Technical Memorandum

Date:	Friday, May 11, 2018
Project:	City of Ashland TID Water Quality Analysis
To:	Kevin Caldwell, PE, City of Ashland
From:	Kelsey Harpham, Pierre Kwan, PE, HDR
Subject:	2017 Water Quality Data Summary

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JUNE 30 2015
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EXPIRES: 07 / 30 / 19

Introduction

The City of Ashland, Oregon (City) has retained HDR as part of another project to investigate the replacement of the City's existing Ashland Water Treatment Plant (WTP) with a new facility. HDR submitted a memorandum to the City in April 2017 requesting additional water quality data, and prescribing a sampling schedule for May to October of 2017 (Additional Water Quality Data Gaps and Sampling, April 27, 2017). This current memorandum documents the data collected during that time and summarizes the results, comparing them to the City's available historical data for the raw water qualities from the existing treatment plant. The purpose of this memorandum is to identify potential water quality parameters that could affect the subsequent treatment process evaluation and selection for future water treatment.

Water Supply Description

The WTP is primarily supplied surface water from Ashland Creek that flows through and is stored in Reeder Reservoir prior to entering the WTP. The City also purchases water from the Talent Irrigation District (TID) to provide additional supply. Water from TID is available during the irrigation season only, from April to October, and is managed by the Irrigation District. The City of Ashland has a water right equal to 769 acre-feet (af) per year, which is divided between public and private irrigation, canal losses, and service to the WTP. Accounting for the losses and irrigation uses, approximately 223 af of water are available for potable use during a typical year; however, an increased volume can be directed toward the WTP if necessary (City of Ashland Water Conservation and Reuse Study, 2011). Historically, TID water has been used during drought years as a supplement to the Reeder Reservoir supply. The years of 2012, 2013, 2014, and 2015 all saw significant uses of TID water, ranging from 40 to 184 million gallons in a given year. 2001 and 2009 were also drought years where TID water was used to supplement the main reservoir supply. When needed, TID water is pumped out of the Ashland Canal to the WTP at the Terrace Street Pump Station. Water at the Terrace Street Pump station is sourced only from the TID, and that water is mixed with water from the Reeder Reservoir supply prior to entering the WTP.

Water Quality Data Collection

In 2009, water samples were taken at the Terrace Street Pump Station, where water is pumped directly from the TID canal, and it is not yet mixed with Reeder Reservoir supply water. Samples were analyzed for a suite of inorganic compounds, metals, minerals, and physical characteristics. These are all critical factors in determining treatment parameters. The results from these samples were discussed in the Water Quality Data Summary and Review, (April, 2017), and are summarized in Table 1 below.

Table 1: Summary of TID Data Grab Sample Results

Water Quality Parameter	2009 Grab Sample Results
Turbidity	3.2 NTU
Total Organic Carbon (TOC)	2.9 mg/L
pH	Sample exceeded hold time for accurate measurement
Alkalinity	37 mg/L as $CaCO_3$
Hardness	Not reported but calculated to be 33 mg/L as $CaCO_3$
Temperature	Not analyzed
Pathogens	Zero for *Cryptosporidium* and *Giardia*
IOCs	Non-detect for nitrate, sulfate, fluoride. No data for all other regulated IOCs or for UCMR3 analytes.
VOCs and SOCs	Non-detect for all compounds.
Algae and cyanotoxins	99 counts/mL
T&O Compounds	Non-detect for both MIB and Geosmin. 1 TON for odor.
Color	20 PCU
Other	
Ammonia	Non-detect
Dissolved organic carbon	2.7 mg/L
Dissolved UV-254 absorb.	0.050/cm
Specific conductance	78 umhos/cm

As a result of this limited prior data on the TID water, and a comprehensive analysis of water quality was performed during the 2017 irrigation season. A Sonde automated water quality analyzer was used for the collection of continuous data at the Terrace Street pump station, and additional water samples were taken by City staff and sent to Nielsen labs for analysis of inorganic, organic, and volatile organic compounds, along with several other water quality parameters. The potential for increased use of the TID water as a supplementary water supply for the City creates the need for a comprehensive understanding of the impact of the TID supply to water treatment.

Sampling frequency varied by the analyte sampled for. Below is a table summarizing the sampling frequency of the analytes. All sampling frequencies refer to the time period of the irrigation season, from May 5, 2017 to October 12, 2017.

Table 2: 2017 TID Sampling Frequency

Analyte or Suite of Analytes	Sampling Frequency	Analyte or Suite of Analytes (continued)	Sampling Frequency
Alkalinity	Monthly	Regulated Primary Inorganic Compounds	Twice
Hardness	Monthly	All Regulated Synthetic Organic Carbon Compounds	Once
UV-254 absorbance	Monthly	All Regulated Volatile Organic Carbon Compounds	Once
Total organic carbon	Monthly	Aluminum	Once
Dissolved organic carbon	Monthly	Chloride	Once
Calcium	Monthly	Copper	Once
Magnesium	Monthly	Silver	Once
Apparent color	Monthly	Sulfate	Once
True color	Monthly	Total Dissolved Solids	Once
Algae counts and enumeration	Monthly	Zinc	Once
Iron, Total	Monthly	Ammonia	Twice
Manganese, Total	Monthly	Phosphorus, Total	Twice
Strontium	Once	Sulfide, Total	Once
Chromium, Hexavalent	Once	*Cryptosporidium*	Monthly
Chromium, Total	Once	*Giardia*	Monthly
Silica	Once	*Algal Enumeration*	Monthly

Water Quality Data Analysis

Water quality data was analyzed in regard to the potential impact on the water treatment process, and compared to existing data reported in the Ashland Water Quality Summary and Review Technical Memorandum, April 2017, regarding the Ashland Creek and Reeder Reservoir water quality.

Sonde Continuous Data Collection

Continuous data was collected for dissolved oxygen (DO), pH, Specific Conductivity, oxidation reduction potential (ORP), and turbidity. The Sonde analyzer collected samples in 15-minute intervals continuously throughout the collection period of May 10 to October 12. Due to technical issues, modification of analyte selection request, and auxiliary maintenance requirements, not all analyte data was collected over the entire time period. Additionally, the data collected for pH, DO, and ORP shifts slightly throughout the data collection period. Based on the time periods that the data shifts occur, it is likely that this is due to slight calibration differences that occurred when data was downloaded from the Sonde instrument. All data remains within a relatively small overall range and is within expectations for raw water quality characteristics.

pH

pH data was collected from May 10 to June 14, and then from July 5 to October 12. A diurnal trend in data can be observed throughout the collection period, with pH levels increasing during the night, reaching a peak at approximately 6:00 pm, and decreasing during the day to a minimum level at approximately 6:00 am. In May and June, daily fluctuations were approximately 0.2 units, while swings in July and August were approximately 0.6 units. As days became shorter and cooled into fall, the diurnal swing returned to approximately 0.2 units. This suggests that the pH of the TID water is closely tied to presence of algae in the water. As it is a plant, algae consumes carbon dioxide (which is carbonic acid in water) during the day, and at night, plant respiration stops and exhalation starts so that the algae is releasing a trace of carbonic acid into the water. This hypothesis is confirmed by correlating DO data, discussed in detail in a later section of this report. DO trends generally follow behind pH, increasing with algal respiration during the daytime hours, and decreasing at night when algae stop producing oxygen.

Below are two graphs showing the diurnal trends of pH in the TID water. The first is over a short period of time to demonstrate the clear day and night trends of the pH levels. Daily fluctuations are approximately over a range of 0.6 units. The second graph is over the entire data collection period and represents the range of fluctuations that occurred seasonally. The majority of data points are between 7.40 pH units and 8.60 pH units.

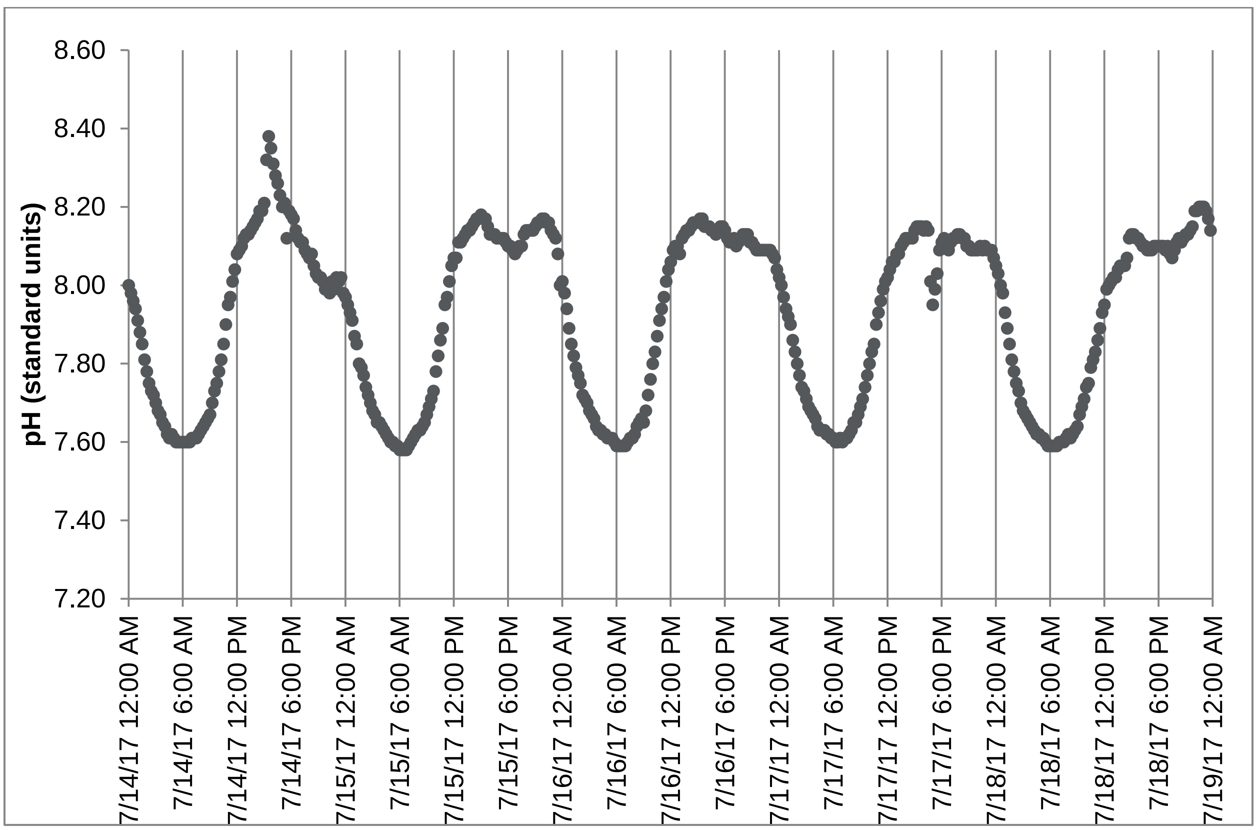


Figure 1: TID pH data 7/14/17 to 7/19/17

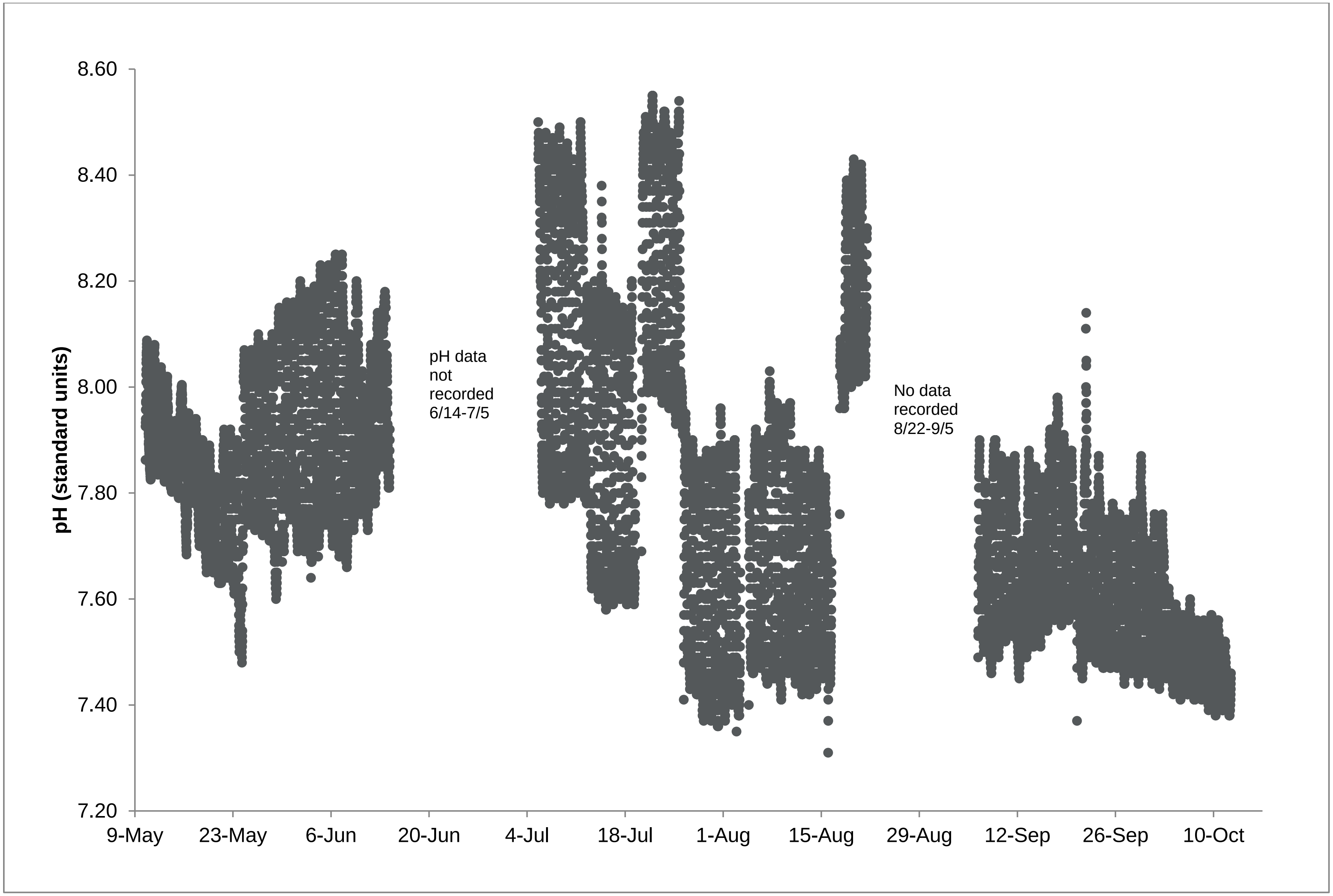


Figure 2: TID pH data, May-October 2017

The pH data daily fluctuations are relevant to the treatment because they suggest that frequent (hourly or more) operator attention will be required to keep track of the coagulants being used when TID water is a portion of the supply. The TID water is also typically slightly higher in pH than previous samples taken from Ashland Creek, which ranged from 6.8 to 7.9. When TID water is incorporated into the supply, it may impact treatment efficiency and require modification to the treatment process to maintain finished water compliance.

Turbidity

Similar to the diurnal peaks seen in pH and DO, turbidity levels also fluctuate on a daily level. Fluctuations were generally between 3 nephelometric turbidity units (NTU) and 15 NTU, with higher daily swings observable during the warmer summer months. This diurnal pattern, along with the seasonal trends, indicates that the turbidity reading is also due to algae in the water. Algae grow during the daytime hours, and growth slows during the night.

Turbidity has a significant impact on the type of water treatment system chosen. High levels of turbidity also increase risk for the presence of pathogenic organisms. The TID water turbidity indicates that conventional sedimentation/media filtration or membrane filtration would be a better treatment system if new filtration equipment is selected for treating 100 percent TID water, as 10 NTU is generally regarded as the limit for maximum turbidity level recommended for treatment by direct filtration, the process at the existing WTP. This issue can also be addressed by purposely limiting TID water supply to only when blended with Reeder Reservoir water.

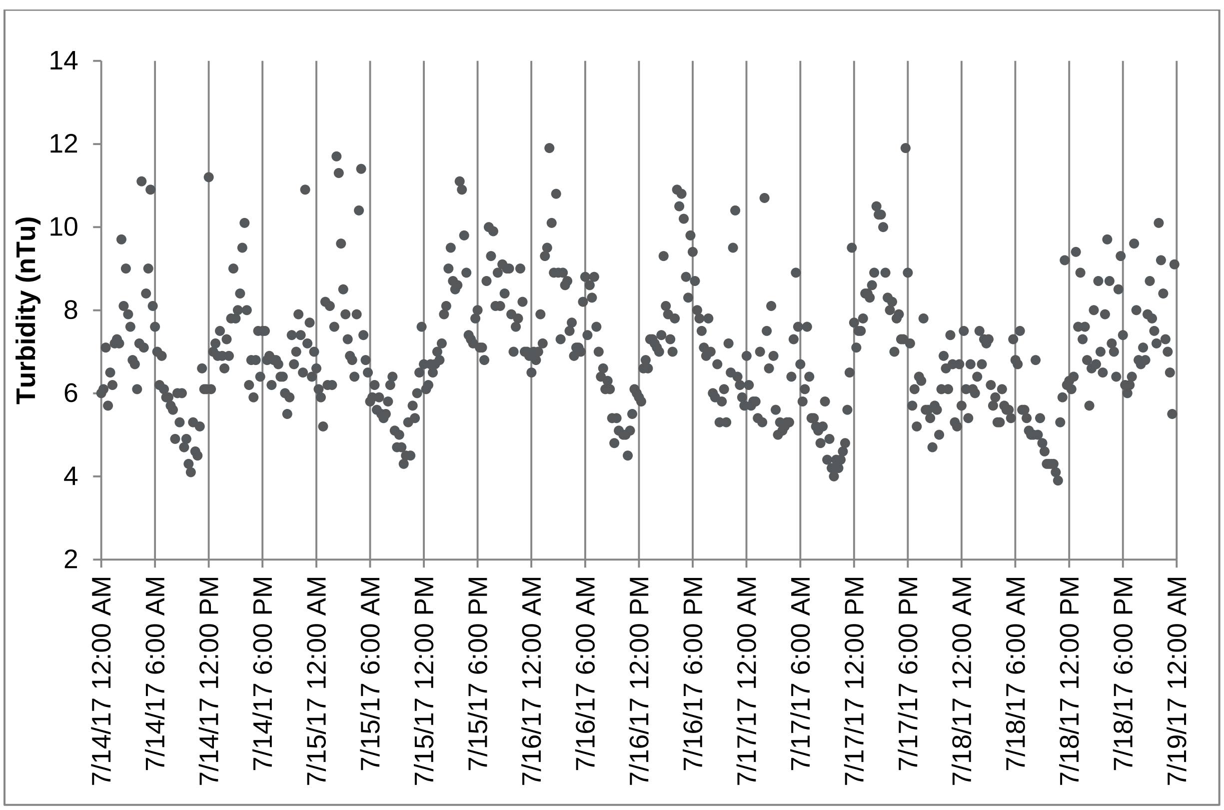


Figure 3: TID Turbidity data 7/14/17 to 7/19/17

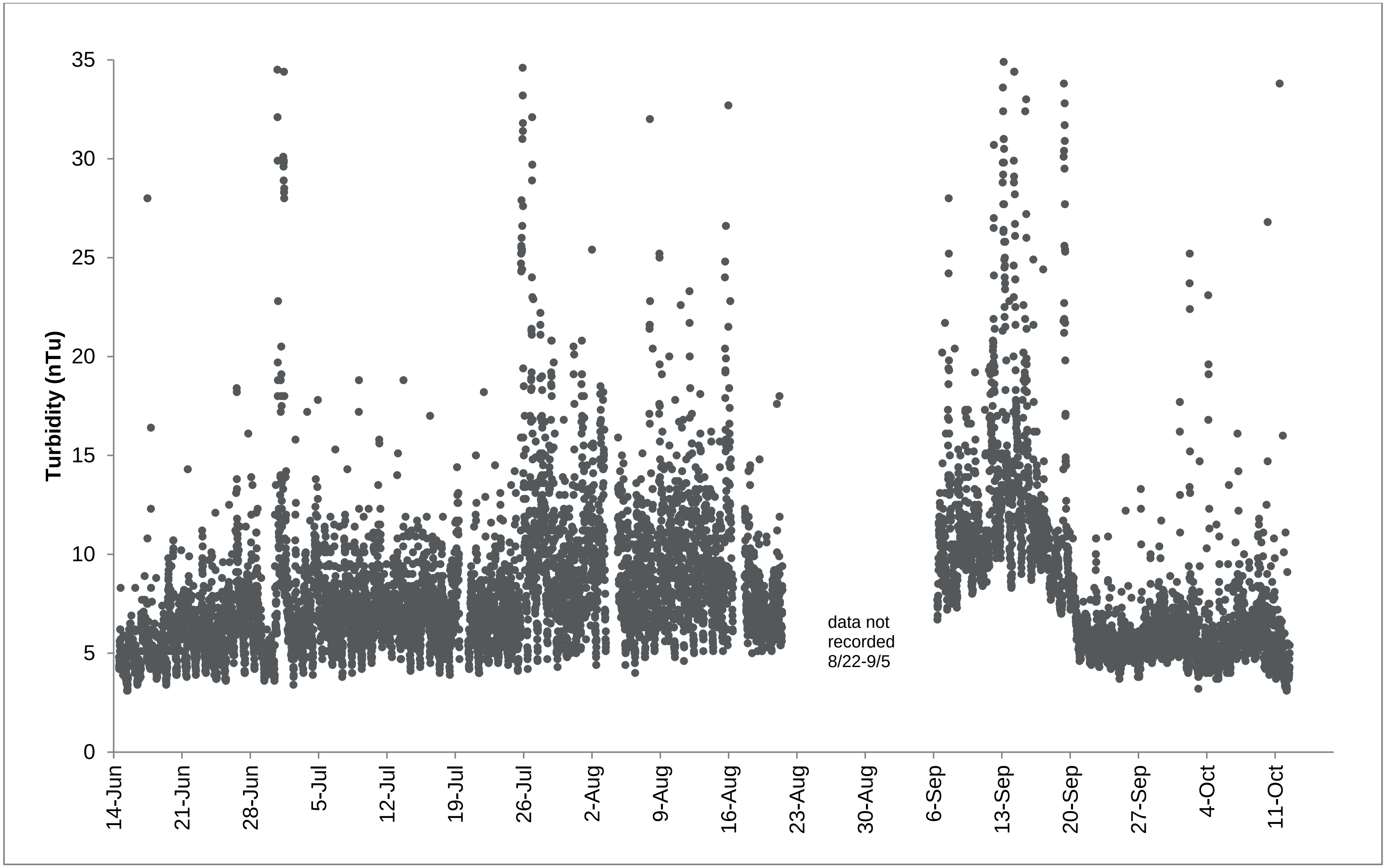


Figure 4: TID Turbidity data, June-October 2017

***Note that at total of 31 results over the sampling period were measured at a turbidity level greater than 35. The graph above captures the majority of data points and recognizes that these points are outliers.**

These levels of turbidity are significantly higher than the typical levels observed in Ashland Creek. The average monthly turbidity recorded in the WTP raw water is below 1 NTU, with some higher levels seen during storms and summer months. While some spikes in turbidity have been observed in historical WTP raw water data during the summer months, these peaks are less than 6 NTU, while peaks in the TID data are as high as 35 NTU. Further, the highest levels of turbidity seen in the summer months occurred at times when TID water was used to supplement the Ashland Creek supply (2009, 2012, 2013, 2014, and 2015), potentially indicating that the TID water is the cause of increased turbidity during these years, rather than an increase in the Ashland Creek turbidity levels. The monthly treatment Ashland Creek data does not account for storm events, which could contribute to higher levels of turbidity that what is seen in the figure below.

Higher levels of turbidity result in increased headloss in filtration systems, as filters clog from these materials being removed. Additional coagulant use may be required to bind fine colloidal and/or neutrally buoyant particles that show up as turbidity. The combination of the two would result in more backwash waste generation.

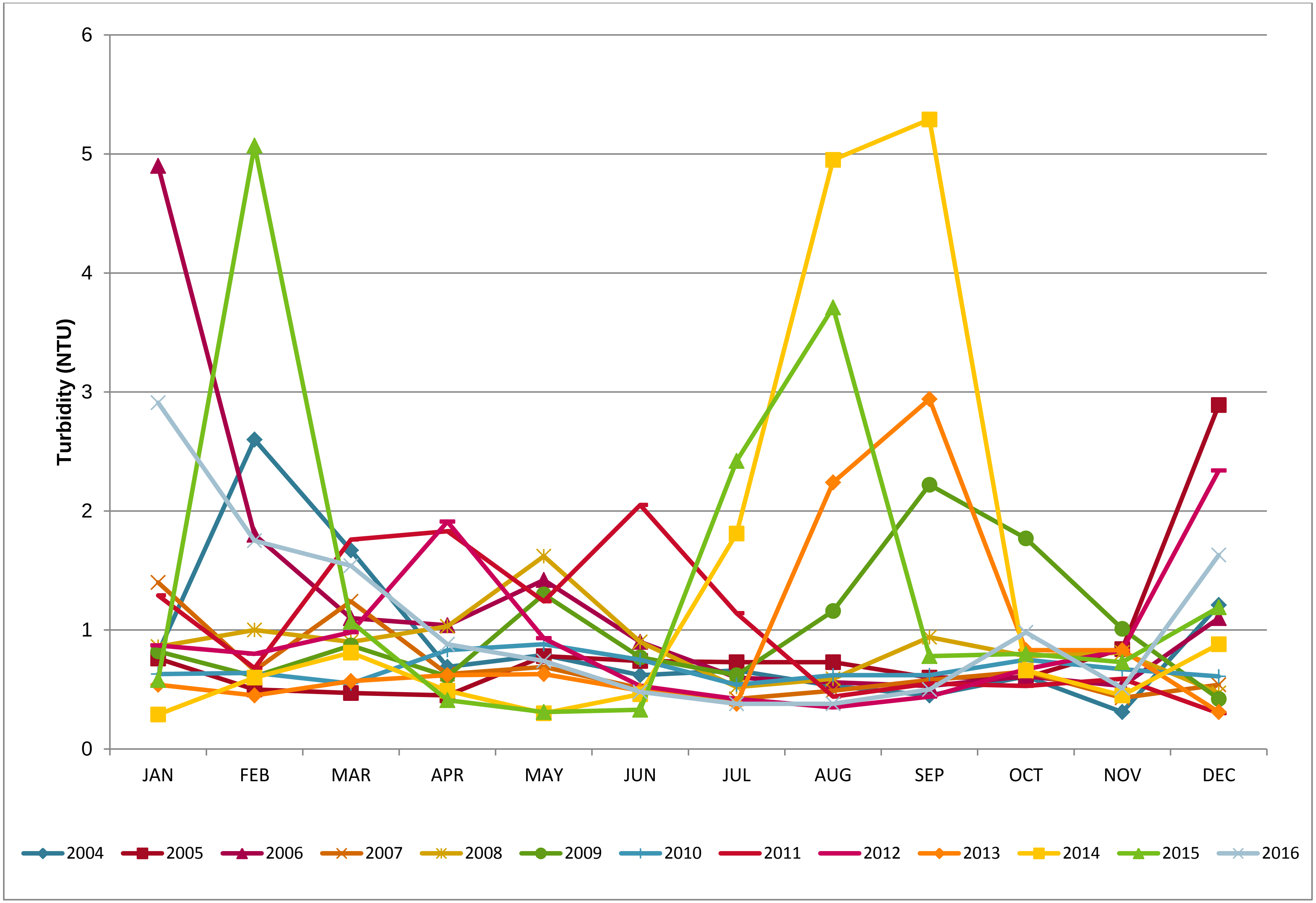


Figure 5: WTP Raw Water, Average Monthly Turbidity

Oxidation Reduction Potential

ORP exhibits diurnal swings similar to pH and turbidity. ORP follows the swing of pH directly, increasing between the hours of 6:00 am and 6:00 pm, and decreasing during the night from 6:00 pm to 6:00 am. This corroborates the pH and turbidity data to suggest that algae are the main driver of diurnal shifts in water quality parameters. ORP increases as the carbonic acid in water is consumed during the day and decreases as it is released at night. The changes in ORP are likely to have an impact on some instrumentation in the WTP, the most significant being the streaming current monitors. The streaming current monitors are used to automate chemical dosing in the treatment process. The fluctuations in ORP can easily be overcome, but are relevant, and both design engineers and operators need to be aware of the daily changes.

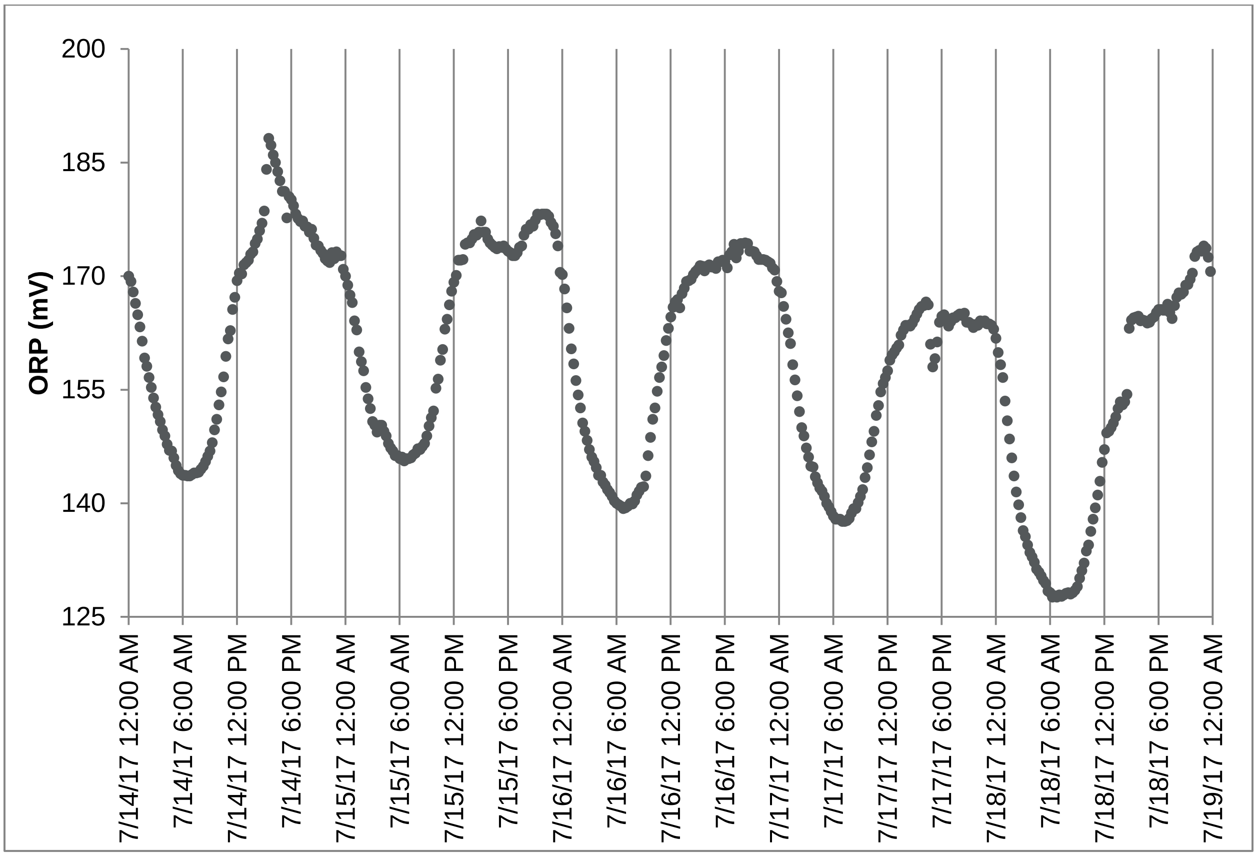


Figure 6: TID ORP data 7/14/17 to 7/19/17

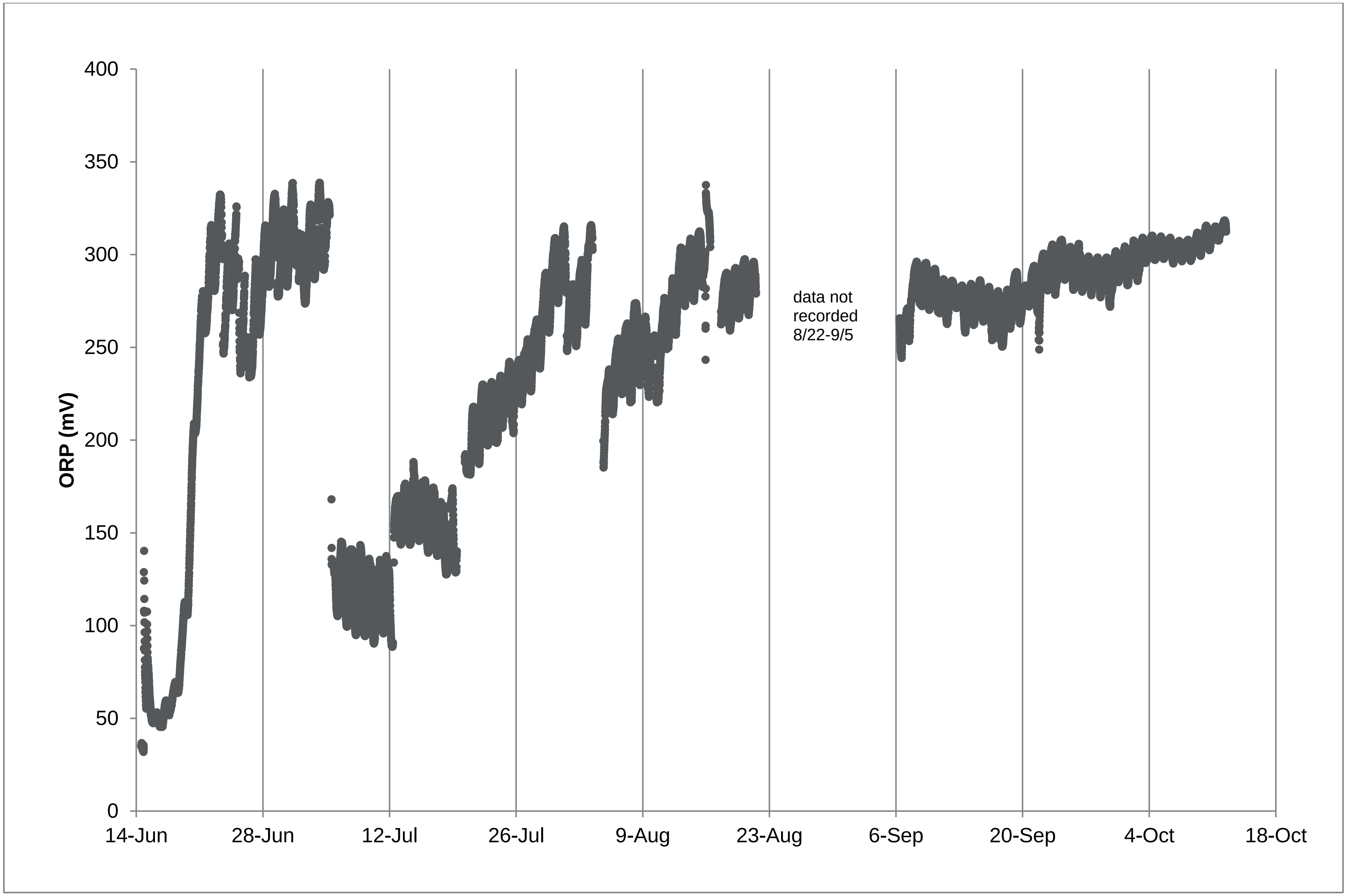


Figure 7: TID ORP data, June-October 2017

No ORP data was available for the WTP raw water, but no indication has been given that it is an issue at this time. As a result of increased use of TID water, ORP may need to be continually monitored to ensure that automated chemical dosing is occurring correctly within the treatment plant.

Dissolved Oxygen

DO levels remained at levels above 6.0 mg/L throughout the summer irrigation season, revealing water that is well oxygenated and oxidative. DO exhibits similar daily diurnal shifts as what is seen in pH, turbidity, and ORP, supporting the hypothesis that the behavior is algae driven. The algae release oxygen during the day as they consume carbonic acid, resulting in a daily fluctuation in DO of approximately 2.0 mg/L. DO does not directly mirror pH levels, but rather lags behind; pH levels generally begin to drop off in the late afternoon and evening, while DO levels begin to reflect the released oxygen beginning at approximately midnight, and climbing until midday.

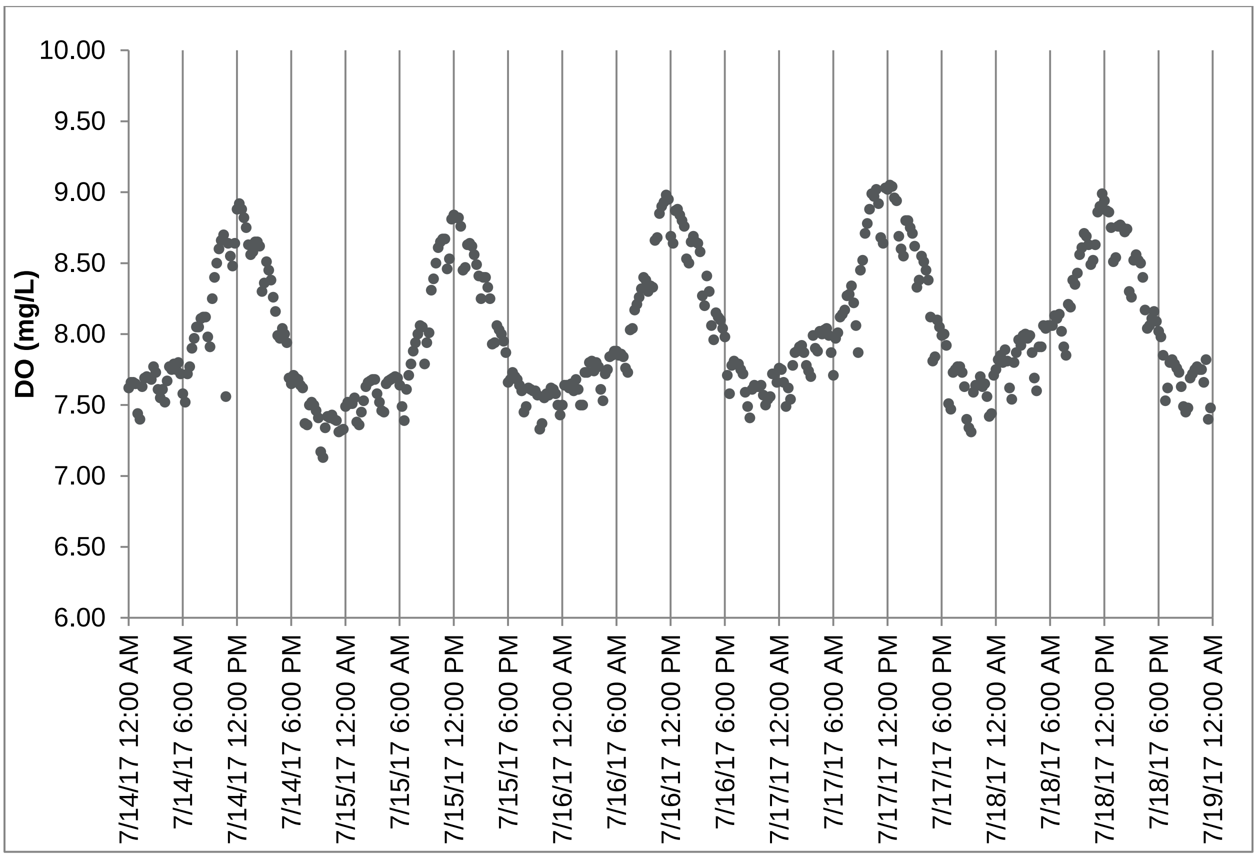


Figure 8: TID Dissolved Oxygen data 7/14/17 to 7/19/17

Specific Conductivity

Over the duration of the 2017 irrigation season, specific conductivity was seen to decrease from approximately 0.115 mS/cm to 0.075 mS/cm. This suggests that the TID water decreases in salinity over the season. As the water decreases in salinity, the coagulation step becomes more straightforward, other things being equal. However, the potential operational benefits of decreasing salinity are likely outweighed by the variance in pH, DO, ORP, and turbidity that is seen in the TID water.

Temperature

Temperature data was recorded throughout the 2017 irrigation season in the TID canal. Temperature is relevant to the treatment process as it can impact coagulation, filtration, and disinfection. Temperatures recorded at TID exhibit an expected seasonal trend, being cooler May through June and warming in July and August. The temperature ranges from 8.1°C (46.6°F) to 24.9°C (76.9°F), with an average of 17.4°C (63.2°F). This is somewhat higher than the existing temperatures recorded in the WTP raw water, which range from 3°C (37°F) in winter months to 20°C (68°F) in summer months. The TID water is likely warmer since the water is drawn from a shallow, long canal so solar gain is higher compared to the deep Reeder Reservoir. Warmer temperatures has affects coagulation processes (faster reaction times), filter backwashing (higher backwashing flowrates), and chlorine disinfection (less C x T credit).

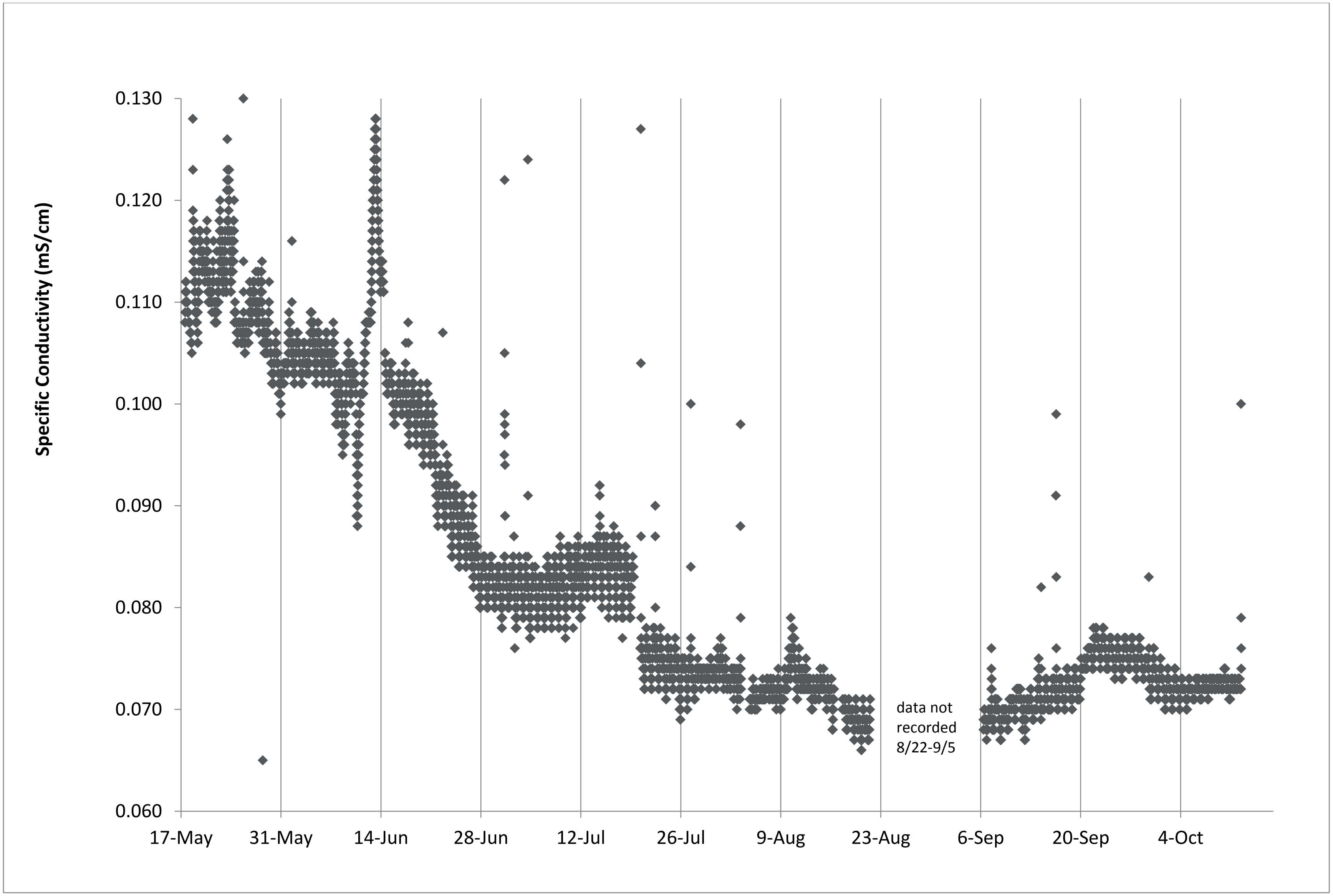


Figure 9: TID Specific Conductivity, May-October 2017

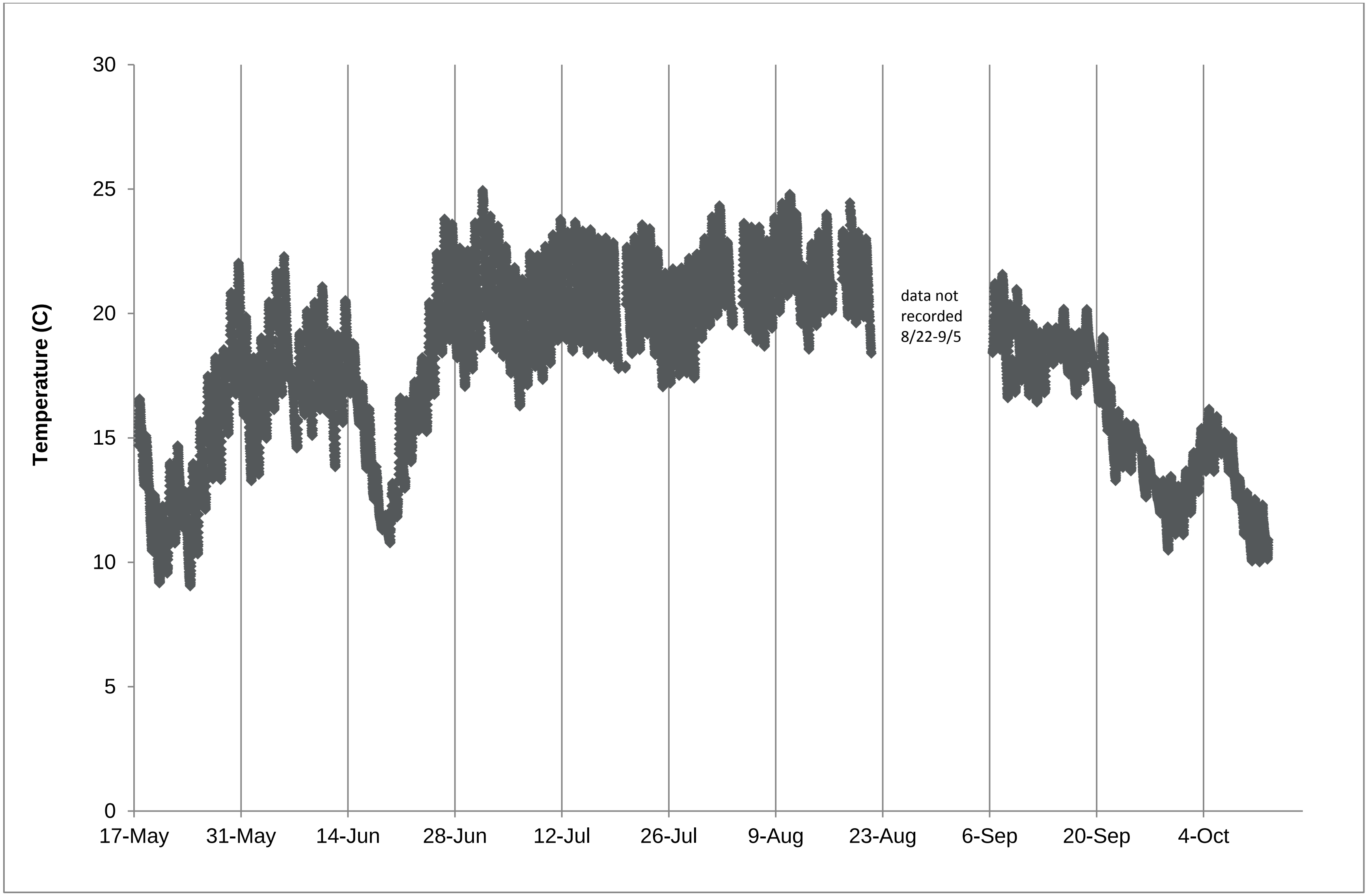


Figure 10: TID Temperature, May-October 2017

Lab Tested Water Quality Data

Water samples were collected and sent to Neilsen Research Corporation in Medford, OR for additional analysis.

Alkalinity and Hardness

Alkalinity and hardness are water quality parameters that affect several key treatment and water quality processes. Alkalinity is a key factor for chemical coagulation and maintaining a stable pH in the distribution system, while hardness is associated with potential precipitation and scaling issues in distribution piping and customer plumbing, taste complaints, and impacts the effectiveness of soap and detergent usage by businesses and individuals.

TID alkalinity and hardness water quality results for five samples taken during the summer or 2017 are plotted below the monthly average data from the intake of the existing WTP. The range of alkalinity values found in the TID water is within the range of the alkalinity values already observed at the WTP, although the values are slightly higher than the average at the WTP in June and July, and slightly lower in September and October. Additionally, in 2014 and 2015, years where TID water supplemented the Ashland Creek water supply, the alkalinity observed at the WTP was generally higher than seen in other years. The TID water hardness were also higher than average for what has historically been observed at the WTP intake, as shown in Figure 12. In 2014, when the highest volume of TID water was used to supplement water supply, the most elevated levels of hardness were also seen in the WTP raw water. Hardness was also generally higher than other years in the summer months in 2015, another year where TID water supplemented the supply. As mentioned in the April 2017 Water Quality memorandum, this may also be due to the fact that these were drought years with a reduced snowpack, and thus reduced snowmelt runoff which tends to reduce the concentration of minerals found in the raw water. This is supported by the fact that in most years, alkalinity and hardness decrease from May through August, when snowmelt is most prevalent. Future planning for treatment and water quality processes must consider the impacts to alkalinity and hardness of both adding TID water and the increased potential for drought years.

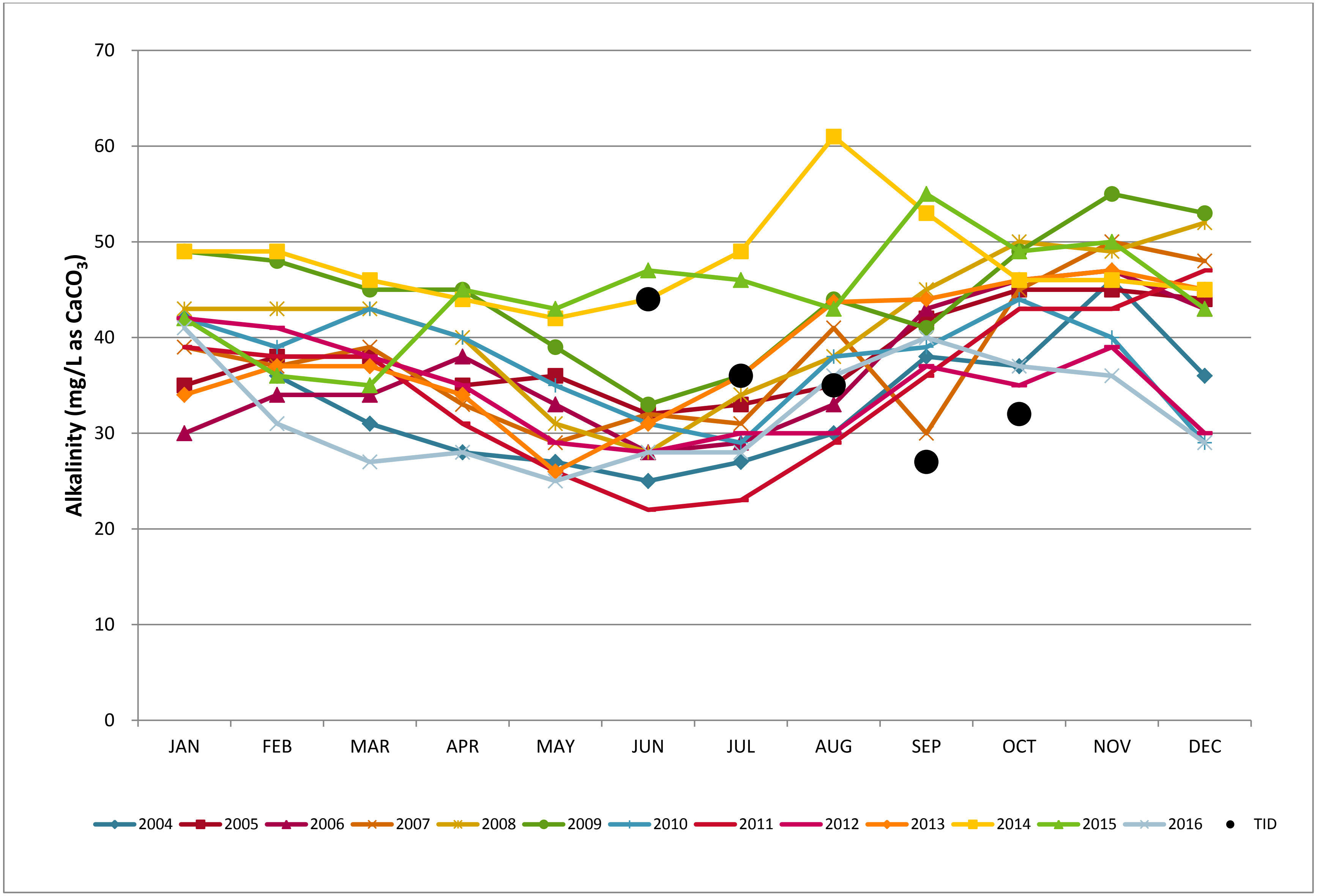


Figure 11: Alkalinity - TID and WTP Raw Water Comparison

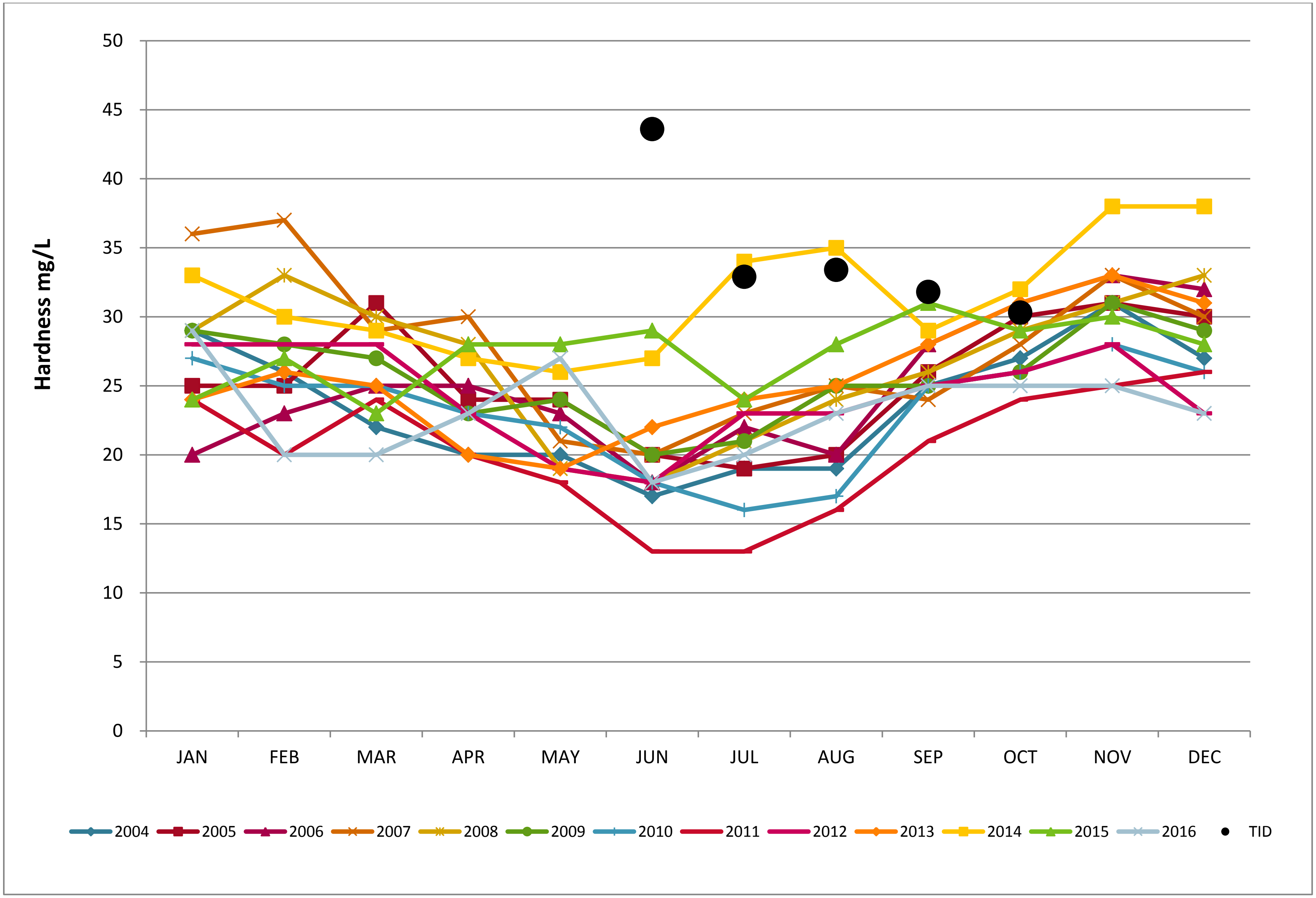


Figure 12: Hardness - TID and WTP Raw Water Comparison

Total Organic Carbon (TOC)

TOC is relevant to treatment process selection because it is a key precursor of disinfection byproducts (DBPs) that are regulated under the Federal State 2 Disinfection/Disinfection Byproducts Rule. The level of TOC in the finished water is related to the DBP formation potential of the water, and thus it is critical to understand the TOC content in the raw water. TOC was measured in five samples during the 2017 irrigation season. The results ranged from 2.90 to 3.39 mg/L. These values are slightly higher than the average summer values observed at the WTP, however they are within the range of levels of TOC that are typically seen at the plant on an annual basis. Based on these results, additional consideration of impacts from increased use of TID water is not necessary for the future plant development.

Iron and Manganese

Water quality samples of TID water revealed the presence of iron and manganese in the water, as seen in Table 3. Levels of iron exceed the maximum contaminant limit (MCL) set by the National Secondary Drinking Water Standards. Levels of manganese detected in the TID water are below the MCL. The presence of iron and manganese in raw water can impact the treatment process. Both iron and manganese can contribute to membrane fouling, create issues of scaling, coat activated carbon and thus prevent full capacity organics removal in treatment equipment. Iron and manganese have not previously been found in notable quantities at the WTP intake. The increased use of TID water will necessitate treatment considerations for iron and manganese at the WTP.

Table 3: TID Iron and Manganese Results

Analyte	Result (mg/L)					SMCL
	6/21/2017	7/24/2017	8/23/2017	9/29/2017	10/9/2017	
Iron	0.392	0.452	0.459	0.514	0.469	0.3
Manganese	ND	0.0426	0.0488	ND	0.0244	0.05

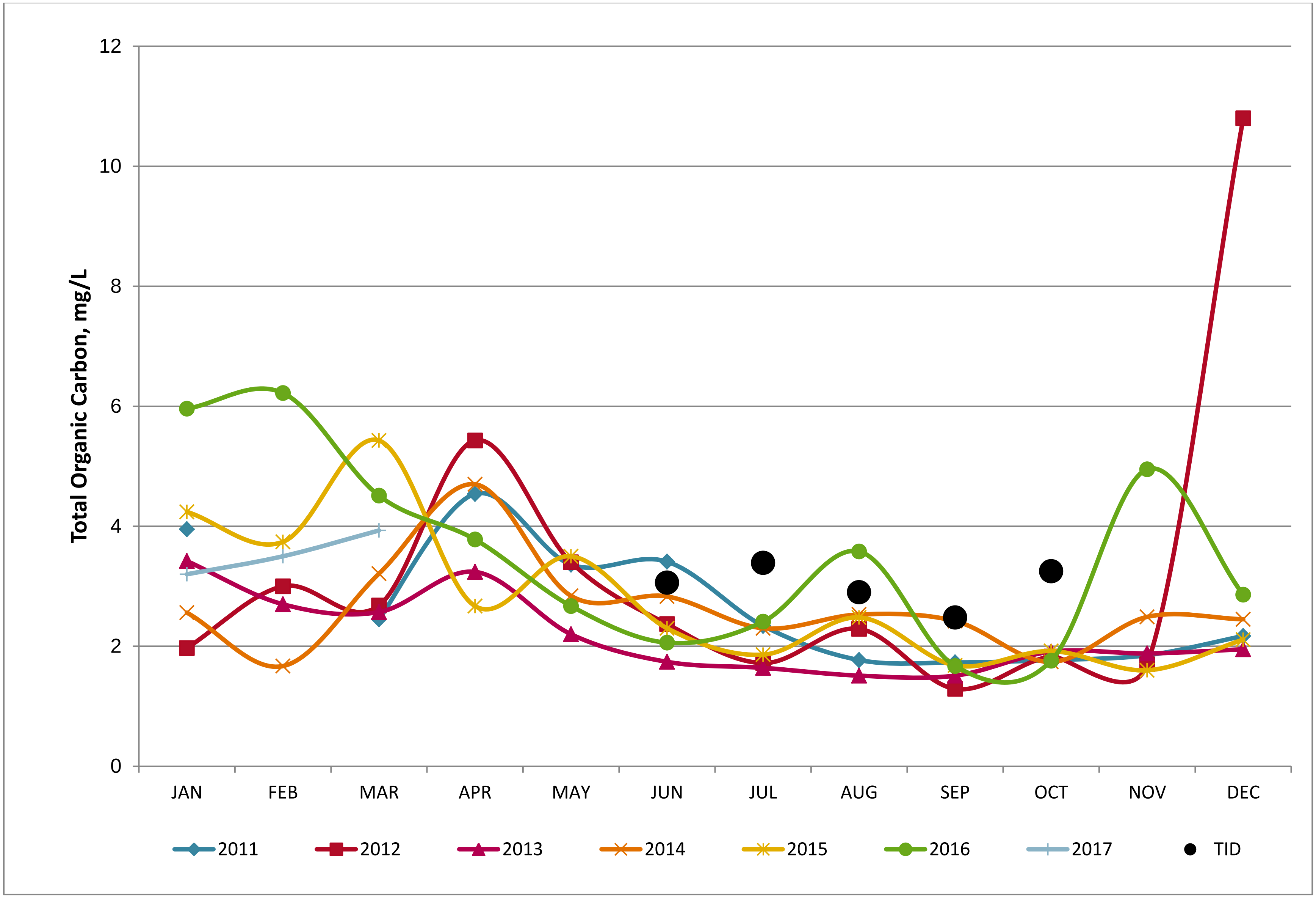


Figure 13: Total Organic Carbon - TID and WTP Raw Water Comparison

Color

Color was analyzed in monthly samples of raw TID water during the irrigation season. Apparent color was recorded at 20 and 25 platinum-cobalt units (PCU) for all samples during this period. This is above the secondary maximum contaminant level set at 15 PCU. Color is typically the result of iron, manganese and/or organic matter in the raw water. Apparent color is for an unfiltered water sample whereas true color is for samples after 0.45-micron filtration. True color represents fully dissolved color constituents and the difference between apparent and true color is the impact of filtration.

Table 4: TID Color Results 2017

Analyte	Result (PCU)					SMCL
	6/21/2017	7/24/2017	8/23/2017	9/29/2017	10/9/2017	
Color (Apparent)	20	25	25	20	20	15
Color (True)	5	10	5	<1	<1	None

The high levels of iron in the TID water likely contribute to color of the water. The apparent color observed in the TID data is similar to the apparent color recorded in the WTP intake data during the summer months, as seen below in Figure 14. The Ashland Creek water does not reveal levels of iron or manganese that would cause discoloration of the water, and thus organic matter is the likely cause of the high apparent color values seen in Ashland Creek. Color is regulated with a secondary maximum contaminant level of 15 PCU. Color will need to be a treatment consideration in the future, and will need to address both the levels of iron and manganese as well as the presence of organic matter in the combined raw water.

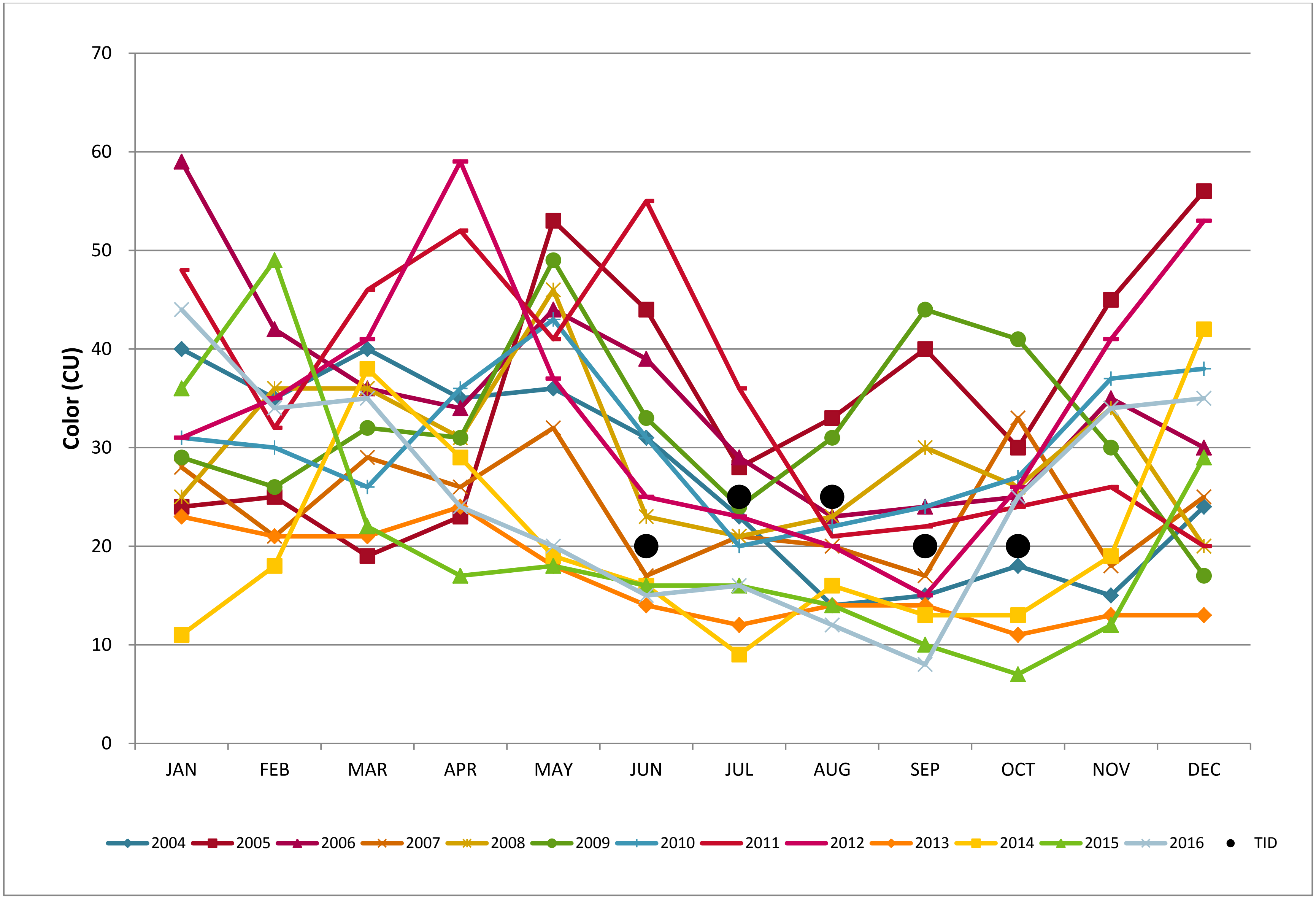


Figure 14: Color - TID and WTP Raw Water Comparison

Pathogens

A critical element of surface water treatment is the removal of pathogens that are liable to cause water-borne illness. Those of primary interest include Cryptosporidium, Giardia, and viruses, and determining the levels of these pathogens in raw water is essential for determining the most appropriate treatment process. During the irrigation season, a total of seven TID water samples were analyzed for Cryptosporidium oocysts and Giardia cysts. No samples in this time period detected any Cryptosporidium oocysts. Two samples, both in September, detected Giardia cysts in the raw water resulting in levels of 0.100 to 3.500 organisms per liter. See the summary table below for testing results.

Table 5: TID Cryptosporidium and Giardia Results 2017

	***Cryptosporidium* Oocysts**	***Giardia* Cysts**
Date Sampled	**no. organisms observed/(organisms/L)**	**no. organisms observed/(organisms/L)**
6/20/2017	0/(0.000)	0/(0.000)
7/11/2017	0/(0.000)	0/(0.000)
7/24/2017	0/(0.000)	0/(0.000)
8/8/2017	0/(0.000)	0/(0.000)
8/22/2017	0/(0.000)	0/(0.000)
9/12/2017	0/(0.000)	**35/(3.500)**
9/26/2017	0/(0.000)	**1/(0.100**)
10/9/2017	0/(0.000)	0/(0.000)

One sample was analyzed for Total Coliform and E.coli. Results from this analysis demonstrated the presence of Total Coliform at a level greater than 2419.6 organisms/100ml, using the statistical analysis method SM 9223, which returns the number of organisms as a most probable number with a 95% confidence range. E.coli results revealed the presence of E.coli at a probable number of 114.5 organisms/100ml. The observed quantities of pathogens in the TID water are higher than what has historically been recorded at the WTP intake, and thus may dictate treatment requirements.

Treatment requirements are such that Cryptosporiudium must be reduced by 2.0 log, Giardia by 3.0 log, and viruses by 4.0 log. See the Technical Memorandum on Regulatory Review and QA goals dated April 21st, 2017. The presence of both Giardia and viruses in some water samples indicates that a two step treatment process will be required, including both filtration and disinfection. Direct and conventional media filtration and membrane filtration do provide some removal of viruses, but further virus removal, such as chlorination, is required.

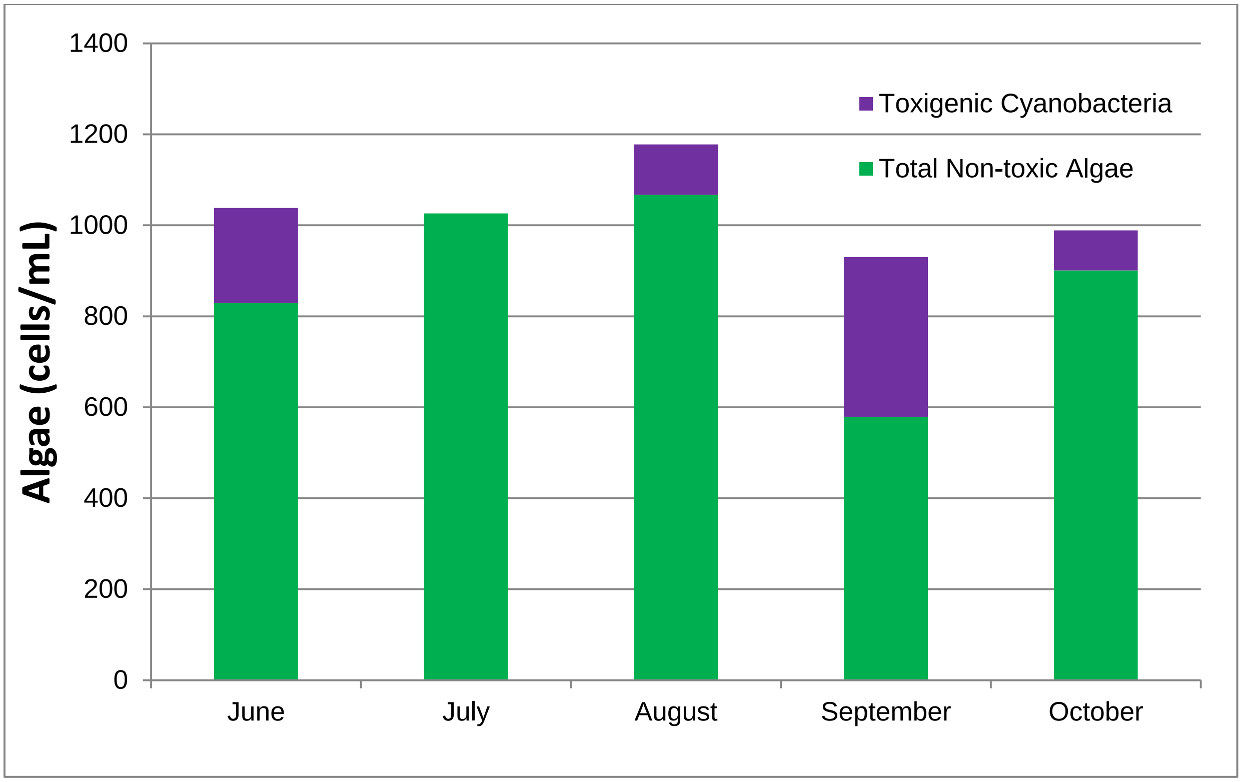
Algae and cyanotoxins

The presence of algae in the TID raw water likely results in the daily cycles of pH, ORP, and turbidity observed in the TID results. Algae enumeration and identification was performed on five samples throughout the summer. Algal counts ranged from 930 to 1178 cells/mL. The primary bacteria present were Diatoms, Cyanobacteria and Cholorophyta. Four out of five samples returned populations of toxigenic Cyanobacteria, with the highest levels observed in June and October. See the summary table below for the composition results of algae present in the TID water.

Table 6: TID Algae Results 2017

Algae Species	June 21		July 24		August 23		September 26		October 9	
	%	cells/ mL	%	cells/ mL	%	cells/ mL	%	cells/ mL	%	cells/ mL
Diatoms	67.9	705	73.3	752	58.4	688	31.1	289	49.6	491
Chlorophyta	6.6	69	11.8	121	8.1	96	6.1	57	12.8	127
Cryptophyta	5.1	53			8.9	105	20.2	188	3.0	30
Cyanobacteria	20.3	211	15.0	154	24.5	289	41.0	381	34.5	341
Euglenophyta					1.2	14	1.5	14	0.03	0.3
Charophyta									0.03	0.3
Toxigenic Cyanobacteria	20.1	209	0	0	9.4	111	37.7	351	8.9	88
Total		1038		1026		1178		930		989

The presence of toxigenic Cyanobacteria is relevant for consideration in treatment. The Reeder Reservoir water supply has had historical cases of cyanotoxins, but they are not a consistent issue in the water supply from this source. As the TID becomes a more consistent supply for drinking water, ensuring that treatment removes all toxigenic cyanobacteria from the raw water is critical. In addition to toxins, algae and the particulate matter associated with that algae may also contribute to color, which is relevant to the treatment process selected.



Inorganic Compounds

Twice during the 2017 irrigation season, TID water was sampled for inorganic compounds (IOCs). No IOCs were present in amounts greater than the EPA limit, and most compounds sampled for were not-detectable. See the table below for a summary of IOC results.

Table 7: TID IOC Results 2017

Analyte	6/21/2017	9/26/2017	MCL
Antimony	ND	ND	0.006
Arsenic	ND	ND	0.01
Barium	0.0138	0.0135	2
Beryllium	ND	N/A	0.004
Cadmium	ND	ND	0.005
Chromium (total)	ND	ND	0.1
Copper	0.00169	0.00596	1.3
Cyanide (as free cyanide)	ND	ND	0.2
Fluoride	ND	ND	4
Mercury (inorganic)	ND	ND	0.002
Nitrate-N	ND	ND	10
Nitrite-N	ND	ND	1
Selenium	ND	ND	0.05
Thallium	ND	ND	0.002

In existing operations at the Ashland WTP, IOCs have not been a past raw water quality issue. In a review of data from the Oregon Health Authority (OHA), nitrate was the only IOC at a concentration that was detectable, and the level was always well below the EPA limit of 10 mg/L. An increase in use of TID water should not have an impact on treatment in regards to the presence of IOCs.

Volatile and Synthetic Organic Compounds

None of the listed secondary contaminants in the form of Volatile Organic Compounds (VOCs) or Synthetic Organic Contaminants (SOCs) regulated by the EPA were detected in the sampling performed at the TID canal. The VOC and SOC analysis obtained from the OHA website with data for the Ashland WTP intake did not detect any VOCs or SOCs at concentrations above the respective detection limits. The addition of TID water to the existing WTP source should not contribute to additional consideration of VOCs and SOCs for treatment alternatives.

Summary

Table 8 provides a summary of the water quality data obtained from TID with a comparison to the existing data from the WTP raw water. The increased use of TID water will require some additional considerations for water treatment and water quality processes. Below the table is a summary of the TID water quality data as it will impact exiting and future performance of the WTP.

Table 8: Summary Comparison of TID and WTP Intake Water Quality Parameters

Water Quality Parameter	TID Water Quality Results	Comparison to WTP Raw Water Results
pH	Range: 7.31 – 8.55 Average: 7.79	Range: 6.8 – 7.9 Average: 7.4
Turbidity	Range: 0 NTU – 209 NTU Average: 8.2 NTU	Range: 0.29 NTU – 5.29 NTU Average: 1.0 NTU
ORP	Range: 31.9 mV – 338.7 mV Average: 246.54 mV	No data
Dissolved Oxygen	Range: 4.7 mg/L – 13.4 mg/L Average: 9.3 mg/L	No data
Specific Conductivity	Range: 0 - .28 m/sec Average: 0.08 m/sec	No data
Temperature	Range: 8.1 °C – 24.9 °C Average: 17.4 °C	Range: 3 °C – 20 °C Average: 9.3 °C
Alkalinity	Range: 27 – 44 mg/L as $CaCO_3$ Average: 35 mg/L as $CaCO_3$	Range: 22 – 61 mg/L as $CaCO_3$ Average: 38.6 mg/L as $CaCO_3$
Hardness	Range: 30.3 – 43.6 mg/L as $CaCO_3$ Average: 34.4 mg/L as $CaCO_3$	Range: 13 – 38 mg/L as $CaCO_3$ Average: 25 mg/L as $CaCO_3$
Total Organic Carbon (TOC)	Range: 2.48 – 3.39 mg/L Average: 3.00 mg/L	Range: 1.29 – 10.8 mg/L Average: 2.9 mg/L
Iron	Range: 0.392 – 0.514 mg/L Average: 0.474 mg/L	Limited data indicates little to non-detectable concentrations
Manganese	Range: ND - 0.0488 mg/L Average: 0.0386 mg/L	Limited data indicates little to non-detectable concentrations
Color	Range: 20 – 25 CU Average: 22 CU Attributable to algae, iron and manganese	Range: 7 – 59 CU Average: 28 CU Attributable to algae
Pathogens	Zero for *Cryptosporidium* Two positive for *Giardia*	One positive *Cryptosporidium* One positive *Giarda*
Fecal Coliform	2420 organisms/100mL	Limited data indicates little to non-detectable concentrations
E.Coli	115 organisms/100mL	Limited data indicates little to non-detectable concentrations

Water Quality Parameter	TID Water Quality Results	Comparison to WTP Raw Water Results
Toxigenic Cyanobacteria	Range: 0 – 351 cells/mL Average: 152 cells/mL	Reeder Reservoir sample as high as 31.6 million cells/mL in isolated grab samples. None detected in WTP raw water.
Non-Toxic Algae	Range: 579 – 1067 cells/mL Average: 880 cells/mL	No data
IOCs	Barium and Copper were detected at minimal levels, 200 times below EPA limit. No other IOCs were detected.	Nitrate was detected at a level 10 times below EPA limit. No other IOCs were detected.
VOCs and SOCs	Non-detect for all compounds.	Non-detect for all compounds
T&O Compounds	No data	Algae and Geosmin contribute to T&O issues

Summary of key points:

- The overall pH of the TID water is slightly higher than the pH currently found at the WTP, however it is generally within a range that should not result in significant impact treatment requirements.

- The TID water has significantly higher levels of turbidity than those currently found at the WTP. In general, direct filtration facilities, either using granular media or with membranes, can operate with up to 10 NTU raw water turbidity without an issue. Future sedimentation processes at the WTP are needed to provide increased turbidity removal prior to the filters (membrane or granular) to account for the higher peak TID turbidity.

- However, the hourly/daily variability in the pH, turbidity, ORP, and DO exhibited in the shallower TID water will necessitate more frequent operator attention than currently takes place in the Reeder Reservoir supply (whose much larger volume buffers much of the variability) to maintain correct levels of chemical dosing and to ensure that finished water quality is within compliance limits. This additional effort for monitoring and control is required regardless of the filtration process selected for the new WTP.

- The specific conductivity of the water is highest in late spring and decreases through the summer. This suggests a reduction in salinity of the water, which might provide some benefit to treatment by facilitating coagulation. However, the daily variability of other water quality factors will likely outweigh this benefit.

- The temperature of the TID water is 8 °C higher on average than the current raw water at the WTP, but demonstrates similar seasonal trend of warmer temperatures in the late summer months as the existing raw water. Temperature is an important consideration in the selection of any treatment process. For granular media filtration, warmer water means filter backwashing flowrates have to increase, and increases the possibility of biological growth within the filters and along the filter walls. Membranes are even more impacted by warmer water temperatures, but positively, as warmer water is easier to filter than cold water. This results in a potential net production increase with warmer water through membranes, even taking into consideration backwash and cleaning cycle water use. (Conversely, membranes have a more difficult time filtering cold water and requires more membranes [and associated capital and operating] costs).

- The alkalinity values detected in water samples from the TID were similar to those reported at the WTP, while the hardness values are slightly higher. These values are still within the range of alkalinity and hardness values for other raw water sources in Oregon. These values are not different enough to meaningfully affect the selection of one type of filter versus the other, but it does impact the ability of the future WTP to provide a consistent water quality in the distribution system.

- The Total Organic Carbon (TOC) present in the TID water quality samples is very similar to the TOC found in samples in the WTP raw water. No additional consideration is needed as a result of increasing the volume of TID water treated at the plant.

- Iron was detected at levels above the SMCL in the TID water, and manganese at levels just below the SMCL. Iron and manganese have previously not been issues at the WTP, and thus future design should consider if iron and manganese can be removed by the new WTP. In addition, iron and manganese are serious foulants on membranes that can result in increasing backwash frequency, greater backwash waste generation, less net water production, more frequent chemical cleanings, and more system downtime.

- The color detected in the TID water is similar or lower than that found in the WTP raw water. Color is an important treatment consideration, but additional steps will not be required as a result of increasing TID water use.

- Fecal coliform and E. Coli were found in the one sample of the TID water. Total coliform was measured at 2,420 organisms/100mL, and E. Coli at a probable level of 115 organisms/100mL. These are considerably high values and the City should consider providing greater disinfection than currently used at the existing WTP. Inherently, a properly operating membrane filtration provides greater removal and public health protection than media filtration for pathogens. However, OHA may not provide this disinfection credit if the membrane vendor has not conducted all the required testing and submitted the documentation for OHA approval.

- TID water was found to contain high levels of algae, including significant numbers of toxinogenic cyanobacteria. Reeder Reservoir also exhibited algae, including those algae that can produce cyanotoxins. This issue must be addressed in future design and operation of the WTP. Specifically, membrane filtration should remove more of this material than granular media filters. However, algae often exude a viscous biopolymer (a “slime”) that becomes a problematic membrane foulant requiring chlorine washes to control. Granular media filters can also clog due to this biopolymer, but the required amount to cause a problem is several orders of magnitude higher than for membranes.

- *Giarda* and *Cryptosporidium* were detected in the TID water in approximately the same range as the Reeder Reservoir water. There is no indication that TID water would require increased treatment per LT2ESWTR regulations

- Finally, the presence of IOCs, VOC, and SOCs were not detected at levels that require additional water quality and treatment process consideration. Barium and copper were the only detected IOC contaminants, and they were found at levels 200 times below the EPA contaminant limit. This means the TID water does not require any additional removal methods for these contaminants compared to the existing WTP.

Summary

The TID water quality sampling and analysis program conducted in the summer and fall of 2017 determined that the TID water quality is generally similar in quality to the Ashland Creek/ Reeder Reservoir water. There are key differences in several parameters, but on the whole, the data does not suggest that the TID water would be more amenable to granular media filtration or with membrane filtration. Instead, the overall data indicates that both filtration processes would be able to successfully treat the raw TID water to all drinking water standards, though each have different advantages and challenges that needed to be addressed as design advances. More importantly, the differences in water quality affect the required amount of pre- and post-filtration treatment regardless of filtration.

References

HDR. 2017, Additional Water Quality Data Gaps and Sampling, April 27, 2017.

HDR. 2017, Ashland Regulatory Review and WQ Goals Technical Memorandum, April 27,2017.

Carollo. 2011, City of Ashland Water Conservation and Reuse Study, June 2011.

HDR, 2017. Water Quality Data Summary and Review, April 21, 2017.