Appendix D. Predicting natural functional flow metrics

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The California Environmental Flow Framework (CEFF) Guidance Document describes a statewide approach to develop reference-based, stream segment-scale ecological flow criteria that are protective of functional flows. This approach requires that the natural range of variation of functional flow metrics (FFMs) be estimated at any potential location of interest in California. Here, we present the statistical modeling approach for predicting FFM reference ranges in stream segments throughout the state. First, we describe the methods used for model training and model performance assessment. We then present the model performance results and describe an alternative approach for estimating FFMs that are not reliably predicted by the models. Finally, we describe how predictions of reference FFMs can be incorporated within CEFF to develop ecological flow criteria.

Functional Flow Metric Modeling Approach

The statistical hydrologic modeling approach relies on daily streamflow data from reference gages in California (**Figure 1, Supplemental Table S1**), in addition to a suite of geospatial variables that describe the physical characteristics of each gage's watershed. We used the functional flow calculator (https://eflows.ucdavis.edu, Patterson et al. 2020, Appendix C) to calculate annual FFMs from the daily flow records available for each gage (**Table 1**). Data for the watershed variables were accessed from public sources (Falcone et al. 2010, Falcone 2011, Olson and Hawkins 2012, PRISM Climate Group 2004).

Figure 1. Reference gages (n = 219) used for developing models to predict functional flow metrics in California, colored by natural stream class.

Table 1. Functional flow metrics (FFM)

Flow Component	Flow Characteristic	Flow Metric Name	Flow Metric Description
Fall pulse flow	Magnitude (cfs)	Fall pulse magnitude	Peak magnitude of fall pulse event (maximum daily peak flow during event)
	Timing (water year day)	Fall pulse timing	Water year day of fall pulse event peak
	Duration (days)	Fall pulse duration	Duration of fall pulse event
Wet-season base flow	Magnitude (cfs)	Wet season low and median baseflow	Magnitude of wet-season baseflows (10th percentile and median of daily flows within that season, including peak flow events)
	Timing (water year day)	Wet-season timing	Start date of wet-season in water year days
	Duration (days)	Wet-season duration	Wet-season baseflow duration (# of days from start of wet-season to start of spring season)
Peak flow	Magnitude (cfs)	Peak flow magnitude	Peak-flow magnitude (2-year, 5-year, and 10-year recurrence interval)

	Duration (days)	Peak flow duration	Seasonal duration of 2-year, 5-year, and 10-year recurrence interval peak flow (cumulative number of days in which this peak flow magnitude is exceeded)
	Frequency	Peak flow frequency	Frequency of 2-year, 5-year, and 10-year recurrence interval peak flow within a season
Spring recession flow	Magnitude (cfs)	Spring recession magnitude	Spring recession magnitude (daily flow on start date of spring-flow period, 4 days after last wet-season peak)
	Timing (water year day)	Spring timing	Start date of spring in water year days
	Duration (days)	Spring duration	Spring flow recession duration (# of days from start of spring to start of dry-season baseflow period)
	Rate of change (%)	Spring rate of change	Spring flow recession rate (median daily rate of change over decreasing periods during the recession)
Dry-season base flow	Magnitude (cfs)	Dry season median and high baseflows	Base flow magnitude (50th and 90th percentile of daily flow within dry season)
	Timing (date)	Dry-season timing	Dry-season baseflow start timing (water year day of dry season)
	Duration (days)	Dry-season duration	Dry-season baseflow duration (# of days from start of dry season to start of wet season)

For each FFM, a random forest (RF) model (Cutler et al. 2007) was developed using the annual FFMs calculated from the reference gage streamflow and watershed data. For most FFMs, observed values were calculated for each year in the reference period of record of each gage. For peak-flow magnitude FFMs, single recurrence interval values were estimated at each gage for the entire period of record. For each RF model, the FFM was specified as the dependent variable and a total of 158 watershed variables were used as predictor variables, including static indicators of topography (n=6), hydrologic setting (n=17), soil properties (n=17), and geology (n=16). In addition to static predictors, water-year specific (i.e., time-varying) climatic indicators were considered. For each site-year observation of a FFM, the following combinations of monthly precipitation, air temperature, and estimated runoff were included as predictors: each month of the water year (n=36); each of the 9 months preceding the start of the water year (n=27); total precipitation and runoff and mean air temperature for the entire water year and each season of the water year (n=15); running total (precipitation and runoff) and mean air temperature for each season and year in the previous the water year (n=15).

FFM Model Performance Assessment

The RF models include a built-in resampling routine that provides estimates of model performance comparable to what is obtained on independent validation data (Liaw and Wiener 2018). However, our dataset included repeated observations of FFM values in each of the 219 reference sites. As a result, replicate datasets generated from RF's internal sampling would not have been independent, and therefore would have generated overly optimistic estimates of model performance. We therefore used leave-one-out cross-validation to estimate model performance. For this approach, each reference site (including observations for all water years of record) was excluded in turn from a calibration dataset used to construct a unique RF model as described above, with 2000 trees. The model was subsequently used to predict FFM values at the excluded reference site. Each of the 2000 trees produced a prediction for each observation of the excluded site. We retained the 10th, 25th, 50th, 75th, and 90th percentiles of the 2000 predictions for each excluded reference site. We then compared these predicted values to observed values to assess model performance.

We evaluated several model performance criteria. First, we calculated the percent of observed values (over the period of record) that fell within the inter-quartile range (IQR, 25th to 75th percentile) of predicted values and within the inter-80th percentile range (I80R, 10th to 90th percentile) at each site. Next, we evaluated if the median value of FFM predictions (50th percentile) fell within the IQR and I80R of the observed values. Sites with fewer than 20 observations were excluded from the model performance assessment. Finally, for each FFM, the performance criteria calculated at each site were compiled as: the mean and standard deviation of the percent IQR and I80R values for all sites and the percent of sites with predictions that fell within the IQR and I80R. We also compared the median value of predictions with the median value of observation at all sites using the following performance criteria: observed/predicted ratio, coefficient of determination (r-squared), percent bias, and Nash-Sutcliffe Efficiency (NSE) (**Table 2**).

Table 2. Model performance criteria

Performance Criteria
Mean of the site-specific percent of observations within inter-quartile range (25th to 75th percentile) of site-specific predicted values
Mean of the site-specific percent of observations within inter-80th percentile range (10th to 90th percentile) of site-specific predicted values

Percent of sites for which the median of predicted values fall within the inter-quartile range (25th to 75th percentile) of observed values
Percent of sites for which the median of predicted values fall within the inter-80th percentile range (10th to 90th percentile) of observed values
Mean of the ratio of the median value of site-specific observations with the median value of site-specific predictions (expectations)
Coefficient of determination calculated between the median value of site-specific observations with the median value of site-specific predictions
Percent bias calculated between the median value of site-specific observations with the median value of site-specific predictions
Nash-Sutcliffe Efficiency calculated between the median value of site-specific observations with the median value of site-specific predictions

Finally, all performance criteria were standardized so that values ranged between 0 (poor performance) and 1 (perfect performance) and averaged to develop a composite performance metric for each FFM. We assigned a qualitative performance rating, using guidelines modified from Moriarsi et al. 2007 as follows: 0.91-1.00 as very good, 0.81-0.90 as good, 0.71-0.80 as fair, less than 0.70 as poor. The summary results of the performance assessment are presented in **Table 3**.

Table 3. Functional flow metric model performance summary, indicating the number of sites from which performance criteria were calculated and the composite performance value of several standardized performance criteria.

Functional Flow Metric	Number of Sites	Composite Performance	Performance Rating
Fall Pulse Magnitude	70	0.87	Good
Fall Pulse Timing	70	0.85	Good
Fall Pulse Duration	70	0.80	Fair*

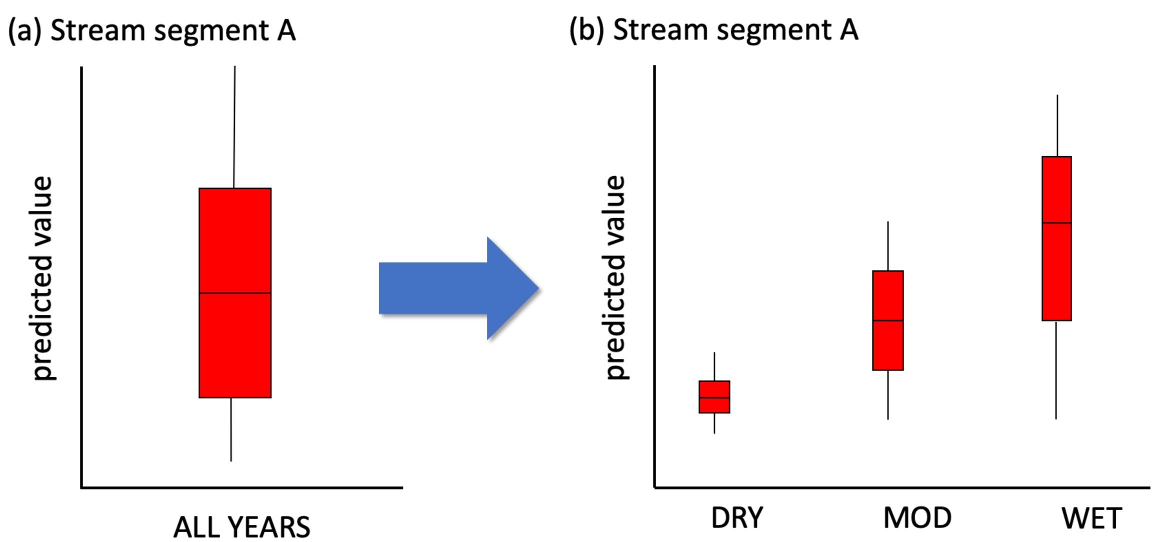
Wet Season Baseflow (10th percentile) #	145	0.91	Very Good
Wet Season Baseflow (50th percentile) #	145	0.89	Good
Wet Season Timing #	145	0.89	Good
Wet Season Baseflow Duration#	145	0.84	Good
Peak Flow Magnitude (2-year recurrence interval)	219	0.96	Very Good
Peak Flow Magnitude (5-year recurrence interval)	214	0.97	Very Good
Peak Flow Magnitude (10-year recurrence interval)	214	0.94	Very Good
Within-Year Peak Flow Duration (2-year recurrence interval)	68	0.95	Very Good*
Within-Year Peak Flow Duration (5-year recurrence interval)	124	1.00	Very Good*
Within-Year Peak Flow Duration (10-year recurrence interval)	124	0.98	Very Good*
Within-Year Peak Flow Frequency (2-year recurrence interval)	68	0.71	Fair*
Within-Year Peak Flow Frequency (5-year recurrence interval)	124	1.00	Very Good*
Within-Year Peak Flow Frequency (10-year recurrence interval)	124	1.00	Very Good*
Spring Recession Flow Magnitude #	154	0.89	Good
Spring Recession Flow Timing #	153	0.87	Good
Spring Recession Flow Duration #	152	0.86	Good
Spring Recession Flow Rate of Change	152	0.78	Fair*
Dry Season Magnitude (50th percentile) #	139	0.73	Fair
Dry Season Magnitude (90th percentile)#	139	0.91	Very Good
Dry Season Timing#	153	0.88	Good
Dry Season Duration#	139	0.86	Good

*Metrics for which stream network predictions are derived from the observed reference gages. All other stream network predictions of functional flow metrics are derived from the statistical modeling approach.
Metrics for which stream network predictions are provided for different water year types (dry, moderate, wet)

FFM Predictions Across California Stream Network

For most FFMs, we created 100 RF models, each with 1000 trees using a random subset of 90% of the reference gages. For each RF model, predictions were made at each segment in the state's stream network, represented by the National Hydrography Database. FFM predictions were generated for every year between 1950 and 2015 for each segment. The quantiles (10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th} percentile) of segment-year predictions were saved from the trees. For each segment, the median value of each quantile across all years was then calculated. The result was a predicted range of variation of a particular FFM at each segment (**Figure 3a**). For a subset of FFMs, predictions were compiled by water-year type. To do so, water-year class designations were obtained from the functional flows database (https://eflows.ucdavis.edu/hydrology) and the median value of the prediction quantiles was calculated for the subset of years classified as "dry", "moderate", and "wet" (**Figure 3b**).

Figure 3. Example predictions of FFMs at stream segments for all years (a) and by water year type (b)



For the remaining FFMs, observations of natural flows at reference gages were determined to be more reliable for predicting FFM values across the stream network than the models (FFMs with asterisk in Table 3). For example, the fall pulse duration metric had fair model performance, but a fairly narrow range of values observed at reference gages across all stream classes (**Figure 4**). For this metric, the range of variation of values (10th, 25th, 50th, 75th, and 90th percentiles) were calculated from the reference gages in each stream class and then assigned to all stream segments within that class. Models for the spring flow recession rate-of-change metric also performed poorly and the metric was instead calculated directly based on reference gages for each stream class, using the same approach as for the pulse flow duration (**Figure 5**). Although many of the peak flow duration and peak flow metrics had good predictive performance, we found that the observed values consistently fell within a narrow range within each stream class (**Figure 6**), so the percentiles of the observed values for those FFMs were used as predictions for the stream network, instead of the modeled values.

Figure 4. Fall pulse duration values, observed at reference gages within each stream class in California. The percentile values (10th, 25th, 50th, 75th, 90th) of the observed distribution for gages within each stream class were used to predict the values of this FFM at all stream segments within their respective stream class.

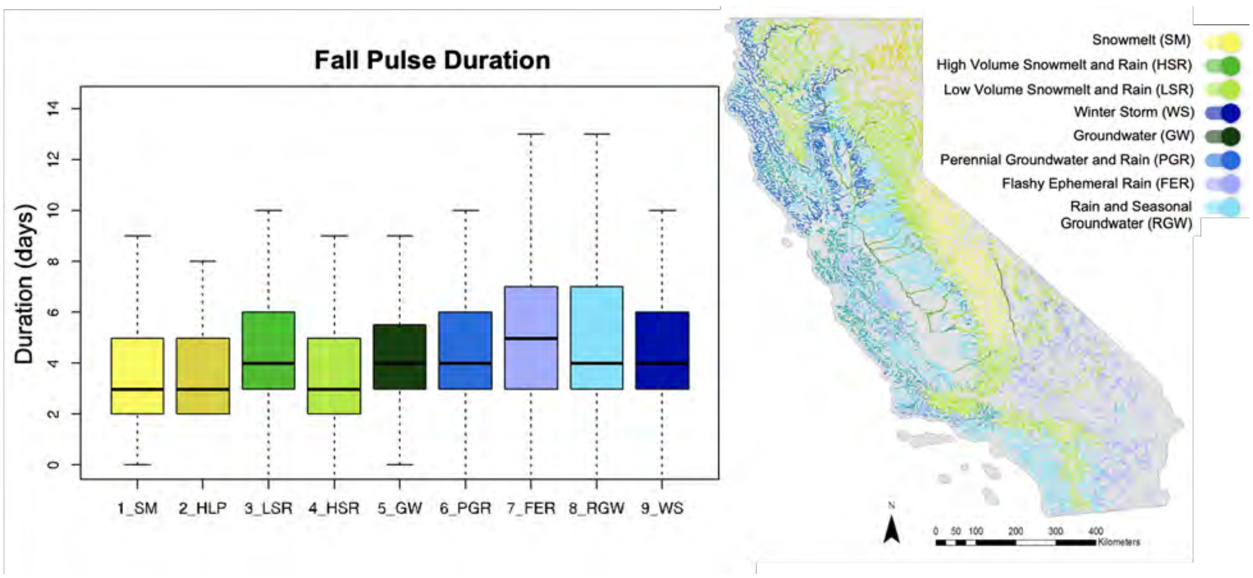


Figure 5. Spring recession flow rate-of-change values, observed at reference gages within each stream class in California. The percentile values (10th, 25th, 50th, 75th, 90th) of the observed distribution for gages within each stream class were used to predict the values of this FFM at all stream segments within their respective stream class.

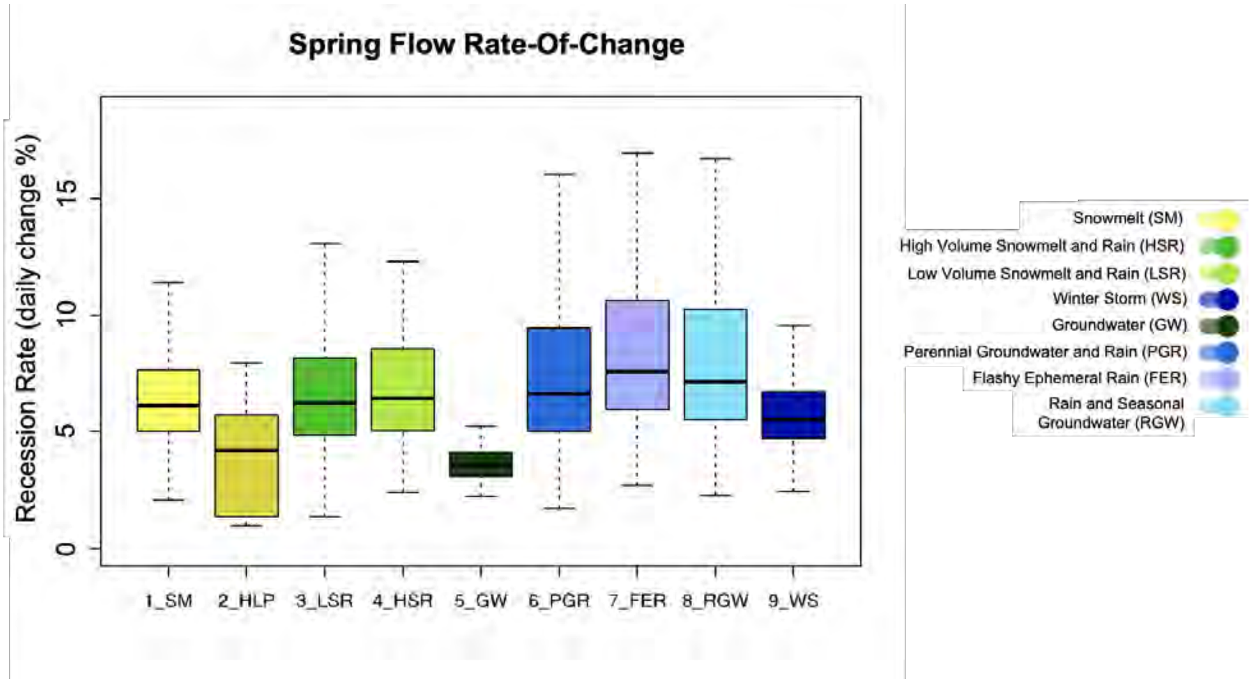
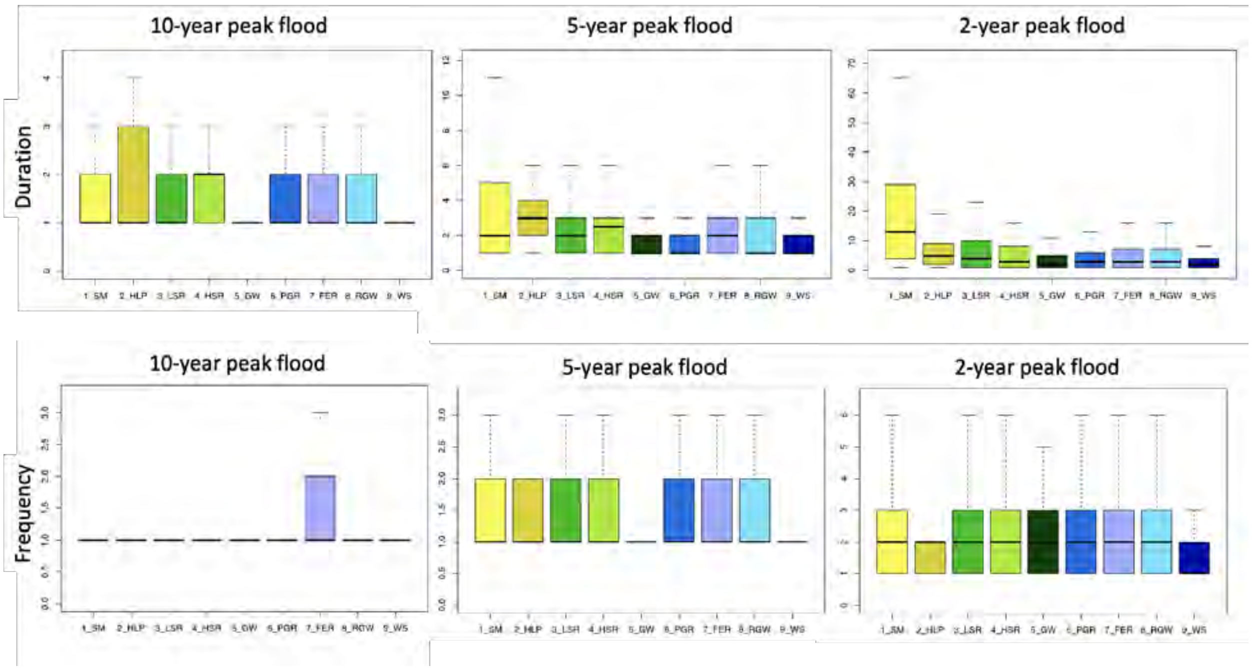


Figure 6. Peak flow duration and frequency values, observed at reference gages within each stream class in California. The percentile values (10th, 25th, 50th, 75th, 90th) of the observed distribution for gages within each stream class were used to predict the values of this FFM at all stream segments within their respective stream class.



In summary, predictions for 16 FFMs were generated from the statistical modeling approach and predictions for 8 FFMs were taken directly from the calculated metrics for reference streamflow gages (**Table 3**). All FFM prediction data were compiled in a tabular (.csv) file format (**Table 4**).

Table 4. File structure of FFM prediction data

Functional Flow Metric	Stream (COMID)	Water Year Type	10th percentile	25th percentile	50th percentile	75th percentile	90th percentile
SP_Mag	10000042	ALL	39.0	48.3	60.8	89.9	102.3
SP_Mag	10000042	WET	44.8	58.0	69.2	99.0	115.2
SP_Mag	10000042	MOD	40.9	50.2	63.2	91.2	99.1
SP_Mag	10000042	DRY	32.8	44.2	55.8	85.3	90.8
…	…	…	…	…	…	…	…

Literature Cited

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Supplemental Tables

Table S1. USGS reference gages used for model training

USGS STATION ID	STATION NAME
10255800	COYOTE C NR BORREGO SPRINGS CA
10255810	BORREGO PALM C NR BORREGO SPRINGS CA
10257500	FALLS C NR WHITEWATER CA
10257600	MISSION C NR DESERT HOT SPRINGS CA
10258000	TAHQUITZ C NR PALM SPRINGS CA
10258500	PALM CYN C NR PALM SPRINGS CA
10259000	ANDREAS C NR PALM SPRINGS CA
10259200	DEEP C NR PALM DESERT CA
10263500	BIG ROCK C NR VALYERMO CA
10264000	LITTLE ROCK C AB LTTLE ROCK RES NR LITTLEROCK CA
10264600	OAK C NR MOJAVE CA
10281800	INDEPENDENCE C BL PINYON C NR INDEPENDENCE CA
10291500	BUCKEYE CREEK NEAR BRIDGEPORT, CA
10295500	L WALKER R NR BRIDGEPORT, CA
10308200	E F CARSON R BL MARKLEEVILLE C NR MARKLEEVILLECA
10308783	LEVIATHAN C AB MINE NR MARKLEEVILLE CA
10310000	WEST FORK CARSON RIVER AT WOODFORDS, CA
10336580	UPPER TRUCKEE R AT S UPPER TRUCKEE RD NR MEYERS CA
10336600	UP TRUCKEE R NR MEYERS CA
10336645	GENERAL C NR MEEKS BAY CA

10336660	BLACKWOOD C NR TAHOE CITY CA
10336676	WARD C AT HWY 89 NR TAHOE PINES CA
10336770	TROUT CK AT USFS RD 12N01 NR MEYERS CA
10336780	TROUT CREEK NR TAHOE VALLEY CALIF
10340500	PROSSER C BL PROSSER C DAM NR TRUCKEE CA
10343500	SAGEHEN CR NR TRUCKEE CA
10360900	BIDWELL C BL MILL C NR FORT BIDWELL CA
11023250	POWAY C NR POWAY CA
11023310	RATTLESNAKE C A POWAY CA
11023325	BEELER C A POMERADO RD NR POWAY CA
11031500	AGUA CALIENTE C NR WARNER SPRINGS CA
11033000	WF SAN LUIS REY R NR WARNER SPRINGS CA
11037700	PAUMA C NR PAUMA VALLEY CA
11046300	SAN MATEO C NR SAN CLEMENTE CA
11046500	SAN JUAN C NR SAN JUAN CAPISTRANO CA
11048553	SAND CYN C A IRVINE CA
11058600	WATERMAN CANYON CREEK NR ARROWHEAD SPRINGS CA
11063000	CAJON C NR KEENBROOK CA
11073470	CUCAMONGA C NR UPLAND CA
11077000	SANTIAGO C NR VILLA PARK CA
11080500	EF SAN GABRIEL R NR CAMP BONITA CA
11082000	WF SAN GABRIEL R A CAMP RINCON CA
11084500	FISH C NR DUARTE CA

11094000	TUJUNGA C BL MILL C NR COLBY RANCH CA
11095500	BIG TUJUNGA C NR SUNLAND CA
11098000	ARROYO SECO NR PASADENA CA
11100000	SANTA ANITA C NR SIERRA MADRE CA
11110500	HOPPER CREEK NEAR PIRU CA
11111500	SESPE CREEK NEAR WHEELER SPRINGS CA
11113000	SESPE C NR FILLMORE
11115500	MATILIJA C A MATILIJA HOT SPRINGS
11116000	NF MATILIJA C A MATILIJA HOT SPRINGS CA
11117600	COYOTE CREEK NEAR OAK VIEW CA
11117800	SANTA ANA C NR OAK VIEW
11120500	SAN JOSE C NR GOLETA CA
11120510	SAN JOSE C A GOLETA CA
11120520	SAN PEDRO C A GOLETA CA
11120530	TECOLOTITO C NR GOLETA CA
11120550	GAVIOTA C NR GAVIOTA CA
11124500	SANTA CRUZ C NR SANTA YNEZ CA
11128400	ALISAL C NR SOLVANG CA
11132500	SALSIPUEDES C NR LOMPOC CA
11134800	MIGUELITO C A LOMPOC CA
11138500	SISQUOC R NR SISQUOC CA
11141150	ARROYO GRANDE AB PHOENIX C NR ARROYO GRANDE CA
11141280	LOPEZ C NR ARROYO GRANDE CA

11143000	BIG SUR R NR BIG SUR CA
11143500	SALINAS R NR POZO CA
11148900	NACIMIENTO R BL SAPAQUE C NR BRYSON CA
11151300	SAN LORENZO C BL BITTERWATER C NR KING CITY CA
11151870	ARROYO SECO NR GREENFIELD CA
11152900	CEDAR C NR BELL STATION CA
11153470	LLAGAS C AB CHESBRO RES NR MORGAN HILL CA
11153900	UVAS C AB UVAS RES NR MORGAN HILL CA
11154100	BODFISH C NR GILROY CA
11154700	CLEAR C NR IDRIA CA
11156500	SAN BENITO R NR WILLOW CREEK SCHOOL CA
11159690	APTOS C NR APTOS CA
11160000	SOQUEL C A SOQUEL CA
11160020	SAN LORENZO R NR BOULDER C CA
11160070	BOULDER C AT BOULDER CREEK CA
11160300	ZAYANTE C A ZAYANTE CA
11160500	SAN LORENZO R A BIG TREES CA
11162500	PESCADERO C NR PESCADERO CA
11162540	BUTANO C NR PESCADERO CA
11162570	SAN GREGORIO C A SAN GREGORIO CA
11169800	COYOTE C NR GILROY CA
11172100	UP PENITENCIA C A SAN JOSE CA
11172945	ALAMEDA C AB DIV DAM NR SUNOL CA

11173200	ARROYO HONDO NR SAN JOSE CA
11176400	ARROYO VALLE BL LANG CN NR LIVERMORE CA
11180500	DRY C A UNION CITY CA
11180825	SAN LORENZO C AB DON CASTRO RES NR CASTRO V CA
11180960	CULL C AB CULL C RES NR CASTRO VALLEY CA
11181000	SAN LORENZO C A HAYWARD CA
11181390	WILDCAT C A VALE RD AT RICHMOND CA
11182100	PINOLE C A PINOLE CA
11182500	SAN RAMON C A SAN RAMON CA
11183000	SAN RAMON C AT WALNUT CREEK CA
11195500	SAN EMIGDIO C A SAN EMIGDIO RANCHHOUSE CA
11196400	CALIENTE C AB TEHACHAPI C NR CALIENTE CA
11197250	AVENAL C NR AVENAL CA
11199500	WHITE R NR DUCOR CA
11203580	SF TULE R NR CHOLOLLO CAMPGROUND NR PORTERVILLE CA
11204100	SF TULE R NR RESERVATION BNDRY NR PORTERVILLE CA
11208000	MARBLE F KAWEAH R (R ONLY) A POTWISHA CAMP CA
11208500	MF KAWEAH TRIB NR HAMMOND CA
11209900	KAWEAH R A THREE RIVERS CA
11213500	KINGS R AB NF NR TRIMMER CA
11214000	NF KINGS R BL MEADOWBROOK CA
11218500	KINGS R BL NF NR TRIMMER CA
11220000	BIG C AB PINE FLAT RES NR TRIMMER CA

11220500	SYCAMORE C AB PINE FLAT RES NR TRIMMER CA
11224500	LOS GATOS C AB NUNEZ CYN NR COALINGA CA
11226500	SAN JOAQUIN R A MILLER CROSSING CA
11230500	BEAR C NR LAKE THOMAS A EDISON CA
11237500	PITMAN C BL TAMARACK C CA
11253310	CANTUA C NR CANTUA CREEK CA
11257500	FRESNO R NR KNOWLES CA
11258000	FRESNO R BL HIDDEN DAM NR DAULTON CA
11259000	CHOWCHILLA R BL BUCHANAN DAM NR RAYMOND CA
11264500	MERCED R A HAPPY ISLES BRIDGE NR YOSEMITE CA
11266500	MERCED R A POHONO BRIDGE NR YOSEMITE CA
11268000	SF MERCED R NR EL PORTAL CA
11269300	MAXWELL C A COULTERVILLE CA
11274500	ORESTIMBA C NR NEWMAN CA
11274630	DEL PUERTO C NR PATTERSON CA
11274790	TUOLUMNE R A GRAND CYN OF TUOLUMNE AB HETCH HETCHY
11275000	FALLS C NR HETCH HETCHY CA
11281000	SF TUOLUMNE R NR OAKLAND RECREATION CAMP CA
11282000	M TUOLUMNE R A OAKLAND RECREATION CAMP CA
11283500	CLAVEY R NR BUCK MEADOWS CA
11284400	BIG C AB WHITES GULCH NR GROVELAND CA
11292500	CLARK FORK STANISLAUS R NR DARDANELLE CA
11294000	HIGHLAND C BL SPICER MEADOWS RES CA

11294500	NF STANISLAUS R NR AVERY CA
11299000	New Melones Dam
11299600	BLACK C NR COPPEROPOLIS CA
11315000	COLE C NR SALT SPRINGS DAM CA
11316800	FOREST C NR WILSEYVILLE CA
11318500	SF MOKELUMNE R NR WEST POINT CA
11334300	SF COSUMNES R NR RIVER PINES CA
11337500	MARSH C NR BYRON CA
11341400	SACRAMENTO R NR MT SHASTA CA
11355500	HAT C NR HAT CREEK CA
11371000	CLEAR C A FRENCH GULCH CA
11372000	CLEAR C NR IGO CA
11374000	COW C NR MILLVILLE CA
11375700	NF COTTONWOOD C NR IGO CA
11376500	BATTLE C NR COTTONWOOD CA
11379000	ANTELOPE C NR RED BLUFF CA
11390672	STONE CORRAL C NR SITES CA
11394500	MF FEATHER R NR MERRIMAC CA
11396400	SUCKER RUN NR FORBESTOWN CA
11400000	BUTT C AB ALMANOR-BUTT C TU NR PRATTVILLE CA
11406999	Oroville Dam, Feather River (DWR)
11408850	M YUBA R NR CAMPTONVILLE CA
11409300	OREGON C A CAMPTONVILLE CA

11409500	OREGON C NR NORTH SAN JUAN CA
11413100	N YUBA R AB SLATE C NR STRAWBERRY CA
11413320	DEADWOOD C NR STRAWBERRY VALLEY CA
11413323	OWL GULCH NR STRAWBERRY VALLEY CA
11414000	S YUBA R NR CISCO CA
11418000	YUBA R BL ENGLEBRIGHT DAM NR SMARTVILLE CA
11426150	ONION C NR SODA SPRINGS CA
11427700	DUNCAN CYN C NR FRENCH MEADOWS CA
11433260	NF OF MF AMERICAN R NR FORESTHILL CA
11433300	MF AMERICAN R NR FORESTHILL CA
11433500	MF AMERICAN R NR AUBURN CA
11445500	SF AMERICAN R NR LOTUS CA
11446220	American R near Folsom
11449500	KELSEY C NR KELSEYVILLE CA
11451100	NF CACHE C A HOUGH SPRING NR CLEARLAKE OAKS CA
11451715	BEAR C AB HOLSTEN CHIMNEY CYN NR RUMSEY CA
11457000	DRY C NR NAPA CA
11458300	NAPA C A NAPA
11460100	ARROYO CORTE MADERA D PRES A MILL VALLEY CA
11464500	DRY C NR CLOVERDALE CA
11467200	AUSTIN C NR CAZADERO CA
11467500	SF GUALALA R NR ANNAPOLIS CA
11467600	GARCIA R NR POINT ARENA CA

11468000	NAVARRO R NR NAVARRO CA
11468500	NOYO R NR FORT BRAGG CA
11468600	MF TENMILE R NR FORT BRAGG CA
11468900	MATTOLE R NR ETTERSBURG CA
11472160	WILLITS C AB LK EMILY NR WILLITS CA
11472900	BLACK BUTTE R NR COVELO CA
11473100	WILLIAMS C NR COVELO CA
11473900	MF EEL R NR DOS RIOS CA
11474500	NF EEL R NR MINA CA
11475500	SF EEL R NR BRANSCOMB CA
11475560	ELDER C NR BRANSCOMB CA
11475800	SF EEL R A LEGGETT CA
11476500	SF EEL R NR MIRANDA CA
11476600	BULL C NR WEOTT CA
11477000	EEL R A SCOTIA CA
11477500	VAN DUZEN R NR DINSMORE CA
11478500	VAN DUZEN R NR BRIDGEVILLE CA
11480390	MAD R AB RUTH RES NR FOREST GLEN CA
11480800	NF MAD R NR KORBEL CA
11481200	LITTLE R NR TRINIDAD CA
11481500	REDWOOD C NR BLUE LAKE CA
11482110	LACKS C NR ORICK CA
11482120	REDWOOD C AB PANTHER C NR ORICK CA

11482125	PANTHER C NR ORICK CA
11482200	REDWOOD C AT S PARK BOUNDARY NR ORICK CA
11482500	REDWOOD C A ORICK CA
11522300	SF SALMON R NR FORKS OF SALMON CA
11522500	SALMON R A SOMES BAR CA
11523200	TRINITY R AB COFFEE C NR TRINITY CTR CA
11525500	TRINITY R A LEWISTON CA
11525530	RUSH C NR LEWISTON CA
11525670	INDIAN C NR DOUGLAS CITY CA
11526500	NF TRINITY R A HELENA CA
11527400	NEW R A DENNY CA
11528700	SF TRINITY R BL HYAMPOM CA
11529000	SF TRINITY R NR SALYER CA
11532000	SF SMITH R NR CRESCENT CITY CA
11532500	SMITH R NR CRESCENT CITY CA