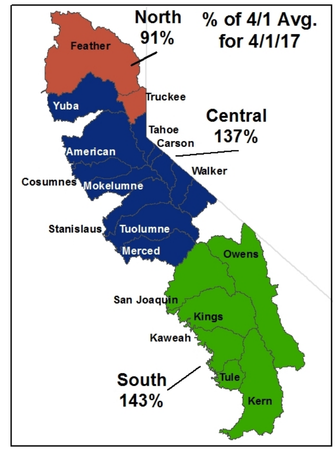
Real Time Snow Water Equivalent (SWE) Simulation
April 1, 2017
Sierra Nevada Mountains, California



Abstract

On April 1, 2017, percent of average April 1st SWE values for this date are 91% for the Northern watersheds, 137% for the Central, and 143% for the Southern watersheds (see map on right). Please note that this map covers only the Feather and Truckee watersheds for the Northern watersheds and is missing Mono for the Southern watersheds. 80 snow sensors in the Sierra network were recording snow out of a total of 99 sensors. The locations of sensors that aren't recording snow are shown in yellow in Figure 3, left map.

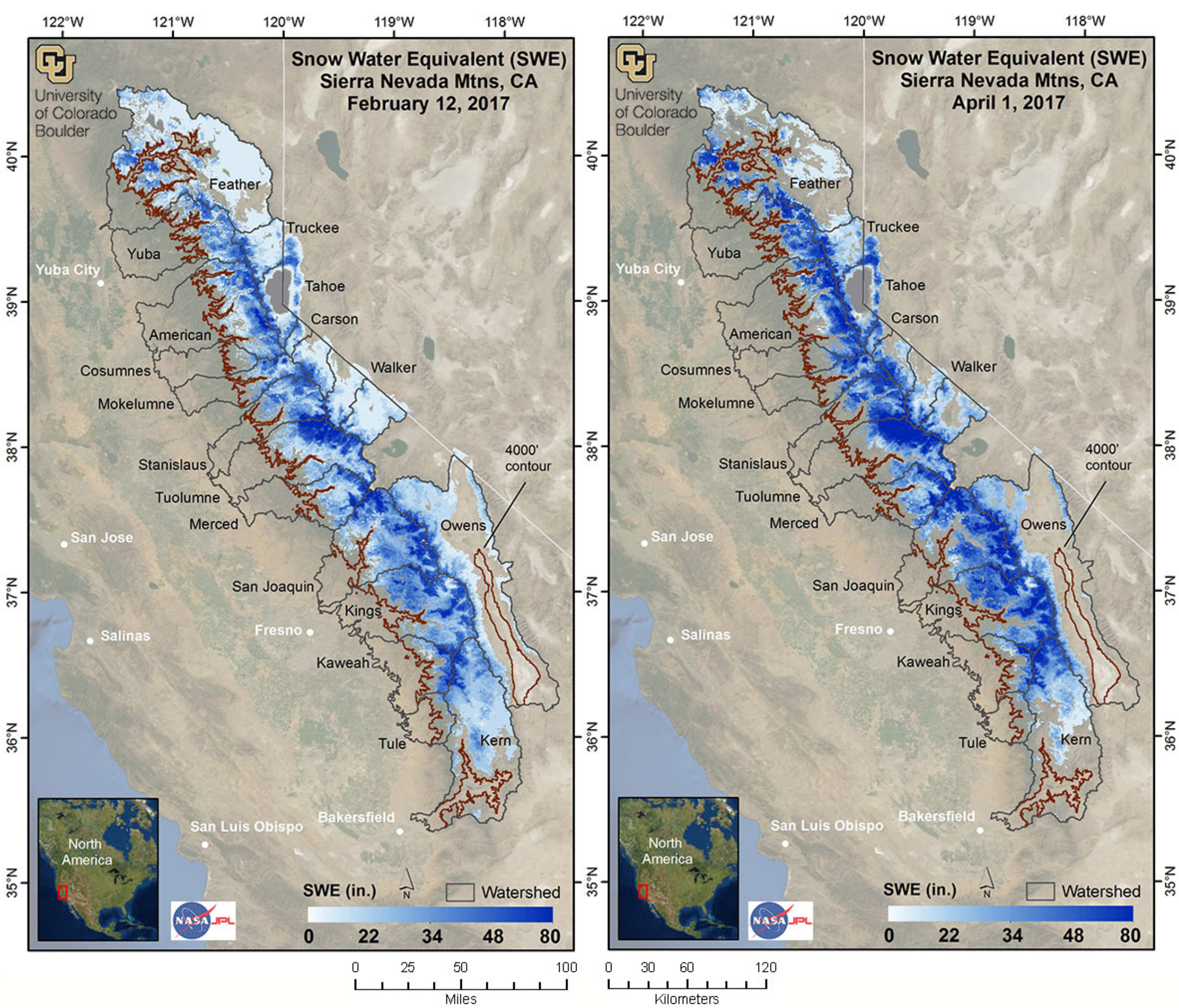


Figure 1. SWE amounts for February 12, 2017 are shown on the left and SWE amounts for April 1, 2017 are shown on the right.

Introduction

We have developed a real-time SWE estimation scheme based on historical SWE reconstructions between 2000-2014, a near real time MODIS/MODSCAG image (Painter et al, 2009 - snow.jpl.nasa.gov), and daily in situ SWE measurements for the Sierra Nevada in California (Molotch, 2009; Molotch and Margulies, 2008; Molotch and Bales, 2006; Molotch and Bales, 2005, Molotch, et. al., 2004 and Guan, et. al., 2013).

Discussion

The most recent cloud-free MODIS/MODSCAG image available is for April 1, 2017. Figure 1 shows SWE amounts for February 12, 2017 and for April 1, 2017. On April 1, 2017 eighty snow sensors in the Sierra network were recording snow out of a total of 99 sensors, with an average SWE of 47". Note the locations of sensors that aren't recording snow on 4/1/17 are shown in yellow in Figure 3, left map. Totals from sensors alone do not accurately calculate SWE for the entirety of each watershed. Figure 2 shows the percent of average (between 2000-2011) April 1st SWE for April 1, 2017 for the snow-covered area on left and on the right is the mean percent of the April 1st average for April 1, 2017 shown by watershed for all model pixels above 4000' (shown as the black elevation contour line on left map). Note that watershed averages are different than those calculated using snow sensors alone. Snow sensors produce a point value whereas the spatial SWE allows for areal calculations. Every square foot above 4000' in the watershed can be used to calculate the mean, therefore the mean value will be different than those calculated by snow sensor point data. Figure 3 shows the 12-year-modeled average SWE (between 2000-2011) for April 1st on the left with snow sensors shown in yellow that recorded no snow on April 1, 2017 and in red for sensors that recorded snow on April 1, 2017; and a banded elevation map on the right. Table 1 shows mean SWE and mean percent of average (between 2000-2011) April 1st SWE for April 1, 2017 summarized for each watershed above 4000'. Table 2 shows mean SWE and mean percent of average April 1st SWE for April 1, 2017, and area in square miles for each elevation band inside each watershed, summarized for each watershed above 4000'. The Owens watershed does not include the White Mountains in the banded elevation totals.

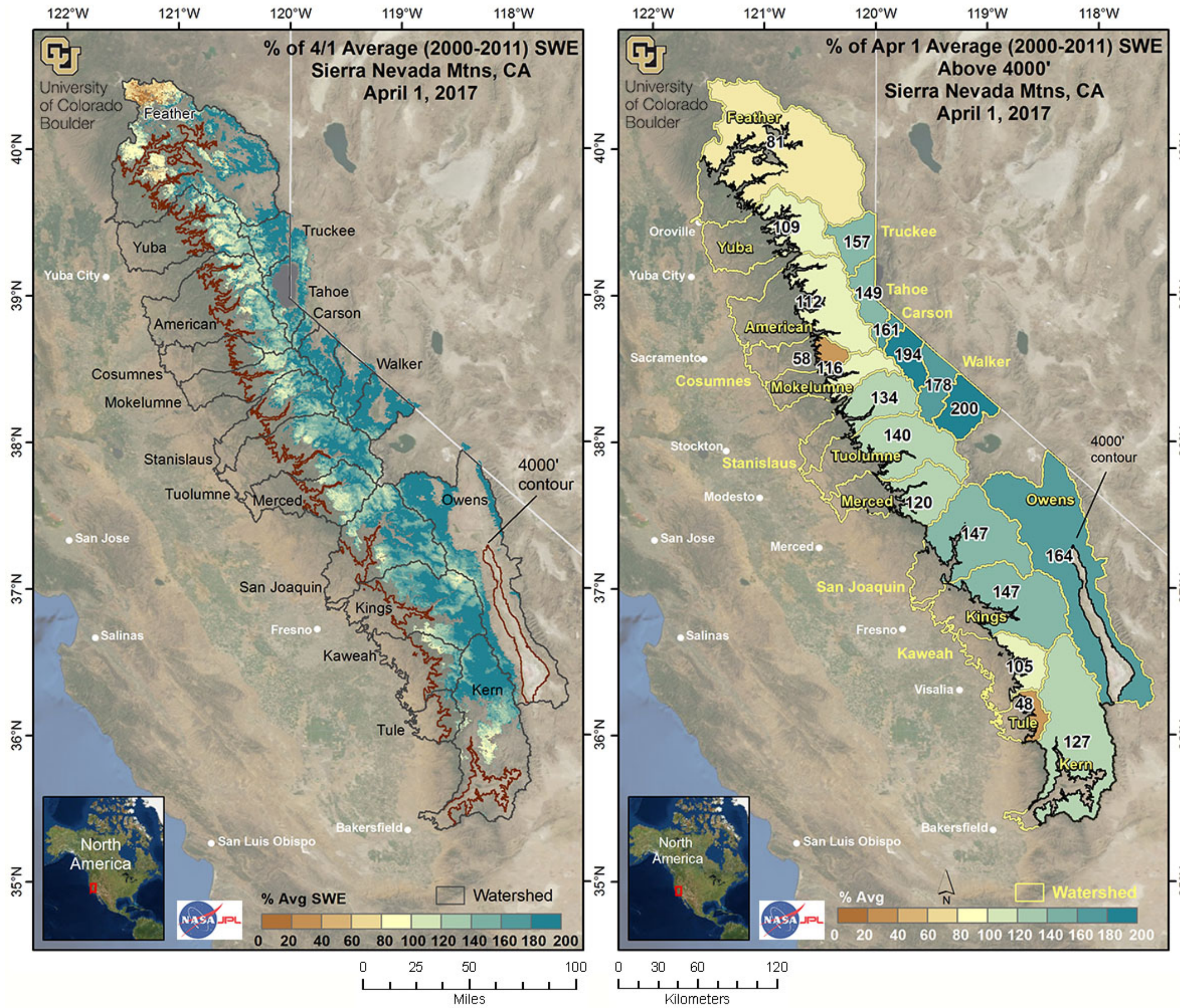


Figure 2. Percent of average April 1st SWE (between 2000-2011) for April 1, 2017 for the entire Sierra (on left) and by watershed (on right). Watershed percentages are calculated for all model pixels above 4000' (shown as red line on left map).

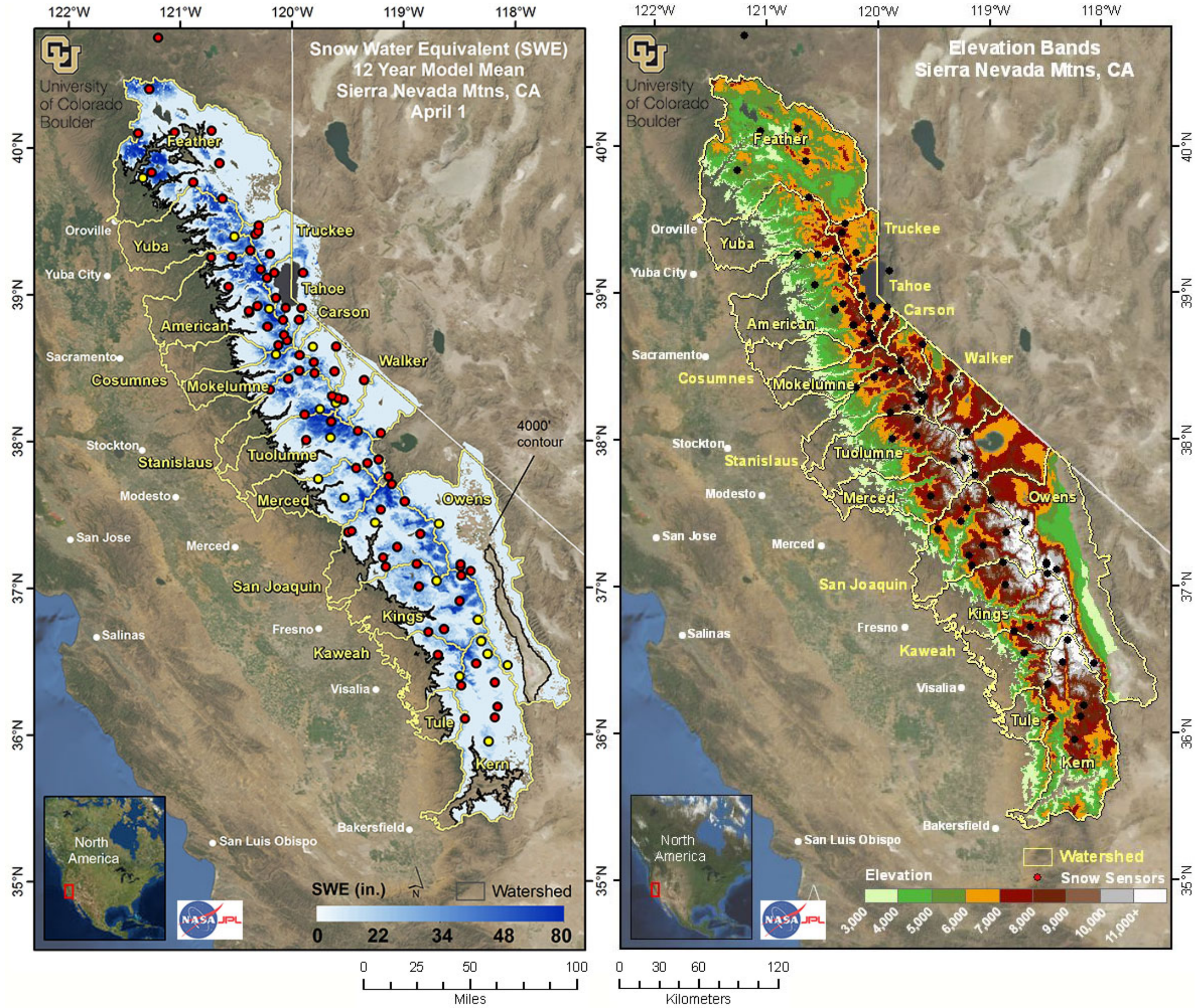


Figure 3. 12-year-modeled average SWE (between 2000-2011) for April 1st on the left with snow sensors shown in yellow that recorded no snow and in red for sensors that recorded snow on April 1, 2017; and a banded elevation map on the right.

Methods

Results for the date of April 1, 2017 are based on April 1, 2017 real-time data from 80 in situ SWE measurements distributed across the Sierra Nevada, one Moderate Resolution Imaging Spectroradiometer (MODIS)/Terra Snow cover daily cloud-free image which has been processed using the MODSCAG fractional snow cover program (Painter, et. al. 2009), a normalized reconstructed spatial SWE image for March 1, 2006, and an anomaly map based on 12 years of modeled SWE (2000-2011). Relative to snow stations and the NWS SNODAS product, the spatial reconstructed SWE product correlates strongly with full natural flow, especially late in the snowmelt season (Guan, et. al. 2013).

Table 1. All calculations are for elevations above 4000', Shown are mean SWE and mean % of Average SWE (between 2000-2011) for April 1, 2017 for each watershed.

Watershed	4/1/17 % 4/1 Avg to Date	4/1/17 SWE (in)
AMERICAN	112.14	27.01
COSUMNES	57.87	6.88
EAST FORK CARSON RIVER	194.17	26.42
EAST WALKER RIVER	200.06	21.80
FEATHER	81.32	11.05
KAWEAH	104.84	18.80
KERN	126.73	13.62
KINGS	146.57	35.86
MERCED	120.41	26.90
MOKELUMNE	115.75	26.74
OWENS	164.20	12.06
SAN JOAQUIN	147.32	36.03
STANISLAUS	133.97	32.45
TAHOE	149.22	37.82
TRUCKEE	157.36	28.18
TULE	48.13	4.52
TUOLUMNE	139.92	34.87
WEST FORK CARSON RIVER	161.50	28.59
WEST WALKER RIVER	177.71	22.56
YUBA	108.80	27.70

Table 2. All calculations are for elevations above 4000’. Mean SWE, mean % of average April 1st SWE (between 2000-2011) for April 1, 2017, and area in square miles for each elevation band inside each watershed. The Owens watershed does not include White Mountain SWE in the banded elevation totals.

Watershed	Elevation	4/1/17 % 4/1 Avg to Date	4/1/17 SWE (in)	Area Sq Mi
AMERICAN	4000-5000'	7.98	0.46	208.0
	5000-6000'	67.68	9.89	287.2
	6000-7000'	121.83	37.59	288.9
	7000-8000'	130.40	54.42	171.6
	8000-9000'	138.37	64.10	73.6
	9000-10,000'	140.07	77.25	8.6
COSUMNES	4000-5000'	0.00	0.00	68.5
	5000-6000'	18.00	2.04	62.8
	6000-7000'	102.09	24.63	26.1
	7000-8000'	114.55	43.47	9.1
E CARSON	5000-6000'	0.00	0.00	32.6
	6000-7000'	170.18	10.16	74.4
	7000-8000'	207.57	26.96	100.5
	8000-9000'	194.96	39.89	94.6
	9000-10,000'	192.19	45.13	30.8
	10,000-11,000'	190.72	43.57	12.9
	> 11,000'	165.16	60.52	0.3
E WALKER	6000-7000'	57.24	1.49	72.6
	7000-8000'	219.48	14.31	152.4
	8000-9000'	240.45	25.20	154.7
	9000-10,000'	197.66	34.65	61.3
	10,000-11,000'	166.99	45.70	48.0
	> 11,000'	155.42	47.43	8.1
FEATHER	4000-5000'	24.79	1.78	637.9
	5000-6000'	70.21	8.88	1252.4
	6000-7000'	104.60	18.80	840.6
	7000-8000'	107.54	28.61	117.0
	8000-9000'	130.49	42.35	5.1
KAWEAH	4000-5000'	0.00	0.00	49.8
	5000-6000'	0.00	0.00	60.4
	6000-7000'	25.57	3.23	62.8
	7000-8000'	73.45	13.92	65.2
	8000-9000'	135.48	31.60	56.1
	9000-10,000'	155.04	39.89	39.7
	10,000-11,000'	146.33	58.42	36.8
	> 11,000'	147.00	66.03	9.1
KERN	4000-5000'	0.00	0.00	192.4
	5000-6000'	1.46	0.05	274.9
	6000-7000'	20.99	1.25	398.6
	7000-8000'	69.49	7.23	337.5
	8000-9000'	135.90	19.29	308.2
	9000-10,000'	180.26	27.34	168.9
	10,000-11,000'	186.90	39.03	150.5
	> 11,000'	181.46	53.66	144.1

KINGS	4000-5000'	4.56	0.31	72.7
	5000-6000'	12.45	1.31	93.9
	6000-7000'	63.56	11.15	136.3
	7000-8000'	133.75	31.00	168.1
	8000-9000'	164.62	39.34	207.9
	9000-10,000'	172.90	42.42	190.3
	10,000-11,000'	172.13	53.09	219.9
	> 11,000'	155.90	58.39	198.1
MERCED	4000-5000'	13.83	0.85	72.9
	5000-6000'	8.57	0.74	73.9
	6000-7000'	64.87	11.72	77.9
	7000-8000'	124.69	29.60	129.2
	8000-9000'	141.68	35.29	125.8
	9000-10,000'	150.71	44.25	74.7
	10,000-11,000'	141.39	62.19	49.5
	> 11,000'	127.68	75.40	13.5
MOKELUMNE	4000-5000'	2.10	0.13	72.4
	5000-6000'	38.73	5.18	81.9
	6000-7000'	108.28	25.69	71.1
	7000-8000'	127.00	45.22	84.4
	8000-9000'	152.85	52.47	80.2
	9000-10,000'	162.83	64.09	7.2
OWENS	4000-5000'	0.00	0.00	376.1
	5000-6000'	0.39	0.01	257.7
	6000-7000'	123.86	5.55	252.5
	7000-8000'	221.88	17.95	301.8
	8000-9000'	203.96	27.36	162.5
	9000-10,000'	191.62	30.30	113.6
	10,000-11,000'	181.58	36.81	187.8
	> 11,000'	158.42	46.70	166.8
SAN JOAQUIN	4000-5000'	0.65	0.02	76.5
	5000-6000'	18.16	1.25	129.1
	6000-7000'	117.43	16.31	184.5
	7000-8000'	152.39	31.51	207.5
	8000-9000'	159.84	42.51	196.2
	9000-10,000'	159.81	47.96	173.6
	10,000-11,000'	155.51	59.47	189.1
	> 11,000'	151.43	65.55	143.2
STANISLAUS	4000-5000'	2.43	0.12	83.5
	5000-6000'	45.34	5.34	105.1
	6000-7000'	122.00	28.53	139.9
	7000-8000'	142.77	43.04	141.9
	8000-9000'	159.32	53.72	121.3
	9000-10,000'	159.05	62.58	45.8
	10,000-11,000'	153.84	74.34	18.0
	> 11,000'	173.57	64.55	0.4

TAHOE	6000-7000'	149.68	23.09	99.2
	7000-8000'	145.70	45.07	73.9
	8000-9000'	151.68	52.58	51.4
	9000-10,000'	159.03	52.73	11.9
	10,000-11,000'	162.91	48.90	0.6
TRUCKEE	5000-6000'	200.11	12.80	50.1
	6000-7000'	166.32	23.51	245.3
	7000-8000'	143.94	42.09	108.3
	8000-9000'	150.05	57.66	14.2
TULE	4000-5000'	0.00	0.00	40.0
	5000-6000'	0.00	0.00	52.2
	6000-7000'	9.12	0.89	45.0
	7000-8000'	54.90	8.59	27.9
	8000-9000'	129.19	23.70	15.4
	9000-10,000'	171.17	35.20	6.1
TUOLUMNE	4000-5000'	3.01	0.12	125.9
	5000-6000'	17.62	1.60	168.4
	6000-7000'	108.43	19.70	148.1
	7000-8000'	149.80	43.02	147.6
	8000-9000'	164.58	55.69	171.1
	9000-10,000'	159.88	61.51	151.1
	10,000-11,000'	150.86	62.10	113.2
	> 11,000'	135.99	57.33	29.9
W CARSON	4000-5000'	0.00	0.00	1.4
	5000-6000'	14.73	0.40	15.9
	6000-7000'	114.78	14.72	8.7
	7000-8000'	162.51	30.01	36.1
	8000-9000'	173.37	39.59	30.1
	9000-10,000'	172.27	47.36	9.5
	10,000-11,000'	160.99	55.61	2.2
W WALKER	5000-6000'	3.39	0.02	45.7
	6000-7000'	91.69	3.38	59.4
	7000-8000'	214.45	14.83	89.4
	8000-9000'	210.45	25.07	92.5
	9000-10,000'	171.72	41.95	71.6
	10,000-11,000'	161.21	51.47	41.1
	> 11,000'	162.35	41.16	2.5
YUBA	4000-5000'	7.98	0.53	161.6
	5000-6000'	83.38	16.01	178.0
	6000-7000'	121.94	43.53	234.8
	7000-8000'	125.25	51.80	119.2
	8000-9000'	143.60	67.55	5.8

Location of Reports and Excel Format Tables
ftp://snowserver.colorado.edu/pub/fromLeanne/forCADWR/Near_Real_Time_Reports/

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