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INTERDEPARTMENTAL MEMORANDUM

TO: Butte County Water Commission

FROM: Kelly Peterson, Water Resources Scientist

SUBJECT: 2019 Groundwater Quality Trend Monitoring Update

DATE: February 5, 2020

INTRODUCTION AND BACKGROUND

The Butte County Department of Water and Resource Conservation (Department) conducted its eighteenth year of groundwater quality trend monitoring within the county July 31, 2019 - August 2, 2019. 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. In 2019, all samples fell within the acceptable range of water quality values set forth by State and Federal agencies and Basin Management Objectives (BMOs) defined in Chapter 33A and described in Table 1.

Table 1. Butte County Basin Management Objectives for Water Quality

Parameter	Basin Management Objective
Temperature	Within 5 ° Celsius of the historic range (all but current year) of temperatures for that well
pH	Between 6.5 and 8.5
Electrical Conductivity *	< 900 µS/cm for drinking water < 700 µS/cm for agricultural water

METHODOLOGY AND RESULTS

In 2013, Department purchased a Hach HQd portable meter with a pH and conductivity probe. This was the seventh year this meter was used to do the groundwater quality testing. 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, the Chico Urban Area well, the Pentz well, the Vina well and the Llano Seco wells 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 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.

All thirteen wells in the network were sampled this year. The Western Canal (West) well had been inaccessible the previous two years due to irrigation infrastructure changes that prevented sampling. Following standard sampling procedures, 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 three subsequent water samples 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 2019 values are presented in 2.

Table 2. US EPA Secondary Standards for measured parameters

Parameter	Secondary Standard or Secondary WQ Threshold	Range of 2019 Values	Notes re: Butte County Results
pH	6.5 to 8.5	6.9 – 8.1	Within range of secondary water quality thresholds.
Electrical Conductivity *	< 900 µS/cm – drinking water < 700 µS/cm – ag water	188 – 515	Within range of secondary water quality thresholds.

* A positive correction factor was applied to the 2019 results per recommendation of the Butte County Water Commission Technical Advisory Committee, due to an error in calibration of the probe.

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." All 2019 well measurements were within their respective temperature BMO and within 5.0° Celcius (C) of their historic ranges.

All 2019 groundwater quality measurements were within their respective temperature BMO and within 5.0 degrees Celcius (° C) of their historical ranges. All but one of the 2019 measurements were within 1.0° C of each well's average historic temperature (Table 3). The Thermalito domestic well was 2.9° C higher than the well's recorded 11-year average. The lowest groundwater temperature reading was in the M & T well (17.5° C) and the highest was in the Thermalito domestic well (22.6° C). At the Thermalito domestic well, the groundwater temperature was recorded from water sample taken after purging the well with the outdoor household hose versus irrigating with sprinklers to purge the well as had been done in previous years which may have affected the high readings.

Measurements for pH remained relatively stable compared to previous years, in all wells sampled. The lowest pH was found in the Western Canal East area well (6.9) and the highest pH was found in the Llano Seco well (8.1). All measurements for pH were within the secondary water quality thresholds of 6.5 - 8.5 (Table 1, Table 4 and included graphs).

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

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 one particular well (Western Canal-west), yet 2019 measurements were all well within the secondary water quality thresholds established by State and Federal regulatory agencies (Table 5, Table 6 and included graphs). A positive correction factor was applied to the 2019 results per recommendation of the Butte County Water Commission Technical Advisory Committee, due to an error in calibration of the probe. Calibration was originally performed using standards too high in concentration for the instrument; hence the low readings observed in the field. Using corrected results, the highest EC measurement was from the Esquon well (515 µS/cm) and the lowest was from the Llano Seco well (188 µS/cm). The greatest change compared to 2018 EC levels occurred in the Thermalito domestic area well which increased in value by 102 µS/cm; however, this may be due to the well purging method used at the well this year as described above.

CONCLUSIONS

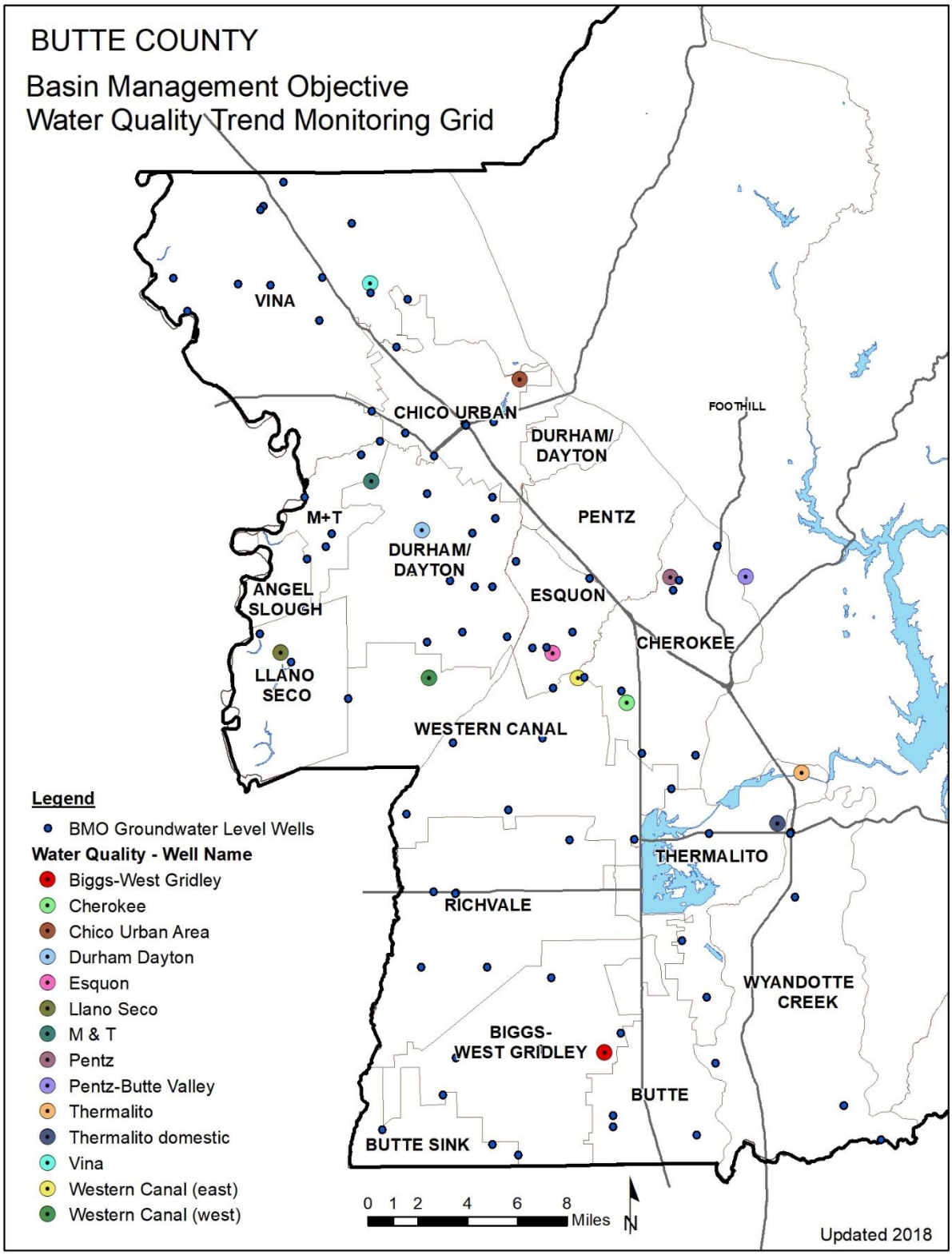
This was the eighteenth season the Department collected groundwater quality information. Overall, the results of the water quality sampling indicate no significant changes in groundwater quality with respect to temperature, pH or electrical conductivity. All samples were within the acceptable range for electrical conductivity and pH, and temperatures remained relatively consistent. The greatest change compared to 2018 was observed in the EC levels measured at the Thermalito domestic area well which increased in value by 102 µS/cm; however, this may be due to the well purging method used at the well this year as described above.

Water quality parameters have naturally occurring variability, so year to year changes are expected and nothing in this year's measurements gives cause for concern or immediate further investigation or analysis. Further investigation would be advisable if values were to fall outside of the acceptable range.

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 and the basin appears 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.

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 1. Annual groundwater temperature (ºC)

Well / Area	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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	18.5	18.4	18.6	19.3	18.9
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	21.2	20.8	21.2	21.3	21.1
Chico Urban Area						18.4	20.1	18.2	18.8	19.5	21.6	18.0	NM	18.4	17.8	19.0	22.6	18.0
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	18.1	18.0	18.8	19.9	18.0
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	18.9	18.0	19.1	18.6	18.4
Llano Seco							20.8	20.6	20.7	20.6	21.7	20.4	23.5	19.9	20.0	19.9	20.1	20.0
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	17.1	17.2	17.2	17.9	17.5
Pentz						22.2	21.5	21.3	21.5	23.9	21.9	21.9	21.9	21.5	21.5	21.6	22.1	21.2
*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	17.3	17.4	17.5	17.8	17.6
Thermalito (domestic)							19.4	19.4	19.4	NM	NM	19.8	NM	19.9	19.8	20.0	20.3	22.6
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	19.5	19.8	19.5	20.5	19.6
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	18.5	19.1	18.6	20.1	19.5
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	18.6	18.8	NM	NM	18.7

*Pentz-Butte Valley well discontinued in 2006

NM – No measurement

Table 2. 2019 Groundwater temperature results, historic averages, ranges and years measured (°C)

Well / Area	Years Measured	Historic Average (°C)	2019 Results (°C)	Historic Range (°C)
Biggs-West Gridley	18	18.8	18.9	18.0 - 20.5
Cherokee	18	21.4	21.1	20.7 - 22.4
Chico Urban Area	12	19.2	18.0	17.8 - 22.6
Durham Dayton	15	19.0	18.0	17.4 - 21.8
Esquon	18	19.4	18.4	18.0 - 21.4
Llano Seco	12	20.7	20.0	19.9 - 23.5
M & T	16	17.9	17.5	17.1 - 19.2
Pentz	13	21.8	21.2	21.3 - 23.9
*Pentz-Butte Valley	4	25.8	--	23.2 - 27.0
Thermalito	16	17.7	17.6	17.1 - 18.9
Thermalito (domestic)	9	20.1	22.6	19.4 - 20.3
Vina	18	19.8	19.6	18.8 - 22.8
Western Canal (East)	17	19.0	19.5	18.2 - 20.5
Western Canal (West)	16	19.5	18.7	18.1 - 21.8

*Pentz-Butte Valley well discontinued in 2006

NM – No measurement

Table 3. Annual groundwater pH

Well / Area	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Biggs-West Gridley	7.6	7.5	7.5	7.0	7.6	7.6	7.7	7.9	7.9	7.2	7.9	7.9	7.1	7.6	7.6	7.7	7.7	7.5
Cherokee	7.5	7.5	7.1	7.4	7.4	7.3	7.3	7.3	7.2	7.6	7.3	7.3	6.9	7.2	7.2	7.1	6.9	7.2
Chico Urban Area						6.9	6.9	6.9	7.0	7.5	7.3	7.1	NM	6.9	7.0	7.0	7.1	7.0
Durham Dayton	7.7	7.2	7.6	7.6	7.5	NM	7.5	NM	7.4	7.7	NM	7.5	NM	7.5	7.5	7.3	6.7	7.2
Esquon	7.3	7.5	7.1	7.4	7.5	7.4	7.2	7.4	7.4	7.6	7.2	7.3		7.4	7.2	7.3	6.9	7.2
Llano Seco							7.9	8.1	8.2	8.1	7.9	8.0	7.0	7.8	7.8	7.7	7.8	8.1
M & T	7.2	7.5	6.9	7.8	7.9	7.6	7.7	7.6	7.6	NM	7.2	7.9	NM	7.4	7.7	7.6	7.6	7.6
Pentz						7.6	7.4	7.5	7.4	7.3	7.8	7.5	6.7	7.0	7.4	7.2	7.3	7.2
*Pentz-Butte Valley	7.1	6.9	7.3	6.2														
Thermalito	7.0	6.5	7.1	7.1	7.9	7.4	7.4	7.4	NM	NM	8.0	7.7	7.5	7.1	7.1	7.1	7.4	7.4
Thermalito domestic							7.7	7.8	7.7	NM	NM	7.8	NM	6.9	7.6	7.6	7.4	7.5
Vina	7.5	7.6	6.9	6.2	7.7	7.5	7.5	7.4	7.6	8.0	7.3	7.8	7.9	7.1	7.4	7.3	7.4	7.6
Western Canal (East)	7.0	6.6	6.8	6.9	7.3	6.9	7.0	7.0	7.1	7.0	NM	7.2	6.5	7.1	7.0	7.0	7.0	6.9
Western Canal (West)	7.8	8.1	7.1	6.9	7.9	7.9	7.8	6.6	7.8	7.5	7.7	7.5	7.1	7.5	7.4	NM	NM	7.7

*Pentz-Butte Valley well discontinued in 2006

NM – No measurement

Table 4. 2019 Groundwater pH results, historic averages and ranges.

Well / Area	Historic Average	2019 Results	Historic Range
Biggs-West Gridley	7.6	7.5	7.0 - 7.9
Cherokee	7.3	7.2	6.9 - 7.6
Chico Urban Area	7.0	7.0	6.9 - 7.5
Durham Dayton	7.4	7.2	6.7 - 7.7
Esquon	7.3	7.2	6.9 - 7.6
Llano Seco	7.9	8.1	7.0 - 8.2
M & T	7.6	7.6	6.9 - 7.9
Pentz	7.3	7.2	6.7 - 7.8
*Pentz-Butte Valley	6.9	--	6.2 - 7.3
Thermalito	7.3	7.4	6.5 - 8.0
Thermalito domestic	7.6	7.5	6.9 - 7.8
Vina	7.4	7.6	6.2 - 8.0
Western Canal (East)	7.0	6.9	6.5 - 7.3
Western Canal (West)	7.5	7.7	6.6 - 8.1

*Pentz-Butte Valley well discontinued in 2006

Table 5. Annual groundwater electrical conductivity [micro Siemens / centimeter (µS/cm)]

Well / Area	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019**
Biggs-West Gridley	346	370	323	361	351	382	354	331	343	320	300	291	326	288	296	290	297	306
Cherokee	222	232	215	266	242	267	268	243	270	275	245	260	330	255	261	284	293	299
Chico Urban Area						280	291	260	249	250	248	217	NM	214	221	254	295	243
Durham Dayton	315	348	259	340	322	NM	327	NM	307	315	NM	298	304	322	316	322	355	358
Esquon	388	526	470	557	507	480	439	419	427	415	408	512	443	417	499	416	529	515
Llano Seco							204	195	196	198	192	184	240	180	182	179	186	188
M & T	418	551	678	504	465	451	667	445	592	NM	427	391	NM	362	333	498	337	360
Pentz						218	229	227	225	224	204	204	231	210	204	207	213	221
*Pentz-Butte Valley	195	186	211	240														
Thermalito	132	164	149	150	152	242	205	158	NM	NM	292	179	181	136	159	136	204	306
Thermalito domestic							374	350	354	NM	NM	342	NM	320	324	327	333	364
Vina	197	225	180	216	192	224	203	200	199	194	174	188	201	200	186	181	190	191
Western Canal (East)	447	344	400	524	492	471	482	488	465	459	NM	447	442	449	444	441	422	418
Western Canal (West)	464	248	407	501	309	477	469	462	455	460	630	629	695	428	581	NM	NM	450

*Pentz-Butte Valley well discontinued in 2006

** A positive correction factor was applied to the 2019 electrical conductivity (EC) results per recommendation of the Butte County Water Commission Technical Advisory Committee due to an error in calibration of the EC probe.

NM – No measurement

Table 6. 2019 Groundwater electrical conductivity results, historic averages, ranges and years measured [micro Siemens / centimeter (µS/cm)]

Well / Area	Years Measured	Historic Average (µS/cm)	2019 Results** (µS/cm)	Historic Range (µS/cm)
Biggs-West Gridley	18	328	306	288 - 382
Cherokee	18	260	299	215 - 330
Chico Urban Area	12	253	243	214 - 295
Durham Dayton	15	318	358	259 - 355
Esquon	18	462	515	388 - 557
Llano Seco	12	194	188	179 - 240
M & T	16	475	360	333 - 678
Pentz	13	216	221	204 - 231
*Pentz-Butte Valley	4	208	--	186 - 240
Thermalito	16	176	306	132 - 292
Thermalito domestic	9	341	364	320 - 374
Vina	18	197	191	174 - 225
Western Canal (East)	17	451	418	344 - 524
Western Canal (West)	16	481	450	248 - 695

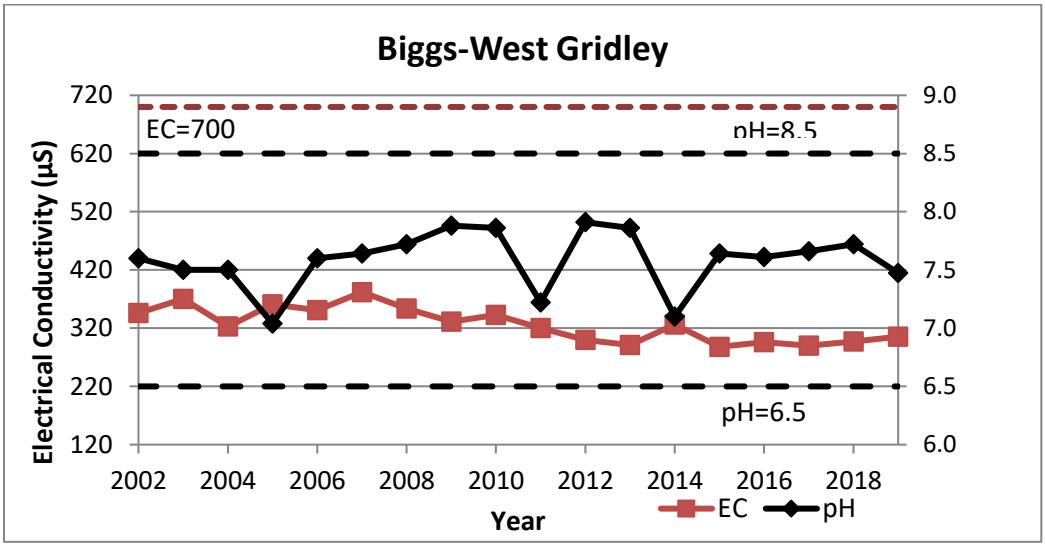
*Pentz-Butte Valley well discontinued in 2006

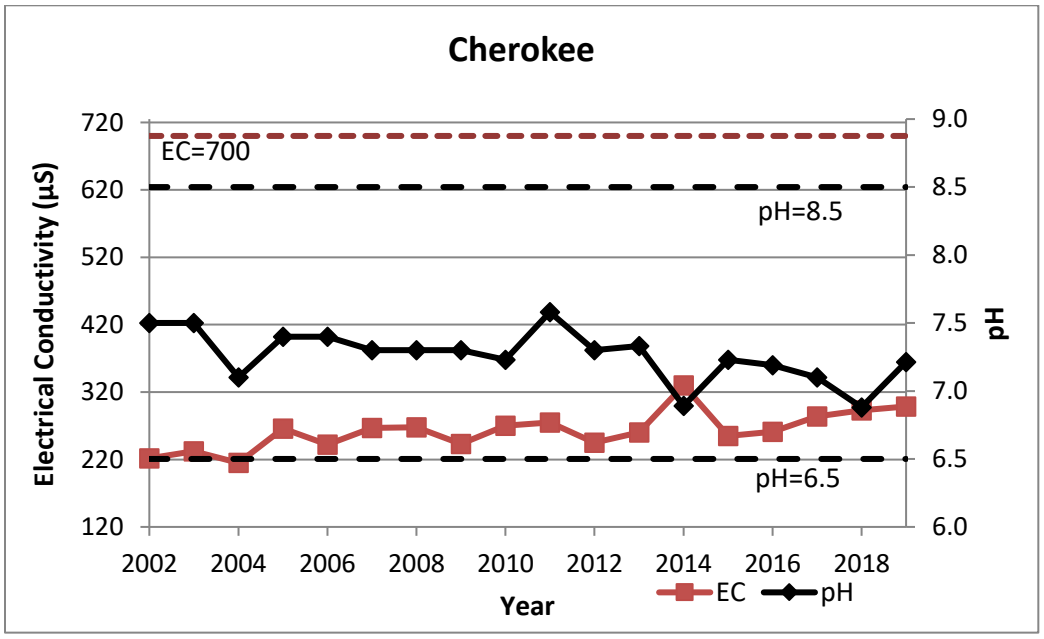
** A positive correction factor was applied to the 2019 electrical conductivity (EC) results per recommendation of the Butte County Water Commission Technical Advisory Committee due to an error in calibration of the EC probe.

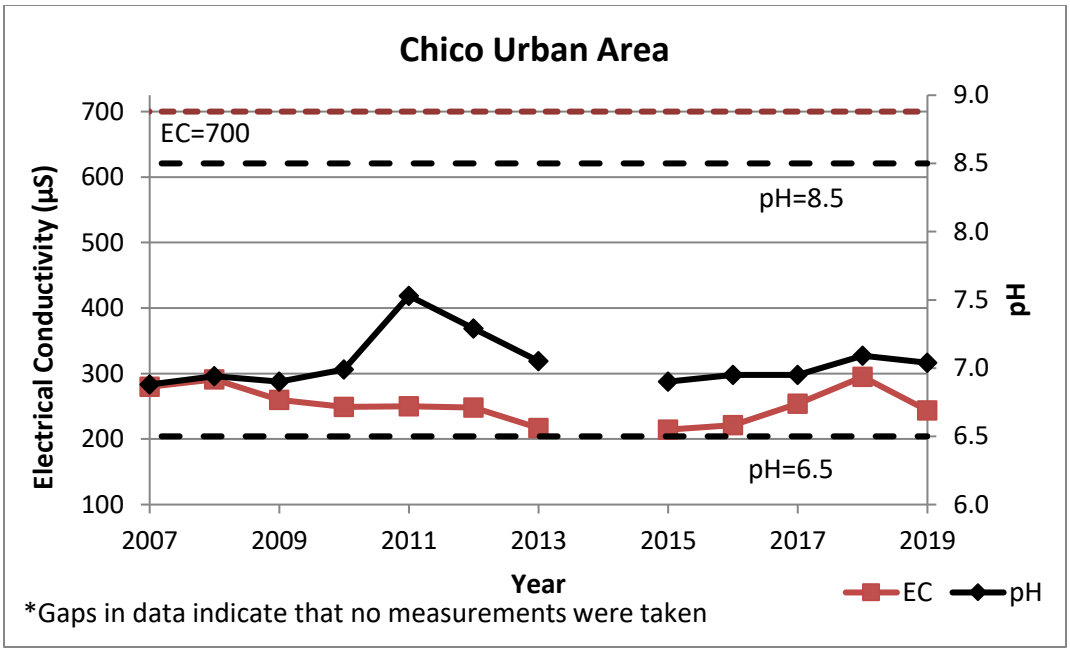
NM – No measurement

In the figures below, the red dashed line indicates the preferred maximum level for EC for agricultural uses (700 µS/cm) which is lower than the preferred maximum level for EC for drinking water (900 µS/cm). Therefore, when the red plot of EC values is below the red dashed line, the measured EC is within the EPAs limits for secondary standards for agricultural water (< 700 µS/cm), and drinking water (< 900 µS/cm). The black dashed lines bound the acceptable pH range of 6.5 - 8.5. To be within the acceptable pH range, the solid black line should be within the black dashed lines.

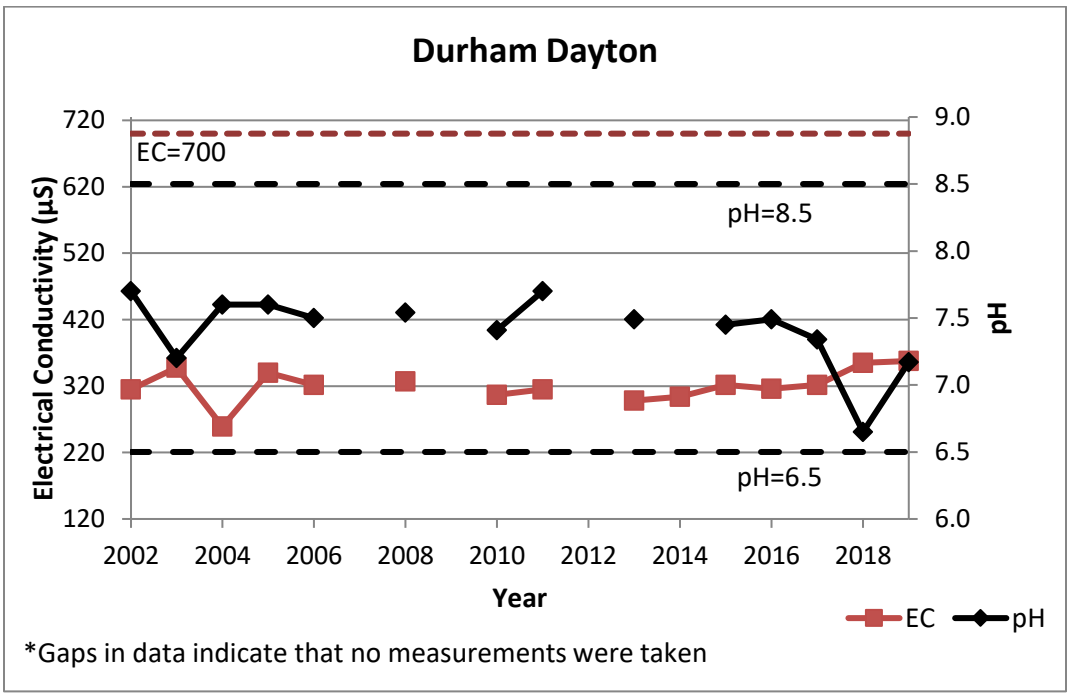
Figures 2. – 15. Annual Electrical Conductivity (EC) [micro Siemens per centimeter (µS/cm)] and pH for each water quality sampling well.



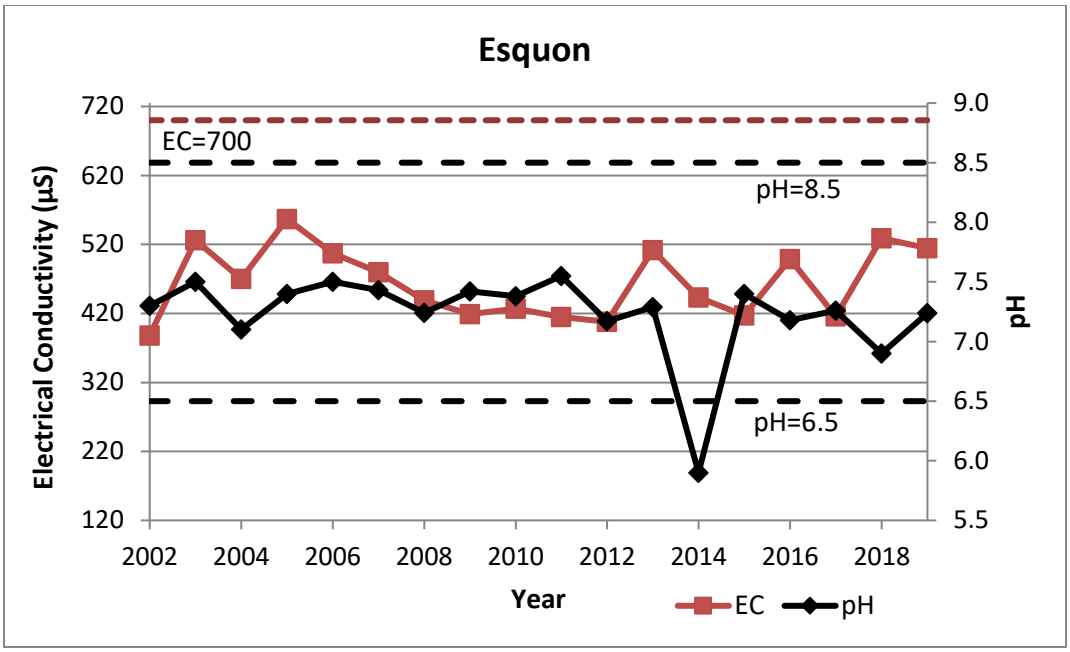




*Gaps in data indicate that no measurements were taken



*Gaps in data indicate that no measurements were taken


Esquon
720
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EC=700
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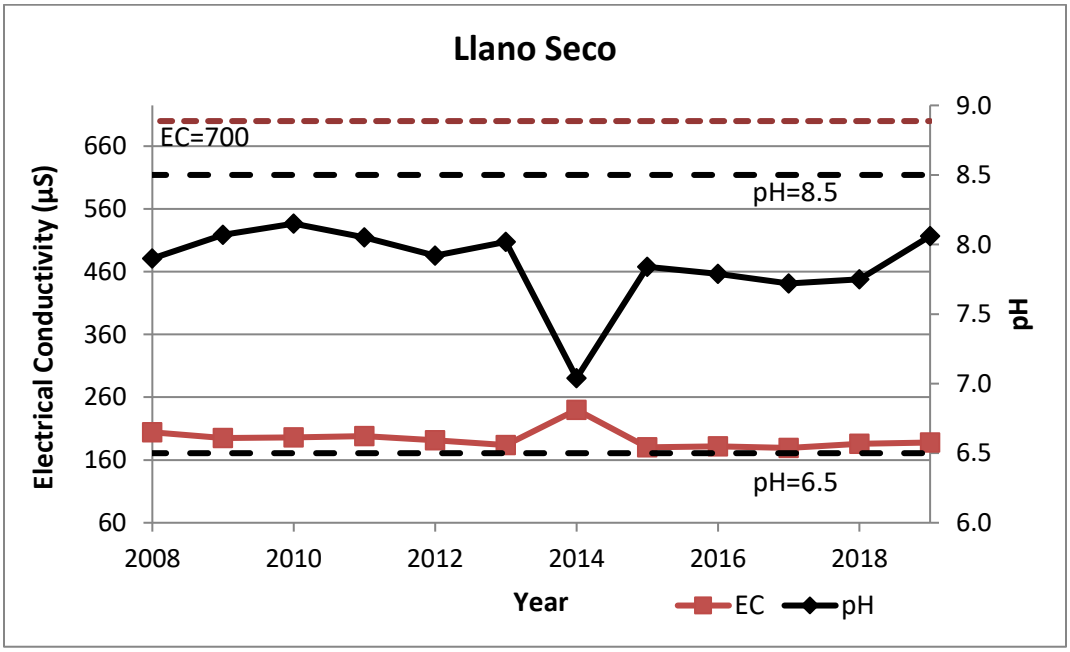
Llano Seco
660
560
460
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EC=700
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Electrical Conductivity (µS)
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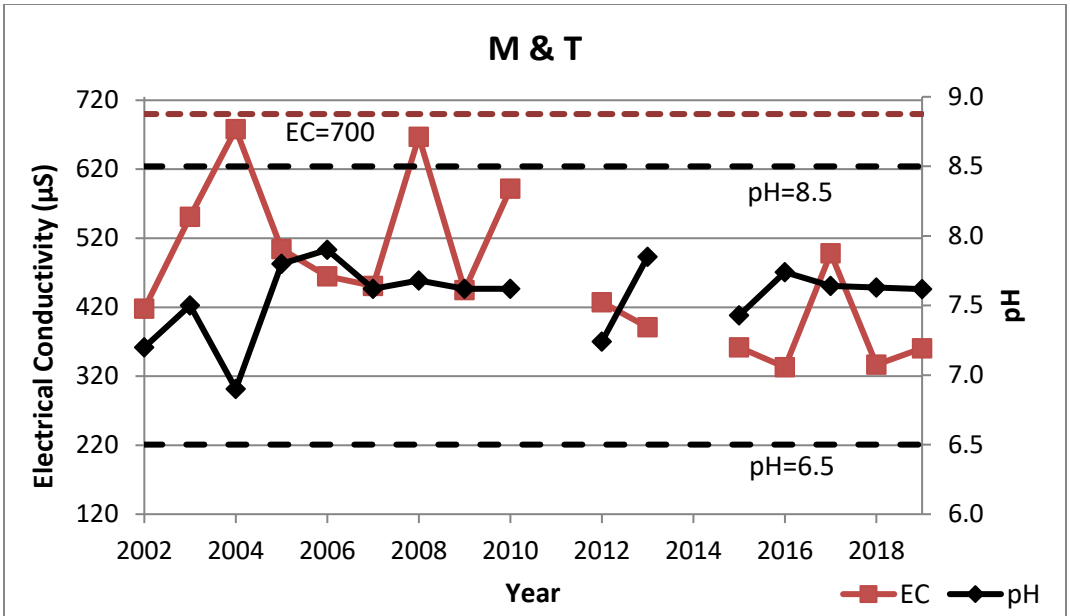

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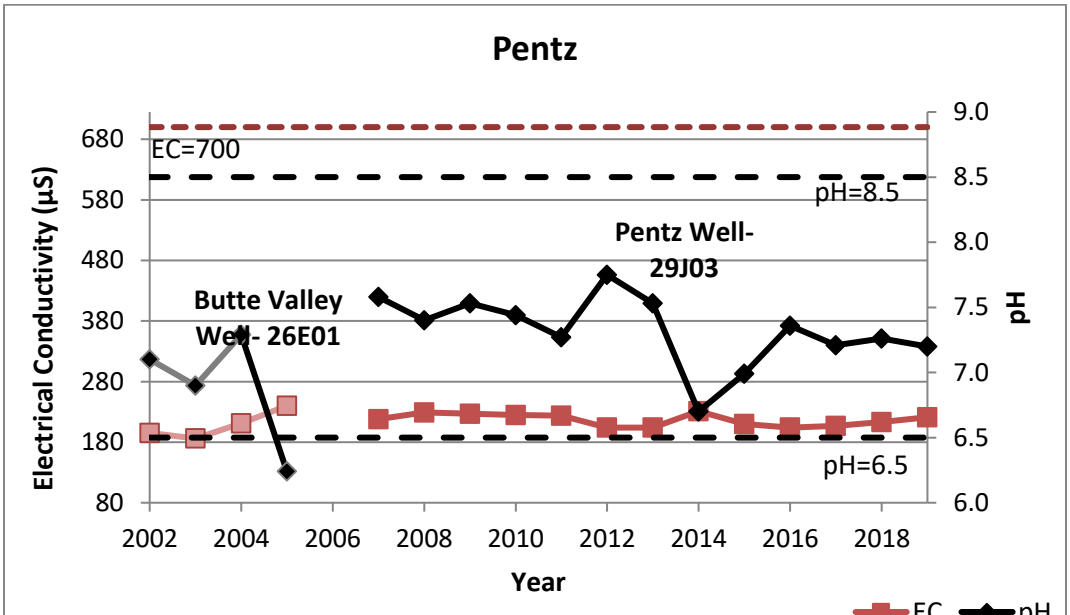

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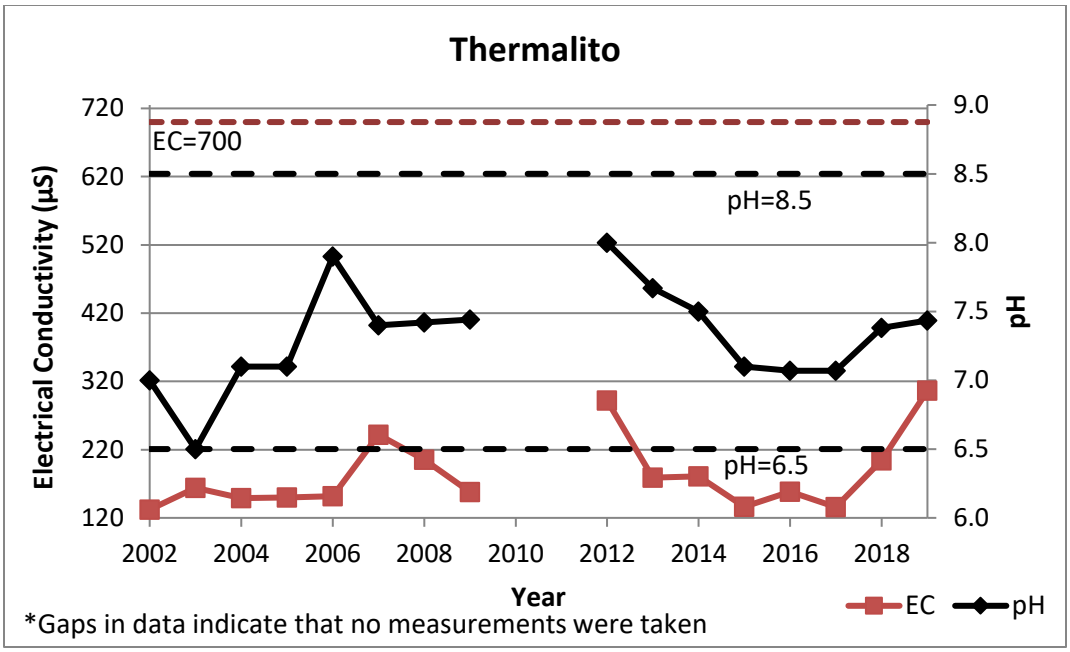
Thermalito
720
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EC=700
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pH=6.5
Electrical Conductivity (µS)
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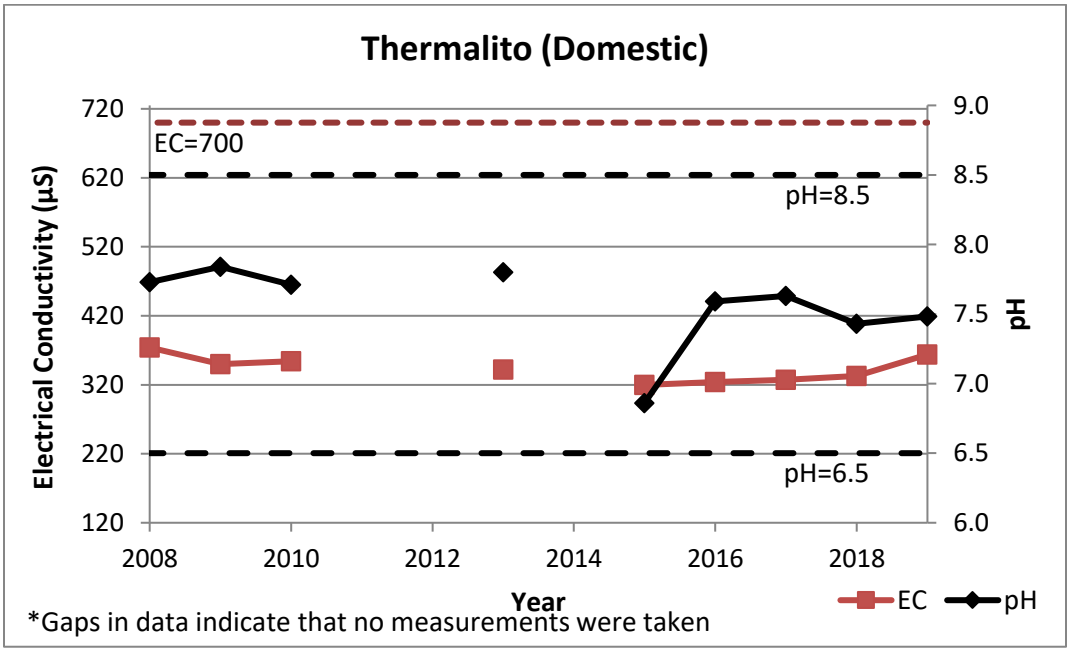
Year
EC
pH
*Gaps in data indicate that no measurements were taken


Thermalito (Domestic)
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EC=700
pH=8.5
pH=6.5
Electrical Conductivity (µS)
pH
2008
2010
2012
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2018
Year
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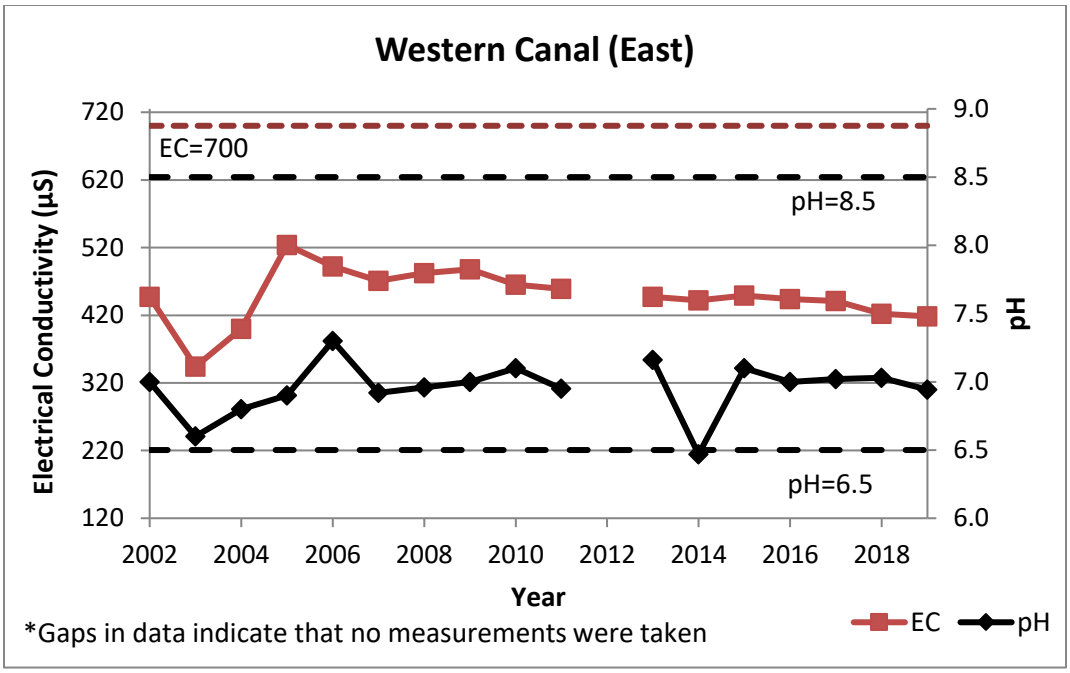
pH
*Gaps in data indicate that no measurements were taken


Western Canal (East)
Electrical Conductivity (µS)
720
620
520
420
320
220
120
EC=700
pH=8.5
pH=6.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH
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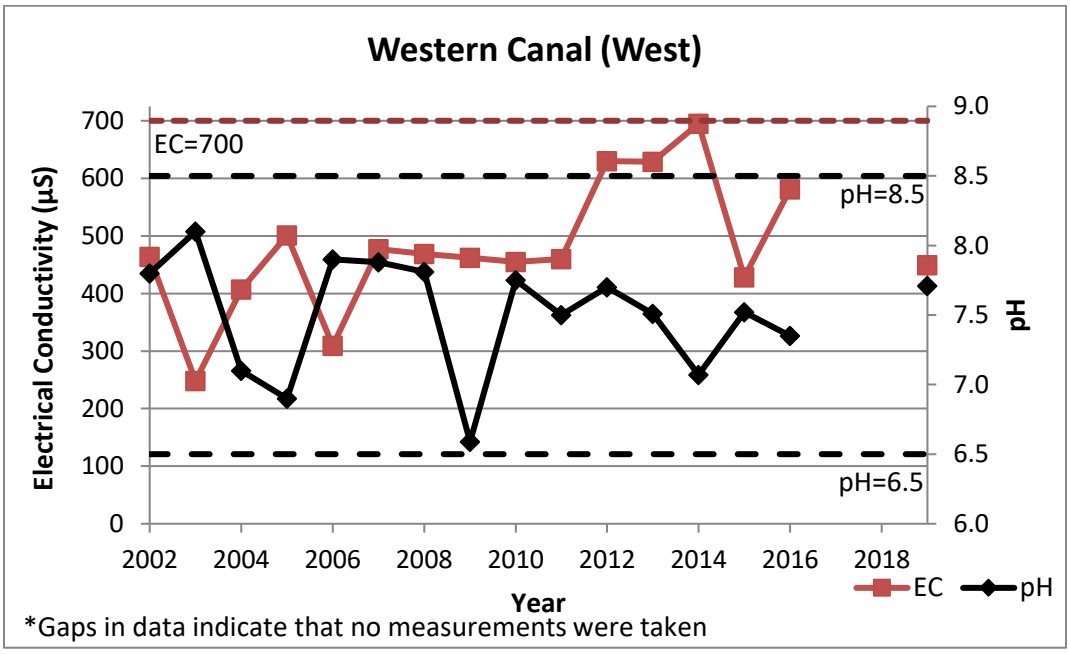
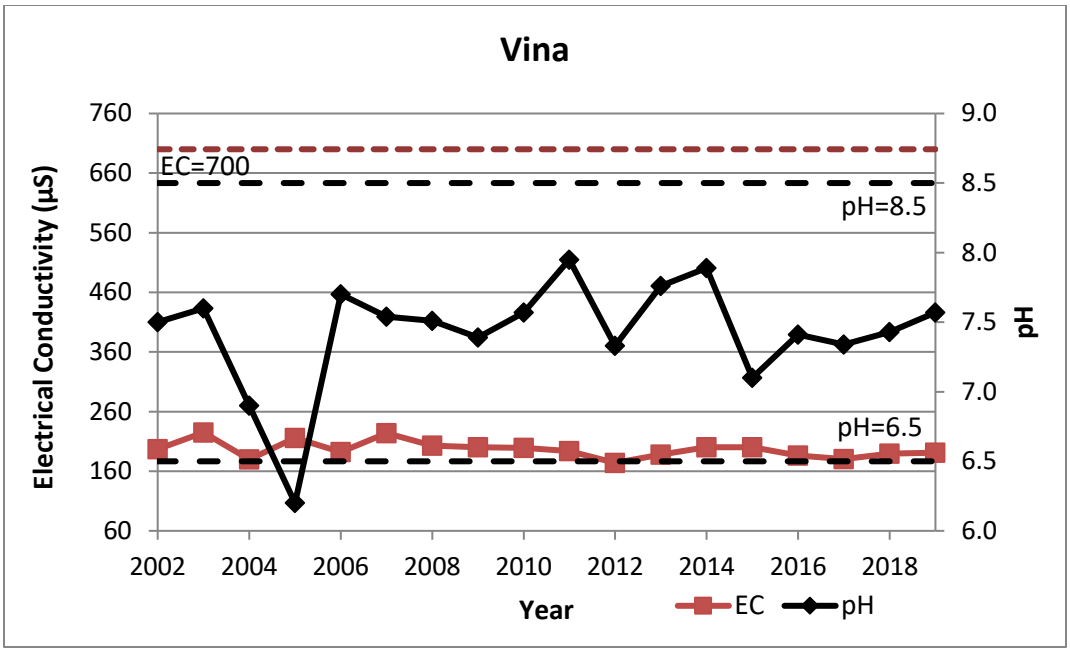
2014
2016
2018
Year
EC
pH
*Gaps in data indicate that no measurements were taken


Western Canal (West)
Electrical Conductivity (µS)
700
600
500
400
300
200
100
0
EC=700
pH=8.5
pH=6.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
EC
pH
*Gaps in data indicate that no measurements were taken


Vina
Electrical Conductivity (µS)
760
660
560
460
360
260
160
60
9.0
8.5
8.0
7.5
7.0
6.5
6.0
pH
EC=700
pH=8.5
pH=6.5
2002
2004
2006
2008
2010
2012
2014
2016
2018
Year
EC
pH