2017 South East Kelowna Irrigation District System Annual Drinking Water Report

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Report Date Covered: January through December 2017
Report Submitted: October 30, 2018

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Introduction

As required by the *British Columbia Drinking Water Protection Act*, the City of Kelowna provides the following annual report on the newly acquired water system formerly owned by the South East Kelowna Irrigation District (SEKID) in accordance with the conditions on permit. For the remainder of this document the system will be referred to as SEKID or the SEKID system.

This report provides an overview of the service area, the water system components, capital improvement projects, water quality monitoring, action taken towards water source protection, water conservation initiatives, staff certification, emergency response planning, and water services provided to the public.

SEKID's primary focus is to provide sustainable, quality drinking water from source to tap and to ensure it is safe to drink for the customers of the Water Utility. For further details on the content of this report or to request additional information, please contact the SEKID office at 250-861-4200 or email info@sekid.ca.

Water System Overview

The South East Kelowna Irrigation District was incorporated under letters patent by the order in council of the British Columbia legislature on November 2, 1920. The irrigation District was primarily established to provide local farmers with a consistent supply of gravity fed water for a wide variety of Orchards and various fruit production industries, which still thrive to this day.

The water sources originate from natural upland reservoirs and lower valley wells that currently services about 7,000 area residents. Until June 4, 2018 SEKID was governed by an elected Board of Trustees that administered the Operational and Financial management of the District and participateed in the Kelowna Joint Water Committee as one of the 5 Water Districts within the City of Kelowna municipal boundary.

Service Area

The defined geographical service area for SEKID is presented in Figure 1 with an estimated cultivated area of 1,800 hectares. About 85% of the domestic water provided is used for agricultural irrigation with the remaining 15% utilized for residential consumption. There are several areas that are identified as "Future SEKID" which currently does not have water supplied by the District, but is slated for servicing pending future water demand and land development (**Figure 1**).

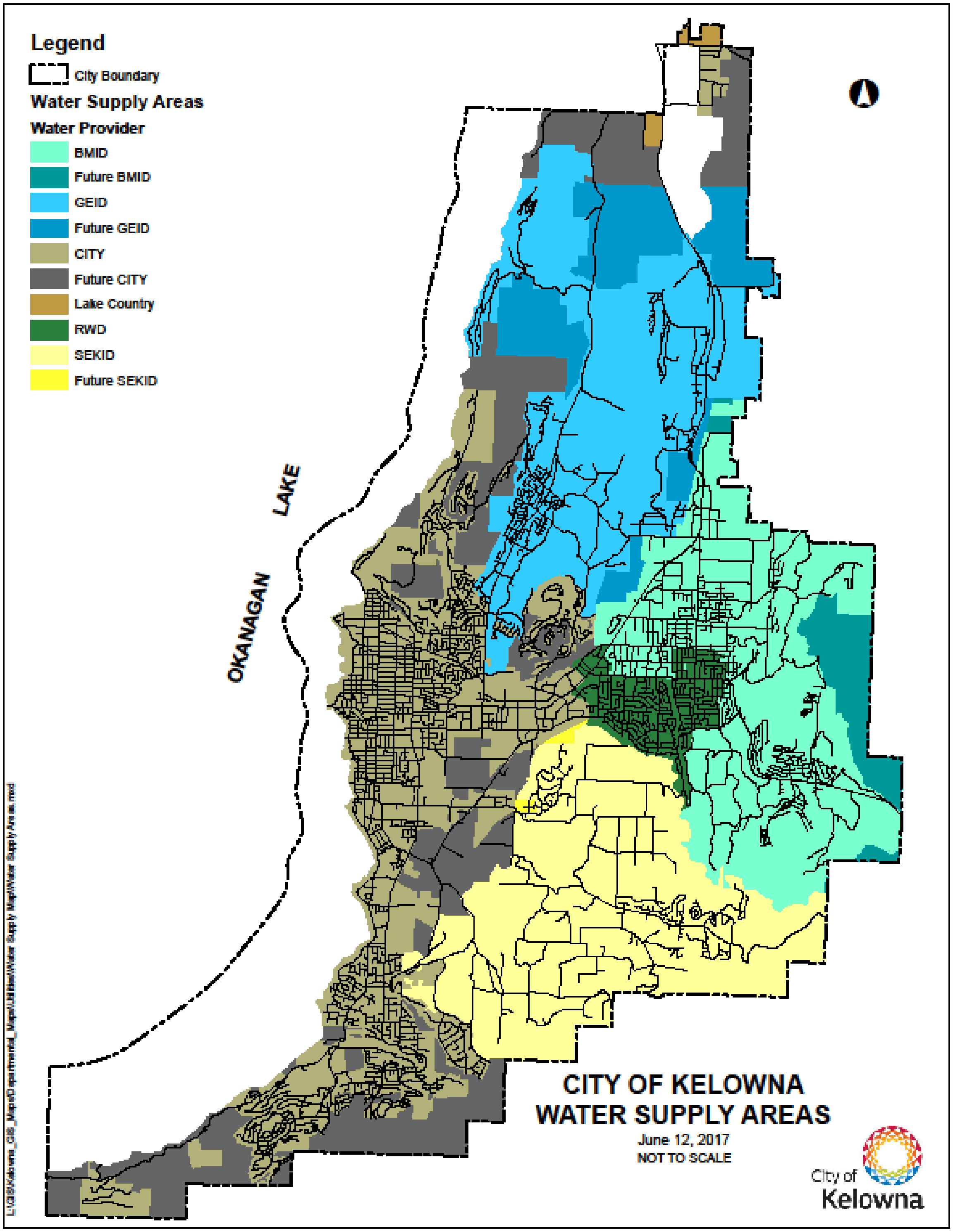


Figure 1. Water service area for SEKID and surrounding water districts

Water Source and Treatment

SEKID's water source primarily comes from a series of upland reservoirs in the Hydraulic Watershed that covers approximately 140 km² and relies predominantly on snow pack for annual water supply. The reservoirs feed tributary streams that converge to supply the water intake located on Hydraulic Creek. The intake supplies 94% of the source water for distribution with the remaining 6% drawn from a series of smaller wells that service select geographical areas or are used to supplement the main distribution system during high seasonal irrigation demand. SEKID employs a single-barrier water treatment system that consists of course mechanical screening and chlorine dosing for disinfection against pathogens, which complies with the "Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in BC" as established and adopted by the Ministry of Health – Health Protection Branch.

Reservoir and Dam Inspections

The upland water sources are located in the Hydraulic Creek, Grouse, and Stirling Creek watersheds and consist of 4 lake reservoirs that utilize dams that require either monthly or annual inspections based on their risk classification to ensure that safety and integrity of the dams are maintained. Inspection indicated that the dam infrastructure was kept in a good state of repair and did not pose a significant risk to the integrity or safety of the water system. A full report on the status of the dam system can be found in the *SEKID Annual Dam Inspection 2017 Report* prepared by Mould Engineering and submitted to the Provincial Dam Safety Program for compliance.

Distribution System

The District has 2,830 water service connections of which 2,250 connections are classified as residential and 580 as farm or agricultural. Currently, all of the water supplied through the distribution system is considered potable, although a year round water quality advisory remains in place due to elevated source water Turbidity.

The SEKID distribution system consists of 1 main pump station, 3 Wells, 1 booster station, 36 pressure reduction stations, and 2 balancing reservoirs. Associated costs for treatment and delivery are recovered through flat rate water allocation fees and Water Quality Improvement Levy collected quarterly.

System Control

The operation and maintenance monitoring of the water quality, operating pumps, reservoir water levels, distribution system water pressures are all conducted through the use of a Supervisory Control and Data Acquisition Software (SCADA) program. Connected by wireless links, the SCADA software remotely collects information at the Hydraulic Creek Treatment Facility.

Centralized information is monitored by the water system operators from in-line monitors and sensors. The software interprets the receiving data to automatically adjusts pumps and system settings to maintain pre-defined operating requirements. When an issue is detected within the system, the SCADA system issues alerts and alarms to water system operators who then respond to the concerns. This software platform also allows SEKID operators to collect and track historical performance of the system.

Staffing

The SEKID water system is Environmental Operator Certification Program (EOCP) classified as a small Level 2 water system and employs water operators that are qualified as per Section 12 of the *Drinking Water Protection Regulations* (DWPR). EOCP requires specific certification levels of water operators to maintain, operate, or repair a water system and is determined by the class of the system under the EOCP. The list of water system operators and certification levels in 2017 are listed in Table 1.

Name	Water Distribution				Chlorine Handling
	I	II	III	IV	
D. Melcalf					
D. Van Asseldonk					
J. Evans					
D. Siewert					

Table 1. SEKID Operators certification levels

Capital Works Projects

A number of water related projects were scheduled and completed in 2017 that involved upgrades and improvements to existing water infrastructure that totaled over $100,000. Projects were completed by priority and long term development planning. Summary of budgeted water projects descriptions and values are presented in Table 2.

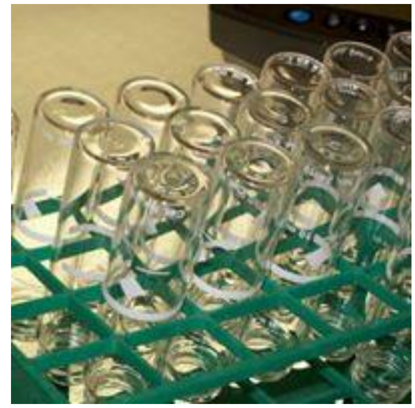
Water Capital Projects	Description	Value	Level of Completion
Small Service Connections	Agriculture water line connections	$ 11,000	Complete
Pump Replacement	Hall Road Well Head Pump	$ 13,000	Complete
Software Upgrade	SCADA system upgrade	$ 83,000	Complete
	Total	**$ 107,000**	

Table 2. SEKID Water capital projects

Cross Connection Program

SEKID, along with all other local water districts, works in partnership with the City of Kelowna Water Utility, through the Kelowna Joint Water Committee, to ensure that all backflow devices are installed and annually tested through a comprehensive Cross Connection Control (CCC) program. The CCC program is designed to protect water quality in the distribution system from backflow and any subsequent contaminants that could be carried from point of use sources. SEKID is in regular contact with the Kelowna Cross Connection Coordinator to confirm that all backflow assemblies in the SEKID area are tested and compliant. In addition, all new and renovated facilities are inspected by the Kelowna building department to ensure that all backflow devices are installed as required.

There were a total of 66 backflow assemblies in 44 SEKID facilities in 2017, of which 64 were tested and found to be in compliance with the annual testing requirement.



Water Quality Monitoring

The SEKID Water Quality Program references the following regulations and guidelines to develop a reporting program:

- *Guidelines for Canadian Drinking Water Quality (GCDWQ)*
- *British Columbia Approved Water Quality Guidelines*
- *British Columbia Drinking Water Protection Act and Regulation (DWPA)*
- *Drinking Water Treatment Objectives for Surface Water in BC*
- *IHA Decision Tree for Responding to Turbidity Events in Unfiltered Water*

The *Guidelines for Canadian Drinking Water Quality* are based on the current, published scientific research related to the health effects, aesthetic effects, and operational considerations. Health based guidelines are established on the basis of comprehensive review of the known health effects associated with each contaminant, on exposure levels and on the availability of treatment and analytical techniques. The highest priority guidelines are those dealing with microbiological contaminants such as bacteria, protozoa, and viruses.

Sample Collection

A source to tap drinking water quality monitoring program is a function of source water quality, water treatment, and water quality through the distribution system. As a result, the monitoring of the SEKID drinking water quality consists of 3 main sample and information collection components:

- Raw Water Quality monitoring
- Monitoring in the Distribution System
- Customer concerns and Service Requests

The sampling location, frequency, and water quality parameters required at each of the source to tap sites are reviewed yearly and adjusted to meet the sampling requirements in the BC Water Quality Guidelines. Qualified sampling staff conduct weekly and monthly testing on source and distribution water from various sites throughout the system. Data collection consists of SCADA monitoring, field measurements, and submission of samples to an external third party, accredited laboratory as part of the quality assurance program.

Source Water Quality Parameters

Raw water quality is the primary indicator of potential health risks as well as representative of the water quality throughout the distribution system. Source water collected prior to the Hydraulic Creek Intake and is tested weekly for the following parameters:

- Turbidity (Figure 6)
- Total Coliform (Table 4, Figure 9)
- Escherichia coli. (Table 5, Figures 10-11)

In addition, a monthly sample is tested for a variety of physical, chemical, and biological parameters and monitored against aesthetic and operational guidelines:

- pH (Table 6, Figures 12-13)
- Color (Table 7, Figures 14-15)
- Temperature (Table 8, Figures 16-17)
- Iron (Table 9, Figures 18-19)
- Turbidity (Table 3, Figures 7-8)
- Ammonia (Table 10, Figures 20-21)
- Ortho-Phosphate (Table 11, Figures 22-23)
- Conductivity (Table 12, Figures 24-25)
- Hardness (Table 13, Figures 26-27)

Source Water Quality Observations

- Testing indicated that the main Hydraulic Creek source water Turbidity remained above 1 NTU throughout the 2017 calendar year, resulting in a year round Water Quality Advisory (WQA). Elevated Turbidity above 5 NTU in March and April resulted in a Boil Water Notice which is consistent with previous years' observations with no long term indication of water quality improvement.
- Total Coliform and E. coli. results began to increase beginning in June, well after freshet began indicating that elevated bacterial counts had a stronger relation to water temperature. 5-year trending indicated that Total Coliform counts remained consistent while E. coli. counts demonstrated a distinct decrease over that period of time.

Distribution Water Quality Parameters

Similar to the source water sampling program, water distribution sites were tested for physical, chemical and biological parameters in order to comply with the established *GCDWQ* health and aesthetic guidelines.

Weekly

- Free Chlorine (Figure 30)
- Total Coliform (Table 4)
- Escherichia coli (Table 5)

Monthly

- Turbidity (Table 3, Figures 7-8)
- Free Chlorine (Table 15, Figures 31-32)
- pH (Table 6, Figures 12-13)
- Color (Table 7, Figures 14-15
- Temperature (Table 8, Figures 16-17)
- Iron (Table 9, Figures 18-19)
- Ammonia (Table 10, Figures 20-21)
- Ortho-Phosphate (Table 11, Figures 22-23)
- Conductivity (Table 12, Figures 24-25)
- Hardness (Table 13, Figures 26-27)
- Nitrates (wells only) (Table 14, Figures 28-29)

Quarterly

- Trihalomethanes (Figures 33-34)

Annually

- Full Comprehensive analysis (Table 16)

Distribution Water Quality Observations

- Chlorine residuals and THM concentrations indicate a relatively high chlorine demand, which is an indication of high organic material and subsequent elevated treatment byproducts such as Chloroform and has been reported to be over the Health Canada MAC guidelines since measurements began. Free Chlorine residual was maintained throughout distribution, but not always to operational objective levels.
- Conductivity and Hardness concentrations would classify Hydraulic Creek as a soft water source while all well systems are considered hard.
- Both Color and Iron concentrations remained above the Canadian Drinking Water Quality aesthetic guidelines resulting in the distinctive darker amber discoloration of the water through the year. Alternately, the water source drawn from the Johnson Road Well and Well#2 (supplementing the Dunster Road area) all exhibited acceptable concentrations relative to the Canadian Drinking Water Quality Guidelines. The resulting blend of some of these water sources improved the overall appearance and quality relative to the non-blended sources.
- Nitrate concentrations were within acceptable health limits for all wells, but did show a sign of moderate long-term increases.
- Ammonia and Phosphorus concentrations tended to peak during freshet, but not to concerning levels that would significantly contribute to water system fouling.

Annual Physical, Chemical and Biological Analysis Observations

Samples from the Recorder Building station and Johnson Road Well were collected and submitted to CARO Analytical Services (CALA Accredited) for full comprehensive physical, chemical, and microbiological analysis.

- All of the external testing validated the accuracy of the in-house and field testing results reported weekly and monthly
- Recorder Building results met the CDWQG Health and Aesthetic requirements with the exception of Turbidity (MAC), Color (AO), Iron (AO), and pH (AO)
- Johnson Road met all of the CDWQ guidelines with the exception of Hardness (AO) and Total Dissolved Solids (AO). Both of these parameters are considered a personal preference aspect of water quality

Watershed Protection Assessment and Response Plan

A Source Water Protection Assessment of the Hydraulic Watershed was commissioned in 2008 and reported in 2009 by Ecoscape Environmental Consultants. The assessment followed Modules 1, 2, 7, and 8 of the *Comprehensive Drinking Water Source to Tap Assessment Guidelines* (MHS & MWLAP, 2005), which identified both current and future drinking water health hazards and recommendations to reduce the overall impacts on the drinking water source.

Of primary concern are the hazards found in high vulnerability zones of the watershed, that are likely to occur, and/or have a high consequence from contamination. The inventory of hazards in these areas included:

1) Wildlife
2) Human and Recreational Traffic
3) Natural Organic Material Erosion
4) Wildfire
5) Livestock grazing

Forty recommendations were presented in the Protection Plan addressing concerns related to specific hazard mitigation, large scale natural disasters, land ownership, watershed access, livestock presence, forestry practices, and climate change. While some of these have been actioned since the plan was published, there are still many complex discussion points that require a formalized action plan and coordination with various stakeholder groups. Overall, access to the watershed remains the underlying hazard which increases the risk levels of all other hazards and therefore the implementation of an *Access Management Plan* was recommended as receiving the highest priority. This type of planning and enforcement requires the active participation and involvement of those stakeholders that have direct jurisdiction in the watershed. SEKID has been in communication with IHA, MOE, FNLRO and various local interest groups that have all have a vested interest in protecting the upland water source and is working towards on-going collaborative efforts to limit development, protect foreshore, and restrict access to sensitive riparian areas.

Water Production

The SEKID board utilizes a water allotment system for all metered irrigation services in the district and a quarterly flat rate charge for all residential water usage. The allotment system provides landowners with a seasonal volume of water for irrigation that is determined by the water rights of that property and expressed in acre feet (AF) of water per acre of irrigated land. Both irrigation and residential use is all captured by water meters and financial penalties incurred for irrigation use above and beyond the allotted volumes. In 2017, the irrigation water allotment was set at 2.25 AF and in line with previous years' allotment designations.

Water Supply

Although a series of interconnected upland reservoirs are utilized in the watershed, the primary reservoir that is monitored for storage and supply is McCulloch. This reservoir began 2017 with seasonably high water levels and rapidly filled in the beginning of March through May due to precipitation and unusually fast snow melt (Figure 2). This was followed by an early, high demand in July through September which saw very dry and hot weather conditions (**Figure 3**). Drought restrictions were not implemented on the supply with the anticipation that 2018 snow pack levels would bring the reservoir levels back in line with historical norm.

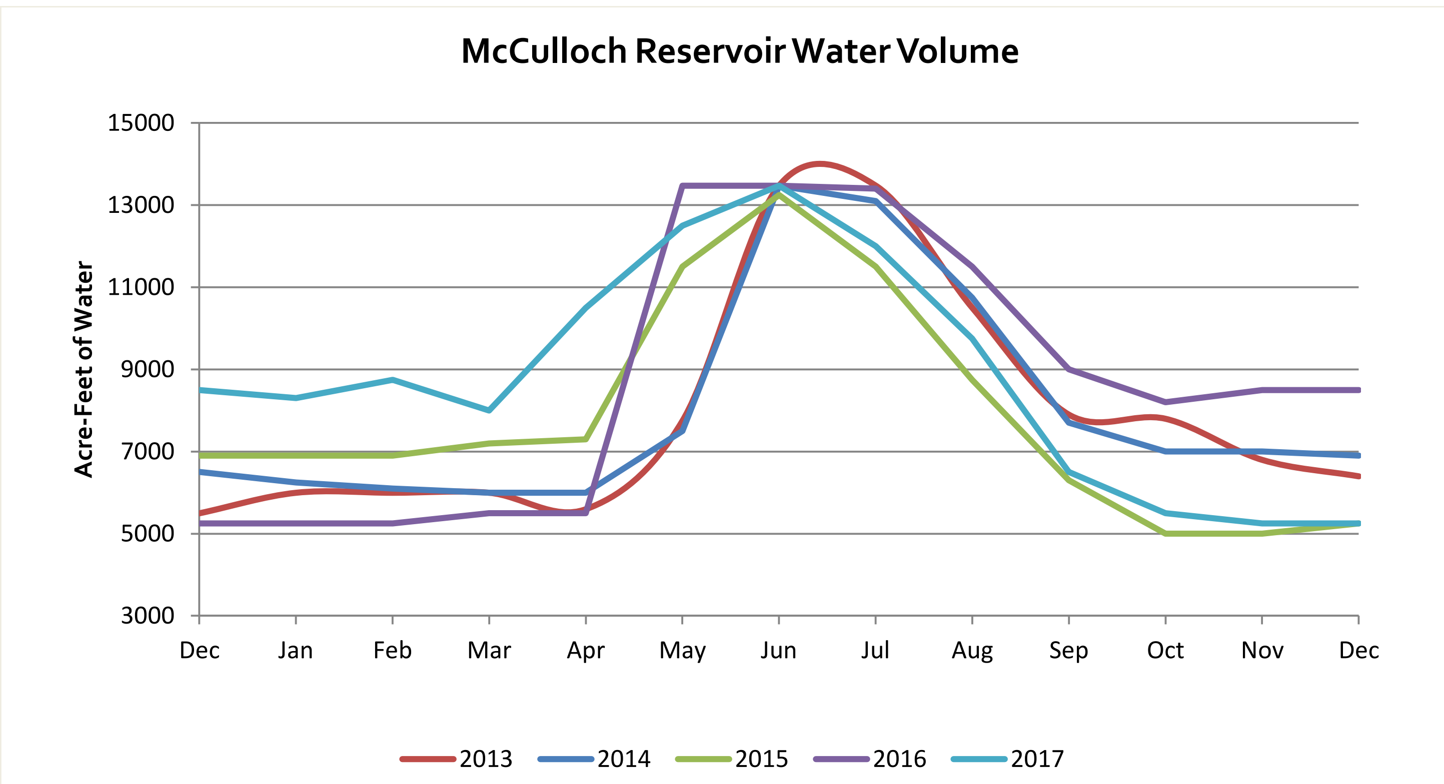


Figure 2. McCulloch reservoir monthly water storage volume

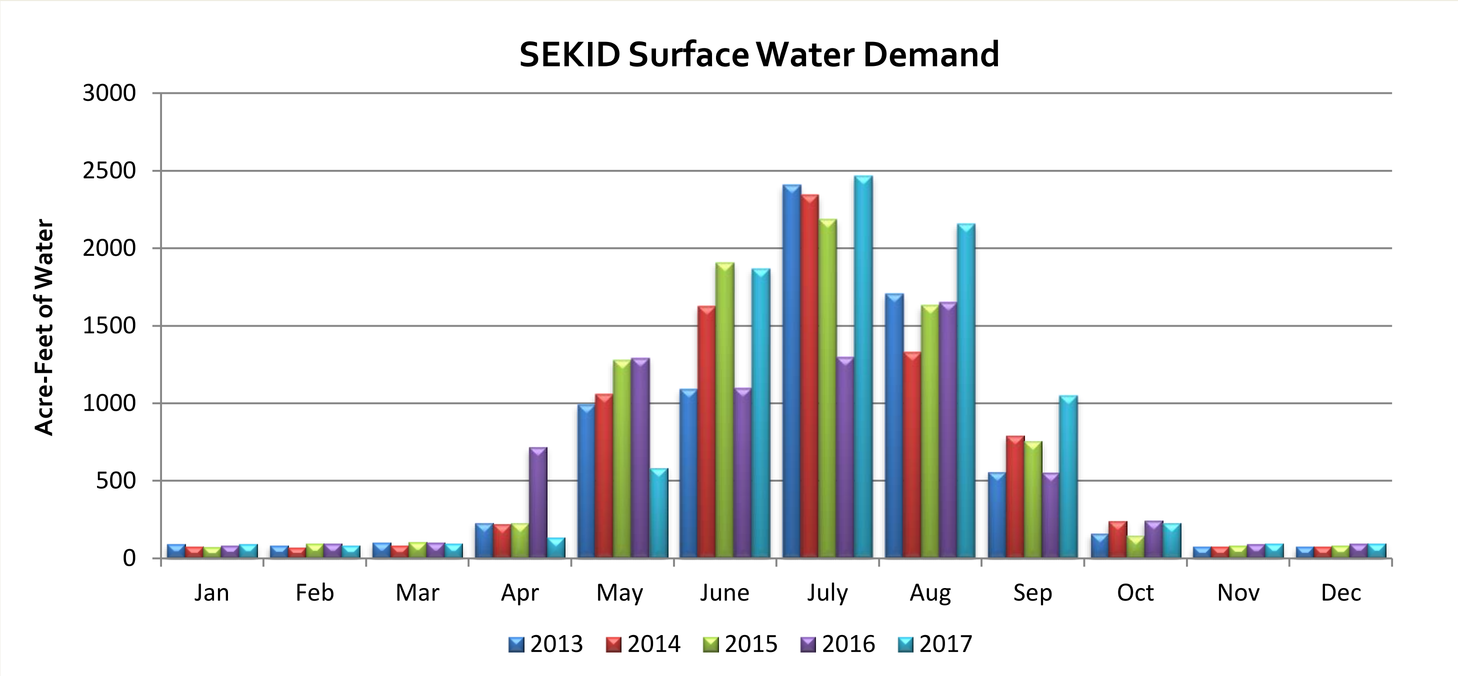


Figure 3. Hydraulic Intake monthly water demand

Well water demand was similarly very low between April to May due to the wet weather conditions, but rapidly increased in July to keep up with irrigation demand in July and remained high through September (**Figure 4**).

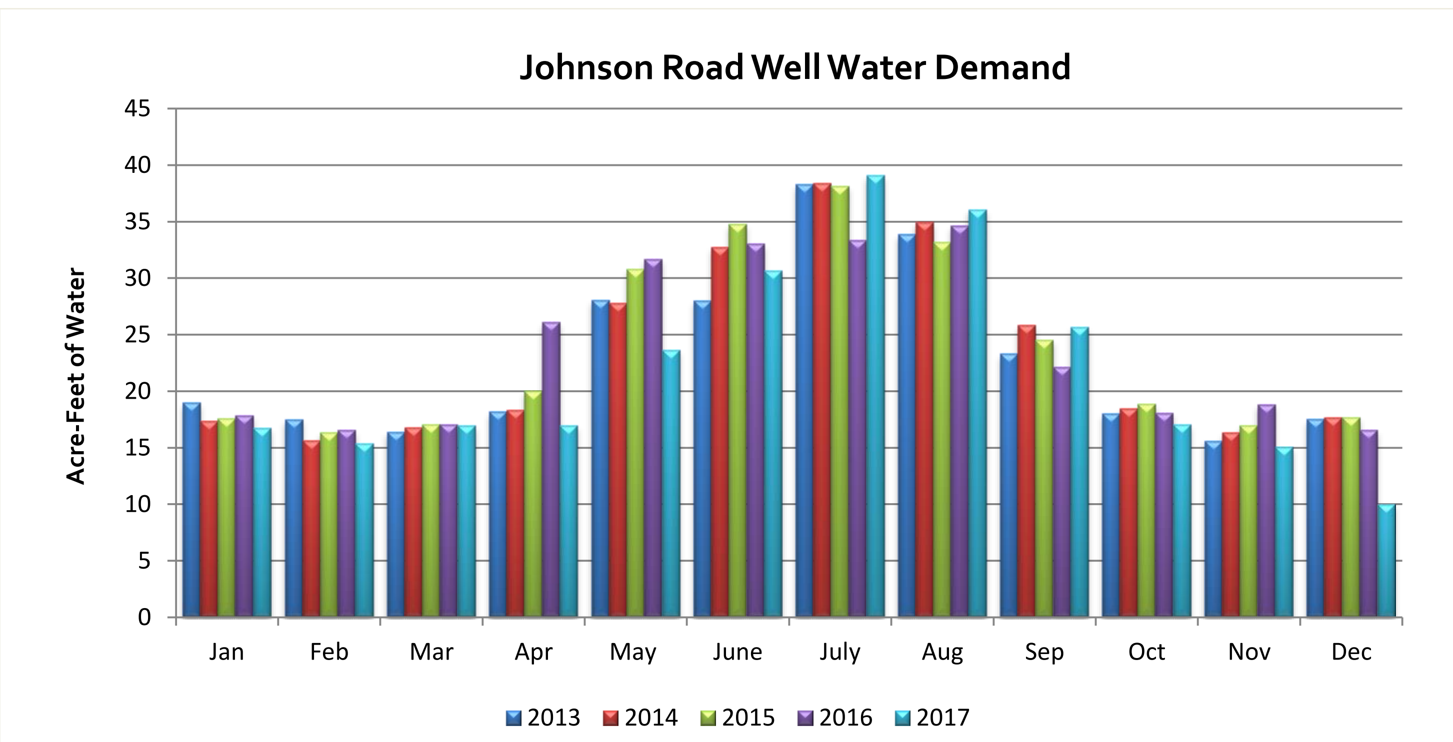


Figure 4. Johnson Road Well monthly water demand

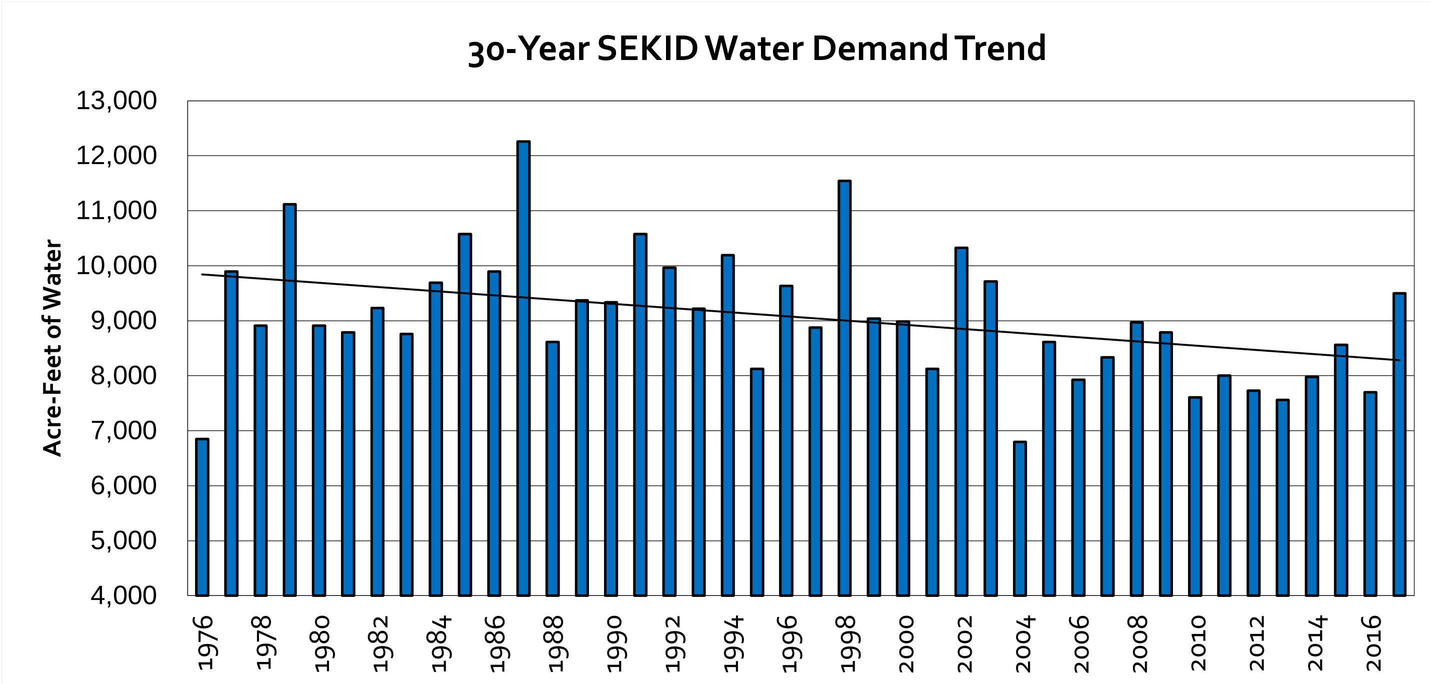


Figure 5. Long term SEKID water demand trending

Water Conservation

SEKID has historically been known as a district with limited supply due to the reliance on snow pack for source water. Conservation is encouraged not only to preserve the limited supply but also to defer expensive infrastructure replacement and lower on-going operating costs. SEKID is associated with the Okanagan Basin Water Boards "Make Water Work" water conservation program that promotes efficient residential water usage throughout the Okanagan Valley. Block rates are applied as per the *2005 Agricultural Water Conservation Program Review* with financial penalties applied for excessive volumes through Bylaw 579. As noted in the long term production trend (Figure 5), 2017 saw a much higher demand than in the past 13 years due to dry conditions, but overall is trending toward an overall 15% lower water demand – indicating an improvement in water conservation and irrigation practices.

Water Restrictions

Year round watering restrictions remain in place since first introduction in 2016. Intent is to make residents cognoscente of their water usage and to level the water production demand on the water system throughout the week. Allowable residential irrigation times are limited to 3 days per week and specific times during the allowable day. This policy has been adopted and enforced by the City of Kelowna as well as all other water purveyors within the City boundary.

Water Disruption Events

As with all water utilities, there are certain events throughout the year that interrupt water services – either planned or unplanned. These include pipe breaks, seized valves, leaking hydrants, and power outage occur. Regardless of cause, the SEKID strives to quickly correct the deficiencies with minimal disruption to water service.

	2017
Water Main break repairs	3
Water service leak repairs	30
Agriculture Meter Replacements	74
Water Main Blow off replacements	3
Water Disruption Events	10

SEKID strives to be as proactive as possible with planned infrastructure replacements, whereas repairs tend to be reactive and have dedicated water utility staff on standby at all times to address concerns – both in terms of repair as well as water quality assessments in order to comply with AWWA standard C651-14.

Emergency Response and Notifications

SEKID has developed an Emergency Response Plan (EMP) and Public Notification Procedure document that incorporates all necessary steps to carry out in the event that water quality deviations occur. Protocols describe possible water related emergencies that require public and/or IHA notification including:

- Turbidity Exceedances
- Loss of Source Water
- Chemical contamination of Source Water
- Biological contamination of Source Water
- Chlorination failure
- Infrastructure failure

SEKID is responsible for notifying IHA as well as the public in the event that the treated water quality does not meet drinking water standards. Notifications are issued in the form of media releases, electronic sign boards, social media outlets, radio messages, automated email and phone call notifications for those registered through the Kelowna Joint Water Committee (KJWC) automated notification program, and website updates.

The EMP was reviewed and updated in 2017 and published in January of 2018 to reflect current contacts, document locations and titles, and instructions relevant for public notification.

Customer Service

SEKID receives various calls, requests, and complaints throughout the year regarding water supply, water pressure, and water quality from its customers. Calls are taken by office staff and forwarded to the Water Manager or Water Operators as appropriate and are responded to in a timely fashion. SEKID will be moving towards implementing a service request system whereby residents will have the option to submit these requests on-line and have the information documented and formally responded to in order to create further transparency and accountability.

Long Term Improvements

The federal and provincial governments have approved the City of Kelowna funding application to the *Clean Water and Wastewater* fund grant for SEKID's improvement project to provide clean drinking water to all citizens living in South East Kelowna. A value planning review was completed by an objective third party consultant entitled "*Strategic Value Solutions"*, out of which the *2017 Kelowna Integrated Plan* was developed. This integration plan outlines the supply of domestic water to SEKID residents through a new transmission line connecting to the City of Kelowna's water distribution system from Okanagan Lake. Grant funding was approved with the understanding that the SEKID water board be dissolved and operation/ownership be transferred to the responsibility of the City of Kelowna Water Utility by 2020.

The implementation phase of the water integration plan includes the separation of agricultural and domestic systems in SEKID with all well sources being replaced with lake water options. Planning, contract tenders, and construction are scheduled to begin in 2018 with a tentative completion date in 2021. During this process, water operations, allotments, and rates will continue to be administered as per previous years' practices. Public information on timelines, progress, and implications to rates, supply, metering, and improvement to water quality will all be made available through various publications, notifications, and through the City of Kelowna website at www.kelowna.ca.

The City of Kelowna, on behalf of SEKID, is pleased to present the 2017 Annual Water Quality Report, detailing the health and direction of our water system. If you have any questions about this report or wish to have additional information provided, please contact the SEKID offices at 250-469-8475.

Appendix A

Water Quality Monitoring Parameters

Water Quality Parameters

Turbidity- Health Objective

Turbidity measurements are related to the optical properties of water. Suspended materials such as clay, silt, organic and inorganic particles, plankton, and other microscopic organisms all contribute to Turbidity and can have a negative effect on disinfection techniques.

As per previous years, the Source Water Turbidity remained above 1 NTU for the majority of the year and was marked with Water Quality Advisory. There were also subsequent high Turbidity events (>5 NTU) during freshet that resulted in temporary Boil Water notices being issued (**Figure 6**). The onset of freshet was slightly delayed in 2017 relative to 2016, but with similar Turbidity concentration profiles.

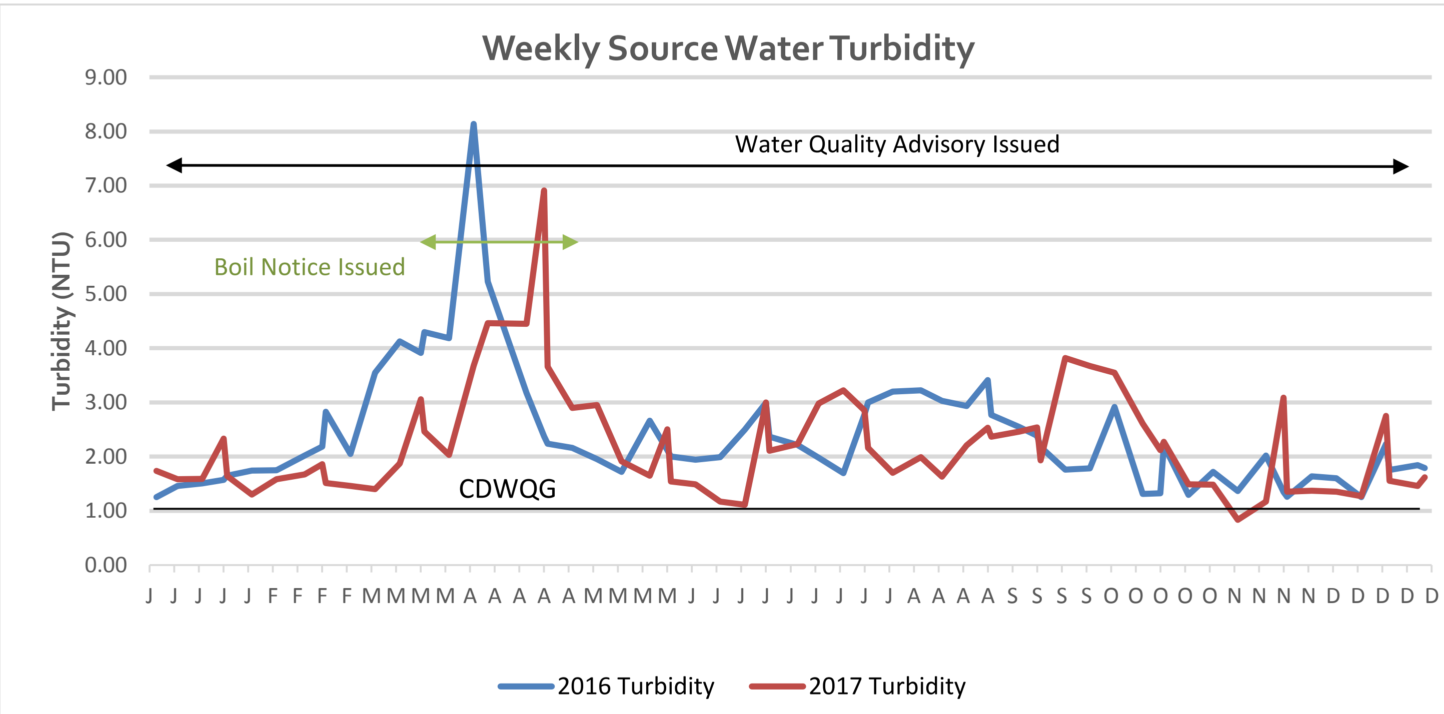


Figure 6: Source Water Weekly Turbidity concentrations

Turbidity (NTU)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	3.18	2.81	4.14	7.06	2.88	4.62	4.08	3.15	3.14	3.94	3.46	2.69
STEWART & SAUCIER RD	2.43	2.77	3.72	6.91	3.14	4.28	4.64	2.93	2.25	2.18	3.32	2.94
DUNSTER RD	2.52	2.67	3.75	7.18	3.45	0.42	0.86	0.23	0.14	1.93	3.17	2.97
CDWQG	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 3. Monthly Turbidity average summary

The monthly distribution Turbidity averages mirrored the Intake Turbidity with the exception of the summer months when Well#2 was used to supplement the water supply (**Figure 7**).

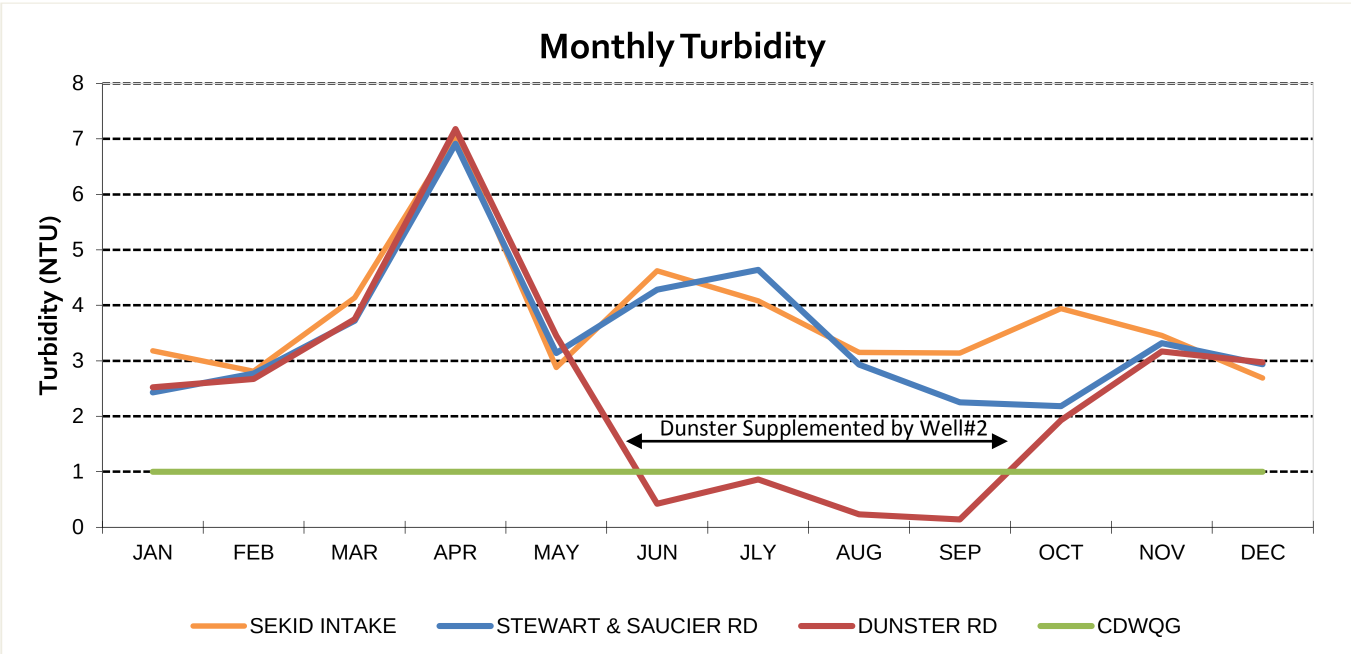


Figure 7. Monthly Turbidity averages

The 5-year Turbidity tracking indicates relative consistency in average Turbidity concentrations (**Figure 8**) and well above the CDWQG.

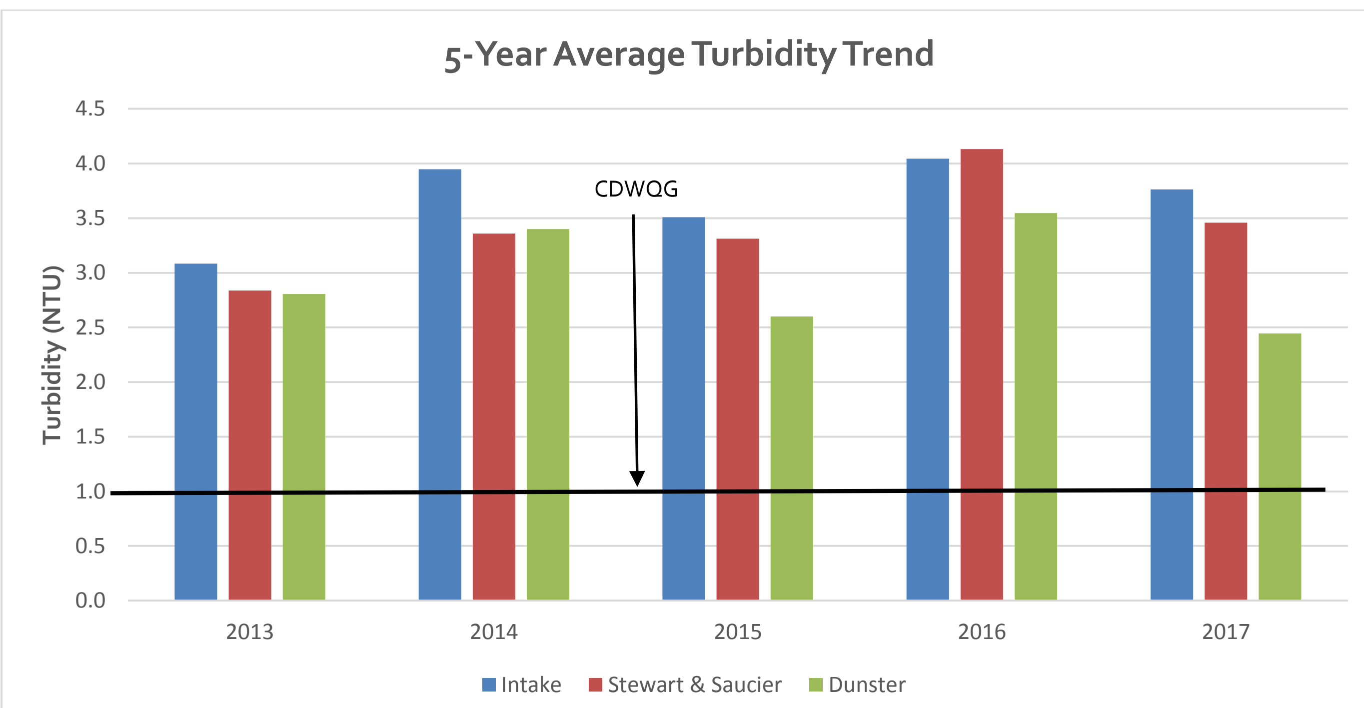


Figure 8. 5-Year Turbidity trend in Source Water

Total Coliform - Health Objective

The coliform group consists of several genera of bacteria belonging to the Enterobacteriaceae family. The detection of these bacteria can be determined with a variety of analytical techniques including membrane filtration. Weekly samples were submitted to and tested by CARO Analytical Services and reported for both Source Water and all distribution sampling points. Increased testing was conducted during the Boil Notification period to assess the risk and ensure that the distribution system remained bacteria free.

Total Coliform was detected in each of the Source Water samples tested throughout the year, but all tested negative for all of the distribution sites (**Table 4**).

	Average (CFU/100ml)	Min (CFU/100ml)	Max (CFU/100ml)	Number of Tests in 2017	# of Tests >100 CFU	2017 % of Tests >100CFU	2016 % of Tests >100CFU
SEKID Intake	238	1	1700	65	25	38	42
Distribution	0	0	0	480	0	0	0

Table 4. Source Water Total Coliform annual summary

Of note, elevated Total Coliform counts did not coincide with the elevated Turbidity events during freshet, but was limited to the summer months between June through September when temperatures were at the highest (**Figure 9**). This pattern was also witnessed during the previous year with similar concentrations.

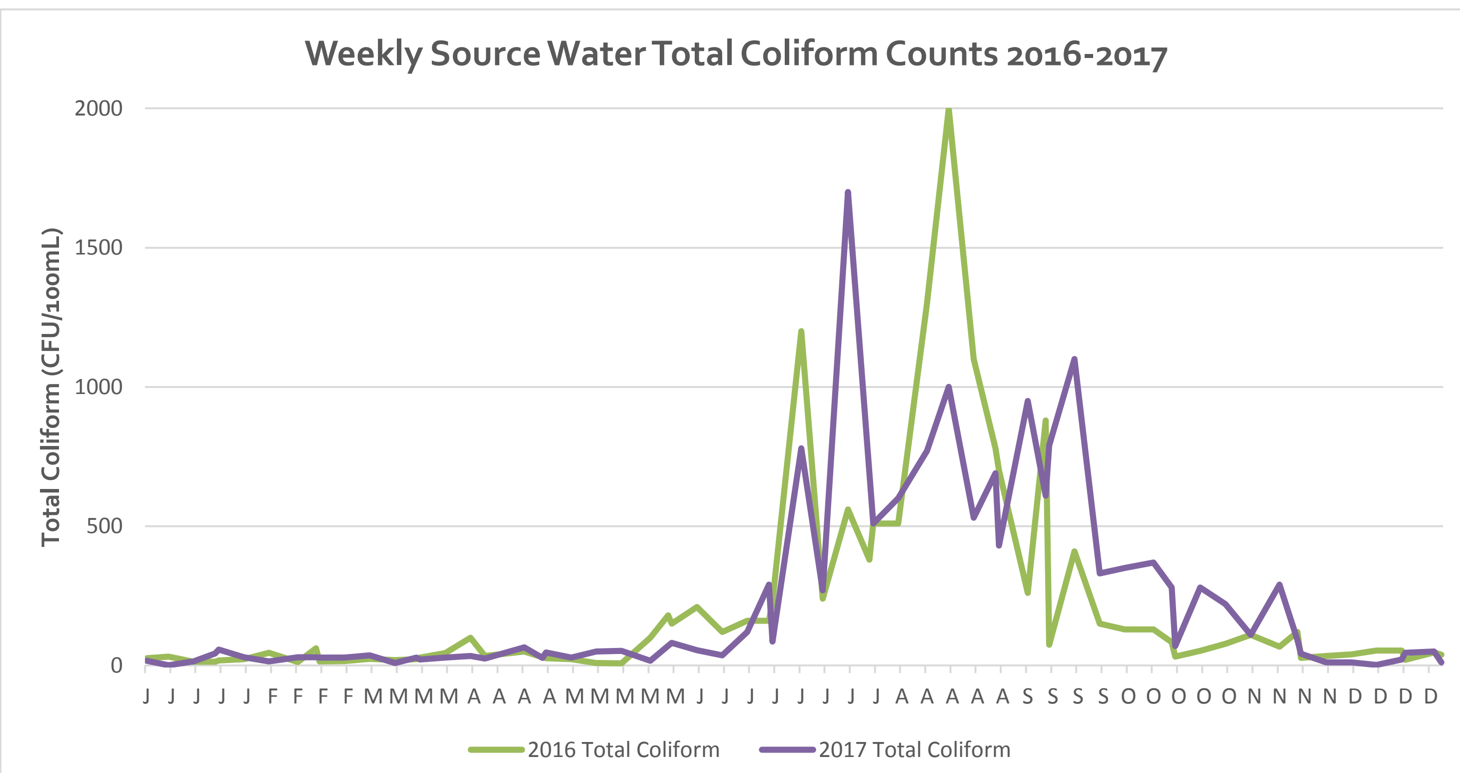


Figure 9. Weekly Total Coliform counts at Intake source

E. coli. - Health Objective

Escherichia coli (E. coli.) is a sub-category within the coliform family and is used as a high risk indicator of harmful pathogens derived from human or animal fecal matter. The principle behind the methodology to detect E. coli. is identical to the Total Coliform method in that samples are filtered and plated on a nutrient Agar base and left to grow over 24 hours before counting of the colonies takes place.

No significant spikes in E. coli. concentrations in the Source Water were noted in 2017 and none within any of the distribution system samples indicating effective treatment neutralization (**Table 5**).

	Average (CFU/100ml)	Min (CFU/100ml)	Max (CFU/100ml)	Number of Tests in 2017	# of Tests >20 CFU	2017 % of Tests >20CFU	2016 % of Tests >20CFU
SEKID Intake	6	0	41	65	4	6	12
Distribution	0	0	0	480	0	0	0

Table 5. E. coli. concentrations in Source and Distribution samples

The presence pattern of E. coli. was not as succinct as Total Coliform, but did tend to peak during summer months and remained fairly low during early freshet period (**Figure 10**).

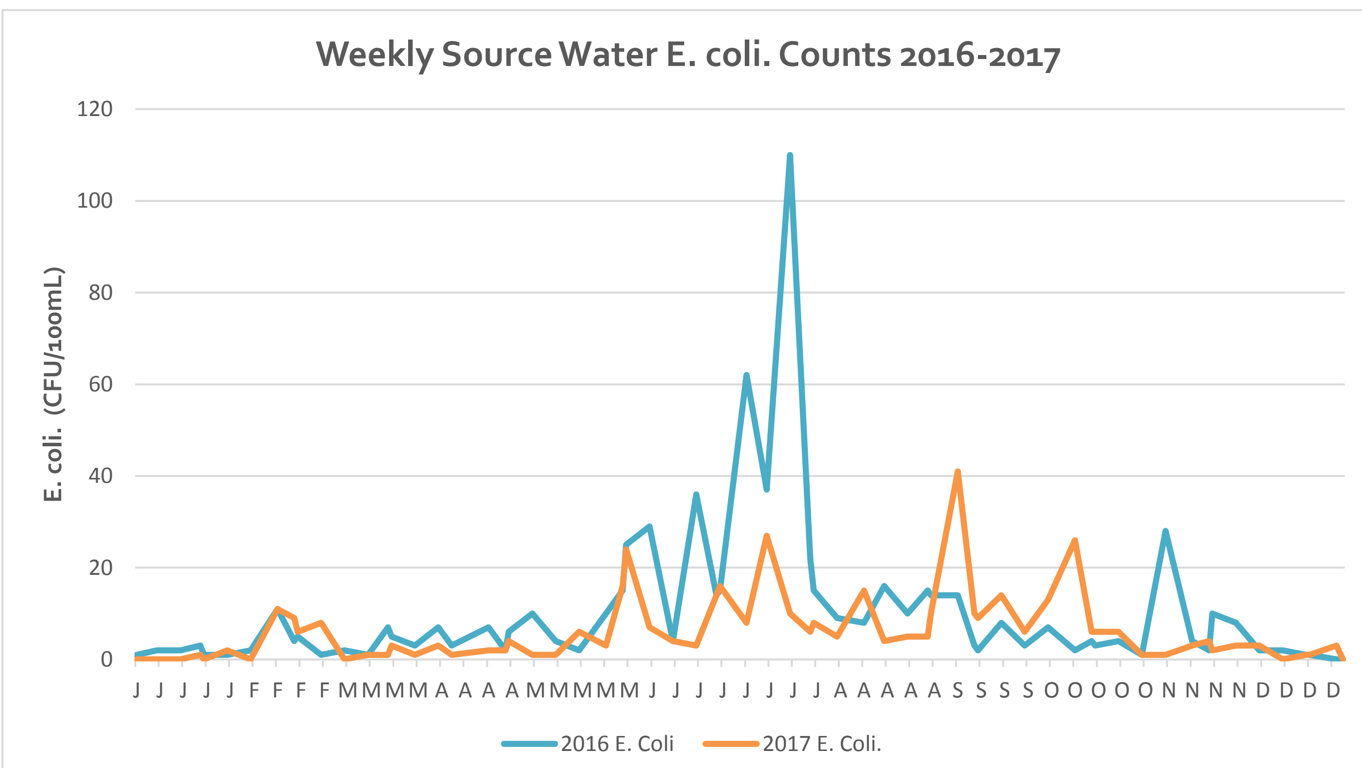


Figure 10. Monthly E. coli. average at Intake source

The average yearly E. coli. concentration continued to decline as per 5-year trend (**Figure 11**).

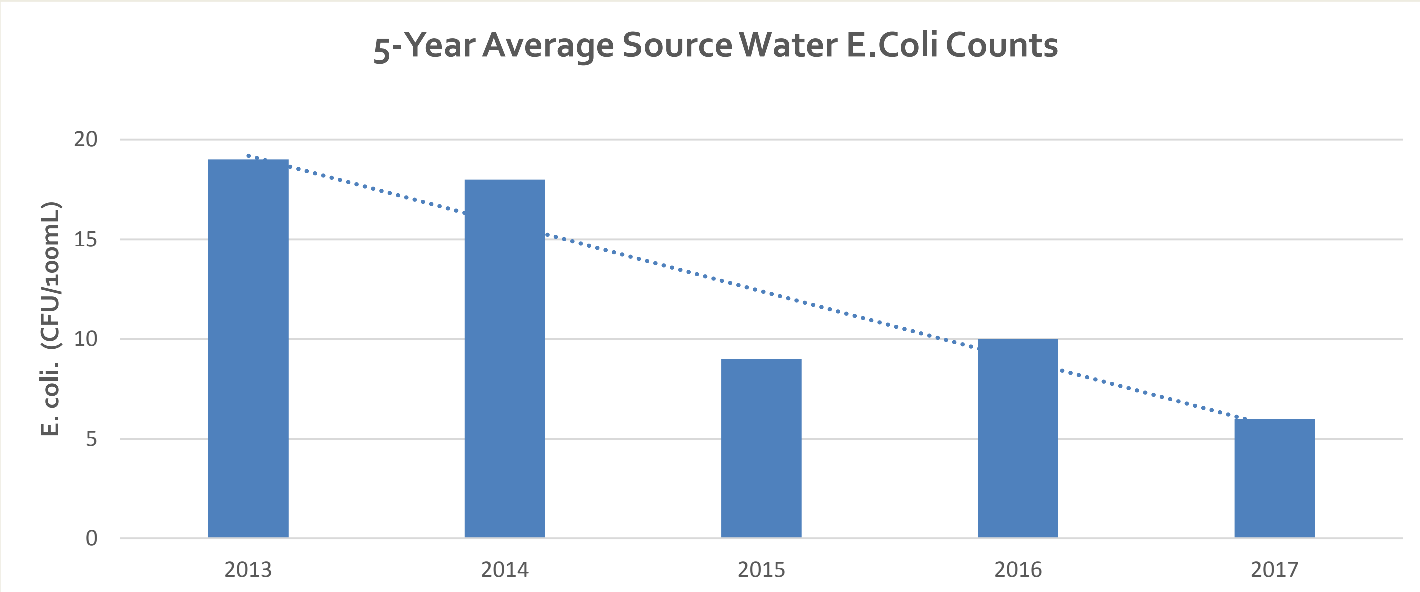


Figure 11. Yearly Average E. coli. counts in the Source Water

pH – Operational Objective

Measurement of pH is one of the most import and frequently used tests in water chemistry. Practically every aspect of water supply and treatment is pH dependent such as acid-base neutralization, water softening, precipitation, coagulation, disinfection, and corrosion control. At a given temperature, the intensity of the acidic or basic character of a solution is indicated by pH or hydrogen ion activity. Natural waters tend to have a pH value in the range of 4-9, and most are slightly basic (7.5-9) due to the presence of bicarbonates and carbonates of the alkali and alkaline earth metals in the environment.

The monthly pH average value for the intake was within the objective range of 7.0-10 while each of the distribution sites were at or just below the threshold (**Table 6, Figure 12**). The overall 5-year trend in pH reflects no distinguishable trend with 2017 values being in line with the overall average pH average (**Figure 13**).

pH												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	7.4	7.3	7.3	7.2	7.0	7.2	7.3	7.4	7.5	7.3	7.7	7.3
STEWART & SAUCIER RD	6.9	7.0	7.0	6.6	6.7	6.7	6.8	6.8	6.9	6.8	7.0	7.1
DUNSTER RD	6.9	7.0	7.0	6.7	6.8	7.4	7.4	7.5	7.5	6.9	7.0	7.1

Table 6. Monthly pH summary

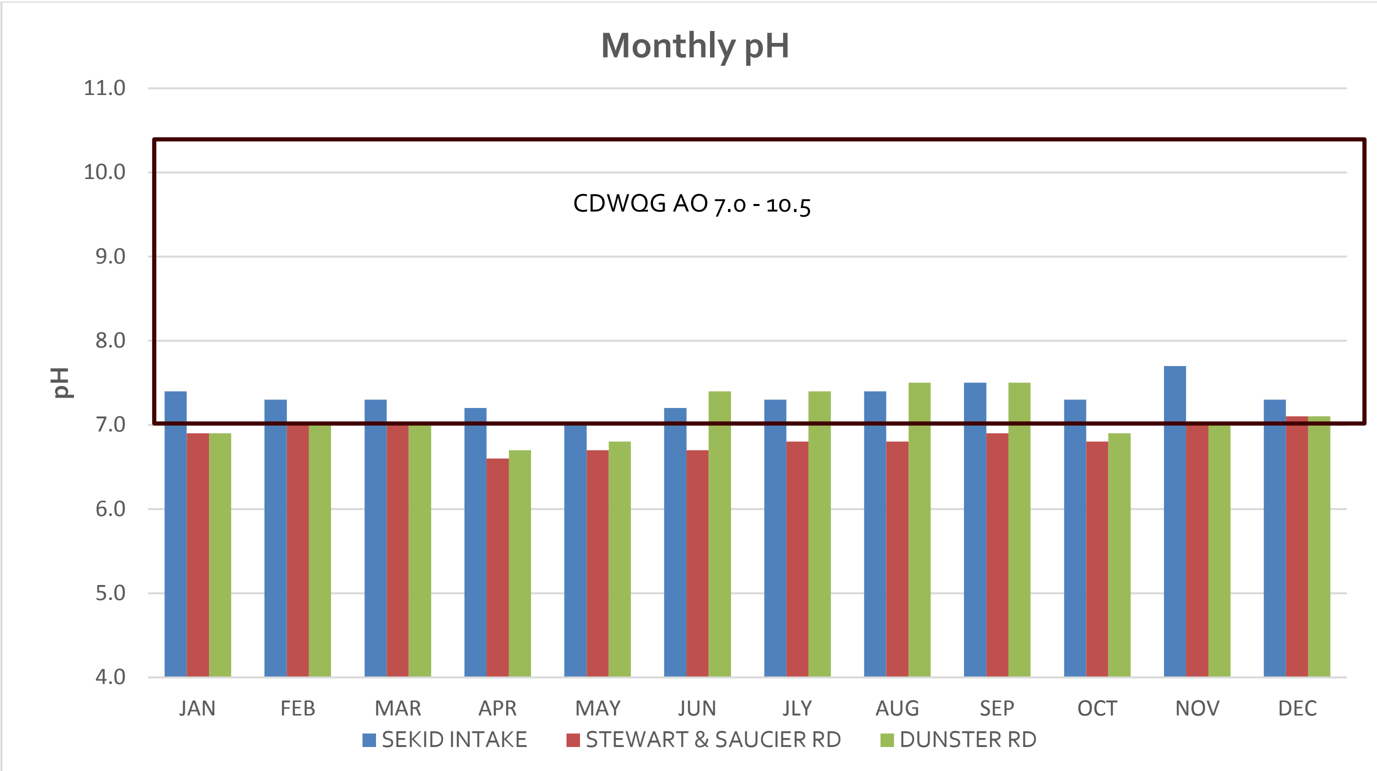


Figure 12. Monthly pH average at Intake source

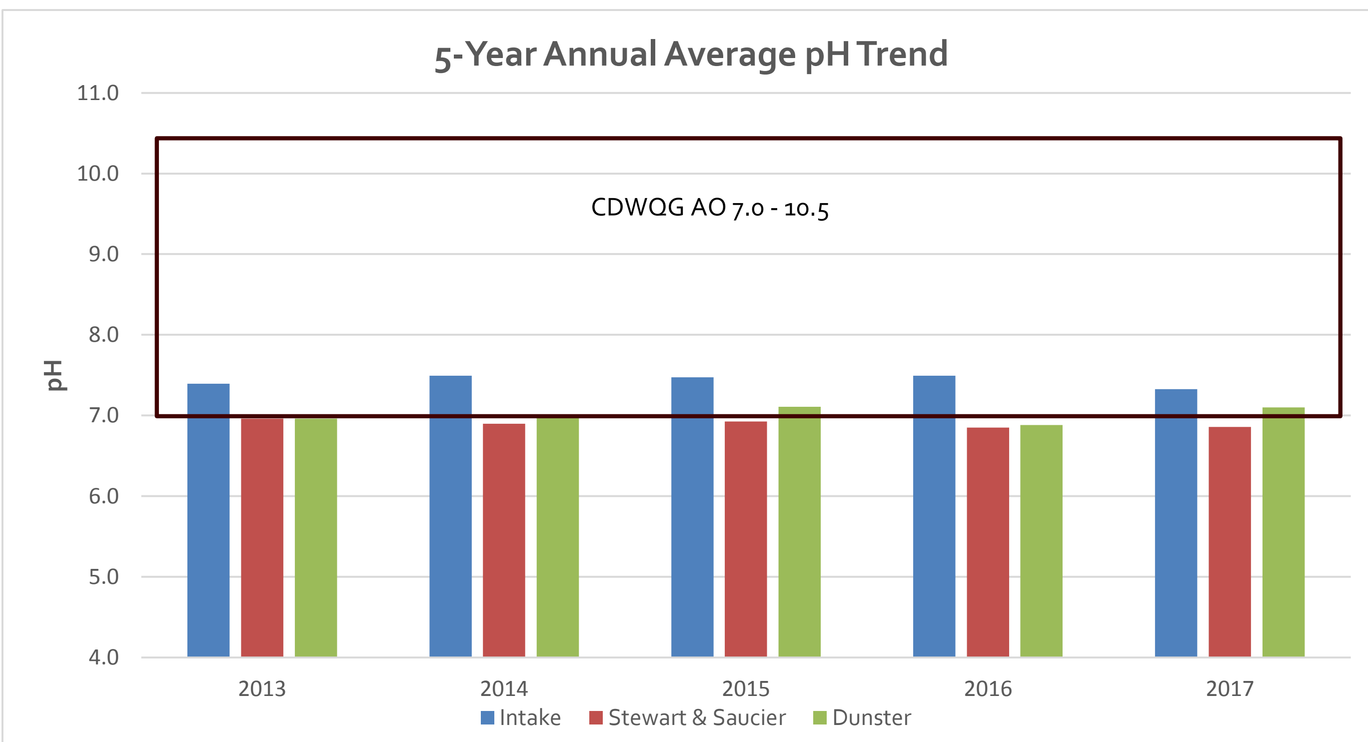


Figure 13. 5-Year pH trend

Color – Aesthetic Objective

Color in surface waters result primarily from the presence of natural organic matter which consists of humic and fulvic acids; both of which cause a yellow-brown color that can be measured by spectrophotometer wavelength. Color is preferred to be kept to a minimum as those compounds are considered precursors in the formation of chlorine disinfection byproducts such as chloroform. Assessment of color data is primarily gauged against an aesthetic objective of 15 color units.

With the influx of significant amount of organic debris from the tributaries during freshet, it was not surprising to see a general increase in the color concentration in the source water beginning in April and continuing through August (**Table 7, Figure 14**). Lower distribution color observed may have been related to water source blending and particulate settling. The 5-year trend indicates a spike in color concentration in 2016 with 2017 returning to the statistical average concentration (**Figure 15**).

TRUE COLOUR (TCU)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	50	48	44	101	95	68	83	73	60	41	36	26
STEWART & SAUCIER RD	19	43	31	43	40	50	54	43	21	18	19	24
DUNSTER RD	20	40	27	45	31	0	12	0	0	14	23	25
CDWQG AO	15	15	15	15	15	15	15	15	15	15	15	15

Table 7. Source Water Color annual summary

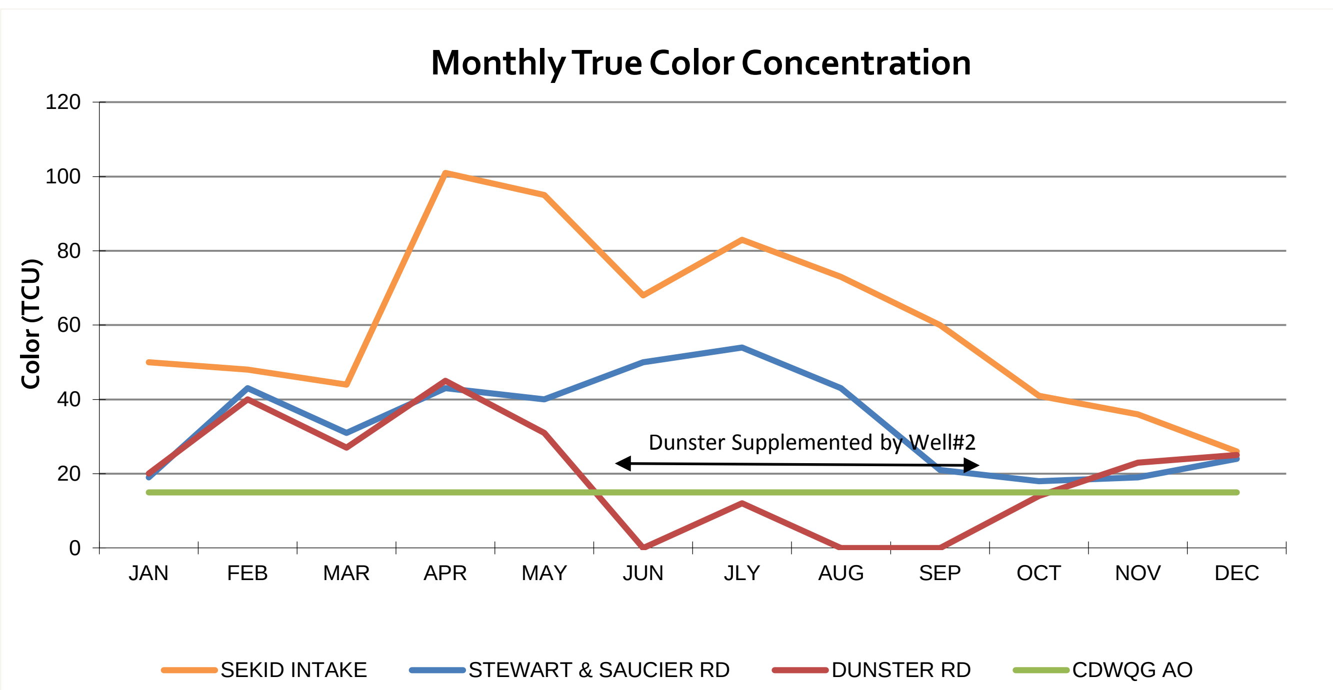


Figure 14. Monthly Color averages

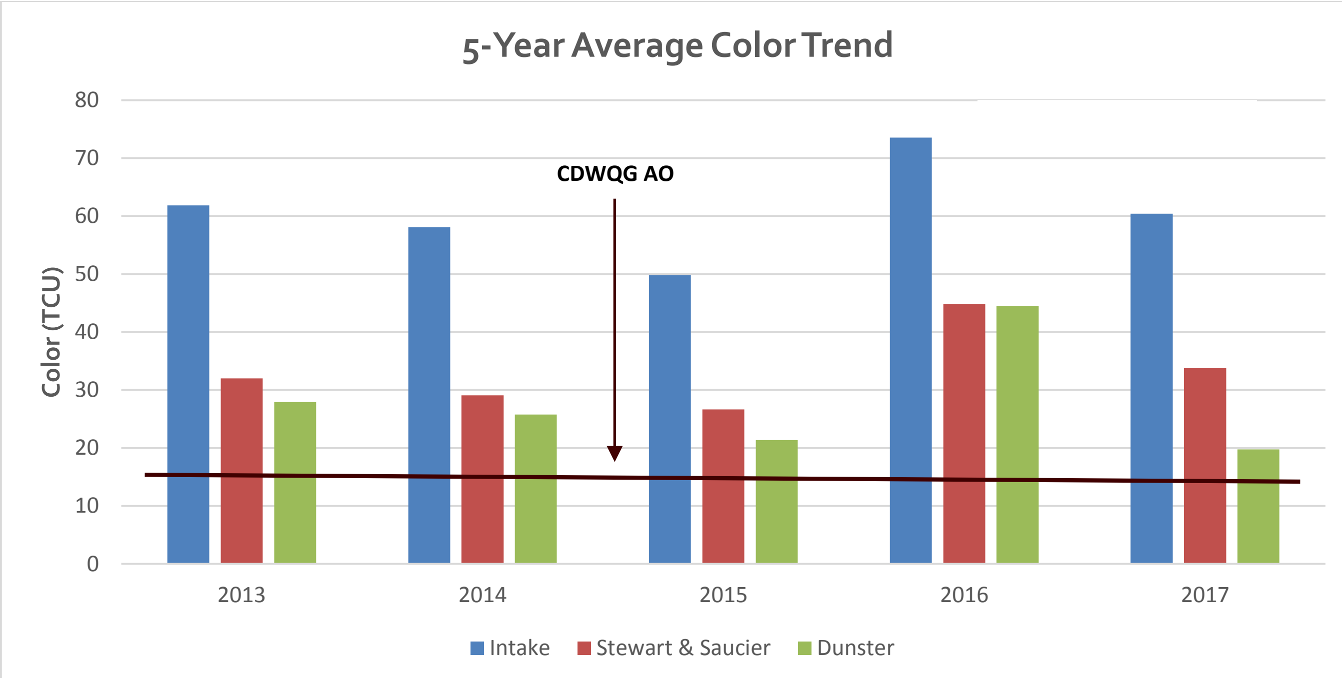


Figure 15. 5-Year Color trend

Temperature – Aesthetic Objective

Temperature is an important factor to consider in water quality as it has influences on several other parameters and can alter the physical and chemical properties of water. Water temperature is considered when determining:

- Metabolic rates of aquatic life
- Dissolved Oxygen
- Conductivity and Salinity
- pH
- Water Density

The SEKID operational objective is to consistently provide water at <15°C, which was maintained 90% of the time (**Table 8, Figure 16**). The temperature is primarily regulated by weather and ambient conditions and is not altered in any way by treatment or through distribution.

Temperature (°C)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	2.0	2.5	2.0	3.5	11.0	13.5	17.0	15.5	15.0	5.5	3.0	2.0
STEWART & SAUCIER RD	3.5	3.5	3.5	6.5	11.0	13.0	16.0	16.0	17.5	9.5	6.0	4.5
DUNSTER RD	3.5	4.0	3.5	6.0	11.0	11.5	11.5	11.5	10.5	11.5	7.0	5.0
CDWQG AO	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0

Table 8. Water Temperature annual summary

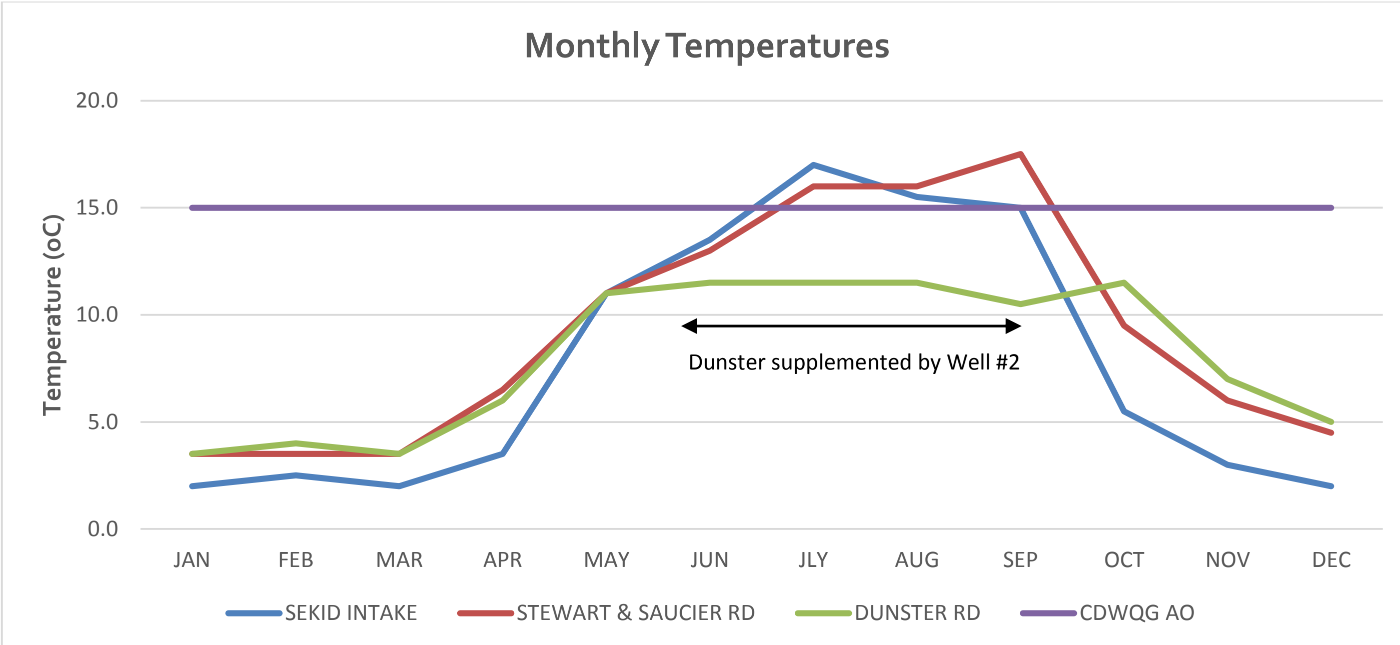


Figure 16. Monthly Water Temperature average

There is no distinguishable temperature trend in the 5-year averages (**Figure 17**).

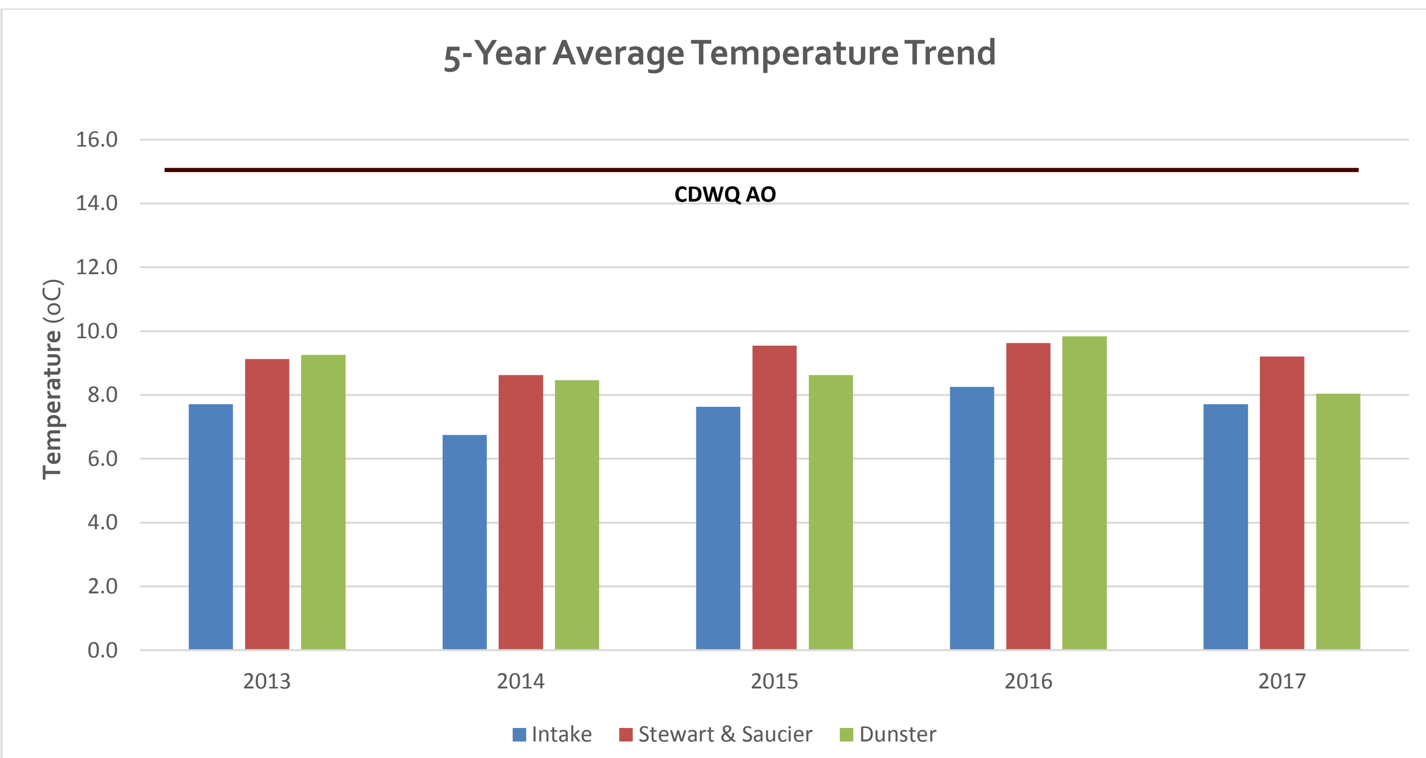


Figure 17. 5-Year Temperature trend

Iron – Aesthetic Objective

Iron (Fe) is a naturally occurring element found in many natural mineral deposits and has the ability to leach into groundwater and surface water sources in various forms. Consuming tap water generally contributes 5% of the daily dietary requirement for iron intake (EPA, 2010). Although not considered to be hazardous to human health, it is linked to a disagreeable metallic taste, leaves reddish brown stains on fixtures, and can lead to the growth of Iron reducing bacteria in pipes, which produce a biofilm and subsequent unpleasant odors.

The Canadian Drinking Water Quality Guidelines has a stated AO concentration limit of 0.3 mg/L, at which point the Iron can cause taste and staining issues. Iron concentrations have been found to be over the AO limit from all upland sources throughout the year with the exception of when blended with well water sources, which have been found to be naturally very low in the area (**Table 9, Figure 18**). Chlorination treatment has not been found to impact the removal of Iron. The 5-year average monitoring does not indicate any trend in Iron concentration (**Figure 19**).

Iron (mg/L)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	0.6	0.8	0.9	0.4	0.3	0.5	0.6	0.4	0.4	0.5	0.5	0.6
STEWART & SAUCIER RD	0.6	0.8	0.9	0.6	0.3	0.5	0.6	0.4	0.4	0.4	0.5	0.6
DUNSTER RD	0.6	0.8	0.9	0.5	0.4	0.0	0.2	0.0	0.0	0.3	0.6	0.6
CDWQG AO	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Table 9. Monthly Iron Concentrations

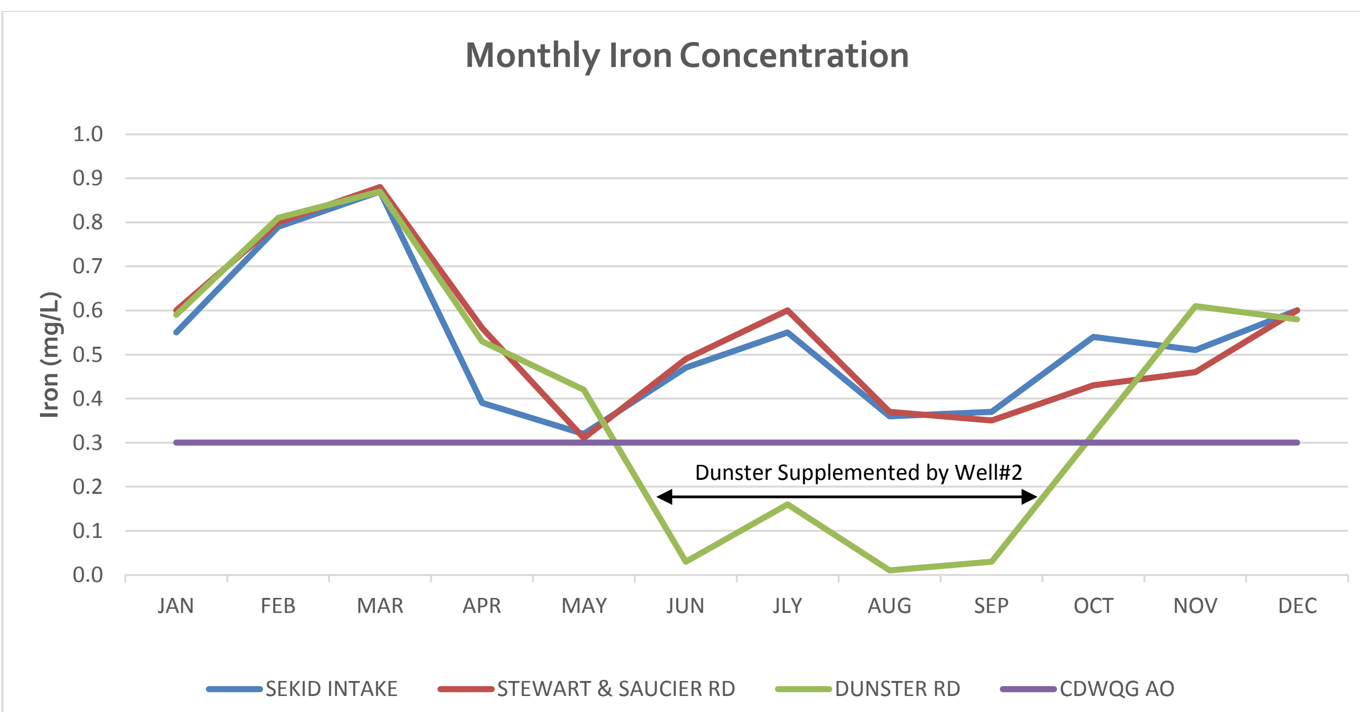


Figure 18. Monthly Iron Concentration

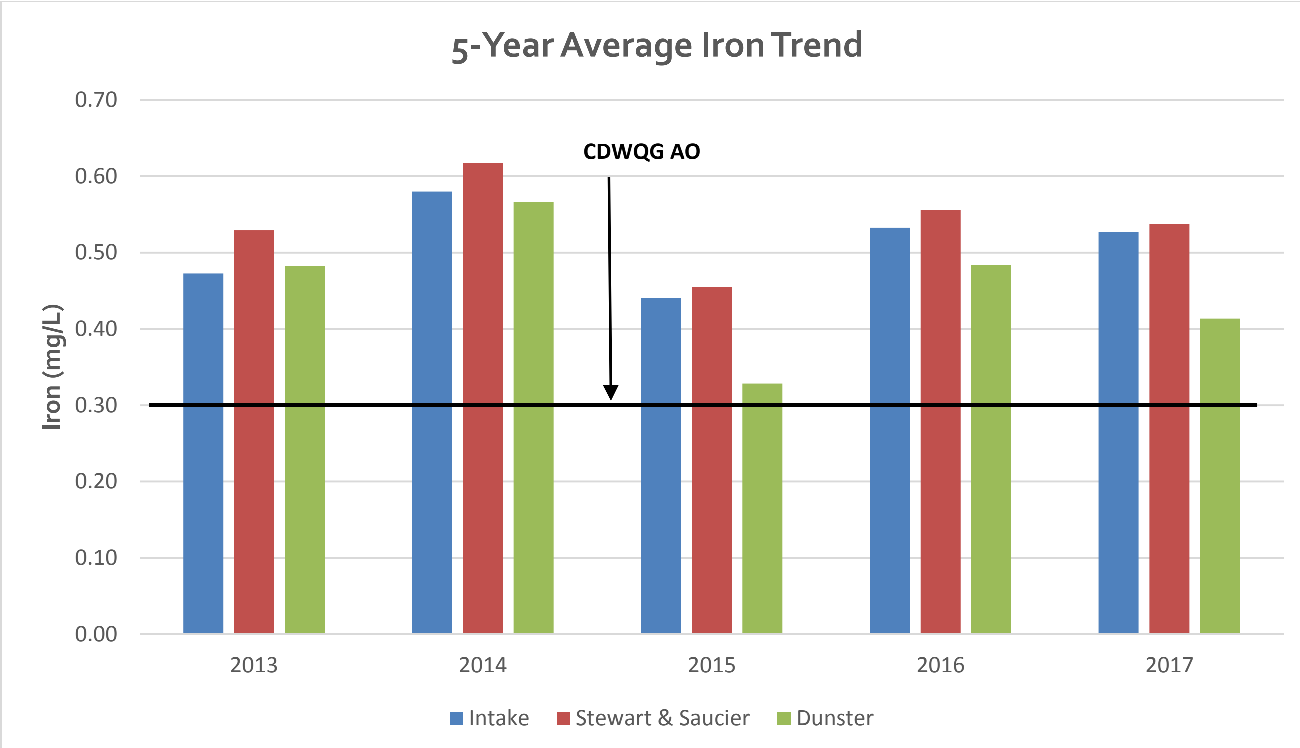


Figure 19. 5-Year Iron Concentration tracking

Ammonia – Operational Objective

Ammonia is a colorless, gaseous compound of hydrogen and nitrogen that is highly soluble in water. It is a biologically active compound found in most natural waters as a normal biological degradation product of nitrogen rich organic material.

There is no maximum health or aesthetic water quality guideline associated with this compound, however, it has been known that Ammonia (NH_3) is toxic to fish and the toxicity increases with increasing pH and temperature of the water. Ammonia is also monitored as an indicator of Fecal contamination byproduct and potential fertilizer product infiltration into water sources in agricultural areas. Ammonia tended to peak during early freshet (**Table 10, Figure 20**) concurrently with an increase in Color concentrations, but not to concerning levels to indicate potential point source contamination.

Ammonia (mg/L)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	0.51	0.18	0.07	0.62	0.70	0.51	0.10	0.47	0.28	0.36	0.15	0.06
STEWART & SAUCIER RD	0.06	0.06	0.05	0.49	0.49	0.42	0.17	0.37	0.17	0.33	0.18	0.03
FIELD ROAD RESERVOIR	0.12	0.09	0.01	0.79	0.42	0.46	0.22	0.24	0.31	0.14	0.11	0.28

Table 10. Monthly Ammonia Concentrations

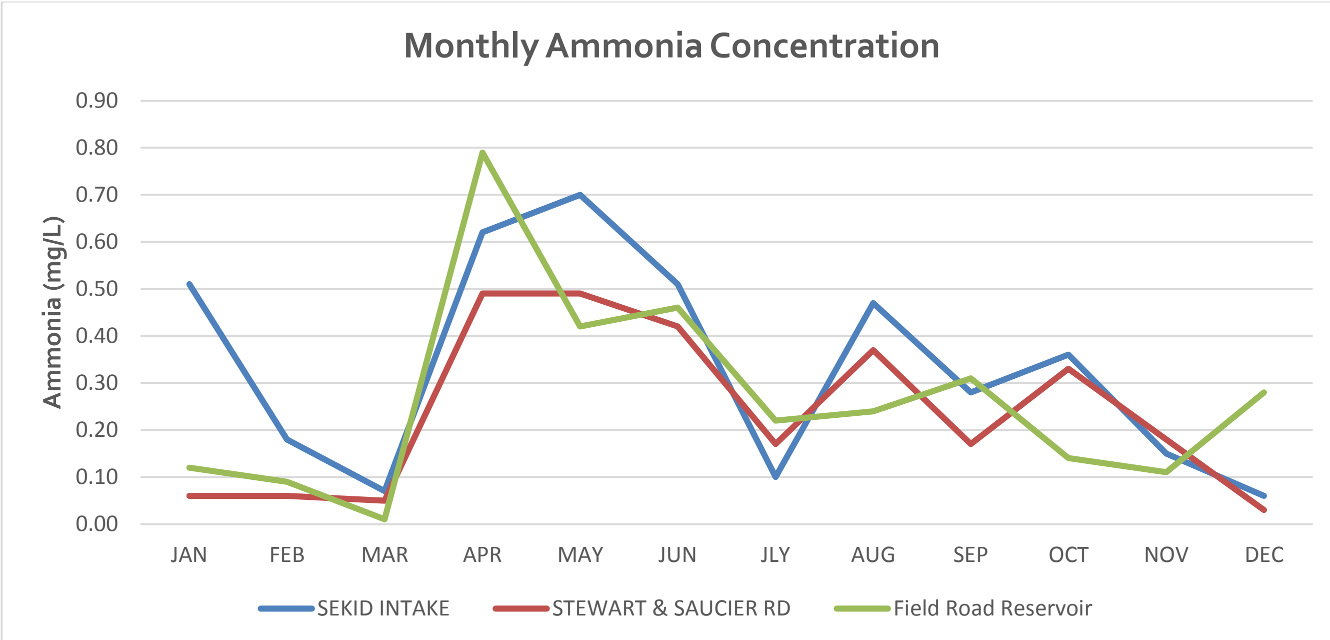


Figure 20. Monthly Ammonia Concentrations

The 5-year trend saw an upswing in concentrations over the past 2 years, but generally in line with 2013 levels (**Figure 21**).

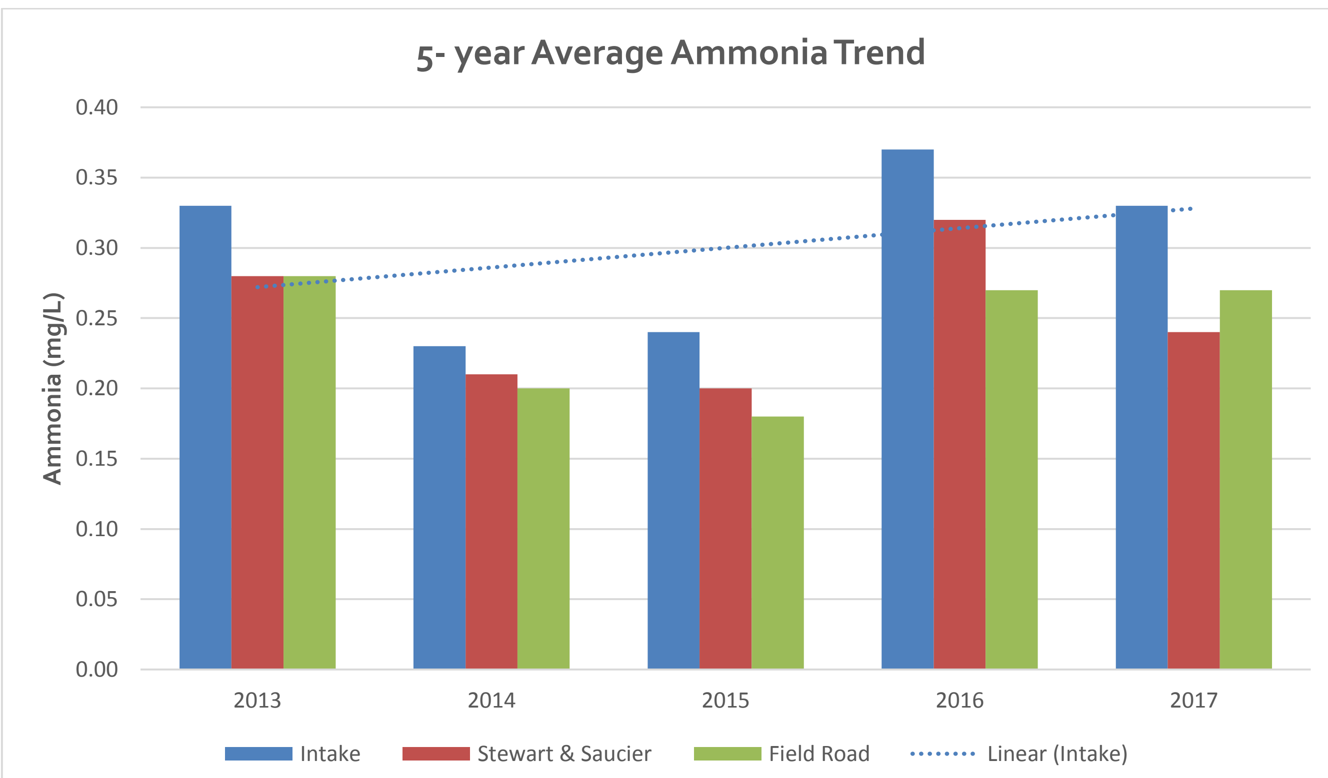


Figure 21. 5-Year Ammonia Concentration tracking

Phosphorus – Operational Objective

Phosphorus is a vital nutrient necessary for the growth of plants and animals. It can be found in various compounds, but is primarily detected in drinking water in the organic form of Ortho-phosphate (PO_4). Although naturally occurring in open water sources, an increase in phosphorus concentrations can lead to algae and weed growth (eutrophication), which uses up large amounts of oxygen and can result in fish and aquatic organism death. Increased levels may also indicate the presence of pesticides and fertilized decomposition in water sources.

Similar to Ammonia, there is no maximum health or aesthetic water quality guideline associated to concentration. Ortho-Phosphate tended to peak with freshet (**Table 11, Figure 22**), but not to concerning levels that would be indicative of point source contamination. Most monthly concentrations ranged between 0.025-0.1 mg/L, at which level plant growth is typically stimulated, but not to the point of excessive eutrophication. However, these concentrations do contribute to the overall increase of Phosphorus baseline concentrations in Okanagan Lake.

Ortho-Phosphate (mg/L)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	0.09	0.04	0.08	0.06	0.12	0.10	0.02	0.04	0.07	0.10	0.04	0.03
STEWART & SAUCIER RD	0.08	0.07	0.05	0.09	0.12	0.06	0.01	0.03	0.05	0.06	0.08	0.03
FIELD ROAD RESERVOIR	0.04	0.07	0.07	0.07	0.10	0.06	0.01	0.01	0.05	0.02	0.11	0.03

Table 11. Monthly Ortho-Phosphate concentrations

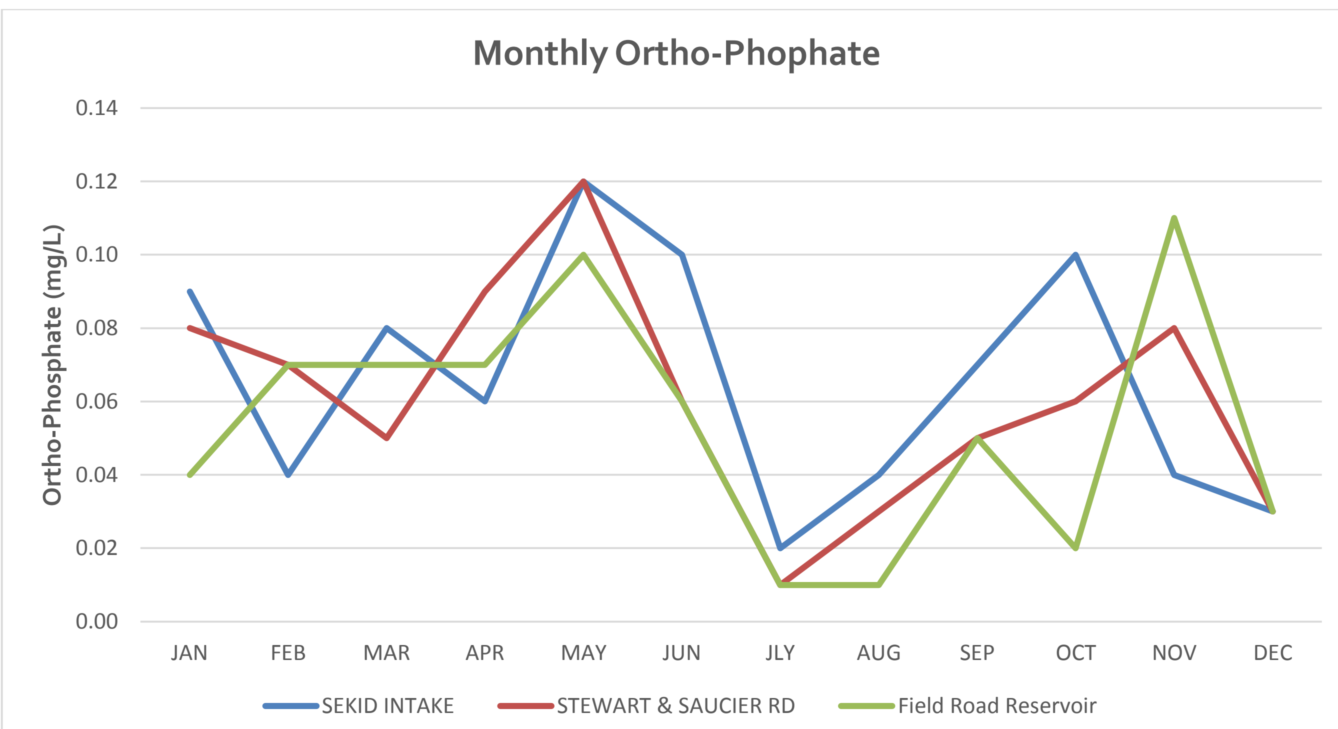


Figure 22. Monthly Ortho-Phosphate concentrations

The 5-year monitoring trend saw a moderate decrease in concentrations over the past 4 years, but in line with 2013 levels (**Figure 23**).

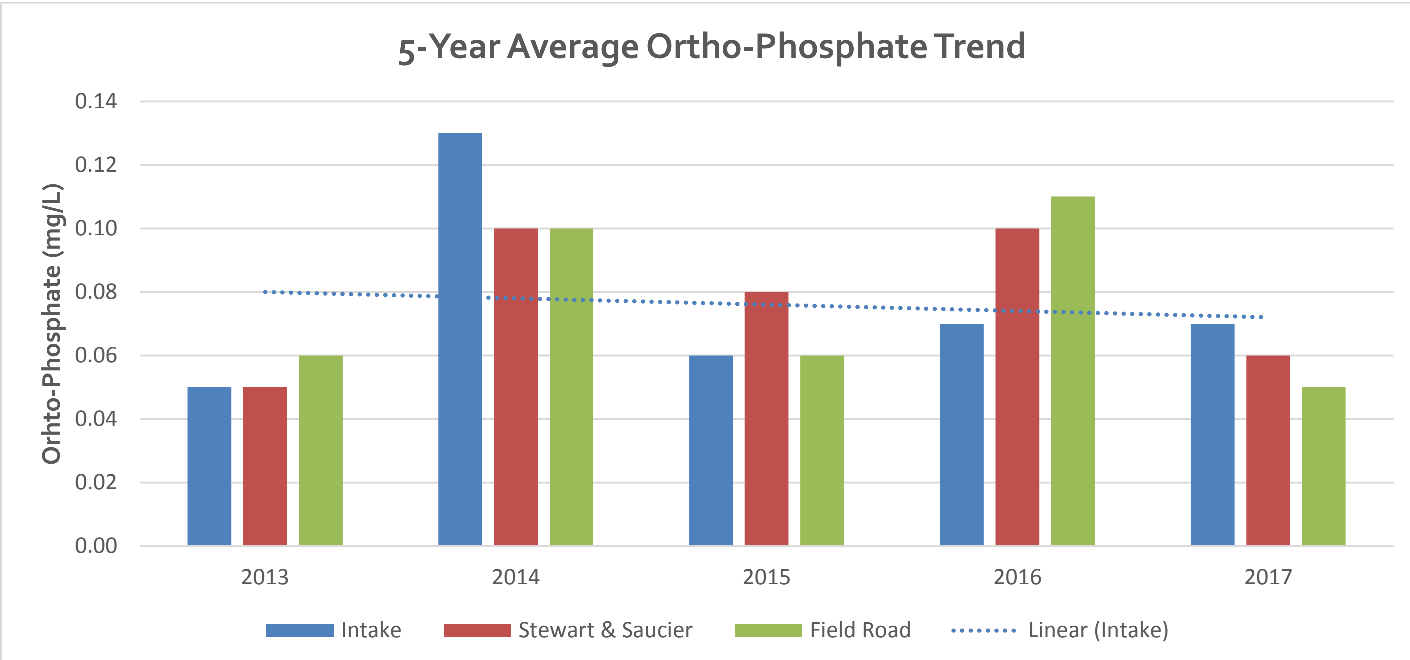


Figure 23. 5-Year Ortho-Phosphate Concentration tracking

Conductivity – Operational Objective

Conductivity is a general indicator to the degree of water mineralization and is used as both a short and long term monitoring tool for water quality trends. Minerals that are dissolved in water have the capacity to carry electrical current, are easily measured, and can note rapid changes during water quality events. Detecting these changes can be vital to being able to quickly respond to immediate issues as well as detect long term changes in upland water quality over time. Conductivity is also proportional to the hardness scale of water and can determine the amount of treatment chemicals that need to be added.

Conductivity tended to be at lowest concentrations during snow melt and high flow conditions (**Table 12, Figure 24**). From Source to Tap, the distribution values consistently mirrored each other.

Conductivity (uohm/cm)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	110	109	115	64	88	52	46	47	56	85	194	134
STEWART & SAUCIER RD	114	118	113	96	98	56	46	46	57	84	179	174
FIELD ROAD RESERVOIR	123	124	127	91	121	62	66	53	60	81	173	144

Table 12. Monthly Conductivity concentrations

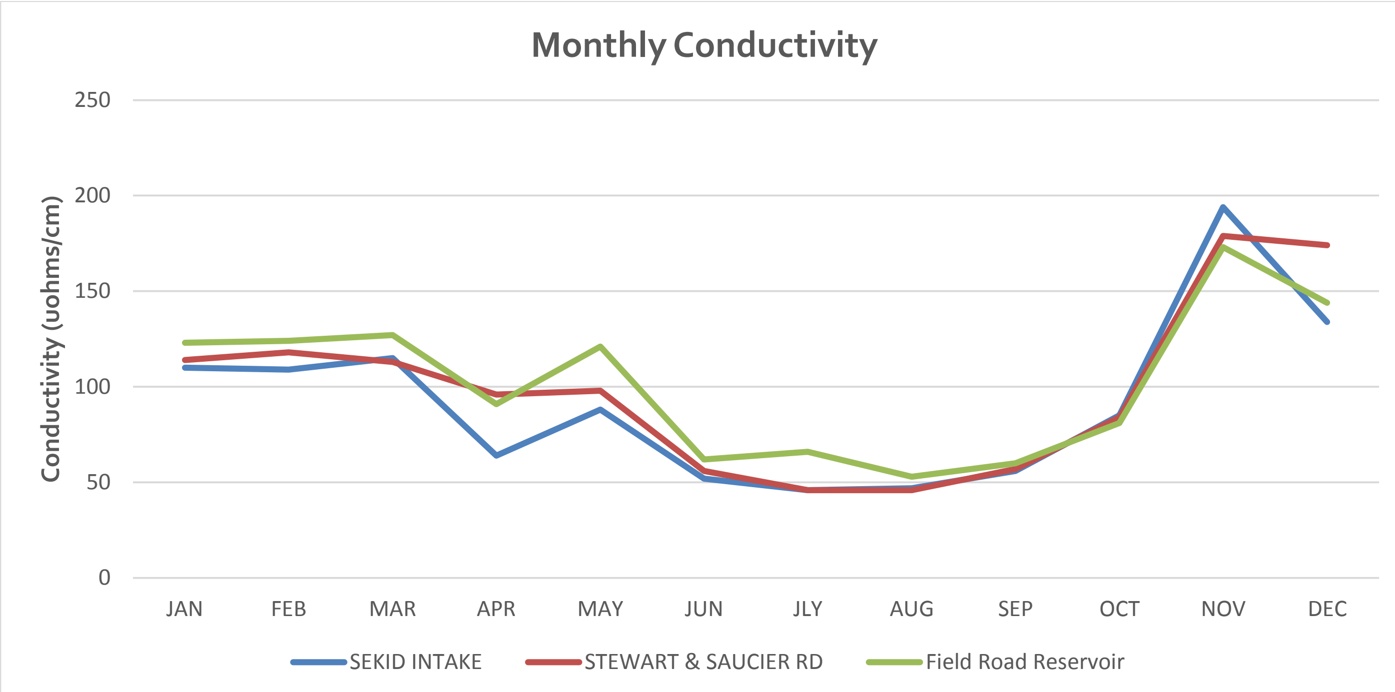


Figure 24. Monthly Conductivity Concentration tracking

The 5-year average for Source Water and distribution sites remained statistically similar with no significant trends (**Figure 25**).

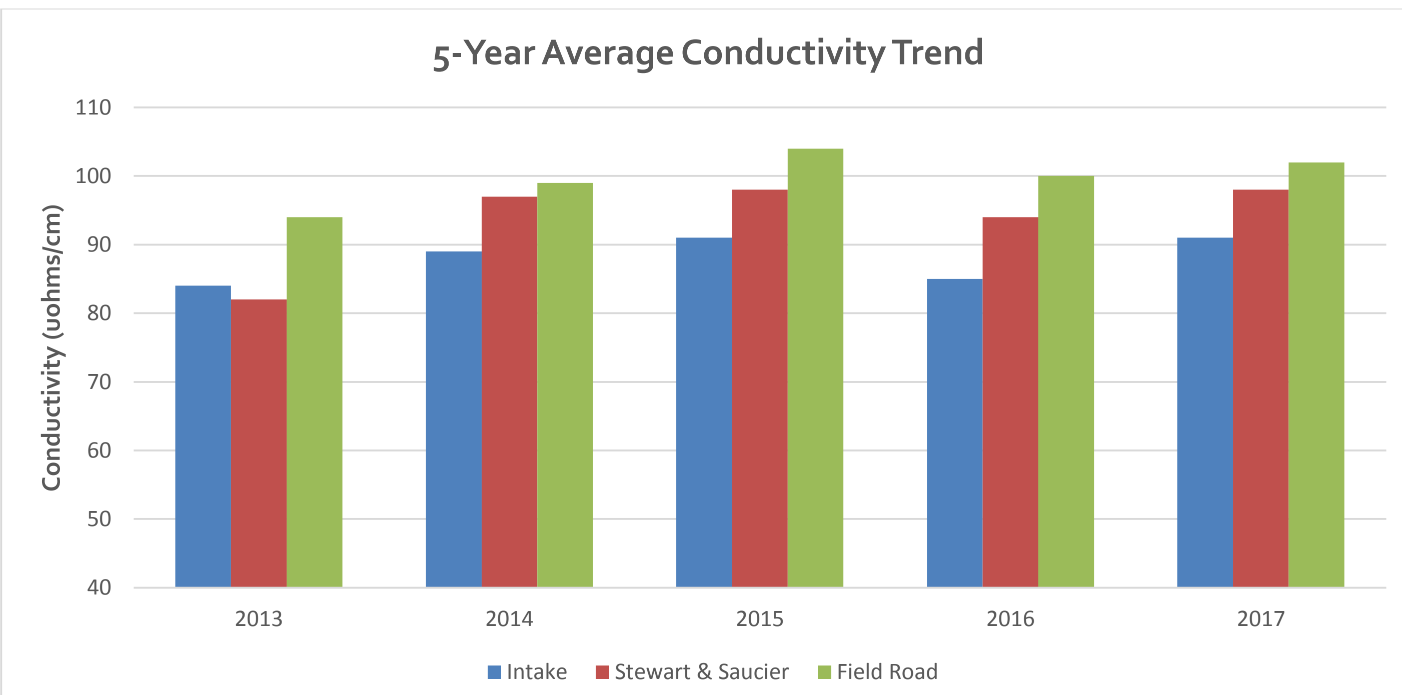


Figure 25. 5-Year Conductivity Concentration tracking

Hardness – Aesthetic Objective

Hardness is measured by the concentrations of dissolved Calcium and Magnesium minerals in the water and determines the extent of water scaling or corrosion potential. Hardness levels between 80-100 mg/L provide an acceptable balance between corrosion and incrustation and are used as operational objectives. Water with a Hardness concentration less than 100 mg/L is typically considered Soft while concentrations in excess of 500 mg/L is considered Very Hard with a sliding scale in-between. None of the SEKID applied water treatment has a direct impact on the Hardness found in the water system.

The SEKID water is considered to be on the Soft side of the Hardness scale with values remaining below 100 mg/L for the majority of the year. Similar to Conductivity, Hardness concentrations were in proportion to seasonal flows and remained consistent through the distribution system (**Table 13, Figure 26**).

Hardness (mg/L)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
SEKID INTAKE	56	57	59	47	50	30	29	24	31	47	102	75
STEWART & SAUCIER RD	55	54	56	51	48	29	28	24	28	40	89	64
Field Road Reservoir	52	54	51	46	50	28	25	23	30	40	80	72
CDWQG AO	100	100	100	100	100	100	100	100	100	100	100	100

Table 13. Monthly Hardness concentrations

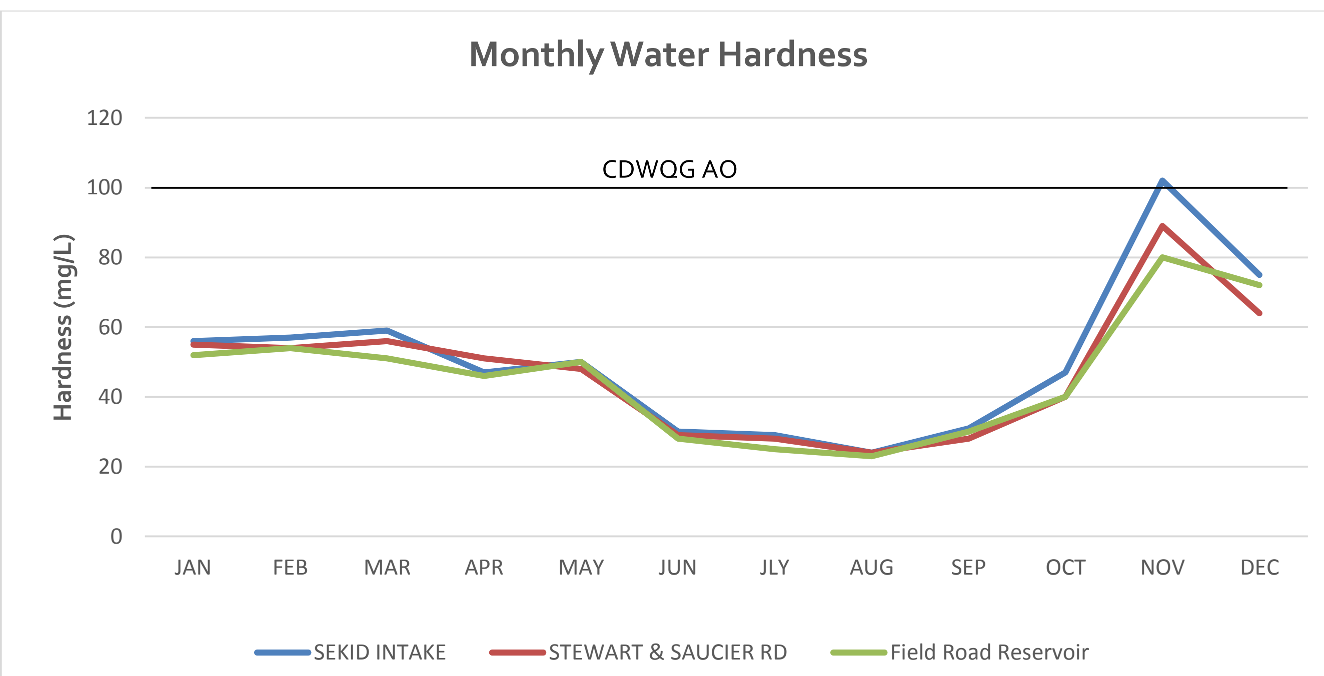


Figure 26. Monthly Hardness concentrations

The 5-year average for source water and distribution sites remained statistically similar with a slight increase in 2017 (**Figure 27**).

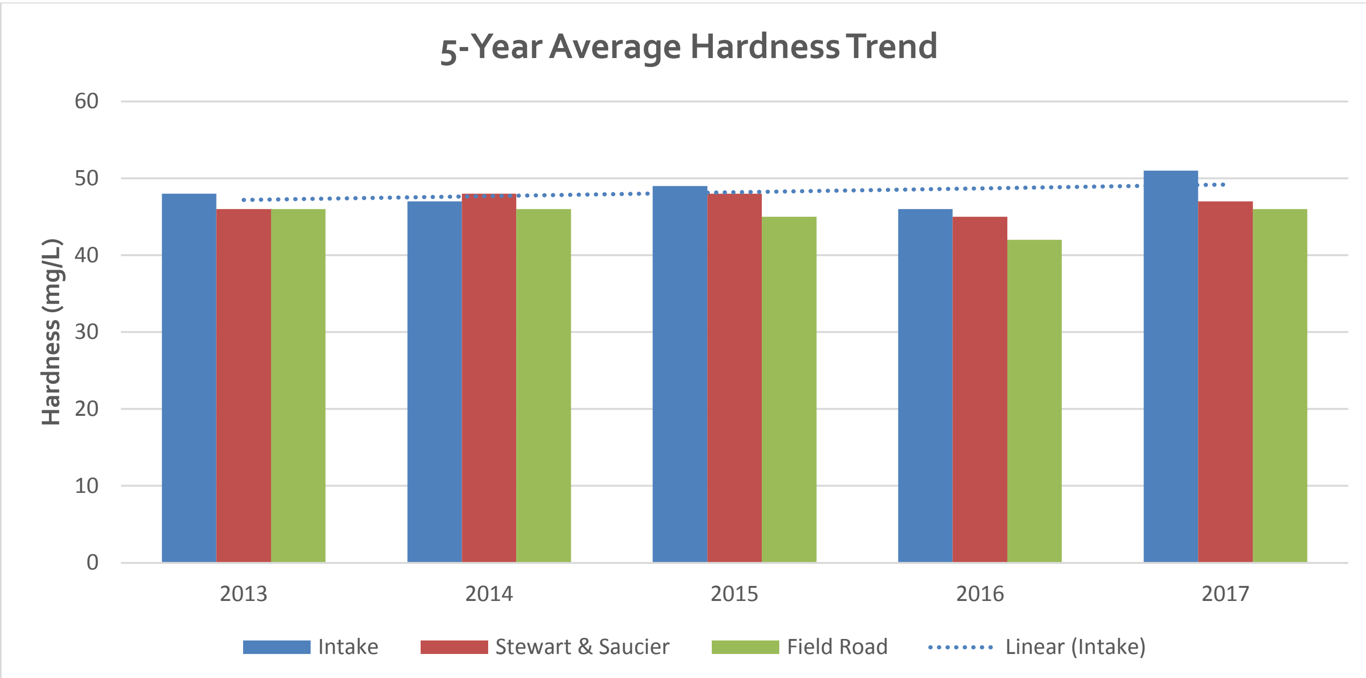


Figure 27. 5-Year Hardness Concentration tracking

Nitrates – Health Objective

Nitrate (NO3-N) is an inorganic compound that occurs under a variety of conditions in the environment, both naturally and synthetically. Nitrate is one of the most common groundwater contaminants in rural areas and is regulated in drinking water due to a health concerns associated with methemoglobinemia and as an indicator of other serious contaminants such as bacteria or pesticides. Nitrate in groundwater primarily originates from fertilizers, septic systems, and manure storage or spreading operations.

Nitrates are monitored in the SEKID well systems on a monthly basis (if in operation) and compared to the CDWQG limits. Nitrate concentrations have been found to be below health guidelines and statistically consistent throughout the year (Table 14, Figure 28). There are no current indications of point source contamination.

Nitrates (NO_3-N) mg/L												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
Johnson Well	5.1	5.4	5.1	4.8	5.0	5.1	5.9	5.2	4.9	5.0	5.0	5.1
Well#2						6.8	6.3	6.9	6.3	5.0		
CDWQG MAC	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Table 14. Monthly Nitrate concentrations

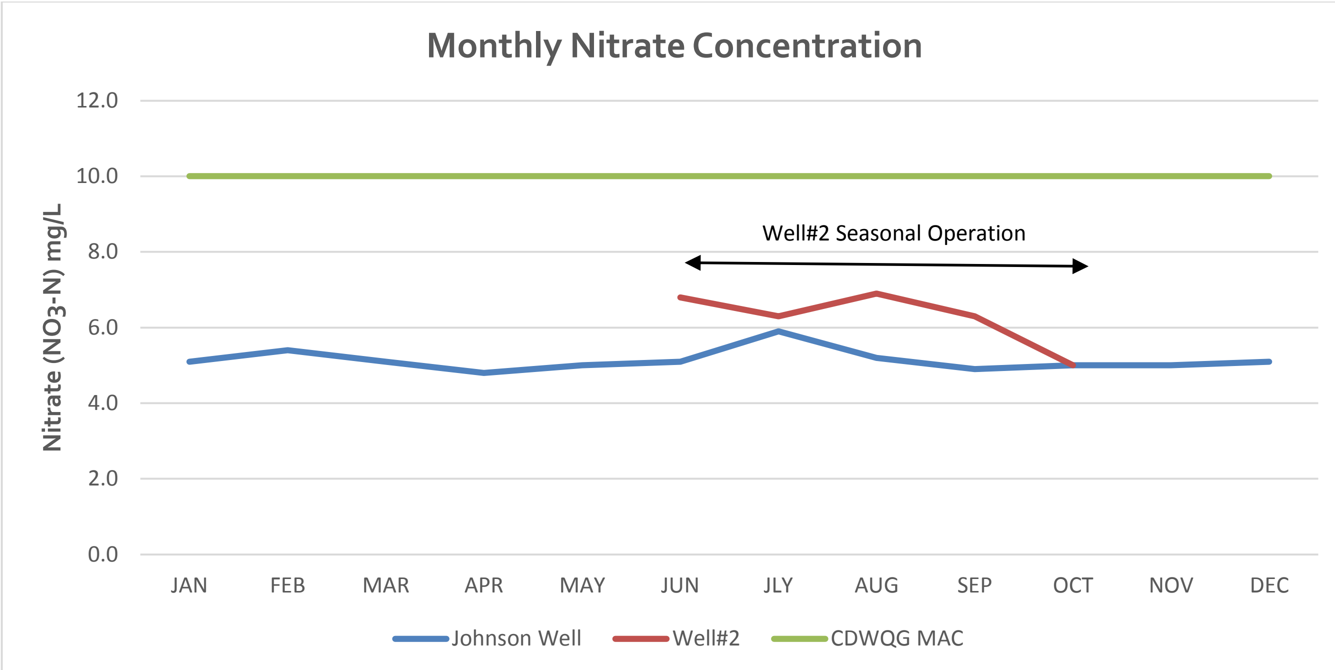


Figure 28. Monthly Nitrate concentrations

The 5-year average for the well sites remained statistically similar with a minor increasing concentration trend at the Johnson Road Well site (**Figure 29**).

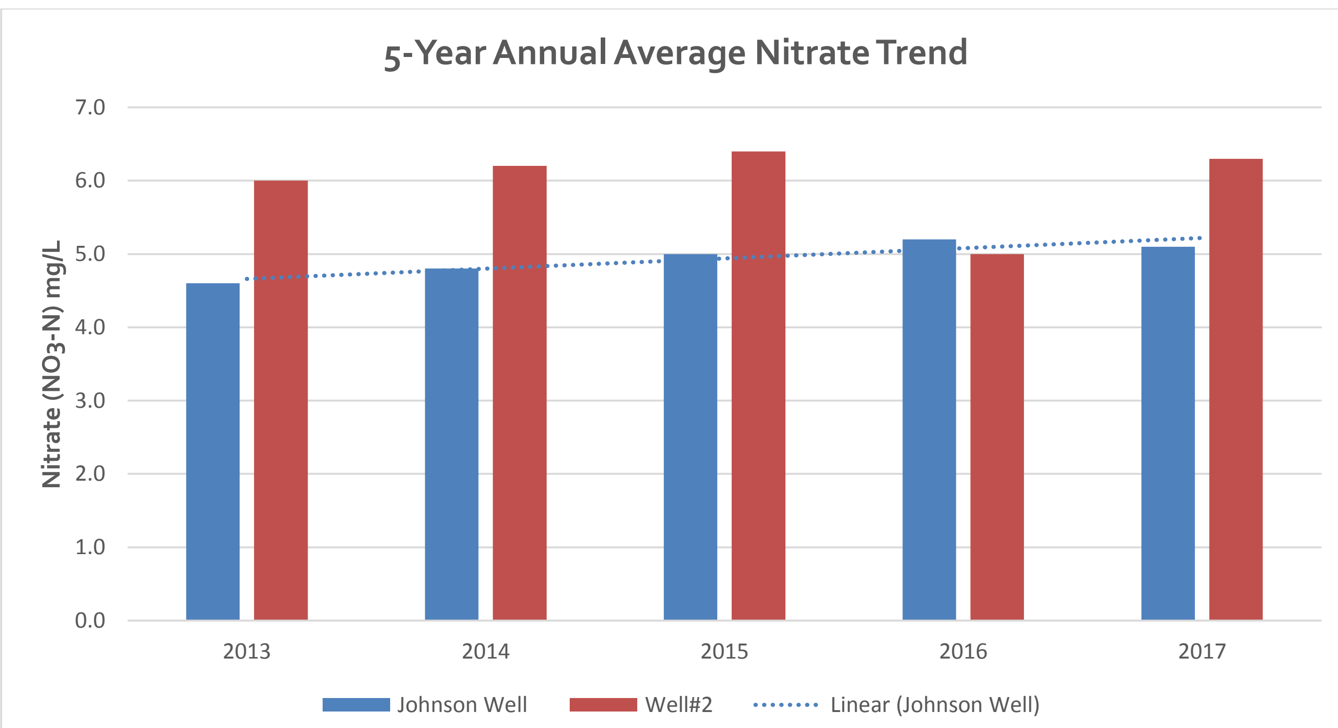


Figure 29. 5-Year Nitrate Concentration tracking

Free Chlorine – Operational Objective

Chlorine (Cl^-) gas is introduced to the source water at the Hydraulic Intake as the sole disinfection treatment to meet the criteria of 3 and 4-log reduction of bacteria and pathogens. Free Chlorine is primarily monitored relative to the Total concentration of Chlorine applied as that is the form of chlorine available to neutralize pathogens. Concentrations are closely monitored and alarmed through the SCADA on-line data collection system as well as tested in the field to verify instrument readings.

Free Chlorine is monitored immediately post treatment as well as 8 distribution points with an operational objective to maintain a 0.20 mg/L chlorine residual through the entire system. Three representative sampling points are presented from dosing point, distribution mid-point, and to end of the distribution line. In order to achieve adequate chlorine contact time and to ensure that chlorine residual remains present in the system, a high initial dose of chlorine is required and reflected in the Intake post-treatment measurements. Dosing is typically increased during freshet to accommodate high organic material content in the water and subsequent higher chlorine demand.

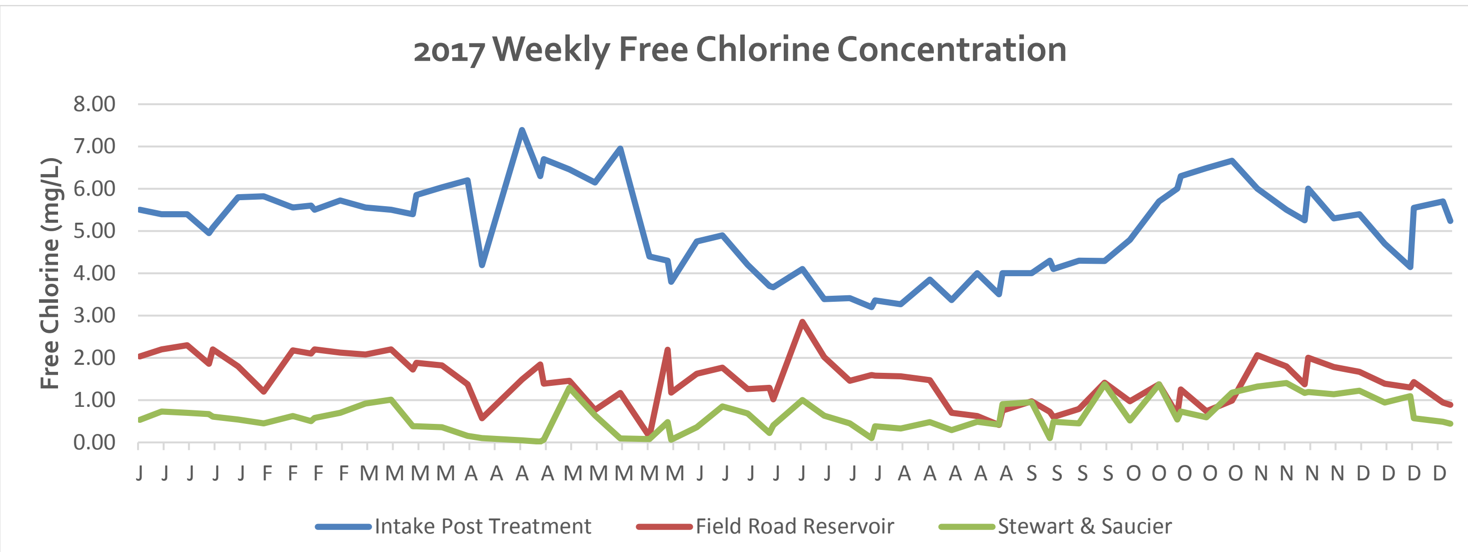


Figure 30. Weekly Free Chlorine concentration tracking

Both the weekly and monthly measurements indicated a minimal amount of free chlorine was present at all sampling points, but did not always achieve the operational target of 0.20 mg/L (**Figure 30,31, Table 15**).

Free Chlorine Residual (mg/L)												
	JAN	FEB	MAR	APR	MAY	JUN	JLY	AUG	SEP	OCT	NOV	DEC
INTAKE POST-TREATMENT	5.00	5.00	5.40	6.30	4.30	3.70	3.20	3.60	4.60	6.00	5.30	4.30
FIELD ROAD RESERVOIR	1.86	2.05	1.72	1.84	2.19	1.29	1.59	0.41	0.72	0.65	1.37	1.30
STEWART & SAUCIER RD	0.67	0.65	0.38	0.02	0.48	0.22	0.10	0.42	0.10	0.54	1.17	1.09
OPERATIONAL OBJECTIVE	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 15. Monthly Free Chlorine concentrations

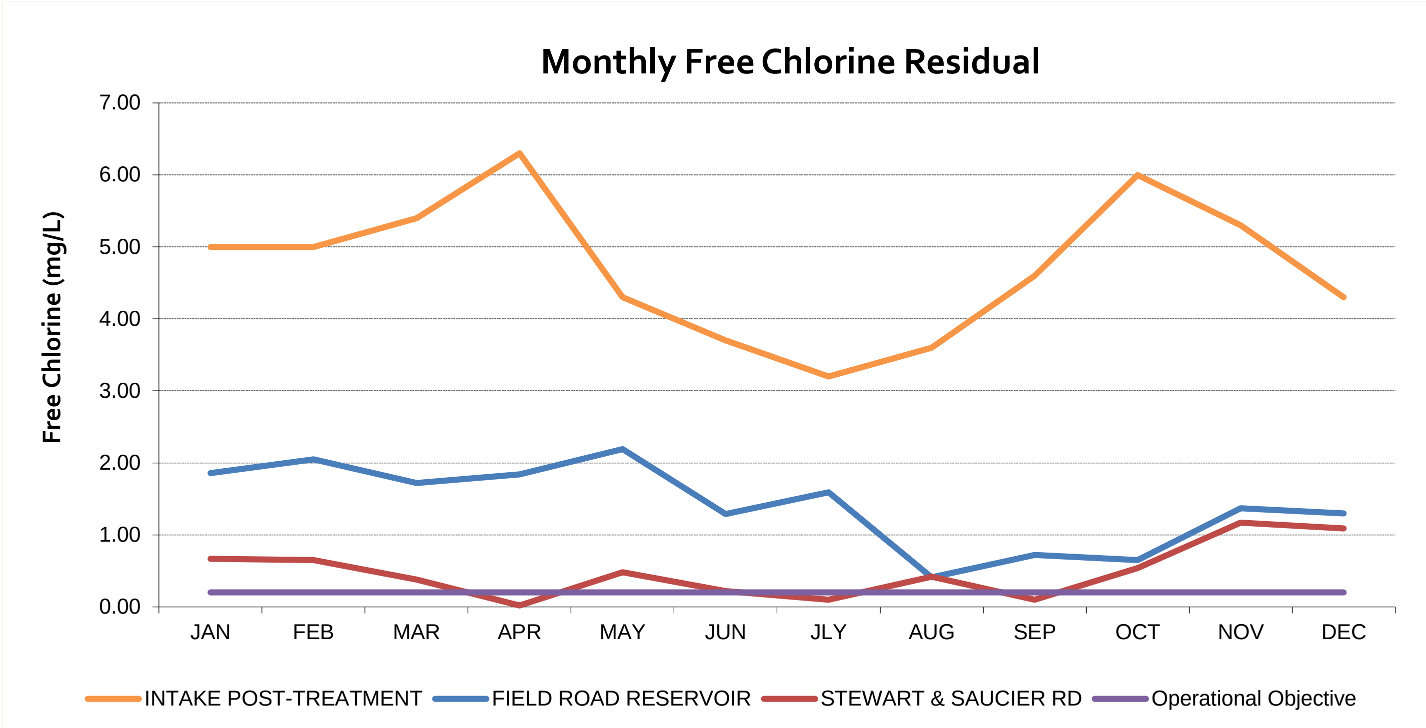


Figure 31. Monthly average Free Chlorine of Treated Water

On an annualized basis, average free chlorine concentrations did meet the operational requirements, but minimally at end of line distribution points. Dosing and measurements have not significant trended over the past 5 years (**Figure 32**).

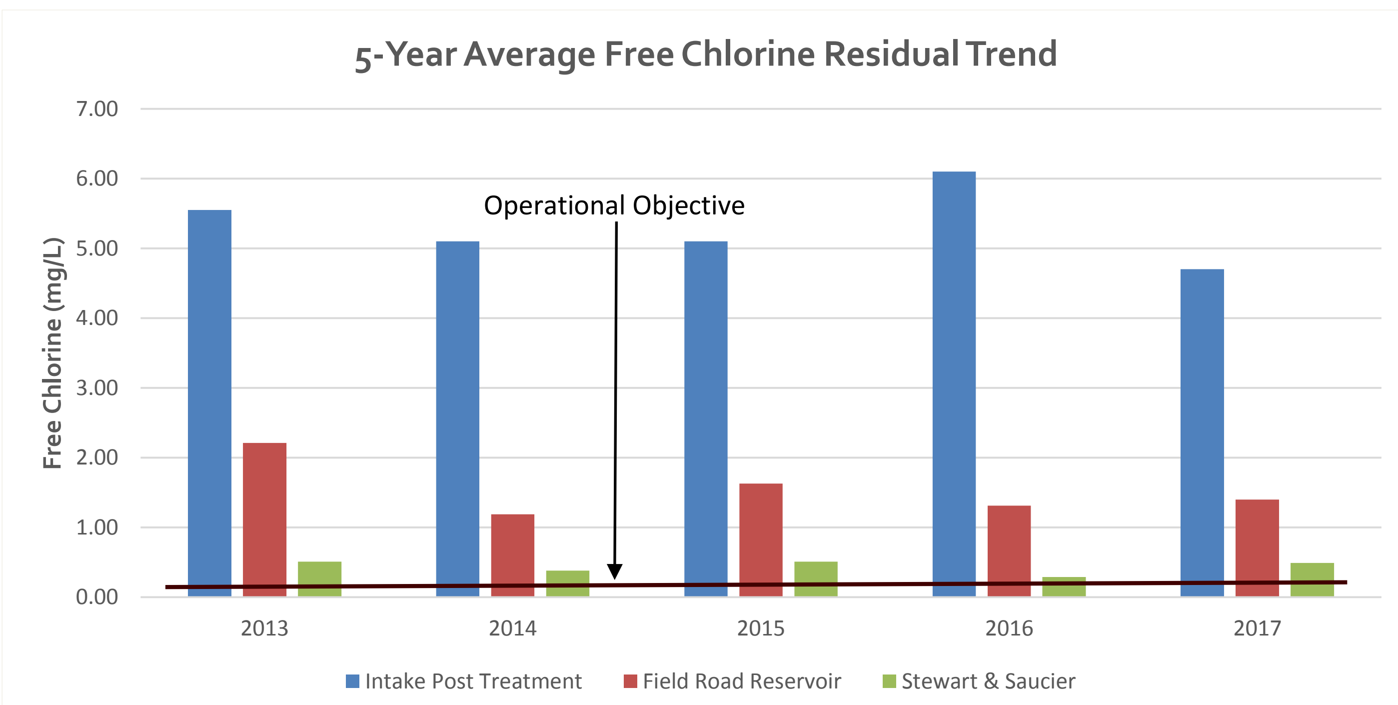


Figure 32. 5-Year Free Chlorine trending

Trihalomethanes – Health Objective

Trihalomethanes (THM) consist of 4 compounds made up of chlorinated and brominated carbon chains and are a byproduct of chlorine, bromine, temperature, pH, and presence of naturally occurring organic precursors such as humic and fulvic acids. The maximum acceptable concentration (MAC) for Trihalomethanes in drinking water is 0.100 mg/L based on a running annual average with a minimum of quarterly sampling conducted in the distribution system.
Due to naturally occurring, highly organic material being leached into the water supply, THM concentrations were elevated throughout the year and above the annual acceptable MAC limit (**Figure 33**). The concentrations have been consistently high and appears to be marginally increasing year over year as observed in the 5-year trend (**Figure 34**). In order to lower the THM concentrations, some form of pretreatment to reduce the various natural acids or alternate source with lower organic content is required.

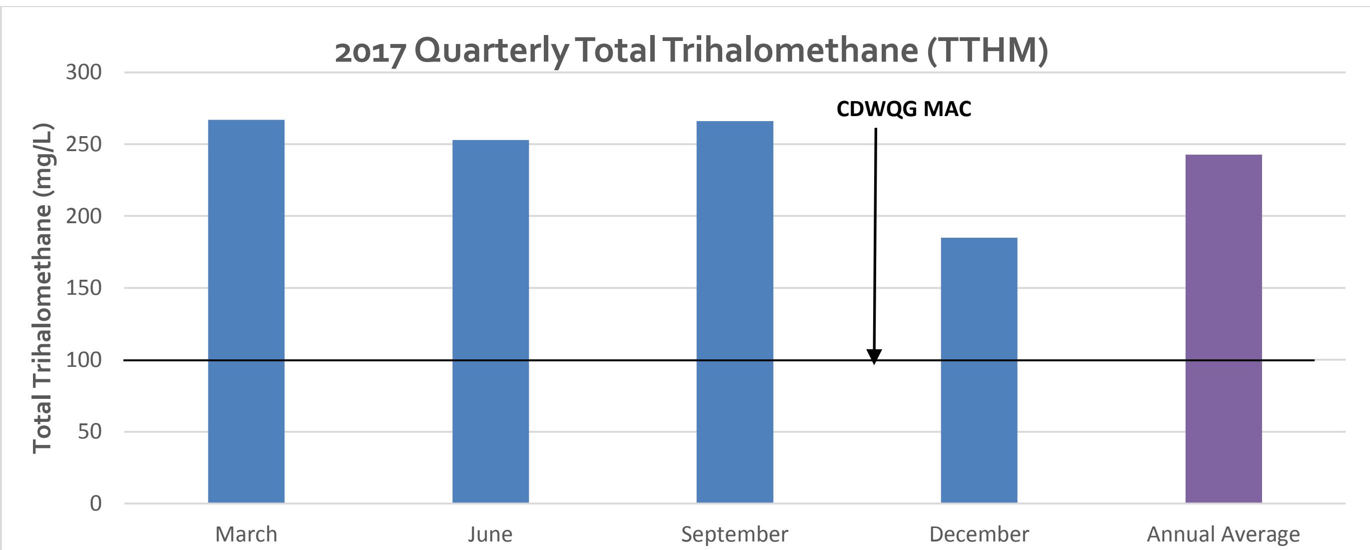


Figure 33. Quarterlyand annual average THM in Distribution System

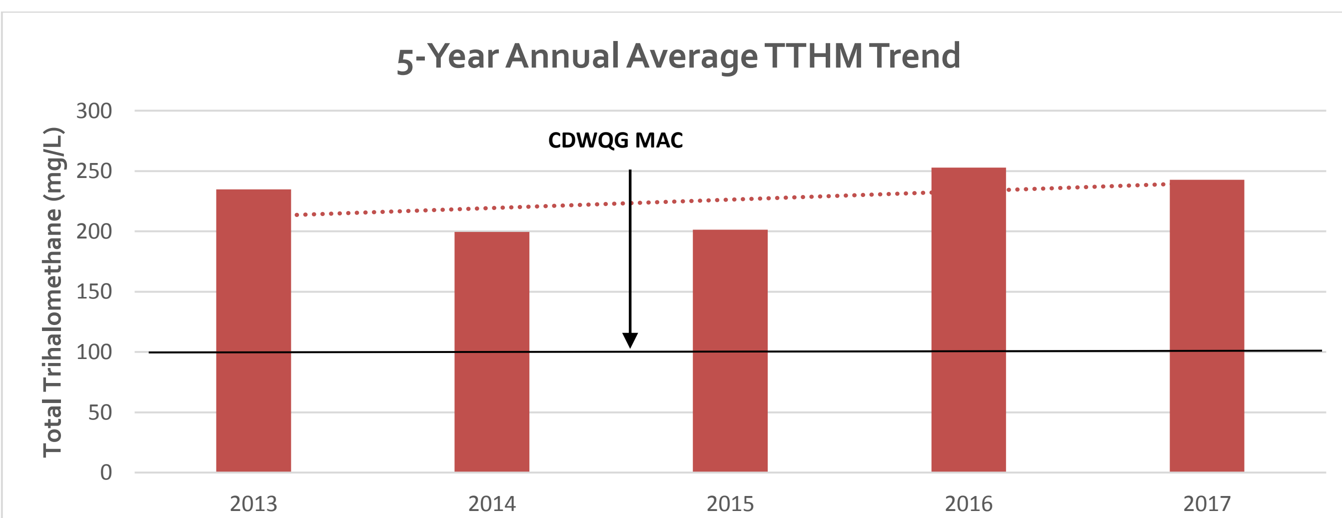


Figure 34. 5-year THM trend in Distribution System

Annual Physical, Chemical and Biological Analysis

Comprehensive water analysis is conducted annually at the Recorder Building (first customer) sampling site and the Johnson Road Well. Samples were submitted to CARO analytical services and reported in relation to a variety of health (MAC) and aesthetic (AO) objectives (Table 28). Recorder Building site had MAC exceedances for Turbidity and AO exceedances for Color, pH, and Iron. Johnson Road site only had an AO exceedance for Hardness and Total Dissolved Solids.

CARO Analytical Services			RECORDER BUILDING TREATED	JOHNSON ROAD WELL
Date Sampled			23-Jan-2017	23-Jan-2017
Physical Tests (Water)	Units	Guideline		
Color, True	CU	AO=15	16.0	<5.0
Conductivity	uS/cm		116	455
Hardness (as CaCO3)	mg/L	AO = 100	46.6	197
pH	pH	7.5-10	7.27	7.87
Total Dissolved Solids	mg/L	AO=100	58.4	248
Turbidity	NTU	MAC=1	2.26	<0.10
Anions and Nutrients (Water)				
Alkalinity, Total (as CaCO3)	mg/L		39	180
Chloride (Cl)	mg/L	AO=250	7.37	7.42
Fluoride (F)	mg/L	MAC=1.5	0.23	0.19
Nitrate (as N)	mg/L	MAC=10	0.127	4.04
Nitrite (as N)	mg/L	MAC=1	<0.010	<0.010
Sulfate (SO4)	mg/L	AO=500	5.2	30.2

CARO Analytical Services			RECORDER BUILDING TREATED	JOHNSON ROAD WELL
Date Sampled			23-Jan-2017	23-Jan-2017
Bacteriological Tests (Water)				
E. coli	MPN/100mL	MAC=<1	<1	<1
Coliform Bacteria - Total	MPN/100mL	MAC=<1	<1	<1
Total Metals (Water)				
Aluminum (Al)-Total	mg/L	AO=0.1	0.077	<0.005
Antimony (Sb)-Total	mg/L	MAC=0.006	<0.0001	<0.0001
Arsenic (As)-Total	mg/L	MAC=0.01	<0.0005	<0.0005
Barium (Ba)-Total	mg/L	MAC=1	0.007	0.015
Boron (B)-Total	mg/L	MAC=5	0.012	0.034
Cadmium (Cd)-Total	mg/L	MAC=0.005	<0.00001	<0.00001
Calcium (Ca)-Total	mg/L		12.2	54.0
Chromium (Cr)-Total	mg/L	MAC=0.05	<0.0005	0.0006
Copper (Cu)-Total	mg/L	AO=15	0.0052	0.0037
Iron (Fe)-Total	mg/L	AO=0.3	0.53	<0.01
Lead (Pb)-Total	mg/L	MAC=0.01	0.0002	<0.0001
Magnesium (Mg)-Total	mg/L		3.94	15.0
Manganese (Mn)-Total	mg/L	AO=0.05	0.0345	<0.0002
Mercury (Hg)-Total	mg/L	MAC=0.001	<0.00002	<0.00002
Potassium (K)-Total	mg/L		0.83	2.67
Selenium (Se)-Total	mg/L	MAC=0.05	<0.0005	0.0012
Sodium (Na)-Total	mg/L	AO=200	4.60	11.0
Uranium (U)-Total	mg/L	MAC=0.02	0.00049	0.00418
Zinc (Zn)-Total	mg/L	AO=5	<0.004	<0.004
Dissolved Metals (Water)				
Mercury (Hg)-Dissolved (mg/L)	mg/L	AO=5	<0.00002	<0.00002

Table 16. Comprehensive annual water analysis summary