YOLO COUNTY

FLOOD CONTROL &
WATER CONSERVATION
DISTRICT

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Tim O'Halloran
General Manager

March 16, 2009

Danny McClure
Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670

RE: Draft 2008 Update to 303d list: Yolo County Listings

Dear Mr. McClure and Board,

The Yolo County flood Control and Water Conservation District (the District) would like to comment on the draft 2008 303(d) list update. We have coordinated our comments with the members of Yolo Water Resources Association Technical Committee and Yolo Solano sub-watershed of the Sacramento Valley Water Quality Coalition.

The Water Resources Association of Yolo County (WRA) is a consortium of 10 local water agencies providing a regional forum to coordinate and facilitate solutions to water issues in Yolo County. Water quality is of great importance to the WRA and we commend the Regional Board in their efforts to protect the beneficial uses of water in the County. In this spirit, this letter provides clarifying comments to Regional Board on the 2008 proposed updated to the 303(d) listings. With our many decades of local knowledge and experience, we wish to support the Regional Board staff in finding economically efficient and effective methods of improving water quality in Yolo County.

This letter has five sections:

1. General Hydrologic Details of Yolo County
2. The Boron Story
3. Hg in Sulfur Creek
4. Diazinon in the Winters Canal
5. Summary

1. General Hydrologic Details of the County

Some of the proposed new listings name multiple water bodies that share similar water sources. For example, the listings for boron in Lower Cache Creek (Decision ID 14988), Willow Slough (Decision ID 11488), and Willow Slough Bypass (Decision ID 11457) all contain Cache Creek water during the summer and should be considered together in any analysis.

The Knights Landing Ridge Cut (in Decision ID 14425) and the Tule Canal (in Decision ID 11625) are the same water body. The Tule Canal is an extension of the Ridge Cut. These two segments should also be considered together in any analysis.

It is unclear if there are listings for salinity, selenium, or both for the Ridge Cut and Tule Canal. There are salinity listings in Appendix A (http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/app_a_303d_changes_30jan09.pdf) but not in the supporting fact sheets in Appendix F (http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/303d/index.shtml). Conversely, there are selenium listings for these two water bodies in Appendix F, but not in Appendix A. In any case these two water bodies are separated by name only and should be considered together.

Also, please note that the most of the water in the Knights Landing Ridge Cut comes from the Colusa Basin Drain. These two water bodies should always be considered together.

2. The Boron Story

The Cache Creek watershed is naturally enriched in boron. The causes, sources, and seasonal patterns of elevated levels of boron in the Cache Creek/Willow Slough watershed are very well known and documented, beginning in the 1850s. The Yolo County Flood Control and Water Conservation District has conducted monthly monitoring of boron in the watershed since 1930 and 97% of the samples collected have been above the water quality standard for boron. At least thirteen reports and studies have been written addressing boron in the watershed. The proposed 303(d) listing of the potential sources of boron as 'agriculture' or 'unknown' are incorrect.

Attached is a short report on the history of boron in Cache Creek (*Natural Background Levels of Boron in the Clear Lake - Cache Creek Watershed: A Data Analysis and Literature Review. June 2007*). Strategies to ameliorate boron have been discussed in the literature since 1955 (even by the SWRCB itself). But these strategies have never been implemented, as the only effective method involves building a dam on Bear Creek at great economic and ecological expense, with little benefit.

Also attached is a previously submitted (8/31/2006) report on boron and other constituents, which was submitted to the Regional Board in response to Regional Board staff questions, related to the Irrigated Lands Program (ILP). This report entitled *Boron, Salinity, Nutrients and Dissolved Oxygen in the Irrigation Water within the Yolo County Flood Control and Water Conservation District* is also an excellent background document on water quality in the area, especially boron.

After review of the decades of monitoring data, thousands of boron samples, and more than a dozen reports, we are confident that the Regional Board will agree that a TMDL process to identify sources of boron in the Cache Creek watershed is unnecessary. The sources are well known. In addition, agriculture is thriving in Yolo County, and this beneficial use does not appear to be impacted. We respectfully request that the Board not list Lower Cache Creek, Willow Slough, and Willow Slough Bypass as impaired for boron and direct staff to pursue a site specific water quality standard for boron in our area. (Decision IDs are not available for these listings; the proposed listings appear in Appendix A, but not in Appendix F.)

4. Hg in Sulfur Creek

We understand from Regional Board Scientist Janis Cooke, that the listing of Sulfur Creek as impaired for Hg (Decision ID 6536) is a mistake and will be removed, since that water body already has a completed TMDL and Basin Plan Amendment for Hg.

5. Diazinon in the Winters Canal

Diazinon was detected in the Winters Canal during the winter of 2005, resulting in the proposed 303(d) listing (Decision ID 11456). Diazinon toxicity can be a serious problem but neither the Yolo County Ag Commissioner, the Yolo Solano Water Quality Coalition (part of the ILP), nor the Yolo County Flood Control and Water Conservation District, which manages the canal, where aware of these test results (until the proposed 303(d) list was released). If they had known, the problem could have been corrected immediately. As part of the ILP, when a pesticide is detected above a standard, the Pesticide Use Reporting (PUR) system is checked to see who has used that pesticide in that area and then that person is contacted and the problem investigated. In this case, it appears that only one orchard, very close to the canal, is the cause. The Ag Commissioner will contact that grower shortly and confirm that Diazinon will not enter the canal again. Overall, wintertime Diazinon use is declining dramatically in Yolo County. In 2007, the most recent summarized data available, only 6 orchards received Diazinon throughout the entire county.

We respectfully request that the Board remove the Diazinon in the Winters Canal listing (Decision ID 11456), as it appears that Diazinon use is already phasing out, only one orchard is the cause of the test results, and there is already a program (ILP) in place to address this type of water quality problem.

6. Summary

Of the 28 new proposed listings in Yolo County, the District proposes removing four of those, for the reasons explained above.

Table 1. Summary of requested deletions from the proposed 303(d) list.

Water body Segment	**Pollutant**	**Potential Sources**	**Expected TMDL Completion Date**
Cache Creek, Lower (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass)	Boron	Source Unknown	2021
Willow Slough (Yolo County)	Boron	Agriculture	2021
Willow Slough Bypass (Yolo County)	Boron	Agriculture	2021
Winters Canal (Yolo County)	Diazinon	Agriculture	2021

We recognized the tremendous effort expended by the Regional Board staff in creating the proposed 303(d). We hope that our comments are helpful and will increase the effectiveness of Regional Board staff in protecting our water resources. If you have any questions, please contact Max Stevenson, Water Resources Associate, at 530-662-0265.

Sincerely,

Max Stevenson FOR

Tim O'Halloran
General Manager

Enclosures

cc: Rick Landon, Yolo County Ag Commissioner
Denise Sagara, Executive Director, Yolo County Farm Bureau
Water Resources Association of Yolo County

Natural Background Levels of Boron in the Clear Lake - Cache Creek Watershed:

A Data Analysis and Literature Review

June 2007

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FLOOD CONTROL & WATER CONSERVATION DISTRICT

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Natural Background Levels of Boron in the Clear Lake - Cache Creek Watershed: A Data Analysis and Literature Review

Introduction

The Yolo County Flood Control and Water Conservation District (the District) maintains a 1,800 volume report archive regarding issues in the watershed, both published and unpublished. A review of these archives was conducted for data on background boron concentration in both ground and surface water. Ten reports, published from 1955 to 2006, were found with boron data from the Clear Lake – Cache Creek watershed. More than 2,400 water samples were analyzed for boron in these reports. (Additional reports on boron are probably available in other archives and libraries, but only the District archive was researched for this report.)

Boron in Lake and Yolo Counties

Boron is a naturally occurring element in the Clear Lake - Cache Creek watershed. Large Borax deposits were mined here in the 1800s and natural hot and cold springs expel water with extremely high concentrations of boron (215 ppm in Table 1), more than 300 times greater than interpreted narrative water quality objectives for boron (0.7 ppm).

The high boron water in the Cache Creek system has long been a management problem for local farmers. Some crops are sensitive to boron and special considerations must be made when irrigating these crops in Yolo County. In general, the boron does not adversely affect drinking water quality.

Boron is an essential plant micronutrient and some areas of California are deficient in boron. In these cases boron is applied to crops as a fertilizer. However, in Yolo County boron fertilizer is generally not needed. In fact, the boron levels can be high enough to cause crop damage, especially to boron sensitive crops.

In recognition of the high boron levels Cache Creek, monthly monitoring of boron concentration began in 1930 (YCFCWCD, 2006). The District continues this monitoring today. Currently, the District samples eight sites in the Cache Creek watershed once each month for boron. Additionally, 30 wells are sampled for boron concentration on an annual basis. Requests for boron information are, by far, the most popular requested water quality data from the District.

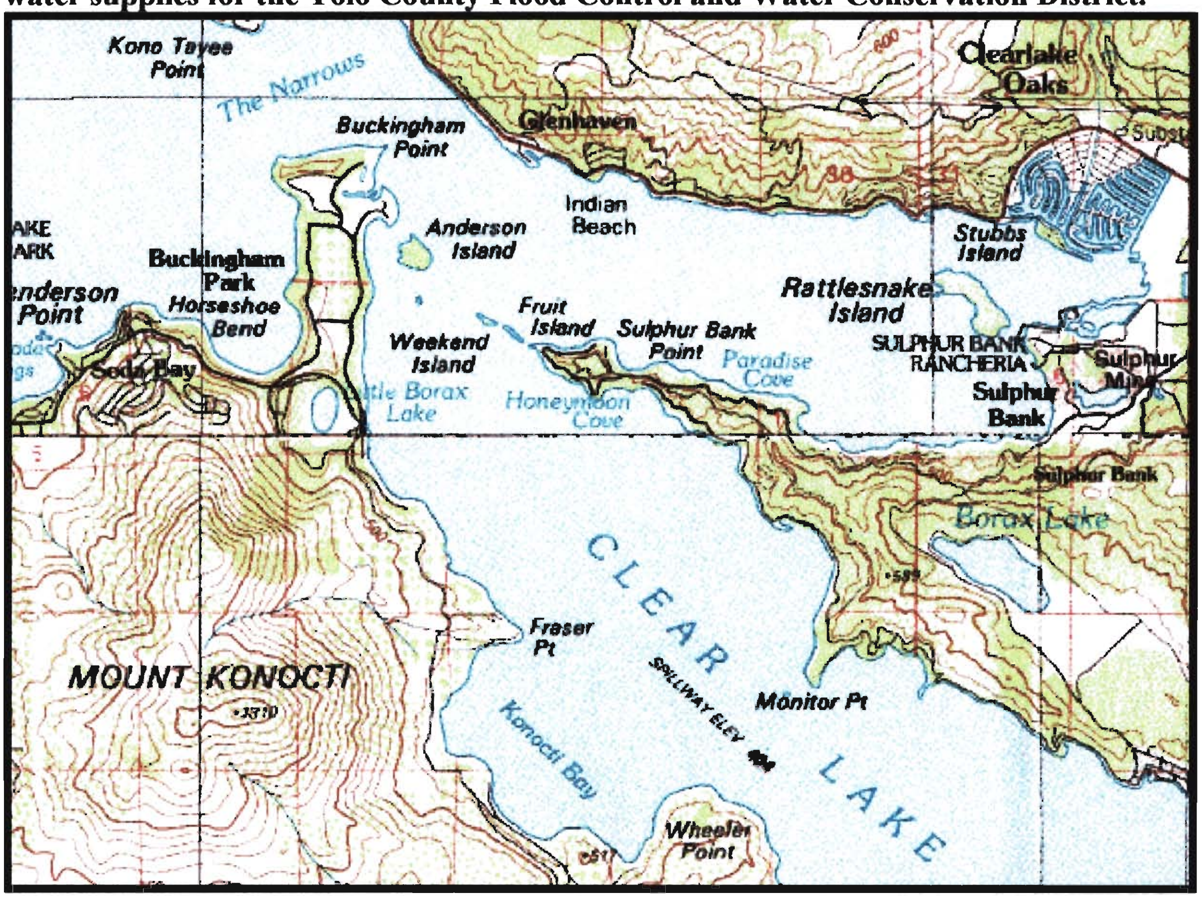
A short history of borax mining is presented. Afterwards, an analysis of Bear Creek boron contributions to the Cache Creek system are analyzed. Then a table with boron meta-data, summarizing the maximum and average concentration of boron in surface and groundwater, is discussed (Table 1).

History of Borax Mining

Borax is a commercially valuable, naturally occurring compound that contains boron. (The chemical formula for anhydrous borax is $Na_2B_4O_7$.) Boron compounds are so common in the watershed that they can be mined from certain surface lake deposits. The first discovery of borax in the USA occurred in the Clear Lake – Cache Creek watershed.

> "Borax was first discovered in Borax Lake in Lake County in 1856, by Dr. John Veatch. Four years later, he found borax in Little Borax Lake, four miles to the west. The California Borax Company operated at the big lake between 1864 and 1868, extracting 590 tons of borax...
>
> In 1868, the company moved all of its operations to Little Borax Lake. This small lake supplied the entire borax needs of the country from 1868 to 1873, the last year of operation, producing 140 tons valued at $89,600. The discovery of enormous beds of the mineral in the deserts of California and Nevada ended all production in Lake County. (Mauldin, 1968)

Figure 1 shows the location of Borax Lake, near the Sulphur Bank mine, and Little Borax Lake, at the base of Mt. Konocti. Clear Lake supplies ~2/3 of the irrigation water supplies for the Yolo County Flood Control and Water Conservation District.



After 1873, the borax operations were abandoned in the Clear Lake area, due to more economical deposits elsewhere. Yet large amounts of boron containing borax remain in these lakes, in Clear Lake, and in the watershed as a whole.

Boron concentration data and a review from the literature – the Bear Creek story

More than fifty years ago, the State Water Resources Control Board stated, "The quality of water in the Clear Lake-Cache Creek Basin, particularly with reference to boron, has long been the subject of much interest and speculation." (SWRCB, 1955). The authors noted that boron levels were higher during low flow times in Cache Creek, but did not specifically call out the Bear Creek tributary as the main source of boron.

In YCFCWCD (1963) Boron is given a section in the "Special Problems" chapter, summarizing the sources, problems with high boron, historical mitigation, and new strategies for amelioration. A multi-color fold out map is also included showing level of boron in groundwater throughout the County. In this document, Bear Creek is identified as a major source of boron in the watershed. Ideas for an impoundment of the boron rich Bear Creek water are discussed. This impounded water would be released during high flows in Cache Creek, so that the boron would become diluted. This strategy was never implemented.

Although Clear Lake, and Cache Creek itself, have high levels of boron, since the 1980's District staff have informally concluded that most of the boron in Cache Creek comes from the Bear Creek tributary. In a review of the District data archives, 32 dates were found with boron concentration and flow data from Bear Creek and Cache Creek at Capay Dam. The effect of Bear Creek boron entering Cache Creek, and increasing boron concentration downstream at Capay, was analyzed (figure 2).

Figure two shows the boron concentration in Cache Creek at Capay Dam, verses boron from Bear Creek. Since the boron from Bear Creek becomes diluted in the main flow of Cache Creek, a "dilution factor" was calculated for this analysis. The relationship shows that as dilution of Bear Creek boron increases, the concentration of boron at Capay Dam decreases. The flattening of the line at high dilutions shows the baseline boron concentration in Cache Creek of 0.6-0.8 ppm. Inputs from Bear Creek elevate the boron concentration above baseline. Dilution factor is calculated as in equation (1).

$$\text{Dilution factor} = a / (b * c) \qquad (1)$$

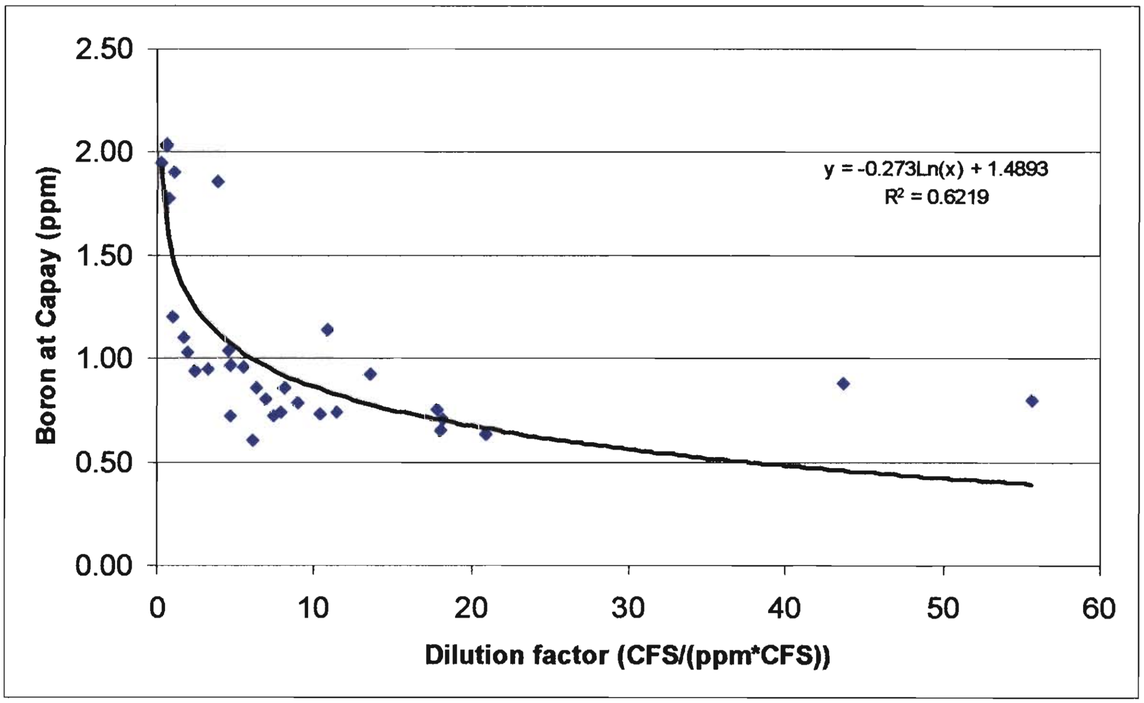
where

a=water flow in Cache Creek at Rumsey (CFS)
b=water flow in Bear Creek (CFS)

c=boron concentration in Bear Creek (ppm)

No probability analysis for statistical significance was completed for figure 2, as it is outside the scope of this report. However, an R-squared of 0.62 means that the correlation is strong, but 38% of the variation in boron concentration at Cache Creek dam is still unexplained. Other sources of high boron, besides Bear Creek, probably exist in the watershed. These other sources (the "springs") are alluded to in EIP Associates, et al. (1995).

Figure 2. Graph of boron concentration in Cache Creek at Capay Dam, verses diluted boron from Bear Creek. When increased flows in Cache Creek dilute the flows from Bear Creek, the concentration of boron in Cache Creek decreases. Flow and concentration data are from 32 dates during 1998-2000.



Past reports

Table 1 below is a summary of boron data from ten reports stored in the District archives. These reports, describing data since 1930, show that both surface and groundwater, in the Cache Creek watershed, on average, are almost always above the interpreted narrative water quality objectives for boron (0.7 ppm). Over more than 75 years, 2400 water samples have been taken and analyzed for boron and it is quite clear that farmers, local watershed managers, and State-level water planners all consider the Cache Creek watershed to be highly enriched in boron.

Of note in Table 1 are two "hot spot" locations that can be identified. Bear Creek, as discussed earlier, has consistently high levels of boron. The other location, "springs in the Cache Creek area" appear to have extremely high levels of boron. These springs probably deserve further investigation in the upcoming Bear Creek Watershed Assessment, described in the next section.

Table 1. Data summary of boron concentration in ground and surface water.

Reference	**Location**	**Period of Record**	**Ground or Surface Water?**	**Max [B] (ppm)**	**Avg. [B] (ppm)***	**Approx. Number of Samples**
YCFCWCD (2006)	Capay Dam, Cache Creek	1930-1940, 1969-2006	surface	6.4	1.7	539
YCFCWCD (unpub)	Bear Creak	1988-2006	surface	34	13.9	250
YCFCWCD (2004)	All regions of Yolo County	2000-2004	ground	9.5	0.6-6.6 (avg. by region)	267
YCFCWCD (1963)	Map showing groundwater [B] in the entire Yolo County area	~1950-1960	ground	6.4	1.8	Not reported, reference to USACE (1950)
EIP Associates, et al. (1995) p. 4.3-10	Springs in the Cache Creek area	1930-1956	springs flowing to surface	215	130	-
EIP Associates, et al. (1995) p. 4.3-11	Near Madison, Woodland, and Knights Landing	1950-1970s	ground	-	4	-
Scott and Scalmanini (1975)	Yolo County	1950-1972	ground	>3	>1	1200
Yolo County (2006)	Cache Creek	2000-2005	surface	2.4	~1.3	21
SWRCB (1955)	Cache Creek at Capay Dam	1930-1939	surface	3.9	2.3	90
Ca DWR (1961)	Bear Creek	1938-1939	surface	34	21	17
Ca DWR (1961)	North Fork Cache Creek	1938-1941	surface	7.2	3.3	41
Ca DWR (1961)	Clear Lake near Lower Lake	not reported	surface	1.4	1.0	-

Reference	Location	Period of Record	Ground or Surface Water?	Max [B] (ppm)	Avg. [B] (ppm)*	Approx. Number of Samples
Ca DWR (1961)	Cache Creek at Capay Dam	1930-1956	surface	6.4	1.8	-

*"Avg." is either the true average, median of the range, or other approximation of average, depending on the data source.

Current watershed planning effort for Bear Creek

The US Bureau of Land Management is currently preparing a stakeholder based watershed assessment for the Bear Creek drainage. Mercury and Boron are of a particular concern. As of 6/6/07 the effort has just begun. Please contact the project manager for more information on the assessment.

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2800 Cottage Way, Room 1928
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Telephone: (916) 978-4656
Cellular: (916) 716-4809

Literature Cited

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Data Appendix

Date	Boron (ppm) in Bear Creek	Boron (ppm) in Cache Creek at Capay Dam	Flow in Cache Creek (cfs) at Rumsey	Flow in Bear Creek (cfs) near Cache Creek
1/26/1988	4.46	2.46	139	
3/1/1988	6.30	1.80	91	
4/7/1988	10.00	0.94	430	
5/9/1988	14.00	1.40	108	
5/26/1988	12.00	1.20	626	
6/2/1988	14.00	1.00	507	
6/6/1988	14.00	1.00	470	
6/9/1988	15.00	1.20	297	
6/13/1988	15.00		372	
6/16/1988	15.00	1.10	518	
6/20/1988	16.00	1.10	551	
6/23/1988	16.00	0.89	598	
6/27/1988	15.00	0.96	524	
6/30/1988	17.00	0.96	602	
7/5/1988	18.00	0.98	590	
7/7/1988	17.00	0.95	620	
7/11/1988	19.00	1.00	523	
7/14/1988	19.00	0.97	620	
7/18/1988	20.00	1.00	478	
7/21/1988	20.00	0.93	641	
7/25/1988	19.00	0.97	436	
7/28/1988	20.00	0.97	448	
8/1/1988	21.00	0.97	426	
8/4/1988	21.00	1.10	373	
8/11/1988	22.00	1.20	331	
8/15/1988	24.00	1.10	282	
8/18/1988	22.00	1.10	272	
8/22/1988	22.00	1.10	261	
8/25/1988	24.00	1.10	308	
8/29/1988	24.00	1.10	313	
9/1/1988	25.00	1.10	334	
9/6/1988	26.00	1.20	202	
9/8/1988	24.00	1.10	205	
9/13/1988	25.00	1.20	211	
9/15/1988	23.00	1.10	119	
9/19/1988	25.00	1.20	77	
9/22/1988	28.00	1.20	56	
9/26/1988	28.00	1.20	37	

Date	Boron (ppm) in Bear Creek	Boron (ppm) in Cache Creek at Capay Dam	Flow in Cache Creek (cfs) at Rumsey	Flow in Bear Creek (cfs) near Cache Creek
9/29/1988	30.00	1.30	16	
10/3/1988	30.00	1.40	25	
10/31/1988	30.00	1.50	27	
12/5/1988	24.00	2.40	24	
1/3/1989	25.00	3.30	8	
2/6/1989	25.00	2.80	27	
2/27/1989	24.00	3.00	18	
3/6/1989	20.00	3.30	125	
3/13/1989	4.90	1.20	235	
3/20/1989	3.70	0.95	396	
3/27/1989	4.10	1.10	235	
4/3/1989	5.60	1.60	52	
4/10/1989	7.70	1.60	192	
4/17/1989	8.50	1.40	476	
4/24/1989	10.00	1.50	588	
5/8/1989	11.00	1.40	326	
5/15/1989	12.00	1.60	243	
5/22/1989	12.00	1.40	321	
5/30/1989	13.00	1.40	298	
6/5/1989	13.00	1.30	298	
6/12/1989	16.00	1.40	286	
6/19/1989	16.00	1.40	304	
6/26/1989	18.00	1.30	398	
7/3/1989	18.00	1.40	312	
7/10/1989	21.00	1.40	329	
7/17/1989	21.00	1.20	302	
7/24/1989	21.00	1.20	252	
7/31/1989	22.00	1.10	286	
8/7/1989	24.00	1.10	315	
8/14/1989	26.00	1.20	286	
8/21/1989	28.00	1.40	204	
8/28/1989	32.00	1.50	169	
9/5/1989	33.00	1.50	224	
9/11/1989	31.00	1.50	206	
9/18/1989	24.00	1.60	19	
10/2/1989	24.00	2.20	23	
11/6/1989	22.00	2.40	23	
12/1/1989	25.00	3.00	24	
1/2/1990	26.00	3.00	23	
2/5/1990	8.40	3.90	38	
3/5/1990	12.00	2.90	27	
4/2/1990	17.00	3.20	21	

Date	Boron (ppm) in Bear Creek	Boron (ppm) in Cache Creek at Capay Dam	Flow in Cache Creek (cfs) at Rumsey	Flow in Bear Creek (cfs) near Cache Creek
5/7/1990	18.00	3.10	24	
6/4/1990	19.00	3.50	22	
7/2/1990	22.00	2.40	22	
8/6/1990	34.00	2.80	21	
9/4/1990	34.00	2.70	23	
10/1/1990	33.00	2.70	23	
11/5/1990	31.00	2.40	26	
12/3/1990	26.00	2.20	22	
1/7/1991	27.00	2.20	21	
2/4/1991	32.00	4.60	23	
3/7/1991	6.10	2.40	25	
4/1/1991	4.50	1.80	24	
5/21/1991	11.00	1.80	471	
6/3/1991	11.00	1.70	465	
7/1/1991	17.00	2.00	279	
8/5/1991	22.00	1.90	250	
9/3/1991	28.00	2.10	51	
10/7/1991	32.00	2.40	37	
11/4/1991	29.00	2.60	36	
12/2/1991	30.00	3.40	35	
1/6/1992	26.00	3.90	34	
2/3/1992	32.00	3.90	21	
3/2/1992	8.60	2.90	21	
4/6/1992	7.20	2.30	27	
5/4/1992	11.00	2.40	459	
6/1/1992	10.00	1.60	316	
7/6/1992	13.00	2.00	310	
8/3/1992	16.00	2.00	284	
9/8/1992	1.90	2.40	134	
10/5/1992	7.90	2.60	31	
11/2/1992	9.00	2.50	44	
12/7/1992	9.90	2.70	24	
1/3/1995	4.60	2.70	199	
2/6/1995	1.90	1.40	3789	
3/6/1995	3.10	1.40	366	
4/3/1995	2.00	1.10	6151	
5/1/1995	3.10	0.94	3023	
6/5/1995	4.60	1.10	1352	
7/5/1995	9.00	1.10	830	
8/7/1995	12.00	1.00	984	
9/5/1995	15.00	1.00	420	
10/2/1995	16.00	1.20	432	

Date	Boron (ppm) in Bear Creek	Boron (ppm) in Cache Creek at Capay Dam	Flow in Cache Creek (cfs) at Rumsey	Flow in Bear Creek (cfs) near Cache Creek
10/31/1995	30.00	1.50	24	
11/6/1995	19.00	2.00	24	
12/5/1995	21.00	2.60	21	
1/2/1996	8.40	2.20	248	
2/5/1996	0.87	0.45	6718	
3/4/1996	1.60	0.86	5918	
3/27/1996	3.20	1.60	1173	
4/1/1996	3.00	1.60	812	
4/8/1996	3.70	1.70	221	
4/15/1996	4.20	1.50	332	
4/29/1996	5.10	1.30	587	
5/6/1996	5.90	1.30	680	
6/3/1996	7.30	1.20	682	
7/1/1996	9.60	1.00	614	
8/5/1996	12.00	0.82	605	
9/3/1996	15.00	0.69	488	
10/7/1996	16.00	1.20	214	
1/6/1997	2.30	0.72	7681	
2/3/1997	2.20	0.82	5496	
3/3/1997	4.00	1.20	663	
4/7/1997	5.70	1.00	352	
5/5/1997	8.40	0.93	527	
6/2/1997	10.00	0.84	504	
7/7/1997	12.00	0.76	934	
8/4/1997	16.00	0.78	406	
9/2/1997	20.00	0.92	302	
10/6/1997	21.00	0.97	91	
11/3/1997	16.00	0.88	140	
12/1/1997	3.60	1.90	175	44
1/5/1998	3.20	1.10	308	58
2/2/1998	2.30	1.20	4958	2380
3/2/1998	1.40	0.65	6782	269
5/4/1998	2.63	0.95	708	83
6/1/1998	2.19	0.73	2616	116
7/6/1998	4.64	0.86	790	21
8/3/1998	9.15	0.74	790	7.6
9/8/1998	12.30	0.72	477	5.3
10/5/1998	12.90	0.96	301	4.3
11/2/1998	11.80	1.86	277	6.1
12/7/1998	5.96	0.72	467	17
1/4/1999	8.18	1.78	45	7.4
2/1/1999	6.43	1.03	344	28

Date	Boron (ppm) in Bear Creek	Boron (ppm) in Cache Creek at Capay Dam	Flow in Cache Creek (cfs) at Rumsey	Flow in Bear Creek (cfs) near Cache Creek
3/1/1999	2.59	0.70	4080	87
4/5/1999	2.61	0.94	323	52
5/3/1999	3.72	0.86	684	29
6/7/1999	6.32	0.74	493	10
7/6/1999	7.50	0.63	769	4.9
8/2/1999	9.43	0.75	536	3.2
9/8/1999	10.90	0.79	242	2.5
10/11/1999	12.40	0.96	138	2.4
12/6/1999	16.20	2.03	38	3.9
1/3/2000	15.70	2.04	32	3.7
2/7/2000	5.90	1.95	41	34
3/6/2000	1.46	0.61	2003	227
4/3/2000	4.09	1.04	706	38
5/1/2000	5.45	0.81	712	19
6/5/2000	0.84	0.91	1287	5.7
7/5/2000	9.10	0.79	1214	2.4
8/7/2000	13.80	0.87	963	1.6
9/5/2000	18.00	0.92	414	1.7
10/2/2000	19.40	1.14	335	1.6

Boron, Salinity, Nutrients and Dissolved Oxygen in the Irrigation Water

within

the Yolo County Flood Control and Water Conservation District

8/31/06

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Table of Contents

1. Introduction

The water quality of agricultural drainage within, and flowing out of, the Yolo County Flood Control and Water Conservation District (the District) is controlled by multiple factors; more than farming practices alone. A detailed knowledge of the source of the irrigation water (both surface and groundwater) is required to understand why some parameters, tested by the local water quality coalition, may be above water quality objectives (WQOs, either adopted or unadopted in the Basin Plan).

Both Order No. R5-2003-0826 and Order No. R5-2003-0833 state that "*If results indicate that water quality objectives are exceeded at any site, monitoring for the COCs* [constituents of concern] *shall continue and the monitoring must be expanded upstream in a systematic search for sources.*" In the Yolo County area, there is a significant amount of information already available that identifies the most likely sources for high levels of salinity and boron. The farmers and resource mangers in Yolo County have been dealing with these issues for many decades. There is also significant information that explains dissolved oxygen exceedences and this information will also be discussed.

The purpose of this document is to improve communication between Regional board staff and the local water resources managers in Yolo County on issues related to water quality. We share the same goals and support efforts to improve water quality when beneficial uses are impaired.

Both surface and groundwater irrigation supplies will be discussed in this review of source water quality.

2. General Description of the YCFCWCD System

The District's boundaries cover 195,000 acres of Yolo County, of which approximately 55,000 acres receive District delivered water in any one year. This is about 40% of the irrigated farmlands in Yolo County. The District lands are within the Cache Creek and Willow Slough watersheds.

The District's surface water supply consists of water from Clear Lake, Indian Valley Reservoir and limited in-stream flows in Cache Creek. The Capay Diversion Dam, on Cache Creek, is raised 5 feet during the irrigation season so that water can be diverted into the District's 160 miles of canals. In addition to the District's canals used for water deliver, there are over 100 miles of drainage channels, informally called sloughs.

- Clear Lake – Clear Lake is the District's primary water supply. Clear Lake is a large shallow natural body of water with a maximum depth of approximately 50 feet. The maximum withdrawal for irrigation is 150,000 acre-feet. In some dry years, no water is available from Clear Lake for irrigation. Cache Creek Dam controls the irrigation releases from Clear Lake. Cache Creek Dam is located approximately 49 miles upstream from the District's Capay Diversion Dam.

- Indian Valley Dam and Reservoir -- The dam and reservoir are located on the North Fork of Cache Creek approximately 54 miles from the Capay Diversion Dam. When full, Indian Valley Reservoir has a total storage capacity of 300,600 acre-feet. Forty thousand acre-feet of the reservoir storage is dedicated to flood control. Indian Valley Reservoir was designed to provide a firm yield of approximately 55,000 acre-feet.

Because approximately 2/3 of the District's water supply comes from Clear Lake (during a typical year), water quality issues in Clear Lake will directly affect the quality of irrigation water used by District customers. Because of extensive reuse of tailwater, many additional Yolo County farmers indirectly use Clear Lake water also.

3. Nutrient TMDL for Clear Lake

Because two thirds of the District's surface water supplies come from Clear Lake, water quality conditions in Clear Lake have an impact on the quality of surface water in Yolo County.

As described in the Central Valley Regional Water Quality Control Board's proposed amendment to the Basin Plan for Control of Nutrients in Clear Lake (June 2006), the lake is "eutrophic", meaning nutrient rich. Recent improvement in water clarity in Clear Lake are encouraging, nevertheless, the relatively warm water, high nutrients, and algae blooms still can contribute to very low dissolved oxygen under certain conditions.

The most recent significant fish kill, which occurred during the first week in August 2006 was caused by the high water temperatures in Clear Lake. Thousands of threadfin shad, pictured above in figure 1, were found along the North shore of Clear Lake. (Photo by Bob Myskey, Lake County Record-Bee.) According to Rick Macedo, Fisheries Biologist with the California Department of Fish and Game, the threadfin shad in this picture died because of acute temperature changes, not necessarily low dissolved oxygen.

When water is released from Clear Lake for irrigation purposes, the same water quality conditions that contribute to eutrophication, high water temperatures, and low dissolved oxygen in Clear Lake are carried downstream into Yolo County.

Yolo County agriculture may additionally impact nutrient and dissolved oxygen levels in irrigation return flows as well, but how and to what extent is undetermined at this time. A detailed analysis will need to be made comparing drainage to source water. An excellent starting place for the quality of source water is from the data used to develop the Clear Lake TMDL. We ask the Regional Board staff for assistance in this effort, as the current published Clear Lake TMDL reports were not written with this comparison in mind, and the published reports appear to be inadequate for the proposed analysis.

4. Ground versus Surface Water

Within the District, and Yolo County in general, ground and surface water resources are vitally important for agriculture, urban, and environmental uses. The use patterns between ground and surface water, and differences in water quality between ground and surface water, are critical to understanding patterns of water quality in agricultural drainage.

During normal water years, groundwater supplies approximately 36% of irrigation water in all of Yolo County and 50% of irrigation water in the YCFCWCD service area. During drought years, groundwater supplies almost 100% of the irrigation water.

Groundwater in Yolo County, especially the shallow aquifer that agricultural pumps tap, tends to have high levels of Boron and Electrical Conductivity (EC). In fact, the Boron and EC levels in most shallow (0-220 feet) and intermediate (220-600 feet) groundwater aquifers in the County exceed the most conservative recommended goals for salt sensitive crops for Boron and EC.[1] Most likely, ***all*** of the shallow groundwater supplies in the eastern part of the County exceed 700 uS/cm for EC. (YCWCWCD Groundwater Management Plan 2006).

In normal water year types, groundwater is an important water source for agriculture in Yolo County. During drought, groundwater is our 'backup' water supply and is a critical resource. Because of the importance and quantity of groundwater used for irrigation, it must be recognized that agricultural runoff for Boron and EC will have elevated levels of Boron and EC regardless of the agricultural practices used by area farmers.

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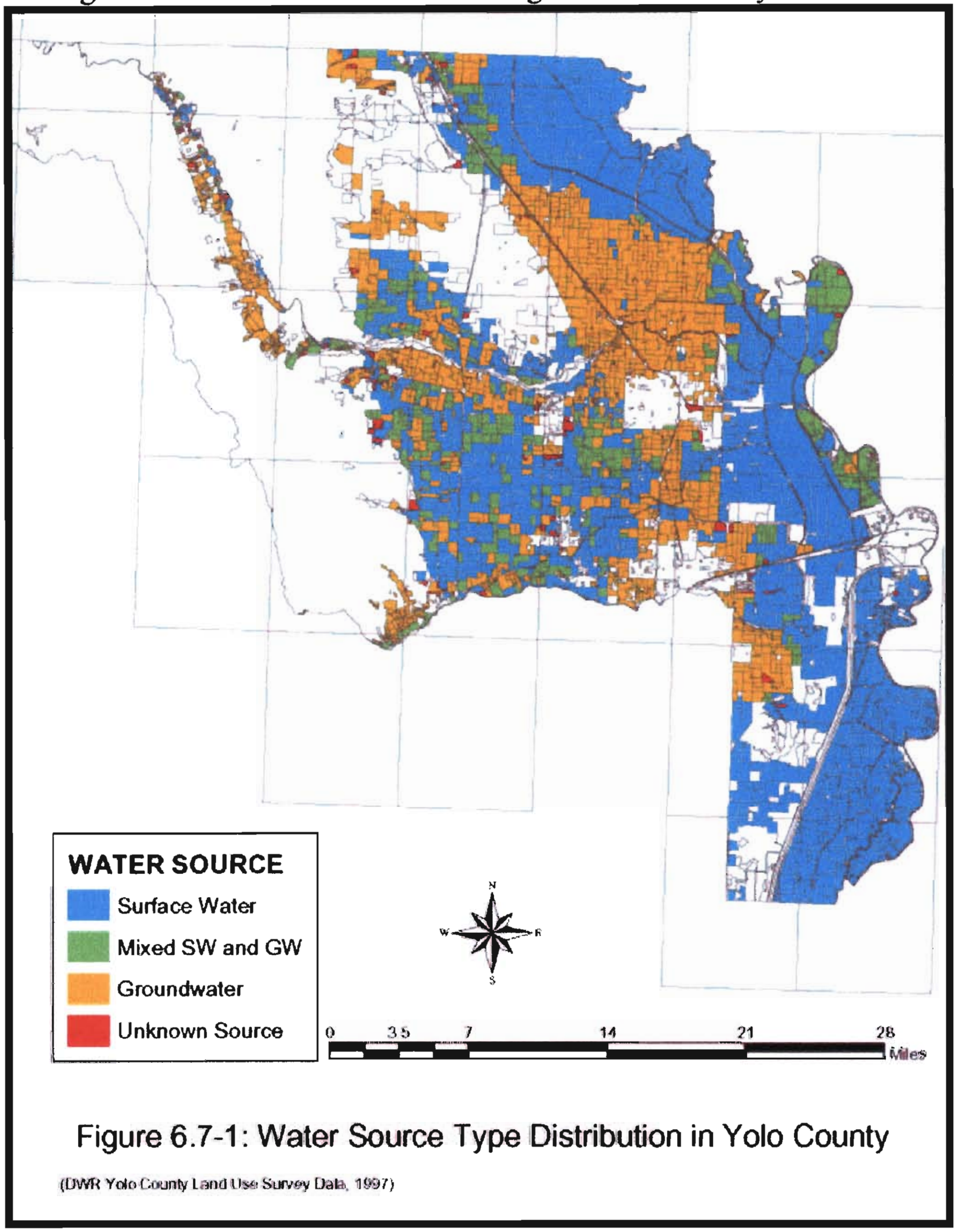
[1] The Water Quality Control Plan for the Sacramento and San Joaquin River Basins does not contain adopted water quality objectives for Electrical Conductivity and Boron. In the absence of adopted objectives, Regional Board staff has interpreted the narrative chemical objective with various available water quality criteria. The water quality criteria available for Boron and EC, as used by the Regional Board, are from the United Nations Recommended Goals for Agriculture (FAO, Irrigation and Drainage Paper #29, 1985). It has not been determined if these goals are applicable to agricultural as it exists within Yolo County and specifically within the District. In a precedential Water Quality Order, the State Water Resources Control required the Regional Board to consider site-specific conditions in determining the appropriate level of EC in the irrigation water. (WQO 2004-0010, June 17, 2004, at page 7.) Thus, the water quality goals are used within this report for comparison purposes only and are not intended to imply that these goals are the appropriate water quality criteria that apply to agriculture in this area.

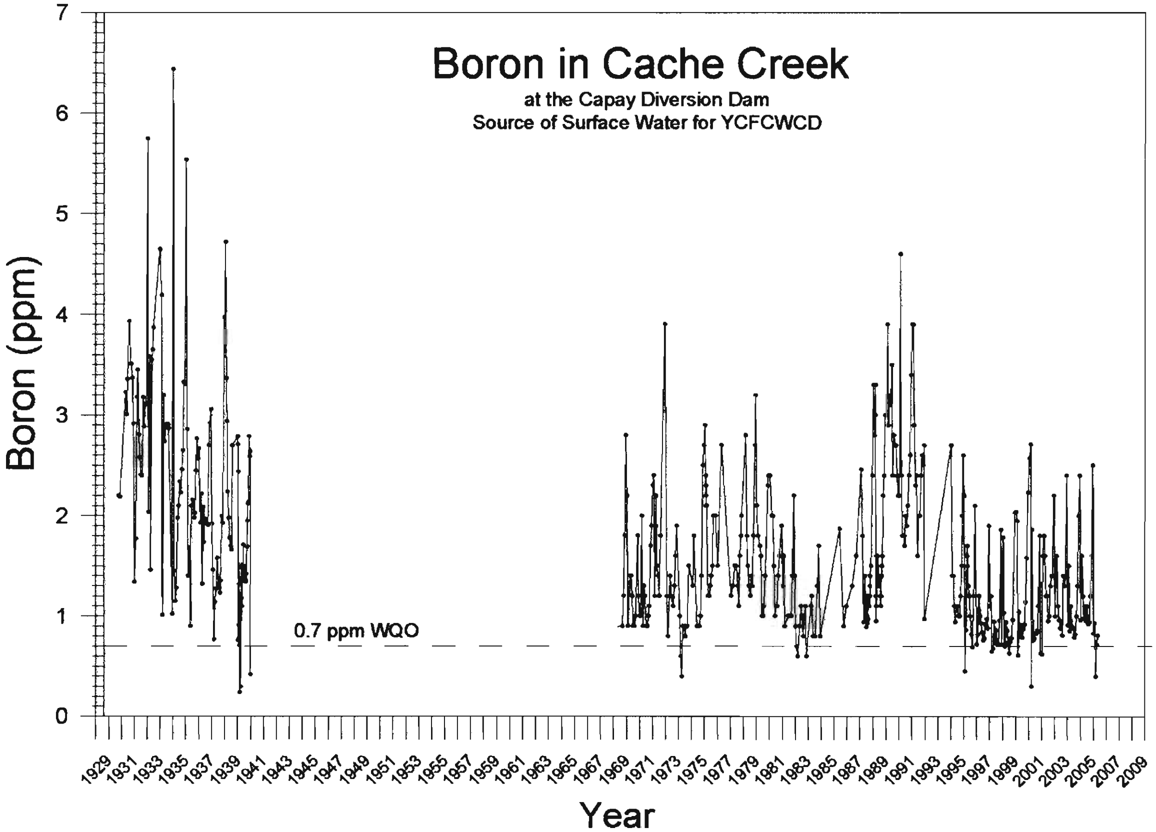
Fig 2. Patterns of ground and surface water use for irrigation Yolo County.



5.a. Boron - surface water

High levels of Boron occur naturally in the Cache Creek watershed. Since 1930, the District and its predecessors have been monitoring background levels of Boron in Cache Creek at the Capay Diversion Dam. Although there are some gaps in the data, it is clear that the main source of surface supplied irrigation water for the District, at its main diversion point at Capay, nearly always exceeds the most conservative water quality criteria available that could be used to interpret narrative WQO that applies to Boron (0.7ppm). The Boron levels in this watershed have been documented for the past 75 years and have probably been high for much longer. (Many other studies and datasets can supply greater detail about Boron in the Cache Creek watershed, and are needed for a full analysis, but they will not be discussed here for sake of simplicity and clarity.)

Figure 3. Boron in Cache Creek, source water for irrigation.



5.b. Boron - groundwater

The District's Groundwater Management Plan (2006) contains an extensive discussion of Boron in groundwater, along with data from 267 recent samples (years 2000 to 2004) from various depth zones and sub-basins. In the sixteen combinations of sub-basin and depth zone, all, except one, had **average** values for Boron at or above the interpreted narrative WQO for Boron.

High levels of Boron can be a problem for some types of crops in Yolo County, especially young tree crops. The farmers in Yolo County are aware of the high levels of Boron and have successfully managed their irrigation practices and water supplies to minimize the potential negative effects that could be caused by high levels of Boron.

The District welcomes ideas and creative efforts to address the Boron issue, however, it appears unlikely that changes in agricultural practices will reduce Boron in agricultural drainage. It also unnecessary to expand upstream drainage monitoring for Boron sources, since the sources are well known and have been monitored and documented for many years. We hope to continue to share information and knowledge we have gained about Boron with the Regional Board, so that we can work on this issue together.

6. EC/Salinity

The CVRWQCB has recently completed an excellent report on EC and salinity in the Central Valley entitled: Salinity in the Central Valley: an Overview (Cismowski, et al. 2006). To quote:

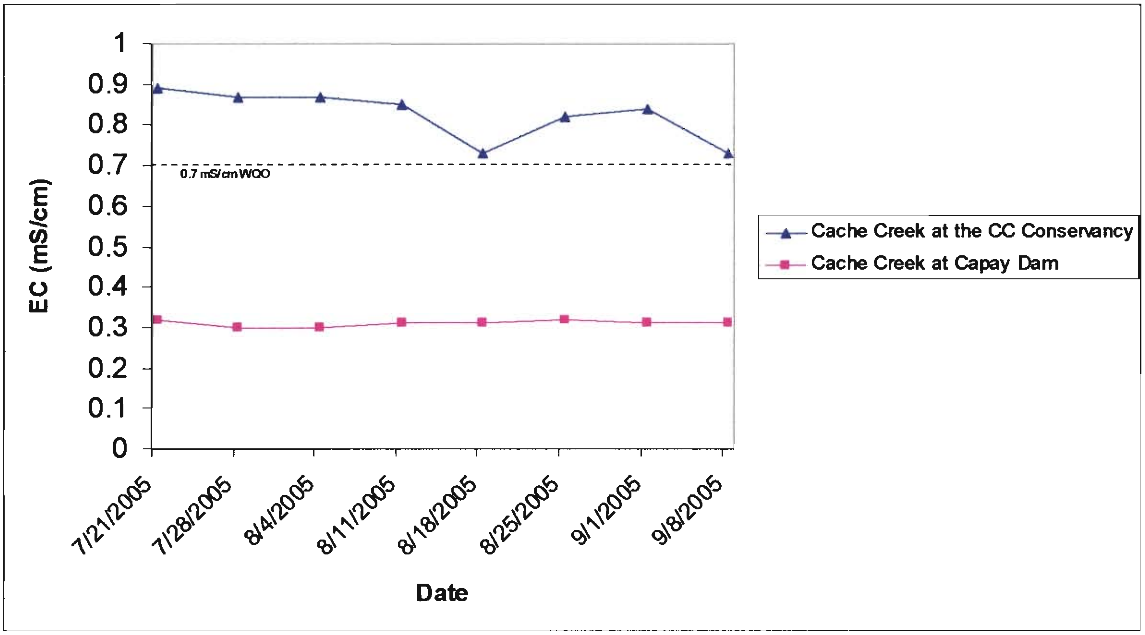
> "The salinity impairment of surface and groundwater in the Central Valley is a subset of a more far-reaching problem shared by most of California, other arid western states, and much of the developed world. As surface and groundwater supplies become scarcer, and as wastewater streams become more concentrated, salinity impairments are occurring with greater frequency and magnitude. Such impairments in the past have led to the fall of civilizations. These impairments will not be resolved by purely technical solutions. Solution of the salinity impairment in the Central Valley will depend upon development and successful implementation of effective land use, water supply, and water quality policies, in conjunction with overcoming institutional barriers...

This salinity report essentially describes salinity problems in water as requiring major statewide efforts and coordination over the next many decades. A long term salinity management plan for the Central Valley is needed.
To quote the report's explanation of how agriculture contributes salt:

> "Surface runoff from agricultural lands usually contains salt levels similar to the water supply... For the most part, it is drainage from the shallow groundwater beneath agricultural lands that is saline as a result of evapoconcentration of the salt and dissolution of salts in the soil profile. This groundwater can be collected by drainage systems or move laterally into surface waters...

Many of the sloughs and creeks in Yolo County are "gaining reaches", meaning that at least some of the water found flowing in them comes from shallow groundwater. This process is well documented in Cache Creek. In the gaining reaches of Cache Creek, EC is high. See Figure 4.

Figure 4. Electrical Conductivity in Cache Creek during the summer of 2005. The Conservancy reach (blue line) is exclusively groundwater, there is no surface water coming from the upper reach at Capay Dam (pink line) nor any drainage flows into the Creek above this point (pers. obs during a walk of the entire creek bed from Capay Dam to CC Conservancy).



In 1975, Scott and Scalmanini predicted increased salinity in shallow Yolo County groundwater of 400 uS/cm by 1990. The current data support this projection (GWMP 2006). This means that the process of salinization of groundwater is generally well understood in Yolo County. This understanding can be used to start addressing salinity issues. Which means there is no need to move monitoring upstream in a systematic search for the source of high EC. The high EC values measured by the Ag Water Quality Coalition monitoring program are from the use of high EC groundwater for irrigation and the drainage of shallow groundwater into waterways in gaining reaches.

Over the long term, the salinity in shallow groundwater will probably continue to increase due to a number of different factors. (See Cismowski, et al. 2006 for details). This salinity problem must be addressed aggressively, methodically, and holistically by considering both surface and groundwater together.

7. Differences in Source Water versus Tail Water

The impact of an agricultural practice on water quality can be determined by comparing water quality of irrigation source water to the water quality of the tail water. This is especially true on an individual field basis. On a watershed basis this becomes more difficult, but it is still a straightforward analysis for certain agricultural practices. For example, when an ag chemical is added to unknown fields upstream of a tail water monitoring station, and that ag chemical is not in the source water already, and the ag chemical shows up in the tail water, one can safely assume that the ag chemical has runoff from the fields where it was applied.

Sometimes there are issues with pesticides and fertilizer runoff from farms into waterways. This is a well known fact that the Conditional Waiver Program is addressing. However, some water quality issues do not follow this pattern. Some water quality issues involve constituents that are not ag chemicals and are not applied to fields as part of an ag management practice. A good example of this is the issue of high EC/salinity. Although farmer's add fertilizer, which is a component of salt, this amount is very small compared to the amount of salt that comes in the with the source water itself. The issue of high EC in shallow groundwater is from the natural process of evapotranspiration and poor soil drainage and is a cumulative process taking decades or centuries (as explained in Cismowski, et al. 2006). Depending on the water year type, source of irrigation water used, amount of shallow groundwater entering gaining reaches of waterways, and other factors, the tail water EC may be higher or lower than the source water. A comparison of source versus tail water quality is not very useful for issues with EC. Boron is a similar issue.

Nutrients are applied to the land for farming. Although there are other sources of nutrients that may cause water quality issues, fertilizer application can sometimes be a cause. In Yolo County, it will be useful to do a source versus tail water analysis for nutrients.

8. Conclusion

The brief overview of Boron, salinity, and nutrient water quality issues in Yolo County provided in this report is a very simplified description of these three issues in the irrigation water in our area. The primary purpose of this report is to promote communication between local resource managers and the Regional Board technical staff. A lot of information has been collected over many decades regarding water quality issues related to salinity, Boron and nutrients. Because these are primarily source water issues, the District believed it was important to explain how the surface and groundwater irrigation supply impacts water quality monitoring results for ag drainage.

Overall, the District is looking forward to creating a closer working relationship between our local experts and the Regional Board technical staff to address these issues and work towards improved water quality for all identified beneficial uses. In this spirit, we ask the Regional Board staff to assist us with an appropriate analysis of Clear Lake nutrient TMDL data, as it relates to source water quality issues in Yolo County.

9. References

G. Cismowski, et al. 2006 Salinity in the Central Valley:An Overview
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