INTERDEPARTMENTAL MEMORANDUM

TO: Butte County Water Commission Technical Advisory Committee

FROM: Christina Buck, Water Resources Scientist
Water and Resource Conservation

SUBJECT: 2014 Cumulative Groundwater Quality Trend Monitoring Update

DATE: August 20, 2014

INTRODUCTION AND BACKGROUND

The Butte County Department of Water and Resource Conservation (DW&RC) conducted its thirteenth year of groundwater quality trend monitoring within the county August 6-11, 2014. As required by Chapter 33A, the parameters monitored were temperature, pH, and electrical conductivity (EC). These parameters are the basic water quality characteristics needed to evaluate a basin for evidence of saline intrusion. The groundwater quality trend monitoring serves to establish baseline levels for these parameters throughout the county so that any future changes can be identified and further investigation and/or monitoring can subsequently be developed. All samples fell within the acceptable range of water quality values set forth by State and Federal agencies and alert stages defined in Chapter 33A for electrical conductivity. Two of the samples, Esquon and Western Canal (East), had pH values less than the secondary water quality threshold and BMO alert stage. Secondary Standards established by the US Environmental Protection Agency (US EPA) are based on taste, odor, color, corrosivity, foaming, and staining properties of water whereas primary standards are based on health considerations.

METHODOLOGY AND RESULTS

In 2013, DW&RC purchased a Hach HQd portable meter with a pH and conductivity probe. This was the second year this meter was used to do the groundwater quality testing. Glenn County conducts similar water quality monitoring during July or August for about 24 wells throughout their county.

The sites visited in Butte County are on private land and many of the wells are used for agricultural purposes (irrigating orchards, rice, or pasture). However, the two Thermalito wells, Chico Urban Area well, Vina well, and the Llano Seco well provide domestic water supply. The sampling grid spans from north of the Chico Urban Area (Vina sub-inventory unit), west towards the Sacramento River (Llano Seco and M&T sub-inventory units), east towards the foothills (Pentz sub-inventory unit), and south towards Gridley (Biggs-West Gridley sub-inventory unit). Figure 1 shows the approximate locations (township, range, and section) of the water quality wells in relation to wells monitored four times per year for groundwater level in the Basin Management Objectives Program.

As in previous years, we are fortunate to have support and permission from local property owners who coordinate timing of sampling and allow access to their wells. We have provided them with the preliminary results from this year's monitoring. Ten of the thirteen wells were sampled this year with three unable to be measured due to access issues. They should be resumed next year.

Following standard sampling procedure, a water sample is pulled from a discharge location at or near the well and values for temperature, pH and EC are recorded when the pH reading from the water sample stabilizes. Temperature is a standard parameter measured when assessing water quality, mostly to indicate that water being sampled is representative of aquifer water and not water standing in the well itself.

The US Environmental Protection Agency (US EPA) establishes drinking water quality standards using two categories, Primary Standards and Secondary Standards[1]. Primary Standards are based on health considerations and Secondary Standards are based on taste, odor, color, corrosivity, foaming, and staining properties of water. Secondary water quality thresholds for pH and EC compared to the range of 2014 values are presented in Table 1.

Table 1. US EPA Secondary Standards for measured parameters

Parameter	Secondary Standard or Secondary WQ Threshold	Range of 2014 Values	Notes re: Butte County Results
pH	6.5 to 8.5	5.92-7.89	Two wells measured pH less than 6.5: Western Canal (East) and Esquon.
Electrical Conductivity (EC)	< 900 µS/cm – drinking water < 700 µS/cm – ag water	181-695	Within range of secondary water quality thresholds.

Water quality data for specific wells is presented in tables and graphs on the following pages.

Temperature is an important parameter because it affects chemical reactions that may occur in groundwater. Also, considerable changes in temperature could be an indication of other source waters migrating into the aquifer system such as stream seepage or flow from a different aquifer system. To date, temperature has been relatively consistent in all wells. Chapter 33A states that "the BMO Alert Stage for temperature will be reached when the measurement is more than five (5) degrees outside of the historic range of measurements." The 2014 measurements were all within 2.3 ^{o}C of the average temperature for each well. The 13 year temperature range for all wells is less than 5 ^{o}C (Table 3). The lowest temperature reading was in the Thermalito well (17.5 ^{o}C) and the high was in the Llano Seco well (23.5 ^{o}C).

Measurements for pH generally dropped in a number of the measured wells this year (see attached graphs). This includes the measurement from Biggs West Gridley, Cherokee, Esquon, Llano Seco, Pentz, Western Canal (East), and Western Canal (West) wells. The highest pH was found in the Vina well (7.89) and the lowest in the Esquon well (5.92). This measurement is less than the secondary standard. The pH measured in the Western Canal (East) well, 6.47, was also slightly below the threshold.

Electrical conductivity (EC) measures the ability of a solution to conduct an electrical current due to the presence of ions. Observed readings for electrical conductivity can have a large range, up to 447 µS/cm at a particular well (Western Canal-west), yet 2014 measurements were all within the secondary water quality thresholds established by State and Federal regulatory agencies (Table 1, Table 6 and included graphs). The highest EC measurement was from the Western Canal (west) well (695 µS/cm) and the lowest was from the Thermalito well (181 µS/cm).

CONCLUSIONS

This was the thirteenth season the DW&RC collected groundwater quality information. Overall, a number of the wells sampled reached new lows for pH and a few reached new highs for EC this year, but were still mostly well within the acceptable range for these parameters. Exceptions include the sample from the Esquon well which had a pH of 5.92

[1] http://www.epa.gov/safewater/consumer/2ndstandards.html

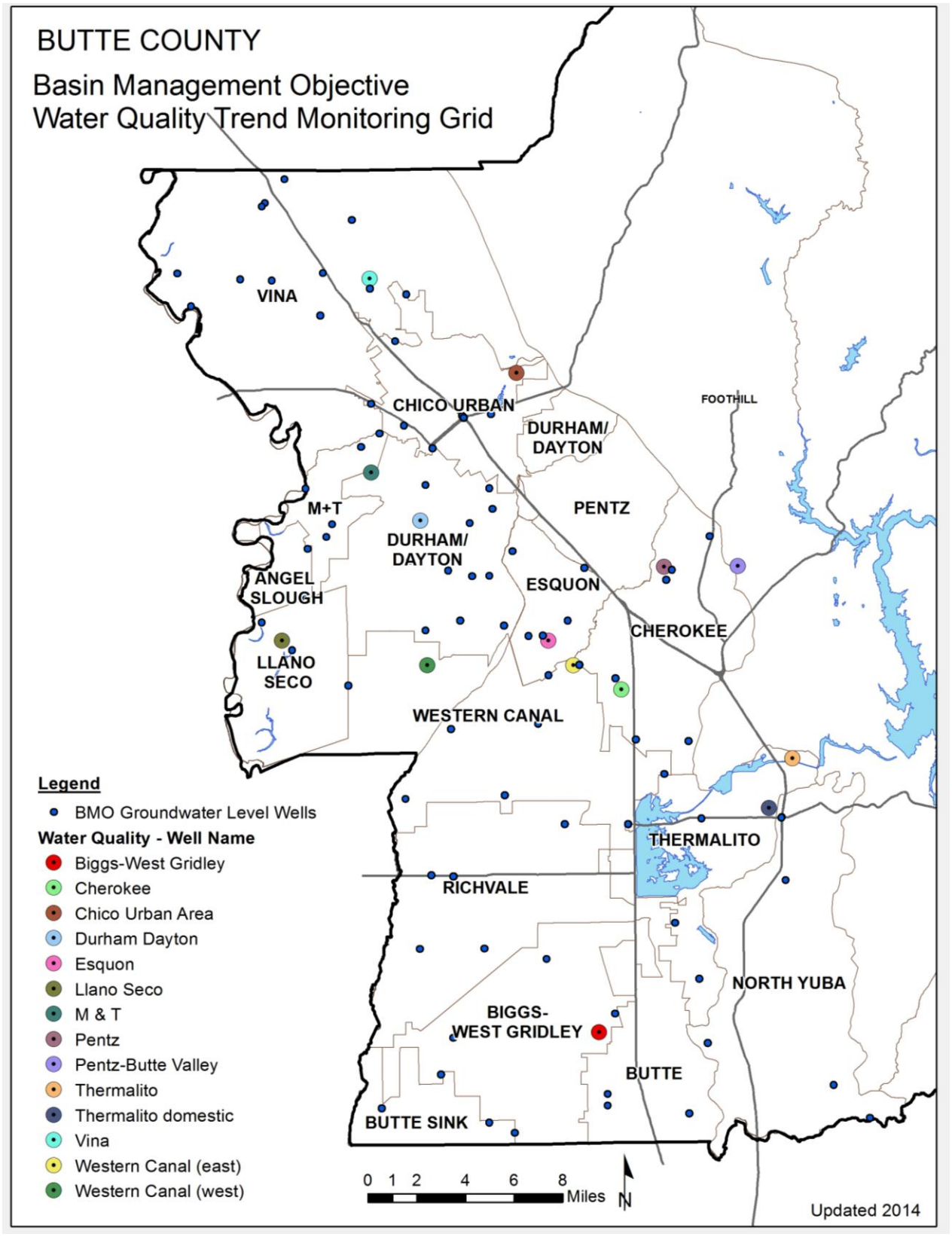
and the Western Canal (East) sample with a pH of 6.47, just slightly below the 6.5 threshold. In consultation with an environmental scientist from DWR Northern Region, the Esquon measurement could be considered suspect given its significant change from earlier years. Previously, its range in measurements was 7.1-7.5. However, the water quality meter was calibrated in the field with pH 4 and 7 buffers and multiple water samples from the well reportedly yielded the same result. Unfortunately, this well cannot be resampled in the immediate future to confirm or replace the unusual measurement. We will flag this well for next year's water quality program to watch that this downward movement out of the secondary standard does not continue. Droughts and rainy seasons can affect water quality and the current drought could be contributing to observed water quality in this year's results. However, it would not usually cause as great a difference as was measured in the Esquon well. Five wells had measurements with new minimums in the range of their measured pH values. Results are not cause for immediate concern and will be on the agenda for further evaluation and discussion at the Technical Advisory Committee meeting in November.

The focus of this trend monitoring program is to evaluate the basin for evidence of saline intrusion. No major shifts occurred in the EC measurements in the sampled wells. This suggests the basin continues to be free of saline intrusion in these areas. This data continues to help establish baseline levels for these parameters across the county so that any future changes in water quality can be evaluated and further investigation and/or monitoring can be developed.

Further information on water quality standards for different constituents can be found at www.swrcb.ca.gov or in the *Compilation of Water Quality Goals*, published by the State Water Resources Control Board. Additionally, in 2010 the State Water Resources Control Board published the *Groundwater Quality Protection Strategy for the Central Valley Region, a Roadmap*[2]. Work plans for high priority actions identified in the Roadmap document have subsequently been developed.

[2] http://www.swrcb.ca.gov/rwqcb5/water_issues/groundwater_quality/index.shtml

Figure 1. Approximate well locations for water quality wells in relation to wells monitored annually (four times) for water level.



DATA TABLES AND GRAPHS

Table 2. Annual groundwater temperature (°C)

Sub-Inventory Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Biggs-West Gridley	18.5	18.5	18.1	20.5	18.2	18.3	18.7	19.0	19.2	20.1	18.0	18.4	19.0
Cherokee	22.4	21.9	21.2	21.4	21.1	20.7	21.0	20.9	21.9	21.8	21.8	21.3	21.9
Chico Urban Area						18.4	20.1	18.2	18.8	19.5	21.6	18.0	NM
Durham Dayton	18.8	19.9	21.8	20.4	17.4	NM	19.3	NM	18.9	18.0	NM	18.5	19.1
Esquon	19.7	18.9	19.6	20.1	20.7	19.0	19.6	19.0	19.1	20.0	21.4	18.1	20.2
Llano Seco							20.8	20.6	20.7	20.6	21.7	20.4	23.5
M & T	17.6	18.2	17.8	19.2	18.6	18.0	17.7	18.6	17.8	NM	18.3	17.9	NM
Pentz						22.2	21.5	21.3	21.5	23.9	21.9	21.9	21.9
*Pentz-Butte Valley	27.0	26.4	26.7	23.2									
Thermalito	18.3	17.9	17.1	17.1	18.4	17.7	18.9	17.6	NM	NM	17.8	17.3	17.5
Thermalito domestic							19.4	19.4	19.4	NM	NM	19.8	NM
Vina	19.6	20.3	19.2	19.2	19.6	18.9	19.6	18.9	18.8	22.8	18.8	20.2	21.4
Western Canal (East)	18.4	18.2	19.9	20.5	18.8	18.6	19.1	19.0	18.8	19.0	NM	18.3	18.9
Western Canal (West)	19.0	18.1	19.8	20.8	18.5	20.6	21.8	18.5	19.1	20.5	20.1	19.1	20.2

*Pentz-Butte Valley well discontinued in 2006

Table 3. Groundwater temperature average and range over 13 year sampling period (°C)

Sub-Inventory Unit	Average	Range
Biggs-West Gridley	18.8	2.5
Cherokee	21.5	1.7
Chico Urban Area	19.2	3.6
Durham Dayton	19.2	4.4
Esquon	19.6	3.3
Llano Seco	21.2	3.1
M & T	18.2	1.6
Pentz	22.0	2.6
*Pentz-Butte Valley	25.8	3.8
Thermalito	17.8	1.8
Thermalito domestic	19.5	0.4
Vina	19.8	4.0
Western Canal (East)	19.0	2.3
Western Canal (West)	19.7	3.7

Table 4. Annual groundwater pH

Sub-Inventory Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Biggs-West Gridley	7.60	7.50	7.50	7.04	7.60	7.64	7.72	7.88	7.86	7.22	7.91	7.86	7.10
Cherokee	7.50	7.50	7.10	7.40	7.40	7.30	7.30	7.30	7.23	7.58	7.30	7.33	6.89
Chico Urban Area						6.88	6.94	6.90	6.99	7.53	7.29	7.05	NM
Durham Dayton	7.70	7.20	7.60	7.60	7.50	NM	7.54	NM	7.41	7.70	NM	7.49	NM
Esquon	7.30	7.50	7.10	7.40	7.50	7.43	7.24	7.42	7.38	7.55	7.17	7.29	5.92
Llano Seco							7.90	8.07	8.15	8.05	7.92	8.02	7.04
M & T	7.20	7.50	6.90	7.80	7.90	7.62	7.68	7.62	7.62	NM	7.24	7.85	NM
Pentz						7.58	7.40	7.53	7.44	7.27	7.75	7.53	6.70
*Pentz-Butte Valley	7.10	6.90	7.29	6.24									
Thermalito	7.00	6.50	7.10	7.10	7.90	7.40	7.42	7.44	NM	NM	8.00	7.67	7.50
Thermalito domestic							7.73	7.84	7.71	NM	NM	7.80	NM
Vina	7.50	7.60	6.90	6.20	7.70	7.54	7.51	7.39	7.57	7.95	7.33	7.76	7.89
Western Canal (East)	7.00	6.60	6.80	6.90	7.30	6.92	6.96	7.00	7.10	6.95	NM	7.16	6.47
Western Canal (West)	7.80	8.10	7.10	6.90	7.90	7.88	7.81	6.59	7.75	7.50	7.70	7.51	7.07

Table 5. Groundwater pH average and range over 13 year sampling period

Sub-Inventory Unit	Average	Range
Biggs-West Gridley	7.57	0.87
Cherokee	7.32	0.69
Chico Urban Area	7.08	0.65
Durham Dayton	7.53	0.50
Esquon	7.25	1.63
Llano Seco	7.88	1.11
M & T	7.54	1.00
Pentz	7.40	1.05
*Pentz-Butte Valley	6.88	1.05
Thermalito	7.37	1.50
Thermalito domestic	7.77	0.13
Vina	7.45	1.75
Western Canal (East)	6.93	0.83
Western Canal (West)	7.51	1.51

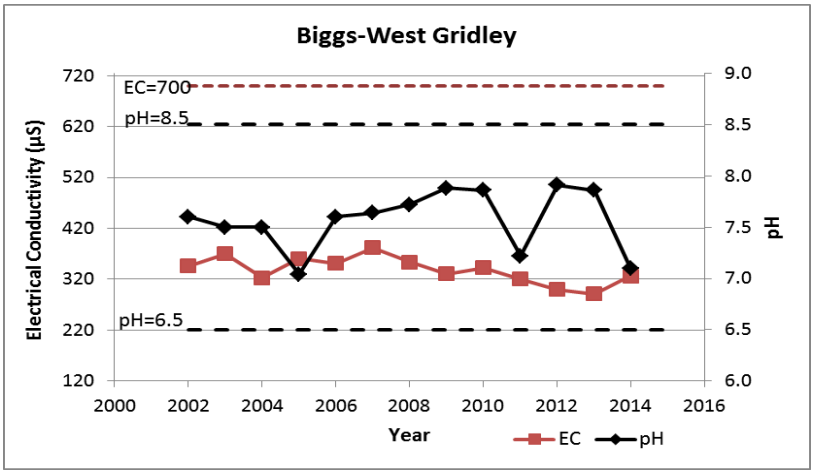
Table 6. Annual groundwater Electrical Conductivity (µS/cm)

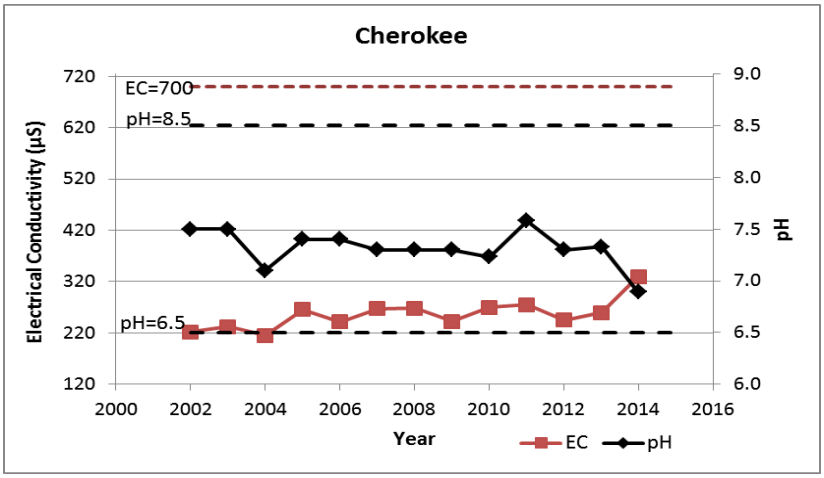
Sub-Inventory Unit	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Biggs-West Gridley	346	370	323	361	351	382	354	331	343	320	300	291	326
Cherokee	222	232	215	266	242	267	268	243	270	275	245	260	330
Chico Urban Area						280	291	260	249	250	248	217	NM
Durham Dayton	315	348	259	340	322	NM	327	NM	307	315	NM	298	304
Esquon	388	526	470	557	507	480	439	419	427	415	408	512	443
Llano Seco							204	195	196	198	192	184	240
M & T	418	551	678	504	465	451	667	445	592	NM	427	391	NM
Pentz						218	229	227	225	224	204	204	231
*Pentz-Butte Valley	195	186	211	240									
Thermalito	132	164	149	150	152	242	205	158	NM	NM	292	179	181
Thermalito domestic							374	350	354	NM	NM	342	NM
Vina	197	225	180	216	192	224	203	200	199	194	174	188	201
Western Canal (East)	447	344	400	524	492	471	482	488	465	459	NM	447	442
Western Canal (West)	464	248	407	501	309	477	469	462	455	460	630	629	695

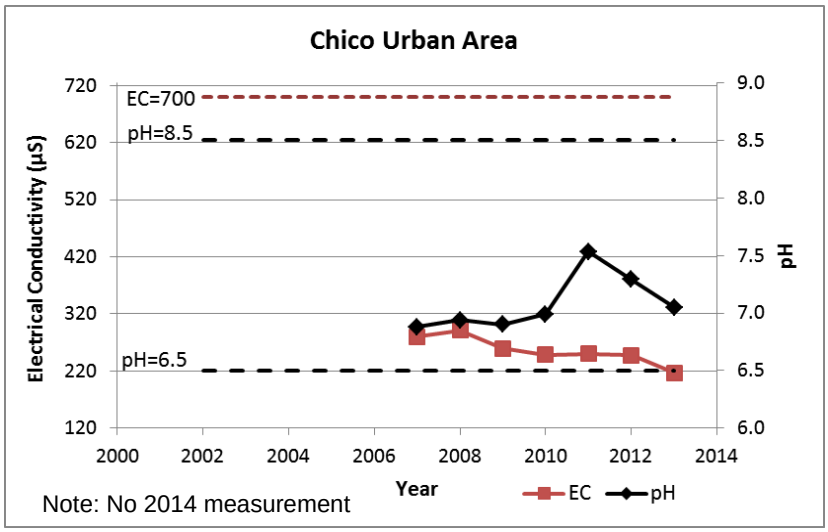
Table 7. Groundwater EC (µS/cm) average and range over 13 year sampling period

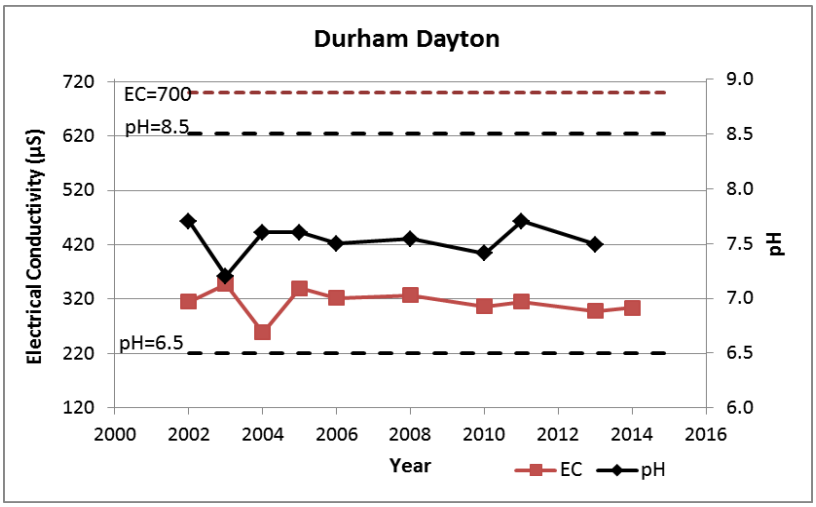
Sub-Inventory Unit	Average	Range
Biggs-West Gridley	338	91
Cherokee	257	115
Chico Urban Area	256	74
Durham Dayton	314	89
Esquon	461	169
Llano Seco	201	56
M & T	508	287
Pentz	220	27
*Pentz-Butte Valley	208	54
Thermalito	182	160
Thermalito domestic	355	32
Vina	199	51
Western Canal (East)	455	180
Western Canal (West)	477	447

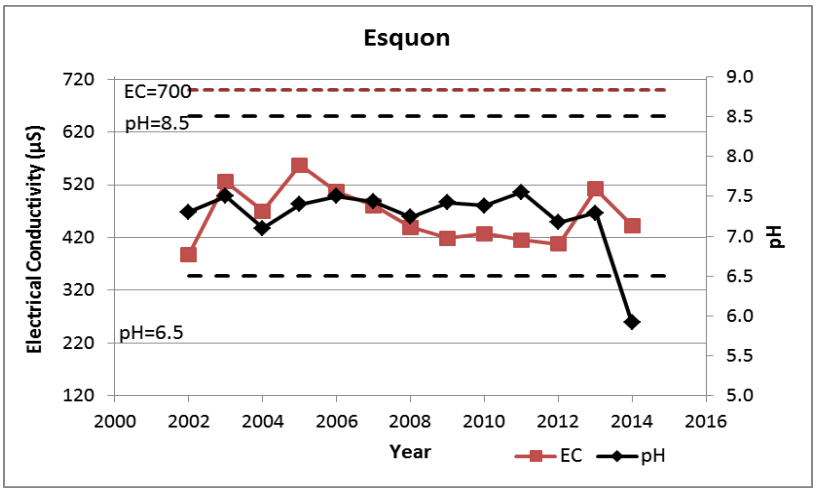
Annual Electrical Conductivity (µS/cm) and pH for each water quality sampling well. The red dashed line indicates the preferred maximum level for EC and the black dashed lines bound the acceptable pH range, 6.5-8.5. Therefore, when the red plot of EC values is below the red dashed line (as it always is), then measured EC is within the secondary standard for agricultural water (<700), which is more restrictive than for drinking water (<900). To be within the acceptable pH range, the black line should be within the black dashed lines.

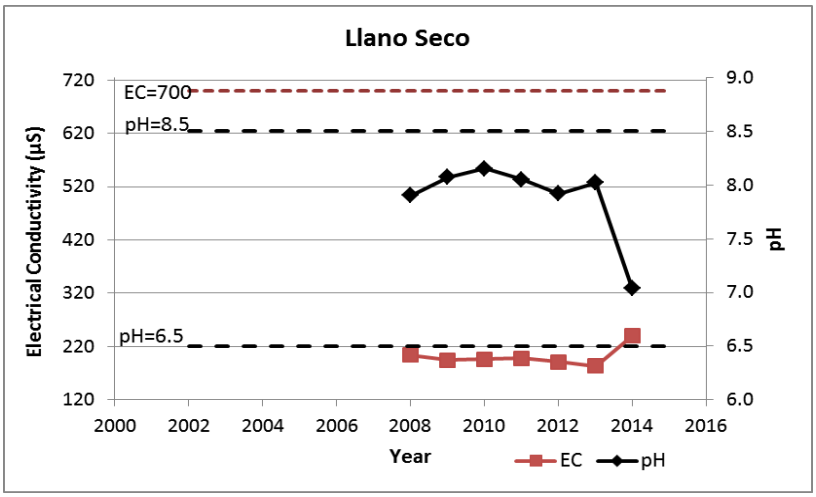












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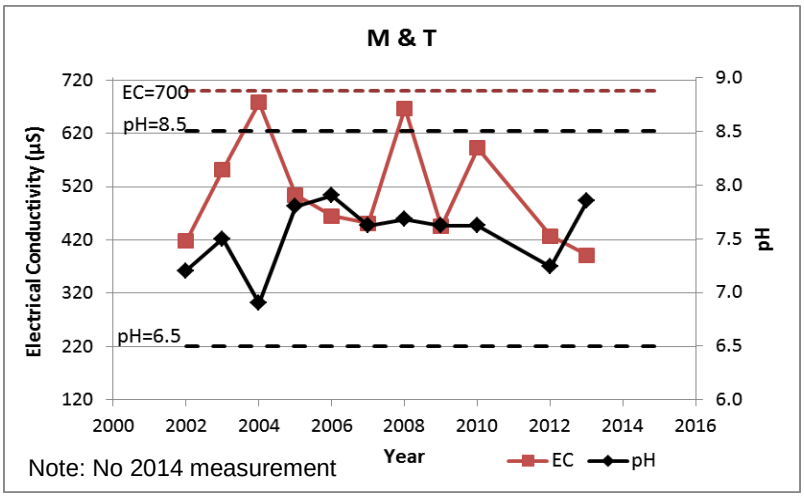

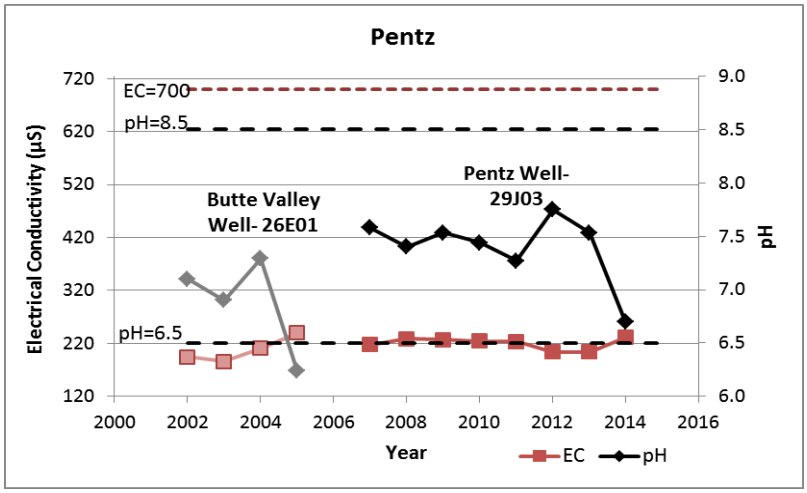

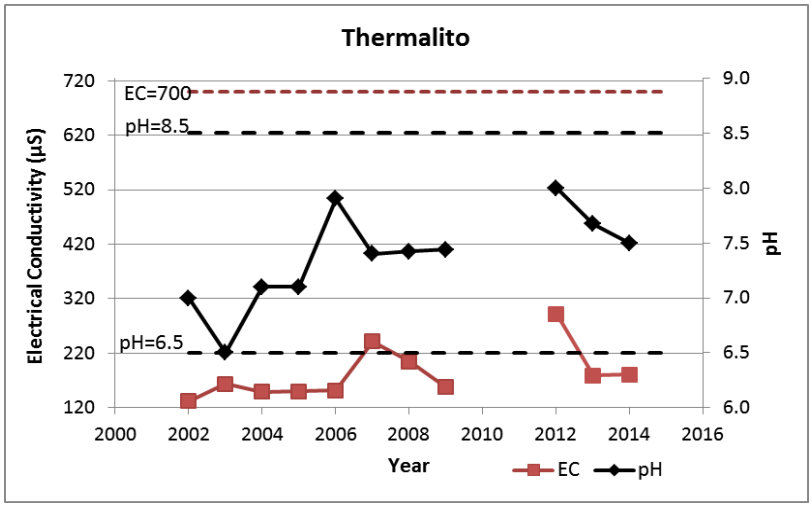

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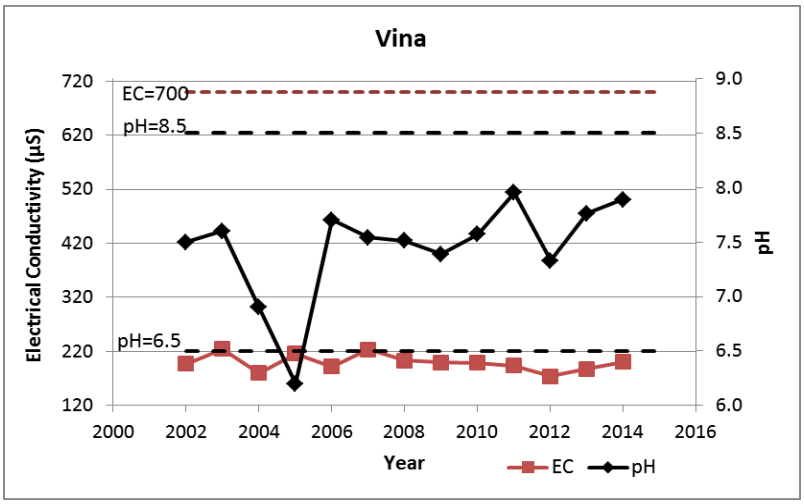

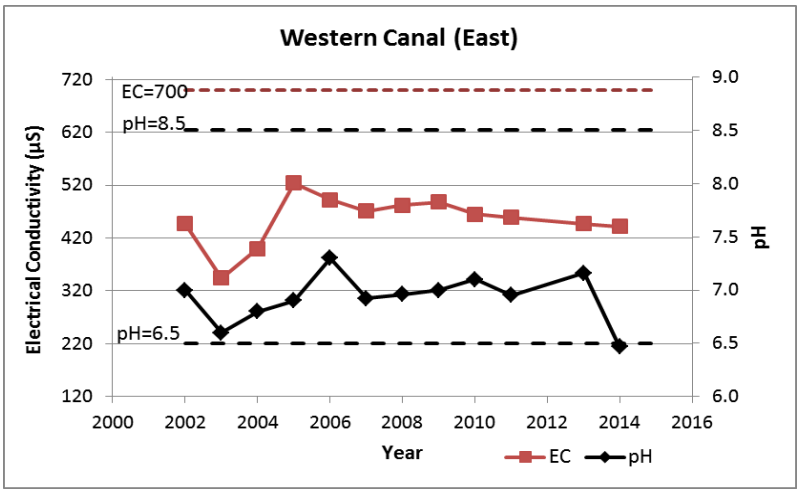

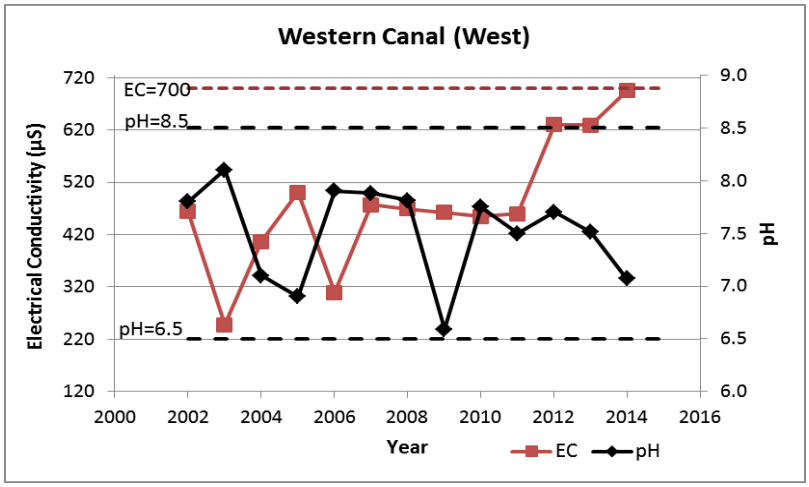

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