, inundation of potentially irrigable land, and loss of onstream storage; or
3. Remove dam without replacement of existing onstream storage – short-term construction activities, release of sediment held behind the dam, and loss of onstream storage and onstream surface area.

The short-term construction activities required to bring existing unauthorized dams into compliance could potentially give rise to some indirect environmental impacts. These potential indirect environmental impacts would be limited to the construction period and would be the impacts typically associated with any small-scale construction project.

The loss or relocation of onstream storage or surface area due to removal of a dam by owners could potentially give rise to both short-term and long-term secondary indirect environmental impacts.

In assessing the potential indirect environmental impacts, it is assumed that the actions that would result in the highest potential impact would be taken at all the estimated existing unauthorized dams, regardless of stream classification. In most cases, the highest potential impact would result if all existing unauthorized dams were removed without replacement of existing onstream storage.

This is a conservative (highest; most severe) estimate of the potential actions of dam owners and the potential indirect environmental impacts of their actions in response to the proposed Policy at the estimated existing unauthorized dams because:

- Some existing unauthorized dams might already be in compliance with the Policy, in which case, no action would be required;
- Some existing unauthorized dams could be modified to meet proposed Policy requirements, in which case, there would be no loss of onstream storage volume or onstream surface area; and
- Even if existing unauthorized dams are removed, some existing onstream storage could be moved to an offstream location, in which case, there would be no loss of onstream storage volume or onstream surface area.

Section 5.1 summarizes the estimated existing unauthorized dams in terms of number of dams, onstream storage volume, and onstream surface area. Sections 5.2 – 5.14 provide a discussion of

the potential indirect environmental impacts that might occur from actions that owners of these estimated existing unauthorized dams might take in response to the Policy for each potentially affect environmental issue area. Section 5.15 summarizes the potential indirect environmental impacts.

5.1 Summary of Estimated Existing Unauthorized Dams

Unauthorized pending dams and unauthorized non-filer dams may be equally affected by the proposed Policy. For the discussion of indirect impacts, Table 11 lists the total estimated number of dams, onstream storage volume, and onstream surface area that might be affected by the Policy, grouped by stream class and county. This includes both estimated unauthorized pending dams (summarized in Table 7, Section 3) and estimated unauthorized non-filer dams (summarized in Table 10, Section 4).

Table 11. Summary of Estimated Existing Unauthorized Dams

Estimated Stream Class	County					Total
	Humboldt	**Marin**	**Mendocino**	**Napa**	**Sonoma**	
Estimated Number of Regulatory Dams						
I	0	0	64	3	29	96
II and III	0	0	45	6	55	106
Total	**0**	**0**	**109**	**9**	**84**	**202**
Estimated Number of Impoundment Dams						
I	0	39	50	72	51	212
II and III	0	141	337	229	650	1,357
Total	**0**	**180**	**387**	**301**	**701**	**1,569**
Total Number of Estimated Existing Unauthorized Dams						
I	0	39	114	75	80	308
II and III	0	141	382	235	705	1,463
Total	**0**	**180**	**496**	**310**	**785**	**1,771**
Estimated Onstream Storage Volume (AF)						
I	0	14,561	1,589	3,244	3,307	22,701
II and III	0	3,472	5,924	7,534	18,843	35,774
Total	**0**	**18,033**	**7,513**	**10,778**	**22,150**	**58,474**
Estimated Onstream Surface Area (acres)						
I	0	971	106	216	220	1,513
II and III	0	231	395	502	1,256	2,385
Total	**0**	**1,202**	**501**	**719**	**1,477**	**3,898**

Figures 2 and 3 are exceedance curves that show the range of estimated onstream storage volume and estimated onstream surface area at the estimated existing unauthorized dams with onstream storage (impoundment dams). For example, the median estimated onstream storage volume is approximately 10 acre-feet and the median estimated onstream surface area is 0.7 acres.

Figure 2. Range of Onstream Storage Volume at Estimated Existing Unauthorized Impoundment Dams

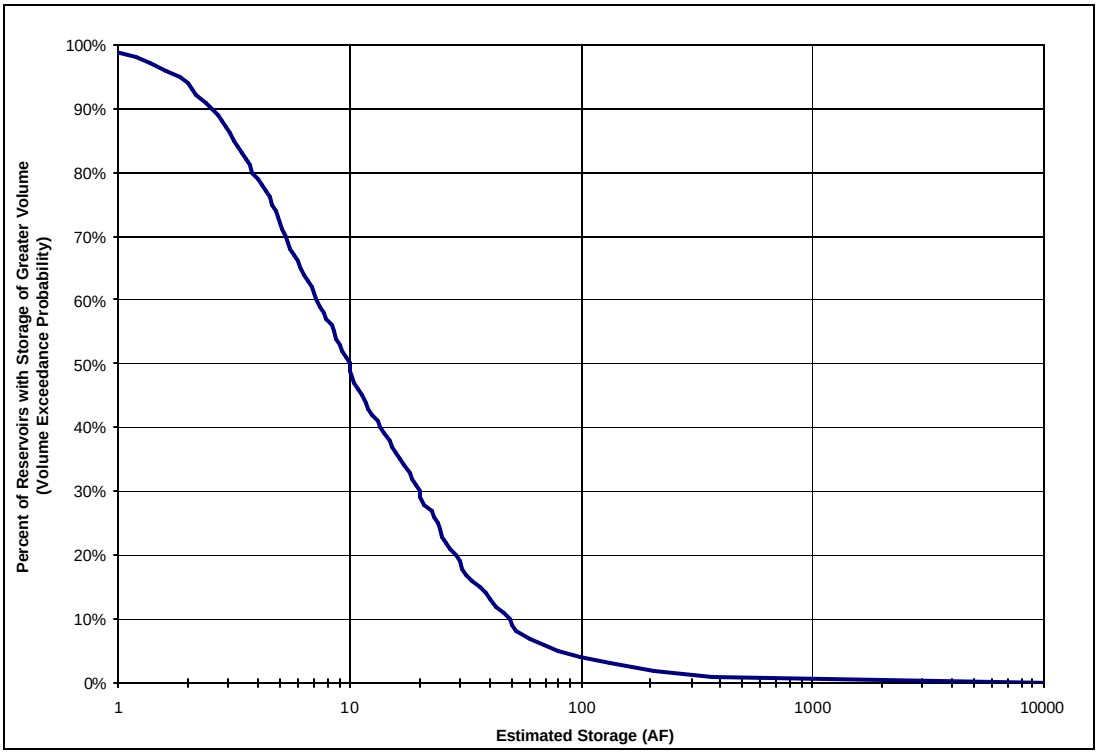
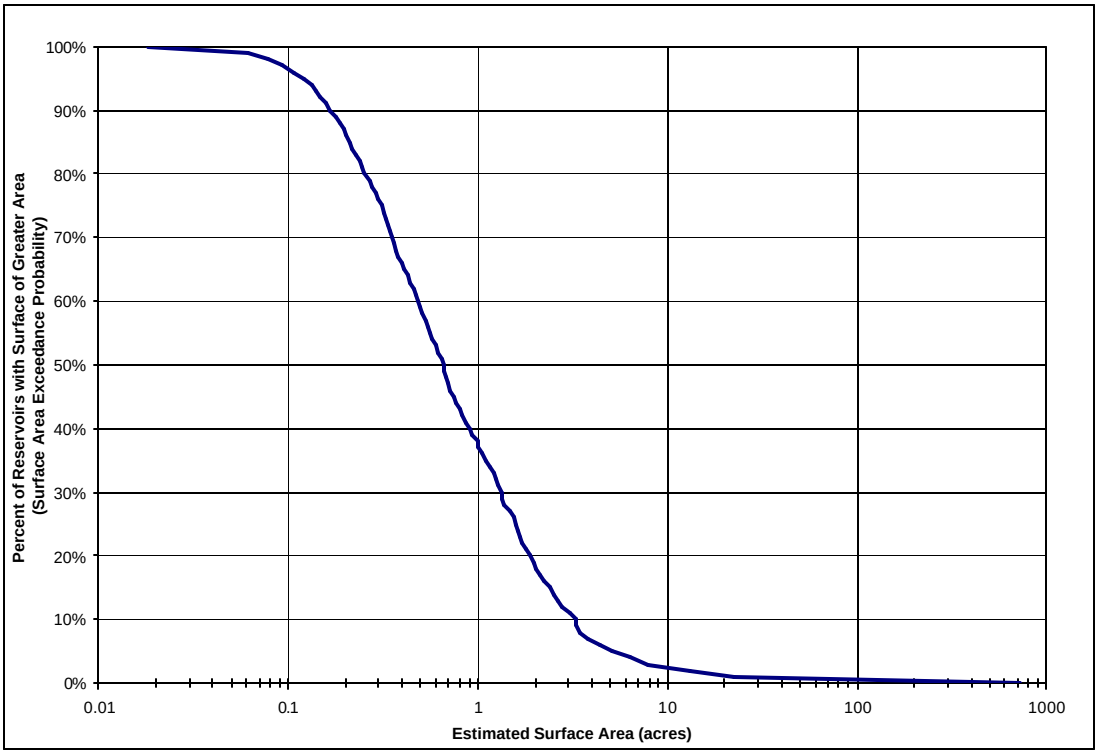


Figure 3. Range of Onstream Surface Area at Estimated Existing Unauthorized Impoundment Dams



5.2 Aesthetics

Short-term construction activities could create temporary visual disturbances to scenic areas. Longer-term changes to aesthetics could occur if onstream storage was moved to offstream which would require the installation of a water conveyance system.

5.3 Air Quality

Short-term construction activities could give rise to contributions to higher PM10, ozone, or other pollutant levels. The potential indirect environmental impact to air quality is limited to the construction period.

5.4 Agricultural Resources

New offstream storage reservoirs may be constructed to replace the onstream storage currently provided by existing unauthorized dams. This construction could inundate potentially irrigable land and result in reduced agricultural resources. The loss of land area could be mitigated by the recovery of some of all or the land previously inundated by the onstream storage; however, this recovered land would be adjacent to the stream channel and may not be practicably irrigable due to the higher potential of flooding than the lost potentially irrigable land.

The potential loss of irrigable land is estimated to be equal to the estimated onstream surface area at estimated existing unauthorized dams. This estimate assumes that all onstream storage will be removed and replaced by offstream storage of the same surface area on land that is irrigable. Table 12 summarizes the potential loss of irrigable land in acres, grouped by county.

Table 12. Estimated Potential Loss of Irrigable Land

	County					**Total**
	Humboldt	**Napa**	**Marin**	**Mendocino**	**Sonoma**	
Irrigable Area (acres)	0	1,202	501	719	1,477	**3,898**

If existing unauthorized dams could be modified to meet operational criteria required by the Policy to remain onstream, there would be no loss of irrigable land caused by the building of offstream storage. If onstream dams were to be removed and the onstream storage could not be replaced by offstream storage, there would also be no loss of potentially irrigable land due to inundation for offstream storage; however, the loss of the onstream storage may reduce the amount of surface water available to irrigate agricultural lands at these locations. Indirect impacts resulting from using an alternate water supply are discussed in a separate report (Stetson, 2007).

5.5 Biological Resources

Biological resources include specific species as well as entire communities of species and the environments they inhabit. Dam removal may affect a variety of terrestrial and aquatic

environments. Table 13 summarizes information presented in environmental impact reports for various dam removal projects in California.

Table 13. Estimated and Observed Impacts to Biological Resources Resulting from Dam Removal Projects

Dam	Storage Volume or Surface Area	Impacts	Source
A-Frame Dam on Brandy Creek near Redding, CA	6 AF 0.5 acres	• Gain of 7,300 square feet of riparian vegetation • Loss of 0.5 acres of pond habitat • No impairment of vegetation	NPS, 2002
Saeltzer Dam on Clear Creek, Clear Lake, CA	48 AF	• Temporary impact to 1.52 acres of riparian habitat • Temporary disturbance of 0.78 acres of riverine habitat • Temporary disturbance of 1.16 acres of wetlands • No permanent loss of wetlands	NSR, 2000
Upper Dam on Lost Man Creek near Orick, CA		• Disturbance of 1.5 acres of riparian vegetation	Sacklin et al, 1988

The following habitats could potentially be affected by dam removals:

- Wetland - An ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate, CGER, 1995.
- Open water - A lentic[2] zone characterized by an absence of contact with either the lake bottom or shore, Horne and Goldman, 1994.
- Riparian - Relating to or living or located on the bank of a natural watercourse, Merriam-Webster Online Dictionary, 2006.

Potential impacts to each of these three types of environments due to dam removals are discussed below.

5.5.1 Wetlands

Removal of existing unauthorized impoundment dams could potentially result in a loss of wetlands associated with existing onstream storage.

Wetland area is not necessarily a function of reservoir surface area or shoreline length. Very large reservoirs may have little wetland area. The type and magnitude of dam removals on wetlands is largely site-specific (ICF Consulting, 2005). The key variables determining the location and distribution of wetlands are the frequency, duration and timing of inundation and saturation (CGER, 1995). Total wetland area, before and after dam removal, would remain

[2] Lentic is defined as of, relating to, or living in still waters (as lakes, ponds, or swamps), Merriam-Webster Online Dictionary, 2006.

constant if the lost lentic wetland is replaced with lotic[3] wetland, a phenomenon that other analyses of dam removals have observed (NSR, 2000).

For this study, it is assumed that 90% of onstream surface area is open water and that the remaining 10% along the water's edge is wetland. The potential loss of wetland habitat is estimated as 10% of the estimated onstream surface area at estimated existing unauthorized dams. Table 14 summarizes the potential loss of open wetland in acres, grouped by county.

Table 14. Estimated Potential Loss of Wetland

	County					Total
	Humboldt	**Napa**	**Marin**	**Mendocino**	**Sonoma**	
Wetlands (acres)	0	120	50	72	148	**390**

If existing unauthorized dams could be modified to meet the proposed Policy requirements to remain onstream, there would be no loss of wetland habitat at these dams.

5.5.2 Open Water

Removal of existing unauthorized impoundment dams would result most significantly in a loss of open water and littoral[4] habitat and a corresponding decline in the diversity and number of organisms that prefer this habitat. The potential loss of open water habitat is estimated as 90% of the estimated onstream surface area at estimated existing unauthorized dams. Table 15 summarizes the potential loss of open water in acres, grouped by county.

Table 15. Estimated Potential Loss of Open Water

	County					Total
	Humboldt	**Napa**	**Marin**	**Mendocino**	**Sonoma**	
Open Water (acres)	0	1,082	451	647	1,329	**3,508**

If existing unauthorized dams could be modified to meet proposed Policy requirements to remain onstream, or if existing onstream storage could be relocated to an offstream location, there would be no loss of open water habitat at these dams.

5.5.3 Riparian Habitat

Environmental impact assessments for various dam removal projects in California that are listed in Table 13 indicate only temporary losses of riparian habitat and eventual gains. In addition, a study of the removal of an unnamed dam on Ferrari Creek in 2002 showed that riparian habitat reestablished itself after dam removal (ICF Consulting, 2005). Riggsbee et al (2007) also found that riparian vegetation recovery is initiated in weeks following a dam removal. Dam removal

[3] Lotic is defined as of, relating to, or living in actively moving water, Merriam-Webster Online Dictionary, 2006.
[4] Littoral is defined as a zone extending from the shore just above the influence of waves and spray to a depth where the well-mixed warm surface waters still reach the lake bed in summer, Horne and Goldman, 1994.

may also result in changes to channel processes and siltation (discussed in Section 5.9.2) that would also benefit riparian habitat.

If existing unauthorized dams and onstream storage were removed, new riparian habitat would form along the stream channel, replacing the wetland habitat lost on the edges of the removed onstream storage, and there would be a net gain of riparian habitat. If existing unauthorized dams could be modified to meet proposed Policy requirements to remain onstream, there would be no change to riparian habitat at these dams.

5.6 Cultural Resources

Short-term construction activities could generate ground disturbances that could affect cultural resources. This potential indirect environmental impact to cultural resources would be assessed on a site-specific basis at the project-level prior to construction in areas of cultural resources and compliance activities would be mitigated as necessary to prevent impacts.

5.7 Geology and Soil

Short-term construction activities could expose people or structures to potential fault ruptures, seismic ground shaking, land slide or other geologic hazard, and could result in the erosion or loss of topsoil. This potential exposure to hazards or increased erosion would be assessed on a site-specific basis at the project-level prior to construction in regions with potential fault activity, land slides or other geological hazards, and compliance activities would be mitigated as necessary to prevent impacts.

5.8 Hazards and Hazardous Material

Short-term construction activities could result in increased use of hazardous materials associated with construction equipment and materials used in the dam removal. This potential increased exposure to hazardous materials would be assessed on a site-specific basis at the project-level prior to construction and compliance activities would mitigated as necessary to prevent impacts.

Hazardous materials may also be contained in sediment stored behind existing unauthorized dams as discussed in the following section on water quality.

5.9 Hydrology and Water Quality

Removal of existing unauthorized dams could potentially have both short-term and long-term impacts to channel processes and to water quality, particularly sediment load.

5.9.1 Short-term Release of Sediment

In the short-term, the water and sediment stored behind the existing unauthorized impoundment dams could be released during dam removal. Sediment release could have adverse impacts for downstream water quality and habitat.

The quantity of sediment stored in an onstream storage reservoir depends on many factors such as the age of the dam, the topography of the impounded area, the dam design, and the quantity and composition of sediment delivered to the impounded area (ICF Consulting, 2005). Sediment delivery to an impounded area is a factor of the drainage area and the geology, topography, meteorology, hydrology, land use, and land cover of the drainage area.

For example, the Mattole River watershed in the northern portion of the study area receives significant rainfall averaging 60 to115 inches per year. The geology of the watershed is characterized by high tectonic activity and the land use includes logging. Sediment delivery for the Mattole River is 8000 tons per year per square mile of drainage area (US EPA Region IX, 2003). Table 16 presents sediment yield estimates for watersheds in the Policy area.

Table 16. Policy Area Sediment Yield Estimates

Stream	Sediment Yield (tons of sediment/square mile drainage area/year)	Estimation Period	Source
Conn Creek	1,344		Trso, 2005
Mattole River	8,000	1984-2000	US EPA Region IX, 2003
Albion River	602	1921-2000	US EPA Region IX, 2001
Big River	944	1921-2000	US EPA Region IX, 2001
Garcia River	1,380	1952-1997	US EPA Region IX, 1998
Gualala River	1,220	1978-2000	US EPA Region IX, 2001
Navarro River	1,945	1984-1996	US EPA Region IX, 2000
Noyo River	589	1933-1999	US EPA Region IX, 1999
Ten Mile River	1,124	1933-1999	US EPA Region IX, 2000
Average	**1,905**		

The product of the annual sediment delivery, the drainage area of a dam and the age of the dam and the trap efficiency provides a means for estimating the total quantity of sediment stored behind a dam[5]. Data necessary for calculating average reservoir sedimentation percentages are lacking. While sediment production estimates are available, data on the average age, capacity-inflow ratios and watershed areas for existing unauthorized dams are not available. Assuming an average watershed sediment production rate of 1905 tons per square mile per year, a bulk density of 1.6 tons per cubic meter, an average reservoir age of 33 years (based on the average age of

[5] The trap efficiency is a measure of what percentage of sediment delivered to a reservoir actually accumulates in the reservoir. Fine particles typically remain in suspension and spill from the reservoir. Empirical relationships for trap efficiency most commonly use functions of the ratio of reservoir capacity to annual inflow (Verstraeten and Poesen, 2000). A curve developed for small agricultural ponds indicates trap efficiencies of from just above 30% for a reservoir filling and spilling 100 times over the year (a capacity-inflow ratio of 1) to 95% for a reservoir filling only once (a capacity-inflow ratio of 1).

existing permitted reservoirs), an average capacity-inflow ratio of 0.04, and a trap efficiency of 68%, the estimated sediment storage would be 22 acre-feet per square mile of watershed area.

Stetson conducted a search of reservoir sedimentation data for the Policy area. The only major reservoir with two or more known bathymetric surveys in the Policy area is Lake Mendocino. Area-capacity tables generated from survey data prior to construction in 1959 and in 1982 indicate the quantity of sedimentation and the corresponding reduction in reservoir capacity. Comparison of the area-capacity tables show that 575 acre-feet (0.4%) of Lake Mendocino's original total storage volume of 152,515 acre-feet had been filled with sediment by 1982 (USACE, 1959; USACE, 1982). Other large dams and onstream storage reservoirs in the study area such as Lake Sonoma and Lake Hennessy have not been resurveyed since their construction (Phil Brun of the City of Napa, Personal Communication, 2/20/2007 and Mike of the USACE, Personal Communication, 2/20/2007).

An erosion and sedimentation assessment for the Artesa Vineyards expansion project in Napa County provides an estimate for the quantity of sediment stored in Rector Reservoir. The 60 plus-years-old reservoir's original 4,535 acre-feet storage capacity was estimated to be 8% full of sediment. Data for two smaller and older reservoirs in the study area, Crocker Creek Reservoir and Upper York Creek Reservoir, indicate much greater sediment accumulation as a percentage of total reservoir storage. The reservoir created by Crocker Dam on Crocker Creek, a tributary of the Russian River constructed in the early 1900s, had already filled completely with sediment when the dam failed in 1995 (Downing-Kunz et al, 2005). Upper York Creek Reservoir, a water supply reservoir for the City of Saint Helena from 1900 until 1993, as of 2006 "has essentially no water retaining capacity" (City of St. Helena, 2006). Like Crocker Creek Reservoir and Upper York Reservoir, many small onstream reservoirs in the study area, particularly the oldest dams, may have little or no onstream storage remaining due to sedimentation.

Saeltzer Dam on Clear Creek was removed in 2000. After the removal of this 48 acre-feet[6] reservoir, 50,000 cubic yards (31 acre-feet, 40% of estimated 1902 storage) of sediment eroded from the dam site. A portion of the sediment was deposited on a downstream riffle aggrading the bed up to 2.5 feet (Clayton-Niederman and Gilbreath, 2005).

Impacts due to sediment release following dam removal may be of particular concern in watersheds in the Policy area that are already listed as water quality limited for sedimentation/siltation under Clean Water Act Section 303(d). Table 17 lists watersheds streams in the Policy area on the 2002 303(d) list for sediment and gives the affected stream length.

[6] The storage in 1996 was 48 acre-feet. Stetson estimated the original 1902 storage as 79 acre-feet, the sum of the 1996 storage and the 2000 sediment, to calculate the percent of storage filled by sediment (40%).

Table 17. Policy Area Watersheds Impaired by Sediment

Watershed Name	Affected Stream Length (miles)
Albion River	77
Big River	38
Gualala River	455
Laguna de Santa Rosa	96
Lagunitas Creek	17
Mattole River	503
Napa River	65
Navarro River	415
Noyo River	144
Petaluma River	22
Russian River	1,171 (entire watershed)
Sonoma Creek	30
Stemple Creek	61
Ten Mile River	162
Walker Creek	16

Source: SWRCB, 2002

Based on the range of reservoir sedimentation percentages observed for a sampling of reservoirs in the Policy area, from nearly zero percent for very large reservoirs to nearly 100% for small older reservoirs, the potential volume of sediment storage is estimated to be 50% of the estimated onstream storage volume at estimated existing unauthorized dams. Previous studies have found that approximately 10% of stored sediment would be expected to be bedload and 90% would be suspended load (Stetson Engineers 2000; USGS 1978). The potential release of bedload and suspended load are each estimated to be 50% of the estimated potential volume of sediment storage. Table 18 summarizes the potential release of sediment in acre-feet, grouped by sediment type and county.

Table 18. Estimated Potential Release of Sediment from Onstream Storage

		County					Total
		Humboldt	**Napa**	**Marin**	**Mendocino**	**Sonoma**	
Sediment (AF)	Bedload	0	902	376	539	1,107	**2,924**
	Suspended Load	0	8,115	3,381	4,850	9,967	**26,313**
	Total	**0**	**9,016**	**3,757**	**5,389**	**11,075**	**29,237**

This release of sediment could be prevented by mitigation measures at the project-level that could be implemented to stabilize the affected areas through revegetation and other biotechnical means or by removing accumulated sediment prior to dam removal.

If existing unauthorized dams could be modified to meet proposed Policy requirements to remain onstream, there would be no short-term release of sediment.

5.9.2 Changes in Channel Processes and Siltation

Long-term changes in channel processes and siltation could occur due to the change in flow regime and sediment transport allowed by the removal of barriers to flow and sediment transport. This is an intended outcome of the removal of existing unauthorized dams and will benefit the anadromous salmonids and their habitat by supplying spawning gravels and maintaining channel width. Removal of artificial barriers will return streams to a more natural condition; this is considered to be a benefit rather than an environmental impact.

Long-term benefits to channel processes could still occur even if existing unauthorized dams remain in place, because the downstream release of sediment captured in onstream storage and the release of high flows for channel maintenance are some of the operational criteria required by the Policy for existing unauthorized dams to remain onstream.

5.9.3 Impacts to Water Quality

In addition to changes in channel processes and silitation, removal of existing unauthorized dams could result in reduced hydraulic residence time and retention time of carbon, nutrients, and sediments within the impounded area, lower temperatures and changes in dissolved oxygen, dissolved nutrients, dissolved organic carbon, total suspended solids, total dissolved solids, biological oxygen demand and pH (ICF Consulting, 2005). For example, the year after the removal of a dam on Murphy Creek, a tributary of the Mokelumne River, researchers found an order of magnitude increase in nitrogen export over the previous 2-year mean (Ahearn and Dahlgren, 2005).

Potential benefits to water quality may be of particular interest in watershed already listed as impaired. Table 19 lists streams in the Policy area on the 2002 303(d) list for pollutant stressors. This table includes sediment, which is separately summarized in Table 17.

Table 19. Policy Area Streams Listed as Impaired by Pollutants

River or Body of Water	Pollutant Stressor											Length or Area Affected	
	Diazinon	Low Dissolved Oxygen	High Coliform Count	Mercury	Nickel	Nitrogen	Nutrients	Pathogens	Phosphorus	Sedimentation/Siltation	Temperature		
Albion River										x		77	miles
Americano Creek							x					38	miles
Arroyo Corte Madera Del Presidio	x											4	miles
Big River										x	x	225	miles
Corte Madera Creek	x											4	miles
Estero Americano							x			x		199	acres
Garcia River											x	154	miles
Gualala River										x	x	455	miles
Laguna de Santa Rosa		x				x			x	x	x	96	miles
Lagunitas Creek							x	x		x		17	miles
Lake Herman				x								108	acres
Lake Mendocino				x								1,704	acres
Lake Sonoma				x								2,377	acres
Mattole River										x	x	503	miles
Napa River							x	x		x		65	miles
Navarro River										x	x	415	miles
Navarro River Delta										x		48	acres
Novato Creek	x											17	miles
Noyo River										x		144	miles
Petaluma River	x						x		x	x		22	miles
Petaluma River (tidal portion)	x				x		x	x				1	miles
Russian River (Lower, Austin Creek HSA*)										x	x	81	miles
Russian River (Lower, Big Sulphur HSA)										x	x	85	miles
Russian River (Lower, Guerneville HSA)								x		x	x	195	miles
Russian River (Middle, Dry Creek HSA)										x	x	255	miles
Russian River (Middle, Geyserville HSA)										x	x	243	miles
Russian River (Middle, Mark West Creek HSA)										x	x	99	miles
Russian River (Upper, Coyote Valley HSA)										x	x	171	miles
Russian River (Upper, Forsythe Creek HSA)										x	x	122	miles
Russian River (Upper, Ukiah										x	x	460	miles

River or Body of Water	Pollutant Stressor											Length or Area Affected
	Diazinon	Low Dissolved Oxygen	High Coliform Count	Mercury	Nickel	Nitrogen	Nutrients	Pathogens	Phosphorus	Sedimentation/Siltation	Temperature	
HSA)												
San Antonio Creek (Marin/Sonoma Co)	x											18 miles
San Rafael Creek	x											4 miles
Santa Rosa Creek								x		x	x	87 miles
Sonoma Creek							x	x		x		30 miles
Stemple Creek/Estero do San Antonio							x			x		61 miles
Ten Mile River										x	x	162 miles
Tomales Bay				x								8,545 acres
Walker Creek				x			x			x		16 miles

* HSA = Hydrologic Sub-Area defined by California Department of Water Resources in the California Watershed Map

5.9.4 Detention of Storm Flows and Flooding

Removal of existing unauthorized impoundment dams could potentially result in a loss of onstream storage that may currently be used to store storm flows and prevent flooding.

The estimated existing unauthorized impoundment dams are generally small. Figure 2 shows that 90% of the estimated existing unauthorized dams with onstream storage have an estimated onstream storage volume of less than 50 acre-feet. Small onstream dams are typically operated as fill-and-spill reservoirs. The loss of onstream storage at fill-and-spill reservoirs would not be likely to impact the flood storage capacity of a stream network as these reservoirs are usually full and already spilling during flooding season and do not provide storage that effectively reduces flooding.

The potential loss of flood storage is estimated to be the total estimated onstream storage volume at estimated existing unauthorized dams. This is a very conservative estimate because it is assumes that the storage is empty of both water and sediment when floods occur. Table 20 summarizes the estimated loss of potential flood storage in acre-feet, grouped by county.

Table 20. Estimated Potential Loss of Potential Flood Storage

	County					Total
	Humboldt	Napa	Marin	Mendocino	Sonoma	
Flood Storage (AF)	0	18,033	7,513	10,778	22,150	**58,474**

If existing unauthorized dams could be modified to meet proposed Policy requirements to remain onstream, there would be no loss of potential flood storage. If onstream storage were to be removed and replaced with offstream storage, there would be some local retention of runoff from the land surface in the offstream storage reservoir.

5.10 Land Use and Planning

Compliance activities may conflict with local planning policy to protect natural resources, such as Habitat Conservation Plans/Natural Community Conservation Plans. Site-specific studies of existing unauthorized dams with onstream storage that is determined to provide habitat to endangered and threatened species could supersede the requirements of the Policy. In this case, the Policy would have no indirect environmental impacts on land use and planning.

5.11 Noise

Short-term construction activities could give rise to increased noise. The potential indirect environmental impact to noise is limited to the construction period.

5.12 Public Services

Removal of existing unauthorized impoundment dams could potentially result in a loss of onstream storage that may currently store water for fire protection.

The WRIMS database was used to determine which of the unauthorized pending dams have onstream storage that is designated for use as fire protection (Use Type E). 17% of the unauthorized pending impoundment dams[7] and 44% of the onstream storage at these dams are designated for fire protection use. The number and onstream storage volume of the unauthorized pending dams designated for fire protection use are used to estimate the potential loss of fire protection water storage at unauthorized pending dams.

It is not known whether the estimated unauthorized non-filer dams are used for fire protection. In order to estimate the number and onstream storage volume of fire protection at the estimated unauthorized non-filer dams, it is assumed that the percentage of the estimated number and onstream storage volume of estimated unauthorized non-filer dams that could be used for fire protection is equal to the percentages calculated for estimated unauthorized pending impoundment dams. The potential loss of fire protection at estimated unauthorized non-filer dams is estimated to be 17% of the total number of estimated unauthorized non-filer dams and 44% of the estimated onstream storage at estimated unauthorized non-filer dams.

[7] The unauthorized pending regulatory dams are not included in the calculation of numbers of fire protection reservoirs because there is no onstream storage at the regulatory dams.

Table 21 summarizes the potential loss of fire protection in terms of the estimated number of fire protection reservoirs and the estimated fire protection water storage volume in acre-feet, grouped by water right status and county.

Table 21. Estimated Potential Loss of Fire Protection

Water Right Status	County					Total
	Humboldt	Marin	Mendocino	Napa	Sonoma	
Number of Fire Protection Reservoirs						
Unauthorized Pending Dams	0	0	24	6	24	54
Unauthorized Non-filer Dams	0	31	44	46	94	215
Total	**0**	**31**	**68**	**52**	**118**	**269**
Fire Protection Storage Volume (AF)						
Unauthorized Pending Dams	0	0	893	157	3,317	4,367
Unauthorized Non-filer Dams	0	7,907	2,318	4,454	6,593	21,272
Total	**0**	**7,907**	**3,211**	**4,611**	**9,910**	**25,639**

If existing unauthorized dams could be modified to meet proposed Policy requirements to remain onstream, or if onstream storage were to be removed and relocated to an offstream location, there would be no loss of water for fire protection.

5.13 Recreation

Existing unauthorized impoundment dams may provide onstream storage that is currently used for water-related recreation. Swimming and fishing may be a common recreational use of this water. As shown in Figure 3, the estimated existing unauthorized dams are generally small. Over 95% of the dams with onstream storage have an estimated surface area of less than 10 acres. Boating would not be a common recreational activity in these small areas.

Potential loss of recreational opportunities is estimated to be equal to the potential loss of open water. Table 22 summarizes the potential loss of recreational area in acres, grouped by county.

Table 22. Estimated Potential Loss of Recreation Area (acres)

	County					Total
	Humboldt	Napa	Marin	Mendocino	Sonoma	
Recreation (acres)	0	1,202	501	719	1,477	**3,898**

If existing unauthorized dams could be modified to meet proposed Policy requirements to remain onstream, or if onstream storage were to be removed and relocated to an offstream location, there would be no loss of recreation.

5.14 Utilities and Service Systems

Removal of existing unauthorized impoundment dams could potentially result in a loss of onstream storage that may currently be used to store storm flows and prevent flooding as discussed in Section 5.9.4, Detention of Storm Flows and Flooding. If it is necessary to mitigate this potential loss of flood storage, additional storm water drainage systems and flood storage retention ponds would need to be built. These potential construction activities could result in short-term disruptions to existing utilities and service systems.

Development of alternative water supply sources could also impact existing utilities and service systems. These potential impacts are addressed in a separate report (Stetson 2007).

5.15 Summary of Indirect Environmental Impacts

Table 23 summarizes the potential actions that owners of existing unauthorized dams could take to comply with the proposed Policy and the resulting potential indirect environmental impacts as discussed in Sections 5.2 to 5.14.

The potential indirect environmental impacts are estimated by assuming that the actions that result in the highest potential impact would be taken by the owners of all estimated existing unauthorized dams. These are conservative (highest; most severe) estimates of potential actions and associated indirect environmental impacts. They provide an estimate of the upper limit of the potential indirect environmental impacts of the proposed Policy requirements at the estimated existing unauthorized dams.

Table 23. Assessment of Estimated Potential Indirect Environmental Impacts of Policy Restrictions on Existing Unauthorized Dams

Potential Actions in Response to Policy Giving Rise to Potential Indirect Environmental Impact	Environmental Issue Area	Potential Indirect Environmental Impact	Potential Secondary Indirect Environmental Impact
Short term construction activities at up to 1,771 dams; relocate up to 58,474 AF of onstream storage to offstream storage reservoirs	Aesthetics	Temporary visual disturbance, long-term changes to aesthetics	
Short term construction activities at up to 1,771 dams	Air Quality	Higher PM10, ozone or other pollutant levels	
Relocate up to 3,898 acres of onstream surface water to offstream storage reservoirs	Agricultural Resources	Loss of up to 3,898 acres of potentially irrigable land	
Remove up to 3,898 acres of onstream surface water	Biological Resources	Loss of up to 3,508 acres of open water and 390 acres of wetland; benefits to habitat due to gain in riparian habitat	
Short term construction activities at up to 1,771 dams	Cultural Resources	Ground disturbances that could impact cultural	

Potential Actions in Response to Policy Giving Rise to Potential Indirect Environmental Impact	Environmental Issue Area	Potential Indirect Environmental Impact	Potential Secondary Indirect Environmental Impact
		resources	
Short term construction activities at up to 1,771 dams	Geology and Soil	Short-term exposure of people or structures to potential geologic hazards; erosion and loss of topsoil	
Short term construction activities at up to 1,771 dams	Hazards and Hazardous Materials	Short-term exposure to hazardous materials associated with construction equipment and materials	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Hydrology and Water Quality – Short-term sedimentation and water quality	Potential short-term release of up to 29,237 AF of sediment (2,924 AF bedload and 26,313 AF suspended load)	Impacts to riparian habitat due to suspended load or hazardous material carried by released sediment; benefits to habitat due to release of bedload
Removal of up to 1,771 dams and 58,474 AF of onstream storage	Hydrology and Water Quality – Long-term sedimentation and water quality	Benefit to habitat due to continued release of sediment and high flows that allow for channel maintenance	Benefit to habitat due to reduced hydraulic residence times and lower water temperatures
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Hydrology and Water Quality – Flooding	Loss of up to 58,474 AF of potential flood storage	
Removal of up to 1,771 dams and 58,474 AF of onstream storage	Land Use and Planning	Conflict with local planning policy to protect onstream habitat	
Short term construction activities at up to 1,771 dams	Noise	Short-term increases in noise	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Public Services	Loss of up to 269 dams and 25,639 AF of fire protection storage	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Recreation	Loss of up to 3,898 acres of water-related recreational area	
Removal of up to 1,569 impoundment dams and 58,474 AF of onstream storage	Utilities and Service Systems	Construction of new water storage facilities to replace up to 58,474 AF of onstream storage	Various impacts related to construction and operation of new water storage facilities

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APPENDIX A. Maps

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APPENDIX B. Methods Used to Estimate Stream Class

The proposed Policy may classify streams using a system similar to the stream classifications developed by the California Department of Forestry (CDF; Cal. Code Regs., tit. 14, section 916.5, Table 1) which are as follows:

- Class I - Fish always or seasonally present, includes habitat to sustain fish migration and spawning;
- Class II - Fish always or seasonally present offsite within 1,000 feet downstream and/or aquatic habitat for non-fish species; excludes Class III waters tributary to Class I waters; and
- Class III - No aquatic life present, water course showing evidence of being capable of sediment transport downstream to Class I or Class II waters under normal high water flow conditions.

There is no current designation of stream class on a stream-by-stream basis in the Policy area. For the purpose of this analysis, the classification of streams in the Policy area is estimated using a GIS analysis with available digital data sets. The following discussion describes the four available digital data sets and how they are used to estimate stream class.

1. National Hydrography Database GIS data layer of 1:100,000 resolution streams

The National Hydrography Database GIS data layer of 1:100,000 resolution streams (NHD Streams) contains all the streams visible in 1:100,000 resolution maps. However, this data layer alone does not have the level of resolution needed for the purposes of this analysis, because many of the WRIMS POD locations are upstream of the upper extent of the data layer, or are on tributaries that are not included in the data layer. For this reason, the USGS 10-m digital elevation data is utilized to extend the channel network.

2. USGS 10-m digital elevation data

In order to classify streams that are not contained in the NHD streams, Stetson used the USGS 10-m digital elevation data for the Policy area (10-m DEM[8]) to construct a 10-m channel network[9]. This 10-m channel network was generated to provide an extensive channel network at a resolution with enough detail to describe every stream with a water right application point of diversion (POD).

In order to determine the accuracy of the 10-m channel network, a digital data layer of onstream reservoirs in Napa County (Napa digitized onstream reservoirs) was compared to the 10-m

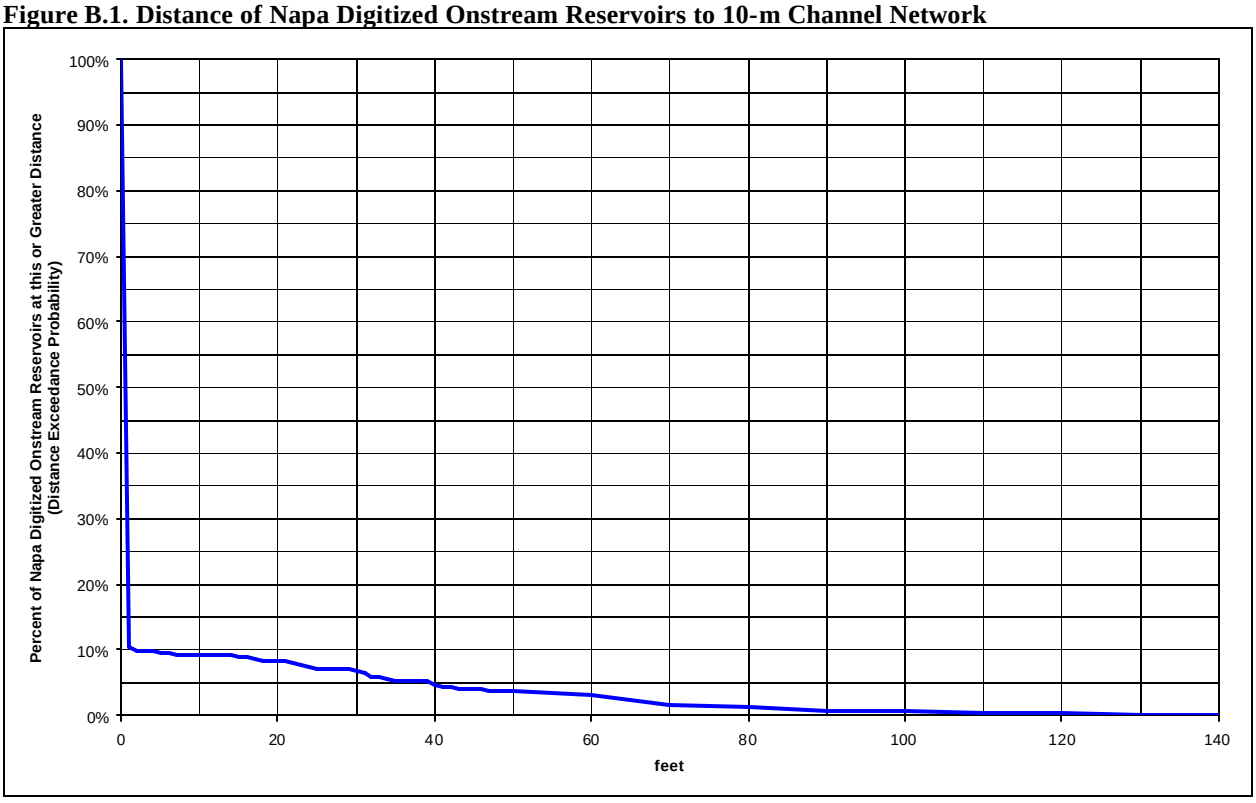
[8] A digital elevation model (DEM) is a digital map of the elevation of the land surface. Elevations are provided on a grid at a set interval. A 10-m DEM is a grid of elevation points at 10 meter intervals.

[9] The channel network was defined as any point in the 10-m elevation grid with at least 200 upstream cells. In a 10-m grid, 200 cells is approximately equal to 5 acres.

channel network. UC Berkeley, under contract to SF Bay Regional Water Quality Control Board, had previously prepared a digital layer of Napa County reservoirs by digitizing reservoirs visible in 1-m color aerial photography shot by Stillwater Sciences. Stetson compared these Napa digitized reservoirs with 1-m color aerial photography purchased from Napa County, which were taken during flights in 2002. All the reservoirs that directly overlaid the stream channel in the aerial photos were designated as Napa digitized onstream reservoirs.

The Napa digitized onstream reservoirs should overlay directly on the 10-m channel network. Where they do not directly overlay the channel network, there is an error in either the 10-m channel network, or the digitizing of the Napa reservoirs. The distances between the Napa digitized onstream reservoirs and the 10-m channel network were measured in the GIS. Figure B.1 is an exceedance curve that shows the range of measured distance between the Napa digitized onstream reservoirs and the 10-m channel network. 90% of the Napa digitized onstream reservoirs are directly on the 10-m channel network; however, the remaining reservoirs are at a distance of up to 182-feet. Because 95% of the Napa digitized onstream reservoirs are within 40-feet of the 10-m channel, 40-feet is selected as an estimate of the average error in the 10-m channel network.

Figure B.1. Distance of Napa Digitized Onstream Reservoirs to 10-m Channel Network



3. NOAA GIS data layer of designated steelhead critical habitat

NOAA provides a stream-by-stream designation of steelhead critical habitat (NOAA Steelhead Critical Habitat) as a GIS data layer at the same 1:100,000 scale as the NHD streams. This is a subset of the NHD streams that includes only the streams designated as steelhead critical habitat. For the purposes of estimating stream class, it is assumed that the range of anadromous salmonids includes only the NHD streams in the NOAA Steelhead Critical Habitat, and this subset of the NHD streams is estimated to be Class I.

The average error in the 10-m channel network is estimated to be 40 feet. For this analysis, it is assumed that streams in the 10-m channel network that are within 40 feet of the NHD Streams represent the same stream channel. Because of this, streams in the 10-m channel network that are within 40 feet of the NHD Class I streams are also estimated to be Class I.

4. CalFish Passage Assessment Database

The CalFish Passage Assessment Database (PAD) is an ongoing GIS map-based inventory of known and potential barriers to anadromous fish in California, compiled and maintained through a cooperative interagency agreement and available from the CalFish website[10]. The inventory identifies the location of barriers suitable for removal or modification to restore habitat connectivity, spawning and riparian conditions for salmon and steelhead and to enhance aquatic and riparian habitat. For the purposes of estimating stream class, barriers described as non-structural with a total barrier status (PAD Natural Barriers) are assumed to represent natural barriers that would block upstream passage of anadromous salmonids and limit the range of anadromy. Streams upstream of the PAD Natural Barriers were not estimated to be Class I even if they are included in the NOAA Steelhead Critical Habitat.

Stetson used the GIS data layers described above and the following stream classifications to create a stream-by-stream designation of estimated stream class for the Policy area:

- Estimated Class I – Includes all the NHD streams in the NOAA Steelhead Critical Habitat that are not upstream of PAD Natural Barriers and those streams in the 10-m channel network that are within 40 feet of the NHD Class I stream;

- Estimated Class II – All streams in the 10-m channel network that are upstream of and within 1,040[11] feet of a Class I stream and that are not upstream of PAD natural barriers; and

- Estimated Class III – Any stream in the 10-m channel network upstream of a Class I stream that are not designated as Class II (i.e. upstream of a PAD natural barrier or more than 1,040 feet upstream of a Class I stream).

[10] The Passage Assessment Database (PAD) is available from the CalFish website, http://www.calfish.org

[11] 1,040 feet is the maximum distance of the Class II streams from Class I streams (defined by CDF as 1,000 feet and/or the upper extent of aquatic habitat for non-fish species which was not known) plus the estimated average 40-foot error in the 10-m channel network.

Figure A.7 shows the GIS data layers used to estimate stream class for the Policy area. Figure A.8 shows the resulting stream-by-stream designation of estimated stream class for the Policy area.

The CDF definition of Class II streams includes streams with fish present offsite within 1,000 feet downstream as well as streams that provide aquatic habitat for non-fish species. The estimated Class II streams include only those streams within 1,040 feet of the Class I streams (1,000 feet from Class I streams plus the estimated average 40-foot error in the 10-m channel network). The aquatic habitat for non-fish species may extend further upstream than 1,040 feet upstream. However, the extent of aquatic animals is not known on a stream-by-stream basis and could not be used to designating estimated stream class. Because of this, the length of Class II streams is limited to 1,040 feet and may be underestimated. Since the threshold between Class II and Class III could not be estimated with certainty, this report groups estimated Class II and Class III streams together when presenting estimated existing unauthorized dams and the potential indirect environmental impacts of removal of these dams.

APPENDIX C. Methods Used to Estimate Existing Unauthorized Non-filer Dams

C.1 Background

The State Water Resources Control Board has previously undertaken investigations to identify existing reservoirs with no water right permits in the following watersheds in the Policy area:

- Navarro River and Maacama River, 1998;
- Mendocino County Russian River, 2002; and
- Sonoma County, on-going.

These investigations relied on complaints, aerial photography, and site investigations to identify potentially unauthorized onstream and offstream storage reservoirs.

Due to time and budget constraints, it was not possible to do site investigations over the 4,900 square mile Policy area to identify existing dams and onstream reservoirs that are diverting water under an unknown basis of right (unauthorized non-filer dams). Instead, Stetson completed two Geographic Information System (GIS) studies that estimated the possible location, onstream storage volume, and onstream surface area of unauthorized non-filer dams: GIS Study #1, which studied Napa County and used existing digitized data available only for the Napa River watershed; and GIS Study #2, which studied the entire Policy area and used digital elevation data. Results of GIS Study #1 are used to estimate the number, onstream storage volume, and onstream surface area of estimated unauthorized non-filer dams in Napa County; results of GIS Study #2 are used to estimate the number, onstream storage volume, and onstream surface area of estimated unauthorized non-filer dams in the remainder of the Policy area. This section provides a summary of the studies.

The GIS studies used the following digital data sets:

- Napa River watershed reservoirs digital GIS shapefile (Napa digitized reservoirs)
- USGS 10-m digital elevation data for the Policy area (10-m DEM[12])
- National Hydrography Database (NHD) GIS coverage of lakes, reservoirs, ponds, and wide streams (NHD water bodies)
- Water Rights Information Management Systems (WRIMS) database of permitted and pending water right applications and point of diversions (PODs)
- National Agriculture Imagery Program 1-m aerial photography

The two GIS studies are described in sections C.2 and C.3.

[12] A digital elevation model (DEM) is a digital map of the elevation of the land surface. Elevations are provided on a grid a set interval. A 10-m DEM is a grid of elevation points at 10 meter intervals.

C.2 GIS Study #1 - Napa County Digitized Reservoir Study

In GIS Study #1, the unauthorized non-filer dams are estimated using an existing GIS data layer of digitized reservoirs in Napa County, aerial photography, and information from the WRIMS database as follows:

1. Napa digitized reservoirs were designated as onstream or offstream based on a study of aerial photos.
2. Napa digitized onstream reservoirs were assigned a water right status (permitted, pending, or non-filer) based on proximity to water right application points of diversion (PODs).
3. A unauthorized non-filer dam is estimated at each Napa digitized onstream reservoir with an estimated non-filer water right status on an estimated Class I, II or III stream.

The data sets and methods used in GIS Study #1 are described further in the sections that follow.

C.2.1. Methods Used to Locate Existing Onstream Reservoirs

UC Berkeley, under contract to SF Bay Regional Water Quality Control Board, had previously prepared a digital layer of Napa County reservoirs by digitizing reservoirs visible in 1-m color aerial photography shot by Stillwater Sciences. Stetson checked the location of each Napa digitized reservoir against 1-m color aerial photography purchased from Napa County, taken during flights in 2002, to determine if the reservoirs were onstream or offstream. Of the 1072 Napa digitized reservoirs, 506 were determined to be onstream and 566 were determined to be offstream.

C.2.2 Methods Used to Estimate the Water Right Status of Existing Onstream Reservoirs

The State Water Board stores information on all permitted and pending water right applications in their WRIMS database. Stetson created a GIS layer of all PODs with a permitted or pending water right application for onstream storage using the following WRIMS database information:

- POD coordinates and zone – the location of each point of diversion in state plane coordinates and state plane zone;
- POD storage – the volume of onstream or offstream storage in acre-feet;
- Application maximum storage – the total volume of onstream and offstream storage in acre-feet for the water right application; and
- POD code – the location of storage: O is onstream; F is offstream; B is both on and offstream. U is used to refer to PODs with onstream storage but an unknown POD code.

A POD is assumed to have onstream storage if the POD storage is non-zero and the POD code is either O (onstream), B (both onstream and offstream), or U (unknown). If there are multiple PODs at one location, only the POD from the first application filed is included in the onstream POD GIS layer. There are sixteen PODs for pending water right applications for onstream

storage that have missing or inaccurate POD locations in the WRIMS database. These PODs could not be included in the GIS layer of onstream PODs.

Each onstream storage POD (and its corresponding water right status, permitted or pending) is assigned to a reservoir if possible. Each reservoir is assigned to a maximum of one POD. Priority is given to PODs with permitted water right status or a POD code of O or B according to the following steps:

1. The distances from each onstream storage POD to the ten nearest Napa digitized onstream reservoirs are measured in the GIS.
2. Onstream storage PODs with permitted water right status and a POD code of O, B or U are assigned to the closest reservoir within 100 feet, if any. If multiple PODs have the same closest reservoir, only the POD with the shortest distance to the reservoir is assigned to that reservoir and the remaining PODs are assigned to the next closest available (not yet assigned to a POD) reservoir within 100 feet, if any.
3. Onstream storage PODs with permitted water right status and a POD code of O or B are assigned to the closest available reservoir within 1000 feet, if any.
4. Onstream storage PODs with permitted water right status and a POD code of U are assigned to the closest available reservoir within 1000 feet, if any.
5. Onstream storage PODs with pending water right status and a POD code of O, B or U are assigned to the closest available reservoir within 100 feet, if any.
6. Onstream storage PODs with pending water right status and a POD code of O or B are assigned to the closest available reservoir within 1000 feet, if any.
7. Onstream storage PODs with pending water right status and a POD code of U are assigned to the closest available reservoir within 1000 feet, if any.

Table C.1 lists the number of onstream storage PODs that are or are not assigned to a reservoir, grouped by water right status and POD code. The PODs that are not assigned have no available Napa digitized onstream reservoir within 1000 feet.

Table C.1. Assignment of Onstream Storage PODs in Napa County to Napa Digitized Onstream Reservoirs

Water Right Status	Storage Location	Number of Onstream Storage PODs Assigned to Napa Digitized Reservoirs	Number of Onstream Storage PODs Not Assigned to Napa Digitized Reservoirs	Total Number of Onstream PODs in Napa County
Permitted	Onstream	149	151	300
	Both onstream and offstream	18	23	41
	Unknown	64	68	132
	Subtotal	**231**	**242**	**473**
Pending	Onstream	4	19	23
	Both onstream and offstream	0	0	0
	Unknown	2	4	6
	Subtotal	**6**	**23**	**29**
	Total	**237**	**265**	**502**

There are several reasons why some of the onstream storage PODs would not be assigned to reservoirs. An unassigned onstream POD with a pending water right status might be at a location where the reservoir has not yet been constructed. An unassigned onstream POD with an unknown POD code might have offstream rather than onstream storage. An unassigned onstream POD with a POD code of B might have a small regulatory dam with an insignificant amount of onstream storage which enables diversion to a larger offstream storage reservoir. It is expected that some of the PODs with pending water right status or a POD code of B or U would not be assigned to a Napa digitized onstream reservoir.

Each permitted POD with a POD code of O is a location where a water right for only onstream storage has already been permitted and there should be a reservoir at this location. However, some of these PODs were not assigned to a Napa digitized onstream reservoir. These unassigned PODs indicate that either there are errors in the POD coordinates, which resulted in the estimated POD location being further than 1000 feet from the reservoir, or that some reservoirs that have been constructed were not included in the Napa digitized reservoirs, probably because they were not visible or not yet constructed at the time of the aerial photography.

The water right status of each Napa digitized onstream reservoir is assumed to be the same as the water right status of the onstream storage POD to which it is assigned. Of the 506 Napa digitized onstream reservoirs, there are 269 that are not assigned to an onstream storage POD using the method described above. These reservoirs are given a non-filer water right status. Table C.2 lists the number of Napa digitized onstream reservoirs, grouped by estimated water right status[13].

Table C.2. Number of Napa Digitized Onstream Reservoirs by Estimated Water Right Status

Estimated Water Right Status	Napa
Permitted	231
Pending	6
Non-filer	269
Total	**506**

Figure A.2 shows the results of GIS Study #1. Napa digitized onstream reservoirs are drawn in the shape of the water surface and colored by estimated water right status.

C.2.3 GIS Study #1 Existing Unauthorized Non-filer Dams

An unauthorized non-filer dam is estimated at every Napa digitized onstream reservoir with an estimated non-filer water right status on a Class I, II or III stream. There are 269 Napa digitized reservoirs that are estimated to have a non-filer water right status. Each reservoir is assigned an estimated stream class based on the estimated stream-by-stream classification at the reservoir location, developed by Stetson as described in Appendix B.

[13] There are 502 onstream storage PODs in Napa County and 506 Napa digitized onstream reservoirs. Table C.1 lists the number of onstream storage PODs; Table C.2 lists the number of Napa digitized onstream reservoirs.

Table C.3 list the number of unauthorized non-filer dams estimated in GIS Study #1, grouped as either on Class I streams (anadromous fish presence) or on Class II or Class III streams (upstream of anadromous fish presence).

Table C.3. Number of Estimated Unauthorized Non-Filer Dams in GIS Study #1 by Estimated Stream Class

Estimated Stream Class	Napa
I	68
II and III	201
Total	**269**

C.3 GIS Study #2 – Policy Area GIS Analysis

In GIS Study #2, the unauthorized non-filer dams are estimated using digital elevation data, aerial photography, and information from the WRIMS database as follows:

1. A GIS layer of possible onstream reservoirs (GIS onstream reservoirs) was estimated from the digital elevation data and the National Hydrography Database (NHD) water bodies digital data layer.
2. The GIS onstream reservoirs were assigned a water right status (permitted, pending, or non-filer) based on proximity to water right application points of diversion.
3. A unauthorized non-filer dam is estimated at each GIS onstream reservoir with an estimated non-filer water right status on an estimated Class I, II or III stream.

The data sets and methods used in GIS Study #2 are described further in the sections that follow.

C.3.1. Methods Used to Locate Existing Onstream Reservoirs

There is no existing digitized reservoir coverage for the entire Policy area as there is for Napa County in GIS Study #1. Due to time and budget constraints, it was not possible to digitize aerial photographs for the remainder of the Policy area. Therefore, in GIS Study #2, Stetson estimated the possible locations of onstream reservoirs (GIS onstream reservoirs) in the entire Policy area using a GIS study of 10-m digital elevation data (10-m DEM). The steps used to estimate the GIS onstream reservoirs are as follows:

1. Possible locations of GIS onstream reservoirs were delineated in the USGS 10-m DEM
2. GIS onstream reservoirs with areas less than 0.2 acres were deleted
3. NHD water bodies in the Policy area were added to the GIS onstream reservoirs
4. GIS onstream reservoirs that were not onstream based on their proximity to a stream channel network derived from the 10-m DEM were deleted
5. GIS onstream reservoirs that were obviously not water surfaces in the National Agriculture Imagery Program aerial photography were deleted.

Each step is described in more detail below.

A GIS data layer of possible onstream reservoirs was estimated from the USGS 10-m DEM by delineating areas of constant elevation[14] (flat surfaces) and areas where elevations are lower than the surrounding areas[15] (sinks).

The resulting possible GIS onstream reservoirs data layer included many very small areas that, based on their size, were more likely to be an artifact of the methods used to construct the data layer rather than representing actual water surfaces. All polygons with areas smaller than 0.20 acres were deleted. This deletion eliminated many potential errors and greatly reduced the number of features. Some of the small areas that were deleted may have indicated the presence of small onstream ponds that should have been considered; however, this loss of detail was small compared to the potential errors avoided by deleting the many areas that were not surface water impoundments. In addition, the deletion allowed a more in-depth analysis of the remaining larger features. Larger features were more likely to indicate the location of existing unauthorized dams whose potential removal to comply with the Policy could potentially have greater impacts.

The NHD water bodies are a GIS data layer of lakes, ponds, reservoirs, and wide streams at a 1:24,000 resolution. The NHD water bodies were added to the possible GIS onstream reservoirs. Where features overlapped, the feature generated from the flat surfaces and sinks in the 10-m DEM was deleted, because the NHD water bodies were assumed to be a more accurate representation of actual surface water.

To eliminate some of the possible GIS onstream reservoirs that are actually offstream, Stetson first determined the maximum distance from the stream channel network at which reservoirs could be assumed to be onstream (designated onstream distance) and then deleted all of the possible GIS onstream reservoirs that were further than this distance from the stream channel.

The 10-m channel network constructed from the USGS 10-m DEM is used to represent the stream channel network because this is the most extensive channel network available for the entire Policy area. As discussed in Appendix B, the average error in the 10-m channel network is estimated to be 40 feet. Because onstream reservoirs should be located directly on the stream channel, it is reasonable to account for the error in the stream channel network by using 40 feet as the designated onstream distance and to assume that any reservoirs within 40 feet of the 10-m channel network are onstream and reservoirs that are further than 40 feet are offstream.

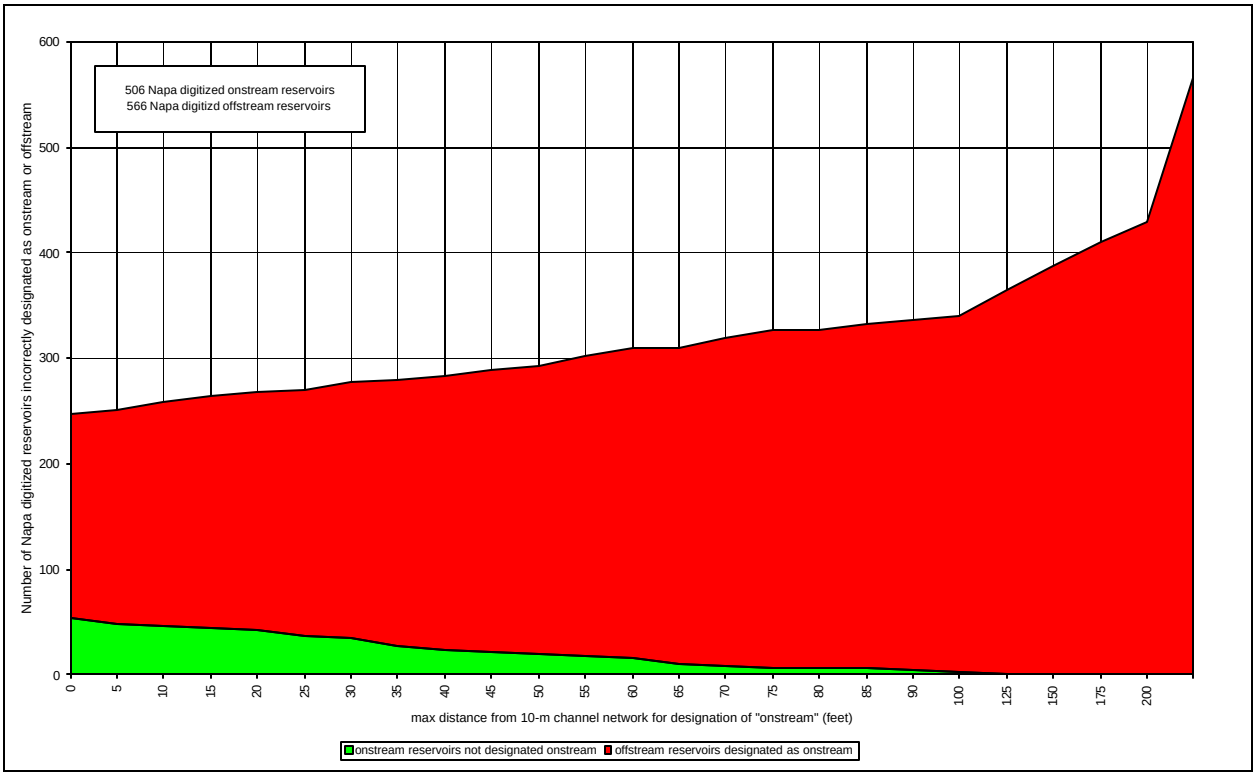
To test this assumption, the distances between the Napa digitized reservoirs and the 10-m channel network were measured in the GIS for both onstream and offstream reservoirs. Figure C.1 shows the number of Napa digitized onstream reservoirs that would be incorrectly identified

[14] Slope was calculated from the USGS 10-m DEM using ArcInfo Spatial Analyst. Areas of zero slope were identified and these flat surfaces were delinated and converted to polygons. Each polygon represents an area with constant elevation in the DEM and could potentially be water surface.

[15] The USGS 10-m DEM was filled using ArcInfo Spatial Analyst. The resulting digital grid represents a land surface that has no areas that are completely surrounded by points with higher elevation, i.e. sinks in the 10-m DEM are filled to be as high as the surrounding areas. These sinks were identfied by calculating a digital grid of the difference between the filled 10-m DEM and the USGS 10-m DEM with the ArcInfo Raster Calculator. The sinks were delinated and converted to polygons. Each polygon represents a sink in the DEM where water could collect to create a lake or pond.

as offstream and the number of Napa digitized offstream reservoirs that would be incorrectly identified as onstream at different designated onstream distances. If all Napa digitized reservoirs within 40 feet of the 10-m channel network were designated as onstream, 95% of the Napa digitized onstream reservoirs would be correctly designated as onstream and 46% of the Napa digitized offstream reservoirs would be correctly designated as offstream[16]. These results support using a designated onstream distance of 40 feet because this would eliminate many reservoirs that are actually offstream and very few of the reservoirs that are actually onstream from consideration as possible GIS onstream reservoirs.

Figure C.1. Error in Designation of Napa Digitized Onstream Reservoirs Based on Distance from 10-m Channel Network



Using 40 feet as the designated onstream distance, all possible GIS onstream reservoirs further than 40 feet from the 10-m channel network were assumed to be offstream and were deleted.

The possible GIS onstream reservoirs were compared with National Agriculture Imagery Program 1-m aerial photography. Areas that were obviously not water surface or not onstream were deleted. In some cases, a possible GIS onstream reservoir matched the location of an

[16] 89.3% of the Napa digitized onstream reservoirs and 37.3% of the Napa digitized offstream reservoirs were directly on the 10-m channel network. 95.3% of the Napa digitized onstream reservoirs and 45.8% of the Napa digitized offstream reservoirs are within 40 feet of the 10-m channel network. The 10-m channel network is very extensive as it includes any area with approximately 5 acres of upstream land surface, whether or not there is a defined channel. The error in designation of offstream reservoirs is largely due to areas where the 10-m channel network extends beyond the true headwaters of the stream channel.

onstream reservoir visible in the aerial photography but the shape of the possible GIS onstream reservoir was inaccurate or enclosed multiple reservoirs surfaces. The possible GIS onstream reservoirs were not manually edited to match visible water surface areas due to time constraints.

C.2.2 Methods Used to Estimate the Water Right Status of Existing Onstream Reservoirs

The WRIMS database information was used to assign onstream storage PODs and their corresponding water right status to the GIS onstream reservoirs using the same methods as GIS Study #1.

As for GIS Study #1, there are onstream storage PODs that are not assigned to GIS onstream reservoirs. The PODs that are not assigned have no available GIS onstream reservoir within 1000 feet. Table C.4 lists the number of onstream storage PODs in the Policy area that are or are not assigned to a GIS onstream reservoir, grouped by water right status and POD code.

Table C.4 Assignment of Onstream Storage PODs in Policy Area to GIS Onstream Reservoirs

Water Right Status	Storage Location	Number of Onstream PODs Assigned to GIS Onstream Reservoirs	Number of Onstream PODs Not Assigned to GIS Onstream Reservoirs	Total Number of Onstream PODs in Policy Area
Permitted	Onstream	535	604	1139
	Both onstream and offstream	30	51	81
	Unknown	235	197	432
	Subtotal	800	852	1652
Pending	Onstream	68	147	215
	Both onstream and offstream	13	44	57
	Unknown	3	23	26
	Subtotal	84	214	298
	Total	**884**	**1066**	**1950**

Table C.5 is a subset of Table C.4 that lists the number of onstream storage PODs in Napa County that are or are not assigned to a GIS onstream reservoir, for comparison with the POD assignments in Napa County for GIS Study #1, which are shown in Table C.1. There are more PODs in Napa County that are not assigned to reservoirs in GIS Study #2 than in GIS Study #1. This is likely because GIS Study #2 had to rely on available digital elevation data to locate possible reservoir locations, which is less accurate than using reservoir locations digitized from aerial photographs.

The water right status of each GIS onstream reservoir is assumed to be the same as the onstream storage POD to which it is assigned. The GIS onstream reservoirs that are not assigned to an onstream storage POD are estimated to have a non-filer water right status. Table C.6 lists the number of GIS onstream reservoirs, grouped by estimated water right status.

Table C.5 Assignment of Onstream Storage PODs in Napa County to GIS Onstream Reservoirs

Water Right Status	Storage Location	Number of Onstream PODs Assigned to GIS Onstream Reservoirs	Number of Onstream PODs Not Assigned to GIS Onstream Reservoirs	Total Number of Onstream PODs in Napa County
Permitted	Onstream	136	164	300
	Both onstream and offstream	16	25	41
	Unknown	60	72	132
	Subtotal	**212**	**261**	**473**
Pending	Onstream	4	19	23
	Both onstream and offstream	0	0	0
	Unknown	0	6	6
	Subtotal	**4**	**25**	**29**
	Total	**216**	**286**	**502**

Table C.6. Number of GIS Onstream Reservoirs by Estimated Water Right Status

Estimated Water Right Status	Humboldt	Marin	Mendocino	Napa	Sonoma	Total
Permitted	0	82	145	212	361	800
Pending	0	0	26	4	54	84
Non-filer	0	299	269	126	562	1,256
Total	**0**	**381**	**440**	**342**	**977**	**2,140**

Figure A.3 shows the results of GIS Study #2. GIS onstream reservoirs are drawn as triangles at the center of the reservoir, colored by estimated water right status.

C.3.3 GIS Study #2 Existing Unauthorized Non-filer Dams

An unauthorized non-filer dam is estimated at every GIS onstream reservoir with an estimated non-filer water right status on an estimated Class I, II or III stream. The stream class of the GIS onstream reservoirs is estimated based on the estimated stream-by-stream classification at the reservoir location. There are 146 GIS onstream reservoirs with an estimated non-filer water right status that are not on a Class I, II or III stream (119 in Marin, 14 in Mendocino, and 13 in Sonoma). These reservoirs are on streams that are not estimated to have any anadromous salmonid presence, according to the methods described in Appendix B, and are not used to estimate unauthorized non-filer dams.

Table C.7 summarizes the number of unauthorized non-filer dams estimated in GIS Study #2, grouped as either on Class I streams (anadromous fish presence) or on Class II or Class III streams (upstream of anadromous fish presence).

Table C.7. Number of Estimated Unauthorized Non-Filer Dams in GIS Study #2 by Estimated Stream Class

Estimated Stream Class	Humboldt	Marin	Mendocino	Napa	Sonoma	Total
I	0	39	35	12	35	121
II and III	0	141	220	114	514	989
Total	**0**	**180**	**255**	**126**	**549**	**1,110**

As discussed, GIS Study #2 used two digital data sources to located onstream reservoirs, the 10-m DEM and NHD water bodies. Table C.8 summarizes the number of existing unauthorized non-filer dams estimated by GIS Study #2, grouped by digital data source and county.

Table C.8. Number of Estimated Unauthorized Non-Filer Dams in GIS Study #2 by Digital Data Source

Digital Data Source	County					Total
	Humboldt	Marin	Mendocino	Napa	Sonoma	
10-m DEM	0	19	36	3	28	86
NHD water bodies	0	161	219	123	521	1,024
Total	**0**	**180**	**255**	**126**	**549**	**1,110**

C.4 Summary of Results

Figure A.4 shows the unauthorized non-filer dams in Napa County estimated by GIS Study #1 and GIS Study #2, drawn in the shape of the water surface and colored by GIS study. Because GIS Study #1 estimated more unauthorized non-filer dams, the results of GIS Study #1 are used to estimate the number and surface area of estimated unauthorized non-filer dams in Napa County. The results of GIS Study #2 are used to estimate the number and surface area of estimated unauthorized non-filer dams in the remainder of the Policy Area. Figure A.5 shows the combined results of both GIS studies. The estimated unauthorized non-filer dams are shown as triangles, colored by GIS study and digital data source.

Table C.9 summarizes the number of estimated unauthorized non-filer dams, grouped as either on Class I streams (anadromous fish presence) or on Class II or Class III streams (upstream of anadromous fish presence).

Table C.9. Number of Estimated Unauthorized Non-filer Dams by Estimated Stream Class

Estimated Stream Class	County					Total
	Humboldt	Marin	Mendocino	Napa	Sonoma	
I	0	39	35	68	35	177
II and III	0	141	220	201	514	1,076
Total	**0**	**180**	**255**	**269**	**549**	**1,253**

APPENDIX D. Pending Water Right Applications

Table D.1. Summary of Pending Water Right Applications

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A029381	49	30	yes		2	0	0	2	30.0
A029511	23	0	no		2	1	1	0	0.0
A029512	23	45	yes		2	1	0	1	22.5
A029525	23	0	no		1	0	1	0	0.0
A029526	23	0	no		1	1	0	0	0.0
A029705	49	2235	no		1	0	1	0	0.0
A029706	49	2235	no		4	0	0	4	2235.0
A029708	49	49	no		1	0	0	1	49.0
A029715	49	199	yes		5	0	1	4	24.9
A029737	49	0	no		1	0	1	0	0.0
A029760	23	158	no	no	1	1	0	0	0.0
A029763	23	139	yes		3	1	2	0	0.0
A029764	23	0	no		1	1	0	0	0.0
A029765	23	0	no		1	1	0	0	0.0
A029772	49	40	no		1	0	0	1	40.0
A029783	23	70	yes		4	0	2	2	5.8
A029784	49	20	yes		4	0	3	1	1.3
A029810	23	12	yes		4	0	2	2	6.0
A029852	28	14	no	no	1	0	0	1	14.0
A029853	28	190	no	no	2	2	0	0	0.0
A029865	28	50	no		2	0	0	2	50.0
A029910	23	55.6	no		1	0	1	0	0.0
A029911	23	0	no		1	1	0	0	0.0
A029929	28	4.5	no		3	0	0	3	4.5
A029983	49	26	no	no	1	1	0	0	0.0
A030012	28	32	no	no	1	1	0	0	0.0
A030015	23	123	yes		3	0	0	3	123.0
A030077	49	0	no		11	0	11	0	0.0
A030126	49	11	no	no	1	1	0	0	0.0
A030162A	23	0	no		2	0	2	0	0.0
A030162B	23	0	no		1	0	1	0	0.0
A030163	23	0	no		2	0	2	0	0.0
A030170	23	0	no		2	0	2	0	0.0
A030181	49	40	yes		2	0	1	1	6.1
A030186	49	0	no		1	0	1	0	0.0
A030223	49	120	no		1	0	0	1	120.0
A030252	28	65	no		2	1	0	1	35.0
A030253	28	65	no	no	1	1	0	0	0.0
A030259	49	22	yes		2	0	0	2	22.0

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A030290	23	17	yes	no	2	1	0	1	8.5
A030336	49	10	no		1	0	0	1	10.0
A030349	23	8.3	no		1	0	0	1	8.3
A030363	23	10	no		1	0	0	1	10.0
A030364	49	23	no		2	0	0	2	23.0
A030365	49	0	no		2	2	0	0	0.0
A030368	49	102	yes		3	0	0	3	102.0
A030369	49	229.2	yes		6	4	0	2	22.8
A030405	49	35.3	no	no	1	1	0	0	0.0
A030429	49	27	no		1	0	0	1	27.0
A030448	23	70	yes		2	0	1	1	35.0
A030449	23	0	no		2	2	0	0	0.0
A030451	23	0	no		2	0	2	0	0.0
A030479	23	12	no		1	0	0	1	12.0
A030492	23	30	no		1	0	0	1	30.0
A030533	23	30	no		1	0	1	0	0.0
A030534	49	79	no		2	0	0	2	79.0
A030553	23	40	yes		2	0	1	1	20.0
A030554	23	45	yes		2	1	1	0	0.0
A030558	49	1100	yes		8	1	4	3	21.9
A030579	49	2004	no		6	0	2	4	2004.0
A030583	49	60	yes		2	0	1	1	30.0
A030592	49	35	yes		2	0	0	2	35.0
A030594	28	98	yes		2	0	0	2	98.0
A030597	28	52	no		1	0	0	1	52.0
A030605	28	40	yes		4	1	3	0	0.0
A030615	23	45	yes		3	0	3	0	0.0
A030655	28	10	no		1	0	0	1	10.0
A030656	23	0	no		4	0	4	0	0.0
A030663	49	0	no		5	0	5	0	0.0
A030674	28	25	no		3	0	0	3	25.0
A030679	28	38	yes		2	1	1	0	0.0
A030683	23	41	no		4	0	0	4	41.0
A030687	49	59	yes		3	0	1	2	7.4
A030688	49	0	no		1	1	0	0	0.0
A030690	28	32	no		1	0	0	1	32.0
A030695	49	15	no		1	0	0	1	15.0
A030711	49	63	yes		2	0	0	2	63.0
A030717	23	8	no	yes	1	0	0	1	8.0
A030718	23	30	no	yes	1	0	0	1	30.0
A030722	23	120	yes	yes	2	1	0	1	64.6
A030725	28	49	no		1	0	0	1	49.0
A030730	49	15	no		1	0	0	1	15.0

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A030735	23	6	no	yes	1	1	0	0	0.0
A030737	28	15	yes		2	0	1	1	7.5
A030740	28	26	no		1	0	0	1	26.0
A030744	49	25	no		2	0	0	2	25.0
A030745	49	85	yes		2	0	0	2	85.0
A030746	49	50	yes		3	0	1	2	25.0
A030747	49	98	yes		3	1	0	2	49.0
A030748	49	113	no		4	0	0	4	113.0
A030756	28	49	no		1	0	0	1	49.0
A030761	23	37.3	yes	yes	4	0	0	4	37.3
A030779	23	231	yes		4	0	2	2	19.3
A030780	23	167	yes		6	0	2	4	18.2
A030781	49	128	no		3	0	1	2	79.0
A030782	49	306	yes		6	1	1	4	98.0
A030787	49	30	no		2	0	1	1	30.0
A030792	23	45	yes	yes	4	2	1	1	23.8
A030794	23	12.5	no	yes	1	1	0	0	0.0
A030796	49	48	no		1	0	0	1	48.0
A030798	49	99	no		1	0	0	1	99.0
A030799	49	49	no		1	0	0	1	49.0
A030800	49	35	yes		2	0	1	1	17.5
A030802	49	229	yes		3	0	2	1	22.1
A030803	28	40	no		1	0	0	1	40.0
A030804	23	30	yes		2	0	2	0	0.0
A030805	49	14	no		1	0	0	1	14.0
A030806	49	20	yes		3	0	0	3	20.0
A030807	49	19	no		1	0	0	1	19.0
A030808	23	10	no		1	0	0	1	10.0
A030815	49	23	no		1	0	0	1	23.0
A030824	28	15	yes		2	0	1	1	7.5
A030828	23	35	no	yes	1	0	0	1	35.0
A030856	28	9.7	no		1	0	0	1	9.7
A030859	23	51	no	yes	4	0	0	4	51.0
A030860	23	20	no	yes	1	0	0	1	20.0
A030861	23	25	yes	yes	3	0	1	2	4.2
A030869	23	12	no	yes	1	0	0	1	12.0
A030870	23	40	yes		2	0	1	1	20.0
A030872	23	20	no	yes	1	0	0	1	20.0
A030873	23	5	no	yes	1	0	0	1	5.0
A030877	23	44	yes		2	0	1	1	5.5
A030878	23	0	no		2	2	0	0	0.0
A030879	49	0	no		2	0	2	0	0.0
A030880	49	0	no		1	1	0	0	0.0

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A030882	49	5	no		1	0	0	1	5.0
A030892	23	0	no		1	0	1	0	0.0
A030912	23	119	yes		5	0	3	2	16.1
A030926	23	30	no	yes	2	0	0	2	30.0
A030929	28	2	no		1	0	0	1	2.0
A030930	23	20	no	yes	1	0	0	1	20.0
A030931	49	82	yes		4	0	2	2	10.3
A030950	28	15	no		1	0	0	1	15.0
A030954	49	198	yes		6	0	1	5	23.4
A030955	49	355	yes		2	1	0	1	44.4
A030965	28	49	yes		2	0	1	1	24.5
A030967	23	0	no		1	0	1	0	0.0
A030978	49	164	no		1	0	0	1	164.0
A030981	49	0	no	no	2	2	0	0	0.0
A030982	23	0	no		1	0	1	0	0.0
A030986	23	0	no		1	0	1	0	0.0
A030987	23	0	no		7	5	2	0	0.0
A030988	23	195	yes		8	0	0	8	195.0
A030991	49	46	yes		2	1	1	0	0.0
A030994	23	9	no	yes	1	0	0	1	9.0
A031003	23	0	no		1	0	1	0	0.0
A031004	23	15	no		1	0	0	1	15.0
A031021	49	45	no		1	0	0	1	45.0
A031022	49	200	yes		5	1	0	4	160.0
A031033	49	6	yes		2	0	1	1	3.0
A031039	49	120	no		1	0	1	0	0.0
A031040	23	193	yes		6	0	2	4	20.2
A031049	49	25	no		1	0	0	1	25.0
A031050	49	156	no		1	0	1	0	0.0
A031055	49	0	no		1	0	1	0	0.0
A031056	49	25	no		1	1	0	0	25.0
A031057	23	45	yes		2	0	2	0	0.0
A031059	23	0	no		1	0	1	0	0.0
A031060	23	30	no		1	0	0	1	30.0
A031076	21	3.4	no	no	1	1	0	0	0.0
A031077	21	1.6	no	no	1	1	0	0	0.0
A031080	23	30	no		1	0	0	1	30.0
A031085	23	0	no		2	0	2	0	0.0
A031086	23	0	no		4	0	4	0	0.0
A031087	23	52	yes		4	0	1	3	9.8
A031088	49	46	no		1	0	0	1	46.0
A031089	49	25	no		1	0	0	1	25.0
A031091	23	0	no		2	1	1	0	0.0

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A031092	23	0	no		1	0	1	0	0.0
A031093	23	0	no		3	2	1	0	0.0
A031094	23	0	no		1	1	0	0	0.0
A031095	49	49	yes		2	0	1	1	24.5
A031096	23	15	no	no	1	1	0	0	0.0
A031097	23	40	no	yes	1	0	0	1	40.0
A031105	23	20	yes		2	1	0	1	10.0
A031133	23	49	no		1	0	1	0	0.0
A031135	23	110	yes	yes	3	0	3	0	0.0
A031138	23	0	no		1	0	1	0	0.0
A031139	23	0	no		1	1	0	0	0.0
A031140	23	200	no		1	0	0	1	50.0
A031141	23	200	no		1	1	0	0	0.0
A031147	49	10	no		1	0	0	1	10.0
A031149	49	30	yes		3	0	2	1	10.0
A031158	49	3	yes		2	0	2	0	0.0
A031159	23	60	yes		3	1	0	2	31.7
A031171	23	30	yes		2	0	2	0	0.0
A031178	23	7.1	no		1	0	0	1	7.1
A031179	23	0	no		1	0	1	0	0.0
A031180	49	15	no		1	0	0	1	15.0
A031183	23	49.5	no		1	0	0	1	49.5
A031184	23	74	no		2	0	0	2	74.0
A031187	49	61	no		2	0	0	2	15.3
A031248	49	6	no		1	0	0	1	6.0
A031250	23	42	yes		4	0	3	1	2.2
A031253	23	0	no		2	0	2	0	0.0
A031254	49	10.1	no		1	0	0	1	10.1
A031255	23	40	yes		5	0	5	0	0.0
A031256	49	147	yes		5	0	2	3	49.0
A031257	49	0	no		1	0	1	0	0.0
A031258	23	60	yes		2	0	2	0	0.0
A031259	23	50	yes		5	0	2	3	26.5
A031260	23	109	yes		4	0	0	4	109.0
A031261	23	0	no		1	0	1	0	0.0
A031262	28	52	no		4	0	0	4	52.0
A031279	28	35	no		1	0	1	0	0.0
A031280	28	49	yes		2	0	1	1	24.5
A031282	23	30	no		1	1	0	0	0.0
A031296	23	123	no		1	0	1	0	0.0
A031300	49	19	no	no	1	1	0	0	0.0
A031304	49	141	yes		5	0	2	3	19.1
A031305	23	97	yes		5	0	0	5	63.2

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A031307	49	37	yes		2	0	2	0	0.0
A031311	23	0	no		1	1	0	0	0.0
A031312	23	2.7	no		1	0	0	1	2.7
A031314	49	14	no		1	0	0	1	14.0
A031315	23	0	no		1	0	1	0	0.0
A031323	49	60	yes		3	0	0	3	15.0
A031336	23	35	yes		5	0	2	3	14.4
A031337	23	171.4	yes		5	0	3	2	30.7
A031339	23	136	yes		11	0	1	10	78.5
A031362	49	154	yes		4	0	0	4	38.5
A031363	49	122	yes		8	0	3	5	19.8
A031373	49	13	no		1	0	0	1	13.0
A031383	23	20	no		1	0	0	1	20.0
A031385	49	20	no		2	0	0	2	8.8
A031386	23	46	no		3	0	0	3	11.5
A031387	23	27	no		3	0	0	3	27.0
A031398	23	49	yes		2	0	1	1	24.5
A031399	23	0	no	no	1	1	0	0	0.0
A031408	49	25	no		1	0	0	1	25.0
A031418	23	116.3	yes		5	0	2	3	4.9
A031426	23	45	no	no	1	1	0	0	0.0
A031434	23	25	yes		2	2	0	0	0.0
A031435	23	10	no		1	0	0	1	10.0
A031437	23	47	no		2	0	0	2	47.0
A031445	23	148	no		1	0	0	1	148.0
A031446	23	7	no		1	0	0	1	7.0
A031447	23	40	yes		2	0	2	0	0.0
A031461	23	55	no		1	0	0	1	55.0
A031463	23	3	no		1	0	0	1	3.0
A031464	23	90	yes		2	0	2	0	0.0
A031467	23	46	no		1	0	0	1	46.0
A031495	23	5000	no	no	0	0	0	0	0.0
A031496	23	0	no		3	0	3	0	0.0
A031500	49	103.4	no		4	0	0	4	103.4
A031501	23	10	yes		2	0	1	1	5.0
A031504	23	49	no		1	0	0	1	49.0
A031505	23	1200	no	no	0	0	0	0	0.0
A031507	49	22	no		1	1	0	0	22.0
A031508	49	0	no		3	0	3	0	0.0
A031509	49	0	no		5	0	5	0	0.0
A031510	49	0	no		1	0	1	0	0.0
A031511	49	0	no		2	0	2	0	0.0
A031513	23	72.7	yes		3	3	0	0	6.1

WRIMS Appl ID	County[1]	WRIMS Appl Max Storage (AF)	WRIMS POD Storage Scaled[2]	Dam Constructed Prior to Water Right Filing[3]	Number of PODs	Number of Duplicate PODs[4]	Estimated Number of Existing Unauthorized		Estimated Onstream Storage (AF)[6]
							Regulatory Dams	Impoundment Dams	
A031515	49	0	no		3	2	1	0	0.0
A031516	49	0	no		1	1	0	0	0.0
A031519	23	70	no		1	0	0	1	70.0
A031521	49	60	yes		2	0	1	1	30.0
A031525	23	19	no		1	0	0	1	19.0
A031533	28	5	no		1	0	0	1	5.0
A031553	23	0	no		1	0	1	0	0.0
A031554	23	0	no		1	0	1	0	0.0
A031567	49	0	no		1	0	1	0	0.0
A031616	49	35	yes		2	0	0	2	35.0
A031617	49	35	no		1	0	0	1	35.0
A031618	49	15	yes		2	0	1	1	7.5
A031620	49	35	yes		2	0	1	1	17.5
A031621	49	156	yes		5	0	2	3	40.7
A031622	49	94	yes		4	0	2	2	11.8
A031623	49	40	no		1	0	0	1	40.0
A031626	49	15	no		1	0	0	1	15.0
A031629	49	13.0	no		2	0	0	2	13.0
D031380R	23	0	no		1	0	1	0	0.0
D031382R	28	4	no		1	0	0	1	4.0
D031390R	49	10	no		1	0	0	1	10.0
D031427R	49	10	yes		2	1	0	1	5.0
D031472R	23	8	no		1	0	0	1	8.0
D031627R	49	1.5	no		1	0	0	1	1.5
D031630R	49	8	no		1	0	0	1	8.0
L031391	49	10	no		1	0	0	1	10.0
L031392	49	10	no		1	0	0	1	10.0
L031393	49	5	yes		2	1	0	1	5.0
X003542	23	6000	no	no	1	1	0	0	0.0
X003559	23	3.5	no		1	0	0	1	3.5
Total					**597**	**79**	**202**	**316**	**9959.9**

Notes:

1. Policy area county codes are: Humboldt 12, Marin 21, Mendocino 23, Napa 28, and Sonoma 49.
2. WRIMS POD Storage Scaled indicates that the sum of the WRIMS POD storage did not equal the WRIMS application max storage. WRIMS POD storage was multiplied by the ratio of the application maximum storage divided by the sum of the POD storage to force the total to equal the WRIMS application max storage.
3. Dam Constructed Prior to Water Right Filing indicates which dams are known to have already been constructed. Yes is listed for all dams identified by the State Water Board's Navarro watershed illegal reservoir investigation; no is noted for the two RVCWD pending applications known to be for new dams and for applications with only duplicate PODs. A blank entry indicates that no information is available regarding construction status. For this analysis, Stetson assumed that all PODs with unknown construction status are at existing unauthorized dams.
4. Duplicate PODs are PODs at the same location as PODs in earlier pending or permitted water right applications.

5. Estimated Number of Existing Unauthorized Dams lists the estimated number of regulatory dams (no onstream storage) and impoundment dams (onstream storage). Numbers do not include duplicate PODs.
6. Estimated Onstream Storage is the total of all onstream storage at the application's estimated existing unauthorized impoundment dams, if any. The estimated onstream storage listed includes all requests for onstream storage at this existing unauthorized impoundment dam location in this application and in any later applications.