REVISED FINAL REPORT

OWEB GRANT # 217-2055
Umpqua Basin Collaborative Monitoring 2015-2018

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Partnership for the Umpqua Rivers
Your Watershed Council

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The Umpqua Basin Watershed Council (UBWC) was a non-profit, non-government, nonregulatory charitable corporation that worked with willing landowners on projects to enhance fish habitat and water quality in the Umpqua Basin. The council had its origins in 1992 as the Umpqua Basin Fisheries Restoration Initiative (UBFRI) and was changed to the UBWC in May of 1997. Three years later, the council was incorporated as a nonprofit organization. The UBWC's 16-member Board of Directors represents resource stakeholders in the Umpqua Basin. In 2006, UBWC's name was changed to the Partnership for the Umpqua Rivers (PUR).

The PUR's *Mission Statement* reads: "Through collaboration with diverse participants, the Partnership for the Umpqua Rivers maintains and improves water quality & fish populations from source to sea in the streams of the Umpqua. We educate people about the value of healthy streams; we work with willing landowners to improve stream conditions; we monitor the health of the streams and their fish populations. Through these actions, the Partnership contributes to the ecological and economic well-being of the basin."

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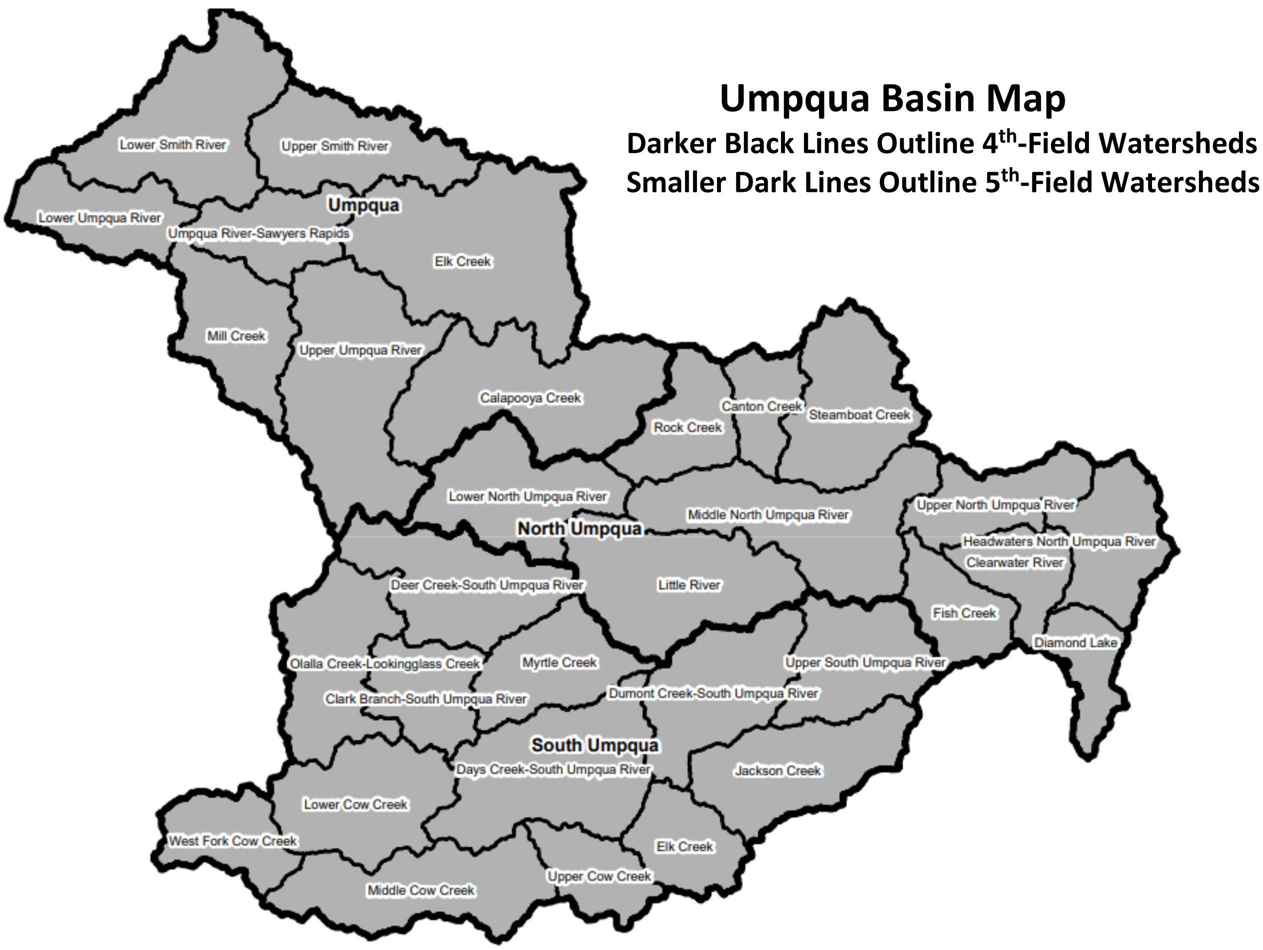
Project Overview

This report is a continuation of the monitoring results of the Partnership for the Umpqua Rivers' (PUR) previous OWEB reports, OWEB Grant #209-2052, #212-2062, #214-2046 and the current final report for #217-2055.

Because of the large size of the Umpqua Basin (2,569,527 acres of land and 1,740 stream miles of anadromous fish habitat, PUR has been monitoring the Umpqua Basin fifth-field by fifth-field. A selected fifth-field is monitored monthly for three years after which a few representative sites are chosen to continue to be monitored as part of its fourth-field reference run. The three years of monitoring are graphed and analyzed and reported in a technical report as part of the final report for the OWEB Grant under which it was completed. Reference runs are updated every three years as well.

Map 1 displays the Umpqua, North Umpqua and South Umpqua fourth-field watersheds containing each of their fifth-field watersheds.



Map 1. **Umpqua Basin fourth and fifth field watersheds.**

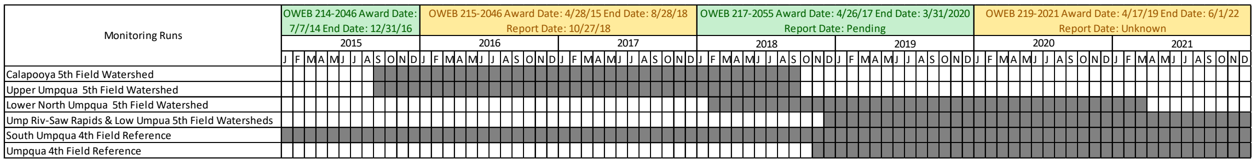


Table 1. Watersheds monitored by grant and year.

In this document, three years of completed monitoring are reported for the Calapooya 5th-Field Watershed and the Upper Umpqua 5th-Field Watershed. A new 4th-Field Watershed Reference Run – The Umpqua 4th-Field Watershed Reference Run - was initiated with reference sites from these two 5th-Fields. The Lower North Umpqua 5th Field Watershed was started as were the Umpqua River-Sawyer Rapids 5th Field and the Lower Umpqua 5th field watersheds, combined into one run. Monitoring continued in The South Umpqua 4th Field Watershed Reference Run and will be reported in the next OWEB Final Report. All water quality data was collected by PUR's volunteer monitoring participants assisting PUR's Monitoring Coordinator and/or PUR's Assistant Monitoring Coordinator.

The objectives of water quality monitoring were to:

- Gather data on temperature, turbidity, conductivity, dissolved oxygen, pH, total coliform and *E. coli* bacteria that will lead to a scientifically based understanding of current and changing watershed conditions;
- Provide current water quality information to PUR's project planning team to support restoration planning;
- Collect and provide water quality data to complement others' work;
- Collect and provide data where none is currently being gathered;
- Gather data where future restoration efforts may be planned so that "pre" water quality parameters can be recorded;
- Provide "A" quality data to the ODEQ's AWQMS-Water Quality Monitoring Database

All data has been sent to DEQ and will be available at DEQ's AWQMS Water Quality Monitoring Data Repository that has replaced the LASAR Database.
https://orwater.deq.state.or.us/Login.aspx

All objectives were met as outlined in Exhibit B and the objectives listed above. All samples were collected monthly and data submitted to DEQ (See uploads at OWEB Project Completion Report and Appendix. The data was carefully analyzed in this report providing maps, sites, protocols used, and sampling design. We work to maintain good relationships with all our partners by staying in touch with them and offer to help them out if they have any monitoring needs.
As mentioned throughout this report the summary of these two watersheds from three years of monitoring has provided us a clear picture of which streams could benefit from restoration improvements. This data is provided to our restoration project planners and discussed at staff planning meetings. We also share this report with our partners and do regular updates at our local monthly Hydro-Breakfast where we catch up with partners and share ideas.

Monitoring Methods

Representativeness of Data:

Though our data will be compared from site to site, month to month, and year to year, it must be stated that, except for the continuous temperature data, all water quality data are from grab sampling. As much as was possible, sampling runs were conducted at the same time of day and in the same direction, upstream or downstream, as previous runs. By taking monthly measurements it was possible to get some indication of annual changes, but even these monthly changes can be greatly affected by diurnal changes. Streamflow, pH, dissolved oxygen, trace elements, nutrients suspended particles, as well as temperature, are known to vary greatly throughout 24 hours. Many of these changes are because of the sun either directly or indirectly – weather changes, seasonal changes, photosynthesis, rainfall, snowmelt, and streamflow. Other changes can be caused by human influence, such as the release of effluent from wastewater treatment plants, the release of water from reservoirs, and irrigation withdrawals. “The amplitude of the diel changes can be as large as changes occurring on annual timescales” (Nimick, Gammons, & and Parker, 2011). Certainly, it would have been ideal to deploy data loggers for all water quality parameters and monitor 24 hours a day. With only one multi-parameter probe available, this would have severely limited the number of sites that could be monitored. Thus, we settled for grab sampling and report the data for what it is; a snapshot of water quality conditions at a particular place at a specific time. Data exceeding ODEQ standards is reported but conditions producing these exceedances may very well have occurred far more often than just at the time of our grab sampling.

Water Quality Parameters

Monitoring of all parameters followed standard methods as described in *Oregon Plan for Salmon and Watersheds Water Quality Monitoring Technical Guide Book*, *The EPA Guide to Volunteer Monitoring*, *YSI Product Training Manual* and the manufacturers' equipment manual recommendations and is approved by ODEQ under our Quality Assurance Project Plan *for the Partnership for the Umpqua Rivers August 12, 2014.* Parameters and methods used are listed in Table 1.

Parameter	Method
E. coli & total coliform	IDEXX Colilert method, manufacturer's protocol
Field Turbidity	YSI Optical wiping turbidity sensor in EXO2 Sonde datalogger, following manufacturer's protocols
Dissolved Oxygen	YSI ROX Optical Dissolved Oxygen Sensor in EXO2 Sonde datalogger, following manufacturer's protocols
Temperature	NIST thermometer and Sonde thermometer
Continuous Temperature	Onset Data Loggers
pH	YSI Low Ionic Water pH sensor Combination pH and Gel Reference, manufacturer protocols
Conductivity	YSI Conductivity Sensor in EXO2 Sonde datalogger, following manufacturer's protocols

Table 2. Parameters monitored, and methods used in PUR's water quality monitoring.

Parameter	Precision	Accuracy	Measurement Range
Temperature	±1.0°C	±0.5°	-5 to 35°C
pH	±0.3 SU	±0.2 SU	0 to 14 SU
Turbidity	±5% of Std. Value	±5% of Std. Value	0 to 1000 NTU
Conductivity	±10% of Std. Value	±7% of Std. Value	0 to 4999 μS/cm
Dissolved Oxygen	±0.3 mg/l	0.2 mg/l	1 to 14.6 mg/l
E. coli	±0.6 log		0 to >2420 MPN
Photo Points		± 3 feet	

Table 3. Precision and accuracy of water quality parameters measured

Precision: Duplicate sample results were used to determine the precision of water quality measurements for each sampling event. Differences between duplicate values were compared against the precision requirements outlined in the DEQ Data Quality Matrix to assign data precision classifications (http://www.deq.state.or.us/lab/qa/deq04-lab-0003-gd.pdf).

Accuracy: Accuracy for pH, turbidity, and conductivity were determined by measuring standards before and after each sampling event. Deviations from standards were compared to accuracy ranges defined in the Data Quality Matrix to assign an accuracy classification for samples collected for each parameter. Temperatures were obtained with a NIST traceable thermometer that is calibrated by Oregon DEQ annually.

Split Samples: Split samples were conducted with the Oregon DEQ at least twice a year to further assess quality assurance.

Representativeness: Site selections were carefully chosen stream reaches that did not have contributing factors such as pond outflow or beaver dams upstream of collection sites. Samples were, when possible, collected from the center of the stream channel where the water is well mixed and, thus, the most representative of the stream conditions.

Comparability: We hoped to ensure comparability with similar projects by following standardized sampling protocols and procedures developed by state agencies. We also performed split samples at least twice a year to ensure that our techniques produced results comparable to those of Oregon DEQ.

Turbidity Overview:

Turbidity in a stream appears cloudy to the human eye due to suspended particles. These particles could be silt or clay from sediment runoff but could also be from microscopic organisms. Measuring turbidity is easy with a light source and a detector such as the YSI optical sensor used by PUR. This device measures the amount of light scattered by the particles in the water which is then picked up by a detector. The result is expressed in nephelometric turbidity units or NTUs. High turbidity levels are a problem for both public and private drinking water systems. Furthermore, fish may experience trouble breathing if particles get into their gills. Fish and other aquatic creatures have trouble feeding due to diminished vision. Fish eggs and fry may suffocate if fine particles are deposited into the gravels where they are developing. Migrating salmon will choose to avoid waters with high turbidity and may even stop their migration until the waters clear. Several researchers have reported that turbidity levels in the 60-70 NTU range will disrupt the feeding behaviors of juvenile coho. Fry that have newly emerged are even more susceptible and have demonstrated reduced growth and a tendency to emigrate from streams with levels of 25-50 NTU. “Effects on salmonids will differ based on their developmental stage. Suspended sediments may affect salmonids by altering their physiology, behavior, and habitat, all of which may lead to physiological stress and reduced survival rates” (Bash, 2001).

The result of turbidity can even affect stream temperature. The deposition of fines has been shown to decrease streambed connectivity and reduce the exchange of groundwater and surface water across the stream bed. “Sediment may alter the dynamics of heating, cooling, and temperature buffering. The two-way exchange between the stream channel and the hyporheic zone is perhaps the most important buffer to high stream temperatures” (Poole and Berman 2001 referenced by Bash, 2001).

Interpreting the results of turbidity data is more difficult than collecting it. Natural background levels can differ by unique individual watershed processes and historical changes to the watershed. For example, headwater streams tend to be less turbid than mainstems. Grab sample monitoring makes it more difficult to conclude because it is only a single moment in time and does not give a complete picture over space and time. DEQ standards for turbidity are currently under revision. As DEQ reports, “The current turbidity standard is outdated and inadequate to fully protect Oregon’s waters from potential effects from turbidity. The current provisions, adopted in 1976, require no more than a ten percent increase over natural background turbidity levels. At low natural turbidity levels that are prevalent in Oregon waters much of the year, a ten percent increase is within the error range of measurement and does not correspond with an impact on beneficial uses. Also, the expression of the standard has made it challenging to implement across all of DEQ’s water quality programs” (Appendix B) (Turbidity Rulemaking Fact Sheet, 2010). Appendix C: British Columbia Turbidity and Suspended Sediment Standards have been included to provide specific levels that experts view of concern for various beneficial uses.

For this report, we provide the percentage of grab sample readings at an individual site that exceeds 10 NTU. This serves only as an indicator of sites that could use further investigation to determine if stream improvement projects might contribute to more favorable conditions for salmonids and other aquatic organisms.

> **The Oregon Watershed Assessment Manual recommends using 50 NTUs as the turbidity evaluation criteria for watershed assessments. At this level, turbidity interferes with sight-feeding aquatic organisms and provides an indication of the biological effect of suspended sediment. Seven out of 454 (1.5%) South Umpqua River turbidity samples exceeded 50 NTUs.[61] Additional monitoring is necessary to determine if turbidity levels are of concern in tributaries.**

pH Overview:

The negative logarithm of the hydrogen ion concentration of a solution is defined as pH with the scale from 0 to 14. This scale indicates the acidity or alkalinity of a solution, with pH 7.0 being neutral. As you climb the scale from 7 the solution becomes more basic or caustic. From 7 down the scale to 0 it becomes more acidic. In a logarithmic scale, each whole unit of incremental change is equal to a ten-fold increase or decrease in acidity or alkalinity. See Appendix D for a scale indicating the pH of common products.

The equipment used to measure pH consists of a meter and an electrode. The electrode measures the number of positive hydrogen ions in the water by running a very low electric current through the water. The electrode placed in the stream then develops an electrical potential that is proportional to the pH of the solution. A reference electrode is needed to complete the circuit and provide a stable reference potential. The voltage is then passed to the meter, amplified, and converted to the pH scale. Because temperature influences the electrical potential of pH electrodes, pH probes must be equipped with a thermometer and automatic temperature compensation. Inaccuracy can be a problem when measuring low ionic strength waters common in the Umpqua. Ions need to be present to pass the low electric current. PUR purchased a special pH probe from YSI that is made to work in low ionic strength streams. This not only increases the accuracy but also reduces the time for the equipment to become stable when moved from one stream to the next.

The following is DEQ's pH criteria for the Umpqua Basin, a summarization from the 303(d) Listing criteria at http://www.deq.state.or.us/wq/assessment/docs/methodology0406.pdf

Parameter	Criteria	Assessment Method	Data Requirements
pH	$6.5 \leq pH \leq 8.5$ Estuarine and freshwaters	Greater than 10 percent of the samples are outside the range of the appropriate criterion and a minimum of at least two samples outside the range of the appropriate criterion for the period of interest.	A minimum of 5 representative data points available per site collected on separate days for each period of interest. Periods are Summer: June 1 through September 30; Fall-Winter-Spring (FWS): October 1 to May 31

Table 3. DEQ pH criteria for the Umpqua Basin

Evaluating grab sample pH data is difficult. As with other parameters, grab samples provide only a momentary snapshot. Levels of pH cycle daily and seasonally. Photosynthesis of aquatic plants during the day takes the sun's energy and consumes carbon dioxide (an acid) producing a base - hydroxide. Therefore, during the day, pH levels become more basic (rise). At night the reverse occurs, and plants respire releasing carbon dioxide making the waters more acid; peaking just before dawn. During summer there can be increased plant growth and nutrients that greatly increase this diurnal effect. Increasing acidity can have additional effects because it acts as a solvent and may leach toxic metals from sediments and substrate depending on local conditions. An unexplained change in pH might be an indication of contamination of the water by possible toxic materials from a spill or urban runoff and should be investigated.

Streams tend to have a narrow range of pH values that typically fall between 6 and 9. The level of the pH in freshwater streams is important for all forms of wildlife and humans. Aquatic organisms generally prefer a pH range between 6.5 and 8.5 and suffer when the pH lies outside this range. It is important to have safe pH ranges for juvenile development. “Chronic effects from low pH can occur at levels that are not toxic to adult fish but that impair reproduction including altered spawning behavior, reduced egg viability, decreased hatchability and reduced survival of the early life stages” (Carter, 2008). Persistent high pH levels can be harmful to salmonids by reducing their activity and feeding levels. Extremely low or high levels can even cause death.

Dissolved Oxygen Overview:

Oxygen is as necessary to aquatic life as it is to life on land. The amount of oxygen found in water is called dissolved oxygen (DO). Many factors influence how much oxygen water can contain as well as how it gets there. Temperature (oxygen is more soluble at colder temperatures), atmospheric pressure (increasing altitude results in less pressure and therefore less ability of water to hold dissolved oxygen), and salinity (increasing salt concentration results in lower DO) all affect DO. Turbulent water can increase DO as does photosynthesis of aquatic plants during the day. At night, aquatic plant respiration consumes the DO. The decomposition of organic matter also uses up dissolved oxygen. Once again grab sampling can only provide a snapshot of that moment in time of day, the season of the year, and current stream condition.

Appendix H contains DEQ's flow chart depicting the evaluation process to determine which dissolved oxygen criteria would apply to any particular water body. Though not as thorough, it easier to understand in the following summarization from the 303(d) Listing criteria at http://www.deq.state.or.us/wq/assessment/docs/methodology0406.pdf

Parameter	Criteria	Assessment Method	Data Requirements
Dissolved Oxygen	*Spawning*: DO ≥ 11.0 mg/l or 95 % saturation; *Cold-water:* ≥ 8.0 mg/l or 90% as an absolute minimum; *Cool-water*: ≥ 6.5 mg/l; *Warm-water*: 5.5 mg/l.	For 10 or more samples greater than 10 percent of the samples may not exceed the appropriate criterion and a minimum of at least two exceedances of the criterion for the period of interest. For 5 to 9 samples in the period of interest, there may be no exceedances of the appropriate criteria.	A minimum of 5 representative data points available per site collected on separate days per applicable period. Applicable periods and fish use available on DEQ's Water Quality Standards web page.

Table 4. DEQ Dissolved Oxygen criteria for the Umpqua Basin

Dissolved oxygen is critical at all life stages of salmonids but, as is indicated in the criteria during the time of spawning, there is the greatest need for high DO for the survival of the eggs placed in the gravel. Without 11.0 mg/l DO egg development will be impaired or stopped altogether. Reduced DO concentrations can adversely affect the swimming performance of migrating salmonids. Sustained swimming speed dropped sharply when DO fell to 6.5-7.0 mg/l (Bjornn T. a., 1991 pg.85).

Conductivity Overview:

Conductivity is a measure of water's ability to conduct an electric current. It is measured in units of current called micro siemens (µS) per centimeter (cm) or µS/cm. Conductivity increases with the number of dissolved ions present in water and with increasing temperature. Conductivity probes come with a built-in temperature probe and software that corrects the reading for the effect of temperature, normalizing conductivity to 25°C. This is then called specific conductance. Conductivity varies by 2% with each 1°C change in temperature. Conductivity is affected by natural local conditions/geology. Because it is a measure of the ions dissolved in the water, conductivity increase in areas with soils that will dissolve easily such as clay soils. Increases in conductivity may be an indication of human influences, such as leaking septic systems or spills of substances containing salts (ionic compounds, not just sodium chloride) that reach the streams. Many types of soluble salts increase conductivity when they are dissolved in water. Examples include potassium chloride, calcium chloride, and magnesium chloride. Acids and bases will also increase the conductivity of a solution. Organic compounds have a very low ability to conduct current, so substances like oil and sugar have a very low conductivity.

There are no established standards for conductivity; however, "Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline for comparison with regular conductivity measurements. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a stream." "Studies in inland freshwaters indicate that streams supporting well-mixed fisheries have a range between 150 and 500 uS/cm" (EPA, 2012).

E. coli Overview:

Bacteria are present in all surface water. In general, resident bacteria are not harmful to the overall aquatic environment or most human uses. However, ingestion of fecal bacteria such as *Escherichia coli (E. coli)* can cause serious illness or death in humans. Bacteria are present in all surface water. *E. coli* is monitored as an indicator species of bacteria. It would be extremely difficult and expensive to monitor for many of the organisms that carry disease. Therefore only *E. coli* was chosen for monitoring because its presence is an indication of fecal contamination and a warning that other pathogens may also be present. It can also be an indicator that best management practices of livestock are not being observed, of failing septic systems, of a large concentration of warm-blooded wildlife contaminating the water, or of a malfunctioning or overloaded wastewater treatment plant.

E. coli is easily measured with EPA approval by using the protocol and supplies from IDEXX Laboratories, Inc. A sample is collected in a sterile 100 milliliter (ml) bottle, kept on ice, and returned to a laboratory for analysis. The results are expressed in terms of the most probable number (MPN) of *E. coli* organisms in a 100 ml sample. The standard is a little difficult to comprehend, but a level greater than or equal to 126 MPN/100 ml determined five times in 30 days could cause a stream to be listed. A single reading greater than 406 MPN/100 ml could also trigger a listing.

The 303(d) Listing criteria for *E. coli* by Oregon Department of Environmental Quality listed at http://www.deq.state.or.us/wq/assessment/docs/methodology0406.pdf is shown below. The National Environmental Protection Agency uses a more conservative, lower criteria of 235 MPN/100 ml. In this report, we will indicate both the 406. The 235 MPN/100 ml criteria can be used as an indicator for evaluating streams in need of further investigation.

There are many possible sources of E. coli and other fecal bacteria in water. These can be divided into "point sources" and "non-point sources." The legal definition of a point source is one for which there is an operational permit, such as the outlet for a wastewater treatment plant. Stream contamination can also come from non-point sources or ones for which there is no operational permit, such as animal waste. Although septic systems require an installation permit, there is no annual operational permit. These sources are considered non-point even if a single failing septic field adjacent to a stream is causing high fecal bacteria levels. Upland areas with concentrated fecal waste can be non-point sources that contribute significantly to bacteria levels because bacteria are washed down into streams during rain events.
According to the Oregon Water Quality Standards, a stream is considered water quality-limited for bacteria when one of two events occurs: 1) 10% of two or more samples taken from the same stream have *E. coli* concentrations exceeding 406 bacteria per 100 ml of water; 2) the average *E. coli* concentration of five samples taken within 30 days exceeds 126 bacteria per 100 ml of water.

Temperature Overview:

Stream temperature is an important factor affecting all aquatic organisms including fish. For salmonids (salmon and trout), which are coldwater fish, healthy growth is supported by water temperatures ranging from 40-66°F; outside this range, they generally don't grow in size and extreme temperatures can be lethal (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1). These temperature extremes can affect every life stage of the salmonids (Bjornn & Reiser, 1991, pp. 106, 112). Temperature and dissolved oxygen (DO) are inversely proportional, therefore, as stream temperature increases the amount of DO available decreases (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1). Decreases in DO may metabolically stress salmonids and also increase the likelihood of disease (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1). As water temperature increases to stressful levels, salmonids seek cold water refugia (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1) and (Nielsen, Lisle, & Ozaki, 1994). Extremely high-water temperatures can be lethal to coldwater fish. One study found the upper lethal limits for steelhead was 75.0°F and for cutthroat trout was 73.0°F (Bell, 1990, p. 11.4). The upper lethal limit for young coho salmon and Chinook salmon acclimated to 70°F was 78.8°F, measured as 50% mortality after 16.7 hours (Brett, 1952, pp. 282-3). Many of our monitoring sites exceeded these potentially lethal temperatures for steelhead and cutthroat and some even exceeded the higher lethal temperatures for coho and Chinook. However, unlike in these lab studies, in natural streams, there is diurnal temperature fluctuation associated with night cooling, so these high stream temperatures are not sustained. The driving factors for stream temperature are stream characteristics, such as flow and surface area, and radiant energy; the most important source is solar radiation. Solar radiation is reduced by shading and cloud cover and increased by solar input, which is often reflected by higher air temperatures. Streams in the Umpqua basin have been anthropogenically altered by the removal of riparian vegetation, water withdrawals, and altered stream characteristics.

Since cloud cover and air temperatures vary daily and annually, there is also annual variability in stream temperatures and seven-day average maximum (7DAM) stream temperatures. Stream temperature increases as it flows downstream due to decreased shading as the stream widens and increased surface area (Murphy & Meehan, 1991, pp. 35-36). Also, stream temperatures may increase lower in the watershed due to a decreasing portion of cooler groundwater inflow and increasing air temperature at lower elevations. The Umpqua Basin Stream Characterization project continuously monitored 269 stream temperature sites in the Umpqua basin from 1998 to 2001 and found a relationship between the distance of the site to the drainage divide and the 7DAM stream temperature (Smith, K., 2003, p. 3).

Continuous Temperature:

Continuous summer temperatures were monitored from 2016-2019 using the protocol in the Water Quality Monitoring Technical Guide Book (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-1 to 6-12). Sites varied by year, with the number of years monitored varying from one to six years depending on the site. Onset water temperature recorders (Tidbit, Hobo, or Tidbit v2 models) were placed in streams in late spring or early summer and retrieved late summer or fall depending on flows and logistical concerns. Water temperature recorders were tied to rocks to prevent movement of the devices and hidden in the streams. Careful site selection was made to ensure there would be flow and good mixing (not stagnant) at the site in late summer when flows are the lowest to ensure the site would be representative of the stream at that location.

Before stream placement of water temperature recorders, pre-deployment accuracy checks were performed on all devices according to established protocols (The Oregon Plan for Salmon and Watersheds, 1999, pp. 6-5 to 6-7) and later modified by DEQ in 2010. Water temperature recorders are placed in warm and ice water baths comparing temperatures to the National Institute of Standards and Technology (NIST) certified VWR Traceable Digital Thermometers that are inspected annually for accuracy by the DEQ Lab. Post-deployment accuracy checks are completed after retrieval of the water temperature recorders using the same method. Field accuracy checks are also conducted comparing NIST certified VWR Traceable Digital Thermometer temperatures to that of the water temperature recorders, when possible, at the time of deployment, mid-season, and at the time of retrieval. Care is taken to check the temperature with the digital thermometer near the location of the water temperature recorder.

Representativeness of Data:

Though our data will be compared from site to site, month to month, and year to year, it must be stated that, except for the continuous temperature data, all water quality data are from grab sampling. As much as was possible, sampling runs were conducted at the same time of day and in the same direction, upstream or downstream, as previous runs. By taking monthly measurements it was possible to get some indication of annual changes, but even these monthly changes can be greatly affected by diurnal changes. Streamflow, pH, dissolved oxygen, trace elements, nutrients suspended particles, as well as temperature, are known to vary greatly throughout 24 hours. Many of these changes are due to the effect of the sun either directly or indirectly – weather changes, seasonal changes, photosynthesis, rainfall, snowmelt, and streamflow. Other changes can be caused by human influence, such as the release of effluent from wastewater treatment plants, the release of water from reservoirs, and irrigation withdrawals. "The amplitude of the diel changes can be as large as changes occurring on annual timescales" (Nimick, Gammons, & and Parker, 2011).

Water Quality Data Analysis

Grab Sample Reporting:

All grab sample data was entered into ODEQ's Volunteer Water Quality Grab Sample Data Submittal Excel Spreadsheet which is available for download from their website (www.deq.state.or.us/lab/wqm/volmonresources.htm).

"The workbook contains two required worksheets. 1) **Worksheet1: Project Information-** This required worksheet includes specific project information needed to add the data into the DEQ Ambient Water Quality Monitoring System is the Oregon DEQ water monitoring data portal. AWQMS replaces the LASAR system which has been retired. 2) Worksheet **2 Raw Data-** This worksheet contains all the fields needed to describe monitoring stations and result values in AWQMS. The first six rows describe the monitoring location. The date and time define when the site was visited. The remaining rows are for entering the raw data results and all the information needed to describe each result in AWQMS --including data quality. Each parameter has a family of 6 or 7 columns containing information needed for upload to AWQMS: result value, duplicate value, precision, accuracy (not for all parameters), data quality level, method, and parameter comment" (DEQ, 2010).

Only data that ranked as "A" or "B" quality were included for analysis in this report. (See Appendix F) Most data was "A"; in only a few cases was the data rated "B." Graphs were produced to compare individual sites and temporal changes. Box plots were used to summarize individual sites throughout the record. (See Appendix G: Interpreting a Box Plot for help in understanding box plots.) For this report we did not discard any "outliers"; the data was carefully reviewed, and notes recorded at the time of sampling considered. It was felt that particularly low or high values were real and denoted a natural occurrence that was indicative of the watershed. Scatter plots were used to display sites' values over time and compared to

DEQ standard criteria. Site values were summarized and presented in a table, when there was enough data to warrant doing so, by percent of measurements exceeding the parameter's standard criteria. For this report, two time periods were used: 1. June through September and 2. October through May. This differs from the often-used Summer (June, July, August) and Fall/Winter/Spring (September through May) that others have employed. The weather conditions in the study area seem to lend themselves to this division as September lends itself to inclusion as a summer month far better than skewing the Fall/Winter/Spring grouping with the warm September conditions.

Continuous Temperature:

All continuous temperature data collected were downloaded from the water temperature recorders with Onset's HOBOware Pro software and summarized using Microsoft Excel software and ESRI ArcGIS. Continuous temperature data was compared to ODEQ temperature criteria for continuous summer temperature (ODEQ, 2011, p. 46) and Figure 320A & 320B (ODEQ, 2003) (See Appendix I and J), using ODEQ's Temperature macro (for Microsoft Excel software) modified by Kent Smith for Excel 2007/2010 and ODEQ's current temperature criteria (ODEQ, 2011, p. 46). All pre-deployment accuracy checks, post-deployment accuracy checks, and field audits were compiled on ODEQ's ExampleContinuousSample.xls workbooks (ODEQ, 2009) and submitted to the ODEQ lab. All data were A quality (+/- 5°C) as per DEQ criteria (DEQ, 2010).

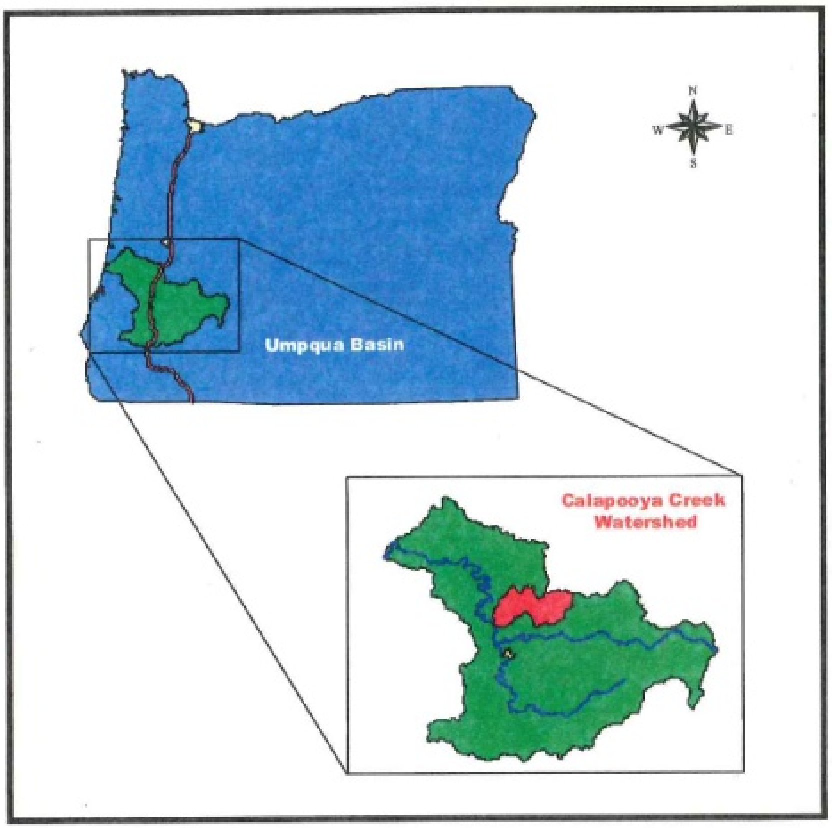
In the analysis, degrees Fahrenheit were chosen as the unit of temperature instead of degrees Celsius because PUR works with partners that use Fahrenheit as the standard of measure. For ease of communication to the public, and greater understanding, degrees Fahrenheit were chosen as the unit of measure.

Data was compared to that collected from a previous PUR large scale basin-wide temperature study, Umpqua Basin Stream Temperature Characterization (Dammann, D.M., 2017).

Water Quality Monitoring Results

Calapooya Creek

Area Description, Background & Monitoring Sites



Map 2. **Calapooya Creek Fifth-Field Watershed Area Map**

The Calapooya Creek fifth-field watershed is located in central Douglas County, Oregon, and encompasses 157,281.8 acres. The City of Oakland is entirely within the watershed and the northwestern section of Sutherlin is also within the Calapooya Creek Watershed (Geyer, Calapooya Creek Watershed Assessment and Action Plan, 2003) The watershed stretches a maximum of 13 miles north to south and 27 miles east to west. There are three highways within the western portion of the watershed: Interstate Five (I-5), Highway 99, and Highway 138.
Calapooya Creek is a major tributary of the upper mainstem Umpqua and enters the mainstem about river mile 102. The lower 30 miles of creek passes through mostly agricultural land, although there are several minor communities as well as the city of Oakland. Oakland and Sutherlin draw their drinking water from the Calapooya as well as discharging treated wastewater into it.

Ecoregion	Acres	Percent of total
Umpqua Interior Foothills	98,899.0	62.9%
Umpqua Cascades	56,209.9	35.7%
Western Cascades Lowlands and Valleys	1,405.6	0.9%
Mid-Coastal Sedimentary	767.3	0.5%
Total	157,281.8	100.0%

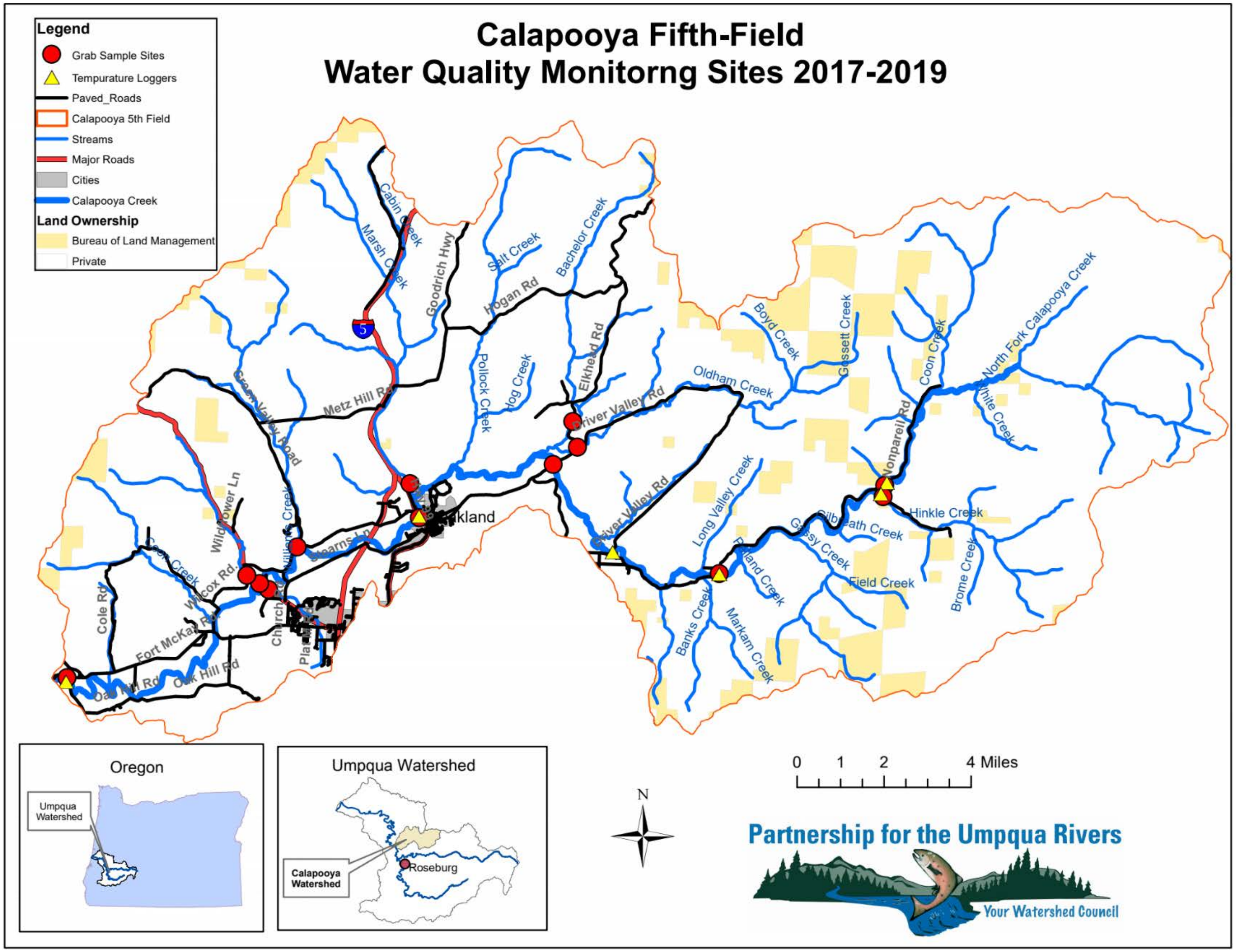
Table 5. Acres and percent of the Calapooya Creek Watershed within each ecoregion

Much of the area consists of narrow interior valleys, broad floodplains, and terraces, with gentle to moderate slopes that characterize the Umpqua Interior Foothills Ecoregion. Elevation for most of the area ranges from 500 to 1,000 feet. The lowest point in the watershed is 320 feet where Calapooya Creek meets the Umpqua River in the southwest. The Umpqua Cascades Ecoregion and the western border of the watershed are generally mountainous. Elevations range from 1,500 to 4,000 feet, and some slopes are steeper than 70%. The maximum height is 4,443 feet at Middle Mountain on the eastern border of the Cascades.
From (Geyer, Calapooya Creek Watershed Assessment and Action Plan, 2003).

PUR's strategy for water quality monitoring is to monitor fifth- field by fifth-field for 3 years of intensive monitoring of the fifth-field at many locations. After three years the next fifth-field will be chosen and monitored intensively. As three years at each fifth-field is completed the intensively monitored phase, it transitions to a few representative sites that are selected to maintain as reference sites. This report completes the first three years of intensive monitoring of the Calapooya 5th-field Watershed.

Photo 1. **Calapooya Creek below at Garden Valley Road Bridge 2/14/17**

Photo 2. **Calapooya Creek below at Garden Valley Road Bridge 7/14/2016**



Map 3. **Calapooya Fifth-Field Water Quality Monitoring Sites 2017-2019**

Calapooya Creek Water Quality Monitoring Sites

	Site ID	River/Stream	Site Description	LASAR ID	Latitude	Longitude	Township, Range, and Section
1	CC1	Calapooya Creek	At Garden Valley Bridge	10996	43.3666	-123.461	T25S R6W S30
2	DCC1	Dodge Canyon Creek	At mouth	33241	43.4028	-123.38	T25S R6W S14
3	CC2	Calapooya Creek	Above Dodge Canyon Creek		43.4003	-123.374	T24S R5W S33
4	CKC1	Cook Creek	At mouth	33464	43.3984	-123.37	T25S R6W S14
5	WC1	Williams Creek	At mouth	33242	43.412736	-123.357977	T25S R6W S1
6	CC3	Calapooya Creek	At old Oakland water intake		43.423912	-123.302468	T24S R5W S36
7	CBNC1	Cabin Creek	At Old Town Road		43.4678	-123.315	T24S R5W S20
8	OC1	Oldham Creek	At Elkhead Road	33243	43.449244	-123.231644	T24S R5W S25
9	BC1	Bachelor Creek	At Elkhead Road	12733	43.4642	-123.234	T24S R5W S24
10	CC4	Calapooya Creek	At Driver Valley Road Bridge	12796	43.443196	-123.242384	T25S R6W S14
11	CC5	Calapooya Creek	At Bridge Downstream Sutherlin Water Plant	12803	43.4088	-123.165	T25S R4W S10
12	HC1	Hinkle Creek	Near mouth	29820	43.4373	-123.093	T24S R3W S31
13	CC7	Calapooya Creek	At Hinkle Creek Road	33227	43.438392	-123.092676	T24S R3W S31

Table 6. Calapooya Creek Water Quality Monitoring Sites

Calapooya Creek Water Temperature Recorder Monitoring Sites

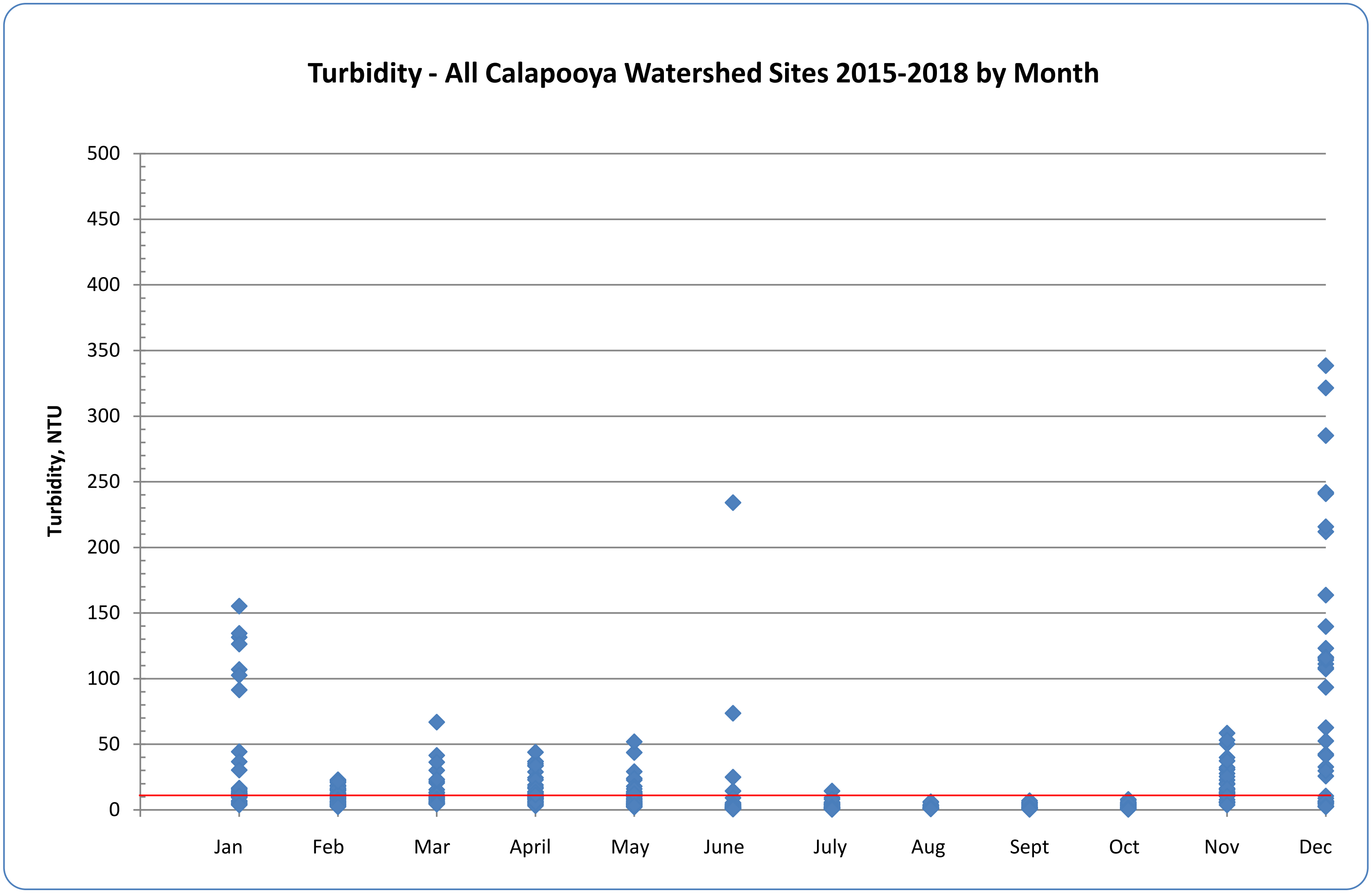
	Site ID	River/Stream	Site Description	LASAR ID	Longitude	Latitude	Township, Range, and Section
1	CC1	Calapooya Creek	At Garden Valley Bridge	10996	43.3666	-123.461	T25S R6W S30
2	CC2	Calapooya Creek	Above Dodge Canyon Creek		43.4003	-123.374	T24S R5W S33
3	CC4.5	Calapooya Creek	At Driver Valley Road Bridge		43.414806	-123.214188	T2 R4W 5S
4	CC7	Calapooya Creek	At Hinkle Creek Road	33227	43.438392	-123.092676	T24S R3W S31
5	HC1	Hinkle Creek	Near mouth	29820	43.4373	-123.093	T24S R3W S31

Table 7. Calapooya Creek Water Temperature Recorder Monitoring Sites

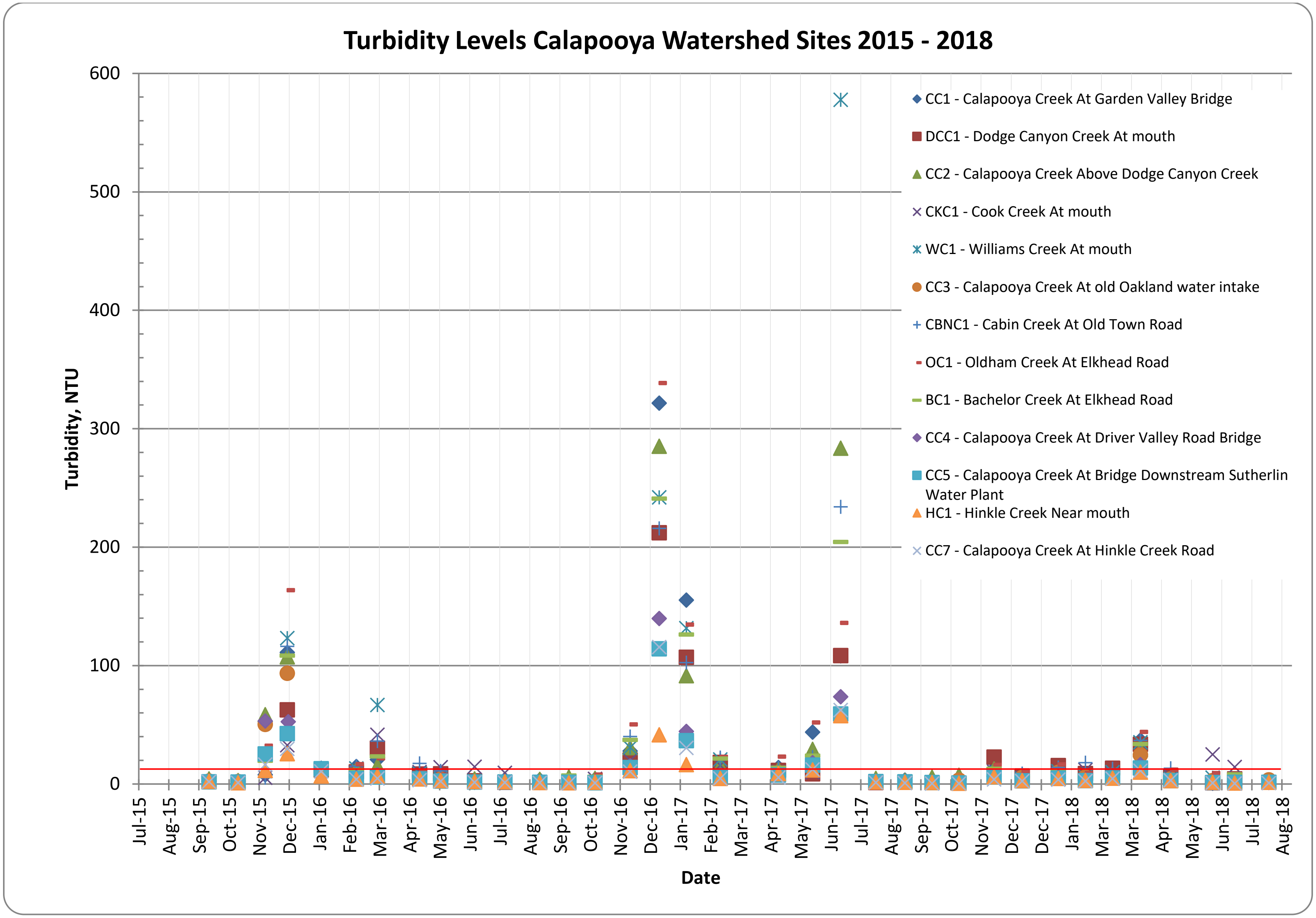
RESULTS – Calapooya Watershed Turbidity 2015-2018

Turbidity levels in the Calapooya Watershed generally follow most watersheds in the Umpqua Basin where it is common to have elevated levels during the winter months coinciding with periods of elevated rain and streamflow. Graph 1 displays three years of monitoring data summarized by month. This indicates that the extreme levels of turbidity occur during the winter months of December and January. Graph 2 also displays this trend. Cabin Creek at Old Town Road (CBNC1) exhibits the most occurrences of high turbidity with 78% of its samplings being greater than 10 NTU See Table 8. 57% of its summer samplings and 88% of winter samplings occurred over 10 NTU. It was not, however the creek exhibiting the highest turbidity. Graph 2 and 3 indicate that the highest turbidity levels occurred in Williams Creek (578 NTU) followed by Oldham Creek (338 NTU) and Calapooya at Garden Valley Road (321 NTU). These values appear as outliers over 300 NTU when plotted as box and whiskers. They are, however, real events correlating to storm events. All sites are summarized in Table 7. Table 8 which rates all the monitoring locations for summer and winter exceedances greater than 10 NTU indicates that Cook Creek (CKC1) and Oldham Creek (OC1) are of extreme concern, with Williams Creek (WC1) and Calapooya at Driver Valley Road Bridge (C4) being of high concern in summer and extreme concern in winter.

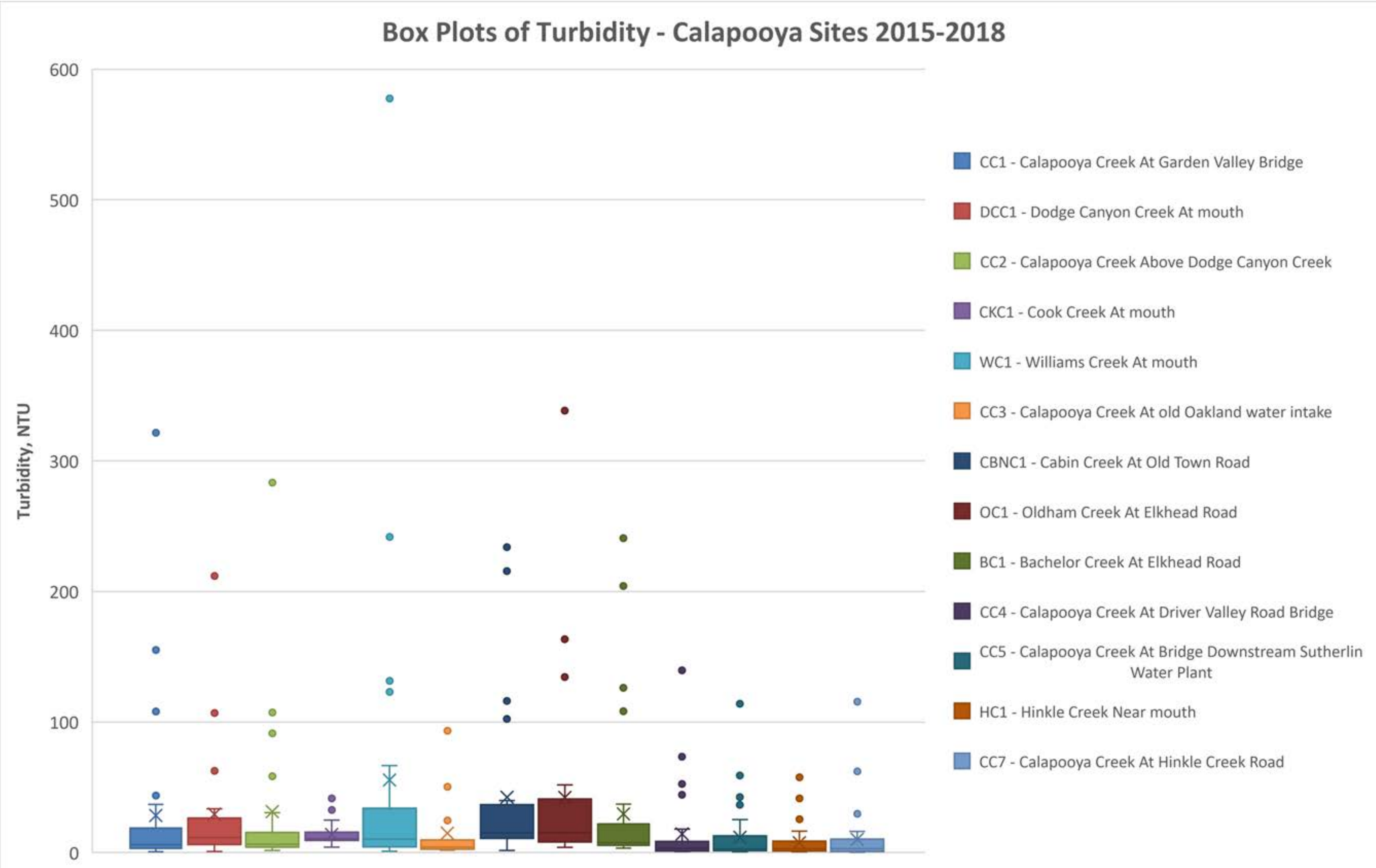
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of the tributaries went to a puddled or dry state. They included: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).



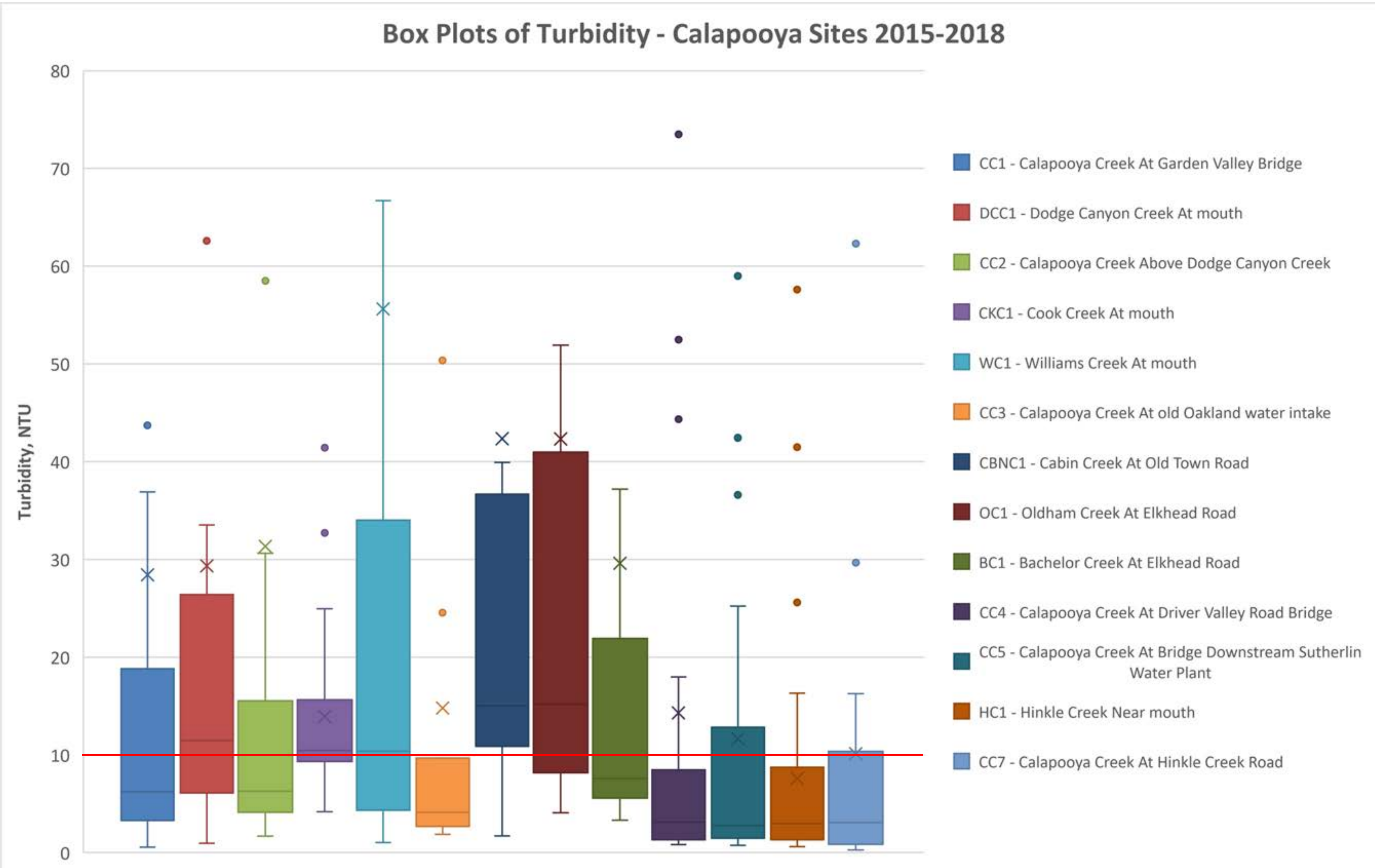
Graph 1. Turbidity levels Calapooya Watershed all sites all years sorted by month.



Graph 2. Turbidity Levels Calapooya Watershed by site and date.



Graph 3. Box Plots of Turbidity levels by sites in the Calapooya Watershed monitored from 2015-2018.



Graph 4. Box Plots of Turbidity Levels for the Calapooya Watershed by site 2015-2018. The turbidity axis cropped to 80 NTU to expand the box and whiskers for clarity.

Turbidity Levels Calapooya Creek Watershed 2015-2018	10 NTU's or Greater		Total
Station ID - Site Description	**Count**	**% of Samples**	**# of Samples**
CC1 - Calapooya Creek At Garden Valley Bridge	14	40%	35
DCC1 - Dodge Canyon Creek At mouth	14	56%	25
CC2 - Calapooya Creek Above Dodge Canyon Creek	15	43%	35
CKC1 - Cook Creek At mouth	15	65%	23
WC1 - Williams Creek At mouth	12	50%	24
CC3 - Calapooya Creek At old Oakland water intake	3	20%	15
CBNC1 - Cabin Creek At Old Town Road	18	78%	23
OC1 - Oldham Creek At Elkhead Road	19	68%	28
BC1 - Bachelor Creek At Elkhead Road	15	44%	34
CC4 - Calapooya Creek At Driver Valley Road Bridge	8	23%	35
CC5 - Calapooya Creek At Bridge Downstream Sutherlin Water Plant	9	26%	35
HC1 - Hinkle Creek Near mouth	7	20%	35
CC7 - Calapooya Creek At Hinkle Creek Road	9	26%	35

Table 8. Summary by the site of turbidity levels equal to or exceeding 10 NTUs.

Turbidity Levels, Summer and Winter, Calapooya Watershed Sites 2015-2018

SITE	Summer (May 1 - Sept.30)				Winter (Oct 1-April 30)		
	Dry # Samples	Total # Sampled	# > 10 NTU	% > 10 NTU	Total # Samples	# > 10 NTU	% > 10 NTU
CC1 - Calapooya Creek at Garden Valley Bridge	0	15	1	7%	20	12	60%
DCC1 - Dodge Canyon Creek at mouth	7	8	0	0%	16	12	75%
CC2 - Calapooya Creek above Dodge Canyon Creek	0	15	1	7%	20	13	65%
CKC1 - Cook Creek at mouth	8	7	5	71%	16	8	50%
WC1 - Williams Creek at mouth	8	8	1	13%	15	10	67%
CC3 - Calapooya Creek at old Oakland water intake	0	6	0	0%	10	3	30%
CBNC1 - Cabin Creek at Old Town Road	10	7	4	57%	16	14	88%
BC1 - Bachelor Creek at Elkhead Road	0	13	1	8%	21	13	61.9%
OC1 - Oldham Creek at Elkhead Road	6	8	2	25%	18	15	83%
CC4 - Calapooya Creek at Driver Valley Road Bridge	0	16	3	19%	19	5	26%
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant	0	14	1	7%	20	7	35%
HC1 - Hinkle Creek near mouth	0	14	1	7%	20	5	25%
CC7 - Calapooya Creek at Hinkle Creek Road	0	14	1	7%	20	6	30%

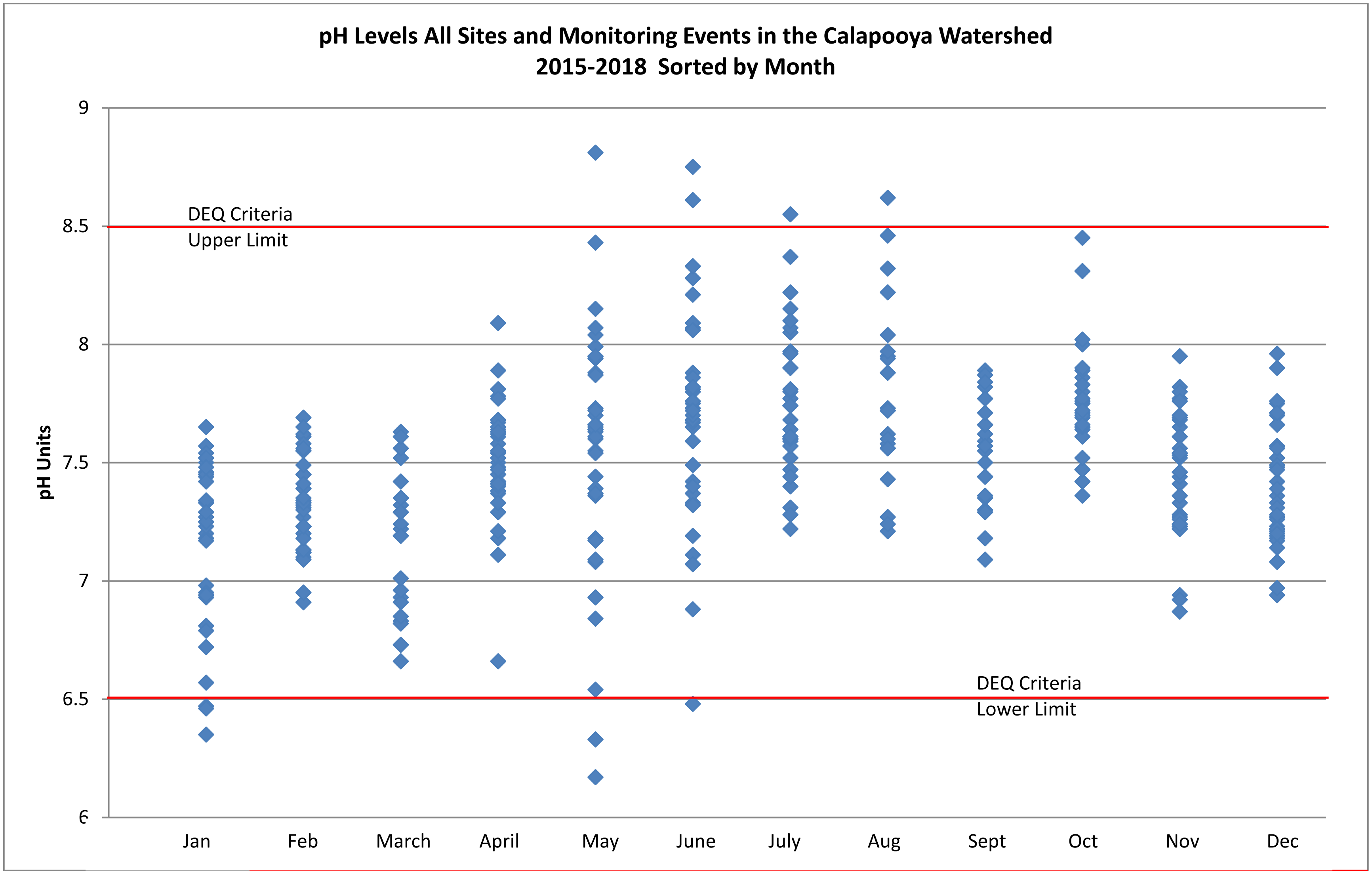
Color Key:	Level of Concern	Color Key Evaluation Criteria
(blue)	No Concern	< 10 NTU
(green)	Low Concern	Between 1 % and 9% of samples ≥10NTU
(yellow)	High Concern	Between 10% and 20% ≥10 NTU
(red)	Extreme Concern	20% or more ≥10 NTU
(olive)	Dry/Puddled	Dry 1 or more attempted sampling events

Table 9. Turbidity levels summer and winter Calapooya Watershed sites 2015-2018 with Color Key ratings.

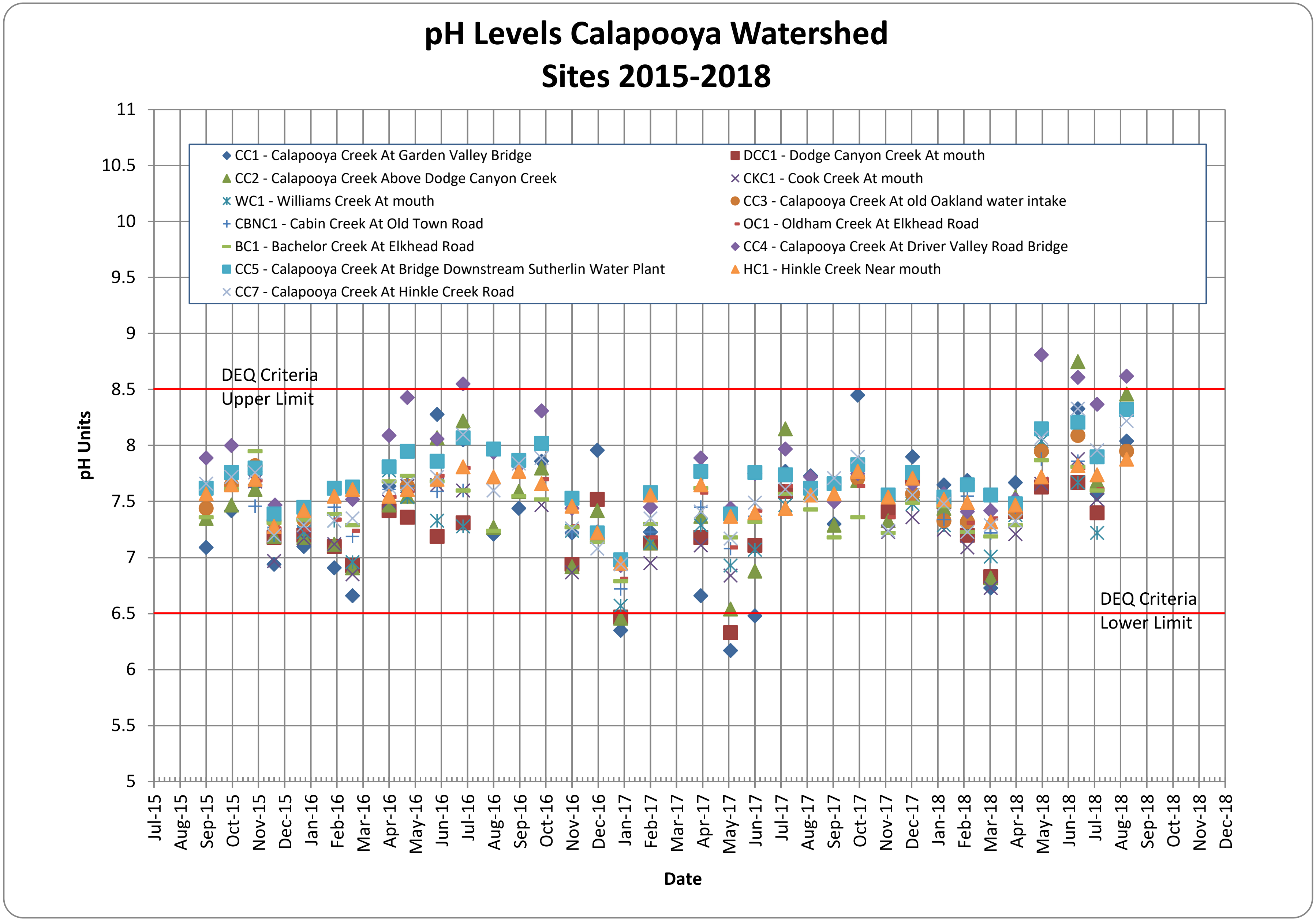
RESULTS – Calapooya Watershed pH 2015-2018

Graph 5. Indicates that May, June, July, and August had exceedances above the upper DEQ limit for pH of 8.5. In January, May, and June pH levels were falling below the DEQ minimum criteria of pH 6.5. On Graph 6 and 7, it can be seen that the upper exceedances occurred four times at Calapooya Creek at Driver Valley Road Bridge and one time at Calapooya Creek above Dodge Canyon Creek. The levels that fell below minimum pH criteria occurred twice at Calapooya Creek at Garden Valley Road. The only other level below 6.5 pH occurred once at Dodge Canyon Creek. Table 9 summarizes the results and rates of the creeks.

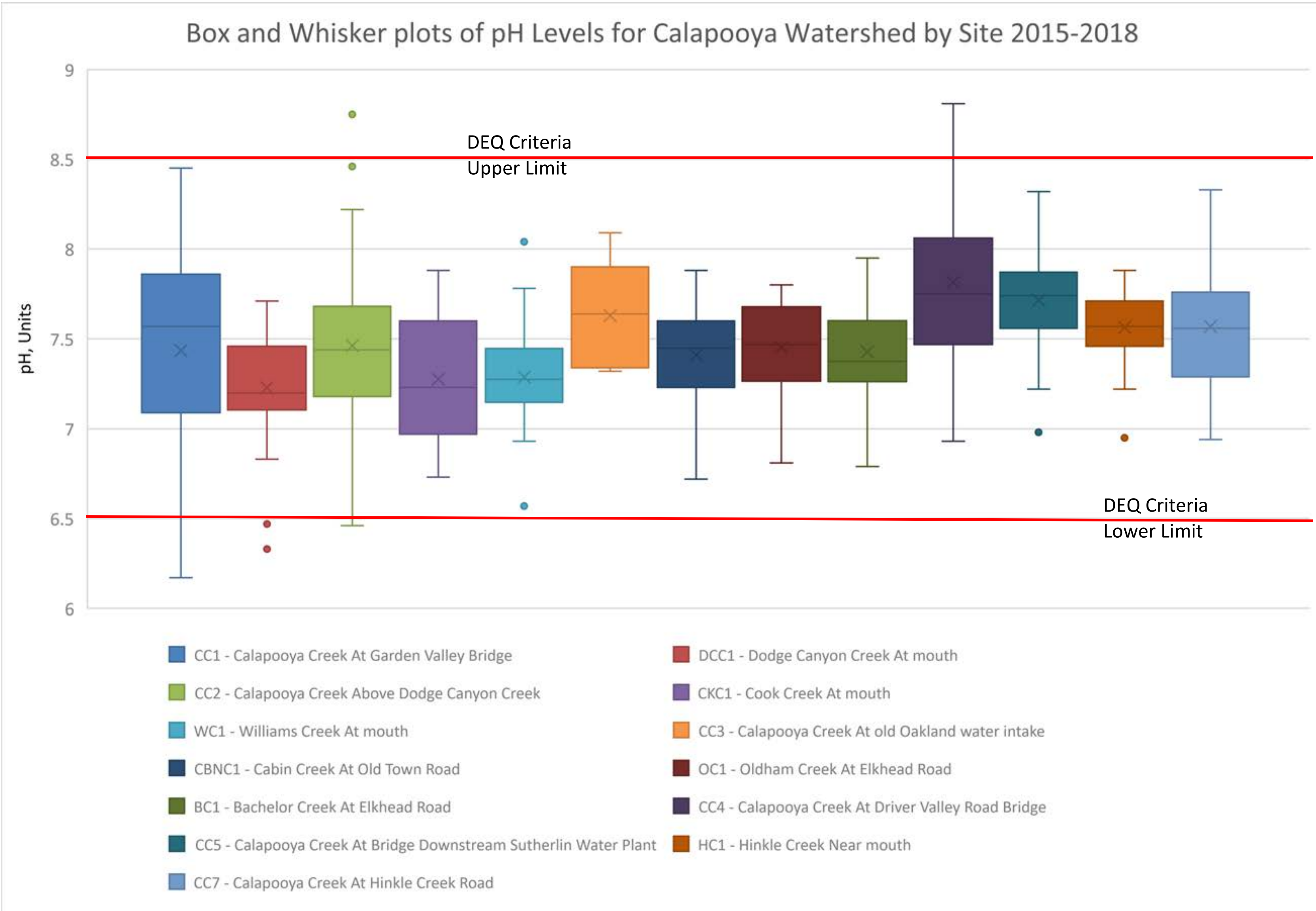
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of the tributaries went to a puddled or dry state. They included: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).



Graph 5. pH levels Calapooya Watershed 2015-2018, all sites, all data sorted by month.



Graph 6. pH levels Calapooya Watershed monitoring sites by date.



Graph 7. Box and Whisker plots of pH levels for Calapooya Watershed by site 2015-2018.

SITE	Sample Events Dry/Puddled	Upper pH RATING	Lower pH RATING
CC1 - Calapooya Creek at Garden Valley Bridge	0		
DCC1 - Dodge Canyon Creek at mouth	7		
CC2 - Calapooya Creek above Dodge Canyon Creek	0		
CKC1 - Cook Creek at mouth	8		
WC1 - Williams Creek at mouth	8		
CC3 - Calapooya Creek at old Oakland water intake	0		
CBNC1 - Cabin Creek at Old Town Road	10		
BC1 - Bachelor Creek at Elkhead Road	0		
OC1 - Oldham Creek at Elkhead Road	6		
CC4 - Calapooya Creek at Driver Valley Road Bridge	0		
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant	0		
HC1 - Hinkle Creek near mouth	0		
CC7 - Calapooya Creek at Hinkle Creek Road	0		

Rating	**Color**	**Upper pH Criteria**	**Lower pH Criteria**
No Concern		None above 8.25	None below 6.75
Low Concern		1 ≥ 8.25	1 ≤ 6.75
Moderate Concern		2 or more ≥ 8.25 or 1 ≥ 8.5	2 ≤ 6.75 or 1 ≤ 6.5
Extreme Concern		2 or more ≥ 8.5	2 or more ≤ 6.5
No Water		Unable to sample dry or puddled	

Table 10. PH levels high, low and dry, Calapooya Watershed sites 2015-2018 with Color Key ratings.

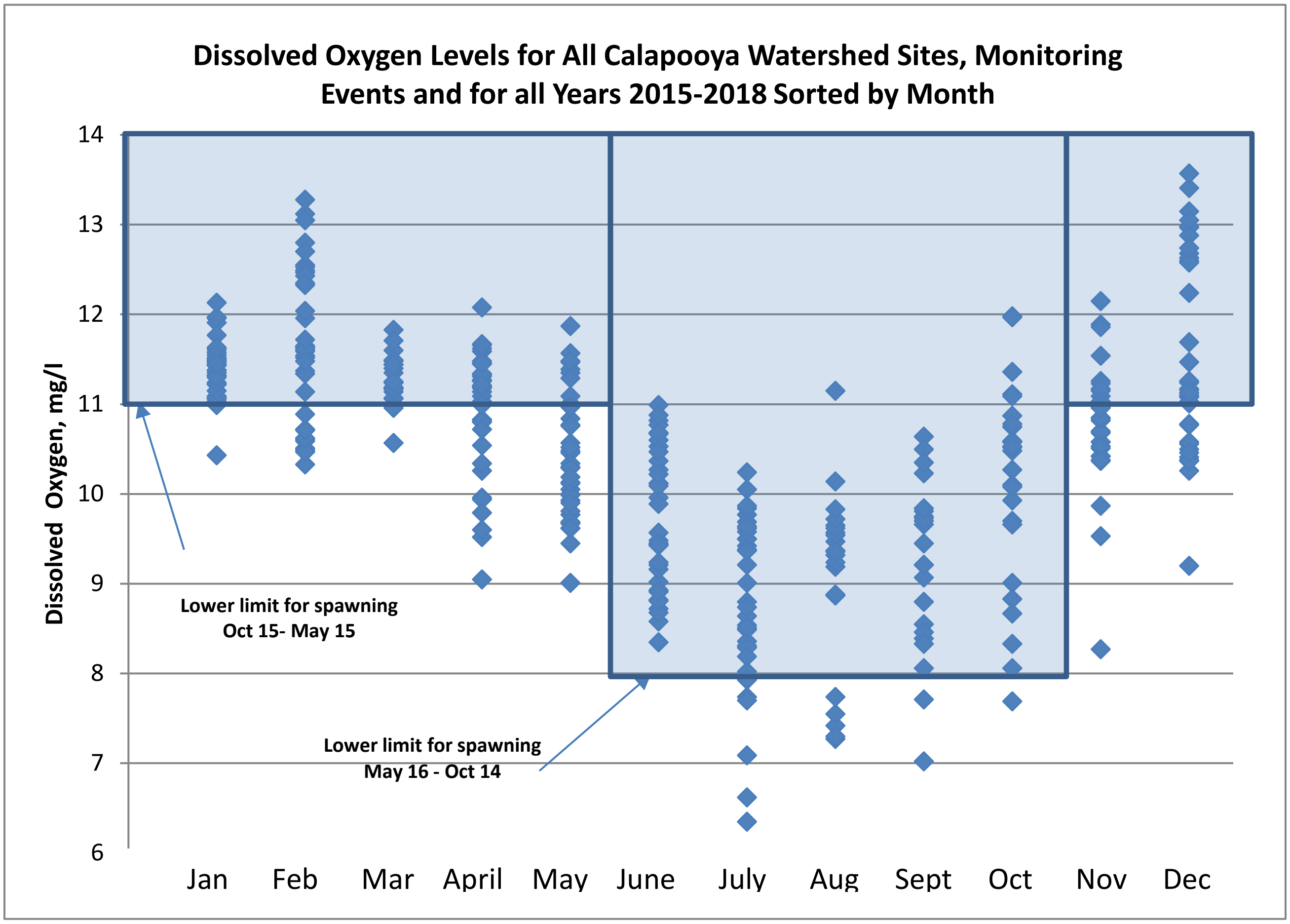
RESULTS – Calapooya Watershed Dissolved Oxygen 2015-2018

Graph 9 displays dissolved oxygen levels for the Calapooya Watershed 2015-2018 all sites, all data sorted by month, it is apparent that all months of the year there were numerous occurrences of the dissolved oxygen levels being too low for either spawning or non-spawning criteria.

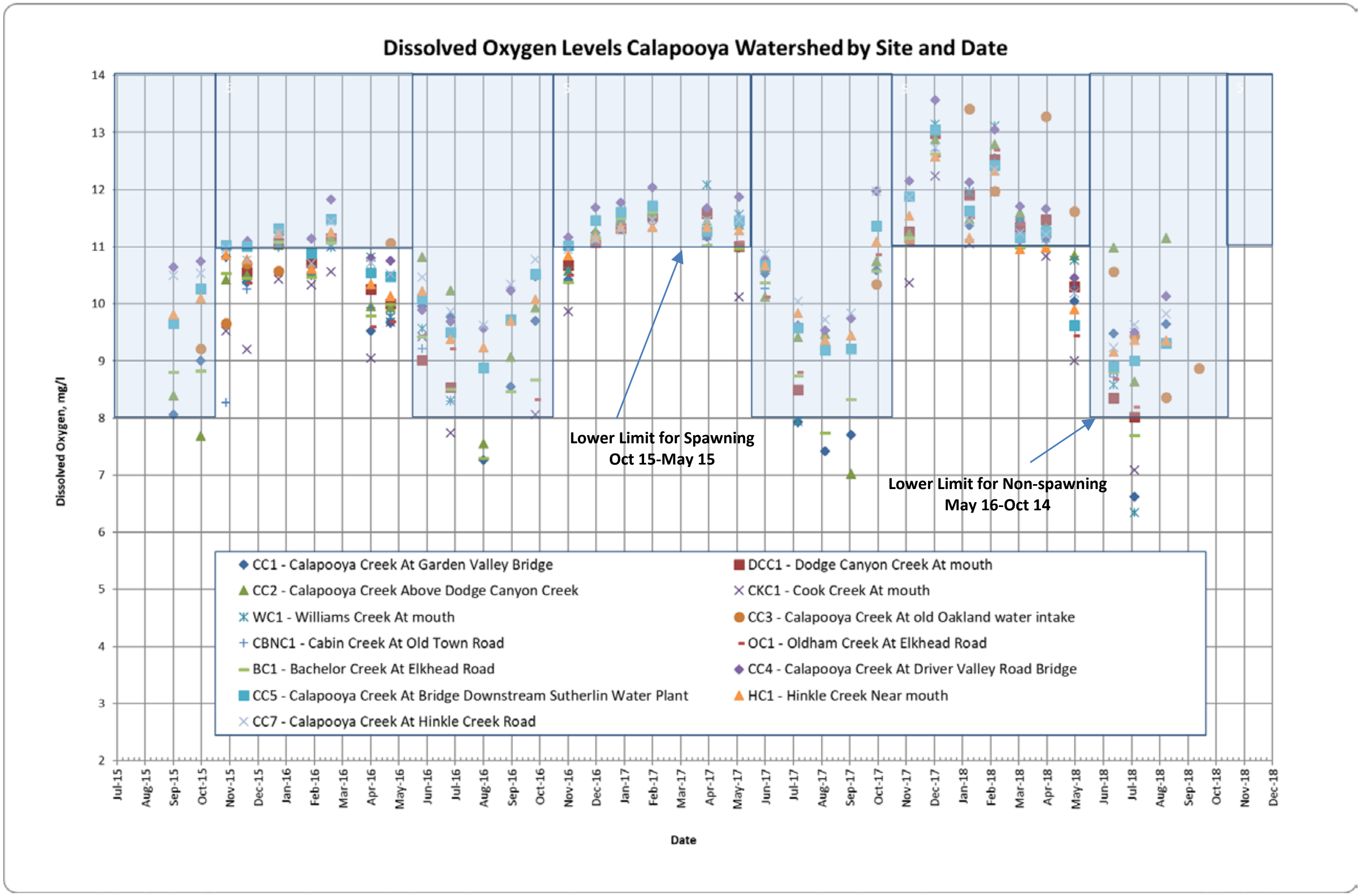
For the non-spawning season of May 16-October 15 for these watersheds, eight sites adhered to DEQ minimum criteria of 8 mg/l at the times when we were able to monitor. Five failed to meet that criteria with one falling to 6.3.

For the spawning season (October 16-May 15) criteria, none of our sites consistently fell above the 11 mg/l dissolved oxygen criteria. The sites failed to meet criteria varying from 20 to 65% of the times sampled. This is one of the cases where grab sample monitoring may not have captured the lowest dissolved oxygen value but certainly was sufficient to indicate failing streams. Four sites had the lower whisker of the box plot fall below the 8 mg/l minimum. These were Calapooya at Garden Valley Road, Cook Creek at its mouth, Williams Creek at its mouth, and Bachelor Creek at Elkhead Road. The lowest outliers were Williams Creek with 6.35 mg/l and Calapooya Creek at Garden Valley Road with 6.62 mg/l.

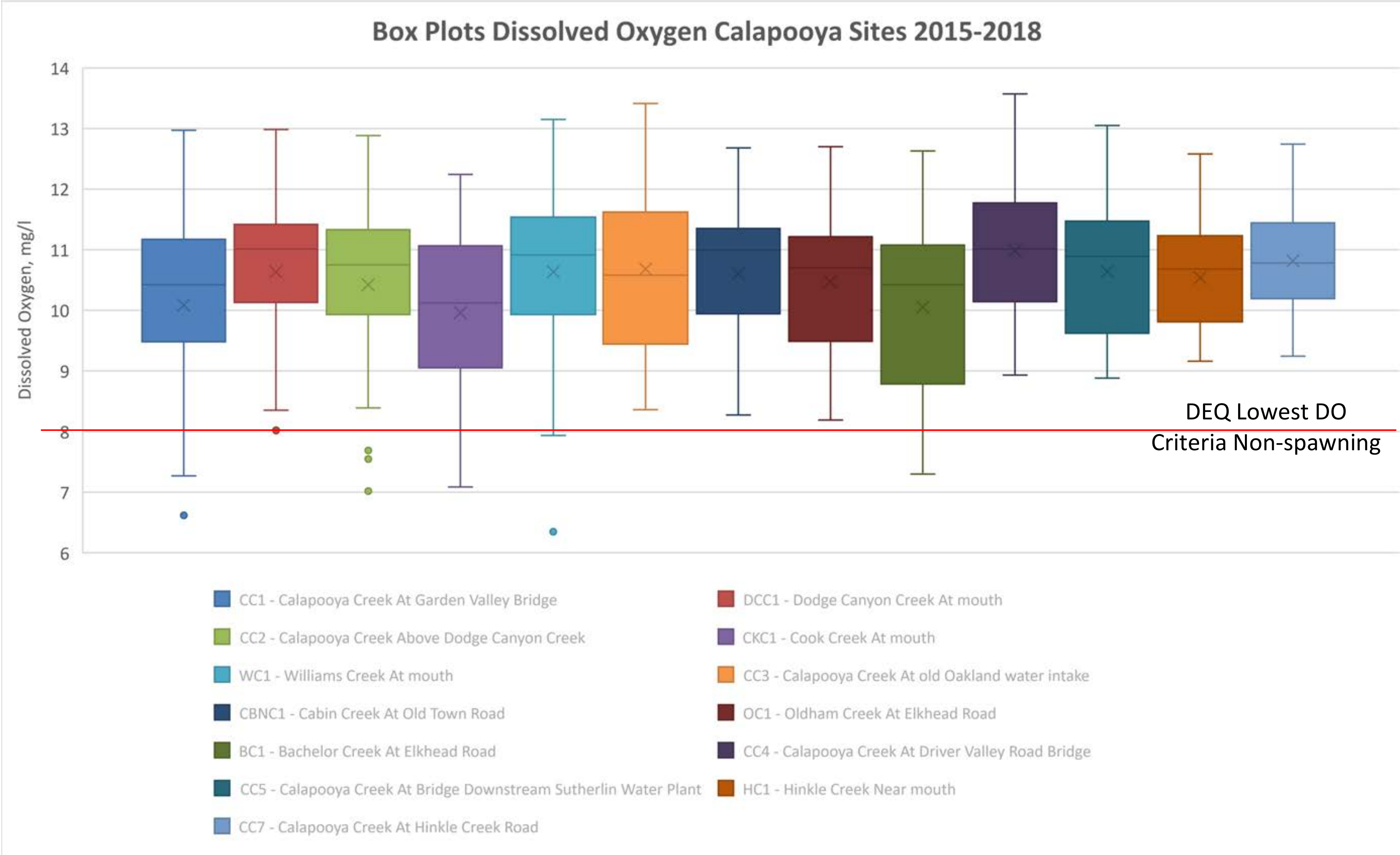
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of the tributaries went to a puddled or dry state. They included: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).



Graph 8. Dissolved Oxygen for Calapooya Watershed 2015-2018 all sites all data sorted by month.



Graph 9. Dissolved Oxygen levels by site and date in the Calapooya Watershed, with DEQ Criteria for spawning and non-spawning times of the year.



Graph 10. Box Plot of Dissolved oxygen levels of sites in Calapooya Watershed 2015-2018.

	Non-spawning Season May 16-October 14						Spawning Season October 15-May 15			
	Sample Events Dry/ Puddled	Total # Sampled	# Below Minimum D.O. Criteria of 8 mg/l	% Below Minimum D.O. Criteria of 8 mg/l	Rating	Total # Samples	# Below Minimum D.O. Criteria of 11 mg/l	% Below Minimum D.O. Criteria of 11 mg/l	Rating
CC1 - Calapooya Creek at Garden Valley Bridge	0	14	3	21%		21	9	43%	
DCC1 - Dodge Canyon Creek at mouth	7	7	0	0%		18	6	33%	
CC2 - Calapooya Creek above Dodge Canyon Creek	0	15	2	13%		20	6	30%	
CKC1 - Cook Creek at mouth	8	6	2	33%		17	11	65%	
WC1 - Williams Creek at mouth	8	7	1	14%		17	6	35%	
CC3 - Calapooya Creek at old Oakland water intake	0	5	0	0%		10	4	40%	
CBNC1 - Cabin Creek at Old Town Road	10	5	0	0%		17	7	41%	
BC1 - Bachelor Creek at Elkhead Road	0	14	3	21%		20	8	40%	
OC1 - Oldham Creek at Elkhead Road	6	9	0	0%		19	7	37%	
CC4 - Calapooya Creek at Driver Valley Road Bridge	0	15	0	0%		20	4	20%	
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant	0	15	0	0%		20	5	25%	
HC1 - Hinkle Creek near mouth	0	15	0	0%		20	8	40%	
CC7 - Calapooya Creek at Hinkle Creek Road	0	15	0	0%		20	6	30%	

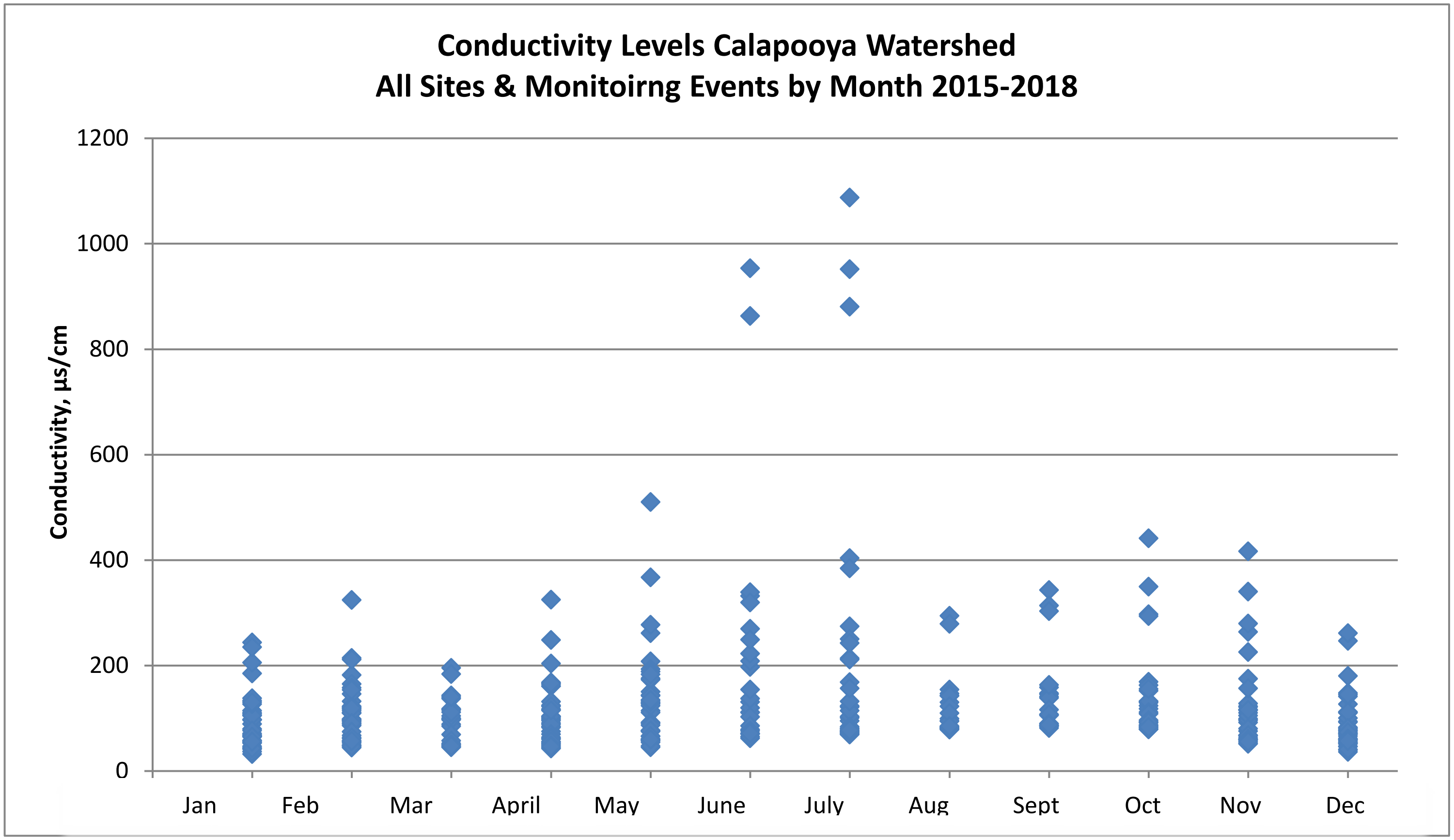
Color Key:	Level of Concern	Color Key Evaluation Criteria
	No Concern	0% (No Exceedances)
	Low Concern	≥1% ≤9% Exceedances
	High Concern	≥10% ≤19% Exceedances
	Extreme Concern	≥20% Exceedances
	No water, dry or puddled	

Table 11. Rating of Calapooya Watershed 2015-2018 Sites for stream dissolved oxygen levels compared to Spawning Season and Non-Spawning Season DEQ Criteria with Color Key.

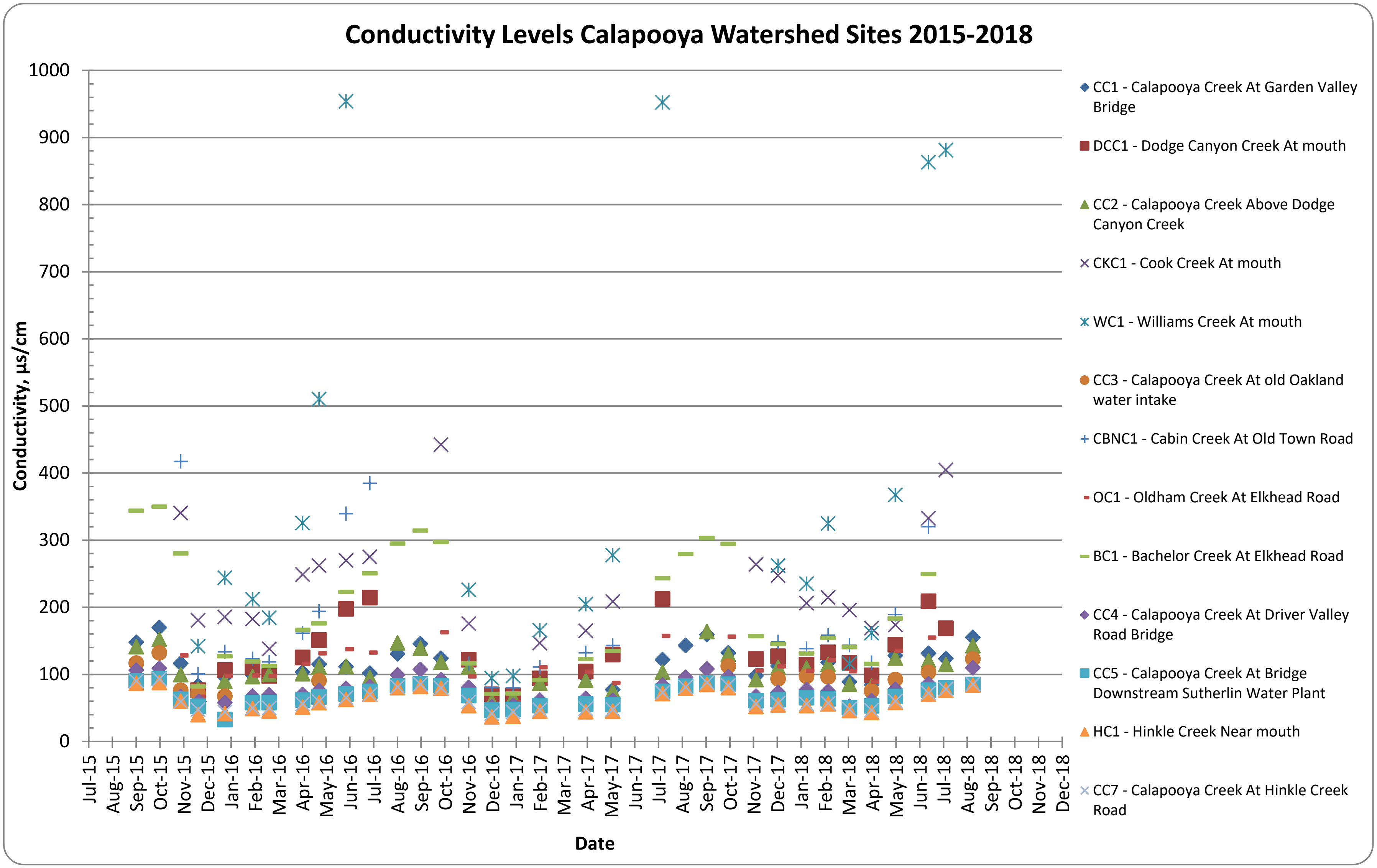
RESULTS – Calapooya Watershed Conductivity 2015-2018

Most conductivity levels in the Calapooya Watershed monitoring area were within normal ranges for the Umpqua Basin, with only one, Williams Creek having 5 occurrences exceeding 500 us/cm. Ten of the sites stayed below 200 us/cm. A few had outliers that were higher during summer months when the flows were low and the small streams tend to concentrate salts as they dry up. Graph 12 shows that Williams Creek's high values are occurring during the summer as the creek dries up on the surface.

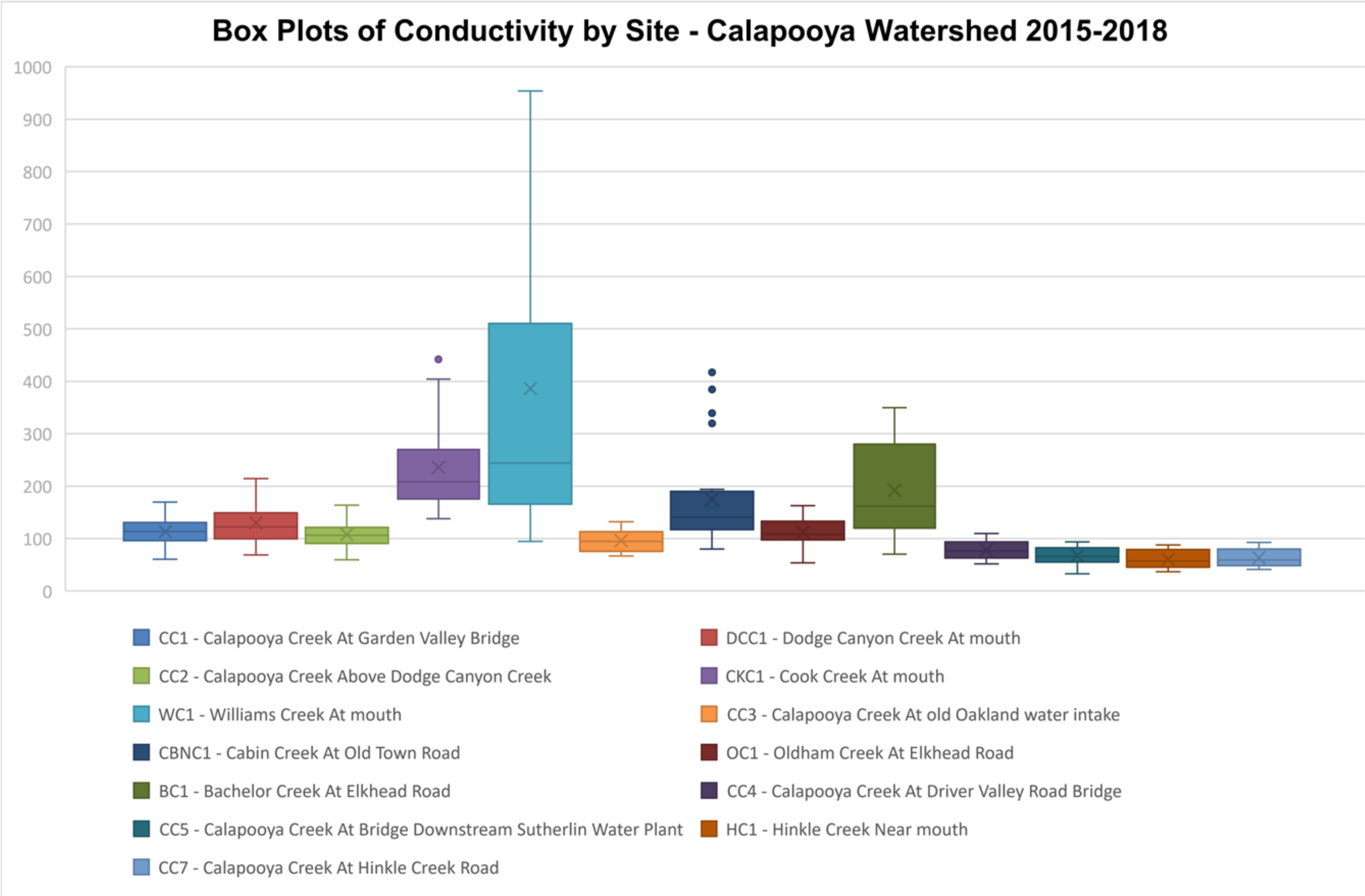
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of the tributaries went to a puddled or dry state. They included: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).



Graph 11. Conductivity levels all Calapooya Watershed sites and events from 2015-2018 displayed by month.



Graph 12. Conductivity Calapooya Watershed by site and date 2015-2018.



Graph 13. Box plots of conductivity levels for Calapooya Watershed sites 2015-2018.

Conductivity Level Rating Calapooya Watershed Monitoring Sites 2015-2018

Sites	Sampling Events Dry/Puddled	Rating when Sampling Possible
CC1 - Calapooya Creek at Garden Valley Bridge	0	
DCC1 - Dodge Canyon Creek at mouth	7	
CC2 - Calapooya Creek above Dodge Canyon Creek	0	
CKC1 - Cook Creek at mouth	8	
WC1 - Williams Creek at mouth	8	
CC3 - Calapooya Creek at old Oakland water intake	0	
CBNC1 - Cabin Creek at Old Town Road	10	
BC1 - Bachelor Creek at Elkhead Road	0	
OC1 - Oldham Creek at Elkhead Road	6	
CC4 - Calapooya Creek at Driver Valley Road Bridge	0	
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant	0	
HC1 - Hinkle Creek near mouth	0	
CC7 - Calapooya Creek at Hinkle Creek Road	0	

Rating	Color	Conductivity Level
No Concern		<500 uS/cm
Concern		>500 uS/cm
No Water		Dry or Puddled

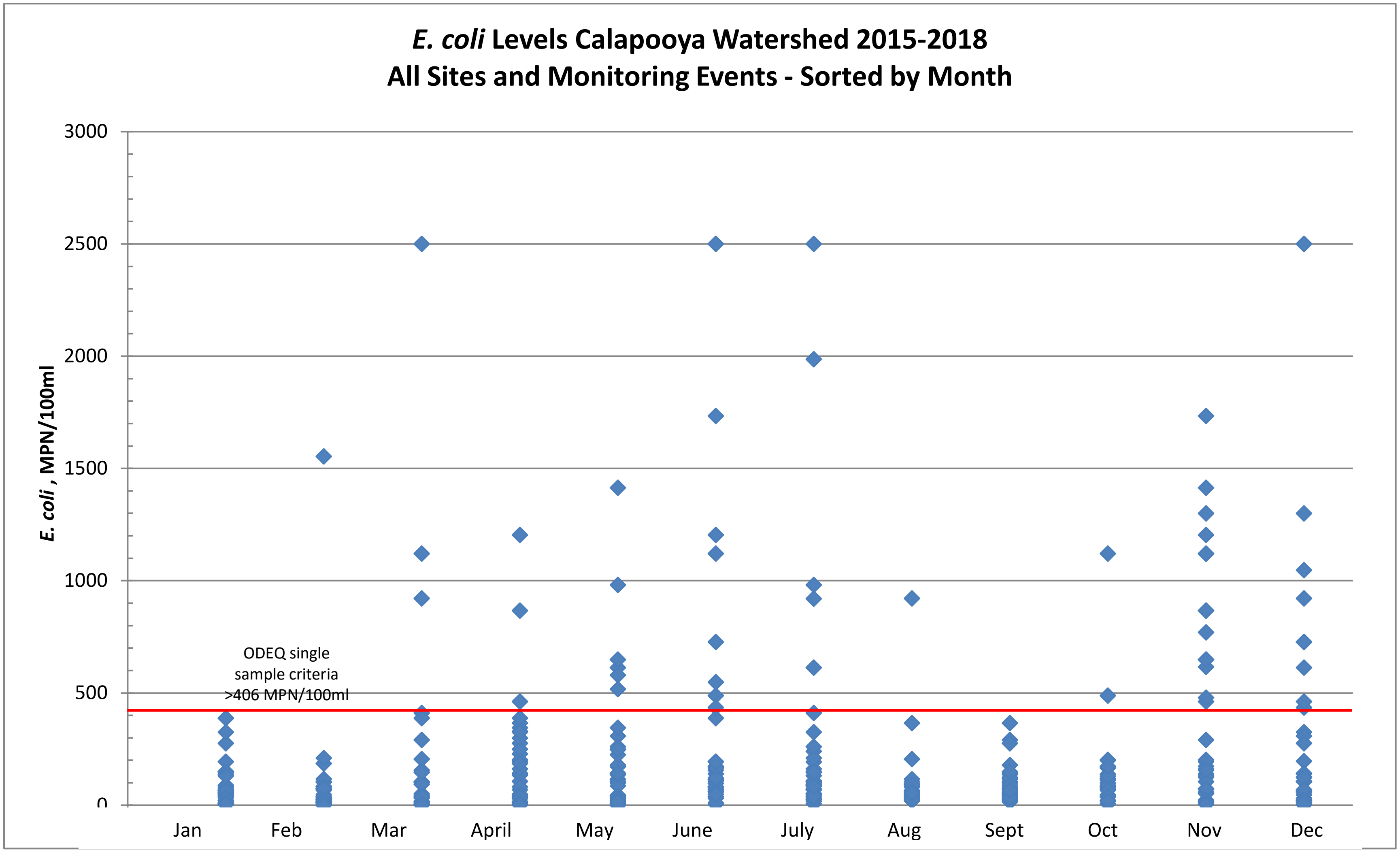
Table 12. Conductivity levels rating Calapooya Watershed monitoring sites 2015-2018

RESULTS - Calapooya Watershed E. coli Bacteria 2015-2018

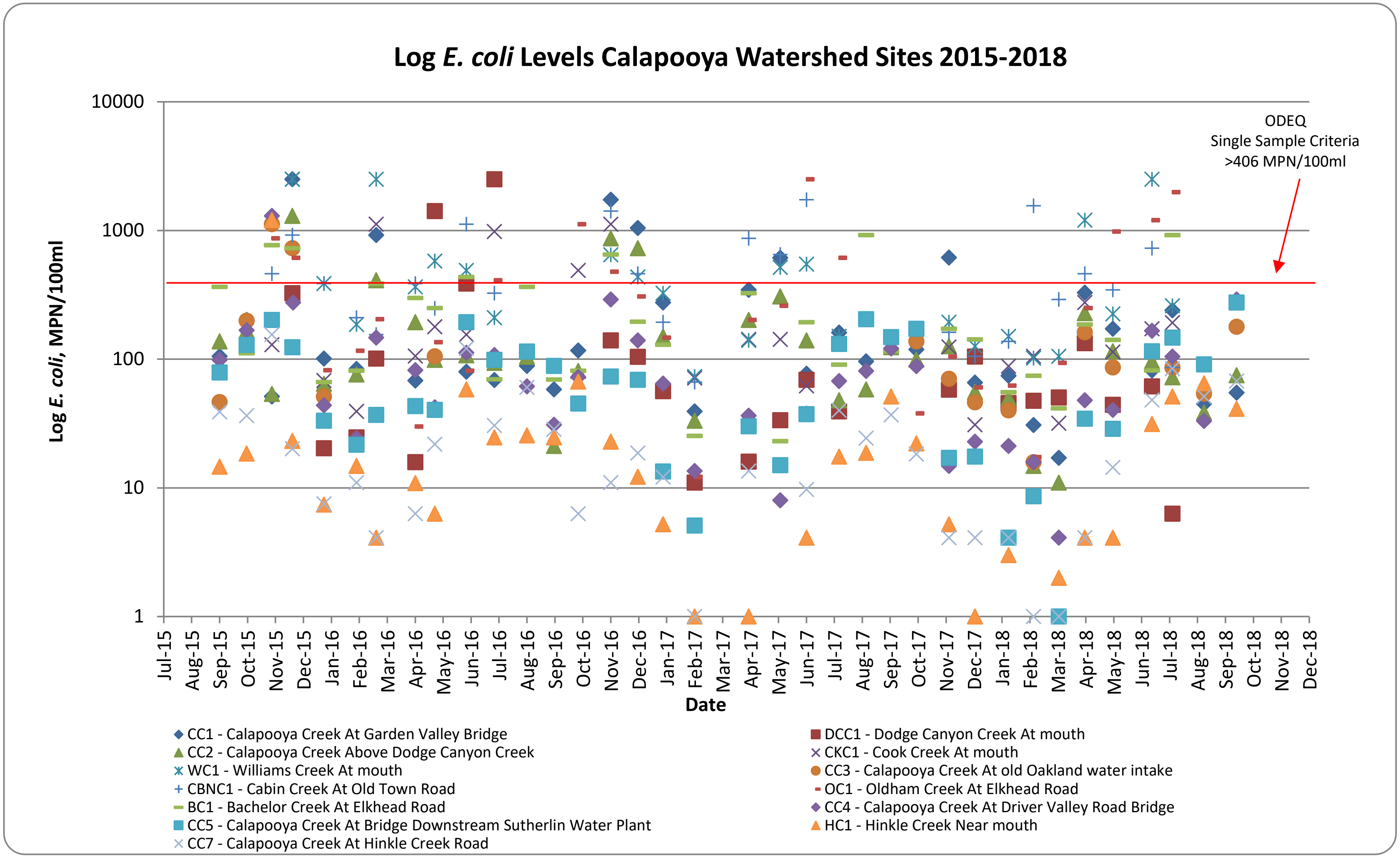
Graph 14 of all data sorted by month shows that exceedances of the DEQ single sample criteria for *E. coli* (406 MPN/100ml) occurred in all months of the year except January and September. Only two sites indicated no samplings that exceeded the criteria. These were CC5 – Calapooya Creek at the Bridge below the Sutherlin Water Plant and the CC7 – Calapooya Creek at Hinkle Creek Road, the uppermost sites that were monitored on Calapooya Creek.

Tributaries are high contributing sources of *E. coli* in this region. Extremely high are five creeks which in Graph 17 show that the maximum of the upper quartile for each is over the limit DEQ's listing criteria of 406 MPN/100ml. These creeks are Cabin Creek with 44% of sample exceeding the 406 criteria, followed by Williams Creek at 40%, Oldham Creek at 36%, Cook Creek at 21%, and Bachelor Creek at 18%. Cook Creek, Williams Creek, and Oldham Creek also had at least one sample exceeding the limit of our assaying technique. Also, Calapooya Creek at Garden Valley Road and Dodge Creek at its mouth had at least one sample each exceeding our assay limits.

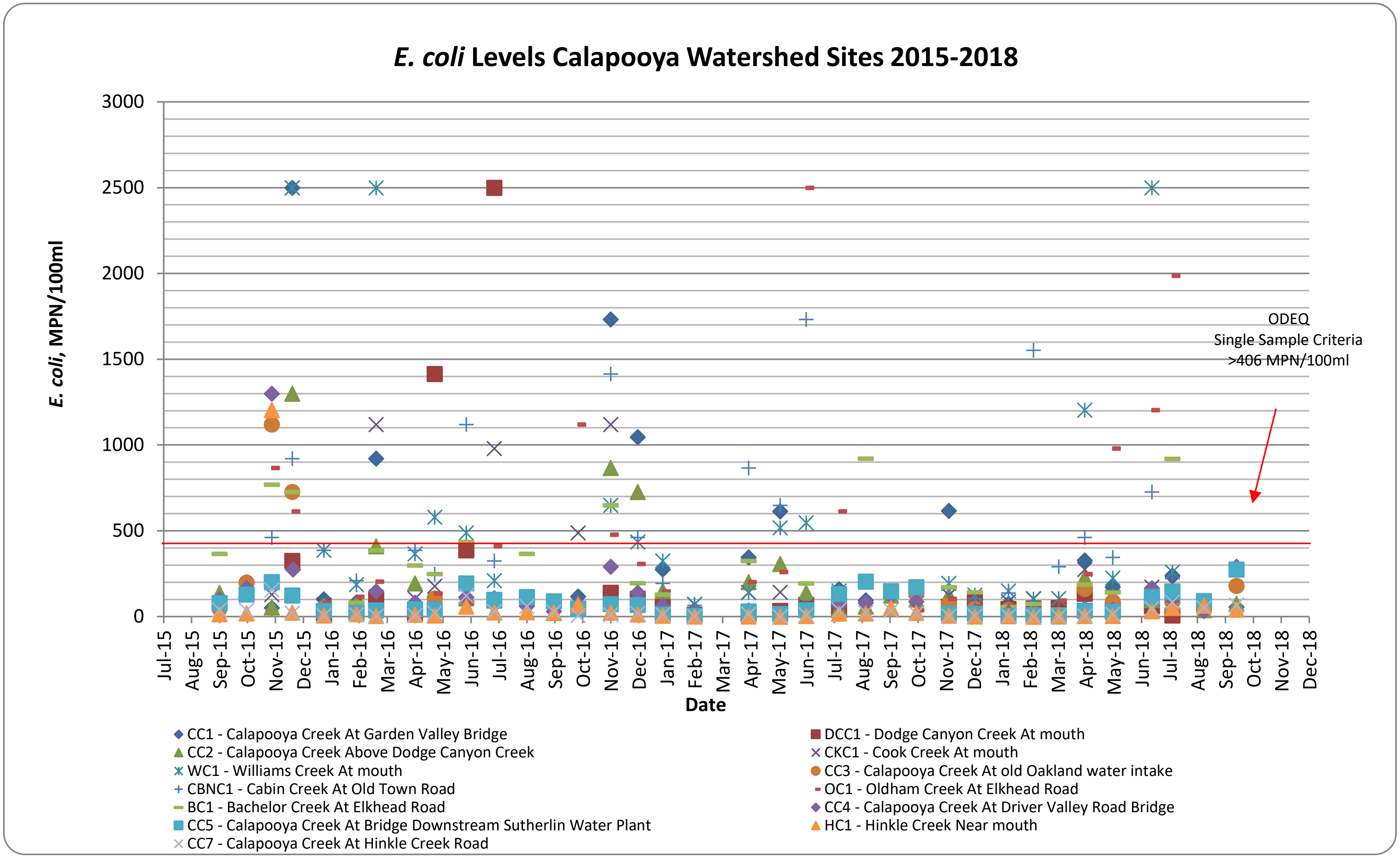
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of the tributaries went to a puddled or dry state. They included: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).



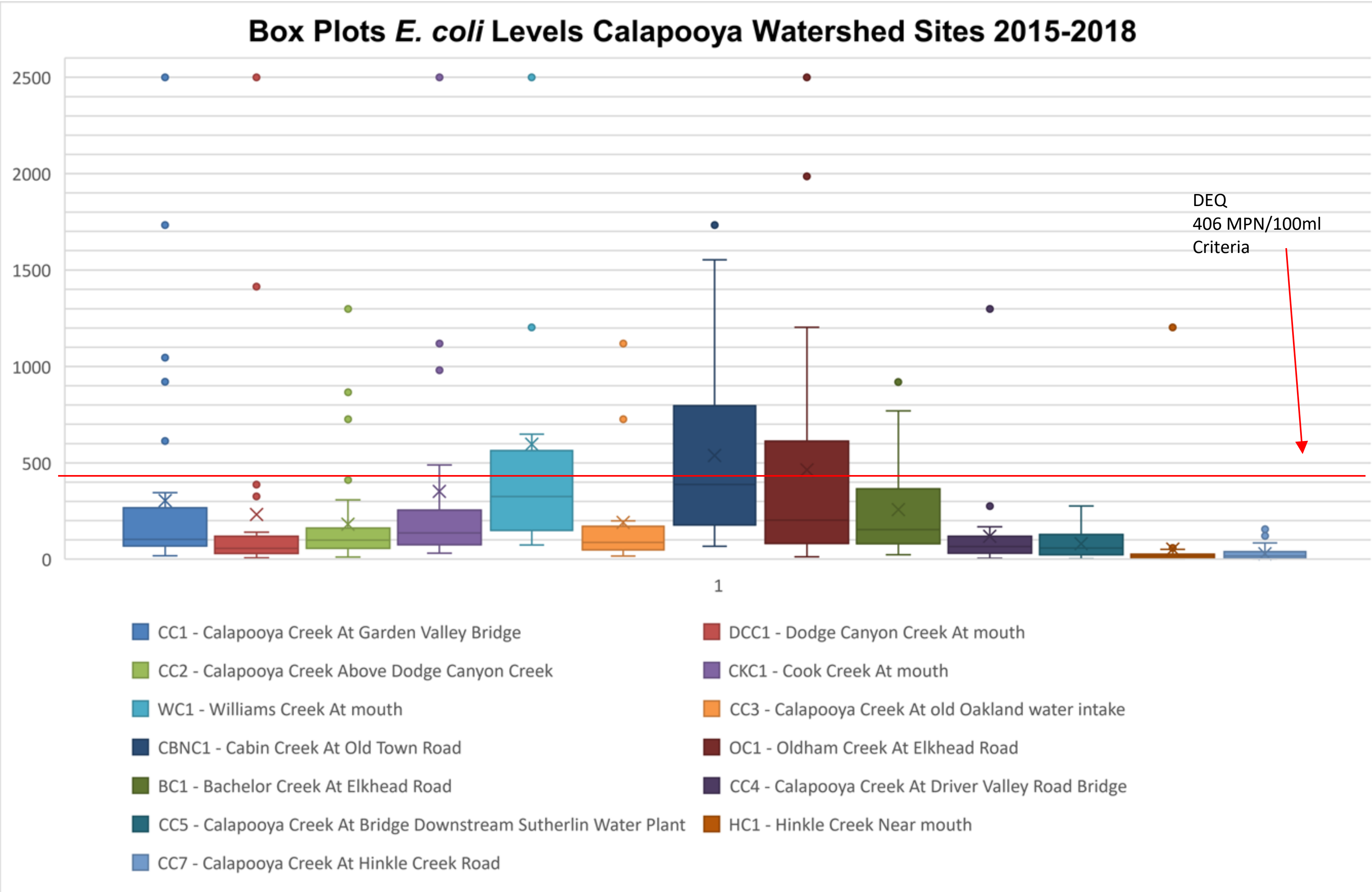
Graph 14. *E. coli* levels all Calapooya Watershed sites and monitoring events 2015-2018 sorted by month. Values of ≥2419.6, the limit of the assay without dilution, are displayed as 2500



Graph 15. Log *E. coli* levels Calapooya Watershed Sites 2015-2018. Values ≥2419.6, the limit of the assay, are displayed at Log 2500.



Graph 16. *E. coli* levels Calapooya Watershed Sites 2015-2018. Values ≥2419.6, the limit of the assay, are displayed at 2500.



Graph 17. Box plots of *E. coli* levels of Calapooya Watershed sites 2015-2018. Values ≥2419.6, the limit of the assay, are displayed at 2500.

Calapooya Watershed Sites	Sampling Events Dry/Puddled	Greater than 406 MPN/100ml		Total
Site ID - Site Description		Count	% of Sampled	# of Sampled
CC1 - Calapooya Creek at Garden Valley Bridge	0	5	13.8%	36
DCC1 - Dodge Canyon Creek at mouth	7	2	5.75%	35
CC2 - Calapooya Creek above Dodge Canyon Creek	0	4	11.1%	36
CKC1 - Cook Creek at mouth	8	5	20.8%	24
WC1 - Williams Creek at mouth	8	10	40.0%	25
CC3 - Calapooya Creek at old Oakland water intake	0	2	11.8%	17
CBNC1 - Cabin Creek at Old Town Road	10	11	44.0%	25
BC1 - Bachelor Creek at Elkhead Road	0	6	17.6%	34
OC1 - Oldham Creek at Elkhead Road	6	10	35.7%	28
CC4 - Calapooya Creek at Driver Valley Road Bridge	0	1	2.8%	36
CC5 - Calapooya Creek at Bridge Sutherlin Water Plant	0	0	0%	36
HC1 - Hinkle Creek near mouth	0	1	2.8%	36
CC7 - Calapooya Creek at Hinkle Creek Road	0	0	0%	36

Table 13. ***E. coli*** **exceedances by site the Calapooya Watershed based on ODEQ single sample criteria.**

Rating of Calapooya Watershed Sites for *E. coli*, Summer and Winter

SITE	Summer (May 1 – Sept 30)					Winter (Oct 1 – April 30)			
	Sampling Events Dry or Puddled	Total # Sumer Samples	# Above ODEQ Criteria (406 MPN/100ml)	% Above ODEQ Criteria (406 MPN/100ml)	ODEQ Rating	Total # Winter Samples	# Above ODEQ Criteria (406 MPN/100 ml)	% Above ODEQ Criteria (406 MPN/100ml)	ODEQ Rating
CC1 - Calapooya Creek at Garden Valley Bridge	0	16	1	6.3%		20	4	20%	
DCC1 - Dodge Canyon Creek at mouth	7	9	2	22.2%		16	0	0%	
CC2 - Calapooya Creek above Dodge Canyon Creek	0	16	0	0%		20	4	20%	
CKC1 - Cook Creek at mouth	8	8	1	12.5%		16	4	25%	
WC1 - Williams Creek at mouth	8	9	5	55.6%		16	5	31.3%	
CC3 - Calapooya Creek at old Oakland water intake	0	7	0	0%		10	2	20%	
CBNC1 - Cabin Creek at Old Town Road	10	8	4	50%		17	7	41.2%	
BC1 - Bachelor Creek at Elkhead Road	0	15	3	20%		20	3	15%	
OC1 - Oldham Creek at Elkhead Road	6	9	6	66.7%		19	4	21.1%	
CC4 - Calapooya Creek at Driver Valley Road Bridge	0	16	0	0%		20	1	5.0%	
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant	0	16	0	0%		20	0	0%	
HC1 - Hinkle Creek near mouth	0	16	0	0%		20	1	5.0%	
CC7 - Calapooya Creek at Hinkle Creek Road	0	16	0	0%		20	0	0%	

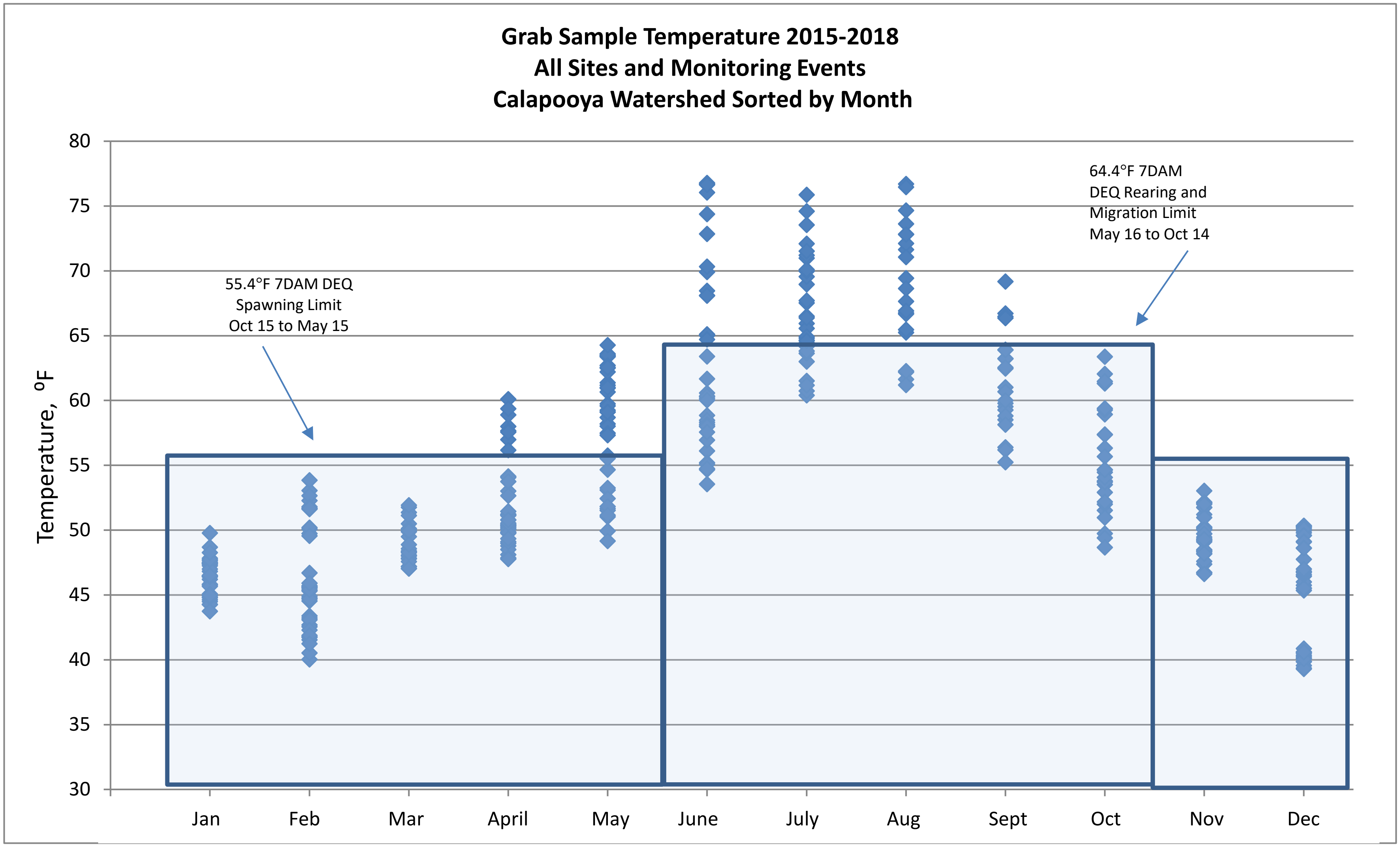
Rating	Color	ODEQ Criteria
No Concern (below standard criteria)		≤406
Concern (exceeds standard criteria)		>406
No Water		

Table 14. Rating of all Calapooya Watershed Sites for *E. coli*, Summer and Winter, ODEQ criteria.

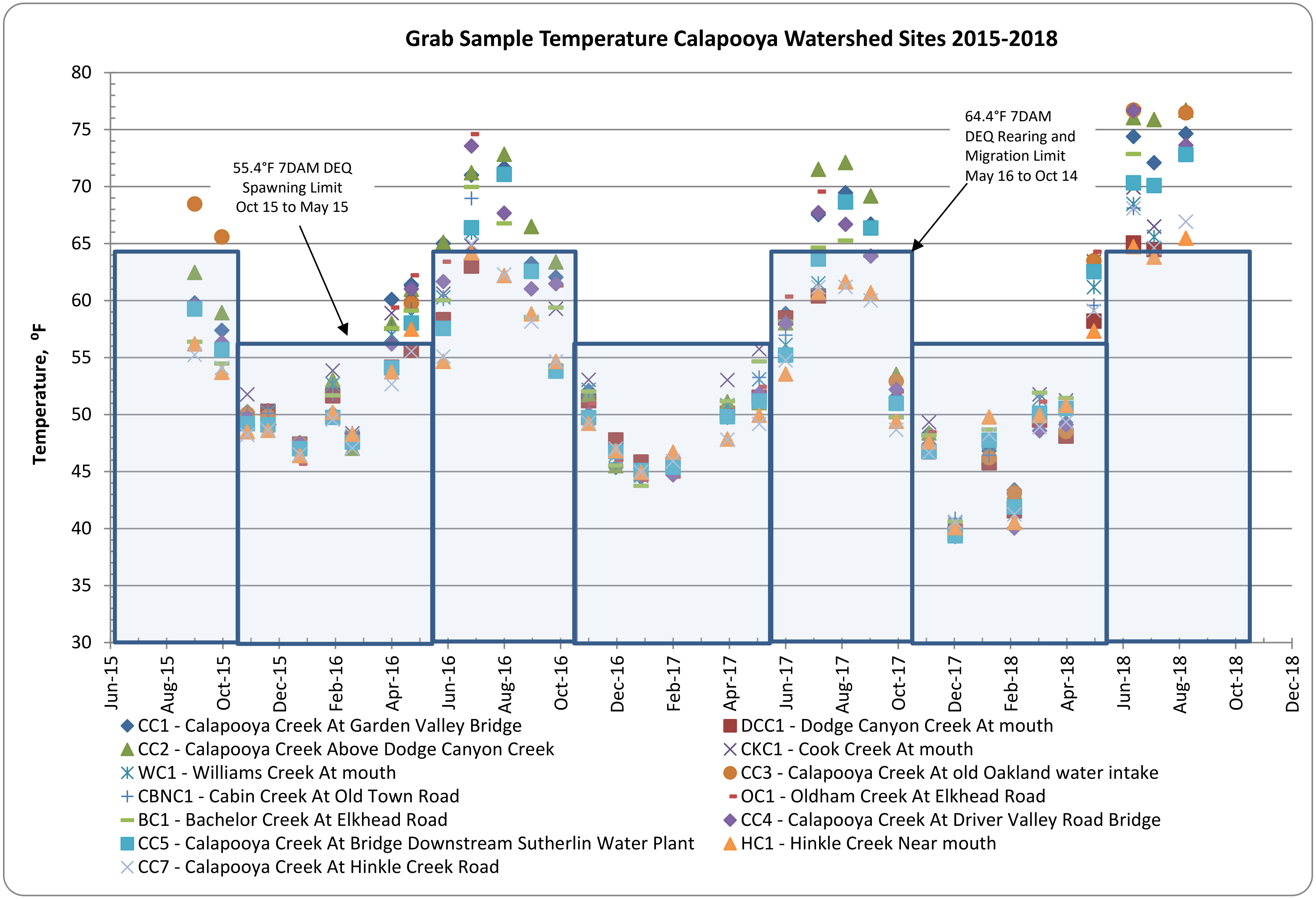
RESULTS - Calapooya Watershed Grab Sample Temperature Monitoring 2015-2018

The temperature was recorded at each of our grab sample monitoring events, and though this would not allow evaluation for DEQ temperature criteria because continuous temperature recording could only provide the 7DAM. It is included here for evaluation and stream rating to provide additional information for planning restoration sites. As it turned out every monitoring site displayed exceedances of both “Rearing and Migration” criteria of 64.4°F for May 16 – October 14 and “Spawning” criteria October 15 to May 15 for the creeks monitored as designated to this criteria on Appendix J (Umpqua Basin Salmon and Steelhead Spawning Use Designations from ODEQ 2003). Therefore, the summary table (Table 15) designated every stream monitored in need of improvement for failing to meet both criteria.

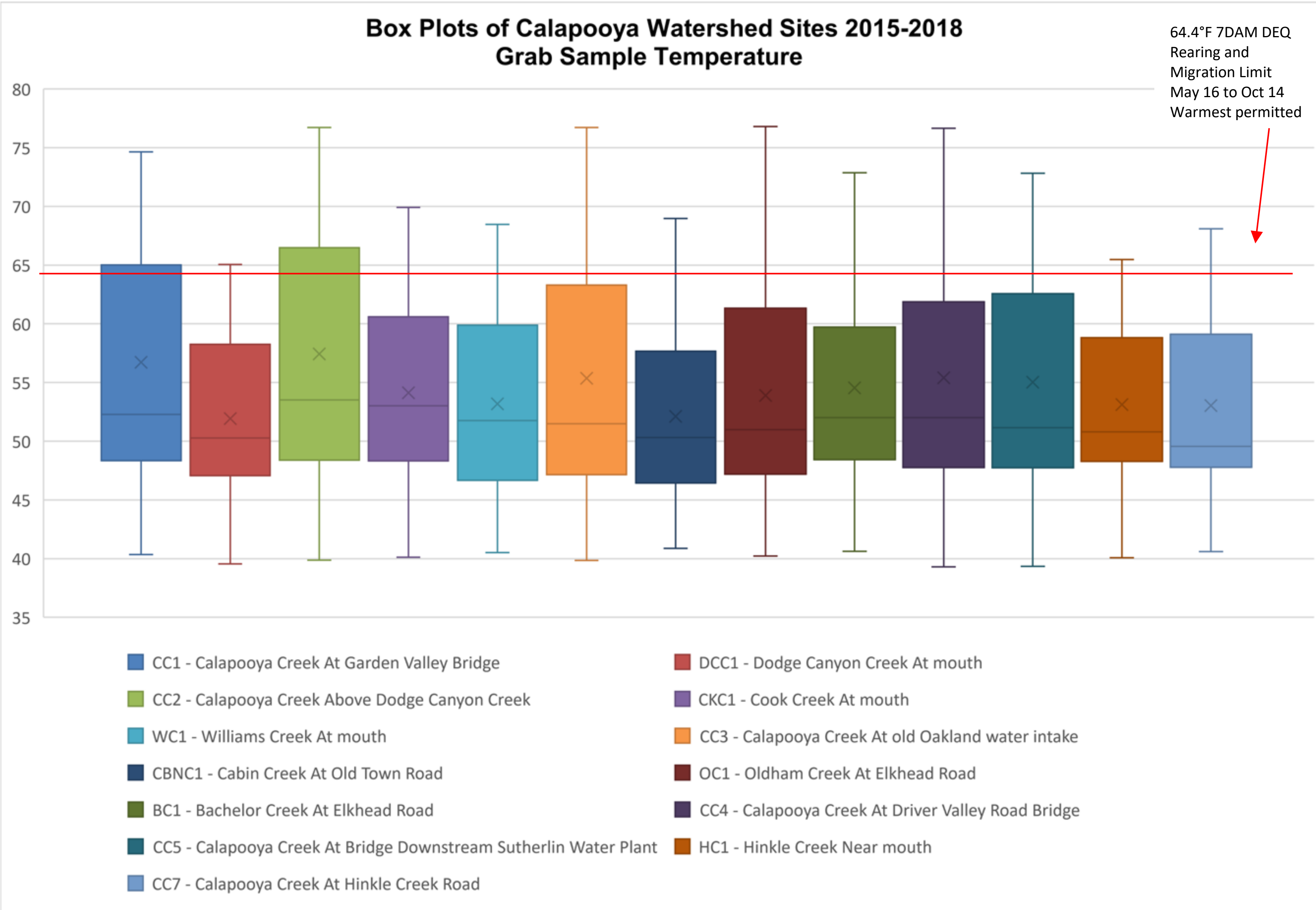
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of the tributaries went to a puddled or dry state. They included: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).



Graph 18. Grab sample temperature data all events and sites sorted by month Calapooya Watershed 2015-2018.



Graph 19. Grab sample temperature results for all Calapooya Watershed sites 2015-2018.



Graph 20. Box and whisker plots of grab sample temperatures for monitoring sites in the Calapooya Watershed 2015-2018.

Grab Sample Temperature Ratings Calapooya Watershed Monitoring Sites 2015-2018

		Spawning Criteria 55.4°F 7DAM Oct 15-May 15				Rearing and Migration Criteria 64.4°F 7DAM May 16-Oct 14			
SITE	Sampling Events Dry/Puddled	Total Sampl es	Samples >55.4°F	%	Rating	Total Samples	Samples >64.4°F	%	Rating
CC1 - Calapooya Creek at Garden Valley Bridge	0	20	2	10		15	8	53	
DCC1 - Dodge Canyon Creek at mouth	7	18	1	6		7	1	14	
CC2 - Calapooya Creek above Dodge Canyon Creek	0	20	4	20		15	10	67	
CKC1 - Cook Creek at mouth	8	17	3	18		6	3	50	
WC1 - Williams Creek at mouth	8	17	3	18		7	3	43	
CC3 - Calapooya Creek at old Oakland water intake	0	18	1	6		4	4	100	
CBNC1 - Cabin Creek at Old Town Road	10	18	3	17		5	2	40	
BC1 - Bachelor Creek at Elkhead Road	0	20	3	15		13	4	31	
OC1 - Oldham Creek at Elkhead Road	6	19	3	16		8	3	38	
CC4 - Calapooya Creek at Driver Valley Road Bridge	0	20	4	20		14	6	43	
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant	0	20	2	10		15	7	47	
HC1 - Hinkle Creek near mouth	0	20	2	10		15	2	13	
CC7 - Calapooya Creek at Hinkle Creek Road	0	20	1	5		15	3	20	

Rating	Grab Sample Temperatures 7DAM Spawning Oct 15 to May 15	Grab Sample Temperatures 7DAM Rearing and Migration May 16- Oct 14	Color
Good	<55.4° F	<64.4° F	
Needs Improvement	>55.4° F	>64.4° F	
No Water			

Table 15. Table of Temperature Ratings Calapooya Watershed Grab Sample Monitoring Sites 2015-2018.

RESULTS - Calapooya Watershed Continuous Summer Temperature Monitoring 2015-2018

Table 15 and Table 16 display a great deal of temperature information from three years at the four sites where we had continuous recording temperature loggers recording every 30 minutes. The seven-day average maximum value – 7DAM – is the common way data is presented as displayed in Graph 23. This graph from PUR's Umpqua Basin Stream Temperature Characterization – Reference Site 2019 Update (Dammann, D.M., 2019) shows that there are great variations in 7DAM over 20 years at the reference site on Calapooya Creek. The reference site is between our CC1 and CC4.5 sites on the Calapooya and our temperatures are lower at the upstream site and higher at the downstream site for 2016, 2017, and 2018 reported in this document. This makes sense as typically stream temperatures increase as they flow further from its headwaters.

The 7DAM, where we had temperature loggers for the three years, agreed with our grab sample temperature data which designated all sites into the red – needing improvement.

Graphs 21 and 22 show 30-minute temperature daily fluctuations for the summer of 2018 for Calapooya Creek at Hinkle Creek Road and Hinkle Creek near its mouth. The same weather patterns can be seen in the fluctuations. The two sites are very close to each other, so the fluctuation patterns match but the 7DAM temperature in Hinkle Creek is consistently around four degrees Fahrenheit cooler than that of Calapooya Creek, as it was for the three years monitored.

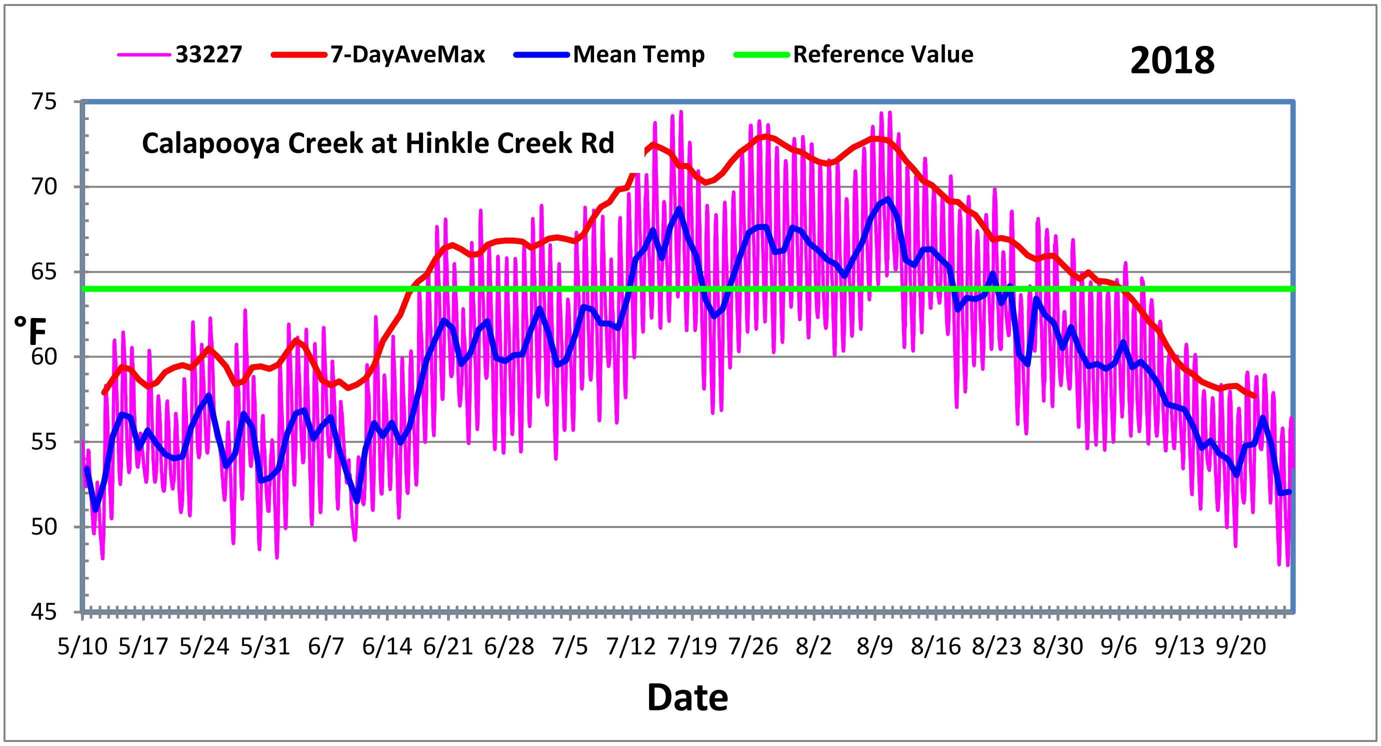
Table 16 adds some interesting temperature information about what instream life is dealing with in terms of the number of days or actual hours that they are submitted to harmful temperatures. This table shows the number of days that are >55°F, >64°F, and >70°F as well as the number of hours that are >55°F, >64°F, and >70°F. For example, Calapooya near the mouth at Umpqua Landing Boat Ramp - CC1 there were 77 days in 2017 that experience temperatures over 70°F, which, breaking it down into hours was 1485.5 hours >70°F.

Site Name	Start Date	Stop date	Seasonal Maximum		Seasonal Minimum		Seasonal Max ΔT		7-Day averages			
			Date	Value	Date	Value	Date	Value	Date	Max	Min	Δ T
Calapooya Creek at Hinkle Creek Road – CC7	06/30/16	09/15/16	08/19/16	73.2	09/14/16	50.9	07/02/16	12.1	08/17/16	71.3	61.4	10.0
Calapooya Creek at Hinkle Creek Road – CC7	06/15/17	10/09/17	08/03/17	74.2	10/09/17	45.2	07/12/17	11.7	08/05/17	72.9	62.8	10.1
Calapooya Creek at Hinkle Creek Road – CC7	05/10/18	09/25/18	07/17/18	74.4	09/25/18	47.7	06/24/18	12.9	07/28/18	73.0	61.6	11.3
Hinkle Creek near Mouth – HC1	06/30/16	09/15/16	08/19/16	69.2	09/14/16	51.3	07/02/16	9.6	08/18/16	67.8	59.9	7.9
Hinkle Creek near Mouth – HC1	06/15/17	10/09/17	08/04/17	70.5	10/09/17	45.9	08/01/17	9.6	08/07/17	69.1	62.0	7.0
Hinkle Creek near Mouth – HC1	05/10/18	09/25/18	08/10/18	71.1	06/01/18	47.9	06/19/18	10.9	07/28/18	69.0	59.7	9.3
Calapooya Creek at Driver Valley Rd bridge - CC4.5	06/30/16	09/15/16	08/20/16	80.9	09/15/16	51.4	09/15/16	14.8	08/18/16	79.5	67.7	11.9
Calapooya Creek at Driver Valley Rd bridge - CC4.5	06/15/17	10/09/17	08/04/17	82.5	10/09/17	49.5	08/18/17	12.1	08/06/17	80.1	71.5	8.5
Calapooya Creek at Driver Valley Rd bridge - CC4.5	05/10/18	08/10/18	07/27/18	83.2	05/12/18	51.5	07/27/18	14.2	07/28/18	81.8	69.0	12.8
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	06/30/16	10/03/16	08/19/16	85.6	10/03/16	56.1	08/18/16	15.2	08/19/16	83.6	70.8	12.8
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	06/30/17	10/09/17	08/03/17	85.8	10/09/17	51.8	08/03/17	11.7	08/04/17	83.1	73.1	10.1
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	05/23/18	07/22/18	07/17/18	84.5	06/01/18	59.7	07/12/18	11.7	07/15/18	83.4	73.2	10.2

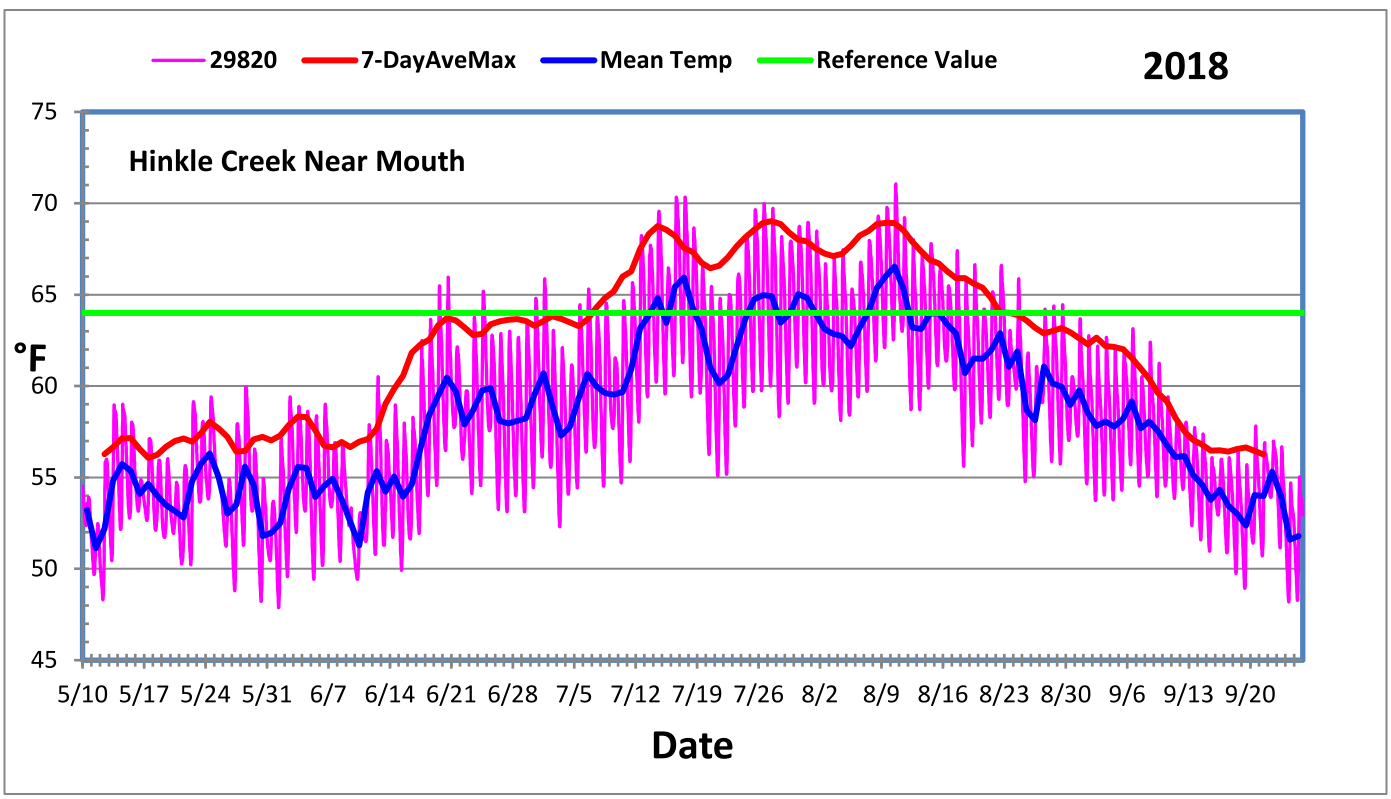
Table 16. Calapooya Watershed continuous temperature logger summary.

Site Name	Days >55 F	Days >64 F	Days >70 F	Hours >55 F	Hours >64 F	Hours >70 F	The warmest day of 7-day		
							Date	Maximum	Minimum
Calapooya Creek at Hinkle Creek Road – CC7	78	57	15	1791.0	591.5	67.5	08/19/16	73.2	62.2
Calapooya Creek at Hinkle Creek Road – CC7	106	85	18	2309.0	914.5	107.0	08/03/17	74.2	63.0
Calapooya Creek at Hinkle Creek Road – CC7	137	78	30	2610.0	891.0	189.0	07/26/18	73.9	61.6
Hinkle Creek near Mouth – HC1	78	34	0	1779.0	252.0	0.0	08/19/16	69.2	60.7
Hinkle Creek near Mouth – HC1	102	56	4	2277.5	449.0	7.0	08/04/17	70.5	62.2
Hinkle Creek near Mouth – HC1	129	56	3	2393.0	522.0	7.5	07/26/18	70.0	59.7
Calapooya Creek at Driver Valley Rd bridge - CC4.5	78	77	53	1844.0	1515.0	553.5	08/20/16	80.9	68.6
Calapooya Creek at Driver Valley Rd bridge - CC4.5	111	92	74	2565.0	2011.0	827.5	08/04/17	82.5	72.7
Calapooya Creek at Driver Valley Rd bridge - CC4.5	93	62	51	2178.0	1289.5	666.0	07/27/18	83.2	69.0
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	78	77	53	1844.0	1515.0	553.5	08/20/16	80.9	68.6
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	102	86	77	2388.0	1929.5	1485.5	08/03/17	85.8	74.1
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	61	60	47	1463.5	1342.5	807.5	07/17/18	84.5	73.6

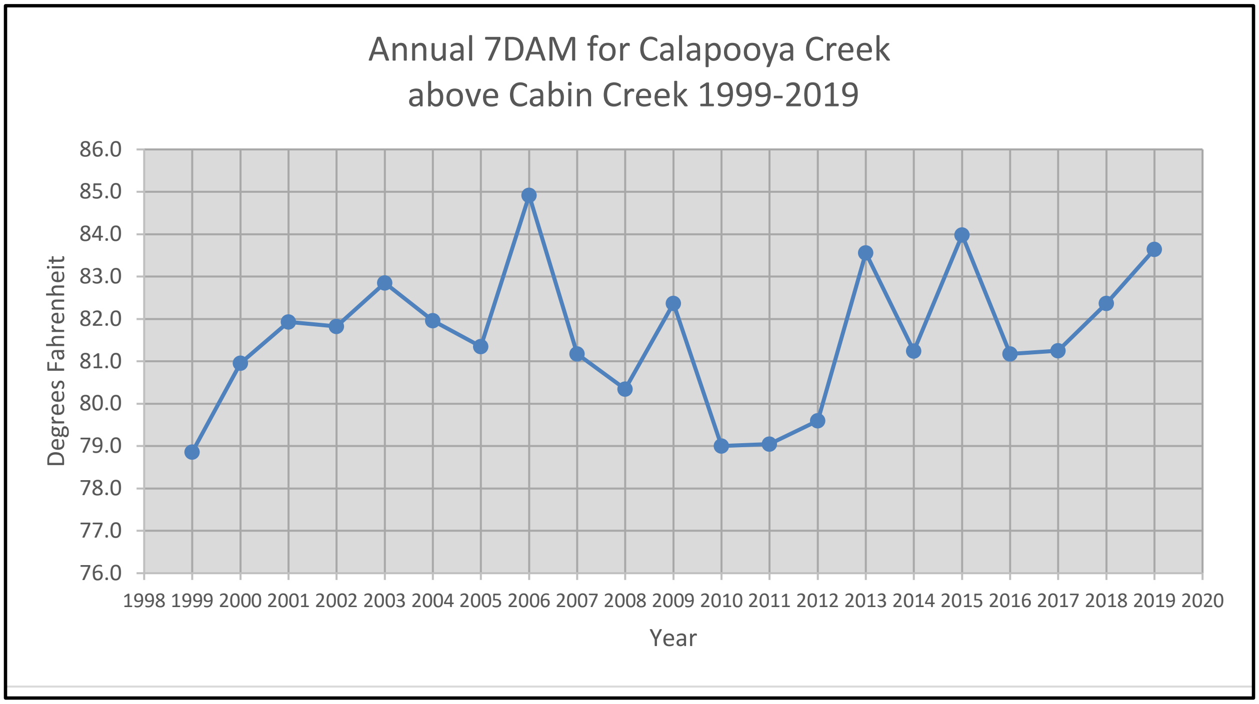
Table 17. Continued for Calapooya Watershed continuous temperature logger summary.



Graph 21. 2018 Daily 30-minute temperature fluctuations at Calapooya Creek at Hinkle Creek Road.



Graph 22. 2018 Daily 30-minute temperature fluctuations at Hinkle Creek near the mouth.



Graph 23. Continuous summer stream 7-day average daily maximum temperature at the Calalpooya Creek Reference Study Site above Cabin Creek for years 1999-2019. This data is part of PUR's Umpqua Basin Stream Temperature Characterization – Reference Site 2019 Update. (Dammann, D.M., 2019)

RESULTS - Calapooya Watershed Summary Results 2015-2018

Table 17 displays the ranking for the tested parameters at our monitoring sites and in the Calapooya Watershed. A glance at the chart indicates that turbidity, dissolved oxygen, and temperature all failed badly at meeting criteria at all sites. PH and *E. coli*, at least, had a few sites that fell within the DEQ criteria range, at least at the times that monitoring was carried out. Conductivity wasn't an issue in this watershed other than when streams were going dry.

The creeks with the worst problems, however, were those tributaries that, numerous times during summer over the three years, went to a puddled or dry state. They were: DCC1 – Dodge Canyon Creek at its mouth (7 months during the three years); CKC1 – Cook Creek at its mouth (8 months during the three years); WE1 – Williams Creek at its mouth (8 months during the three years); OC1 – Oldham Creek at Elkhead Road (6 months during the three years).

All Calapooya Creek (CC1, CC2, CC3, CC4, and CC7) are highly impacted at times by high turbidity, low dissolved oxygen levels, and failing to meet temperature criteria. Only CC4 and CC7, which are the highest in the watershed, had no *E. coli* levels that fell above the 406 MPN/100ml DEQ criteria. CC1, CC2, CC3 all had exceedances.

The following comments were pulled from each parameter's summary which highlighted the worst creeks in each water quality parameter:

Cabin Creek

1. Cabin Creek at Old Town Road (CBNC1) exhibits the most occurrences of high turbidity with 78% of its samplings being greater than 10 NTU
2. 57% of its summer samplings and 88% of winter samplings occurred over 10 NTU
3. The maximum of the upper quartile for Cabin Creek exceeded the limit DEQ's listing criteria of 406 MPN/100ml with 44% of sample exceeding the *E. coli* criteria

Williams Creek

1. The highest turbidity levels occurred in Williams Creek (578 NTU)
2. Williams is of high concern in summer and extreme concern in winter for turbidity
3. The lowest outlier was Williams Creek with 6.35 mg/l dissolved oxygen
4. Williams Creek having 5 occurrences exceeding 500 us/cm conductivity
5. Williams Creek exceeded the limit DEQ's listing criteria of 406 MPN/100ml with 40% of sample exceeding the *E. coli* criteria
6. Williams Creek had at least one sample exceeding the limit of our *E. coli* assaying technique
7. Williams Creek at its mouth was dry 8 months during the three years

Oldham Creek at Elkhead Road

1. Oldham Creek had the second-highest turbidity levels (338 NTU)
2. Oldham Creek is of extreme concern for both summer and winter exceedances greater than 10 NTU
3. Oldham Creek exceeded the limit DEQ's listing criteria of 406 MPN/100ml with 36% of sample exceeding the *E. coli* criteria
4. Oldham Creek had at least one sample exceeding the limit of our *E. coli* assaying technique
5. Oldham Creek was dry 6 months during the three years

Calapooya at Garden Valley Road

1. Calapooya at Garden Valley Road had the third-highest turbidity levels (321 NTU)
2. pH levels fell below minimum pH criteria twice at Calapooya Creek at Garden Valley Road
3. Calapooya at Garden Valley Road had the lower whisker of the box plot fall below the 8 mg/l minimum for dissolved oxygen (6.62 mg/l)
4. Calapooya at Garden Valley Road had at least one sample exceeding the limit of our *E. coli* assaying technique

Cook Creek

6. Cook Creek is of extreme concern for both summer and winter exceedances greater than 10 NTU
7. Cook Creek exceeded the limit DEQ's listing criteria of 406 MPN/100ml with 21% of sample exceeding the *E. coli* criteria
8. Cook Creek had at least one sample exceeding the limit of our *E. coli* assaying technique
9. Cook Creek at its mouth was dry 8 months during the three years

Calapooya at Driver Valley Road Bridge

1. Calapooya at Driver Valley Road Bridge is of high concern in summer and extreme concern in winter for turbidity
2. Upper exceedances in pH occurred four times at Calapooya Creek at Driver Valley Road Bridge

Bachelor Creek

1. Bachelor Creek exceeded the limit DEQ's listing criteria of 406 MPN/100ml with 18% of samples exceeding the *E. coli* criteria

Dodge Canyon Creek at its mouth

1. Dodge Canyon Creek at its mouth was dry 7 months during the three years
2. Dodge Canyon Creek had at least one sample exceeding the limit of our *E. coli* assaying technique

Summary Rating for Calapooya Watershed Monitoring Sites 2015-2018 – Six Water Quality Parameters

	Turbidity	pH	Dissolved Oxygen	Conductivity	E. coli ≥406 MPN/100 ml Criteria	Temperature 2010 Criteria
CC1 - Calapooya Creek at Garden Valley Bridge						
DCC1 - Dodge Canyon Creek at mouth						
CC2 - Calapooya Creek above Dodge Canyon Creek						
CKC1 - Cook Creek at mouth						
WC1 - Williams Creek at mouth						
CC3 - Calapooya Creek at old Oakland water intake						
CBNC1 - Cabin Creek at Old Town Road						
BC1 - Bachelor Creek at Elkhead Road						
OC1 - Oldham Creek at Elkhead Road						
CC4 - Calapooya Creek at Driver Valley Road Bridge						
CC5 - Calapooya Creek at Bridge Downstream Sutherlin Water Plant						
HC1 - Hinkle Creek near mouth						
CC7 - Calapooya Creek at Hinkle Creek Road						

Table 18. Rating summary of Calapooya Watershed monitoring sites. See the individual parameter's summary for the criteria used in establishing the color. Used worst rating between summer and winter data, and spawning and non-spawning season. Brown indicates creeks that went dry for several months during the summer.

Upper Umpqua

Area Description, Background & Monitoring Sites

The area addressed in this assessment is the Upper Umpqua River Watershed, a 169,676-acre area in the Umpqua River sub-basin that drains into the Umpqua River from the confluence with Elk Creek upstream to the confluence with the North and South Umpqua rivers (also known as River Forks). Calapooya Creek, a large tributary that flows into the Umpqua River approximately eight miles downstream of River Forks, was not included in this watershed assessment because it was addressed in a separate watershed assessment in 2003. (PUR monitored the Calalpooya as its own Fifth-field Watershed which is included at the beginning of this document.) The Upper Umpqua includes 62 stream miles of the Umpqua River. The Upper Umpqua Watershed stretches a maximum of 27 miles north to south and 12 miles east to west Kellogg, Tyee, Millwood, Umpqua, and Cleveland are the only population centers within the watershed. Highway 138 (Elkton-Sutherlin Highway) runs north-south, paralleling the Umpqua River in the northern part of the watershed. It is a major connecting route between the Umpqua Valley and the coast.

The watershed drains a varied landscape, from steep-sloped, highly-dissected headwaters to low gradient broad floodplains. Steep slopes and rock outcrops characterize the upland terrain. Many small, high-gradient streams with deeply incised channels originate from headwalls at higher elevations. The major tributary streams within the watershed flow generally from headwaters in the Coast Range to the mainstem of the Umpqua River. Upstream of the Upper Umpqua River Watershed, the North Umpqua and South Umpqua rivers collect water from tributaries as far eastward as the crest of the Cascade Mountains. The alluvial valley width is highly variable, averaging approximately 1,000 feet but reaching a maximum of two miles in width. Over 90% of the floodplain is in private ownership, approximately 40% of which has been converted from native vegetation to agriculture.

The Umpqua Basin lies at the intersection of three physiographic provinces: the Coast Range, the Klamath Mountains, and the Western Cascades. All of the Upper Umpqua River Watershed occurs in the Coast Range Province. Uplifted geological strata in the watershed are largely marine sedimentary rocks, interspaced with some basalt formations.

Geologic processes govern the topography of an area, which in turn greatly influences the morphology of streams. The hydraulic conductivity, or permeability, of rock units, plays a significant role in determining the groundwater inputs to streams, and groundwater can contribute to stream water quality. Generally, groundwater has more consistently high quality than surface water. However, many streams in mountainous areas, such as the Upper Umpqua River Watershed, are naturally surface-water dominated, with groundwater playing a relatively minor role.

Streams in the watershed are characteristically “flashy.” They respond very quickly to rainfall by rapidly increasing discharge due to the steep topography in some portions of the watershed, high stream density, and intensity of the precipitation. High flows typically occur between November and March and low flows from May through October.

Daily streamflow records have been collected for the Umpqua River near Elkton by the USGS since 1906 (Station 14321000). The annual low flow for the Umpqua River averages less than 2,000 cubic feet per second (CFS) during July through October, and the annual high flow is generally near 16,000 CFS in January (Figure 1.1)

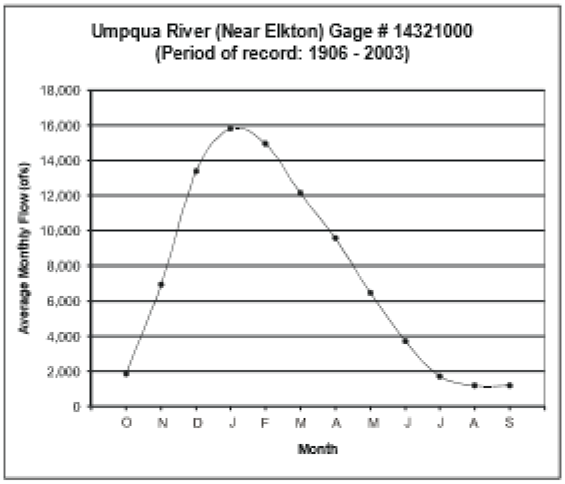


Figure 1.1. Average monthly Umpqua River discharge near Elkton.

Table 1.5 Land ownership in the Upper Umpqua River Watershed.

Ownership	Area (acres)	Percent of Upper Watershed
Federal	57,040	33.6
Private	109,693	64.6
State	312	0.2
Water	2,631	1.6

In the Upper Umpqua River Watershed, slopes range from 0% to 4% in the floodplains along the mainstem Umpqua River. The steepest lands (greater than 85% slope) are found mainly in the western portions of the watershed adjacent to many of the tributary streams.

Within the Upper Umpqua River Watershed, private lands are interspersed with federal lands throughout the watershed. Most of the private lands are managed as tree farms to produce wood fiber on forest rotations of between 40 and 50 years. On BLM lands, natural stands are interspersed with younger, managed plantations.

There are many recreational opportunities in the watershed. These include fishing, boating, camping, picnicking, hiking, mountain biking, and sightseeing. Fishing is very popular for spring and fall chinook, winter and summer steelhead, smallmouth bass, and shad. Many anglers fish from boats, which are commonly launched at Umpqua Landing, Yellow Creek, James Wood Boat Ramp, or Osprey Boat Ramp. There are several take-outs, improved and primitive. Bank angling is common.

The Upper Umpqua Watershed is designated a Salmon and Trout Rearing and Migration area as established by DEQ and included in the Umpqua Basin Temperature TMDL. See Appendix I.

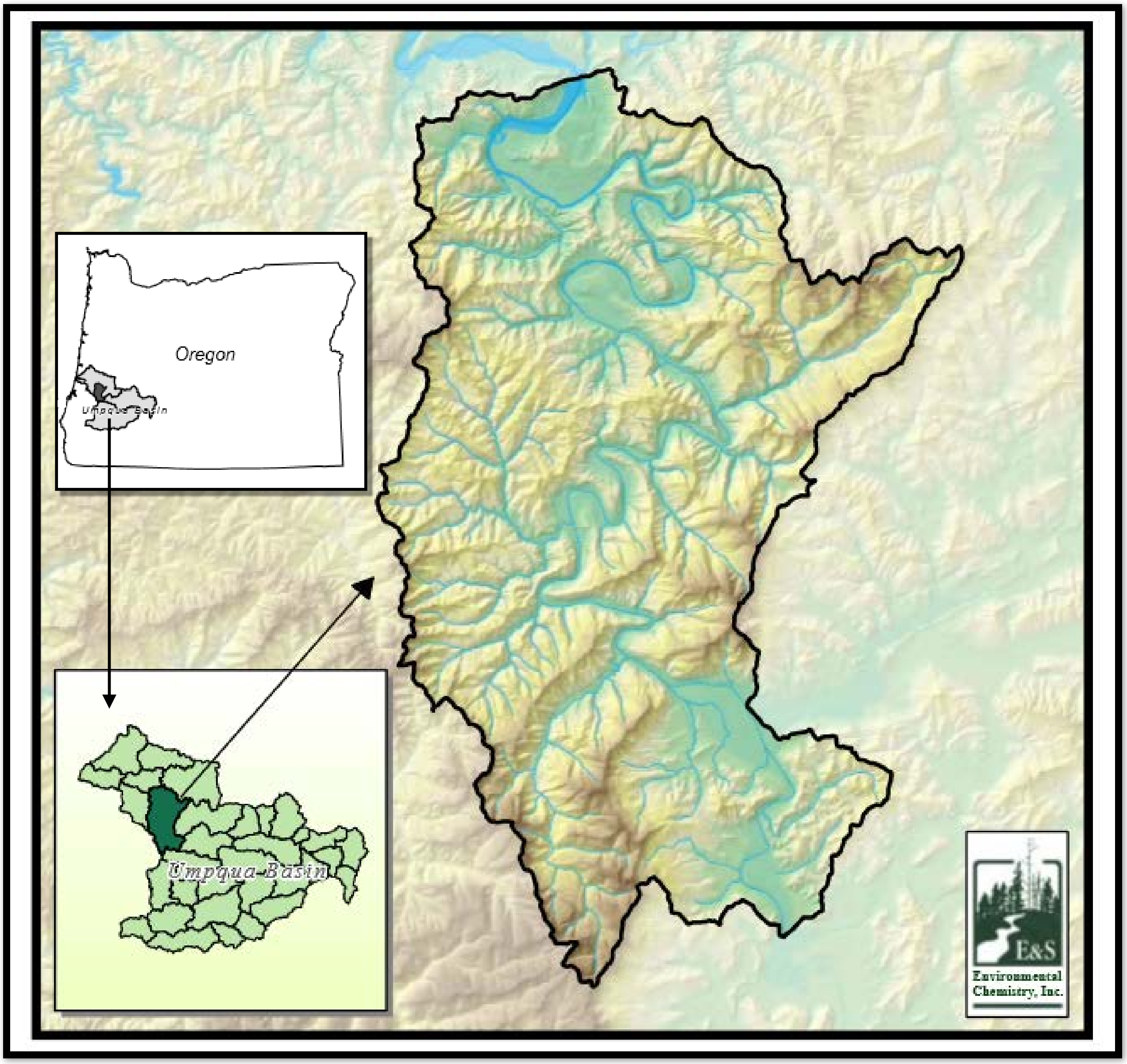
The Upper Umpqua River Watershed is home to many fish species. Table 3.23 lists many common fish species in the watershed that have viable, reproducing populations. In addition to salmon and trout, many warm-water fish, including largemouth bass (Micropterus salmoides), yellow perch (Perca flavescens), and bluegill (Lepomis macrochirus) reside in the watershed. The Umpqua River is well known throughout Oregon and elsewhere for its excellent smallmouth bass (Micropterus dolomieu) fishing opportunities. These fish were introduced to portions of the Upper Umpqua River Watershed.

Table 3.23. Fish with established populations or runs within the Upper Umpqua River Watershed. (Source: ODFW 2004)

Category	Common Name	Scientific Name
Native Salmonid Species	Coho salmon	*Oncorhynchus kisutch*
	Chinook salmon (spring and fall)	*Oncorhynchus tshawytscha*
	Steelhead (winter and summer)/ Rainbow trout	*Oncorhynchus mykiss*
	Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*
Other Native Fish Species	Pacific lamprey	*Lampetra tridentata*
	Western brook lamprey	*Lampetra richardsoni*
	River lamprey	*Lampetra ayresi*
	Umpqua chub	*Oregonichthuys kalawatseti*
	Three-spined stickleback	*Gasterosteus aculeatus*
	Sculpin (various sp.)	*Cottus species*
	Redside shiner	*Richardsonius balteatus*
	Umpqua dace	*Rhinicthys cataractae*
	Speckled dace	*Rhinicthys osculus*
	Long nose dace	*Rhinicthys cataracatae*
	Umpqua pikeminnow	*Ptychocheilus umpquae*
	Largescale sucker	*Catostomus macrocheilus*
	Green sturgeon	*Acipenser medirostris*
	White sturgeon	*Acipenser transmontanus*
Non-Native Fish Species	Smallmouth bass	*Micropterus dolomieu*
	Largemouth bass	*Micropterus salmoides*
	Striped bass	*Morone saxatilis*
	Crappie	*Pomoxis* spp.
	Yellow perch	*Perca flavescens*
	Mosquito fish	*Gambusia affinis*
	Fathead minnow	*Pimephales promelas*
	Bluegill	*Lepomis macrochirus*
	American shad	*Alusa sapidissima*
	Brown bullhead	*Ameiurus nebulosus*

All of the above information has come directly from the Umpqua Basin Watershed Council's Upper Umpqua River Watershed Assessment (Snyder, 2006). This document is available on the Partnership for the Umpqua Rivers Website (https://www.umpquarivers.org/) where more information is available about this watershed.

PUR's strategy for water quality monitoring is to monitor fifth-field by fifth-field for 3 years of intensive monitoring at many locations. After three years the next fifth-field will be chosen and monitored intensively. As three years at each fifth-field is completed, the intensively monitored phase, it transitions to a few representative sites that are selected to maintain as reference sites. This report completes the first three years of intensive monitoring of the Upper Umpqua 5th-field Watershed.



Map 4. **Upper Umpqua Watershed Map and Area Maps**

Photo 3. **Umpqua River at Yellow Creek Boat Ramp, YC1, Winter 1/31/2018**

Photo 4. **Umpqua River at Yellow Creek Boat Ramp, YC1, Summer 7/25/2018**

Photo 5. **Hedding Creek at Mehl Creek Rd., HDC1, Winter 1/25/2017**

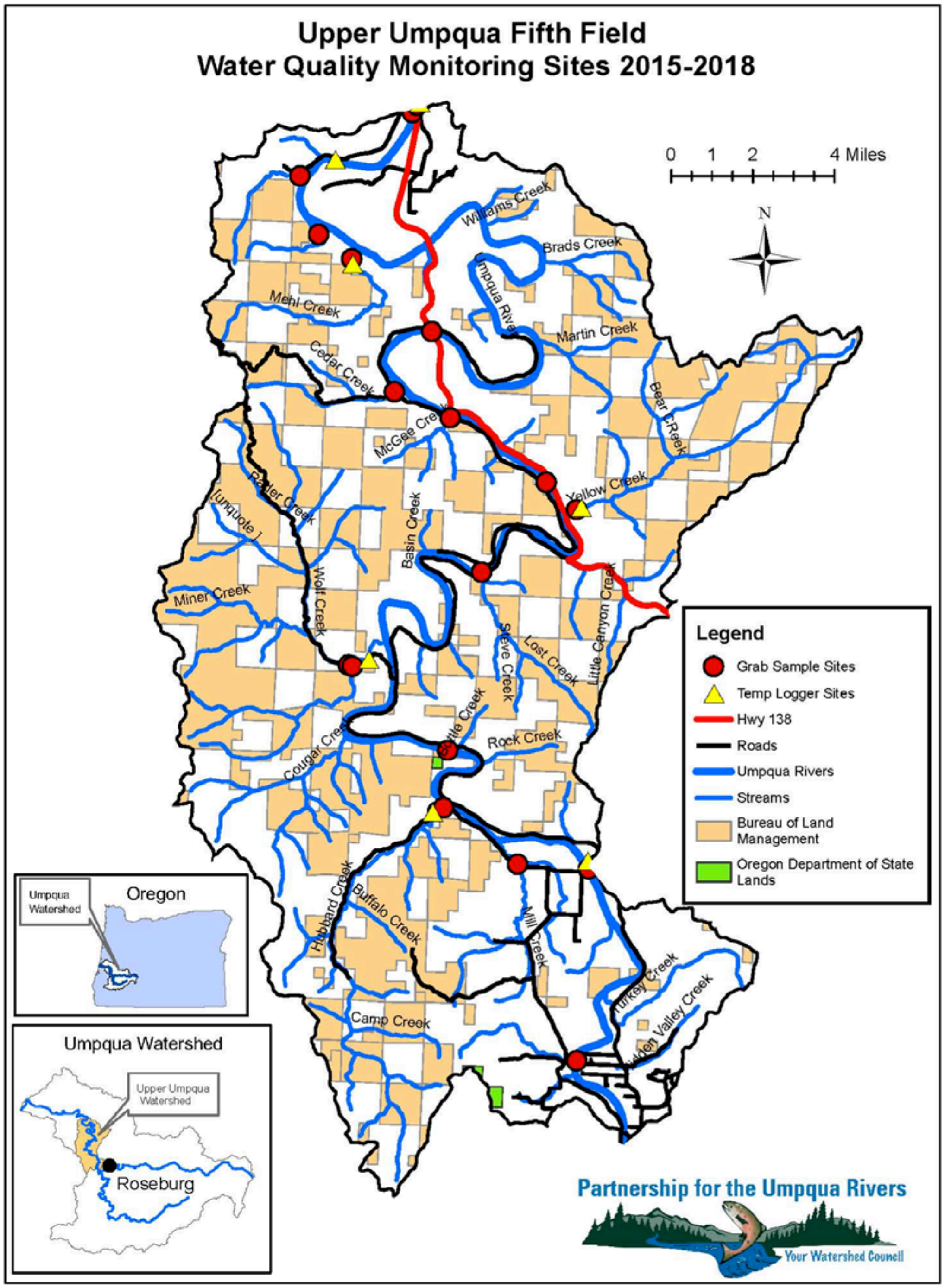
Photo 6. **Hedding Creek at Mehl Creek Rd., HDC1, Summer 7/27/2017**

	Site ID	River/Stream	Site Location	LASAR ID	Latitude	Longitude	Township, Range, Section
1	U1	Umpqua	At Cleveland Rapids Park		43.297304	-123.470718	T26S R7W S24
2	CC1	Calapooya Creek	At Garden Valley		43.366554	-123.460767	T25S R7W S25
3	MLC1	Mill Creek	At Hubbard Creek Road		43.3663	-123.502	T25S R7W S26
4	HBC1	Hubbard Creek	At Hubbard Creek Road		43.3854	-123.539	T25S R7W S21
5	U2	Umpqua	At James Woods Boat Ramp		43.40547	-123.53656	T25S R7W S9
6	LWC1	Little Wolf Creek	At Tyee Access Road Bridge	27902	43.4344	-123.586	T24S R8W S36
7	WC1	Wolf Creek	Upstream Little Wolf Creek		43.4347	-123.588	T24S R8W S36
8	LC1	Lost Creek	At Tyee Road		43.4696	-123.525	T24S R7W S21
9	YC1	Yellow Creek	At Yellow Creek Rd.		43.493092	-123.478383	T24S R7W S12
10	U3	Umpqua	At Yellow Creek Boat Ramp		43.501728	-123.493810	T24S R7W S11
11	MGC1	McGee Creek	At Bullock Road		43.523848	-123.542379	T23S R7W S33
12	U4	Umpqua	At State Hwy 138 W		43.5544	-123.554	T23S R7W S20
13	MHLC1	Mehl Creek	At Mehl Creek Road	28349	43.579498	-123.594674	T23S R8W S12
14	FC1	Fitzpatrick Creek	At Mehl Creek Road		43.5873	-123.611	T23S R8W S11
15	HDC1	Hedding Creek	At Mehl Creek Road		43.6079	-123.621	T22S R8W S35
16	U5	Umpqua	At Mehl Creek Road Bridge	10437	43.6319	-123.567	T22S R7W S30
17	EC1	Elk Creek	At State Hwy 138 W Bridge	10441	43.6346	-123.565	T22S R7W S29

Table 19. Upper Umpqua Water Quality Monitoring Sites.

	Site ID	River/Stream	Site Location	LASAR ID	Latitude	Longitude	Township, Range, Section
1	CC2	Calapooya Creek	At Umpqua Landing Boat Ramp		43.36599	-123.46625	T25S R6W S30
2	HDC1	Hubbard Creek	At Hubbard Creek Road		43.3854	-123.539	T25S R7W S21
3	U2	Umpqua River	At James Wood Boat Ramp		43.40547	-123.53656	T25S R7W S26
4	WFC1	Wolf Creek	Near Mouth		43.4363	-123.5797	T24S R7W S31
5	YC1	Yellow Creek	At State Hwy 138 W		43.4913	-123.485	T24S R7W S12
6	U3	Umpqua	At Yellow Creek Boat Ramp		43.5023	-123.495	T24S R7W S11
8	MHLC1	Mehl Creek	At Mehl Creek Road	28349	43.5792	-123.594	T23S R8W S12
9	FC1	Fitzpatrick Creek	At Mehl Creek Road		43.5873	-123.611	T23S R8W S11
10	HGC1	Hedding Creek	At Mehl Creek Road		43.6079	-123.621	T22S R8W S35
11	U4.5	Umpqua	2-3 miles upstream of Elkton		43.61433	-123.6044	T22S R8W S36
12	EC1	Elk Creek	At State Hwy 138 W Bridge	10441	43.6346	-123.565	T22S R7W S29

Table 20. Upper Umpqua Temperature Recorder Monitoring Sites.



Map 5. **Upper Umpqua Fifth Field water quality monitoring sites.**

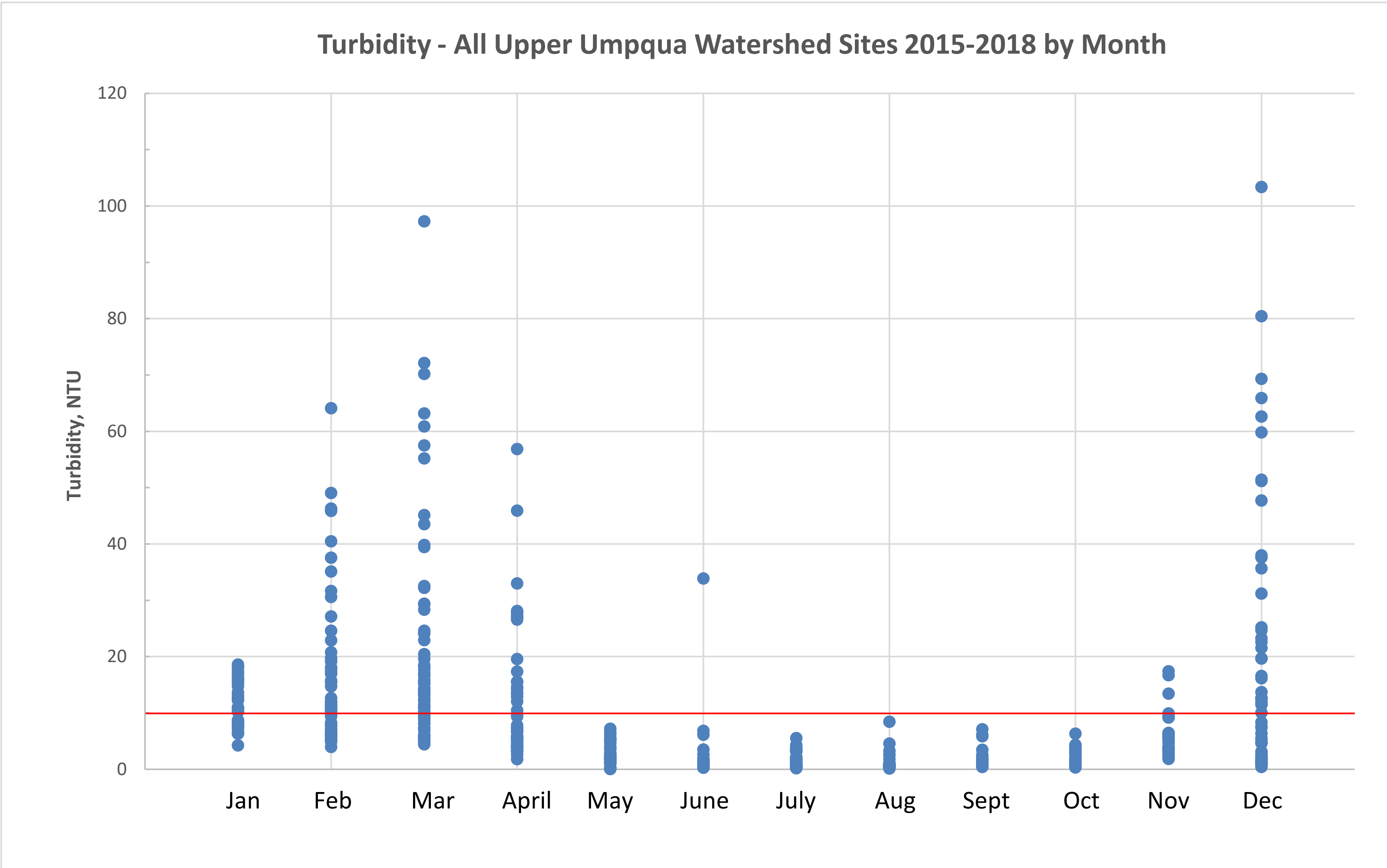
RESULTS – Upper Umpqua Watershed Turbidity 2015-2018

Turbidity levels in the Umpqua Basin are commonly seen to have elevated levels during the winter months coinciding with periods of elevated rain and streamflow. Graph 24 displays three years of monitoring data summarized by month for the Upper Umpqua Watershed. This indicates that the extreme levels of turbidity occurred during December, as well as toward spring months, February, March, and April. Graph 25 also displays this trend. This may be due to more rain in the spring as indicated in Appendixes K-M. If we had continuous data for turbidity it might have matched even better.

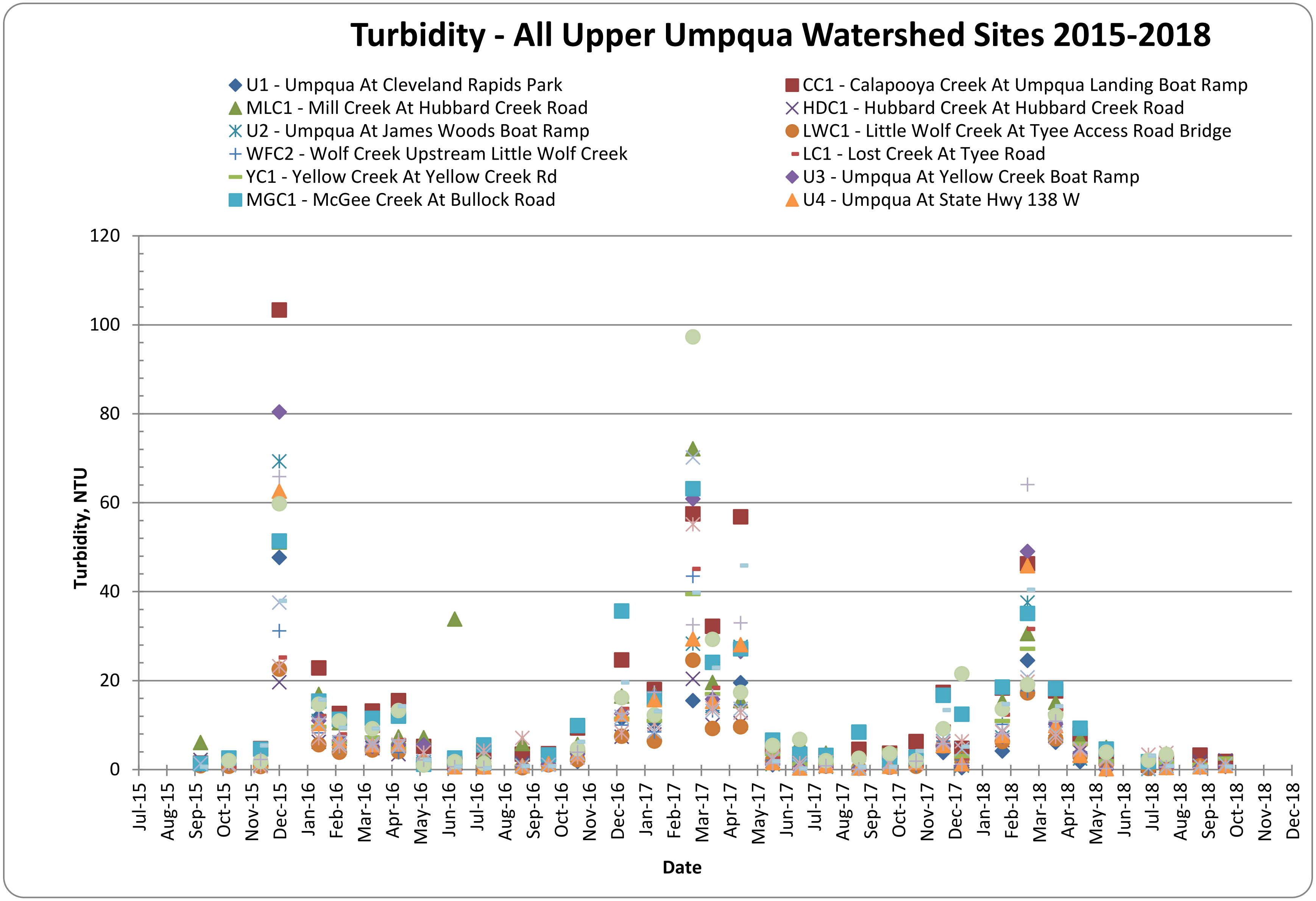
McGee Creek at Bullock Road (CMGC1) exhibits the most occurrences of high turbidity with 47% of its samplings being greater than 10 NTU (See Table 20). None of its summer samplings and 64% of winter samplings occurred over 10 NTU (See Table 21). It was not, however, the creek exhibiting the highest turbidity. Graph 25 and 26 indicate that the highest turbidity levels occurred in Calapooya Creek at Garden Valley Road near its mouth. The high levels in Graph 26 appear as outliers when plotted as box plots. They are, however, real events correlating to storm events.

Table 21, which rates all the monitoring locations for summer and winter exceedances greater than 10 NTU, indicates that the sites have little concern for turbidity from May 1-Sept 30 but all except for Little Wolf Creek and Hubbard Creek are of Extreme Concern between Oct 1-April 30.

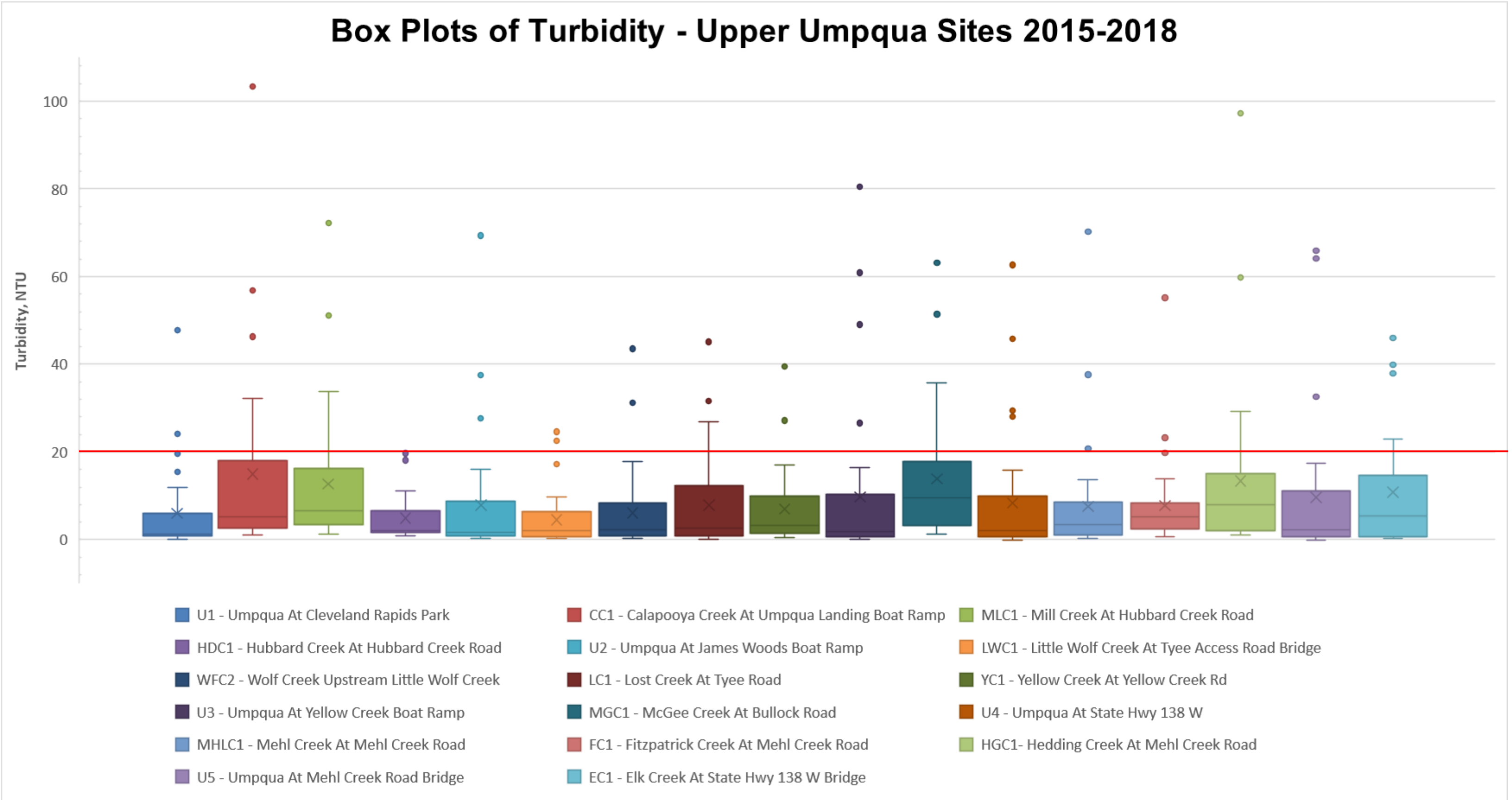
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of six tributaries went to a puddled or dry state. They included: HB1 -Hubbard Creek at Hubbard Creek Road (1 month during the three years); LWC1 – Little Wolf at Tyee Access Road (1 month during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 month during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1 - Hedding Creek at Mehl Creek Road (4 months during the three years).



Graph 24. Turbidity levels in the Upper Umpqua Watershed for all sites, all monitoring events by month.



Graph 25. Turbidity levels by date and site for the Upper Umpqua Watershed sites.



Graph 26. Box Plots of Turbidity Levels for the Upper Umpqua Watershed by site 2015-2018.

Turbidity Levels Upper Umpqua 2015-2018	10 NTU's or Greater		Total
Station ID - Site Description	Count	% of Samples	# of Samples
U1 - Umpqua At Cleveland Rapids Park	8	22%	36
CC1 - Calapooya Creek At Umpqua Landing Boat Ramp	14	39%	36
MLC1 - Mill Creek At Hubbard Creek Road	13	41%	32
HDC1 - Hubbard Creek At Hubbard Creek Road	6	17%	36
U2 - Umpqua At James Woods Boat Ramp	8	22%	36
LWC1 - Little Wolf Creek At Tyee Access Road Bridge	3	9%	35
WFC2 - Wolf Creek Upstream Little Wolf Creek	7	19%	36
LC1 - Lost Creek At Tyee Road	10	29%	35
YC1 - Yellow Creek At Yellow Creek Rd	8	24%	34
U3 - Umpqua At Yellow Creek Boat Ramp	9	26%	35
MGC1 - McGee Creek At Bullock Road	15	47%	32
U4 - Umpqua At State Hwy 138 W	8	24%	34
MHLC1 - Mehl Creek At Mehl Creek Road	7	20%	35
FC1 - Fitzpatrick Creek At Mehl Creek Road	6	19%	31
HGC1- Hedding Creek At Mehl Creek Road	13	43%	30
U5 - Umpqua At Mehl Creek Road Bridge	9	27%	33
EC1 - Elk Creek At State Hwy 138 W Bridge	12	38%	32

Table 21. Summary by the site of turbidity levels equal to or exceeding 10 NTUs.

Turbidity Levels, Summer and Winter, Upper Umpqua Watershed Sites 2015-2018

SITE	Summer (May 1 - Sept.30)				Winter (Oct 1-April 30)		
	Sample Events Dry/ Puddled	Total # Samples	# > 10 NTU	% > 10 NTU	Total # Samples	# > 10 NTU	% > 10 NTU
U1 Umpqua at Cleveland Rapids Park		14	0	0%	22	8	36.4%
CC1 Calapooya Creek at Garden Valley		9	0	0%	27	13	48.1%
MLC1 Mill Creek at Hubbard Creek Road		9	1	11.1%	22	11	50.0%
HBC1 Hubbard Creek at Hubbard Creek Road	1	14	0	0%	22	4	18.2%
U2 Umpqua at James Woods Boat Ramp		13	1	7.7%	23	7	30.4%
LWC1 Little Wolf Creek at Tyee Access Road Bridge	1	13	0	0%	22	2	9.1%
WC1 Wolf Creek Upstream Little Wolf Creek		14	0	0%	22	6	27.3%
LC1 Lost Creek at Tyee Road		13	0	0%	22	10	45.5%
YC1 Yellow Creek at Yellow Creek Rd.		12	0	0%	21	7	31.8%
U3 Umpqua at Yellow Creek Boat Ramp		14	0	0%	22	9	40.9%
MGC1 McGee Creek at Bullock Road	2	10	0	0%	22	14	63.6%
U4 Umpqua at State Hwy 138 W		13	0	0%	21	8	38.1%
MHLC1 Mehl Creek at Mehl Creek Road	1	13	0	0%	22	7	31.8%
FC1 Fitzpatrick Creek at Mehl Creek Road	4	11	1	9.1%	20	5	25.0%
HDC1 Hedding Creek at Mehl Creek Road	4	14	0	0%	22	5	22.7%
U5 Umpqua at Mehl Creek Road Bridge		12	1	8.3%	21	8	38.1%
EC1 Elk Creek at State Hwy 138 W Bridge		12	1	8.3%	20	12	60.0%

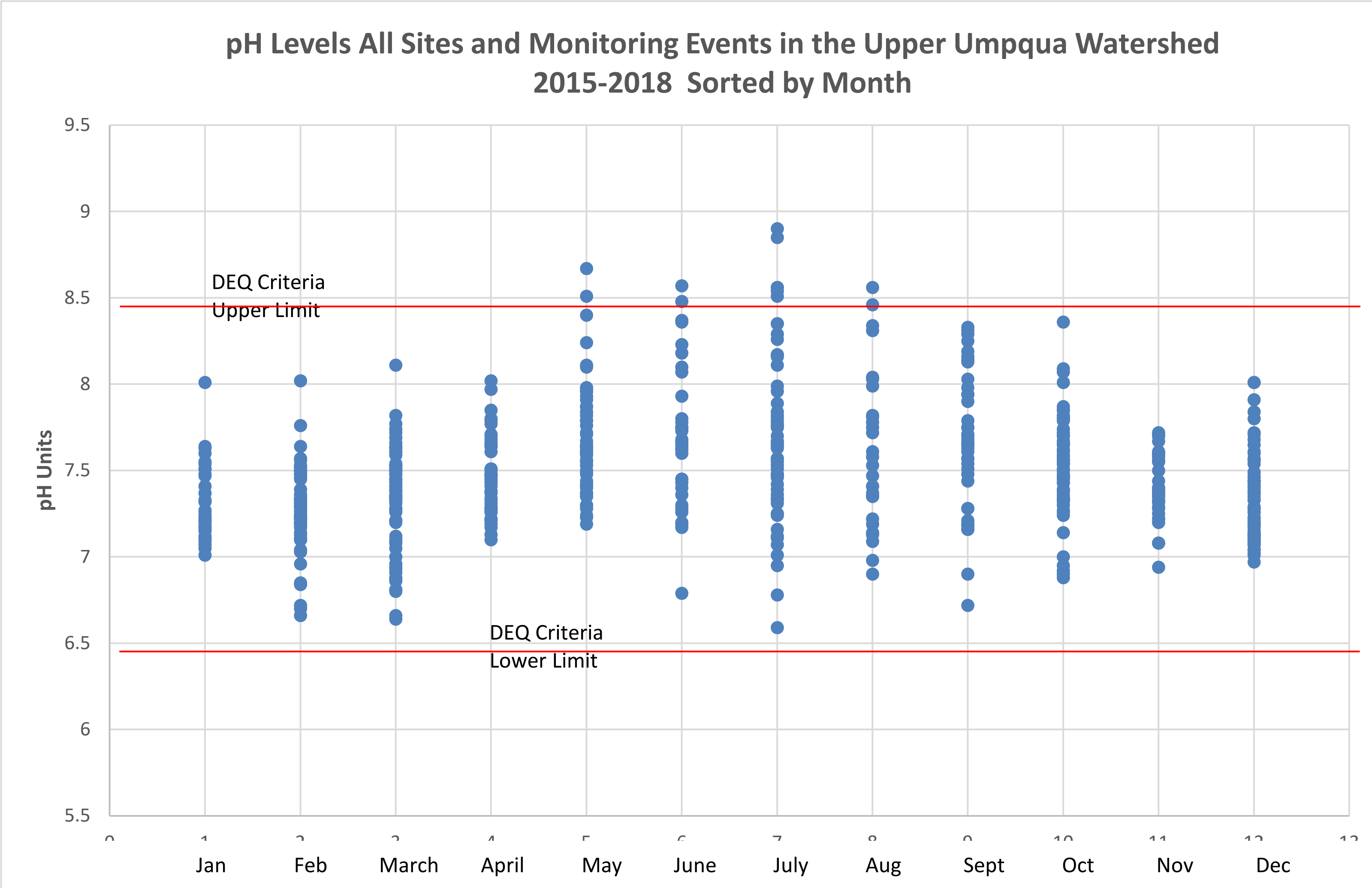
Table 22. Turbidity Levels, Summer, and Winter, Upper Umpqua Watershed Sites 2015-2018 with color key ratings.

Color Key:	Level of Concern	Color Key Evaluation Criteria
(blue)	No Concern	< 10 NTU
(green)	Low Concern	Between 1 % and 9% of samples ≥10NTU
(yellow)	High Concern	Between 10% and 20% ≥10 NTU
(red)	Extreme Concern	20% or more ≥10 NTU
(olive)	Dry/Puddled	Dry 1 or more sampling events

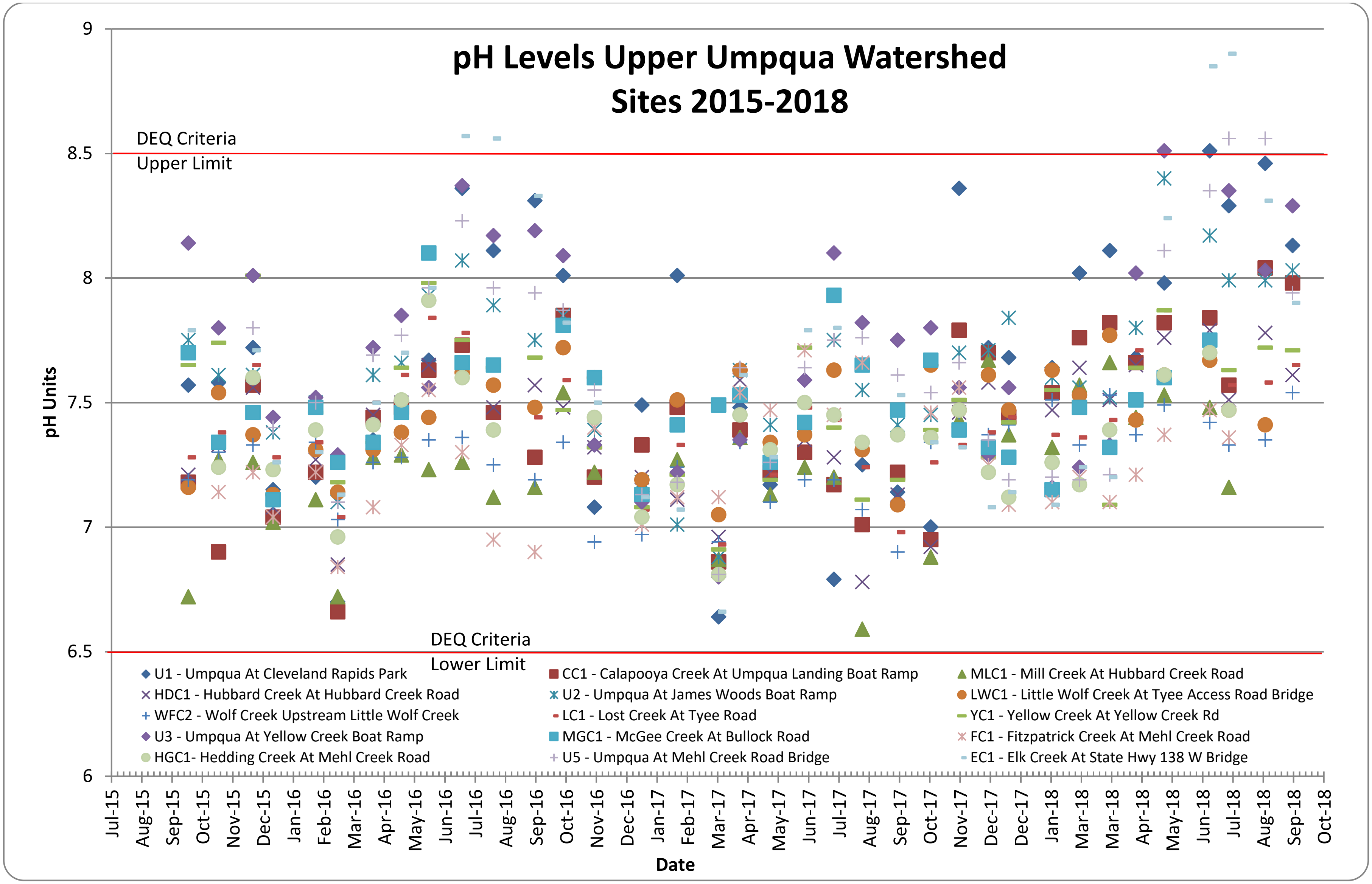
RESULTS – Upper Umpqua Watershed pH 2015-2018

PH values were measured monthly, year-round, for three years and no sites fell below DEQ's lower standard criteria of 6.5. Graph 27 indicates that in May, June, July, and August exceedances above the 8.5 pH DEQ upper exceedance criteria were detected. From Graph 28 and 29, it is easy to see that these occurred at five sites: the Umpqua at Mehl Creek Road, the Umpqua at State Hwy 138W and Elk Creek at State Hwy 138 W Bridge were bad enough to be rated red (Extreme Concern). The other two, the Umpqua at Cleveland Rapids Park and the Yellow Creek Boat Ramp were designated yellow (Moderate Concern) Rating because of a single exceedance of 8.5 which likely may have exceeded 8.5 more times if we had been able to conduct continuous pH measurements throughout the day and on more days.

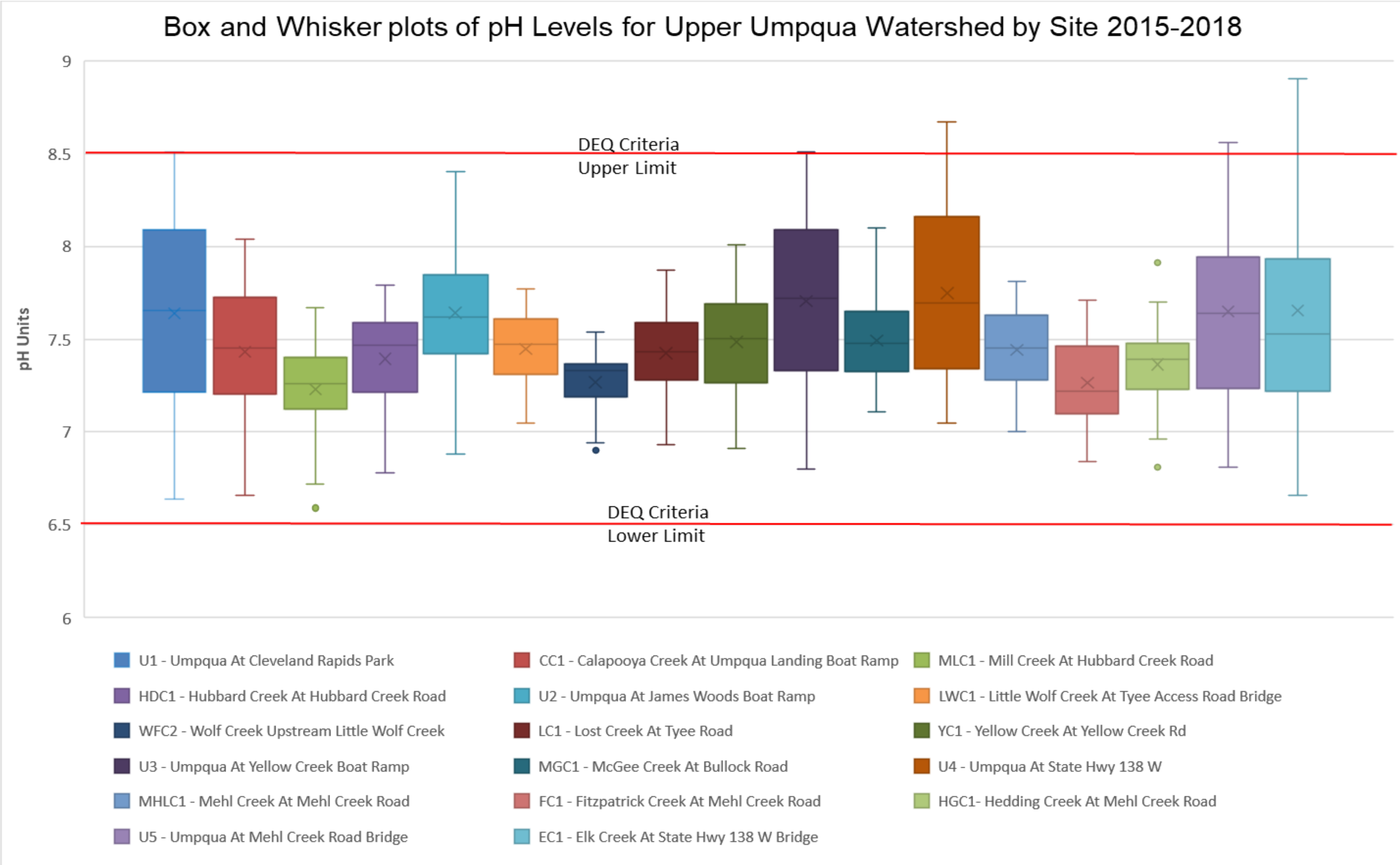
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of six tributaries went to a puddled or dry state. They included: HB1 -Hubbard Creek at Hubbard Creek Road (1 month during the three years); LWC1 – Little Wolf at Tyee Access Road (1 month during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 month during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1 - Hedding Creek at Mehl Creek Road (4 months during the three years).



Graph 27. pH levels Upper Umpqua Watershed 2015-2018, all sites, all data sorted by month.



Graph 28. pH levels Upper Umpqua Watershed monitoring sites by date 2015-20118.



Graph 29. Box and Whisker plots of pH levels for Upper Umpqua Watershed by site 2015-2018.

SITE	Sample Events Dry/ Puddled	Upper pH Rating	Lower pH Rating
U1 Umpqua at Cleveland Rapids Park		Yellow	Green
CC1 Calapooya Creek at Garden Valley		Blue	Green
MLC1 Mill Creek at Hubbard Creek Road		Blue	Yellow
HBC1 Hubbard Creek at Hubbard Creek Road	1	Blue	Blue
U2 Umpqua at James Woods Boat Ramp		Blue	Blue
LWC1 Little Wolf Creek at Tyee Access Road Bridge	1	Blue	Blue
WC1 Wolf Creek Upstream Little Wolf Creek		Blue	Blue
LC1 Lost Creek at Tyee Road		Blue	Blue
YC1 Yellow Creek at Yellow Creek Rd.		Blue	Blue
U3 Umpqua at Yellow Creek Boat Ramp		Yellow	Blue
MGC1 McGee Creek at Bullock Road	2	Blue	Blue
U4 Umpqua at State Hwy 138 W		Red	Blue
MHLC1 Mehl Creek at Mehl Creek Road	1	Blue	Blue
FC1 Fitzpatrick Creek at Mehl Creek Road	4	Blue	Blue
HDC1 Hedding Creek at Mehl Creek Road	4	Blue	Blue
U5 Umpqua at Mehl Creek Road Bridge		Red	Blue
EC1 Elk Creek at State Hwy 138 W Bridge		Red	Green

Rating	Color	Upper pH Criteria	Lower pH Criteria
No Concern	Blue	None above 8.25	None below 6.75
Low Concern	Green	1 ≥ 8.25	1 ≤ 6.75
Moderate Concern	Yellow	2 or more ≥ 8.25 or 1 ≥ 8.5	2 ≤ 6.75 or 1 ≤ 6.5
Extreme Concern	Red	2 or more ≥ 8.5	2 or more ≤ 6.5
Dry/Puddled	Olive	Dry/Puddled	Dry 1 or more attempted sampling events

Table 23. PH levels high and low Upper Umpqua Watershed sites 2015-2018 with Color Key ratings.

RESULTS – Upper Umpqua Watershed Dissolved Oxygen 2015-2018

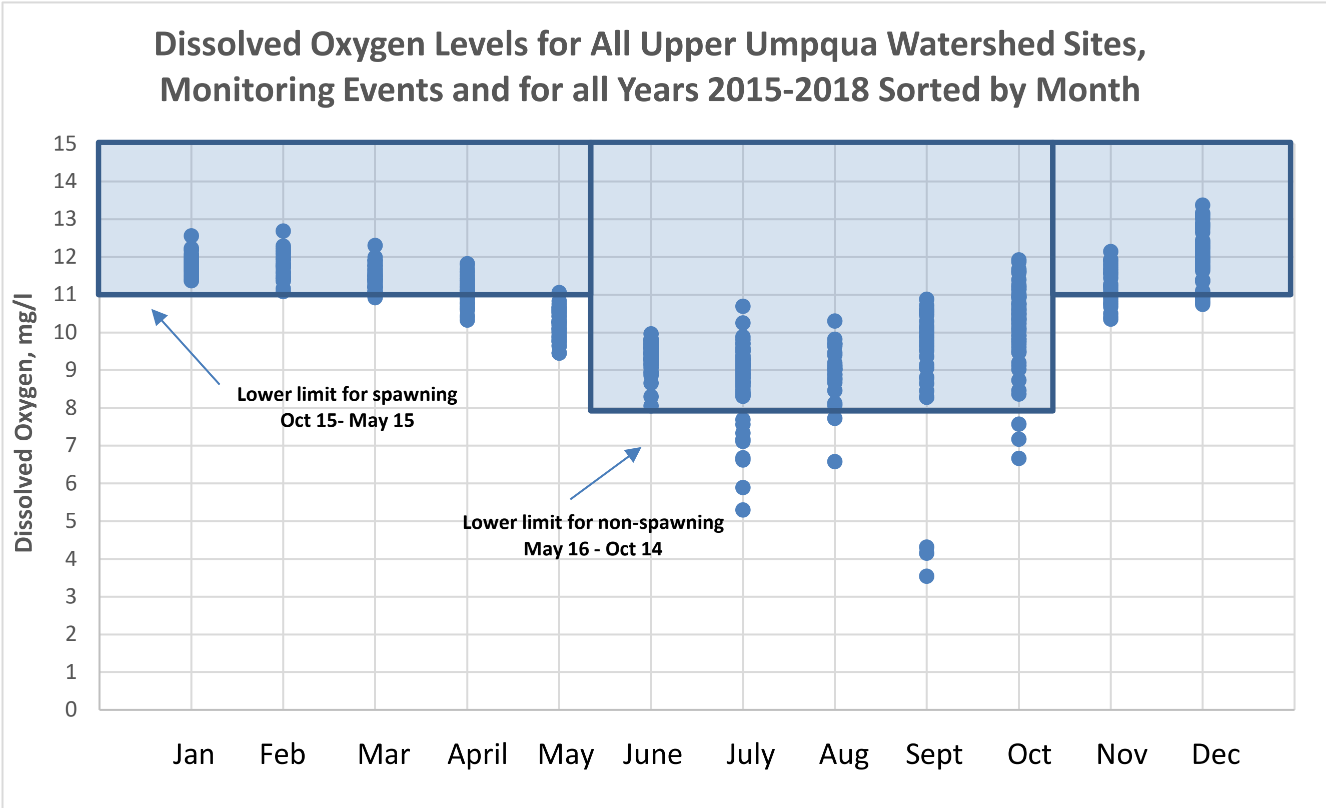
In Graph 30, dissolved oxygen for the Upper Umpqua Watershed 2015-2018 all sites, all data sorted by month, it is apparent that only January and February had no exceedances of the DEQ dissolved oxygen criteria for spawning and March comes very close to having none. Only June had no exceedances for non-spawning criteria.

For the non-spawning season of May 16-October 15 for these watersheds, 14 sites adhered to DEQ minimum criteria of 8 mg/l at the times we monitored. These can be easily seen in Graph 32 where the entire box and whisker of 14 sites are above the 8.5 mg/l line.

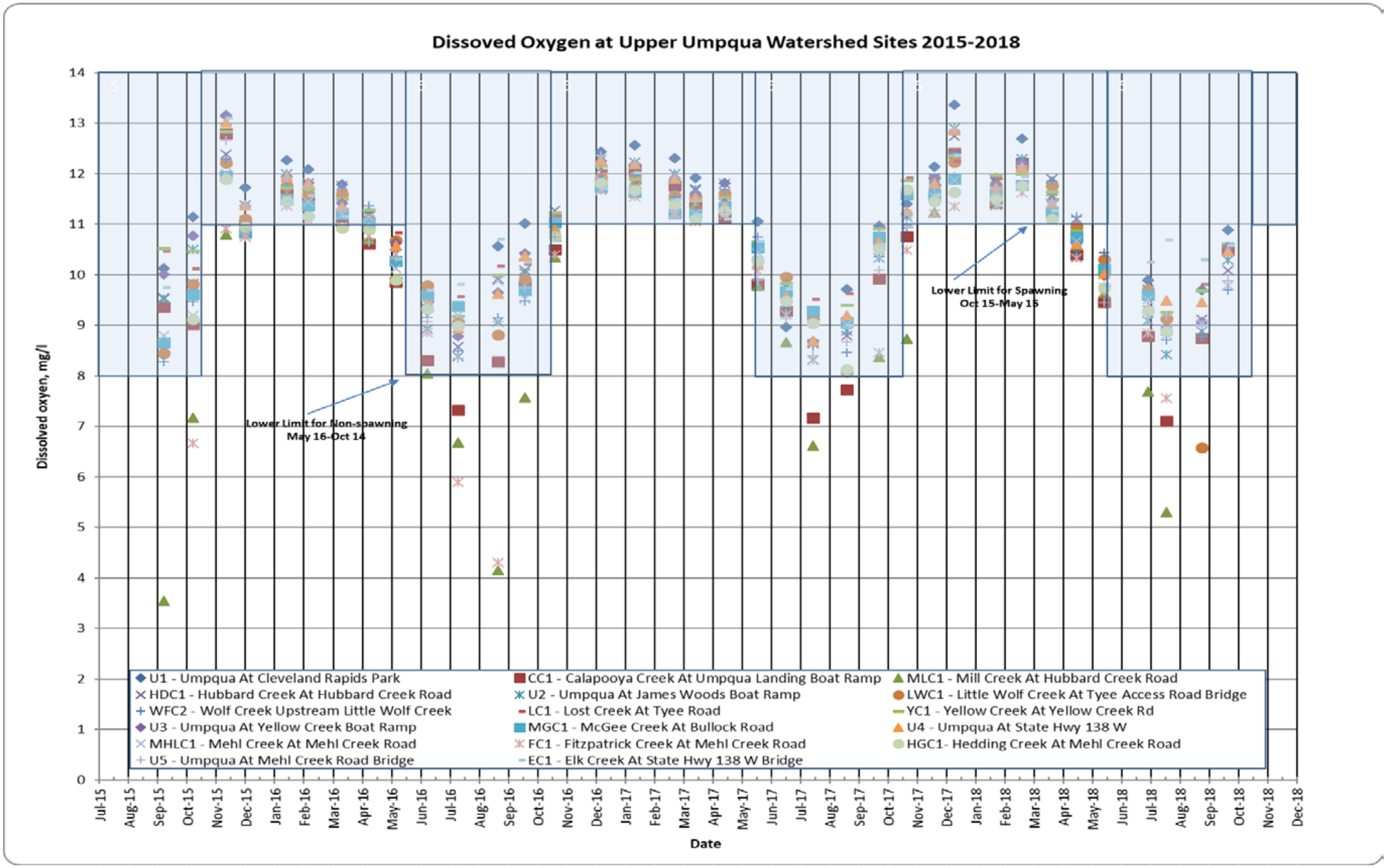
For the spawning season (October 16-May 15) criteria, none of our sites consistently fell within the 11 mg/l dissolved oxygen criteria. Many sites failed to meet criteria 40% of the times sampled (Table 24). This is one of the cases where grab sample monitoring may not have captured the lowest dissolved oxygen value but certainly was sufficient to indicate failing streams.

Two sites fell into the red category for both spawning and non-spawning dissolved oxygen criteria. These were the Calapooya Creek at Garden Valley and Mill Creek at Hubbard Creek Road. Three sites failed to meet dissolved oxygen criteria for Spawning Season only. Those were Mehl Creek at Mehl Creek Road, Fitzpatrick Creek at Mehl Creek Road, and Hedding Creek at Mehl Creek Road.

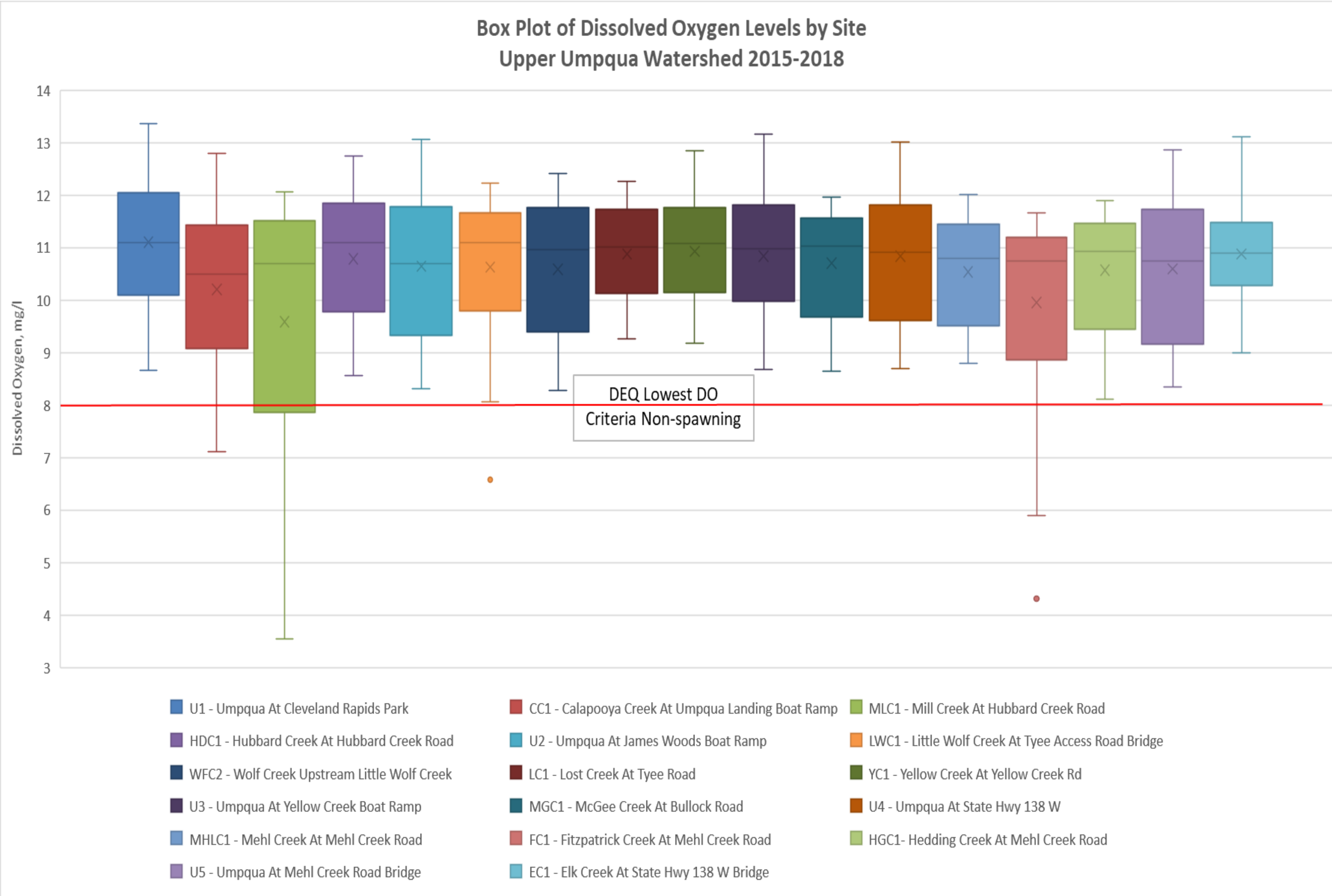
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of six tributaries went to a puddled or dry state. They included: HB1 -Hubbard Creek at Hubbard Creek Road (1 month during the three years); LWC1 – Little Wolf at Tyee Access Road (1 month during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 month during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1
- Hedding Creek at Mehl Creek Road (4 months during the three years).



Graph 30. Dissolved Oxygen for Upper Umpqua Watershed 2015-2018 all sites all data sorted by month.



Graph 31. Dissolved Oxygen levels by site and date in the Upper Umpqua Watershed, with DEQ Criteria for spawning and non-spawning times of the year.



Graph 32. Box Plot of Dissolved Oxygen levels of sites in the Upper Umpqua Watershed 2015-2018.

	Non-spawning Season May 16-October 14					Spawning Season October 15-May 15			
	Sample Events Dry/ Puddled	Total # Samples	# Below Minimum D.O. Criteria of 8 mg/l	% Below Minimum D.O. Criteria of 8 mg/l	Rating	Total # Samples	# Below Minimum D.O. Criteria of 11 mg/l	% Below Minimum D.O. Criteria of 11 mg/l	Rating
U1 Umpqua at Cleveland Rapids Park		16	0	0%		20	1	5%	
CC1 Calapooya Creek at Garden Valley		16	4	25%		20	5	25%	
MLC1 Mill Creek at Hubbard Creek Road		13	7	54%		20	7	35%	
HBC1 Hubbard Creek at Hubbard Creek Road	1	16	0	0%		20	1	5%	
U2 Umpqua at James Woods Boat Ramp		16	0	0%		20	1	5%	
LWC1 Little Wolf Creek at Tyee Access Road Bridge	1	15	1	7%		20	2	10%	
WC1 Wolf Creek Upstream Little Wolf Creek		15	0	0%		21	3	14%	
LC1 Lost Creek at Tyee Road		15	0	0%		20	2	10%	
YC1 Yellow Creek at Yellow Creek Rd.		15	0	0%		19	2	11%	
U3 Umpqua at Yellow Creek Boat Ramp		15	0	0%		20	2	10%	
MGC1 McGee Creek at Bullock Road	2	12	0	0%		20	3	15%	
U4 Umpqua at State Hwy 138 W		15	0	0%		19	3	16%	
MHLC1 Mehl Creek at Mehl Creek Road	1	15	0	0%		20	4	20%	
FC1 Fitzpatrick Creek at Mehl Creek Road	4	11	3	0%		20	8	40%	
HDC1 Hedding Creek at Mehl Creek Road	4	11	0	0%		19	5	26%	
U5 Umpqua at Mehl Creek Road Bridge		15	0	0%		18	3	17%	
EC1 Elk Creek at State Hwy 138 W Bridge		15	0	0%		18	2	11%	

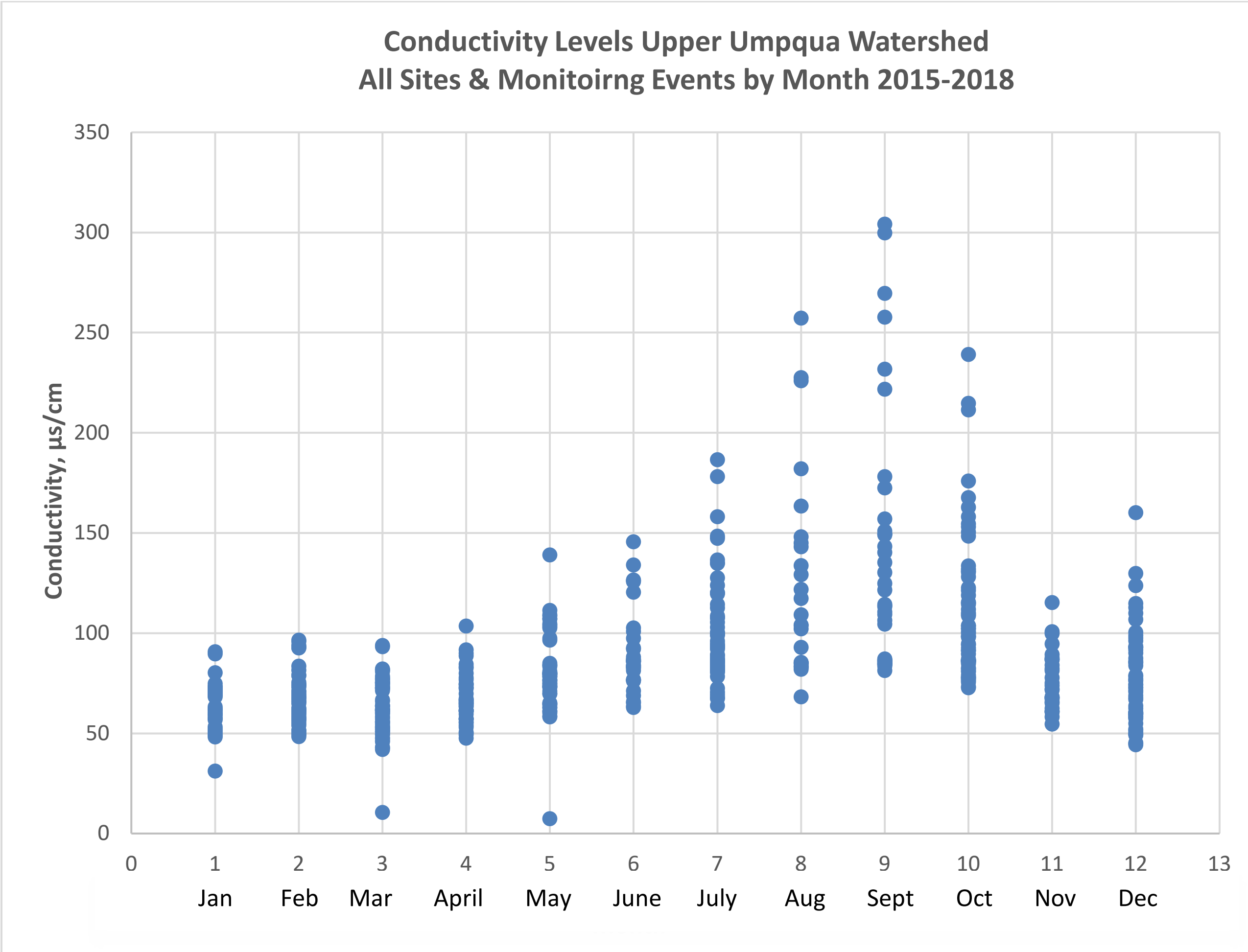
Table 25. Rating of Upper Umpqua 2015-2018 Sites for stream dissolved oxygen levels compared to Spawning Season and Non-Spawning Season DEQ Criteria with Color Key.

Color Key:	Level of Concern	Color Key Evaluation Criteria
	No Concern	0% (No Exceedances)
	Low Concern	≥1% ≤9% Exceedances
	High Concern	≥10% ≤19% Exceedances
	Extreme Concern	≥20% Exceedances
	Dry/Puddled	Dry 1 or more attempted sampling events

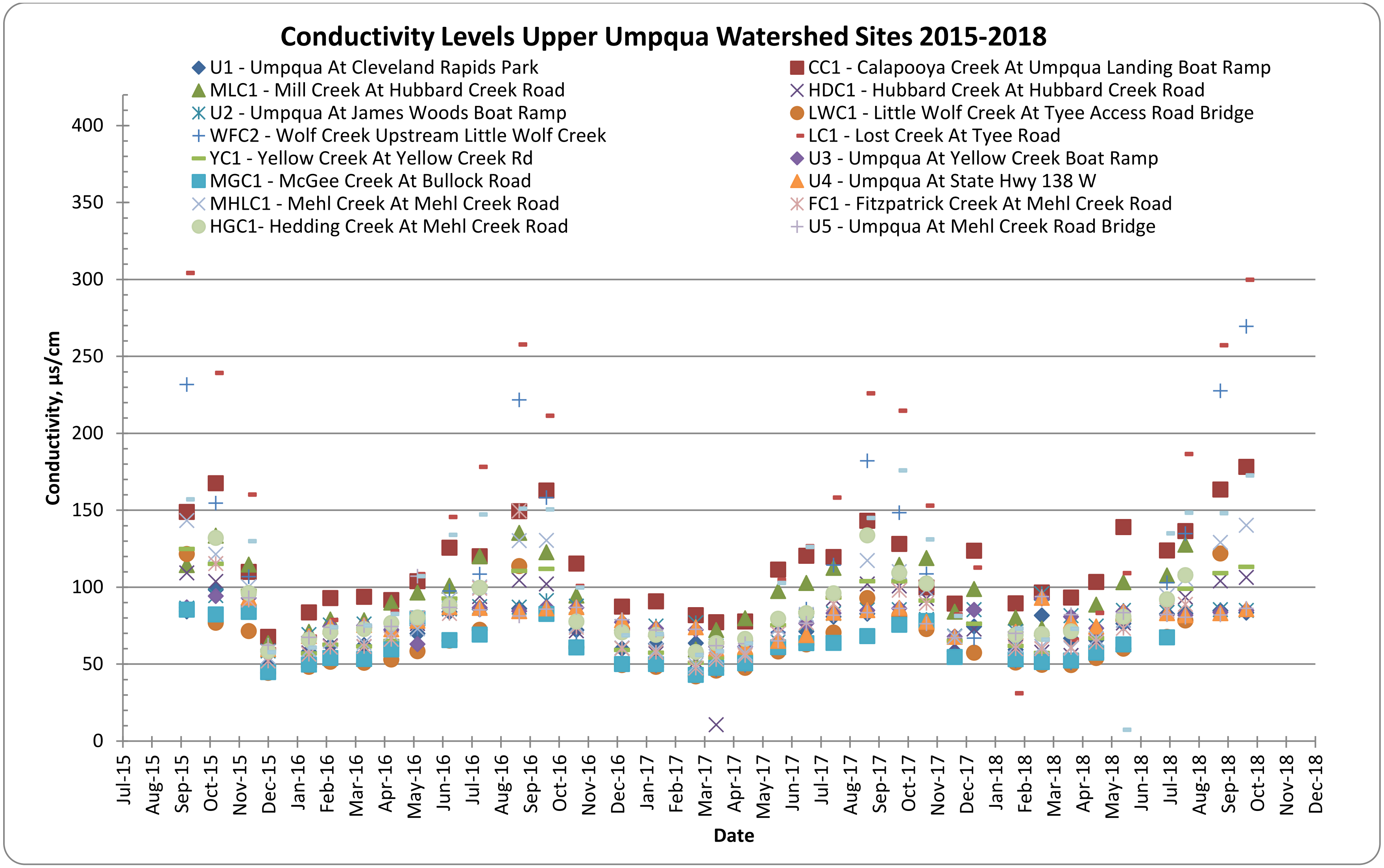
RESULTS – Upper Umpqua Watershed Conductivity 2015-2018

All conductivity levels in the Upper Umpqua monitoring area were within normal ranges for the Umpqua Basin, with none exceeding 500 us/cm. Graph 33 displays an increase in Conductivity through the summer months peaking in September. This is likely due to the reducing flows and increasing concentration of salts and minerals.

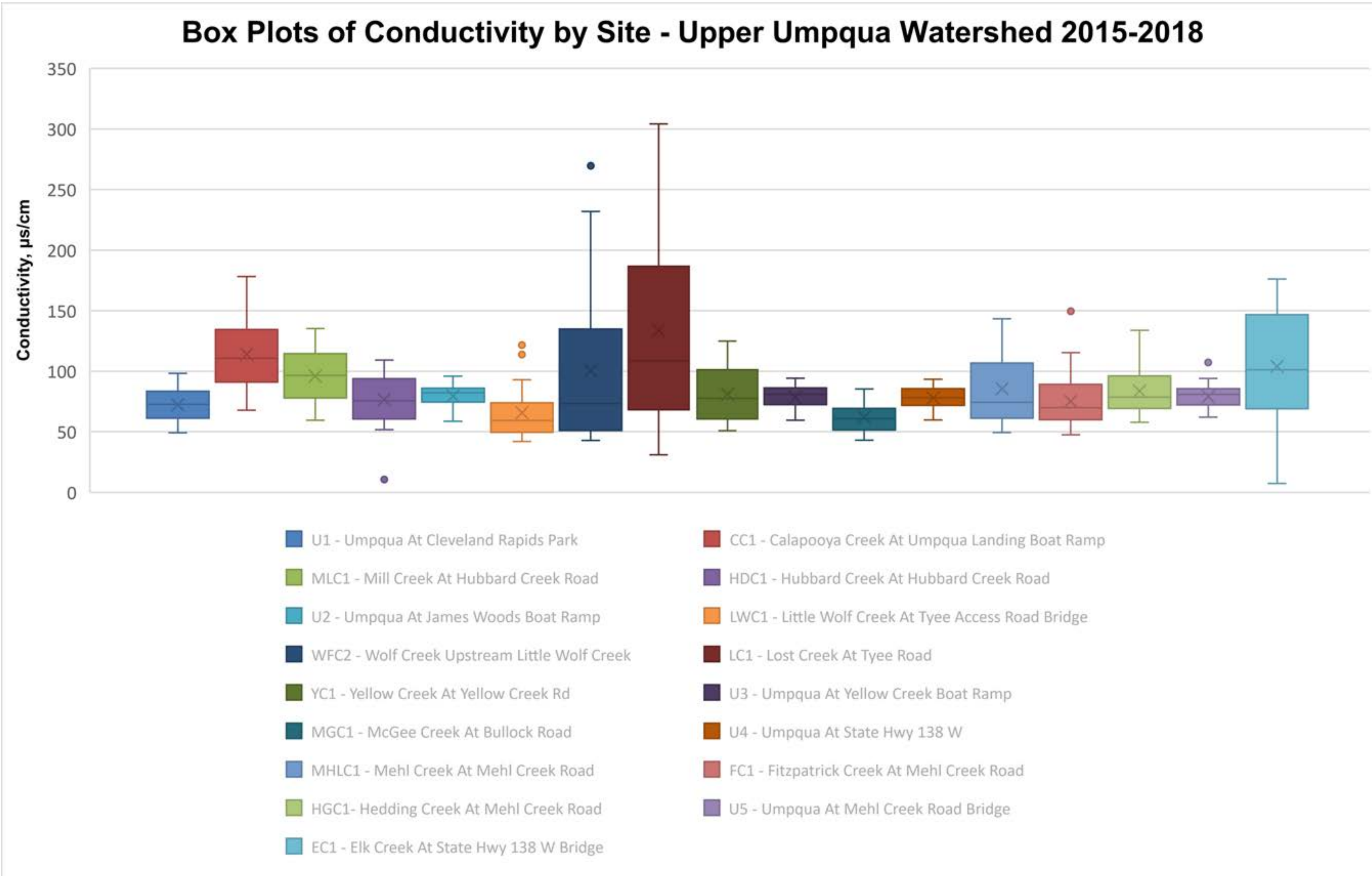
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of six tributaries went to a puddled or dry state. They included: HB1 -Hubbard Creek at Hubbard Creek Road (1 month during the three years); LWC1 – Little Wolf at Tyee Access Road (1 month during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 month during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1 - Hedding Creek at Mehl Creek Road (4 months during the three years).



Graph 33. Conductivity levels all Upper Umpqua Watershed sites and events from 2015-2018 displayed by month.



Graph 34. Conductivity Upper Umpqua Watershed by site and date 2015-2018.



Graph 35. Box plots of conductivity levels for Upper Umpqua Watershed sites 2015-2018.

Conductivity Level Rating Upper Umpqua Watershed Monitoring Sites 2015-2018

	Sample Events Dry/ Puddled	Rating
U1 Umpqua at Cleveland Rapids Park		
CC1 Calapooya Creek at Garden Valley		
MLC1 Mill Creek at Hubbard Creek Road		
HBC1 Hubbard Creek at Hubbard Creek Road	1	
U2 Umpqua at James Woods Boat Ramp		
LWC1 Little Wolf Creek at Tyee Access Road Bridge	1	
WC1 Wolf Creek Upstream Little Wolf Creek		
LC1 Lost Creek at Tyee Road		
YC1 Yellow Creek at Yellow Creek Rd.		
U3 Umpqua at Yellow Creek Boat Ramp		
MGC1 McGee Creek at Bullock Road	2	
U4 Umpqua at State Hwy 138 W		
MHLC1 Mehl Creek at Mehl Creek Road	1	
FC1 Fitzpatrick Creek at Mehl Creek Road	4	
HDC1 Hedding Creek at Mehl Creek Road	4	
U5 Umpqua at Mehl Creek Road Bridge		
EC1 Elk Creek at State Hwy 138 W Bridge		

Rating	Color	Conductivity Level
No Concern		<500 uS/cm
Concern		>500 uS/cm
Dry/Puddled		Dry 1 or more attempted sampling events

Table 26. Conductivity levels rating Upper Umpqua Watershed monitoring sites 2015-2018.

RESULTS - Upper Umpqua Watershed *E. coli* Bacteria 2015-2018

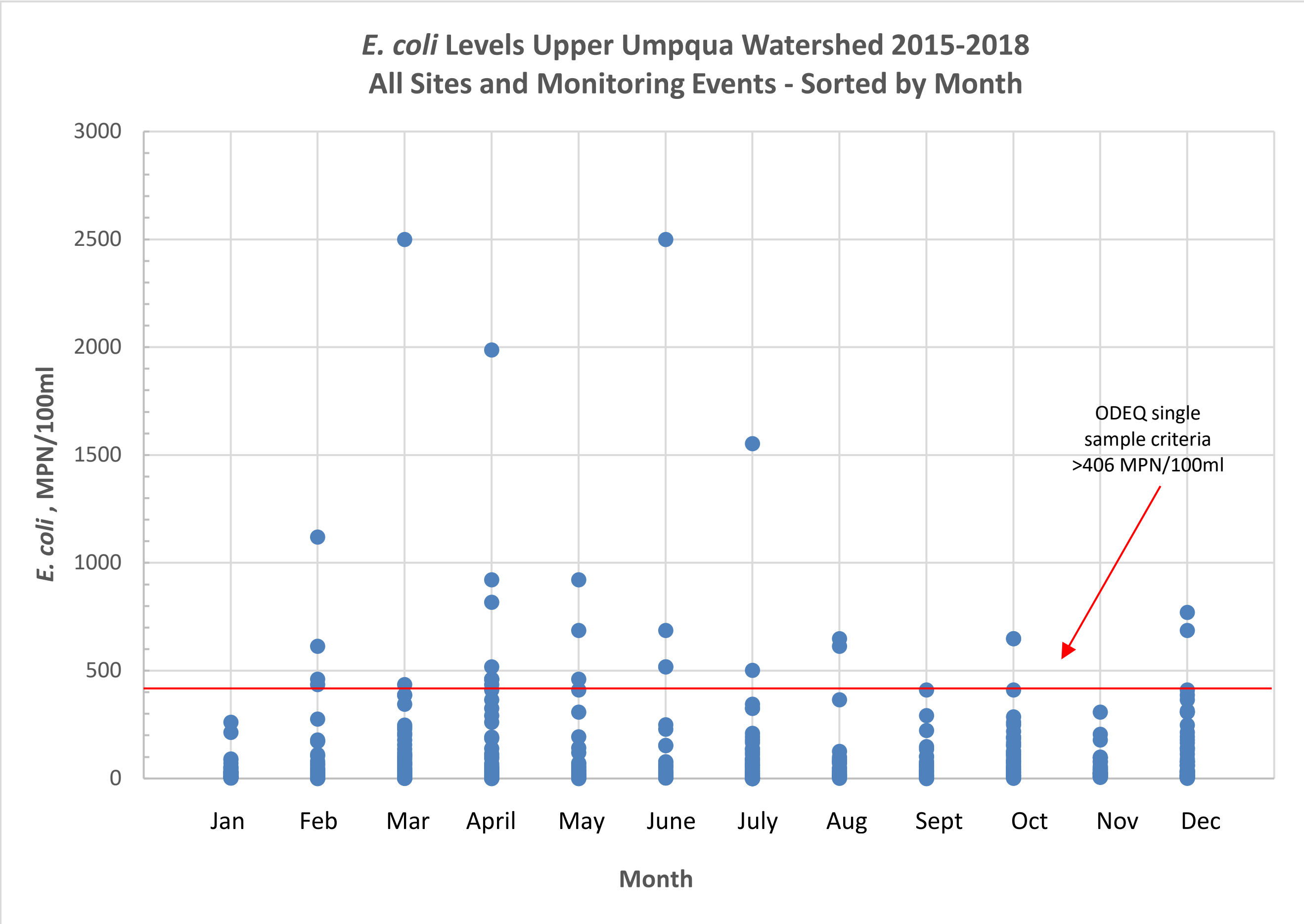
Graph 36 of all data sorted by month shows that exceedances of the DEQ single sample criteria for *E. coli* (406 MPN/100ml) occurred in all months of the year except January and November.
Five sites had no samplings that exceeded the criteria either in summer or winter. These were U1 Umpqua at Cleveland Rapids Park, LWC1 Little Wolf Creek at Tyee Access Road Bridge, LC1 Lost Creek at Tyee Road, YC1 Yellow Creek at Yellow Creek Rd. and EC1 Elk Creek at State Hwy 138 W Bridge.

Table 26 indicates that Mill Creek had the most exceedances with 36% of its sampling events being higher than of the DEQ single sample criteria for *E. coli* (406 MPN/100ml) followed by MGC1 McGee Creek 13 % of samples, and MDC1 Hedding Creek at 10% of its samples. Graph 39 also shows that Mill Creek has the four highest levels recorded with two of them being over the limit of the assay (≥2419.6).

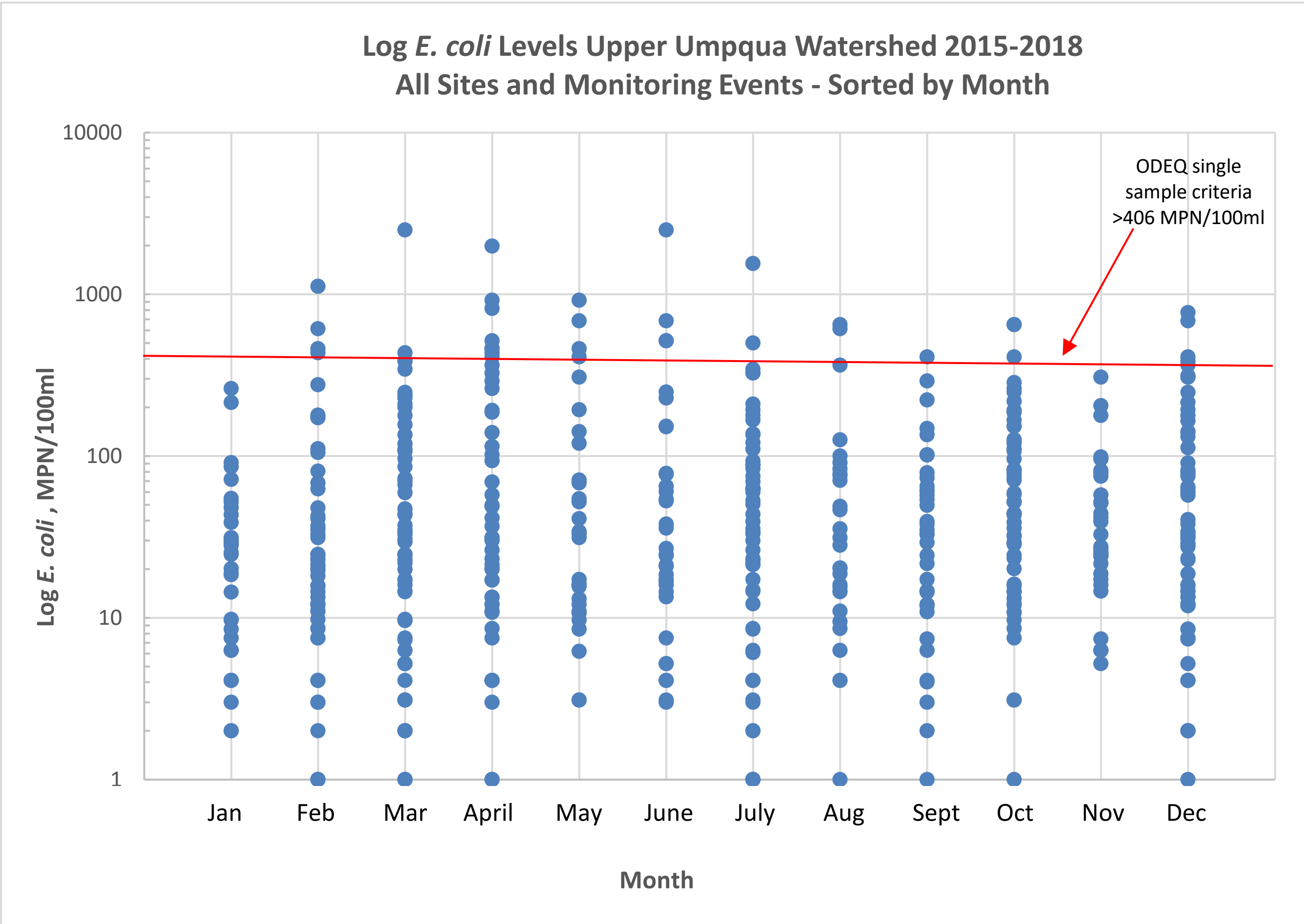
Table 28 displays the data by summer and winter for each creek. For Mill Creek, it can be seen that 54.5% of its exceedances occurred during the summer period, while 27.3% showed exceedances during winter.

Graph 40 displays that the maximum of the upper quartile for Mill Creek and McGee Creek is over the limit for a DEQ single sample criteria for *E. coli* (406 MPN/100ml).

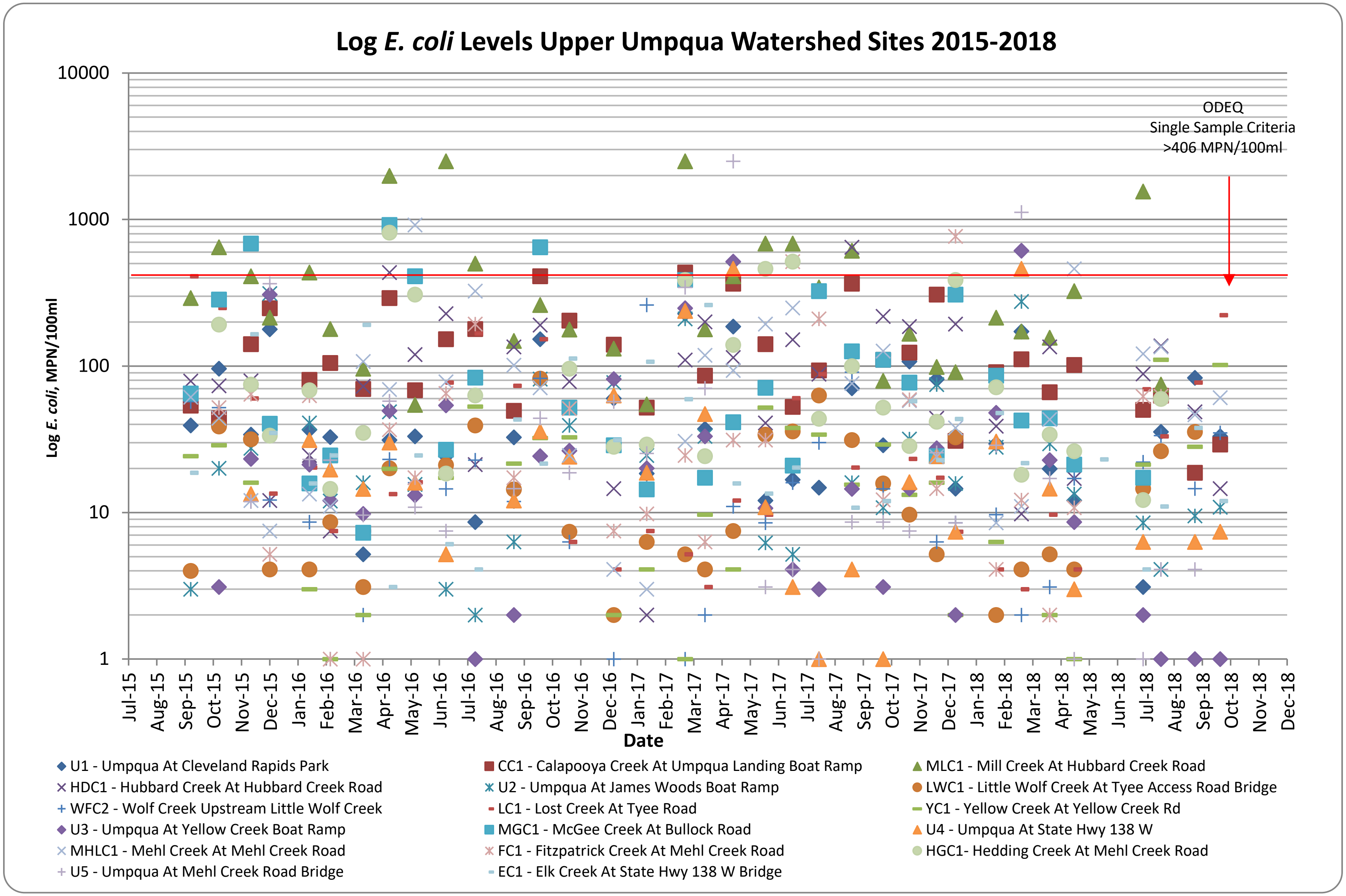
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of six tributaries went to a puddled or dry state. They included: HB1 - Hubbard Creek at Hubbard Creek Road (1 month during the three years); LWC1 – Little Wolf at Tyee Access Road (1 month during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 month during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1 - Hedding Creek at Mehl Creek Road (4 months during the three years).



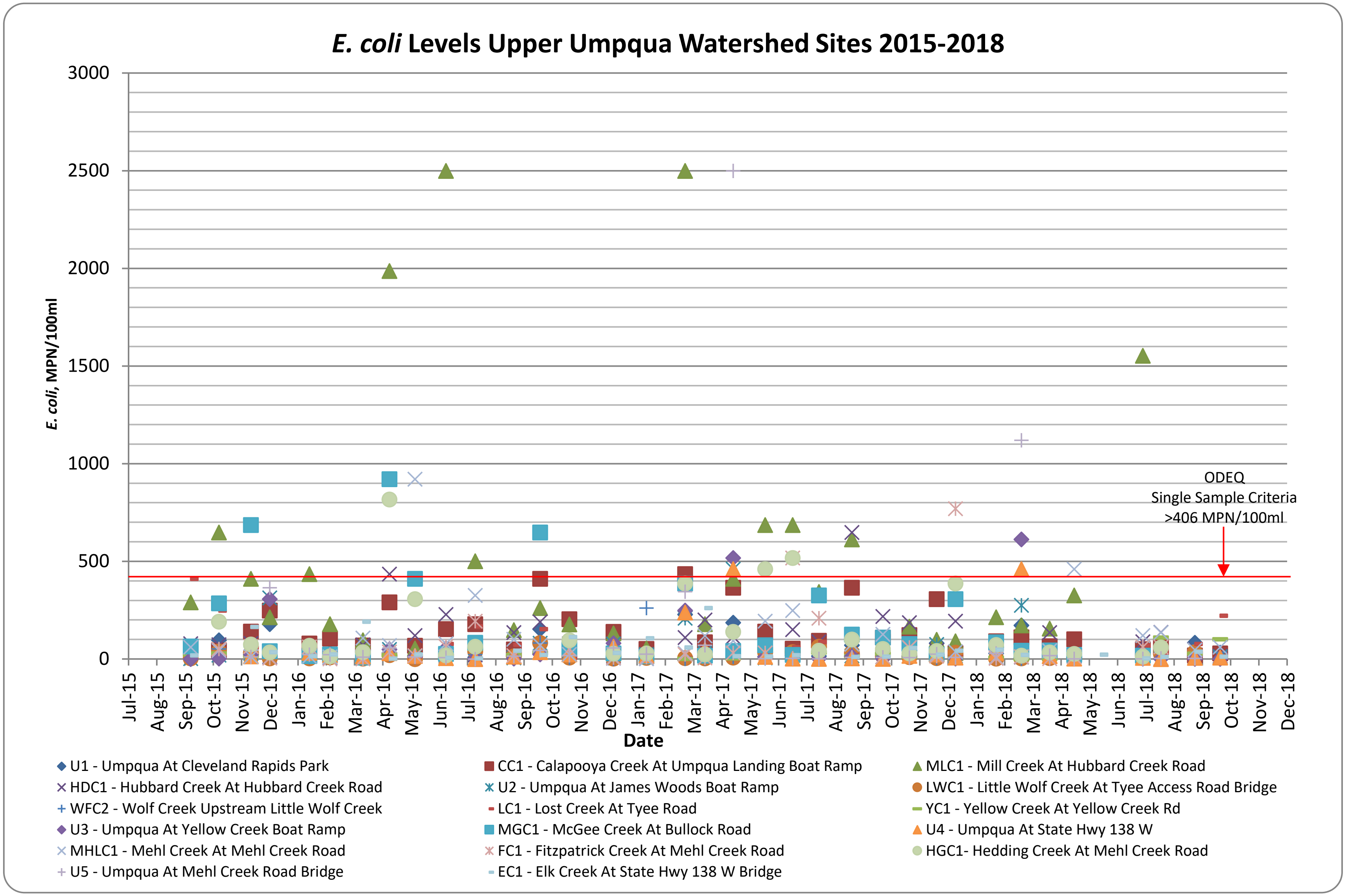
Graph 36. *E. coli* levels all Upper Umpqua Watershed sites and monitoring events 2015-2018 sorted by month. Values of ≥2419.6, the limit of the assay without dilution, are displayed as 2500.



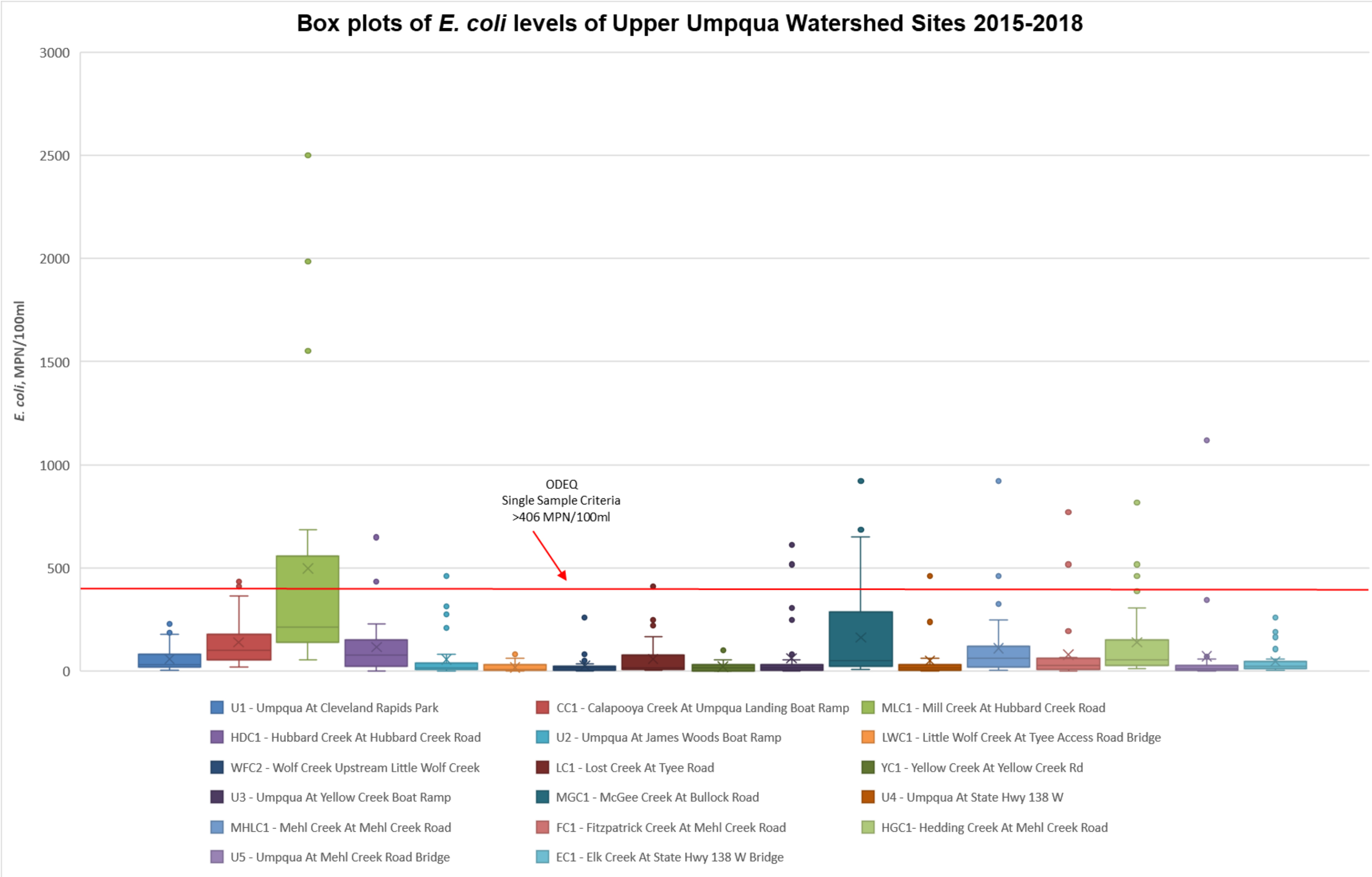
Graph 37. Log *E. coli* levels all Upper Umpqua Watershed sites and monitoring events 2015-2018 sorted by month. Values of ≥2419.6, the limit of the assay without dilution, are displayed as 2500.



Graph 38. Log *E. coli* levels Upper Umpqua Watershed Sites 2015-2018. Values ≥2419.6, the limit of the assay, are displayed at 2500.



Graph 39. *E. coli* levels Upper Umpqua Watershed Sites 2015-2018. Values ≥2419.6, the limit of the assay, are displayed at 2500.



Graph 40. Box plots of *E. coli* levels of Upper Umpqua Watershed sites 2015-2018. Values ≥2419.6, the limit of the assay, are displayed at 2500.

***E. coli* exceedances by site the Upper Umpqua Watershed based ODEQ single sample criteria**

Upper Umpqua Watershed Sites	Total	Greater than 406 MPN/100ml	
Site ID - Site Description	# of Samples	Samples >406	% of Samples
U1 Umpqua at Cleveland Rapids Park	35	0	0%
CC1 Calapooya Creek at Garden Valley	35	1	2.9%
MLC1 Mill Creek at Hubbard Creek Road	33	12	36.4%
HBC1 Hubbard Creek at Hubbard Creek Road	35	2	5.7%
U2 Umpqua at James Woods Boat Ramp	35	1	2.9%
LWC1 Little Wolf Creek at Tyee Access Road Bridge	34	0	0%
WC1 Wolf Creek Upstream Little Wolf Creek	35	1	2.9%
LC1 Lost Creek at Tyee Road	36	0	0%
YC1 Yellow Creek at Yellow Creek Rd.	33	0	0%
U3 Umpqua at Yellow Creek Boat Ramp	35	2	5.7%
MGC1 McGee Creek at Bullock Road	31	4	12.9%
U4 Umpqua at State Hwy 138 W	32	2	6.3%
MHLC1 Mehl Creek at Mehl Creek Road	34	2	5.9%
FC1 Fitzpatrick Creek at Mehl Creek Road	30	2	6.7%
HDC1 Hedding Creek at Mehl Creek Road	30	3	10.0%
U5 Umpqua at Mehl Creek Road Bridge	32	2	6.3%
EC1 Elk Creek at State Hwy 138 W Bridge	32	0	0%

Table 27. *E. coli* exceedances by the site in the Upper Umpqua Watershed based on ODEQ single sample criteria.

Rating of Upper Umpqua Watershed Sites for *E. coli*, Summer and Winter

SITE	Summer (May 1 – Sept 30)					Winter (Oct 1 – April 30)			
	Sample Events Dry/ Puddled	Total # Sumer Samples	# Above ODEQ Criteria (406 MPN/100ml)	% Above ODEQ Criteria (406 MPN/100 ml)	ODEQ Rating	Total # Winter Samples	# Above ODEQ Criteria (406 MPN/100 ml)	% Above ODEQ Criteria (406 MPN/100 ml)	ODEQ Rating
U1 Umpqua at Cleveland Rapids Park		13	0	0%		22	0	0%	
CC1 Calapooya Creek at Garden Valley		13	0	0%		22	2	9.1%	
MLC1 Mill Creek at Hubbard Creek Road		11	6	54.5%		22	6	27.3%	
HBC1 Hubbard Creek at Hubbard Creek Road	1	13	1	7.7%		22	1	4.5%	
U2 Umpqua at James Woods Boat Ramp		13	0	0%		22	1	4.5%	
LWC1 Little Wolf Creek at Tyee Access Road Bridge	1	12	0	0%		22	0	0%	
WC1 Wolf Creek Upstream Little Wolf Creek		13	0	0%		22	0	0%	
LC1 Lost Creek at Tyee Road		13	1	7.7%		22	0	0%	
YC1 Yellow Creek at Yellow Creek Rd.		12	0	0%		21	0	0%	
U3 Umpqua at Yellow Creek Boat Ramp		13	0	0%		22	2	9.1%	
MGC1 McGee Creek at Bullock Road	2	9	1	11.1%		22	3	13.6%	
U4 Umpqua at State Hwy 138 W		13	0	0%		19	2	10.5%	
MHLC1 Mehl Creek at Mehl Creek Road	1	12	1	8.3%		22	1	4.5%	
FC1 Fitzpatrick Creek at Mehl Creek Road	4	10	1	10.0%		20	1	5.0%	
HDC1 Hedding Creek at Mehl Creek Road	4	9	2	22.2%		21	1	4.8%	
U5 Umpqua at Mehl Creek Road Bridge		11	1	9.1%		21	2	9.5%	
EC1 Elk Creek at State Hwy 138 W Bridge		12	0	0%		20	0	0%	

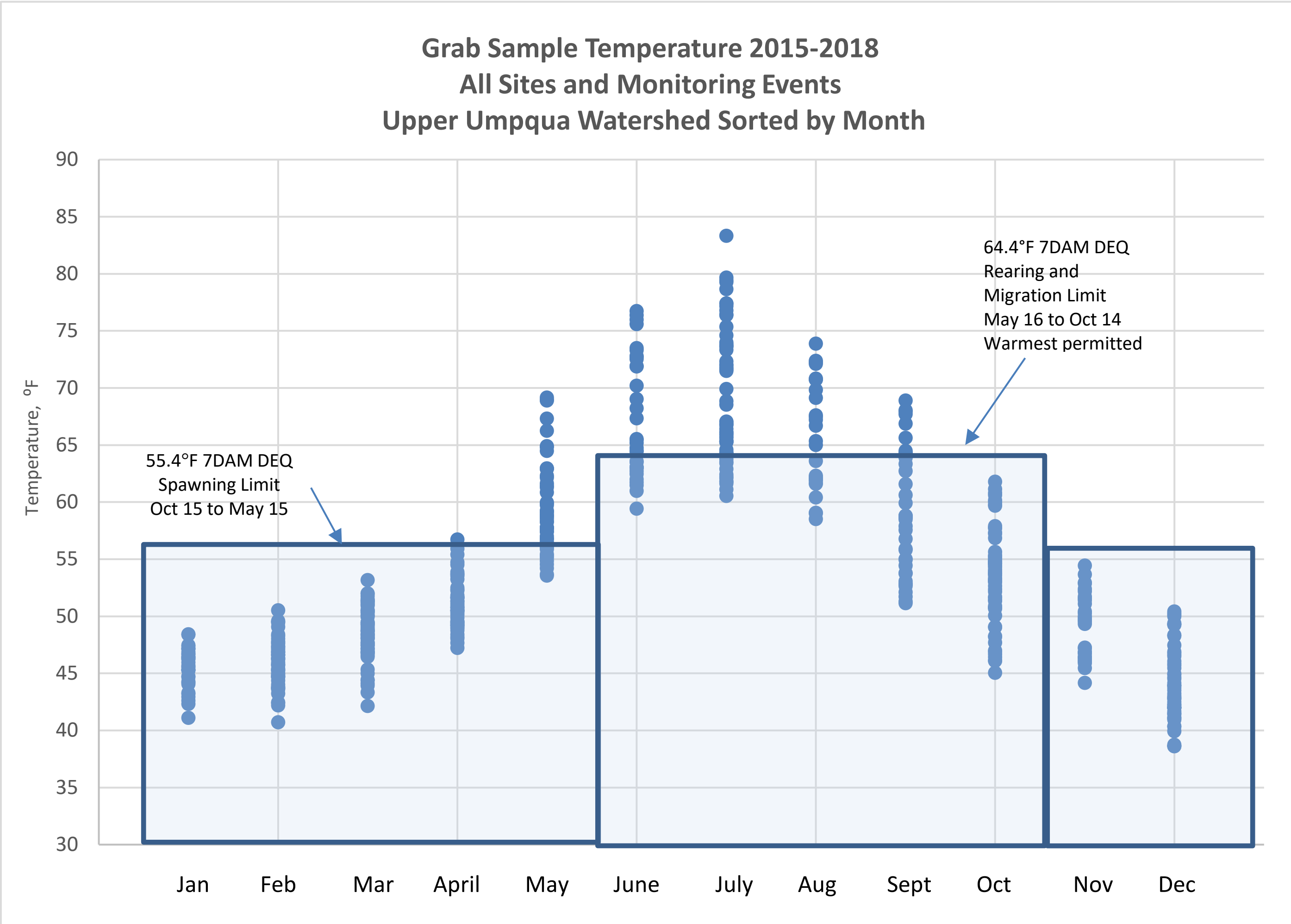
Rating	Color	ODEQ Criteria
No Concern (below standard criteria)		≤406
Concern (exceeds standard criteria)		>406
Dry/Puddled		Dry 1 or more attempted sampling events

Table 28. Rating of all Upper Umpqua Watershed Sites for *E. coli*, Summer and Winter, ODEQ criteria.

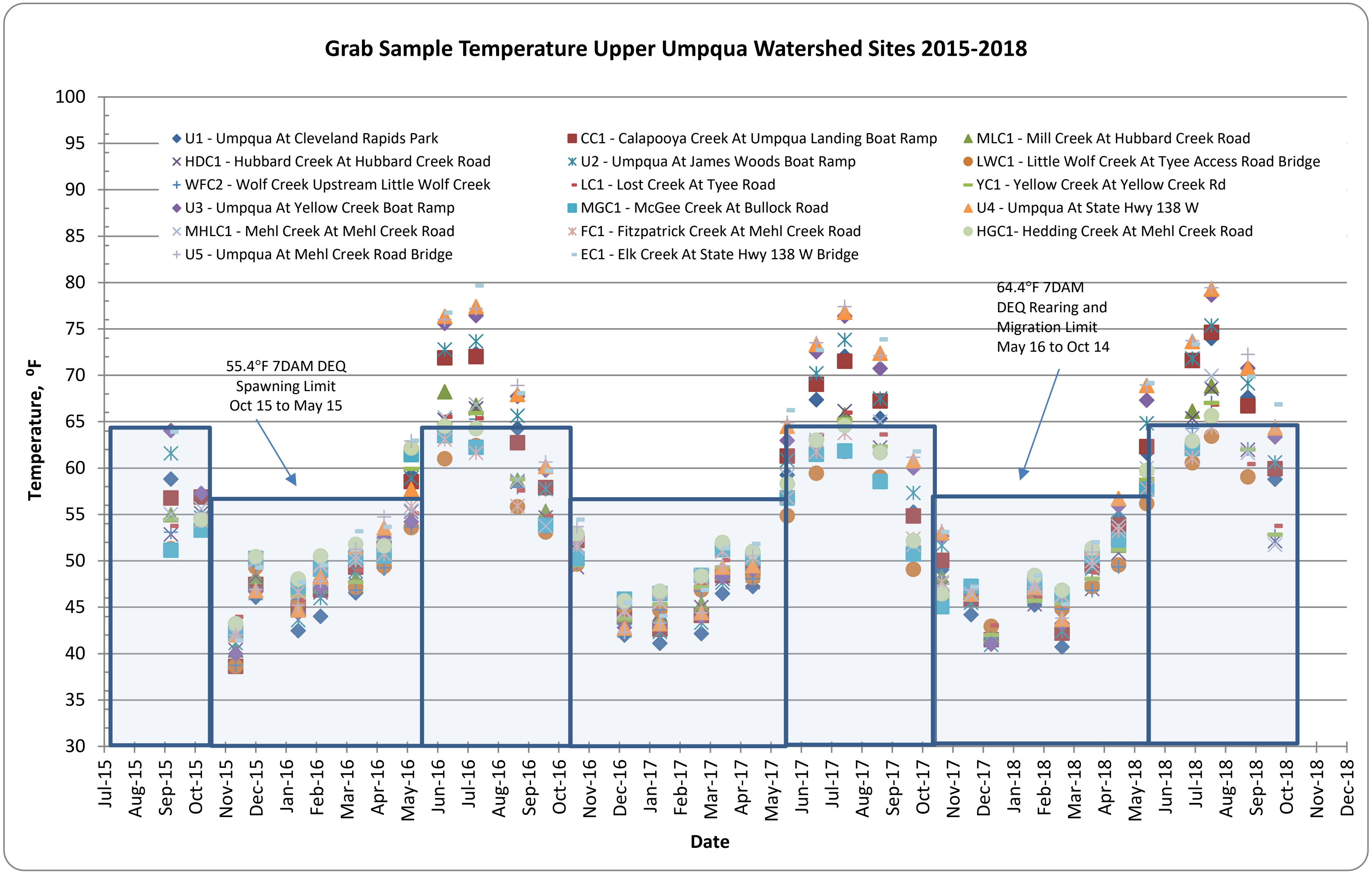
RESULTS - Upper Umpqua Watershed Grab Sample Temperature Monitoring 2015-2018

The temperature was recorded at each of our grab sample monitoring events, and though this would not allow evaluation for DEQ temperature criteria because continuous temperature recording could only provide the 7DAM. It is included here for evaluation and stream rating to provide additional information for planning restoration sites. The summary table (Table 28) rates every stream monitored in terms of whether they succeed or fail to meet "Rearing and Migration" criteria of 64.4ºF for May 16 – October 14 and "Spawning" criteria October 15 to May 15 of 55.4ºF for the creeks monitored as designated to this criteria in the maps in Appendix I and J. Twelve of the sites met Spawning Criteria while the four failed to meet it were due only to one sampling even and one was due to two sampling events. Graph 42 shows that the monitoring events where sites failed to meet the October 15 to May 15 of 55.4ºF Criteria are at the very edge of the late period in May. Whereas, those that exceed the "Rearing and Migration" criteria of 64.4ºF for May 16 – October 14 are seen throughout the period. Little Wolf Creek, McGee Creek, and Fitzpatrick Creeks are the only creeks monitored that managed to meet both criteria.

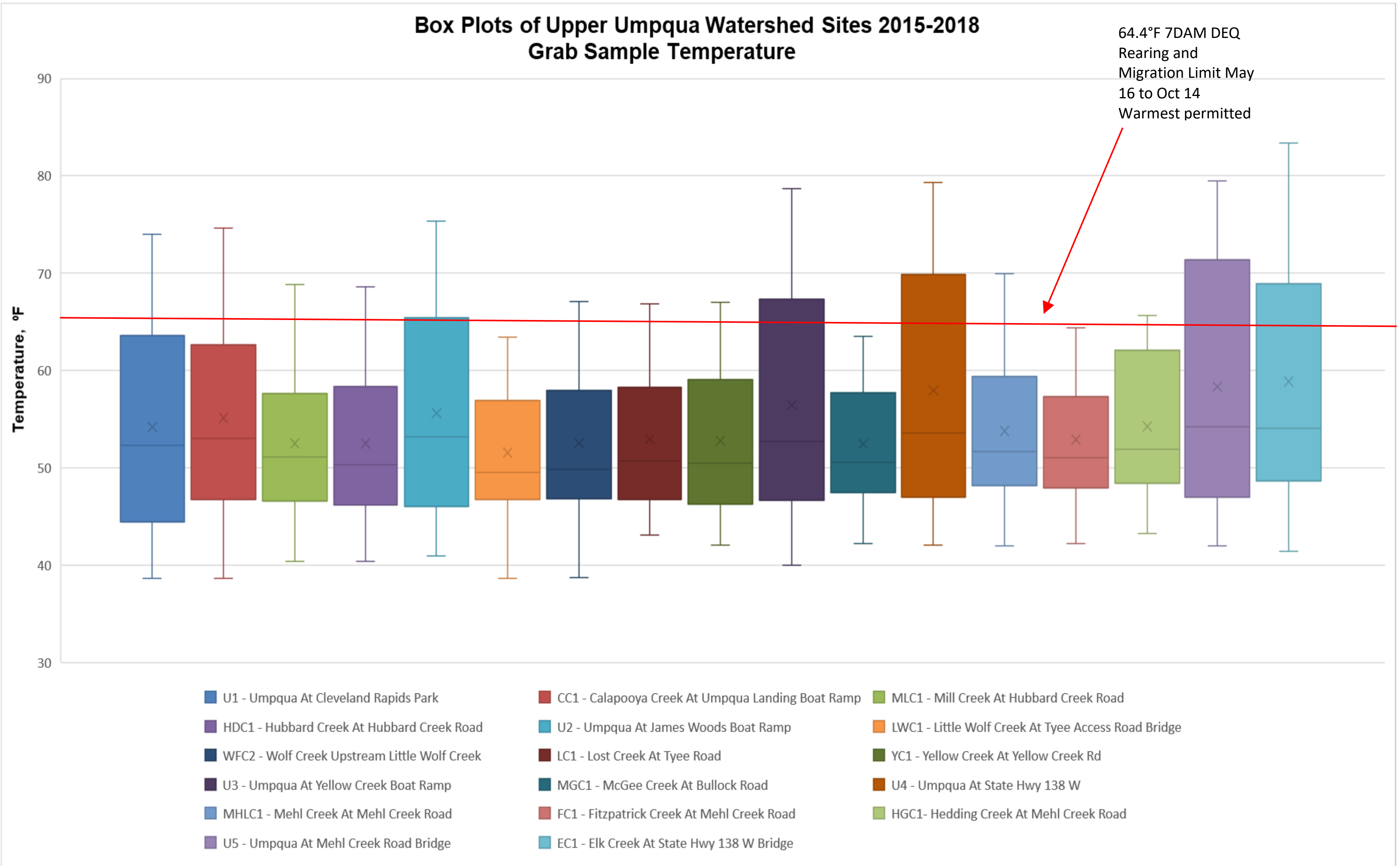
Important consideration:
The above evaluations are based upon times that there was sufficient streamflow to be able to submerge the probe tips on the Sonde. During the three years of monitoring, there were numerous times during summer that some of six tributaries went to a puddled or dry state. They included: HB1 -Hubbard Creek at Hubbard Creek Road (1 month during the three years); LWC1 – Little Wolf at Tyee Access Road (1 month during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 month during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1 - Hedding Creek at Mehl Creek Road (4 months during the three years).



Graph 41. Grab sample temperature data all events and sites sorted by month Upper Umpqua Watershed 2015-2018.



Graph 42. Grab sample temperature results for all Upper Umpqua Watershed Sites 2015-2018.



Graph 43. Box and whisker plots of grab sample temperatures for each site in the Upper Umpqua Watershed 2015-2018.

Grab Sample Temperature Ratings Upper Umpqua Watershed Monitoring Sites 2015-2018

SITE	Spawning Criteria 55.4°F 7DAM Oct 15-May 15				Rearing and Migration Criteria 64.4°F 7DAM May 16-Oct 14				
	Total Samples	Samples >55.4°F	%	Rating	Sample Events Dry/Puddled	Total Samples	Samples >64.4°F	%	Rating
U1 Umpqua at Cleveland Rapids Park	20	0	0%			16	8	50%	
CC1 Calapooya Creek at Garden Valley	20	1	5%			16	8	50%	
MLC1 Mill Creek at Hubbard Creek Road	20	0	0%			13	5	38%	
HBC1 Hubbard Creek at Hubbard Creek Road	20	0	0%		1	16	5	31%	
U2 Umpqua at James Woods Boat Ramp	20	0	0%			16	10	63%	
LWC1 Little Wolf Creek at Tyee Access Road Bridge	19	0	0%		1	15	0	0%	
WC1 Wolf Creek Upstream Little Wolf Creek	19	0	0%			16	3	19%	
LC1 Lost Creek at Tyee Road	20	0	0%			16	4	25%	
YC1 Yellow Creek at Yellow Creek Rd.	19	0	0%			15	4	27%	
U3 Umpqua at Yellow Creek Boat Ramp	20	2	10%			15	9	60%	
MGC1 McGee Creek at Bullock Road	19	0	0%		2	12	0	0%	
U4 Umpqua at State Hwy 138 W	17	1	6%			16	10	63%	
MHLC1 Mehl Creek at Mehl Creek Road	19	1	5%		1	15	4	27%	
FC1 Fitzpatrick Creek at Mehl Creek Road	17	0	0%		4	12	0	0%	
HDC1 Hedding Creek at Mehl Creek Road	16	0	0%		4	12	3	25%	
U5 Umpqua at Mehl Creek Road Bridge	17	1	6%			15	12	80%	
EC1 Elk Creek at State Hwy 138 W Bridge	17	0	0%			15	11	73%	

Table 29. Table of Temperature Ratings Upper Umpqua Grab Sample Monitoring Sites 2015-2018.

Rating	**Grab Sample Temperatures 7DAM Spawning Oct 15 to May 15**	**Grab Sample Temperatures 7DAM Rearing and Migration May 16- Oct 14**	**Color**
Good	<55.4° F	<64.4° F	
Needs Improvement	>55.4° F	>64.4° F	
No Water	Dry or Puddled		

RESULTS - Upper Umpqua Watershed Continuous Temperature Monitoring 2015-2018

Table 29 and Table 30 display a great deal of temperature information from three years at seven sites where we had summer continuous recording temperature loggers recording every 30 minutes. The seven-day average maximum value – 7DAM – is the common way data is presented as displayed in Graph 23. This graph from PUR's Umpqua Basin Stream Temperature Characterization – Reference Site 2019 Update (Dammann, D.M., 2019) shows that there are significant variations in 7DAM over 20 years at the reference site on Calapooya Creek. The reference site is several miles upstream of our site CC1 at the mouth of the Calapooya.

The 7DAM, where we had temperature loggers for the three years, agreed with our grab sample temperature data which designated all sites into the red – needing improvement. Unfortunately, we did not have loggers in Little Wolf Creek, McGee Creek, and Fitzpatrick Creeks to confirm that they might have met both rearing and spawning criteria.

Table 30 adds some interesting temperature information about what instream life is dealing with in terms of the number of days or actual hours that they are submitted to harmful temperatures. This table shows the number of days that are >55°F, >64°F, and >70°F as well as the number of hours that are >55°F, >64°F, and >70°F.

Graphs 44-59 show 30-minute temperature daily fluctuations for the summers of 2016 and 2018 for our temperature loggers. Weather patterns can be seen to match different sites in the fluctuations for the same year, but the temperature readings can be dramatically different particularly when comparing the tributaries to the main Umpqua River.

Graph 57, 2018 at the mouth of Calapooya Creek only has data until July 23 due to someone removing the logger from the water and leaving it on the bank.

Graphs 58 and 59 are the same period from 2016 and 2018 at the same site on the Umpqua for comparison of annual differences.

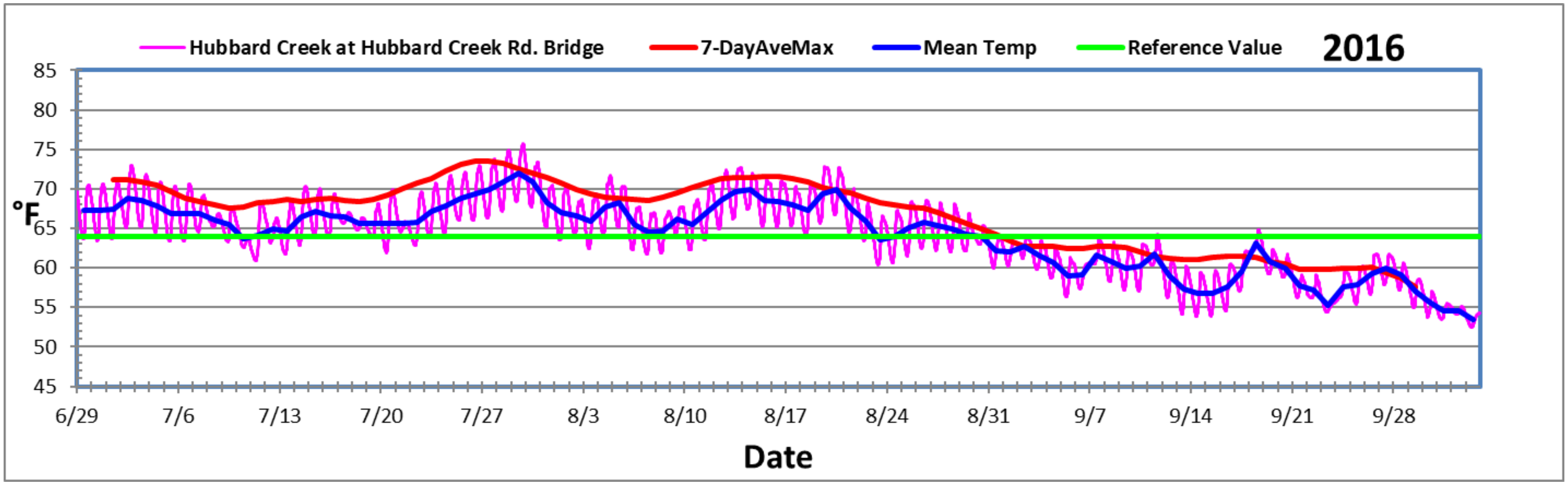
Calapooya Creek at the month consistently had the worst 7DAM of over 83°F each of the three years. The Umpqua River upstream of Elkton was the second-highest breaking 80°F each of the three years.
Both locations even showed a minimum during the 7DAM period of over 70°F. The Umpqua site had 78 days over 70°F in 2016 and 2017 and, in 2018 had 95 days over 70°F!

Site Name	Start Date	Stop date	Seasonal Maximum		Seasonal Minimum		Seasonal Max ΔT		7-Day averages			
			Date	Value	Date	Value	Date	Value	Date	Max	Min	ΔT
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	06/30/16	10/03/16	08/19/16	85.6	10/03/16	56.1	08/18/16	15.2	08/19/16	83.6	70.8	12.8
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	06/30/17	10/09/17	08/03/17	85.8	10/09/17	51.8	08/03/17	11.7	08/04/17	83.1	73.1	10.1
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	05/23/18	07/22/18	07/17/18	84.5	06/01/18	59.7	07/12/18	11.7	07/15/18	83.4	73.2	10.2
Yellow Creek near Hwy 138 – YC1	06/29/16	10/03/16	07/29/16	73.2	10/03/16	51.9	07/11/16	7.1	07/28/16	71.0	65.7	5.2
Yellow Creek near Hwy 138 – YC1	06/30/17	10/02/17	08/03/17	72.3	10/02/17	52.6	07/02/17	8.2	08/05/17	70.9	65.6	5.4
Yellow Creek near Hwy 138 – YC1	05/23/18	09/25/18	07/26/18	72.3	06/01/18	50.8	05/27/18	8.8	07/15/18	71.0	64.8	6.2
Wolf Creek above Little Wolf – WFC2	06/29/16	10/03/16	07/29/16	72.6	10/03/16	51.8	07/14/16	6.8	07/28/16	70.5	64.8	5.7
Wolf Creek above Little Wolf – WFC2	06/30/17	10/02/17	08/03/17	73.0	10/02/17	52.3	07/22/17	7.5	08/06/17	71.9	66.6	5.3
Wolf Creek above Little Wolf – WFC2	05/23/18	09/26/18	09/26/18	86.9	06/01/18	50.3	09/26/18	36.4	07/28/18	72.3	65.0	7.3
Mehl Creek at Mehl Creek Road – MHLC1	06/29/16	10/03/16	06/29/16	82.9	10/03/16	51.0	06/29/16	23.9	07/02/16	66.6	59.3	7.4
Mehl Creek at Mehl Creek Road – MHLC1	06/30/17	10/02/17	07/26/17	68.3	10/02/17	52.1	07/22/17	7.1	08/05/17	67.4	62.9	4.5
Mehl Creek at Mehl Creek Road – MHLC1	05/23/18	09/25/18	07/26/18	69.5	09/25/18	48.5	07/22/18	9.2	07/15/18	68.7	61.7	7.0
Hubbard Creek at Hubbard Creek Rd. Bridge – HDC1	06/29/16	10/03/16	07/29/16	75.8	10/03/16	52.5	07/20/16	7.9	07/27/16	73.5	66.6	7.0
Hubbard Creek at Hubbard Creek Rd. Bridge – HDC1	06/30/17	10/02/17	08/03/17	76.6	10/02/17	53.0	08/02/17	9.1	08/05/17	74.7	67.6	7.2
Hubbard Creek at Hubbard Creek Rd. Bridge – HDC1	05/23/18	09/25/18	07/16/18	76.3	09/25/18	51.5	05/27/18	10.8	07/15/18	75.0	67.3	7.8
Umpqua River at James Wood Boat Ramp – U2	06/29/16	10/03/16	07/29/16	79.4	10/03/16	58.2	07/14/16	4.9	07/29/16	78.0	74.7	3.4
Umpqua River at James Wood Boat Ramp – U2	06/30/17	10/02/17	08/04/17	79.2	09/23/17	56.3	07/04/17	5.2	08/03/17	78.2	74.2	4.0
Umpqua River at James Wood Boat Ramp – U2	05/23/18	09/25/18	07/16/18	80.4	09/25/18	60.0	06/18/18	5.8	07/16/18	79.4	75.7	3.7
Umpqua River 2-3 miles upstream of Elkton – U4.5	06/29/16	10/03/16	07/29/16	82.3	10/03/16	60.9	07/23/16	5.3	07/29/16	80.8	76.4	4.4
Umpqua River 2-3 miles upstream of Elkton – U4.5	06/30/17	10/02/17	08/03/17	82.9	09/24/17	59.6	08/02/17	5.2	08/04/17	81.8	77.5	4.3
Umpqua River 2-3 miles upstream of Elkton – U4.5	05/23/18	09/25/18	07/16/18	83.2	09/25/18	61.9	07/12/18	5.8	07/15/18	82.1	77.2	4.9

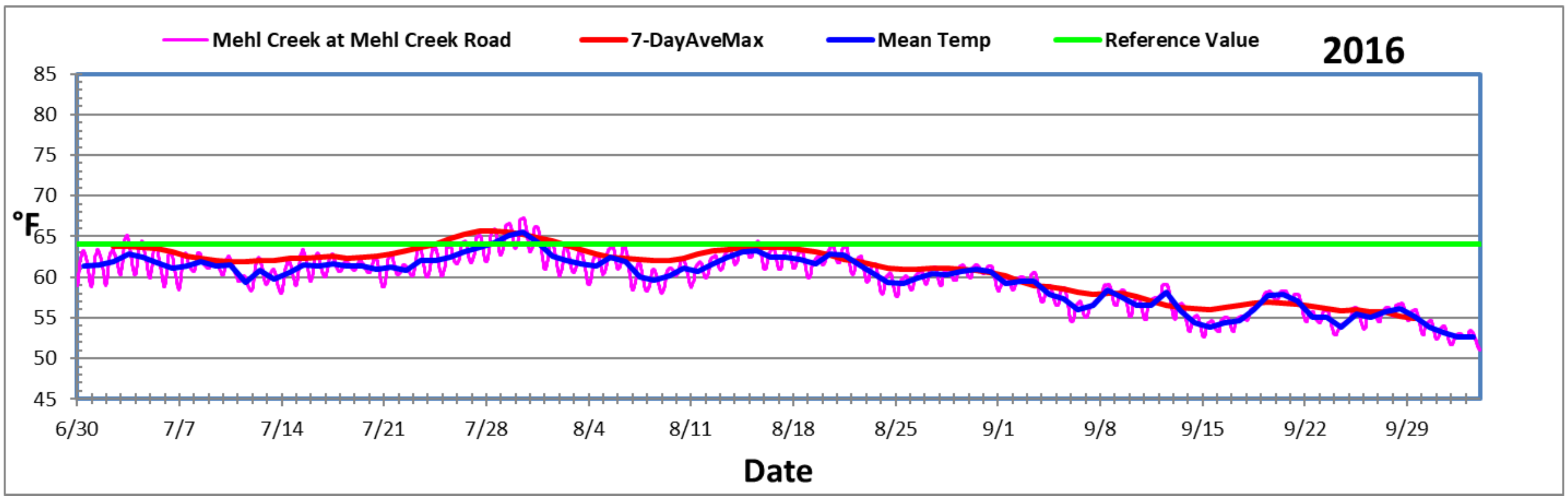
Table 30. Upper Umpqua Watershed continuous temperature logger summary.

Site Name	Days >55 F	Days >64 F	Days >70 F	Hours >55 F	Hours >64 F	Hours >70 F	The warmest day of 7-day		
							Date	Maximum	Minimum
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	78	77	53	1844.0	1515.0	553.5	08/20/16	80.9	68.6
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	102	86	77	2388.0	1929.5	1485.5	08/03/17	85.8	74.1
Calapooya near mouth at Umpqua Landing Boat Ramp - CC1	61	60	47	1463.5	1342.5	807.5	07/17/18	84.5	73.6
Yellow Creek near Hwy 138 – YC1	95	62	12	2244.0	999.0	71.5	07/29/16	73.2	67.3
Yellow Creek near Hwy 138 – YC1	95	73	10	2167.5	1112.0	56.5	08/03/17	72.3	66.1
Yellow Creek near Hwy 138 – YC1	124	75	17	2765.5	1162.0	85.5	07/16/18	72.2	65.4
Wolf Creek above Little Wolf – WFC2	94	54	7	2179.5	799.5	42.5	07/29/16	72.6	66.3
Wolf Creek above Little Wolf – WFC2	95	75	14	2187.5	1217.0	113.0	08/03/17	73.0	66.6
Wolf Creek above Little Wolf – WFC2	126	74	23	2767.5	1203.0	176.5	07/26/18	73.3	65.6
Mehl Creek at Mehl Creek Road – MHLC1	91	12	1	2056.5	118.5	6.0	06/29/16	82.9	59.0
Mehl Creek at Mehl Creek Road – MHLC1	93	37	0	2118.5	412.5	0.0	08/03/17	68.2	63.5
Mehl Creek at Mehl Creek Road – MHLC1	121	47	0	2547.0	407.5	0.0	07/16/18	69.5	62.3
Hubbard Creek at Hubbard Creek Rd. Bridge – HDC1	96	65	33	2225.0	1271.5	251.5	07/29/16	75.8	68.4
Hubbard Creek at Hubbard Creek Rd. Bridge – HDC1	95	76	37	2236.0	1574.0	397.5	08/03/17	76.6	68.2
Hubbard Creek at Hubbard Creek Rd. Bridge – HDC1	126	99	44	2924.5	1636.5	404.5	07/16/18	76.3	68.0
Umpqua River at James Wood Boat Ramp – U2	97	91	65	2327.5	2071.0	1418.5	07/29/16	79.4	75.9
Umpqua River at James Wood Boat Ramp – U2	95	80	63	2279.5	1899.0	1291.0	08/04/17	79.2	75.4
Umpqua River at James Wood Boat Ramp – U2	126	116	84	3023.5	2666.5	1717.5	07/16/18	80.4	76.4
Umpqua River 2-3 miles upstream of Elkton – U4.5	97	95	78	2327.5	2242.0	1704.5	07/29/16	82.3	77.6
Umpqua River 2-3 miles upstream of Elkton – U4.5	95	89	78	2279.5	2055.0	1827.5	08/03/17	82.9	78.4
Umpqua River 2-3 miles upstream of Elkton – U4.5	126	126	97	3023.5	2970.0	2076.5	07/16/18	83.2	78.1

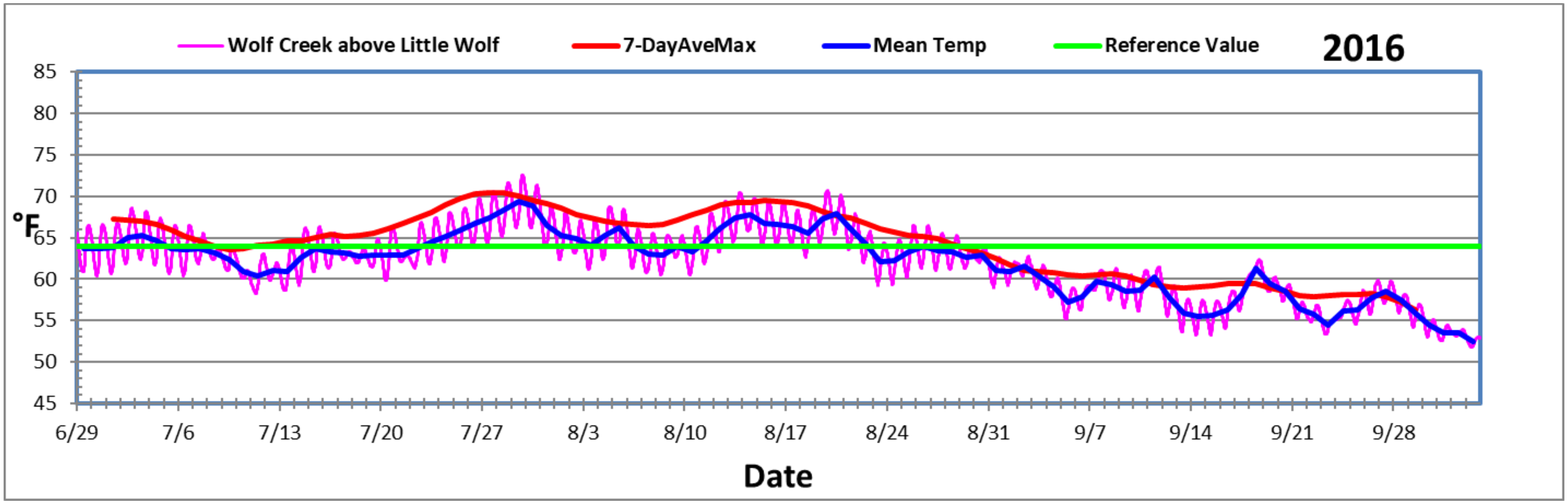
Table 31. Upper Umpqua continuous temperature data summary 2016-2018 continued.



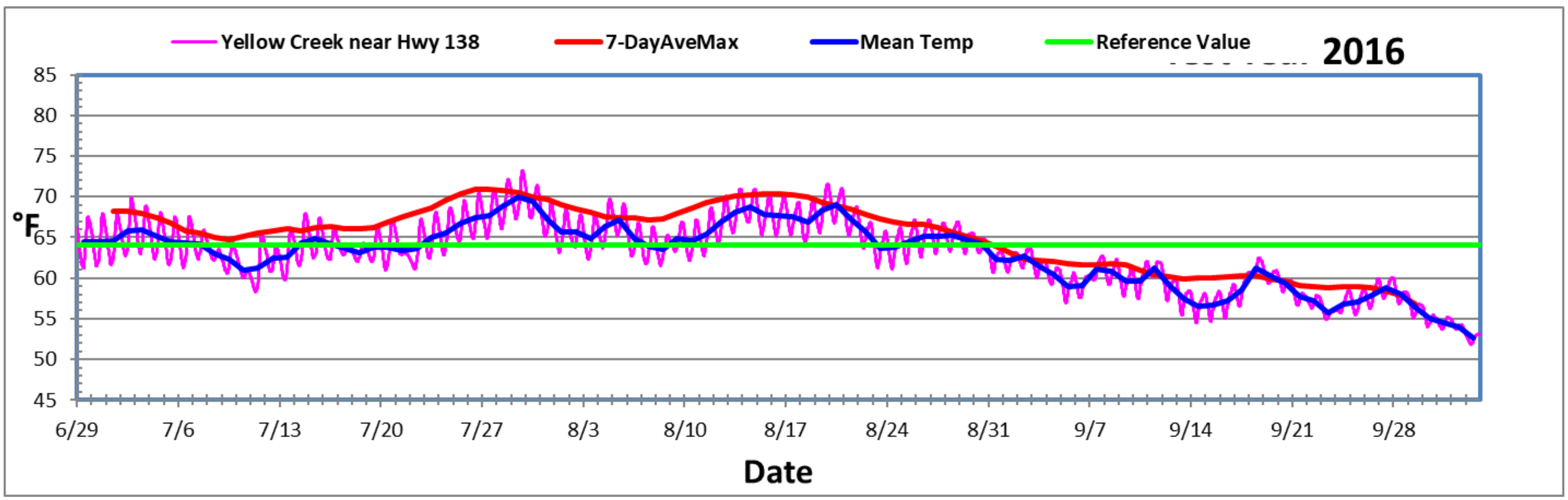
Graph 44. Hubbard Creek 30-minute temperature readings summer 2016.



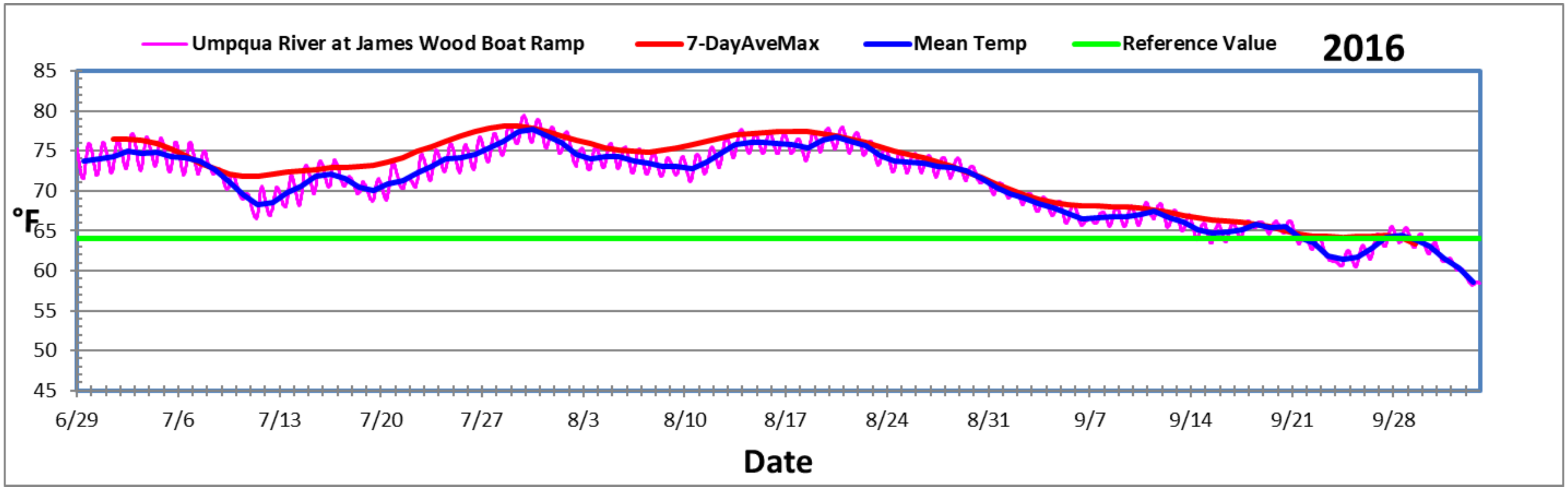
Graph 45. Mehl Creek 30-minute temperature readings summer 2016



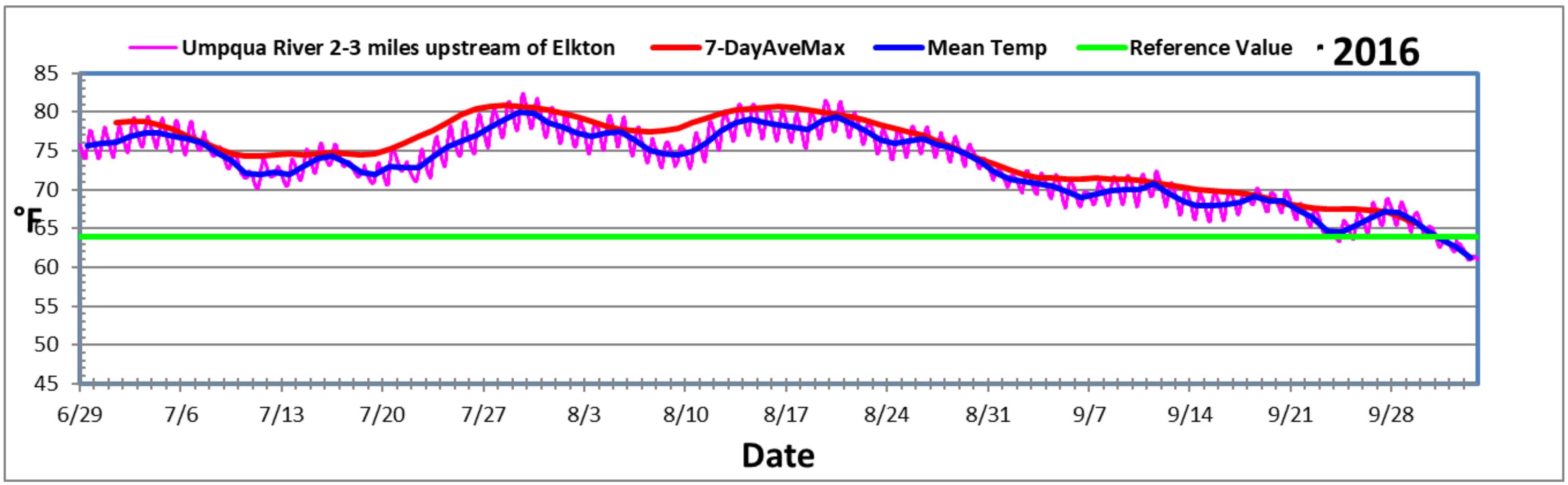
Graph 46. Wolf Creek 30-minute temperature readings summer 2016



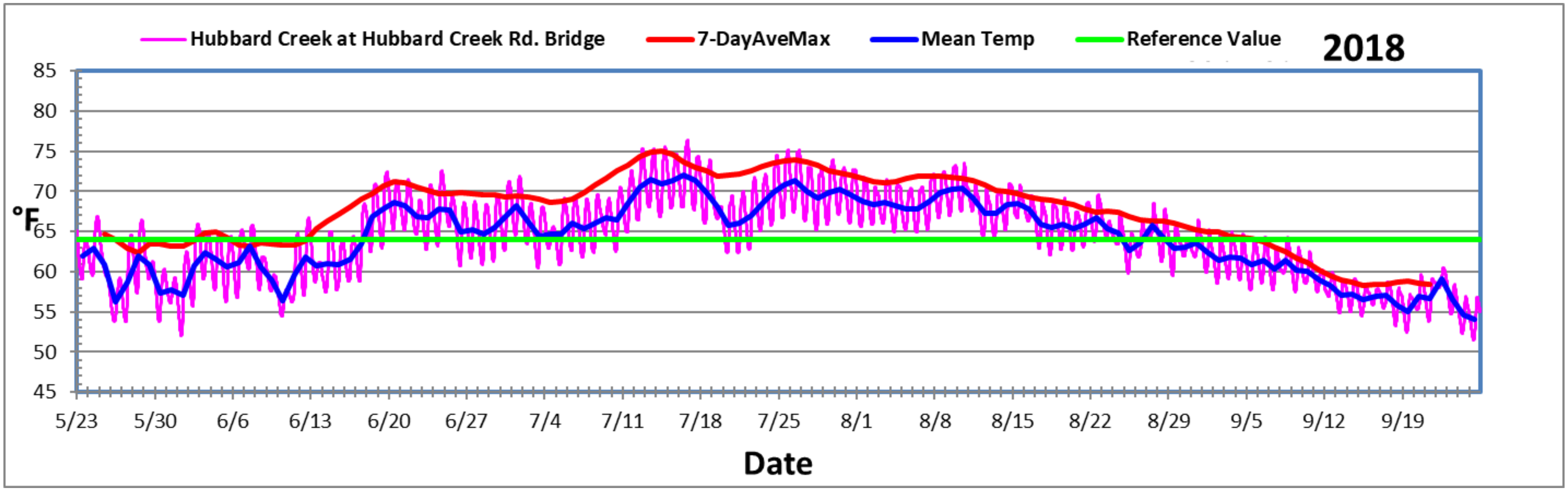
Graph 47. Yellow Creek 30-minute temperature readings summer 2016



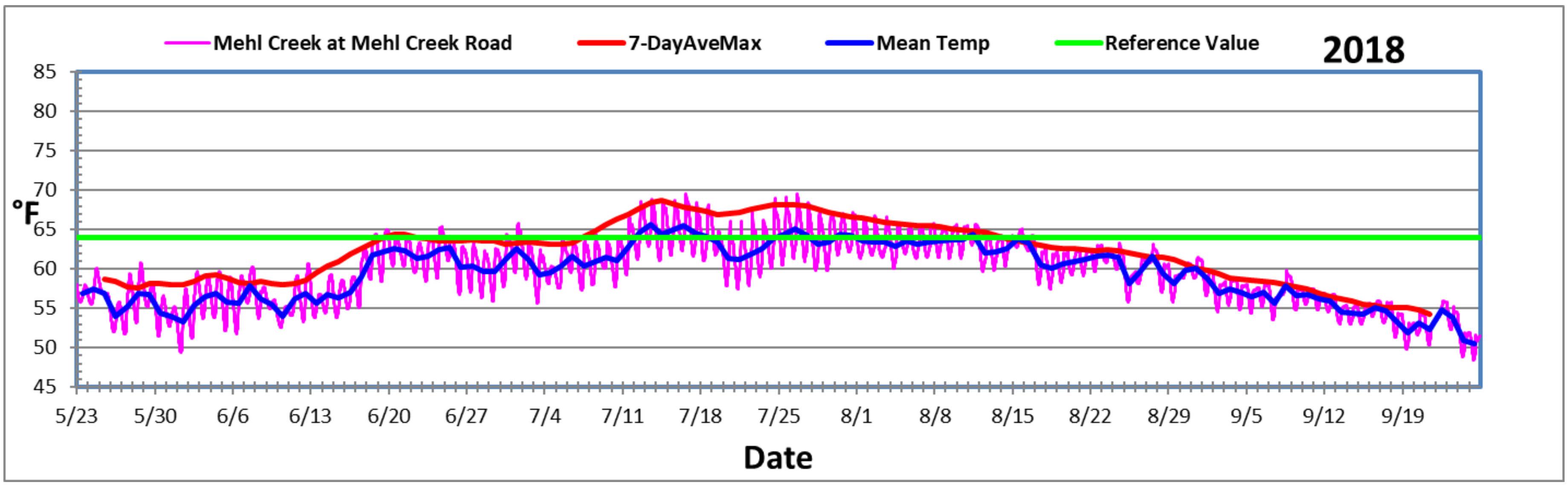
Graph 48. Umpqua River at James Wood Boat Ramp 30-minute temperature reading summer 2016.



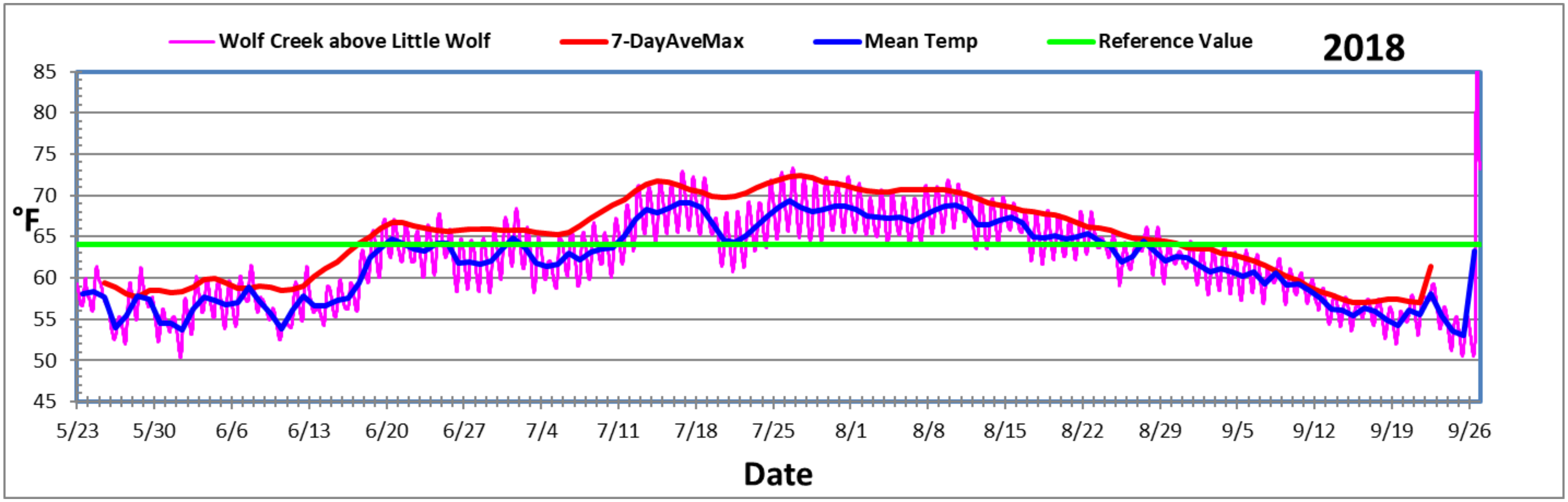
Graph 49. Umpqua River 2-3 miles upstream of Elkton 30-minute summer temperature readings 2016.



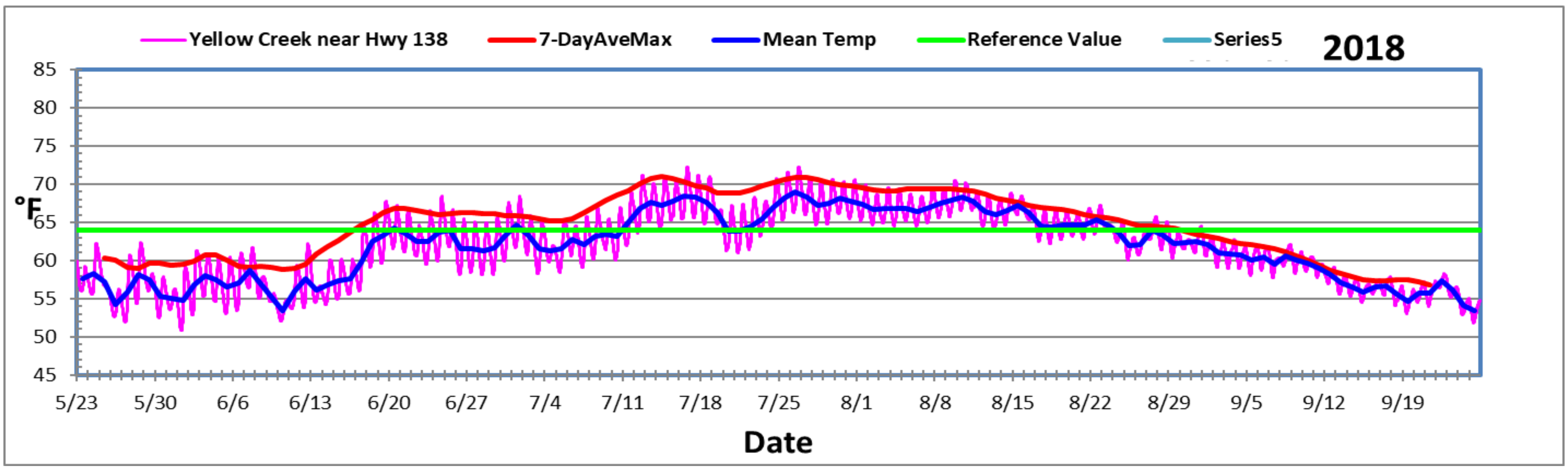
Graph 50. Hubbard Creek at Hubbard Creek Road Bridge 30-minute temperature readings 2018.



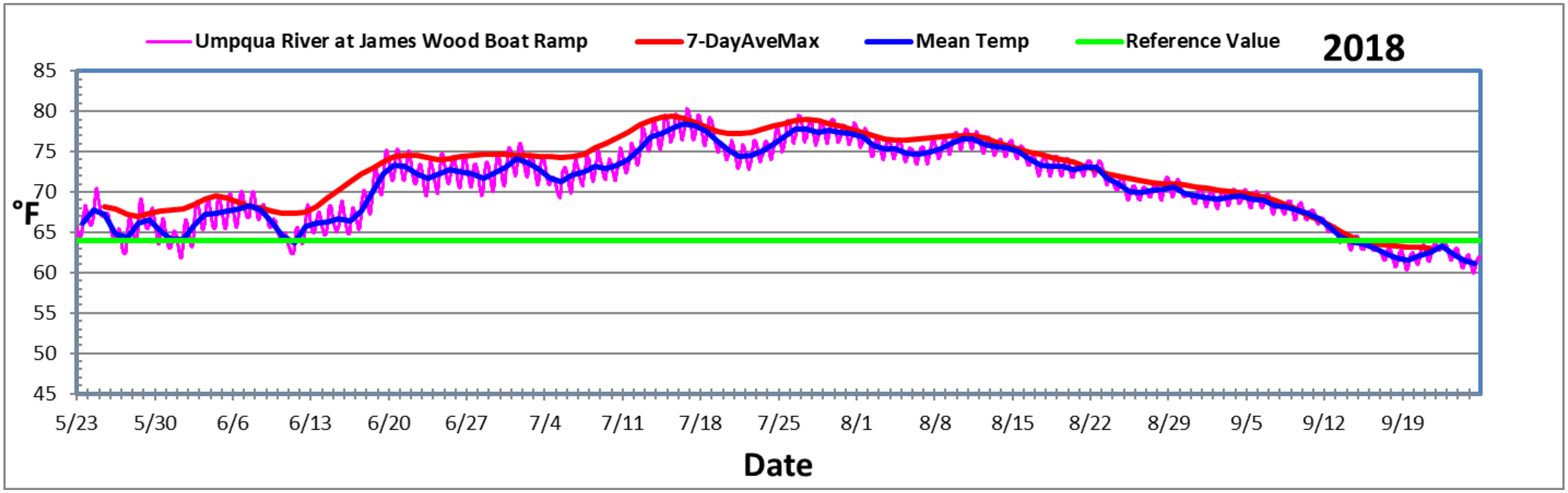
Graph 51. Mehl Creek at Hubbard Creek Road Bridge 30-minute temperature readings 2018



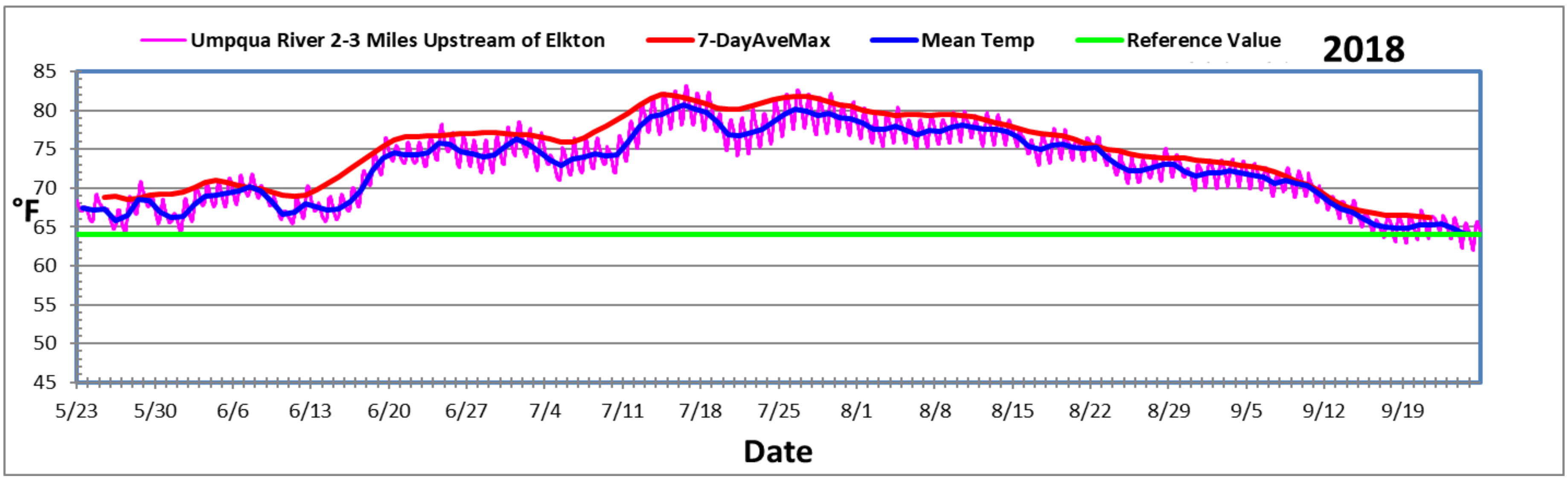
Graph 52. Wolf Creek above Little Wolf Creek 30-minute temperature readings summer 2018.



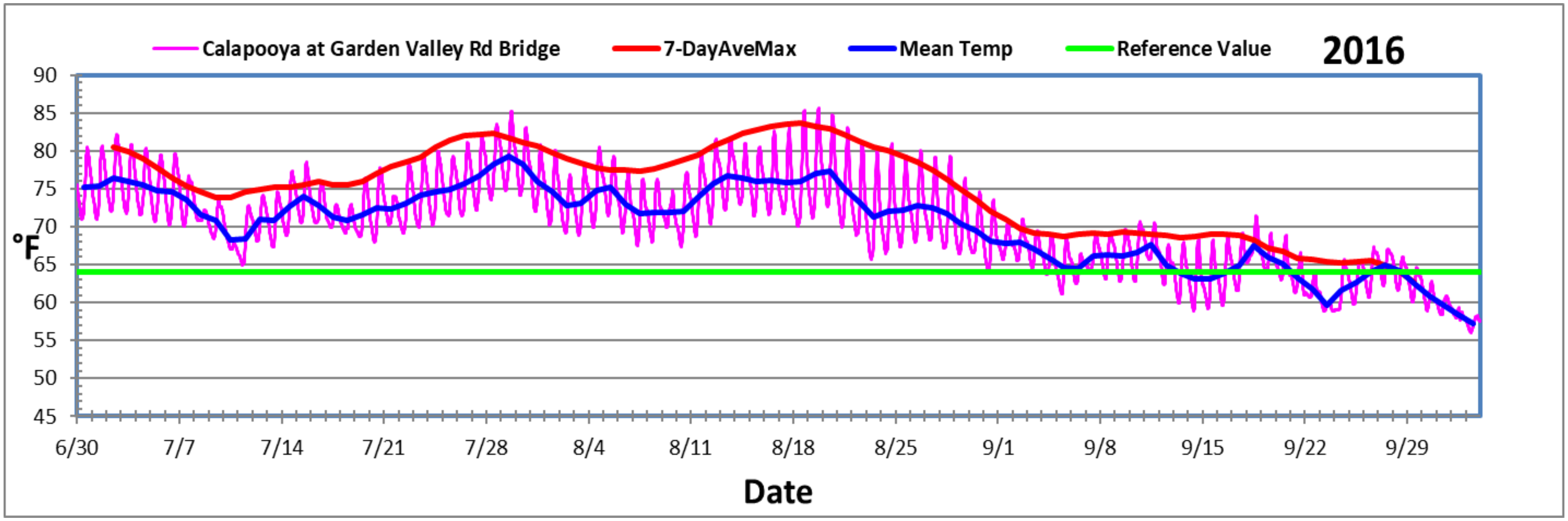
Graph 53. Yellow Creek near Hwy 138 30-minute temperature readings summer 2018.



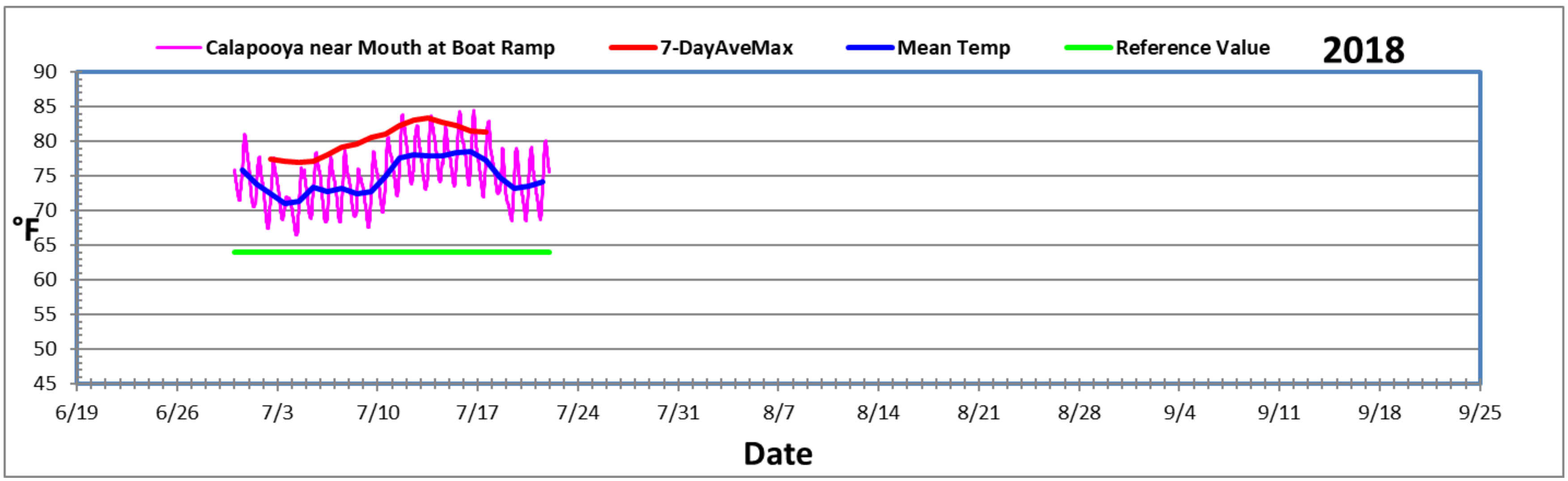
Graph 54. Umpqua River at James Wood Boat Ramp 30-minute summer temperature readings 2018.



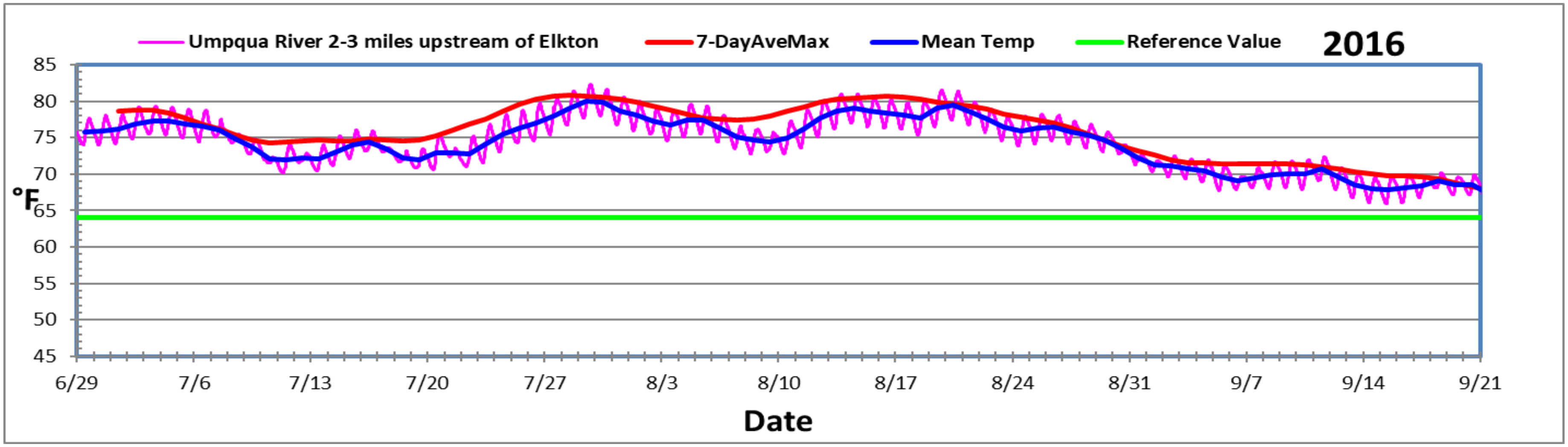
Graph 55. Umpqua River 2-3 miles upstream of Elkton 30-minute summer temperature readings 2018.



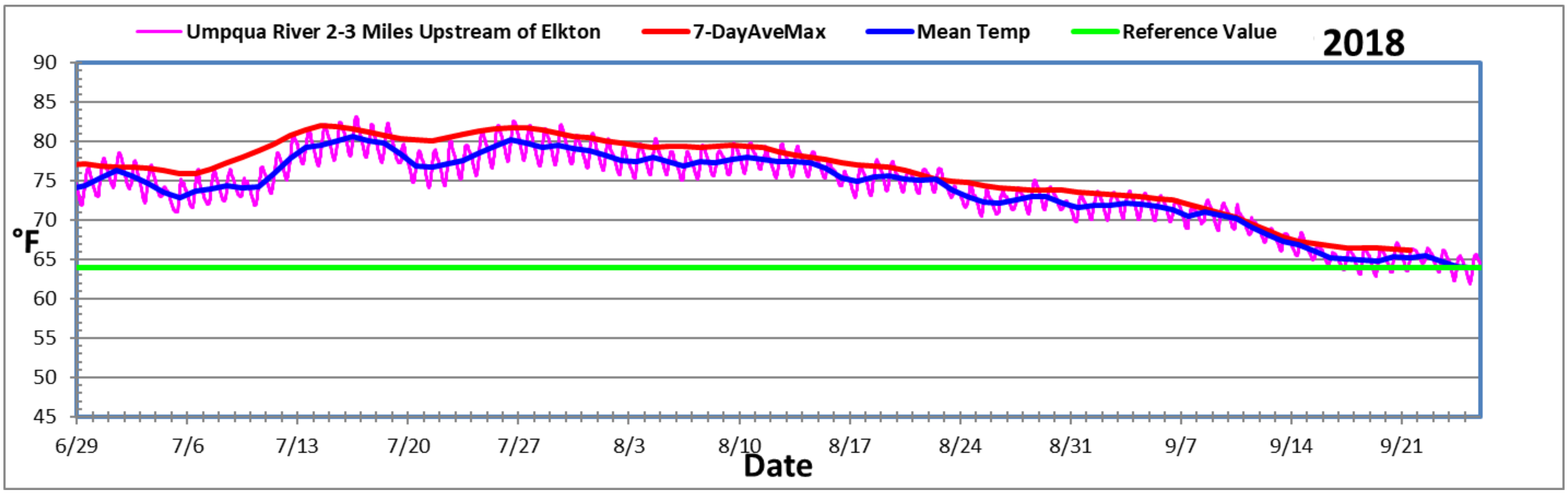
Graph 56. Calapooya at mouth 30-minute summer temperature readings 2016.



Graph 57. Calapooya at mouth 30-minute summer temperature readings 2018 for period logger was in the stream.



Graph 58. Umpqua River 2-3 miles upstream of Elkton 30-minute summer temperature readings 2016.



Graph 59. Umpqua River 2-3 miles upstream of Elkton 30-minute summer temperature readings 2018.

SITE	Spawning Criteria 55.4°F 7DAM Oct 15-May 15				Rearing and Migration Criteria 64.4°F 7DAM May 16-Oct 14					Continuous Temp
	Total Samples	Samples >55.4°F	%	Rating	Sample Events Dry or Puddled	Total Samples	Samples >64.4°F	%	Rating	Rating
U1 Umpqua at Cleveland Rapids Park	20	0	0%			16	8	50%		
CC1 Calapooya Creek at Garden Valley	20	1	5%			16	8	50%		
MLC1 Mill Creek at Hubbard Creek Road	20	0	0%			13	5	38%		
HBC1 Hubbard Creek at Hubbard Creek Road	20	0	0%		1	16	5	31%		
U2 Umpqua at James Woods Boat Ramp	20	0	0%			16	10	63%		
LWC1 Little Wolf Creek at Tyee Access Road Bridge	19	0	0%		1	15	0	0%		
WC1 Wolf Creek Upstream Little Wolf Creek	19	0	0%			16	3	19%		
LC1 Lost Creek at Tyee Road	20	0	0%			16	4	25%		
YC1 Yellow Creek at Yellow Creek Rd.	19	0	0%			15	4	27%		
U3 Umpqua at Yellow Creek Boat Ramp	20	2	10%			15	9	60%		
MGC1 McGee Creek at Bullock Road	19	0	0%		2	12	0	0%		
U4 Umpqua at State Hwy 138 W	17	1	6%			16	10	63%		
MHLC1 Mehl Creek at Mehl Creek Road	19	1	5%		1	15	4	27%		
FC1 Fitzpatrick Creek at Mehl Creek Road	17	0	0%		4	12	0	0%		
HDC1 Hedding Creek at Mehl Creek Road	16	0	0%		4	12	3	25%		
U5 Umpqua at Mehl Creek Road Bridge	17	1	6%			15	12	80%		
EC1 Elk Creek at State Hwy 138 W Bridge	17	0	0%			15	11	73%		

Table 32. Combined Grab Sample and Continuous Temperature Ratings 2015-2018.

Rating	**Grab Sample Temperatures 7DAM Spawning Oct 15 to May 15**	**Grab Sample Temperatures 7DAM Rearing and Migration May 16- Oct 14**	**Color**
Good	<55.4° F	<64.4° F	
Needs Improvement	>55.4° F	>64.4° F	
No Water	Dry or Puddled		

RESULTS - Upper Umpqua Watershed Results Summary 2015-2018

Table 32 displays the ranking for sites and parameters measured in the Upper Umpqua Watershed between 2015 and 2018. A glance at the table indicates that turbidity had 15 sites failing criteria; dissolved oxygen had 5 sites that failed and 9 sites near failing; *E. coli* levels failed to meet criteria at 12 sites; temperature failed at meeting criteria at 14 sites. pH had only 3 sites that fell outside the DEQ criteria range. Conductivity wasn't an issue in this watershed.

The creeks with the worst problems were those tributaries that, during summer at least once over the three years, went to a puddled or dry state. They were HB1 -Hubbard Creek at Hubbard Creek Road (1 time during the three years); LWC1 – Little Wolf at Tyee Access Road (1 time during the three years); MGC1 – Mehl Creek at Mehl Creek Road (1 time during the three years); FC1 – Fitzpatrick Creek at Mehl Creek Road (4 months during the three years) and HDC1 - Hedding Creek at Mehl Creek Road (4 months during the three years.

The following comments were pulled from each parameter's summary which highlighted the worst creek in each water quality parameter:

McGee Creek

1. McGee Creek at Bullock Road (CMGC1) exhibits the most occurrences of high turbidity with 47% of its samplings being greater than 10 NTU
2. 13% of samples of McGee Creek sampling events were higher than of the DEQ single sample criteria for *E. coli* (406 MPN/100ml), one in summer and three in winter

Calapooya Creek at Garden Valley Road

1. Highest turbidity levels occurred in Calapooya Creek at Garden Valley Road near its mouth
2. Calapooya Creek at the mouth consistently had the worst 7DAM of over 83°F each of the three years
3. Calapooya Creek at Garden Valley Road fell into the red category for both spawning and non-spawning dissolved oxygen criteria.
4. Calapooya Creek at the mouth had 9% of its samples exceeding DEQ single sample criteria for *E. coli* (406 MPN/100ml in the winter but none in the summer

Umpqua at Mehl Creek Road

1. Exceedances above the 8.5 pH DEQ upper exceedance criteria were detected enough to rate as red

Umpqua at State Hwy 138W

1. Exceedances above the 8.5 pH DEQ upper exceedance criteria were detected enough to rate as red

Elk Creek at State Hwy 138 W Bridge

1. Exceedances above the 8.5 pH DEQ upper exceedance criteria were detected enough to rate as red

Mill Creek

1. Mill Creek had the most exceedances with 36% of its sampling events being higher than the DEQ single sample criteria for *E. coli* (406 MPN/100ml. It had 55% exceedances in summer and 27.3% in winter
2. Mill Creek had the four highest levels recorded *E. coli* levels with two of them being over the limit of the assay (≥2419.6)
3. Mill Creek had 54.5% of its temperature exceedances occurring during the summer period, while 27.3% showed exceedances during winter
4. Mill Creek fell into the red category for both spawning and non-spawning dissolved oxygen criteria

Hedding Creek

1. Hedding Creek had 10% of its sampling events being higher than of the DEQ single sample criteria for *E. coli* (406 MPN/100ml), two occurred in summer and one in winter
2. Went dry four months during the three years monitored
3. Hedding Creek failed to meet dissolved oxygen criteria for Spawning Season

Umpqua River 2-3 miles upstream of Elkton

1. The Umpqua River had the second-highest temperature 7DAM breaking 80°F each of the three years.
2. This site had 78 days over 70°F in 2016 and 2017 and, in 2018 had 95 days over 70°F!

Hubbard Creek at Hubbard Creek Road

1. Went dry once during the three years monitored
2. Hubbard Creek had one the DEQ single sample criteria for *E. coli* (406 MPN/100ml) in summer and one in winter

Little Wolf at Tyee Access Road

1. Went dry once during the three years monitored

Mehl Creek at Mehl Creek Road

1. Went dry once during the three years monitoring
2. Mehl Creek failed to meet dissolved oxygen criteria for Spawning Season
3. Mehl Creek 6% of samples of its sampling events higher than the DEQ single sample criteria for *E. coli* (406 MPN/100ml), one in summer and three in winter

Fitzpatrick Creek at Mehl Creek Road

1. Went dry four months during the three years monitored
2. Fitzpatrick Creek failed to meet dissolved oxygen criteria for Spawning Season
3. Fitzpatrick Creek had 7% of its sampling events higher than the DEQ single sample criteria for *E. coli* (406 MPN/100ml), one in summer and one in winter

The Umpqua at Cleveland Rapids Park

1. Was designated yellow (Moderate Concern) Rating because of a single exceedance of 8.5 pH

The Umpqua at Yellow Creek Boat Ramp

1. Was designated yellow (Moderate Concern) Rating because of a single exceedance of 8.5 pH
2. The Umpqua at Yellow Creek Boat Ramp had 9% of its samples exceeding DEQ single sample criteria for *E. coli* (406 MPN/100ml in the winter but none in the summer

Summary Rating for Upper Umpqua Watershed Monitoring Sites 2015-2018 – Six Water Quality Parameters

	Went Dry/Puddled At Least 1 Summer Monitoring Event	Turbidity	pH	Dissolved Oxygen	Conductivity	*E. coli* ≥406 MPN/100ml Criteria	Temperature DEQ 2010 Criteria
U1 Umpqua at Cleveland Rapids Park		Red	Yellow	Green	Blue	Blue	Red
CC1 Calapooya Creek at Garden Valley		Red	Green	Red	Blue	Red	Red
MLC1 Mill Creek at Hubbard Creek Road		Red	Yellow	Red	Blue	Red	Red
HBC1 Hubbard Creek at Hubbard Creek Road	Brown	Yellow	Blue	Green	Blue	Red	Red
U2 Umpqua at James Woods Boat Ramp		Red	Blue	Green	Blue	Red	Red
LWC1 Little Wolf Creek at Tyee Access Road Bridge	Brown	Green	Blue	Yellow	Blue	Blue	Blue
WC1 Wolf Creek Upstream Little Wolf Creek		Red	Blue	Yellow	Blue	Blue	Red
LC1 Lost Creek at Tyee Road		Red	Blue	Yellow	Blue	Red	Red
YC1 Yellow Creek at Yellow Creek Rd.		Red	Blue	Yellow	Blue	Blue	Red
U3 Umpqua at Yellow Creek Boat Ramp		Red	Yellow	Yellow	Blue	Red	Red
MGC1 McGee Creek at Bullock Road	Brown	Red	Blue	Yellow	Blue	Red	Blue
U4 Umpqua at State Hwy 138 W		Red	Red	Yellow	Blue	Red	Red
MHLC1 Mehl Creek at Mehl Creek Road	Brown	Red	Blue	Red	Blue	Red	Red
FC1 Fitzpatrick Creek at Mehl Creek Road	Brown	Red	Blue	Red	Blue	Red	Blue
HDC1 Hedding Creek at Mehl Creek Road	Brown	Red	Blue	Red	Blue	Red	Red
U5 Umpqua at Mehl Creek Road Bridge		Red	Red	Yellow	Blue	Red	Red
EC1 Elk Creek at State Hwy 138 W Bridge		Red	Red	Yellow	Blue	Blue	Red

Table 33. Rating Summary of Upper Umpqua Watershed monitoring sites. See the individual parameter's summary for the criteria used in establishing the color. Used worst rating between summer and winter data, and spawning and non-spawning season. Temperature ratings are based on continuous temperature data where it exists, otherwise on grab sample results. Brown indicates creeks that were puddled or dry at least one summer monitoring even

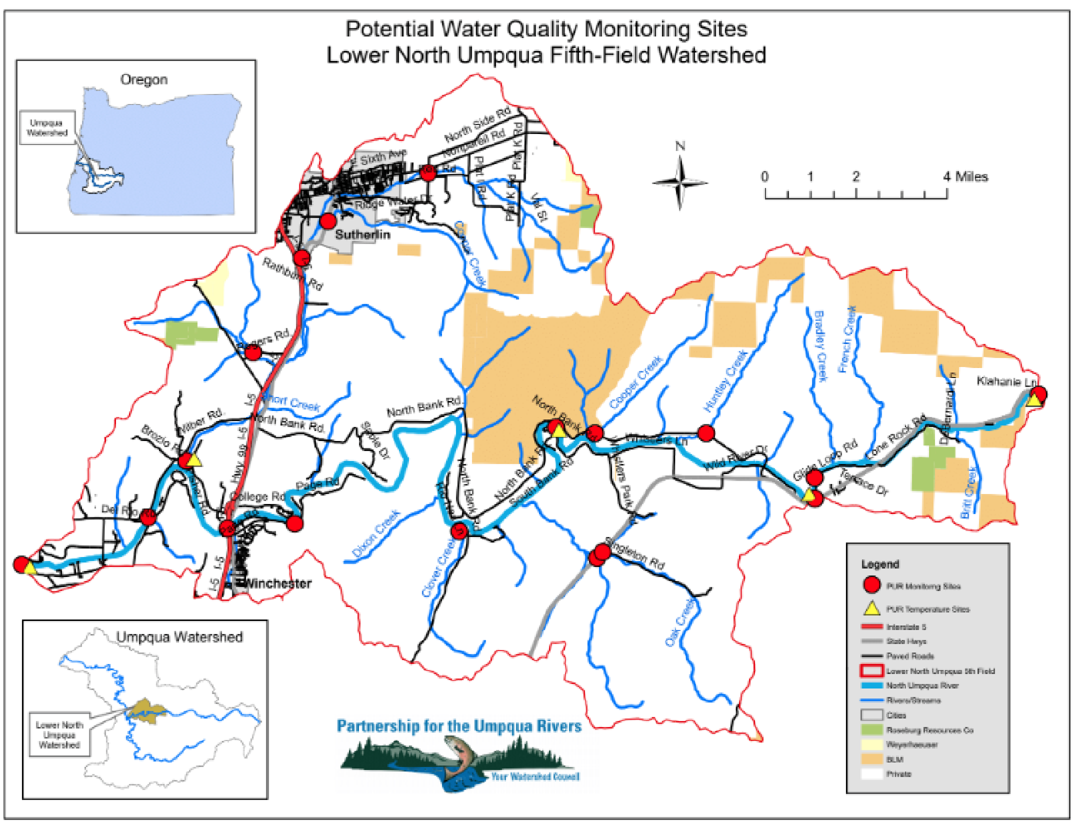
Other Monitoring Runs During This Grant – Data Analysis Will Occur After Completion of Three Years Monitoring

Lower North Umpqua 5th– Field Watershed

The monitoring of this watershed began on 2/6/2018 and will complete three years monitoring in March 2021. It will be graphed and analyzed in the OWEB 219-2021 Final Report. All data through 12/31/2019 was submitted to ODEQ.

Monitoring Run	OWEB 217-2055 Award Date: 4/26/17 End Date: 3/31/2020 Report Date: Pending																								OWEB 219-2021 Award Date: 4/17/19 End Date: 6/1/22 Report Date: Unknown																							
	2018												2019												2020												2021											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Lower North Umpqua 5th Field Watershed																																																

Table 34. Lower North Umpqua 5th-Field Grants and Timeline.



Map 6. **Lower North Umpqua 5th-Field Monitoring Sites.**

	Site ID	River/Stream	Site Location	LASAR ID	Latitude	Longitude	Township, Range, Section
1	NUR1	North Umpqua River	at River Forks Park		43.268159	-123.442363	T26S R6W S32
2	NUR2	North Umpqua River	at Hestness Park		43.283686	-123.391595	T26S R6W S27
3	SNC1	Sutherlin Creek	at Del Rio Rd.		43.302844	-123.375942	T26S R6W S14
4	SNC2	Sutherlin Creek	At Hwy 99 South of exit 138		43.364475	-123.328422	T25S R5W S39
5	CRC1	Cooper Creek	at Hwy 99		43.380090	-123.317782	T25S R5W S39
6	SNC3	Sutherlin Creek	At Hwy 99		43.388416	-123.314706	
7	SNC4	Sutherlin Creek	at Southside Rd.		43.396987	-123.274345	T25S R5W S45
8	TSNC1	Trib to Sutherlin Creek	West Side of I5 near Milepost 132		43.329020	-123.341184	
9	NUR3	North Umpqua River	at Amacher Park	34140	43.2817	-123.3560	T26S R6W S25
10	OKC1	Oak Creek	Near mouth South Bank Dr.		43.293383	-123.224398	
11	NUR5	North Umpqua River	at Whistlers Bend Park		43.312032	-123.220654	T26S R4W S7
12	NUR4	North Umpqua River	At Private property 1532 Echo Dr.		43.301813	-123.261618	
13	JNC1	Jackson Creek	At North Bank Rd.		43.316585	-123.201076	
14	HYC1	Huntley Creek	at North Bank Rd.		43.3170	-123.1500	T26S R4W S10
15	NUR6	North Umpqua River	At North Bank Rd.		43.307484	-123.123831	
16	LER1	Little River	at Hwy 138		43.2974	-123.1010	T26S R3W S19
17	NUR7	North Umpqua River	At Swiftwater Park Rd.		43.332650	-123.005441	
18	RKC1	Rock Creek	At Swiftwater Park		43.332879	-123.003137	

Table 35. Lower North Umpqua 5th-Field Water Quality Monitoring Sites.

	Site ID	River/Stream	Site Location	LASAR ID	Latitude	Longitude	Township, Range, Section
1	NUR1	North Umpqua River	at River Forks Park		43.2666	-123.4468	T26S R6W S32
2	SNC1	Sutherlin Creek	at Del Rio Rd.		43.3026	-123.3750	T26S R6W S14
3	SNC2	Sutherlin Creek	East of Exit 135		43.3684	-123.3280	T25S R5W S39
4	OKC1	Oak Creek	Near mouth South Bank Dr.		43.2942	-123.2246	
5	NUR5	North Umpqua River	at Whistlers Bend Park		43.3173	-123.2150	T26S R4W S7
6	LER1	Little River	at Hwy 138		43.2974	-123.1010	T26S R3W S19
7	NUR6.5	North Umpqua River	At Loan Rock Boat Ramp		43.316989	-123.061359	
8	RKC1	Rock Creek	At Swiftwater Park		43.332879	-123.003137	

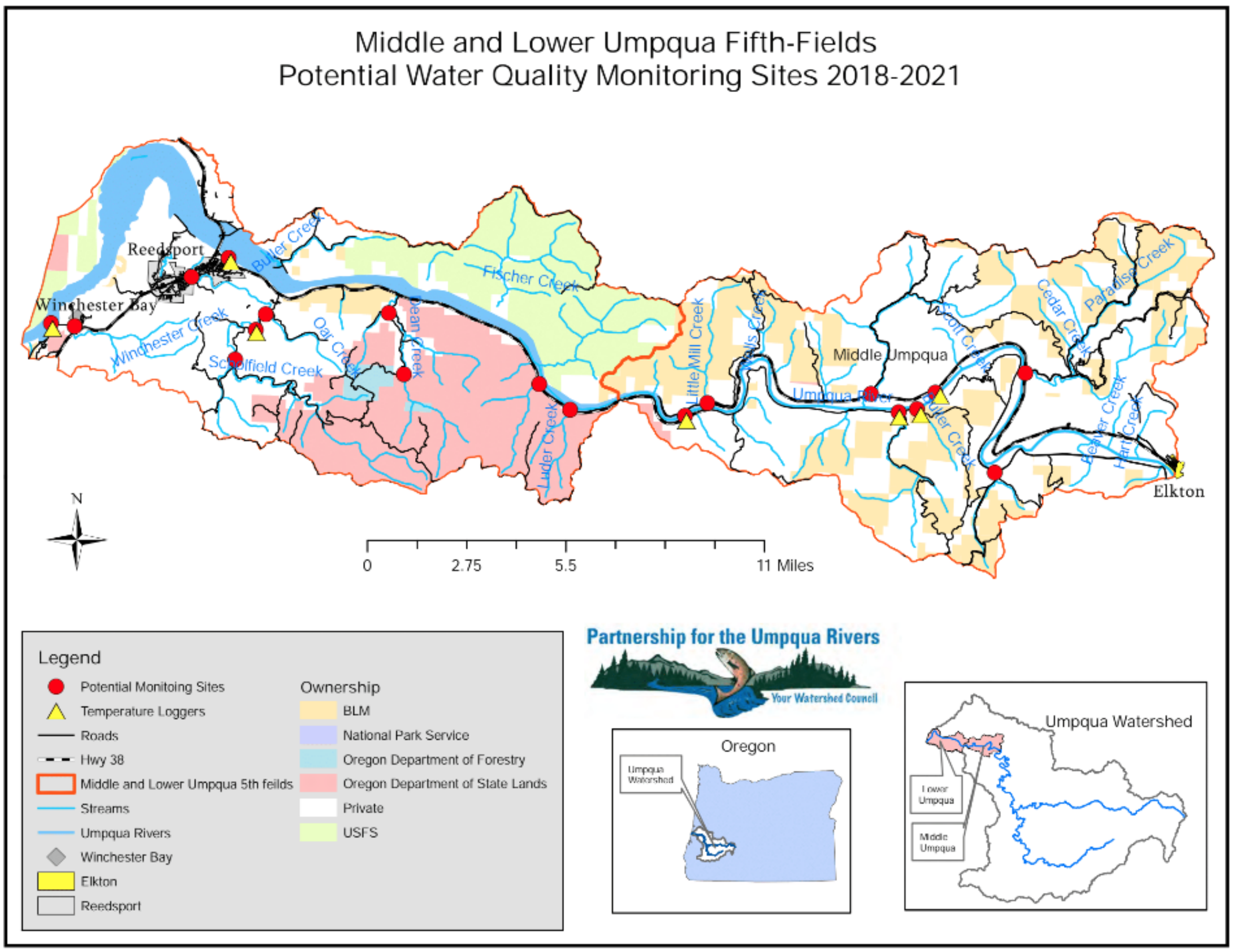
Table 36. Lower North Umpqua 5th-Field Temperature Logger Sites.

UmpquaRiver-SawyerRapids&Lower Umpqua 5th-Field Watersheds

The UmpquaRiver-SawyerRapids&Lower Umpqua 5th-Field Watersheds were started on 12/19/2018. For this run, two 5th-field watersheds were combined for cost-effectiveness. It is a very long run but with the driving distance required to reach the coast and having to pass through the higher watershed, it made sense to combine them for reasons of staff time and mileage. (Note: The official name for the Middle Umpqua 5th-Field was changed to the Umpqua River-Sawyer Rapids 5th-Field.)
The data for this run will be reported with the OWEB 219-2021 Final Report when three years of data have been gathered. All data through 12/31/2019 was submitted to ODEQ.

Monitoring Run	OWEB 217-2055 Award Date: 4/26/17 End Date: 3/31/2020 Report Date: Pending																								OWEB 219-2021 Award Date: 4/17/19 End Date: 6/1/22 Report Date: Unknown																							
	2018												2019												2020												2021											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Ump Riv-Saw Rapids & Low Umpua 5th Field Watersheds																																																

Table 37. The UmpquaRiver-SawyerRapids&Lower Umpqua 5th-Field Watersheds Grants



and Timeline.

Map 7. **The UmpquaRiver-SawyerRapids&Lower Umpqua 5th-Field Watershed Monitoring sites.**

	Site ID	River/Stream	Site Description	LASAR ID	Latitude	Longitude	Township, Range, and Section
1	SRC1	Sawyer Creek	At Henderer Rd.		43.632013	-123.666908	T22s R8W S29
2	PEC1	Paradise Creek	At Hwy 38 Bridge	37507	43.672293	-123.652051	T22s R8W S9
3	U6	Umpqua River	At Sawyer Rapids County Boat Ramp		43.675318	-123.654471	T22s R8W S9
4	BRC1	Buttler Creek	At Lutsinger Creek Rd.		43.656121	-123.711213	T22S R9W S13
5	LTRC1	Lutsinger Creek	At Lutsinger Creek Rd.	37504	43.651919	-123.717484	T22S R9W S13
6	WYC1	Weatherly Creek	At Hwy138 Bridge	37503	43.661638	-123.736953	T22S R9W S14
7	LEMC1	Little Mill	At Scottsburg Rd. W		43.655208	-123.827097	T22S R10W S13
8	U7	Umpqua River	At Scottsburg Park, Dock	37495	43.649762	-123.839234	T22S R10W S24
9	LDRC1	Luder Creek	At Hwy 38, Near Mouth		43.649598	-123.902999	T22S R10W S21
10	CEC1	Charlotte Creek	At Hwy 38 Bridge		43.659646	-123.921913	T22S R10W S17
11	DNC1	Dean Creek	At 1st bridge up Dean Creek Rd.	37496	43.685986	-124.00528	T22S R11W S3
12	DNC2	Dean Creek	At end of road	37497	43.661705	-123.995453	T22S R11W S15
13	U8	Umpqua River	At Discovery Center Dock	37399	43.70528	-124.095069	T21S R12W S35
14	SHR1	Smith River	At Lower Smith River Rd.		43.714716	-124.09470	T21S R12W S26
15	SHR2	Smith River	At S. Smith River Rd.		43.738685	-124.063777	T21S R11W S19
16	SDC1	Schofield Creek	At Hwy 101	37499	43.697061	-124.115177	T22S R12W S3
17	WRC1	Winchester Creek	At Salmon Harbor Dr.	37500	43.675127	-124.178478	T22S R12W S7
18	U9	Umpqua River	Pier off of Salmon Harbor Dr. before Halfmoon Bay		43.675958	-124.191648	T22S R13W S12
19	ORC1	Oar Creek	At Scholfield Rd		43.683428	-124.073196	T22S R12W S12
20	SDC2	Scholfield Creek	At Thorton Oar Ln Bridge		43.678174	-124.086798	T22S R12W S12
21	SDC3	Scholfield Creek	At Scholfield Rd		43.664666	-124.088995	T22S R12W 14

Table 38. Umpqua River-Sawyer Rapids and Lower Umpqua Water Quality Monitoring Sites

	Site ID	River/Stream	Site Description	LASAR ID	Latitude	Longitude	Township, Range, and Section
1	U6	Umpqua River	at Sawyer Rapids County Boat Ramp		43.675318	-123.654471	T22s R8W S9
2	BRC1	Buttler Creek	At Lutsinger Creek Rd.		43.656121	-123.711213	T22S R9W S13
3	LTRC1	Lutsinger Creek	At Lutsinger Creek Rd.	37504	43.649707	-123.718439	T22S R9W S13
4	LEMC1	Little Mill	At Scottsburg Rd. W		43.655208	-123.827097	T22S R10W S13
5	U7	Umpqua River	At Scottsburg Park, Dock	37495	43.649762	-123.839234	T22S R10W S24
6	U8	Umpqua River	At Discovery Center Dock	37399	43.70528	-124.095069	T21S R12W S35
7	U9	Umpqua River	Pier off of Salmon Harbor Dr. before Halfmoon Bay		43.675958	-124.191648	T22S R13W S12

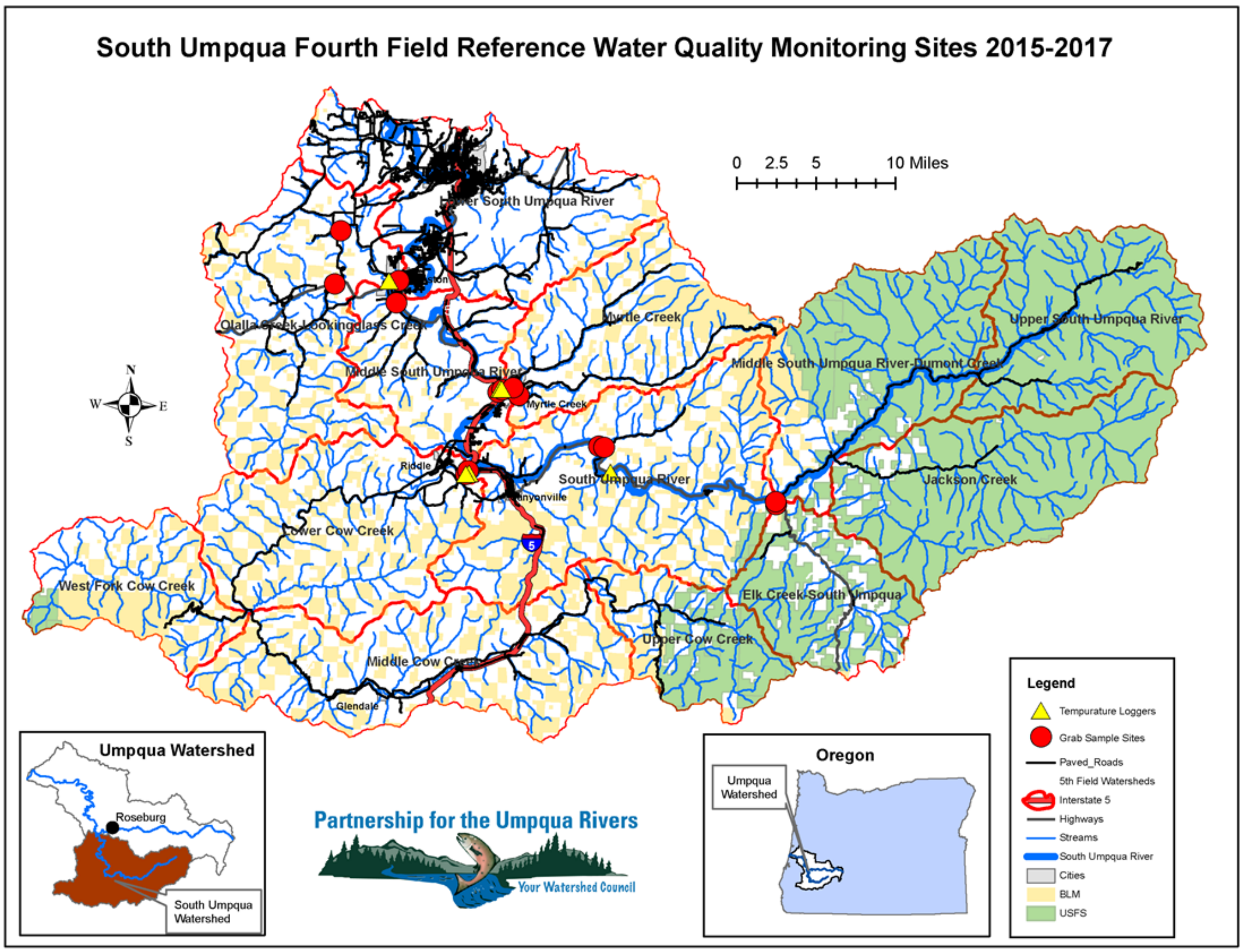
Table 39. Umpqua River-Sawyer Rapids and Lower Umpqua Temperature Logger Sites.

The South Umpqua 4th-Field Reference Run

The South Umpqua 4th-Field Reference Run began in January 2015. The first three years of monitoring were reported in the OWEB 215-2046 Final Report. The next report will occur with the OWEB 219-2021 Final Report and will include all 6 years of monitoring data. All data through 12/31/2019 was submitted to ODEQ.

Monitoring Run	OWEB 214-2046 Award Date: 7/7/14 End Date: 12/31/16	OWEB 215-2046 Award Date: 4/28/15 End Date: 8/28/18 Report Date: 10/27/18		OWEB 217-2055 Award Date: 4/26/17 End Date: 3/31/2020 Report Date: Pending		OWEB 219-2021 Award Date: 4/17/19 End Date: 6/1/22 Report Date: Unknown	
	2015	2016	2017	2018	2019	2020	2021
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
South Umpqua 4th Field Reference							

Table 40. The South Umpqua 4th-Field Reference Run Grants and Timeline.



Map 8. **The South Umpqua 4th-Field Reference Run Monitoring Sites.**

	Site ID	River/Stream	Location	LASAR ID	Latitude	Longitude	Township, Range, Section
1	SU1	South Umpqua	Above Elk Creek	37486	42.92716	-122.95144	T30S R2W S33
2	E1	Elk Creek	Near Mouth	37484	42.833983	-122.84921	T30S R2W S33
3	SU2	South Umpqua	At Hwy 1 bridge		42.9728	-123.172	T30S R4W S9
4	DC4	Days Creek	At Hwy 1 bridge		42.9724	-123.166	T30S R4W S10
5	COC1	Cow Creek	Near Mouth	10997	42.9428	-123.3367	T30S R5W S19
6	SU6	South Umpqua	At Lawson Bar		42.947	-123.334	T30S R5W S19
7	SU8	South Umpqua	Below Myrtle Creek Water Plant		43.0227	-123.297	T29S R5W S28
8	MC1	Myrtle Creek	At mouth		43.0229	-123.296	T29S R5W S28
9	SM1	South Myrtle	At Neil Lane Bridge	33247	43.016972	-123.274371	T29S R5 S27
10	NM1a	North Myrtle	At Evergreen Park Near Mouth		43.0233	123.2832	T29S R5 S27
11	SU11	South Umpqua	At Brockway Road		43.0978	-123.43	T28S R6W S32
12	LG3	Lookingglass Creek	At Hwy 42 Bridge West of Olalla Rd.		43.113333	-123.50773	T28S R7W S27
13	MG2	Morgan Creek	At lower Dairy Loop Rd. Bridge		43.1615	-123.50326	T28S R7W S2
14	LG1	Lookingglass Creek	At Hwy 42 Bridge Winston Near Mouth		43.1177	-123.4283	T28S R6W S20

Table 41. South Umpqua Reference Water Quality Monitoring Sites.

	Site ID	River/Stream	Location	LASAR ID	Latitude	Longitude	Township, Range, Section
1	SU1a	South Umpqua	On Shively Creek Rd.		42.9484	-123.158	T30S R4W S22
2	SU6	South Umpqua	At Lawson Bar		42.947	-123.334	T30S R5W S19
3	SU8	South Umpqua	Below Myrtle Creek Water Plant		43.0227	-123.297	T29S R5W S28
4	MC1	Myrtle Creek	At mouth		43.0229	-123.296	T29S R5W S28
5	LG1	Lookingglass Creek	At Hwy 42 Bridge Winston Near Mouth		43.1177	-123.4283	T28S R6W S20

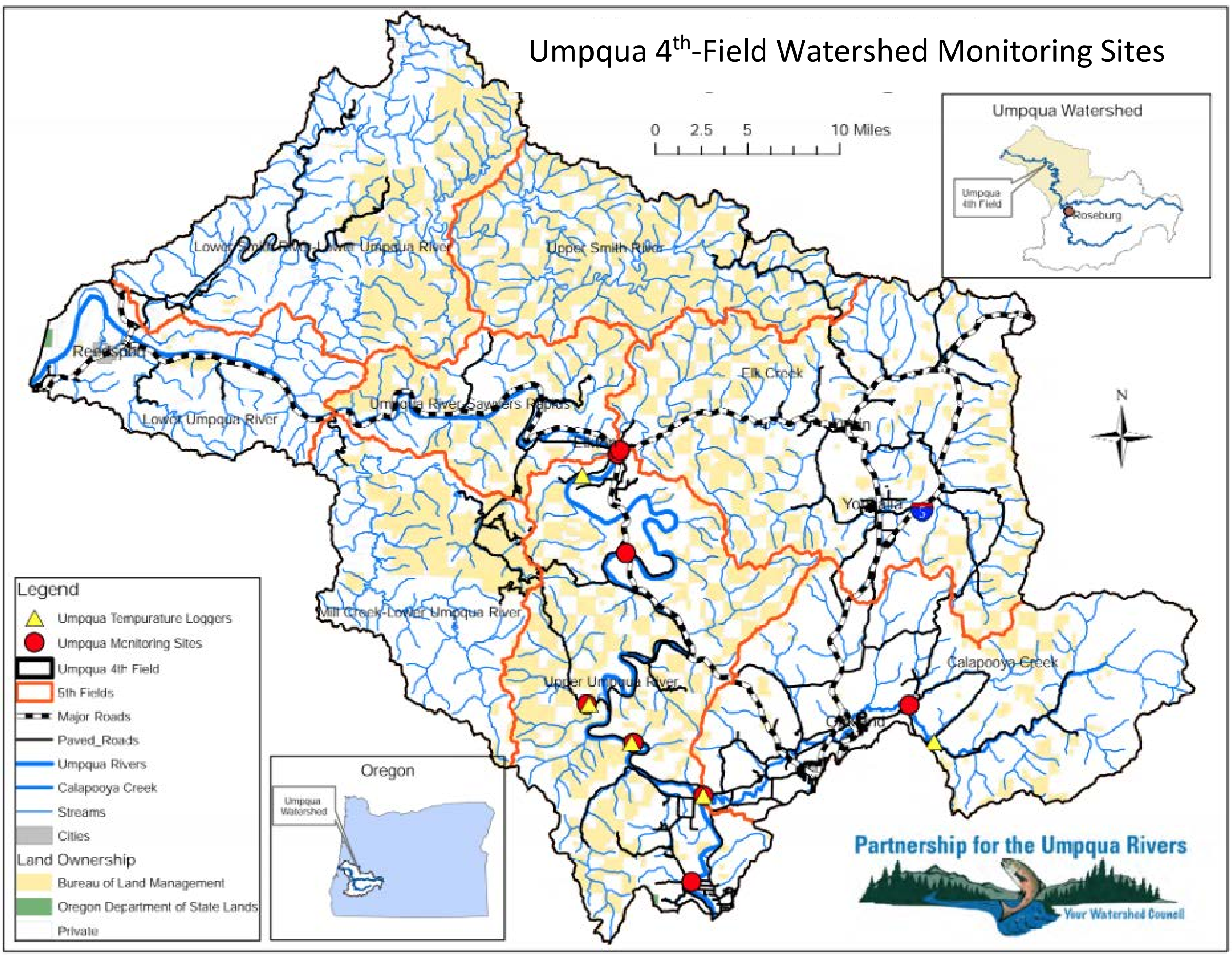
Table 42. South Umpqua Reference Temperature Recorder Monitoring Sites.

Umpqua 4th-Field Watershed Reference Run

The Umpqua 4th-Field Watershed Reference Run was started in November of 2018. Three years of monitoring data will be reported in the OWEB 219-2021 Final Report. All data through 12/31/2019 was submitted to ODEQ.

Monitoring Run	OWEB 214-2046					OWEB 217-2055 Award Date: 4/26/17 End Date: 3/31/2020 Report Date: Pending																								OWEB 219-2021 Award Date: 4/17/19 End Date: 6/1/22 Report Date: Unknown																							
	2015					2018												2019												2020												2021											
	J	F	M	A	M	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Umpqua 4th Field Reference																																																					

Table 43. The Umpqua 4th-Field Watershed Reference Run Grants and Timeline.



Map 9. **Umpqua 4th-Field Watershed Reference Run Monitoring Sites.**

	Site ID	River/Stream	Site Description	LASAR ID	Latitude	Longitude	Township, Range, and Section
1	CC1	Calapooya Creek	At Garden Valley Bridge	10996	43.3666	-123.461	T25S R6W S30
2	U1	Umpqua	At Cleveland Rapids Park		43.2972	-123.47	T26S R7W S24
3	U2	Umpqua	At James Woods Boat Ramp	25175	43.4058	-123.538	T25S R7W S9
4	WoC2	Wolf Creek	Upstream Little Wolf Creek		43.4347	-123.588	T24S R8W S36
5	U4	Umpqua	At State Hwy 138 W		43.5544	-123.554	T23S R7W S20
6	U5	Umpqua	At Mehl Creek Road Bridge	10437	43.6319	-123.567	T22S R7W S30
7	EC1	Elk Creek	At State Hwy 138 W Bridge	10441	43.6346	-123.565	T22S R7W S29
8	CC4	Calapooya Creek	At Driver Valley Road Bridge	12796	43.4003	-123.374	T25S R6W S14

Table 44. Umpqua 4th-Field Watershed Reference Water Quality Monitoring Sites.

	Site ID	River/Stream	Site Description	LASAR ID	Latitude	Longitude	Township, Range, and Section
1	CC1	Calapooya Creek	At Garden Valley Bridge	10996	43.3666	-123.461	T25S R6W S30
2	U2	Umpqua	At James Woods Boat Ramp	25175	43.4058	-123.538	T25S R7W S9
3	WoC2	Wolf Creek	Upstream Little Wolf Creek		43.4347	-123.588	T24S R8W S36
4	U5	Umpqua	above Mehl Creek Road Bridge 2.5 mile	10437	43.6319	-123.567	T22S R7W S30
5	CC4	Calapooya Creek	At Driver Valley Road Bridge	12796	43.4003	-123.374	T25S R6W S14

Table 45. Umpqua 4th Field Reference Water Temperature Recorder Monitoring Sites.

Acronyms

- ODEQ: Oregon Department of Environmental Quality
- DO: Dissolved Oxygen
- EPA: Environmental Protection Agency
- NTU: Nephelometric Turbidity Units
- OWEB: Oregon Watershed Enhancement Board
- PUR: Partnership for the Umpqua Rivers
- QAPP: Quality Assurance Project Plan
- RAC: Secure Rural Schools and Self-Determination Act of 2000 (Public law 110-343)
- UBWC: Umpqua Basin Watershed Council
- OGMS: OWEB Grant Management System
- AWQMS: Ambient Water Quality Monitoring System

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Acknowledgments

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Appendix A: Designated Beneficial Uses for the Umpqua Basin

Table 320A

Designated Beneficial Uses
Umpqua Basin
(340-41-0320)

Beneficial Uses	Umpqua R. Estuary to Head of Tidewater & Adjacent Marine Waters	Umpqua R. Main from Head of Tidewater to Confluence of N. & S. Umpqua Rivers	North Umpqua River Main Stem	South Umpqua River Main Stem	All Other Tributaries to Umpqua, North & South Umpqua Rivers
Public Domestic Water Supply[1]		X	X	X	X
Private Domestic Water Supply[1]		X	X	X	X
Industrial Water Supply	X	X	X	X	X
Irrigation		X	X	X	X
Livestock Watering		X	X	X	X
Fish & Aquatic Life[2]	X	X	X	X	X
Wildlife & Hunting	X	X	X	X	X
Fishing	X	X	X	X	X
Boating	X	X	X	X	X
Water Contact Recreation	X	X	X	X	X
Aesthetic Quality	X	X	X	X	X
Hydro Power			X	X	X
Commercial Navigation & Transportation	X				

[1] With adequate pretreatment (filtration & disinfection) and natural quality to meet drinking water standards.

[2] See also Figures 320A and 320B for fish use designations for this basin.

Table produced November, 2003

Appendix B: ODEQ Current Turbidity Rule

Turbidity Rule (OAR 340-041-0036) (Water Quality Standards, 2010)

Turbidity (Nephelometric Turbidity Units, NTU): No more than a ten percent cumulative increase in natural stream turbidities may be allowed, as measured relative to a control point immediately upstream of the turbidity causing activity. However, limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or other legitimate activities and which cause the standard to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and one of the following has been granted:

1. Emergency activities: Approval coordinated by the Department with the Oregon Department of Fish and Wildlife under conditions they may prescribe to accommodate response to emergencies or to protect public health and welfare;
2. Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of section 401 or 404 (Permits and Licenses, Federal Water Pollution Control Act) or OAR 14l-085-0100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity outlined in the permit or certificate.

Appendix C: British Columbia Turbidity and Suspended Sediment Standards

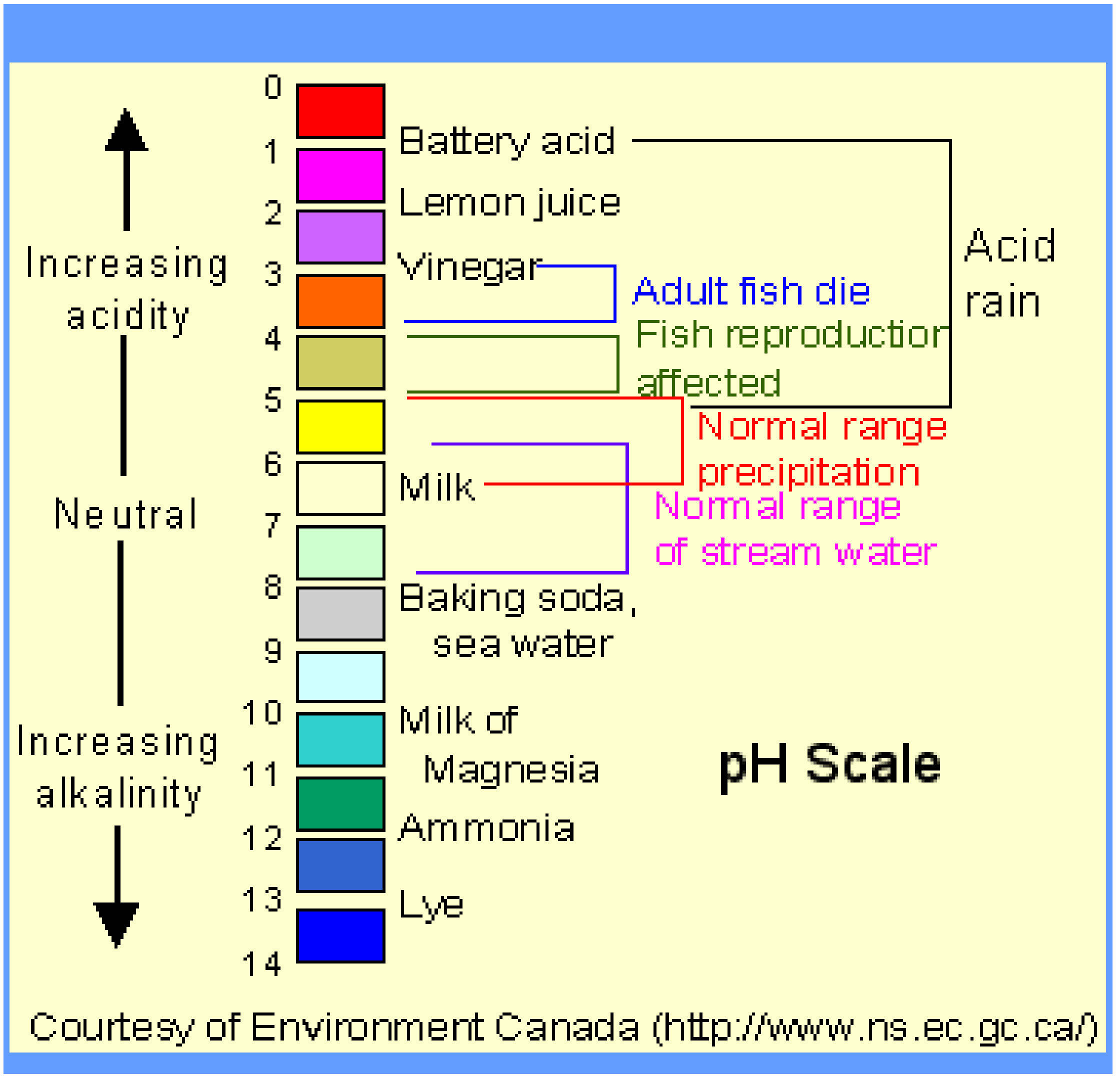
Taken from Bash, 2001, p. 70.

Table C-3. British Columbia turbidity and suspended sediment standards

Water Use	Maximum Induced Turbidity – NTU or % of background	Maximum Induced Suspended Sediments –mg/l or % of background	Streambed Substrate Composition
Drinking Water – raw untreated	1 NTU when background is less than or equal to 5	No guideline	No guideline
Drinking Water – raw treated	5 NTU when background is less than or equal to 50	No guideline	No guideline
Recreation and Aesthetics	Maximum 50 NTU ….. secchi disc visible at 1.2 m	No guideline	No guideline
Aquatic Life -fresh- -marine- -estuarine-	8 NTU in 24 hours when background is less than or equal to 8 …. Mean of 2 NTU in 30 days when background is less than or equal to 8	25 mg/l in 24 hours when background is less than or equal to 25 …. Mean of 5 mg/l in 30 days when background is less than or equal to 25	Fines not to exceed -10% as less than 2mm- -19% as less than 3mm- -25% as less than 6.35mm- at salmonid spawning sites
Aquatic Life -fresh- -marine- -estuarine-	8 NTU when background is between 8 and 80 …. 10% when background is greater than or equal to 80	25 mg/l when background is between 25 and 250 …. 10% when background is greater than or equal to 250	Geometric mean diameter not less than 12 mm …. Fredle number not less than 5mm
Terrestrial Life -wildlife- -livestock water- Irrigation Industrial	10 NTU when background is less than or equal to 50 …. 20% when background is greater than or equal to 50	20 mg/l when background is less than or equal to 100 …. 20% when background is greater than or equal to 100	No guideline

(Web Site Ref. #2)

Appendix D: pH Scale



Appendix E: Annual 7 Day Average Maximum Stream Temperatures

Umpqua Basin Stream Characterization Project Reference Sites from 1998-2019 (Dammann, D.M., 2019, p. 7)

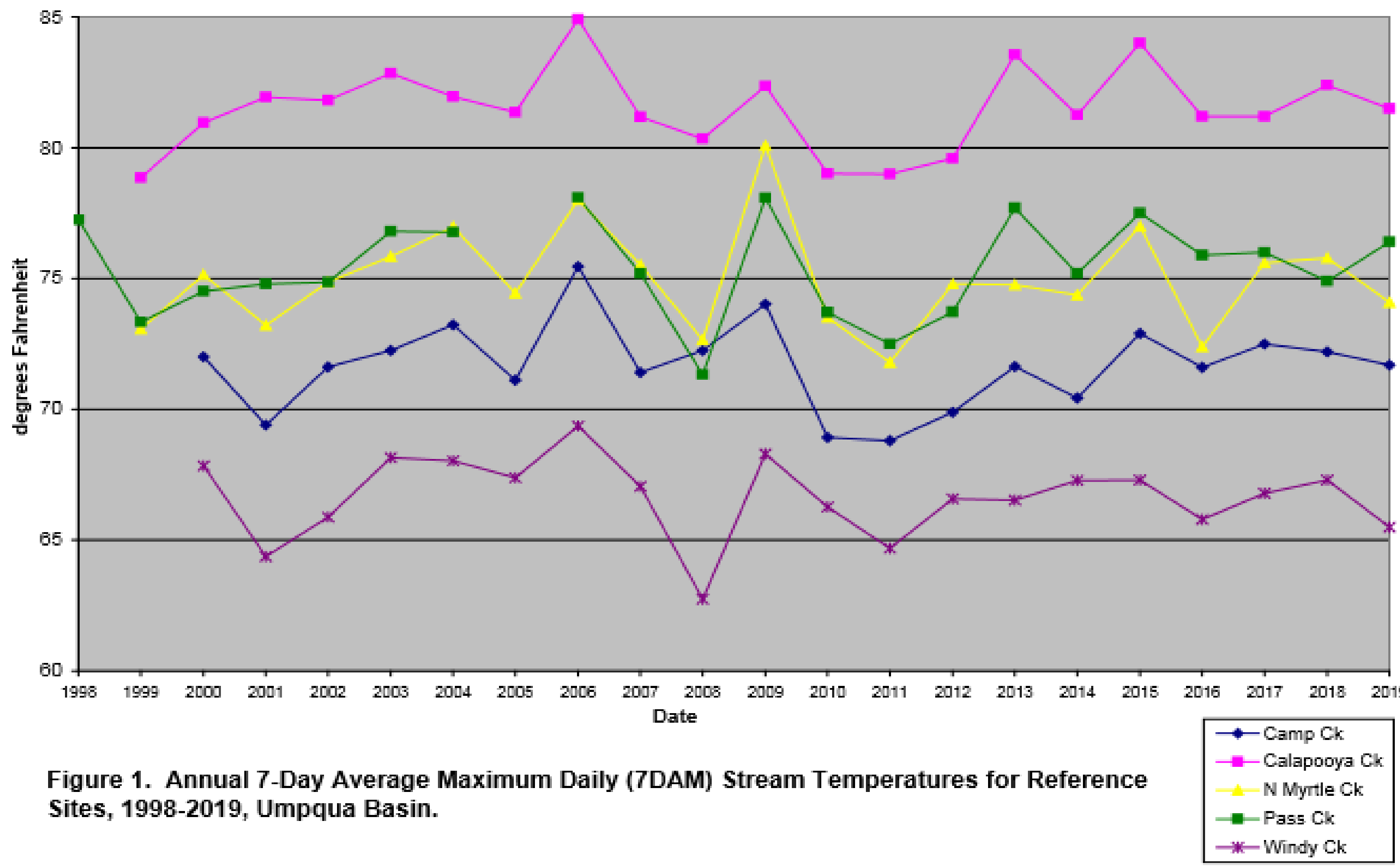


Figure 1. Annual 7-Day Average Maximum Daily (7DAM) Stream Temperatures for Reference Sites, 1998-2019, Umpqua Basin.

Appendix F: Oregon DEQ Data Quality Matrix Data Quality Matrix Oregon Department of Environmental Quality Q04-LAB-0003-QAG March 09 2009 Version 4.0 Page 2 of 2

Data Quality Matrix
DEQ04-LAB-0003-QAG
Version 4.0

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Data Validation Criteria for Water Quality Parameters Measured in the Field

Quality Level	Quality Assurance Plan	Water Temperature Methods	pH Methods	Dissolved Oxygen Methods	Turbidity Methods	Conductivity Methods	Bacteria Methods	Data Uses
A+	DEQ QAPP approved by DEQ QA Officer	Thermometer Accuracy checked with NIST standards $A \le \pm 0.5^{\circ}C$ $P \le \pm 0.5^{\circ}C$	Calibrated pH electrode $A \le \pm 0.2$ S.U. $P \le \pm 0.3$ S.U.	Winkler titration or calibrated Oxygen meter $A \le \pm 0.2\ mgL^{-1}$ $P \le \pm 0.3\ mgL^{-1}$	Nephelometric Turbidity meter $A \le \pm 5\%$ Standard value $P \le \pm 5\%$ ($\pm$ 1 NTU if NTU < 20)	Meter with temp correction to 25°C $A \le \pm 7\%$ of standard value $P \le \pm 10\%$	DEQ Approved Methods Absolute difference between log-transformed values $P \le 0.6$ log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments)
A	External QAPP	External Data Thermometer Accuracy checked with NIST standards $A \le \pm 0.5^{\circ}C$ $P \le \pm 0.5^{\circ}C$	External Data Calibrated pH electrode $A \le \pm 0.2$ S.U. $P \le \pm 0.3$ S.U.	External Data Winkler titration or calibrated Oxygen meter $A \le \pm 0.2\ mgL^{-1}$ $P \le \pm 0.3\ mgL^{-1}$	External Data Nephelometric Turbidity meter $A \le \pm 5\%$ Standard value $P \le \pm 5\%$ ($\pm$ 1 NTU if NTU <20)	External Data Meter with temp correction to 25°C $A \le \pm 7\%$ of standard value $P \le \pm 10\%$	External Data DEQ Approved Methods Absolute difference between log-transformed values $P \le 0.6$ log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments)
B	Minimum Data Acceptance Criteria Met	Thermometer Accuracy checked with NIST standards $A \le \pm 1.0^{\circ}C$ $P \le \pm 2.0^{\circ}C$	Any Method $A \le \pm 0.5$ S.U. $P \le \pm 0.5$ S.U.	Winkler titration or calibrated Oxygen meter $A \le \pm 1\ mgL^{-1}$ $P \le \pm 1\ mgL^{-1}$	Any Method $A \le \pm 30\%$ $P \le \pm 30\%$	Meter with temp correction to 25°C $A \le \pm 10\%$ of standard value $P \le \pm 15\%$	DEQ Approved Methods Absolute difference between log-transformed values $P \le 0.8$ log	Regulatory, permitting, compliance (e.g., 303(d) and 305(b) assessments) with professional judgment
C		$A > \pm 1.0^{\circ}C$ $P > \pm 2.0^{\circ}C$	$A > \pm 0.5$ S.U. $P > \pm 0.5$ S.U.	$A > \pm 2\ mgL^{-1}$ $P > \pm 2\ mgL^{-1}$	$A > 30\%$ $P > 30\%$	$A > \pm 10\%$ $P > \pm 15\%$	Absolute difference between log-transformed values $P > 0.8$ log	Void data. Not used for 303(d) and 305(b) assessments
D		Missing Data	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data	Missing Data
E	No QAPP provided	No Precision Checks	Any Method No Precision Checks	Any Method No Precision Checks or $A \le \pm 2\ mgL^{-1}$ $P \le \pm 2\ mgL^{-1}$	Any Method No precision checks	Meter without routine calibration No precision checks	Any Method No precision checks	Informational purposes only
F	See accompanying notes							

Data Validation Criteria for Water Quality Parameters Measured in the Field

Notes:

QA definitions of Data Quality Levels

A+ – Data of known Quality; collected by DEQ; meets QC limits established in the QAPP.

A – Data of known Quality; submitted by entities outside of DEQ; meets QC limits established in a *DEQ-approved* QAPP.

B – Data of known *but lesser* Quality; data may not meet established QC but is within marginal acceptance criteria, or data value may be accurate, however, controls used to measure Data Quality Objective elements failed (e.g., batch failed to meet blank QC limit); the data may be useful in limited situations or in supporting other, higher quality data.

Note: Statistics for **turbidity, conductivity,** and **bacteria** are concentration-dependent; thus low-concentration B level data may be considered acceptable for all uses.

C – Data of unacceptable Quality; data are typically discarded (Void) in response to analytical failure. **Note:** There may be rare instances where there may be field data that may still meet DQOs as determined by the Project Officer. In these cases, a result should be entered instead of "Void" however the grade must remain at C. There must also be a comment in the final report that explains the qualification.

D – Incomplete data; no sample collected or no reportable results, typically due to sampling failure.

E – Data of unknown quality or known to be of poor quality; no QA information is available, data could be valid, however, no evidence is available to prove either way. Data is provided for Educational Use Only.

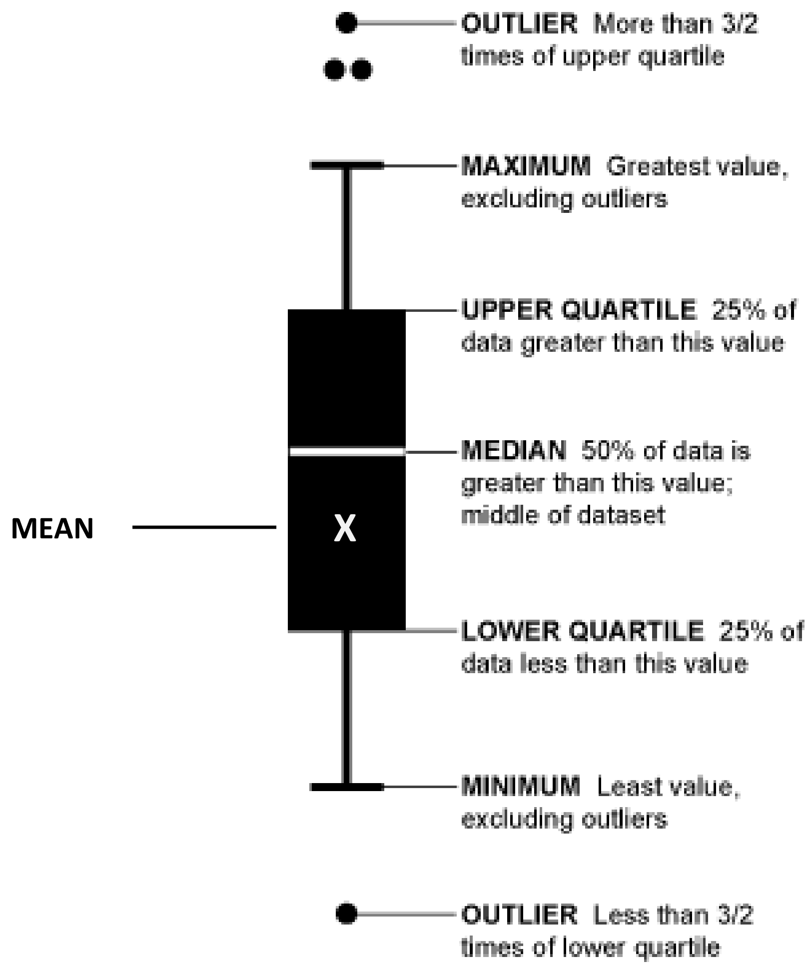
F – Exceptional Event; "A" quality data (data is of known quality), but not representative of sampling conditions as required by the project plan. (e.g., a continuous water quality monitor intended to collect background environmental conditions collects a sample impacted by a fire that created anomalous conditions to the environment).

Data Quality Level Grading Criteria:

A = Accuracy as determined by comparison with standards, e.g., during equipment calibration or pre- and post-deployment checks

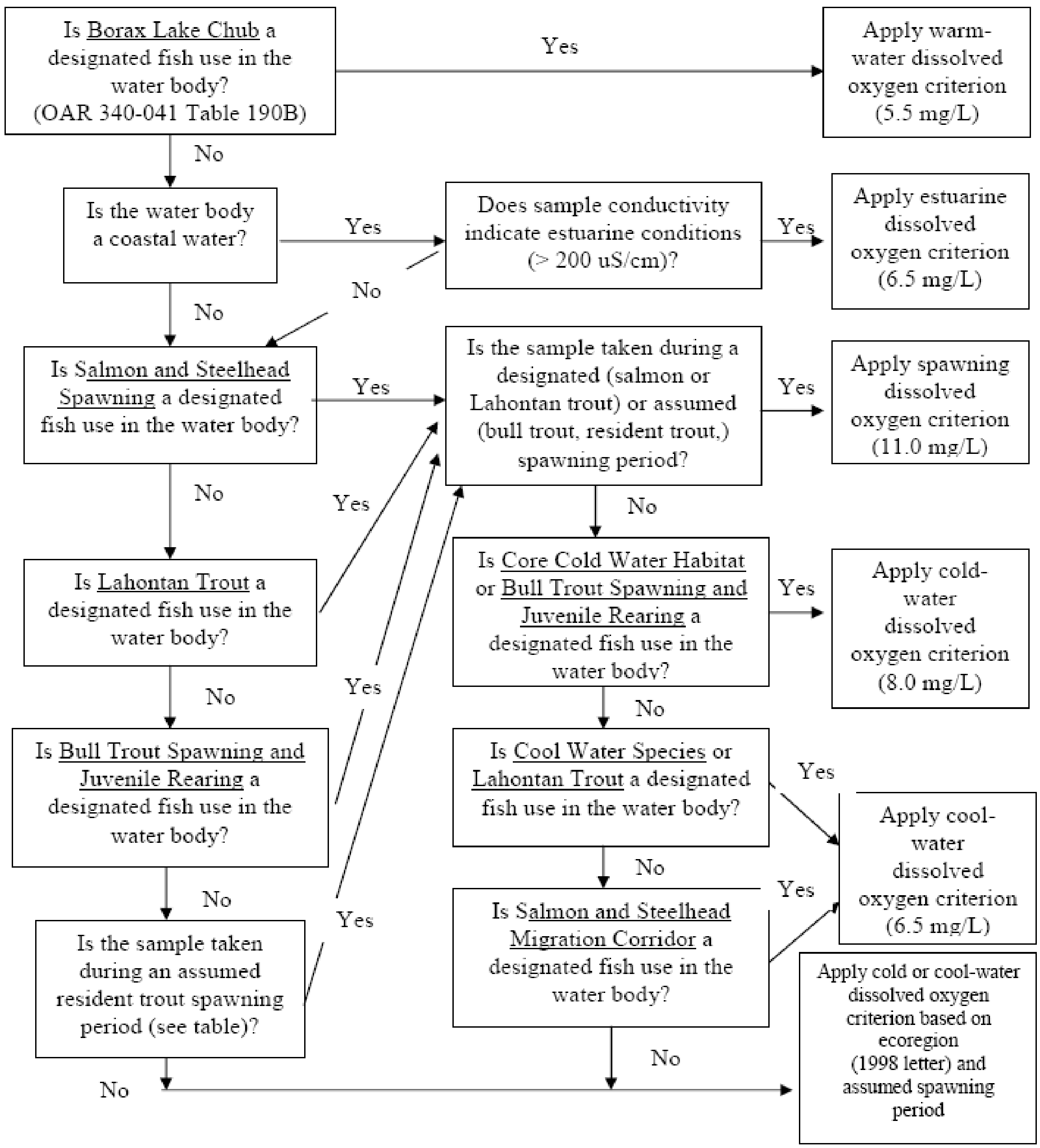
P = Precision as determined by replicate measurements, e.g., during field duplicates, field audits, or split sample

Appendix G: Interpreting a Box Plot

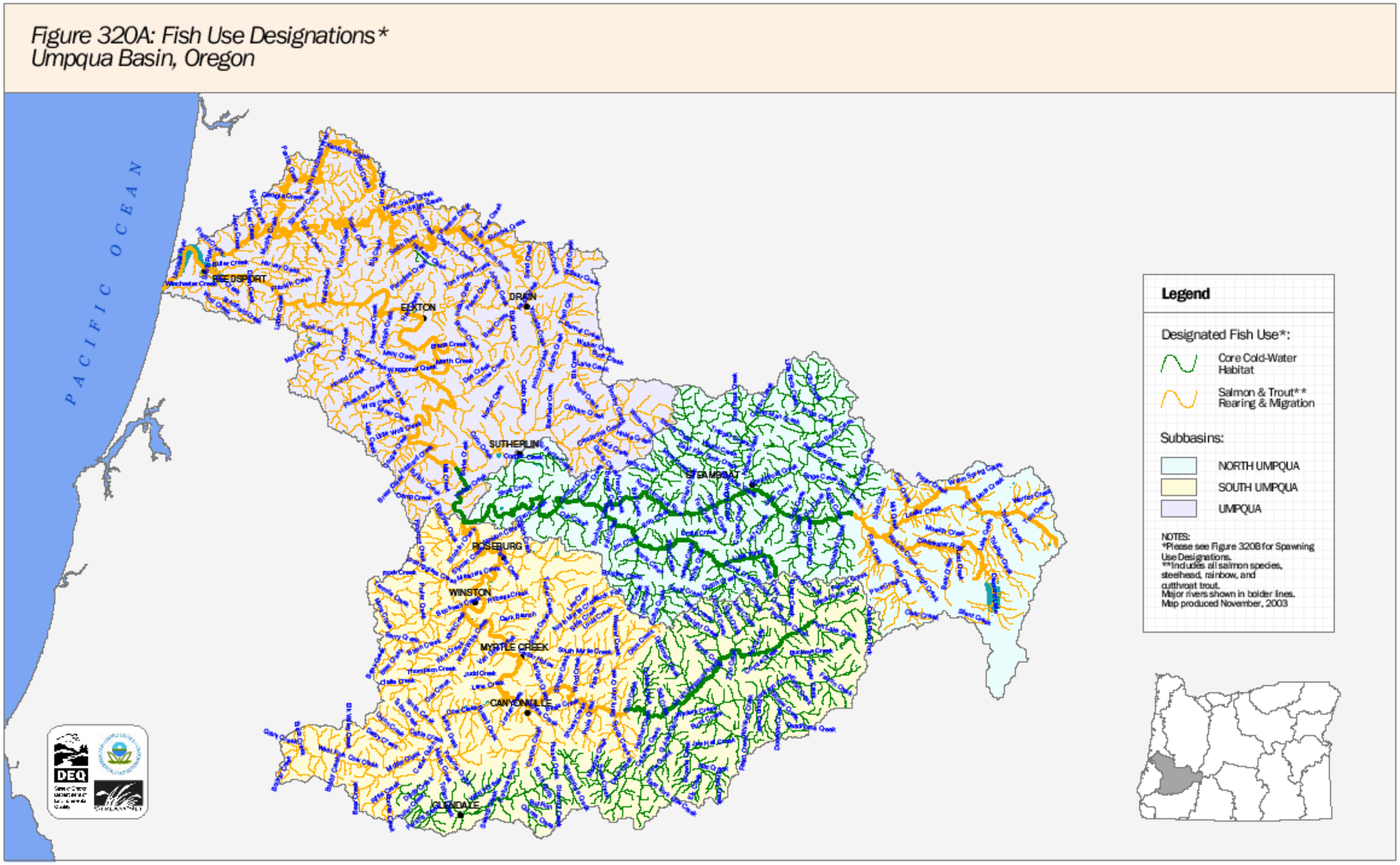


Appendix H: Dissolved Oxygen Evaluation Flow Chart

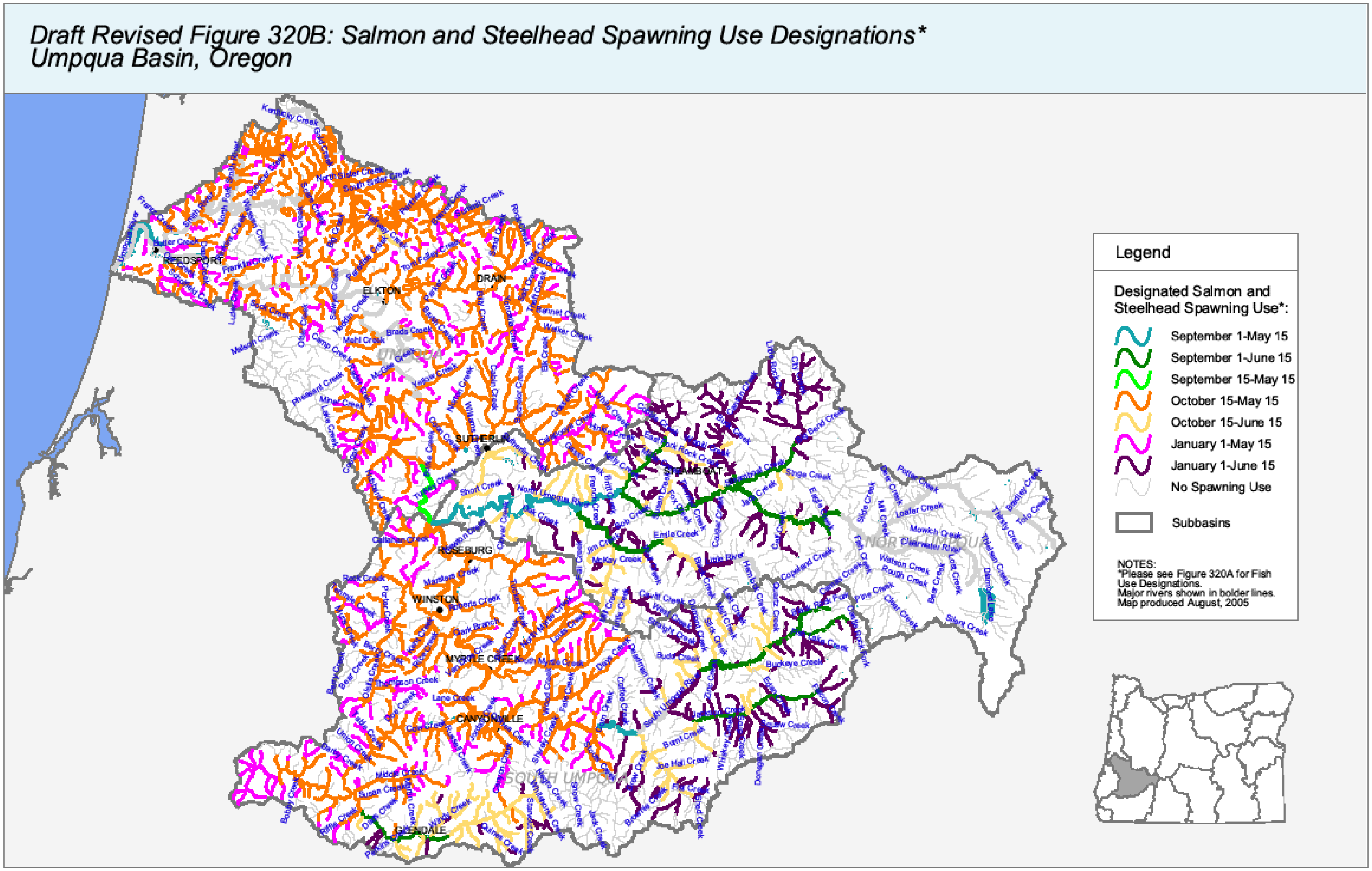
Flow Chart illustrating the evaluation process for dissolved oxygen data collected from Oregon water bodies (Assessment Methodology for Oregon's 2004/2006 Integrated Report on Water Quality Status – ODEQ Water Quality Division)



Appendix I: Umpqua Basin Fish Use Designations from ODEQ 2003



Appendix J: Umpqua Basin Salmon and Steelhead Spawning Use Designations from ODEQ 2003



Appendix K: 2015 Precipitation Data from NOAA gathered at Roseburg Regional Airport

2015

Day	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
1	0	2015	0.13	2015	0	2015	0.03	2015	0	2015	0.24	2015	0	2015	T	2015	0	2015	0	2015	0.15	2015	0.27	2015
2	0	2015	0.34	2015	0.03	2015	0	2015	0	2015	T	2015	0	2015	T	2015	0.08	2015	0	2015	0.06	2015	0.14	2015
3	0	2015	0.88	2015	T	2015	0.04	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.03	2015	0.02	2015	0.56	2015
4	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.01	2015	0	2015	0	2015	0.53	2015
5	0	2015	0.07	2015	0	2015	0.08	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	T	2015	0.03	2015
6	0	2015	1.89	2015	0	2015	0.13	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.78	2015
7	0	2015	0.6	2015	0	2015	0.21	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.31	2015	0.73	2015
8	0	2015	0.21	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.4	2015	0.03	2015
9	0	2015	0.19	2015	0	2015	0	2015	0	2015	T	2015	T	2015	0	2015	0	2015	0	2015	0.06	2015	1.35	2015
10	0	2015	0	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.07	2015	0	2015	1.2	2015
11	T	2015	0	2015	0.37	2015	0.11	2015	0.03	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.05	2015	0.65	2015
12	0.17	2015	0	2015	0	2015	0	2015	0.11	2015	0	2015	0.01	2015	0	2015	0	2015	0	2015	0	2015	1.49	2015
13	0	2015	0	2015	T	2015	0.09	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	1.43	2015
14	0	2015	0	2015	0.64	2015	0.12	2015	T	2015	0	2015	0	2015	0.01	2015	0	2015	0	2015	0	2015	0.25	2015
15	0.4	2015	0	2015	0.15	2015	0	2015	T	2015	0	2015	0	2015	0	2015	T	2015	0	2015	0.92	2015	0	2015
16	0.07	2015	0	2015	0	2015	0	2015	T	2015	0	2015	0	2015	0	2015	0.08	2015	0.05	2015	0.08	2015	0.2	2015
17	0.72	2015	0	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.2	2015	0.15	2015	0.11	2015	0.88	2015
18	0.02	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.09	2015	0.49	2015
19	0	2015	0	2015	0	2015	0	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0.33	2015	0.36	2015	0.03	2015
20	0	2015	0	2015	0.34	2015	0	2015	0.01	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.24	2015
21	0	2015	0	2015	0.05	2015	0	2015	0.03	2015	0	2015	0	2015	0	2015	T	2015	0	2015	0	2015	0.91	2015
22	T	2015	0	2015	0.43	2015	0	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.21	2015
23	T	2015	0	2015	0.78	2015	0.1	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.15	2015	0.92	2015
24	0	2015	0	2015	0.01	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.57	2015	0.22	2015
25	0	2015	0	2015	0	2015	0.03	2015	0	2015	T	2015	0	2015	0	2015	0	2015	0.38	2015	0	2015	0.01	2015
26	0	2015	0.28	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	T	2015	T	2015	0	2015	0	2015
27	0	2015	0.21	2015	T	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.03	2015	0	2015	0.18	2015
28	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0	2015	0.24	2015	0	2015	0.12	2015
29	0	2015	M	M	0	2015	0	2015	0	2015	0	2015	0	2015	0.05	2015	0	2015	0.02	2015	0	2015	0.32	2015
30	0	2015	-	-	0	2015	0	2015	0	2015	0	2015	0	2015	0.17	2015	0	2015	0.01	2015	0.02	2015	0.02	2015
31	0	2015	-	-	0.28	2015	-	-	0.04	2015	-	-	0	2015	0	2015	-	-	0.34	2015	-	-	0	201

Annual Rainfall = 30.46

Appendix L: 2016 Precipitation Data from NOAA gathered at Roseburg Regional Airport

2016

Day	Jan		Feb		March		April		May		June		July		Aug		Sept		Oct		Nov		Dec	
1	0	2016	T	2016	0.05	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.26	2016	T	2016	0.05	2016
2	0	2016	0.2	2016	0.05	2016	0	2016	0.05	2016	0	2016	0	2016	0	2016	0.02	2016	0.61	2016	T	2016	0.02	2016
3	0.09	2016	0.06	2016	0	2016	0.07	2016	0.31	2016	0	2016	0	2016	0	2016	0	2016	0.06	2016	T	2016	0	2016
4	0.07	2016	T	2016	T	2016	0.07	2016	0.06	2016	0	2016	0	2016	0	2016	0	2016	0.1	2016	0	2016	0.35	2016
5	0.11	2016	0.11	2016	0.89	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.38	2016	0.5	2016	0.05	2016
6	0.05	2016	0.02	2016	0.17	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.01	2016	0.01	2016	0	2016	0.18	2016
7	T	2016	0	2016	0.09	2016	0	2016	0	2016	0	2016	0.2	2016	0	2016	0	2016	0.03	2016	0	2016	0	2016
8	0.08	2016	0	2016	0.05	2016	0	2016	T	2016	0	2016	0.52	2016	0	2016	0	2016	0	2016	0	2016	0.17	2016
9	0.14	2016	0	2016	0.42	2016	0	2016	0	2016	T	2016	T	2016	0	2016	0	2016	0	2016	0	2016	0.8	2016
10	0	2016	0	2016	0.26	2016	0	2016	0	2016	0.03	2016	0.05	2016	0	2016	0	2016	0.1	2016	0	2016	0.13	2016
11	0.05	2016	0.02	2016	0.08	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.03	2016	0.19	2016
12	0.16	2016	0.15	2016	0.56	2016	T	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.03	2016	T	2016	0.05	2016
13	0.63	2016	0.06	2016	0.53	2016	0.19	2016	T	2016	0	2016	0	2016	0	2016	0	2016	1.5	2016	0.01	2016	0.01	2016
14	0.41	2016	0.06	2016	0.4	2016	0.91	2016	0.21	2016	0.42	2016	0	2016	0	2016	0	2016	0.53	2016	0.51	2016	2.88	2016
15	0.14	2016	0	2016	0.01	2016	0.01	2016	0.01	2016	0.23	2016	0	2016	0	2016	0	2016	0.81	2016	0.1	2016	0.04	2016
16	0.26	2016	0	2016	0	2016	0	2016	0	2016	0.01	2016	0	2016	0	2016	0	2016	1.35	2016	0.26	2016	0	2016
17	1.41	2016	0.09	2016	0	2016	0	2016	0	2016	0.11	2016	0	2016	0	2016	0	2016	0.51	2016	T	2016	0	2016
18	0.23	2016	0.7	2016	T	2016	0	2016	T	2016	0.06	2016	T	2016	0	2016	0	2016	0.19	2016	0.02	2016	0	2016
19	0.89	2016	0.69	2016	T	2016	0	2016	0.1	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.06	2016	0.04	2016
20	0	2016	0	2016	0.16	2016	0.01	2016	T	2016	0	2016	0	2016	0	2016	0	2016	0.07	2016	1	2016	0.17	2016
21	0.18	2016	0.02	2016	0.77	2016	0.25	2016	0.01	2016	0	2016	0	2016	0	2016	0	2016	0.16	2016	0.12	2016	0	2016
22	0.44	2016	0	2016	0.35	2016	0.21	2016	0.09	2016	0	2016	0	2016	0	2016	T	2016	T	2016	0.25	2016	0.01	2016
23	0.2	2016	0	2016	T	2016	0.1	2016	0.01	2016	0	2016	0	2016	0	2016	0.04	2016	T	2016	0.09	2016	0.7	2016
24	0.15	2016	T	2016	0.06	2016	0.34	2016	0	2016	0	2016	0	2016	0	2016	T	2016	0.34	2016	0.01	2016	0.03	2016
25	T	2016	0	2016	T	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.37	2016	0.11	2016	0	2016
26	T	2016	0.37	2016	0.25	2016	0.02	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.31	2016	0.34	2016	0.04	2016
27	T	2016	T	2016	0.06	2016	0.1	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.93	2016	0.09	2016	0.11	2016
28	0.36	2016	0.01	2016	0.03	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.19	2016	0.01	2016
29	0.22	2016	0.05	2016	0	2016	0.04	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.17	2016	0.07	2016	0	2016
30	0.27	2016	-	-	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0	2016	0.05	2016	0.18	2016	0.05	2016
31	0.07	2016	-	-	0	2016	-	-	0	2016	-	-	0	2016	0	2016	-	-	0.02	2016	-	-	0.01	20

Total Rainfall = 38.25

Appendix M: 2017 Precipitation Data from NOAA gathered at Roseburg Regional Airport

2017

Day	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
1	0.35	2017	0.01	2017	0	2017	0	2017	T	2017	0.02	2017	0	2017	0	2017	0	2017	0.08	2017	0	2017	T	2017
2	T	2017	T	2017	0	2017	0	2017	T	2017	0	2017	0	2017	0	2017	0	2017	T	2017	0.15	2017	0.18	2017
3	0.07	2017	0.5	2017	0.25	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.17	2017	0.12	2017
4	0.05	2017	0.38	2017	0.29	2017	0	2017	0.11	2017	0	2017	0	2017	0	2017	0	2017	0	2017	T	2017	0	2017
5	0	2017	0.1	2017	0.38	2017	0	2017	0.12	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.39	2017	0	2017
6	0	2017	0.02	2017	0.3	2017	0.06	2017	T	2017	0	2017	0	2017	0	2017	0.05	2017	0	2017	0.02	2017	0	2017
7	0.6	2017	0.72	2017	0.33	2017	0.28	2017	0	2017	0.11	2017	0	2017	0	2017	0.06	2017	T	2017	T	2017	T	2017
8	0.77	2017	0.23	2017	0.11	2017	0.09	2017	0	2017	0.25	2017	0	2017	0	2017	0	2017	0	2017	0.16	2017	T	2017
9	0.85	2017	0.66	2017	0.13	2017	0.16	2017	0	2017	0.12	2017	0	2017	T	2017	0	2017	0	2017	0.65	2017	T	2017
10	0.95	2017	0.14	2017	0	2017	0.05	2017	0	2017	0.25	2017	0	2017	0	2017	0	2017	0.03	2017	0.18	2017	0.01	2017
11	0.08	2017	T	2017	0.01	2017	0.11	2017	0.19	2017	0.02	2017	0	2017	0	2017	0	2017	0.22	2017	0	2017	T	2017
12	0	2017	0	2017	0	2017	0.09	2017	0.12	2017	0.02	2017	0	2017	0	2017	0	2017	0.09	2017	0.05	2017	T	2017
13	0	2017	0	2017	T	2017	0.03	2017	0.24	2017	0	2017	0	2017	T	2017	0	2017	0.01	2017	0.33	2017	0	2017
14	0	2017	0.01	2017	0	2017	0.05	2017	0	2017	T	2017	0	2017	0	2017	T	2017	0	2017	T	2017	0	2017
15	0	2017	0.82	2017	0.18	2017	0	2017	0.08	2017	0.04	2017	0	2017	0	2017	0	2017	0	2017	0.51	2017	0.02	2017
16	0	2017	0.99	2017	0.01	2017	0.2	2017	0.27	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.16	2017	T	2017
17	0.11	2017	0.09	2017	0.02	2017	0.42	2017	0.01	2017	0	2017	0	2017	0	2017	T	2017	0	2017	0.04	2017	0	2017
18	0.92	2017	0.23	2017	0.42	2017	0.02	2017	0	2017	0	2017	0	2017	0	2017	0.11	2017	0	2017	T	2017	0	2017
19	0.04	2017	0.59	2017	0.02	2017	0.23	2017	0	2017	0	2017	0	2017	0	2017	0.08	2017	0.29	2017	0.01	2017	0.66	2017
20	0.03	2017	0.92	2017	0.18	2017	0.14	2017	0	2017	0	2017	0	2017	0	2017	0.46	2017	0.76	2017	0.23	2017	0.16	2017
21	0.29	2017	0.47	2017	0.26	2017	0	2017	0	2017	0	2017	0	2017	0	2017	T	2017	0.67	2017	0.03	2017	T	2017
22	0.35	2017	0.67	2017	0.08	2017	0.02	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.77	2017	0.09	2017	0	2017
23	0	2017	T	2017	0.26	2017	0.15	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.32	2017	0	2017
24	0	2017	0.06	2017	0.61	2017	0.21	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.06	2017	T	2017
25	T	2017	0	2017	0.07	2017	0.05	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.02	2017	T	2017
26	0.01	2017	0.56	2017	0.36	2017	0.63	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.29	2017	0.01	2017
27	0	2017	0.04	2017	0.1	2017	0.07	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	T	2017	0.05	2017
28	0	2017	0.05	2017	0.01	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0	2017	0.18	2017	T	2017
29	0	2017	M	M	0.5	2017	0	2017	T	2017	0	2017	0	2017	0	2017	0.16	2017	0	2017	0	2017	0.19	2017
30	0	2017	-	-	0.1	2017	T	2017	0	2017	0	2017	0	2017	0	2017	T	2017	0	2017	0.01	2017	0	2017
31	T	2017	-	-	0	2017	-	-	0	2017	-	-	0	2017	0	2017	-	-	T	2017	-	-	0	2017

Annual Rainfall = 33.03

Appendix N: 2018 Precipitation & Temp Data from NOAA gathered at Roseburg Regional Airport

Date	Temperature			Precip.
	Max.	Min.	Depart.	
1/1/2018	43	38	-1.5	T
1/2/2018	42	38	-2.1	0
1/3/2018	47	38	0.3	0
1/4/2018	48	41	2.3	0.06
1/5/2018	55	42	6.2	0.11
1/6/2018	48	42	2.6	0.02
1/7/2018	57	38	5	0
1/8/2018	48	42	2.5	0.17
1/9/2018	50	43	3.9	0.22
1/10/2018	51	42	3.8	0.07
1/11/2018	59	46	9.7	0.15
1/12/2018	58	43	7.7	0
1/13/2018	57	42	6.6	0
1/14/2018	56	38	4	0
1/15/2018	54	42	4.9	0.22
1/16/2018	54	39	3.4	T
1/17/2018	71	40	12.3	0.44
1/18/2018	52	39	2.2	0.24
1/19/2018	48	38	-0.3	0.05
1/20/2018	51	40	2.1	T
1/21/2018	52	41	3	0.27
1/22/2018	53	38	2	0.01
1/23/2018	56	38	3.4	0.03
1/24/2018	54	37	1.8	0.56
1/25/2018	47	39	-0.7	0.34
1/26/2018	50	36	-0.8	T
1/27/2018	57	47	8.2	0.03
1/28/2018	64	40	8.1	0
1/29/2018	62	43	8.5	0.08
1/30/2018	52	41	2.5	0.08
1/31/2018	47	39	-1.1	0
Sum	1643	1250	-	3.15
Average	53	40.3	3.6	-
Normal	49.7	36.5	-	5.09

Date	Temperature			Precip.
	Max.	Min.	Depart.	
2/1/2018	60	39	5.4	0
2/2/2018	71	47	14.8	0
2/3/2018	64	46	10.7	0
2/4/2018	66	45	11.2	0
2/5/2018	63	42	8.1	0
2/6/2018	60	36	3.5	0
2/7/2018	65	37	6.4	0
2/8/2018	65	39	7.3	0
2/9/2018	56	41	3.8	0
2/10/2018	52	33	-2.3	0
2/11/2018	48	31	-5.4	0.15
2/12/2018	50	30	-5	0
2/13/2018	57	25	-4.1	0
2/14/2018	48	35	-3.7	0.08
2/15/2018	53	35	-1.3	0
2/16/2018	52	31	-3.9	0
2/17/2018	61	43	6.5	0.03
2/18/2018	45	33	-6.6	0.4
2/19/2018	41	31	-9.8	0.01
2/20/2018	44	29	-9.4	0.01
2/21/2018	45	33	-7	0.19
2/22/2018	42	32	-9.1	0.38
2/23/2018	42	23	-13.7	T
2/24/2018	47	39	-3.4	0.29
2/25/2018	49	36	-4	0.74
2/26/2018	46	30	-8.6	0.01
2/27/2018	50	29	-7.2	0
2/28/2018	51	37	-2.9	0.23
Sum	1493	987	-	2.52
Average	53.3	35.3	-1	-
Normal	53.5	37.2	-	3.95

Date	Temperature			Precip.
	Max.	Min.	Depart.	
1/3/2018	47	36	-5.5	0.29
3/2/2018	51	33	-5.1	T
3/3/2018	50	34	-5.2	0
3/4/2018	52	32	-5.4	0
3/5/2018	57	30	-4	0
3/6/2018	59	29	-3.6	0
3/7/2018	55	36	-2.2	T
3/8/2018	60	38	1.2	0.03
3/9/2018	60	42	3.1	0.31
3/10/2018	57	39	0	T
3/11/2018	68	44	7.9	0
3/12/2018	74	39	8.3	0
3/13/2018	68	46	8.7	0.36
3/14/2018	57	37	-1.4	0.06
3/15/2018	49	37	-5.5	T
3/16/2018	54	37	-3.1	0.07
3/17/2018	52	40	-2.7	0.03
3/18/2018	56	38	-1.8	T
3/19/2018	57	35	-2.9	0
3/20/2018	63	36	0.5	0.01
3/21/2018	58	47	3.4	0.24
3/22/2018	50	40	-4.1	0.09
3/23/2018	45	36	-8.7	0.19
3/24/2018	50	34	-7.3	0
3/25/2018	52	35	-5.9	T
3/26/2018	56	31	-6	0
3/27/2018	61	36	-1	0
3/28/2018	66	45	5.9	0
3/29/2018	67	38	2.8	0
3/30/2018	67	39	3.2	0
3/31/2018	68	42	5.1	0
Sum	1786	1161	-	1.68
Average	57.6	37.5	-1.1	-
Normal	57.8	39.3	-	1.71

Date	Temperature			Precip.
	Max.	Min.	Depart.	
4/1/2018	61	37	-1	0.03
4/2/2018	55	36	-4.6	T
4/3/2018	61	32	-3.7	0.01
4/4/2018	73	46	9.2	0.01
4/5/2018	57	50	3.1	0.27
4/6/2018	68	52	9.5	0.03
4/7/2018	63	48	4.9	0.48
4/8/2018	59	43	0.2	0.06
4/9/2018	72	38	4.1	0
4/10/2018	65	46	4.4	T
4/11/2018	60	42	-0.2	0.14
4/12/2018	50	40	-6.4	0.16
4/13/2018	58	44	-0.5	0
4/14/2018	60	45	0.8	0
4/15/2018	55	42	-3.4	0.26
4/16/2018	55	41	-4.1	0.05
4/17/2018	56	41	-3.8	0.04
4/18/2018	63	42	0	0.02
4/19/2018	66	37	-1.2	0
4/20/2018	69	39	1.1	0
4/21/2018	67	44	2.4	T
4/22/2018	68	39	0.2	0
4/23/2018	82	39	7	0
4/24/2018	88	44	12.2	0
4/25/2018	90	50	16	0
4/26/2018	73	52	8.3	0.02
4/27/2018	62	49	1	0.34
4/28/2018	59	49	-0.7	0.46
4/29/2018	57	48	-2.4	0.23
4/30/2018	57	45	-4.2	0.01
Sum	1929	1300	-	2.62
Average	64.3	43.3	1.6	-
Normal	62.4	42	-	2.82

Date	Temperature			Precip.
	Max.	Min.	Depart.	
5/1/2018	63	43	-2.4	0
5/2/2018	76	41	2.8	0
5/3/2018	78	46	6.1	0
5/4/2018	74	51	6.3	0
5/5/2018	80	53	10.1	0
5/6/2018	67	56	4.9	0.25
5/7/2018	76	53	7.6	0
5/8/2018	74	49	4.4	0.02
5/9/2018	72	56	6.7	0
5/10/2018	66	52	1.5	T
5/11/2018	66	49	-0.2	0
5/12/2018	79	49	6	0
5/13/2018	88	50	10.8	0
5/14/2018	84	51	9.1	0
5/15/2018	73	53	4.5	0
5/16/2018	70	54	3.3	0
5/17/2018	77	55	7.1	0
5/18/2018	73	53	3.9	0
5/19/2018	73	52	3.2	0
5/20/2018	69	51	0.6	0
5/21/2018	76	49	2.9	0
5/22/2018	88	50	9.2	0
5/23/2018	74	53	3.6	0
5/24/2018	79	55	6.9	T
5/25/2018	62	50	-4.2	T
5/26/2018	68	44	-4.4	0
5/27/2018	82	46	3.5	0
5/28/2018	81	51	5.3	0
5/29/2018	67	53	-0.8	0
5/30/2018	68	47	-3.4	0
5/31/2018	64	49	-4.6	T
Sum	2287	1564	-	0.27
Average	73.8	50.5	3.6	-
Normal	69.9	47.2	-	2.27

Date	Temperature			Precip.
	Max.	Min.	Depart.	
6/1/2018	78	43	-0.7	0
6/2/2018	86	48	5.6	0
6/3/2018	78	52	3.5	0
6/4/2018	74	48	-0.7	0
6/5/2018	76	46	-0.8	0
6/6/2018	80	47	1.5	0
6/7/2018	75	54	2.4	0
6/8/2018	75	48	-0.8	0.2
6/9/2018	60	49	-8	0.37
6/10/2018	64	45	-8.1	0.03
6/11/2018	76	54	2.2	0.01
6/12/2018	86	49	4.5	0
6/13/2018	72	50	-2.2	0
6/14/2018	74	51	-0.9	0
6/15/2018	73	49	-2.6	0
6/16/2018	75	55	1.2	0
6/17/2018	87	52	5.5	0.01
6/18/2018	88	56	7.8	0
6/19/2018	95	57	11.5	0
6/20/2018	84	61	7.8	0
6/21/2018	81	59	5.1	0
6/22/2018	78	56	1.8	0
6/23/2018	83	56	4.1	0
6/24/2018	95	54	8.8	0
6/25/2018	78	56	1.1	0
6/26/2018	80	49	-1.7	0
6/27/2018	81	52	0	0
6/28/2018	79	53	-0.7	0
6/29/2018	86	52	2	0
6/30/2018	89	55	4.8	0
Sum	2386	1556	-	0.62
Average	79.5	51.9	1.8	-
Normal	76	51.8	-	1.13

Date	Temperature			Precip.
	Max.	Min.	Depart.	
7/1/2018	86	60	5.5	0
7/2/2018	76	55	-2.2	0
7/3/2018	80	52	-2	0
7/4/2018	80	55	-0.7	0
7/5/2018	88	54	2.5	0
7/6/2018	82	56	0.3	0
7/7/2018	83	52	-1.5	0
7/8/2018	85	54	0.3	0
7/9/2018	78	57	-1.9	0
7/10/2018	85	53	-0.6	0
7/11/2018	88	62	5.2	0
7/12/2018	100	62	11	0
7/13/2018	97	63	9.8	0
7/14/2018	99	64	11.1	0
7/15/2018	98	62	9.5	0
7/16/2018	101	64	11.8	0
7/17/2018	95	61	7.2	0
7/18/2018	91	57	3	0
7/19/2018	77	62	-1.6	0
7/20/2018	83	55	-2.2	0
7/21/2018	87	57	0.7	0
7/22/2018	94	54	2.7	0
7/23/2018	95	61	6.6	0
7/24/2018	100	62	9.5	0
7/25/2018	101	62	10	0
7/26/2018	101	63	10.5	0
7/27/2018	96	60	6.4	0
7/28/2018	96	56	4.4	0
7/29/2018	99	59	7.4	0
7/30/2018	92	63	5.9	0
7/31/2018	95	58	5	0
Sum	2808	1815	-	0
Average	90.6	58.5	4.3	-
Normal	84.3	56.2	-	0.42

Date	Temperature			Precip.
	Max.	Min.	Depart.	
8/1/2018	93	57	3.5	0
8/2/2018	84	57	-1	0
8/3/2018	85	60	1.1	0
8/4/2018	89	57	1.6	0
8/5/2018	87	56	0.2	0
8/6/2018	91	59	3.8	0
8/7/2018	93	60	5.4	0
8/8/2018	96	64	8.9	0
8/9/2018	98	63	9.5	0
8/10/2018	95	64	8.6	0
8/11/2018	83	63	2.2	0
8/12/2018	87	56	0.8	0
8/13/2018	91	58	3.9	0
8/14/2018	94	60	6.5	0
8/15/2018	87	61	3.7	0
8/16/2018	82	62	1.8	0
8/17/2018	89	55	1.9	0
8/18/2018	92	53	2.5	0
8/19/2018	90	56	3.1	0
8/20/2018	86	56	1.3	0
8/21/2018	93	58	5.9	0
8/22/2018	94	61	8	0
8/23/2018	73	56	-4.8	0
8/24/2018	78	58	-1.2	0
8/25/2018	81	50	-3.6	0
8/26/2018	79	57	-0.9	T
8/27/2018	81	61	2.2	0.02
8/28/2018	92	54	4.3	0
8/29/2018	88	53	2	0
8/30/2018	73	53	-5.4	0.01
8/31/2018	81	56	0.3	0
Sum	2705	1794	-	0.03
Average	87.3	57.9	2.5	-
Normal	84.7	55.5	-	0.47

Date	Temperature			Precip.
	Max.	Min.	Depart.	
9/1/2018	81	51	-2	0
9/2/2018	85	49	-0.9	0
9/3/2018	84	56	2.3	0
9/4/2018	85	55	2.5	0
9/5/2018	91	53	4.6	0
9/6/2018	87	54	3.3	0
9/7/2018	86	51	1.5	0
9/8/2018	81	57	2.2	T
9/9/2018	82	50	-0.6	0
9/10/2018	76	53	-1.9	0
9/11/2018	73	51	-4.2	0
9/12/2018	69	51	-6	0.06
9/13/2018	73	48	-5.3	0
9/14/2018	74	50	-3.5	0
9/15/2018	73	46	-5.8	0
9/16/2018	69	52	-4.5	T
9/17/2018	72	50	-3.8	0
9/18/2018	75	45	-4.5	0
9/19/2018	76	45	-3.7	0
9/20/2018	79	54	2.5	0
9/21/2018	84	48	2.3	0
9/22/2018	72	54	-0.4	T
9/23/2018	71	46	-4.6	0
9/24/2018	74	43	-4.3	0
9/25/2018	83	44	1	0
9/26/2018	89	46	5.3	0
9/27/2018	88	47	5.6	0
9/28/2018	89	49	7.5	0
9/29/2018	75	55	3.8	0.19
9/30/2018	73	57	4.1	0.01
Sum	2369	1510	-	0.26
Average	79	50.3	-0.2	-
Normal	78.6	51.2	-	0.96

Date	Temperature			Precip.
	Max.	Min.	Depart.	
10/1/2018	73	56	4	T
10/2/2018	75	56	5.3	T
10/3/2018	72	46	-0.9	0
10/4/2018	68	48	-1.5	0
10/5/2018	57	44	-8.7	0.28
10/6/2018	61	49	-3.8	T
10/7/2018	65	49	-1.5	0
10/8/2018	64	54	0.8	0.11
10/9/2018	66	48	-0.8	0.01
10/10/2018	67	46	-1	0
10/11/2018	73	41	-0.1	0
10/12/2018	76	40	1.2	0
10/13/2018	71	41	-0.4	0
10/14/2018	78	36	0.9	0
10/15/2018	80	35	1.7	0
10/16/2018	82	38	4.6	0
10/17/2018	82	40	5.9	0
10/18/2018	80	41	5.7	0
10/19/2018	80	40	5.5	0
10/20/2018	77	41	4.8	0
10/21/2018	79	41	6.2	0
10/22/2018	78	42	6.5	0
10/23/2018	57	43	-3.2	0.02
10/24/2018	68	46	4.1	0
10/25/2018	66	44	2.4	0
10/26/2018	63	53	5.7	0.25
10/27/2018	73	56	12.5	0.19
10/28/2018	68	49	6.8	0.2
10/29/2018	62	43	1.1	0.16
10/30/2018	59	43	-0.2	T
10/31/2018	60	50	4.1	T
Sum	2180	1399	-	1.22
Average	70.3	45.1	2.2	-
Normal	66.3	44.8	-	2.67

Date	Temperature			Precip.
	Max.	Min.	Depart.	
11/1/2018	71	56	12.9	0.02
11/2/2018	69	52	10.2	T
11/3/2018	67	51	8.9	0
11/4/2018	62	45	3.7	0.04
11/5/2018	59	44	2	0.01
11/6/2018	59	41	0.8	0
11/7/2018	50	36	-6	0
11/8/2018	53	34	-5.2	0
11/9/2018	47	32	-9	T
11/10/2018	47	32	-8.7	0
11/11/2018	56	35	-2.4	0
11/12/2018	61	28	-3.2	0
11/13/2018	59	33	-1.4	0
11/14/2018	56	32	-3.2	0
11/15/2018	49	36	-4.4	0
11/16/2018	51	46	1.8	0
11/17/2018	50	45	1.1	0
11/18/2018	50	39	-1.7	0
11/19/2018	49	37	-3	0
11/20/2018	50	35	-3.2	0
11/21/2018	50	41	0	0.71
11/22/2018	54	42	2.8	0.46
11/23/2018	59	46	7.5	0.51
11/24/2018	52	44	3.2	0.02
11/25/2018	56	44	5.4	0
11/26/2018	64	45	10.1	0.01
11/27/2018	63	45	9.8	0.68
11/28/2018	57	42	5.5	0.22
11/29/2018	47	42	0.7	0.27
11/30/2018	52	42	3.4	0.63
Sum	1669	1222	-	3.58
Average	55.6	40.7	1.3	-
Normal	53.5	40.3	-	6.46

Date	Temperature			Precip.
	Max.	Min.	Depart.	
12/1/2018	49	40	1.1	0.33
12/2/2018	50	36	-0.2	0.03
12/3/2018	49	30	-3.6	0
12/4/2018	43	32	-5.4	0
12/5/2018	42	33	-5.2	0
12/6/2018	35	30	-10.1	0
12/7/2018	40	31	-7	0.17
12/8/2018	52	36	1.7	0.05
12/9/2018	47	38	0.3	0.16
12/10/2018	50	43	4.4	0.02
12/11/2018	54	43	6.5	0.24
12/12/2018	49	36	0.6	0.02
12/13/2018	54	33	1.6	0
12/14/2018	56	30	1.2	0.26
12/15/2018	48	36	0.3	T
12/16/2018	59	43	9.3	0.36
12/17/2018	56	41	6.8	0.02
12/18/2018	58	45	9.9	0.68
12/19/2018	55	40	5.9	0
12/20/2018	58	39	6.9	0.63
12/21/2018	49	38	1.9	0
12/22/2018	50	34	0.4	0.01
12/23/2018	54	46	8.4	0.09
12/24/2018	49	45	5.4	0.66
12/25/2018	47	37	0.3	0.04
12/26/2018	46	37	-0.2	0.26
12/27/2018	46	39	0.8	0.02
12/28/2018	48	37	0.7	0
12/29/2018	51	34	0.7	0.03
12/30/2018	50	37	1.6	0.12
12/31/2018	40	38	-3	T
Sum	1534	1157	-	4.2
Average	49.5	37.3	1.3	-
Normal	47.7	36.4	-	6.52

Appendix O: USGS Streamflow 2016-2018.