Eagle Mine - 2015 Mine Permit Groundwater Benchmark Deviation Summary

Community Environmental Monitoring Program
Superior Watershed Partnership
www.swpcemp.org

2015 Mine Permit Groundwater Benchmark Deviation Summary

Benchmark Deviation Summary .... pg. 3

Figure 1. Mine Permit Groundwater Monitoring Locations.......... pg. 4

Table 1. 2015 Groundwater Benchmark Deviation Summary .... pg. 5

Table 2. EPA Drinking Water Standards (where available) for Parameters Exceeding Benchmark Values.......... pg. 7

Figures depicting changes/trends by location and parameter .... pg. 8-24

2015 Mine Permit Groundwater Benchmark Deviation Summary

During 2015, sampling at nine mine permit groundwater (MPGW) monitoring well locations recorded groundwater parameters that were outside of the established benchmarks under the Mine Permit (Part 632) for at least two consecutive sampling events (red highlighted cells, Table 1). Because of this, groundwater quality continues to be watched/tracked for changes but currently poses no known risk to the environment.

For all mine permit groundwater monitoring locations, two sets of **benchmarks** were calculated based on the guidance provided by the Mine Permit 01 2007 (Mine), Mining Permit 01 2010 (Mill), and Part 632. The benchmark that is used for screening monitoring data is the lower of the two values. Due to the required statistical nature of these benchmark values, the accuracy will improve over time as the quantity of data that becomes available increases. If data collected during future monitoring events is deemed to be representative of baseline conditions it may be incorporated into the benchmark calculations. Following is a description of the current calculated benchmarks:

- **Upper prediction limit (UPL) benchmark:** Per reporting requirements under R 426.406(6) and General Condition s of the Mine Permit (MP 01 2007 & MP 01 2010), the UPL has been developed as the upper threshold limit for increased monitoring and is based on a statistical analysis of qualified baseline data. Data outliers are not included in the baseline information. The UPL benchmark represents a value that is two standard deviations above the long-term average. Again, as the data set increases over time, the long term average and standard deviations may need to be adjusted for improved accuracy.
- **Maximum contaminant level (MCL) derived benchmark:** Per reporting requirements under R 426.406(7a), the MCL benchmark was developed as an upper threshold action limit and represents the value ½ way between the long-term average and the drinking water standard (MCL) determined by US EPA. These values may also be reviewed and adjusted as the data set increases over time.

Parameters such as metals and nitrates are found naturally in groundwater but can pose human health risks at high levels. A complete list of potential risks from contaminants based on the U.S. EPA Drinking Water Standards can be found at: http://www.epa.gov/your-drinking-water/table-regulated-drinking-water-contaminants. Eight of the parameters exceeding benchmark values in 2015 are included in the EPA's lists of regulated drinking water contaminants and secondary drinking water standards and are listed in Table 2 below.

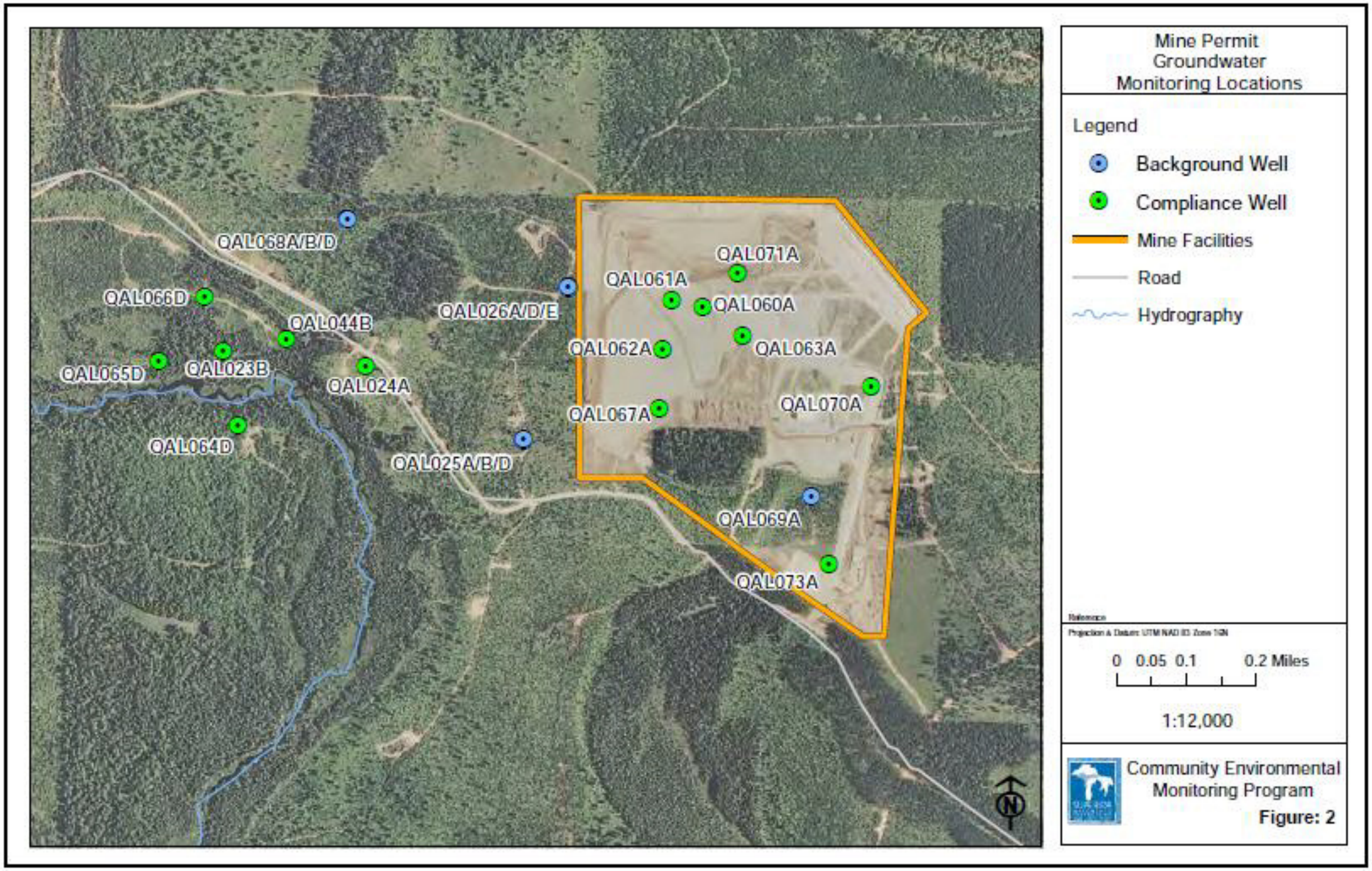


Figure 1. Mine Permit Groundwater Monitoring Locations

Table 1. 2015 Groundwater Benchmark Deviation Summary

Location	Parameter	Unit	Benchmark	Q1 2015	Q2 2015	Q3 2015	Q4 2015
QAL024A *Near the Eagle Mine Vent Raise*	**Alkalinity, Bicarbonate**	mg/L	24	**32**	**34**	**31 e**	**35**
	Chloride	mg/L	1.4	**95**	**81**	**92**	**72**
	Nitrogen, Nitrate	mg/L	0.2	**1.1 e**	**0.94 e**	**1.1**	**0.68 e**
	Sodium	mg/L	1.2 t	**40**	**41**	**27**	**22**
QAL044B *South of Triple A Road*	**Sodium**	mg/L	2.6	**2.6**	2.1	2.4	2.6
	Sulfate	mg/L	8.0	**8.4**	**8.0**	7.8	7.7
QAL060A *Contact Area Near CWBs*	**Arsenic**	ug/L	4.7	**5.0**	**4.8**	4.6	4.7
	Nitrogen, Nitrate	mg/L	0.12	**0.17 e**	**0.48 e**	**0.14**	**0.20 e**
	pH	SU	7.9 - 8.9	8.8	8.7	**9**	**8.9**
QAL062A *Contact Area Near TDRSA*	**Alkalinity, Bicarbonate**	mg/L	48 t	**71**	**81**	**90 e**	**100**
	Chloride	mg/L	1.6	**5.3**	**13**	**20**	**34**
	Sodium	mg/L	0.76 t	**1.3**	**1.1**	**1.3**	**1.9**
QAL063A *Contact Area Near COSA*	**Alkalinity, Bicarbonate**	mg/L	42 t	**51**	**65**	**66 e**	**71**
	Chloride	mg/L	1.7	<1.0	<1.0	**1.9**	**3.1**
	Sodium	mg/L	0.78	0.72	**0.78**	**0.81**	**0.95**
QAL064D *South of Salmon Trout River*	**Alkalinity, Bicarbonate**	mg/L	69	**89**	**75**	**76 e**	**73**
QAL066D *South of Triple A Road*	**Alkalinity, Bicarbonate**	mg/L	45 p	**53**	**58**	41 e	51
	Iron	ug/L	49 p	28	31	**210**	**370**
	pH	SU	10.4 - 11.4 p	**8.9**	**8.8**	**9**	**8.6**
QAL067A *Contact Area Near TDRSA*	**Alkalinity, Bicarbonate**	mg/L	27	25	**33**	**46**	**50**
	Chloride	mg/L	1.9	**1300**	**1300**	**890**	**770**
	Mercury	ng/L	2.0	**3.5**	**3.3 e**	1.83 e	2.48
	Nitrate	mg/L	0.25 t	**1.4 e**	**0.96 e**	**2.1**	**1.8 e**
	Sodium	mg/L	1.6 t	**720**	**660**	**490**	**450**

Location	Parameter	Unit	Benchmark	Q1 2015	Q2 2015	Q3 2015	Q4 2015
	Sulfate	mg/L	8.4 t	**11**	**12**	**15**	**14**
QAL071A *Contact Area Near CWBs*	**pH**	SU	8.1 - 9.1	**8**	**7.7**	**8**	**8**
	Alkalinity, Bicarbonate	mg/L	44 t	**150**	**140**	**130 e**	**120**
	Chloride	mg/L	1.5	**27**	**30**	**44**	**24**
	Nitrate	mg/L	0.31	**9.8 e**	**8.2 e**	**7.4**	**5.6 e**
	Sodium	mg/L	1.8	**8.1**	**5.7**	**11**	**8.7**
	Sulfate	mg/L	3.3	**8.6**	**7.3**	**7.6**	**8**

Benchmarks listed as "pending" (p) or "trending" (t) cannot be statistically derived with accuracy utilizing the baseline data collected to date, either because there are insufficient values (p) or the sequence of values suggest a trend is present (t). "e" = estimated value.

Table 2. EPA Drinking Water Standards (where available) for Parameters Exceeding Benchmark Values

	EPA Drinking Water Standards (Inorganic Chemicals)			
	MCL[1] or TT[2] (mg/L)	**Potential Health Effects from Long-Term Exposure Above the MCL (unless specified as short-term);**	Secondary[3] MCL	**Noticeable Effects above the Secondary MCL**
Arsenic	0.010	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	-	-
Chloride	-	-	250 mg/L	Salty taste
Copper	Action Level[4] - 1.3	Short term exposure: gastrointestinal distress; Long term exposure: liver or kidney damage; People with Wilson's Disease should consult their personal doctor if the amount of copper in their water exceeds the action level	1.0 mg/L	Metallic taste; blue-green staining
Iron	-	-	0.3 mg/L	Rusty color; sediment; metallic taste; reddish or orange staining
Mercury (inorganic)	0.002	Kidney damage	-	-
Nitrogen, Nitrate	10	Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.	-	-
pH	-	-	6.5 - 8.5	Low pH: bitter metallic taste; corrosion. High pH: slippery feel; soda taste; deposits
Sulfate	-	-	250 mg/L	Salty taste

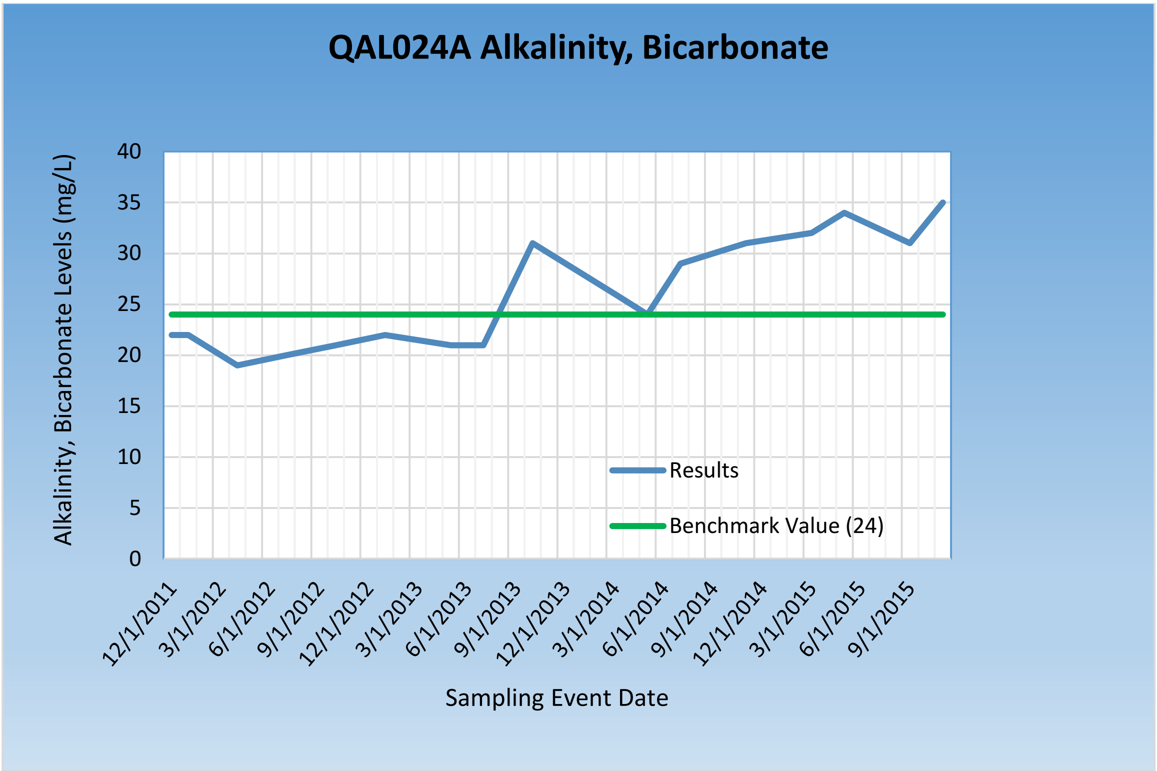
1 - MCL = Maximum Contaminant Level; The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

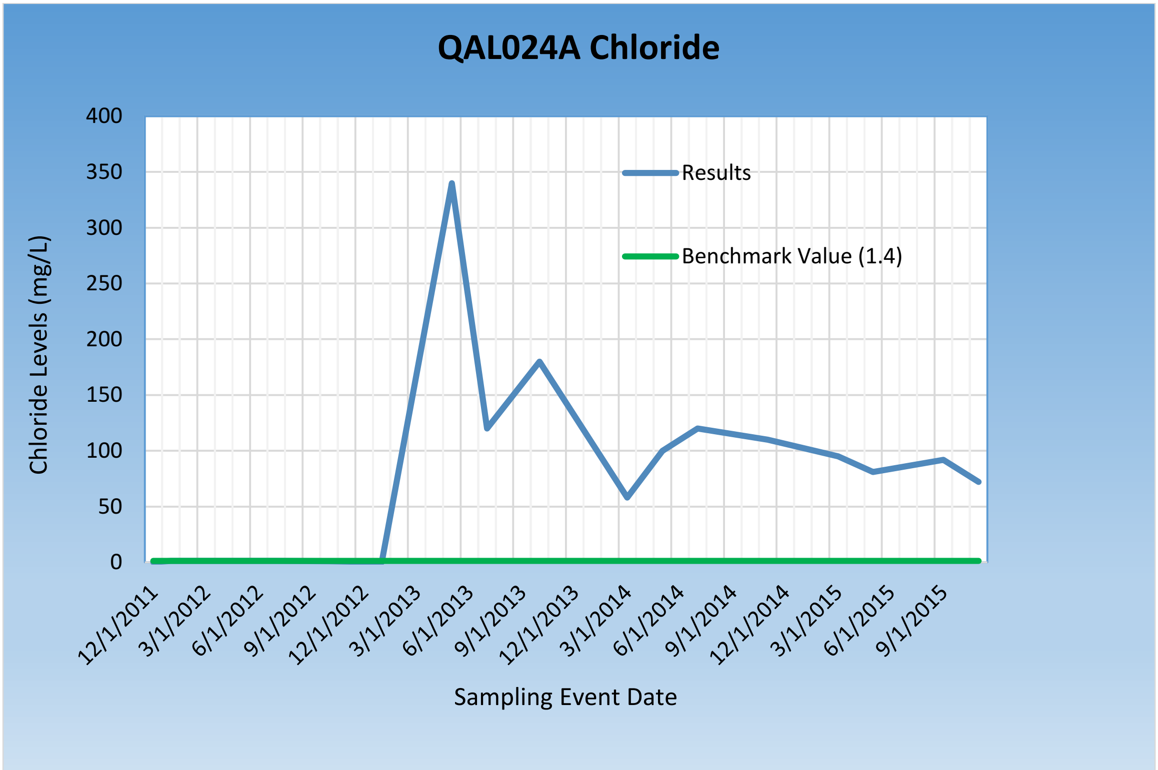
2 - TT = Treatment Technique; A required process intended to reduce the level of a contaminant in drinking water.

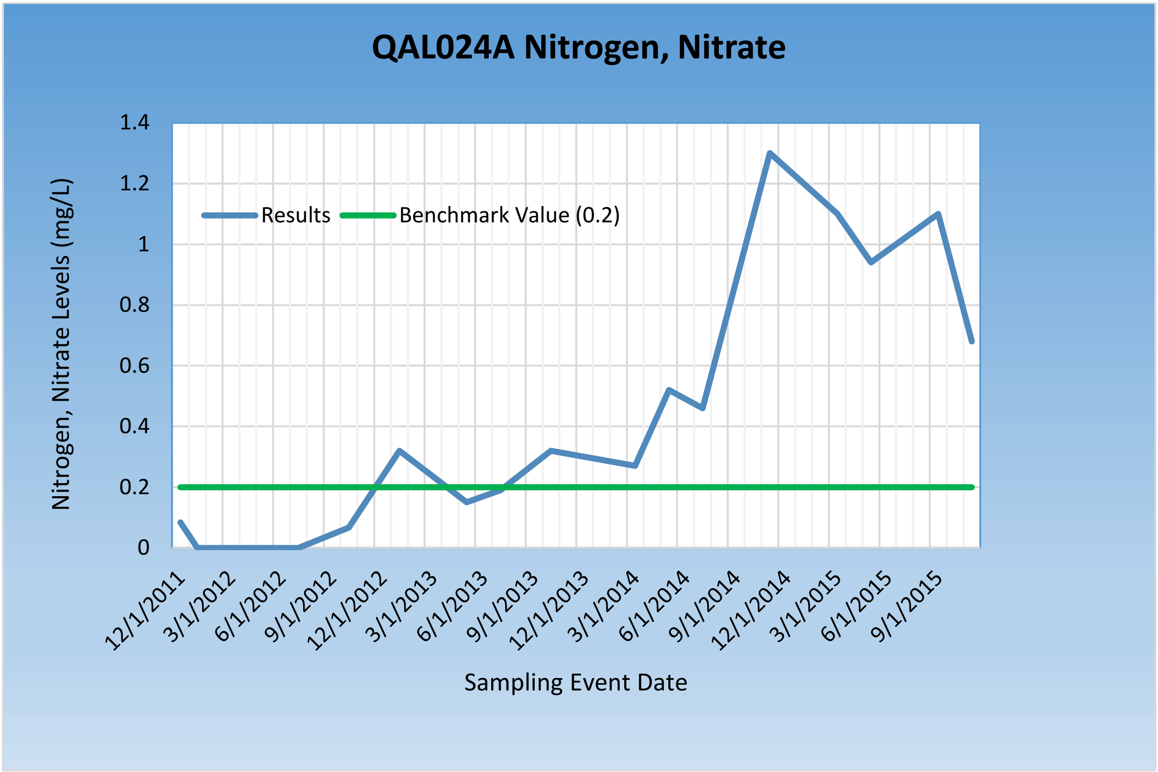
3 - Secondary Standards: Non-enforcable standsards established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants are not considered to present a risk to human health at the SMCL.

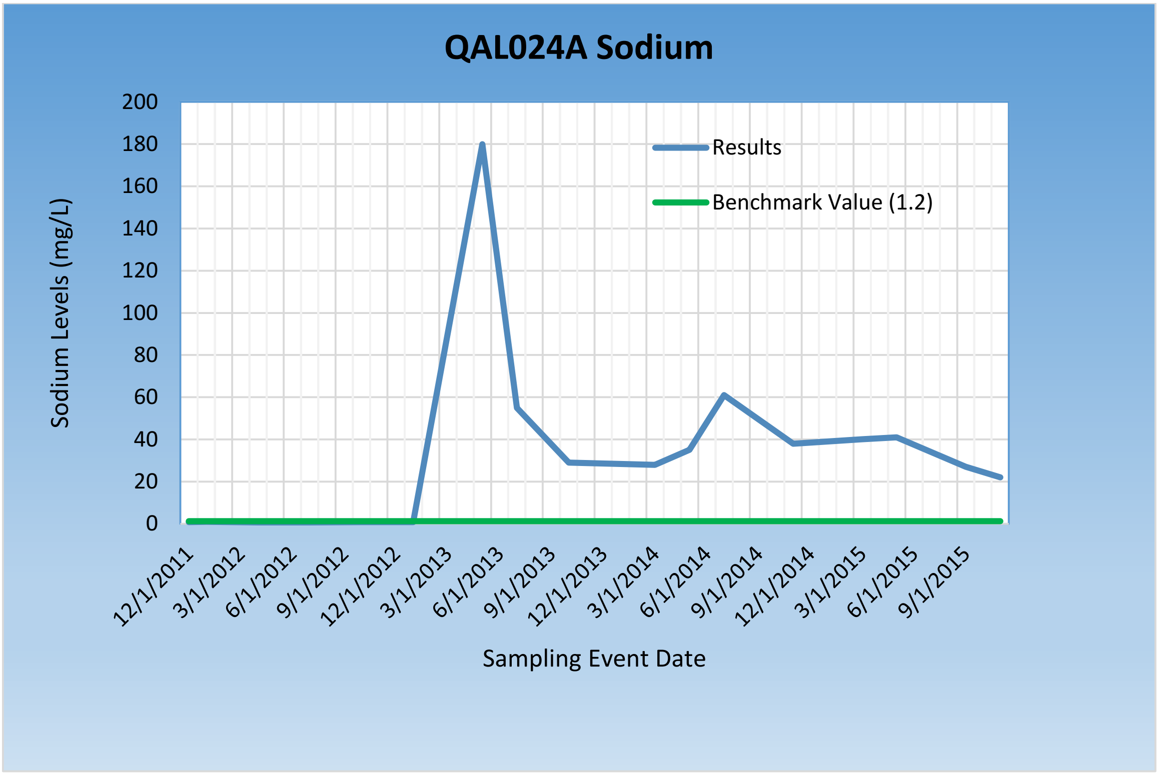
4 - Lead and copper are regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed the action level, water systems must take additional step For copper, the action level is 1.3 mg/L

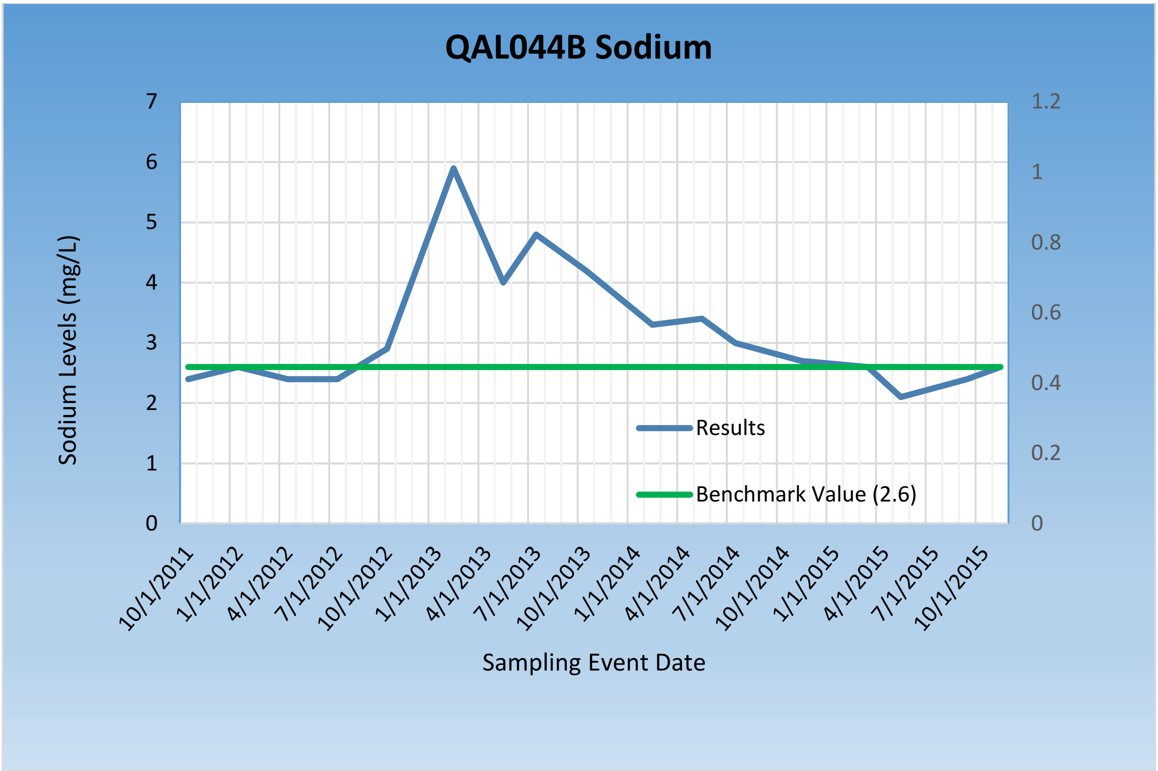
Figures Depicting the Trends/Changes for Each Well Location and Parameter Exceeding Benchmark Values During 2015

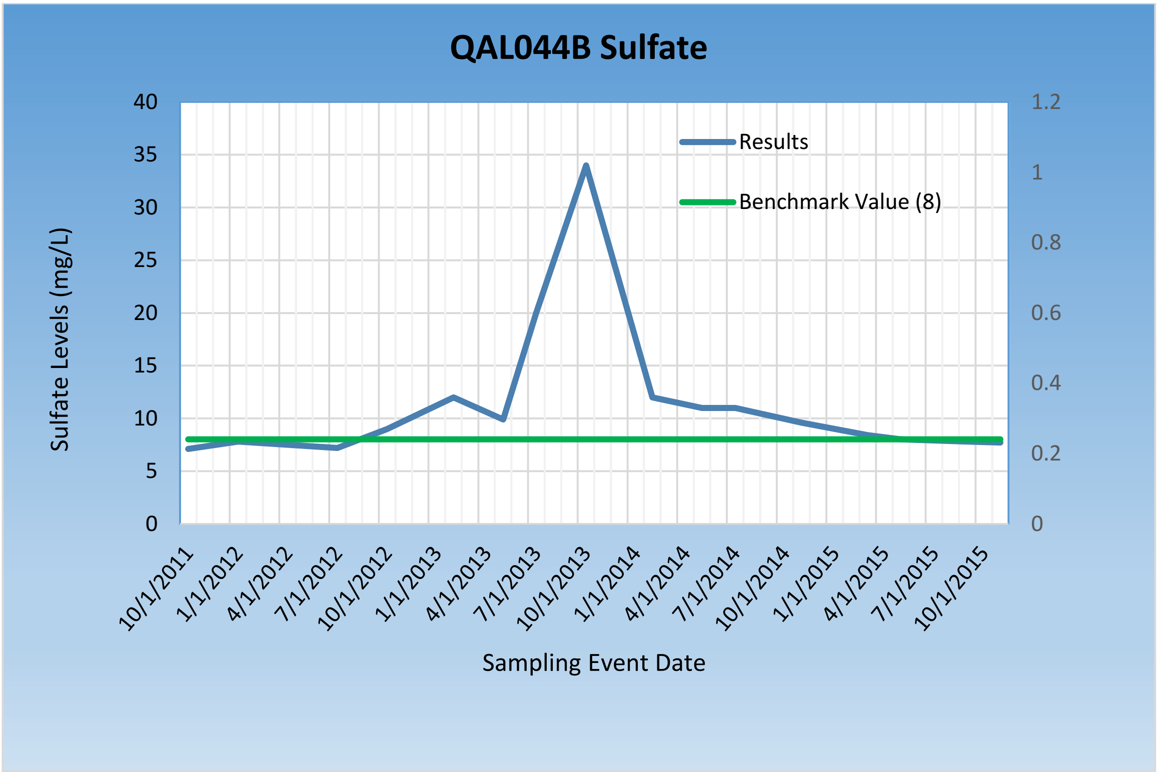

QAL024A Alkalinity, Bicarbonate
Alkalinity, Bicarbonate Levels (mg/L)
40
35
30
25
20
15
10
5
0
Results
Benchmark Value (24)
12/1/2011
3/1/2012
6/1/2012
9/1/2012
12/1/2012
3/1/2013
6/1/2013
9/1/2013
12/1/2013
3/1/2014
6/1/2014
9/1/2014
12/1/2014
3/1/2015
6/1/2015
9/1/2015
Sampling Event Date

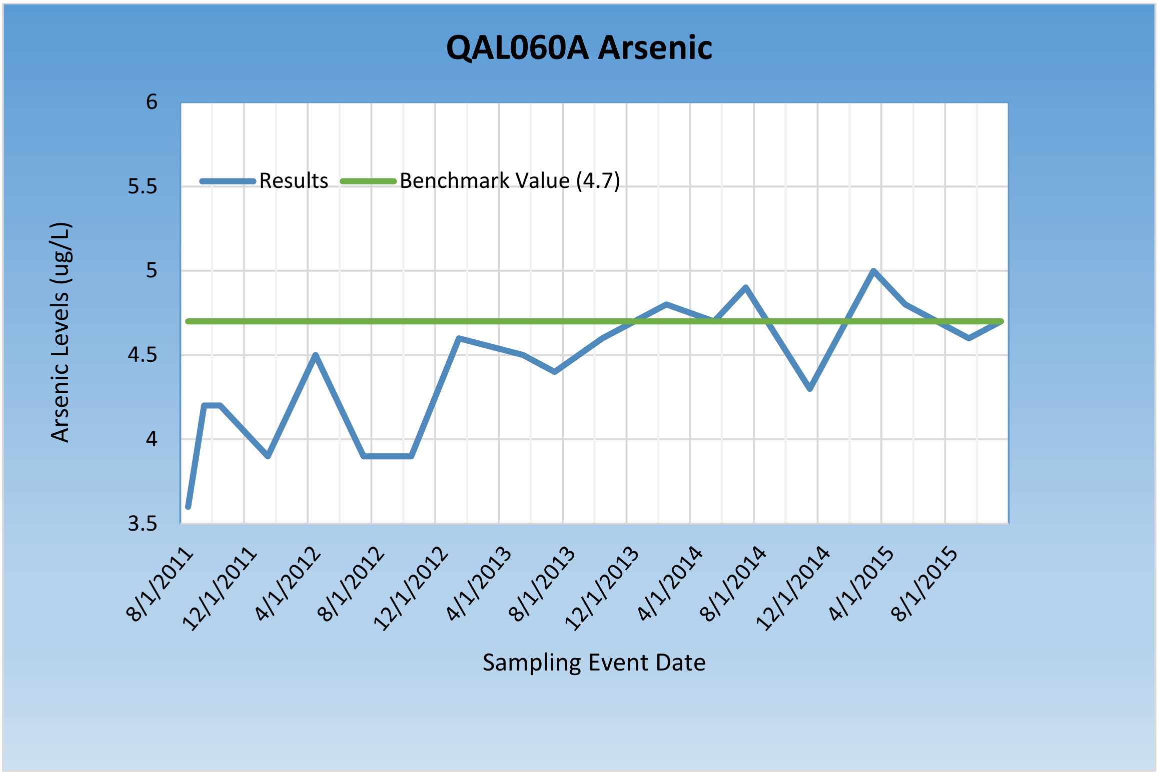

QAL024A Chloride
Chloride Levels (mg/L)
400
350
300
250
200
150
100
50
0
Results
Benchmark Value (1.4)
12/1/2011
3/1/2012
6/1/2012
9/1/2012
12/1/2012
3/1/2013
6/1/2013
9/1/2013
12/1/2013
3/1/2014
6/1/2014
9/1/2014
12/1/2014
3/1/2015
6/1/2015
9/1/2015
Sampling Event Date

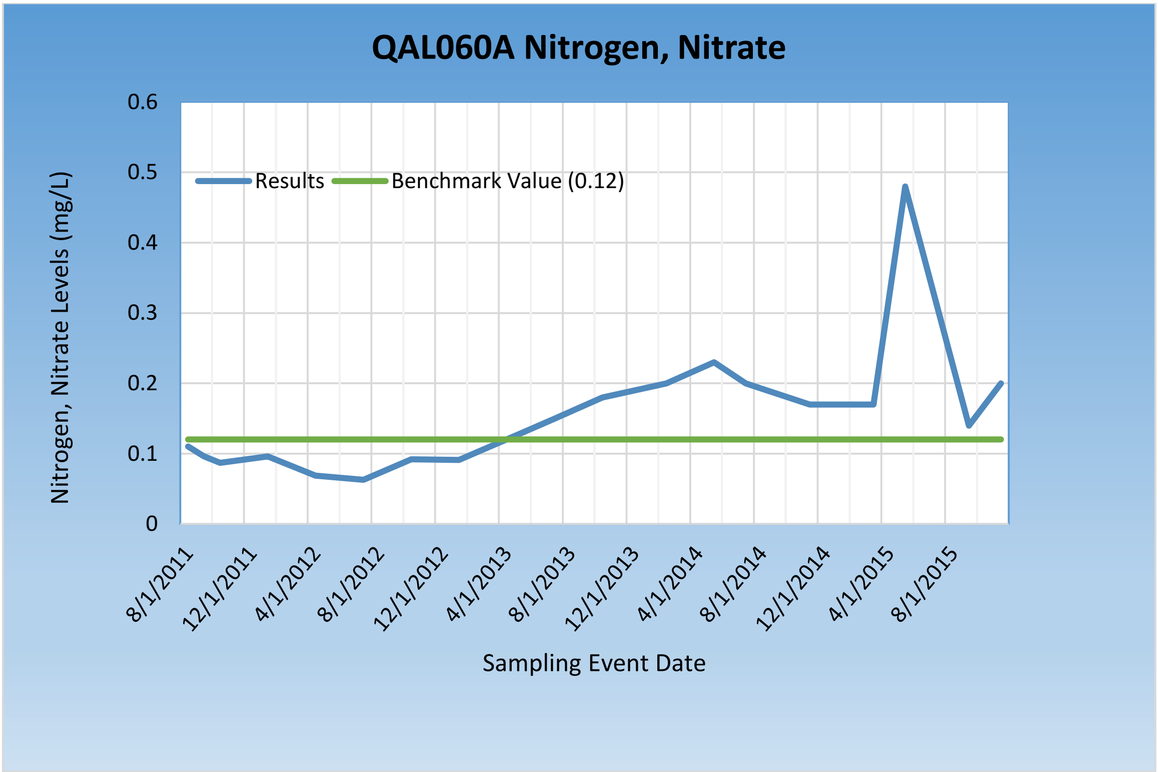

QAL024A Nitrogen, Nitrate
Nitrogen, Nitrate Levels (mg/L)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Results
Benchmark Value (0.2)
12/1/2011
3/1/2012
6/1/2012
9/1/2012
12/1/2012
3/1/2013
6/1/2013
9/1/2013
12/1/2013
3/1/2014
6/1/2014
9/1/2014
12/1/2014
3/1/2015
6/1/2015
9/1/2015
Sampling Event Date

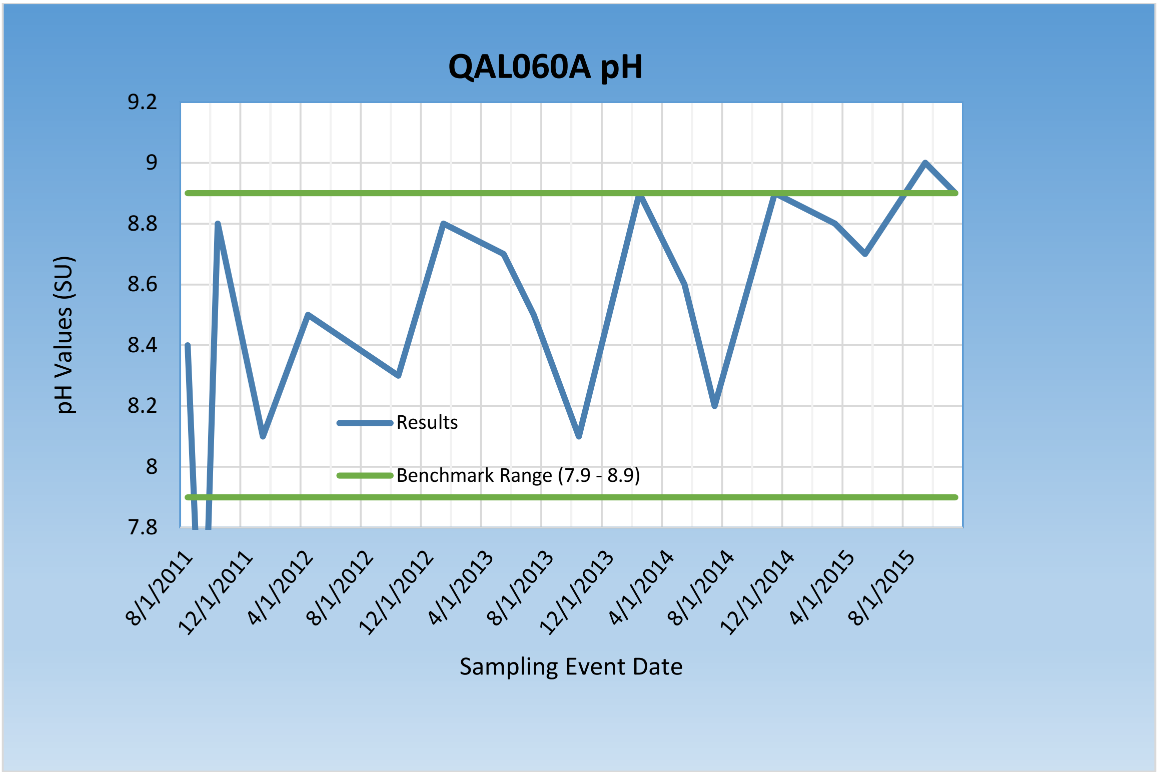

QAL024A Sodium
Sodium Levels (mg/L)
200
180
160
140
120
100
80
60
40
20
0
Results
Benchmark Value (1.2)
12/1/2011
3/1/2012
6/1/2012
9/1/2012
12/1/2012
3/1/2013
6/1/2013
9/1/2013
12/1/2013
3/1/2014
6/1/2014
9/1/2014
12/1/2014
3/1/2015
6/1/2015
9/1/2015
Sampling Event Date


QAL044B Sodium
Sodium Levels (mg/L)
Sampling Event Date
Results
Benchmark Value (2.6)
0
1
2
3
4
5
6
7
0
0.2
0.4
0.6
0.8
1
1.2
10/1/2011
1/1/2012
4/1/2012
7/1/2012
10/1/2012
1/1/2013
4/1/2013
7/1/2013
10/1/2013
1/1/2014
4/1/2014
7/1/2014
10/1/2014
1/1/2015
4/1/2015
7/1/2015
10/1/2015

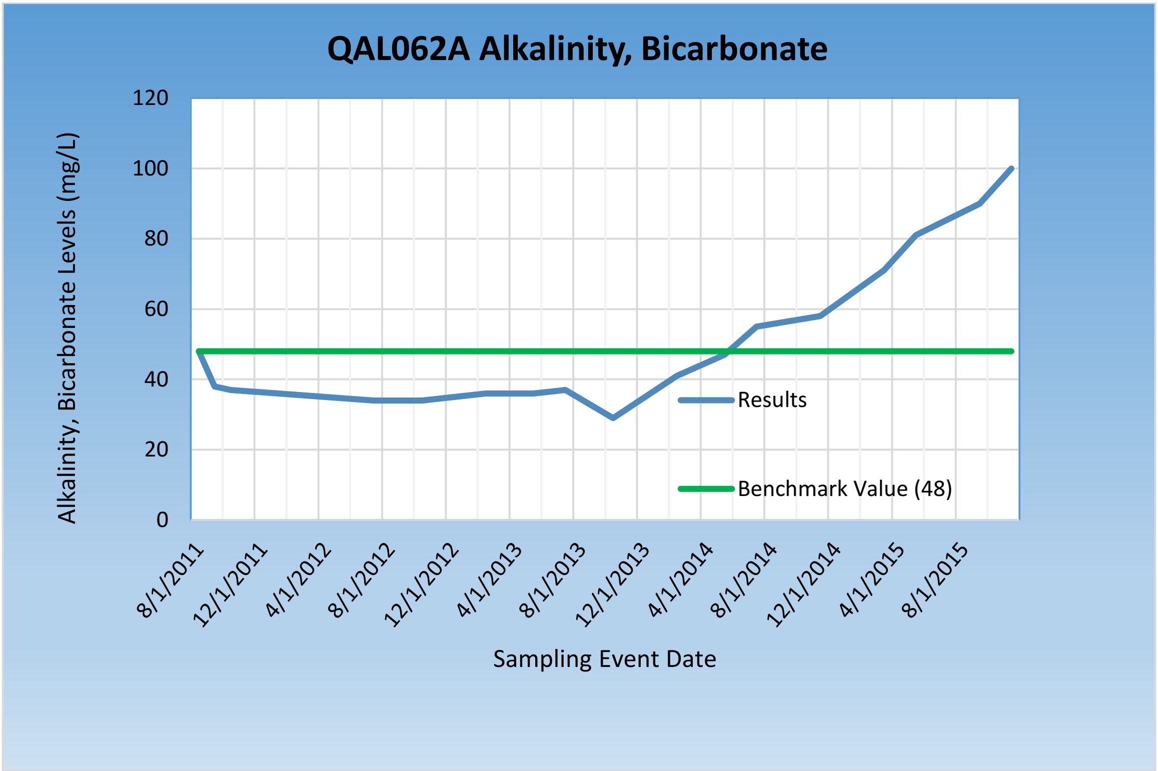

QAL044B Sulfate
Sulfate Levels (mg/L)
Sampling Event Date
Results
Benchmark Value (8)
0
5
10
15
20
25
30
35
40
0
0.2
0.4
0.6
0.8
1
1.2
10/1/2011
1/1/2012
4/1/2012
7/1/2012
10/1/2012
1/1/2013
4/1/2013
7/1/2013
10/1/2013
1/1/2014
4/1/2014
7/1/2014
10/1/2014
1/1/2015
4/1/2015
7/1/2015
10/1/2015


QAL060A Arsenic
Results
Benchmark Value (4.7)
Arsenic Levels (ug/L)
6
5.5
5
4.5
4
3.5
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

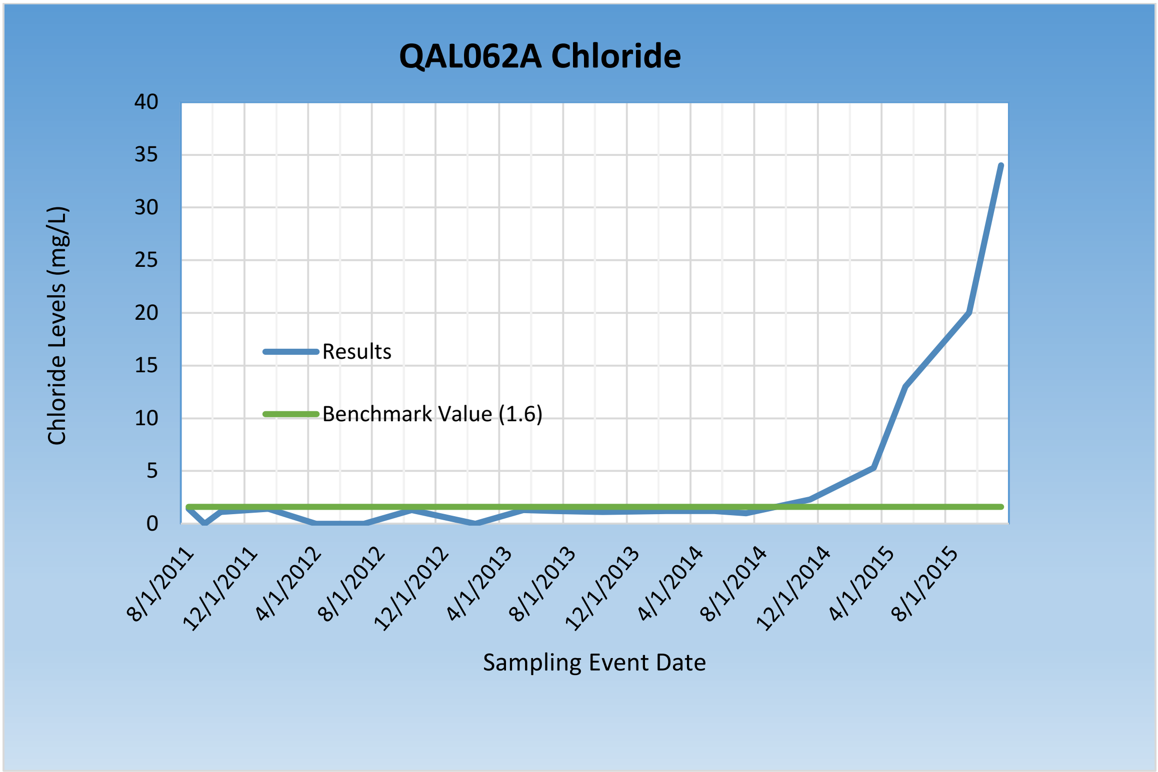

QAL060A Nitrogen, Nitrate
Results
Benchmark Value (0.12)
Nitrogen, Nitrate Levels (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

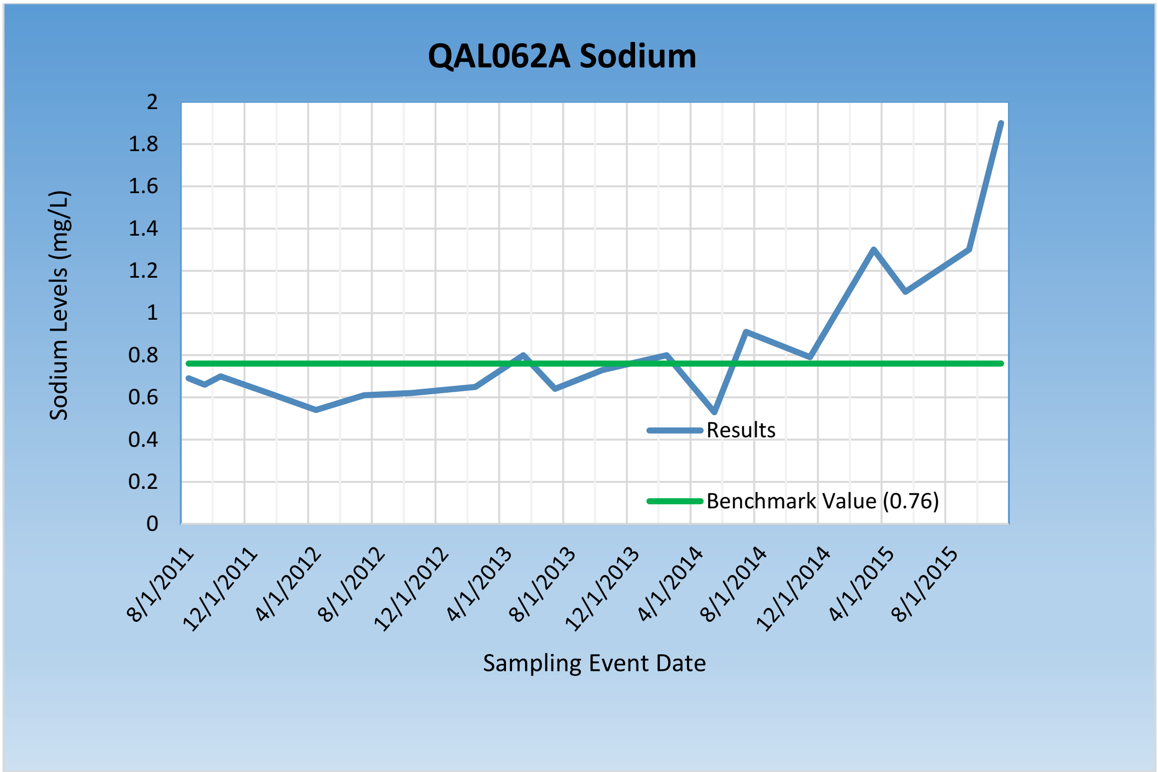


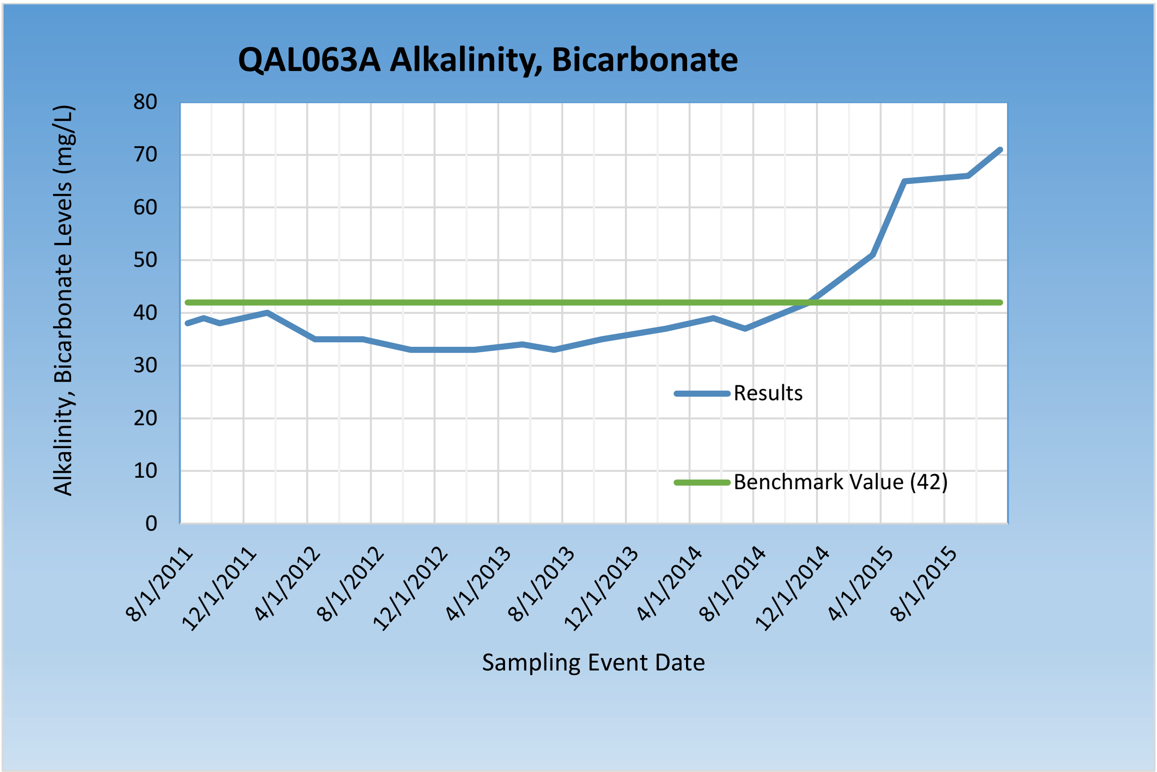
QAL060A pH
9.2
9
8.8
8.6
8.4
8.2
8
7.8
pH Values (SU)
Results
Benchmark Range (7.9 - 8.9)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

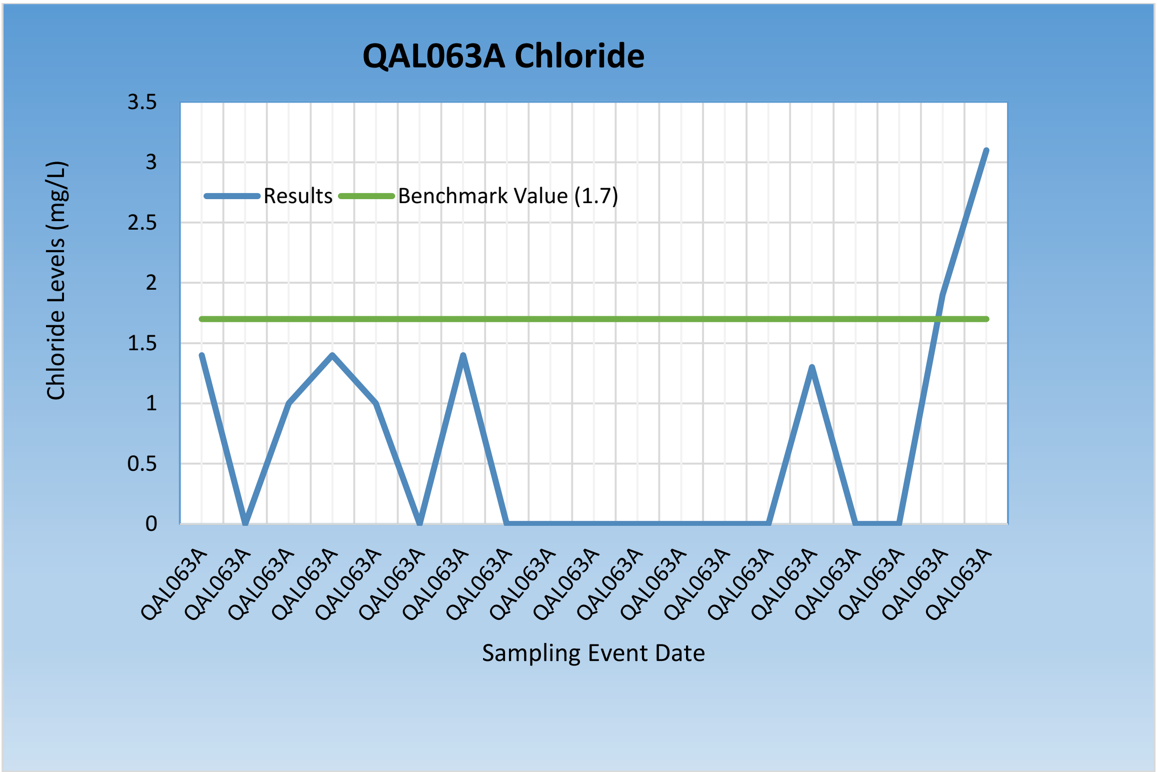


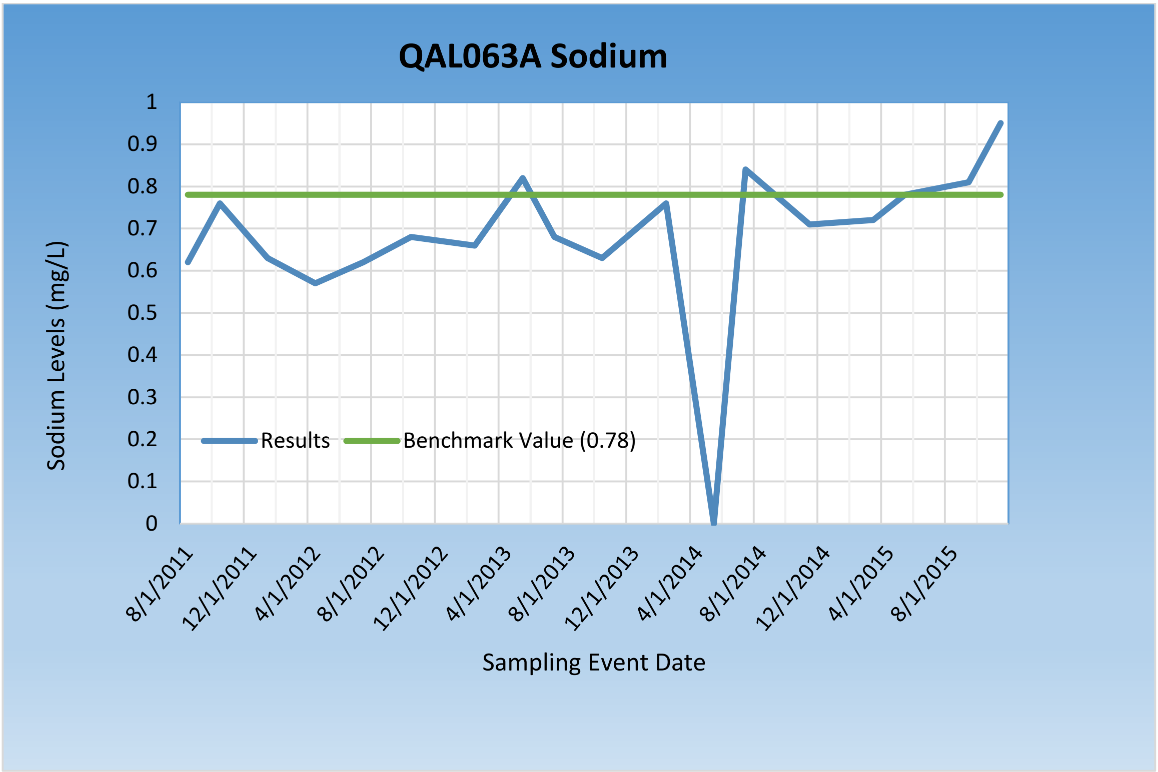
QAL062A Alkalinity, Bicarbonate
120
100
80
60
40
20
0
Alkalinity, Bicarbonate Levels (mg/L)
Results
Benchmark Value (48)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

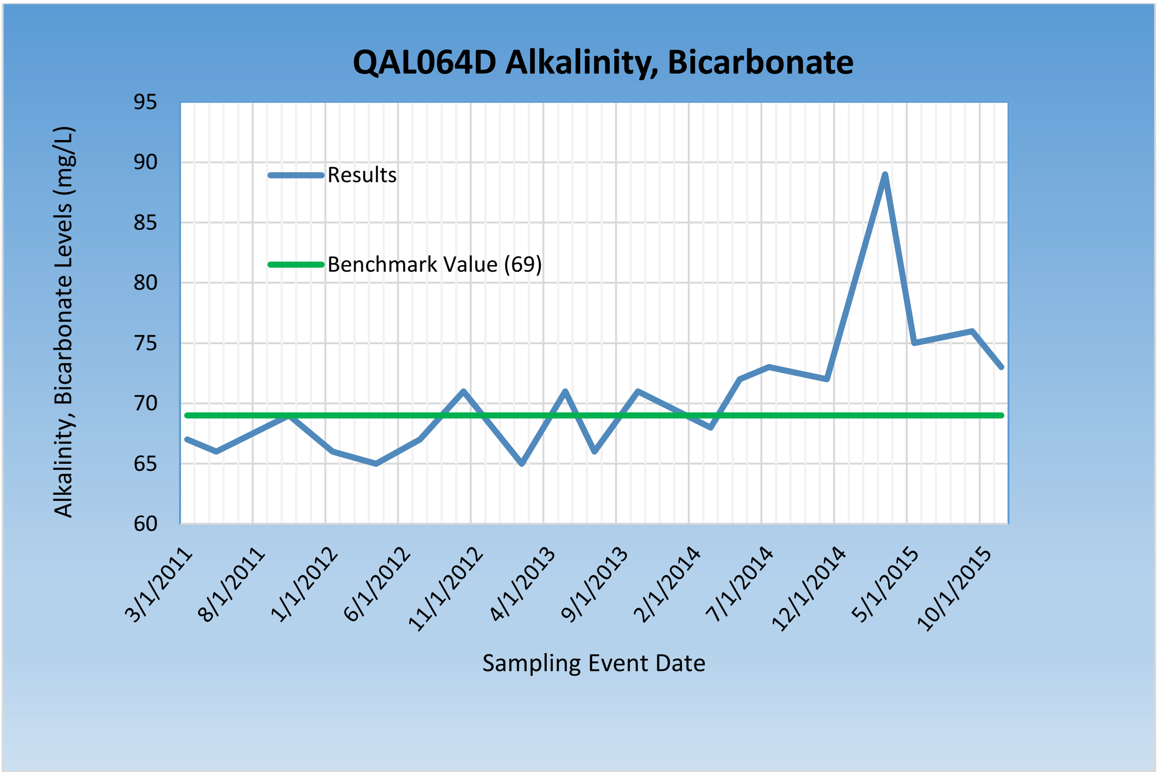

QAL062A Chloride
Chloride Levels (mg/L)
40
35
30
25
20
15
10
5
0
Results
Benchmark Value (1.6)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

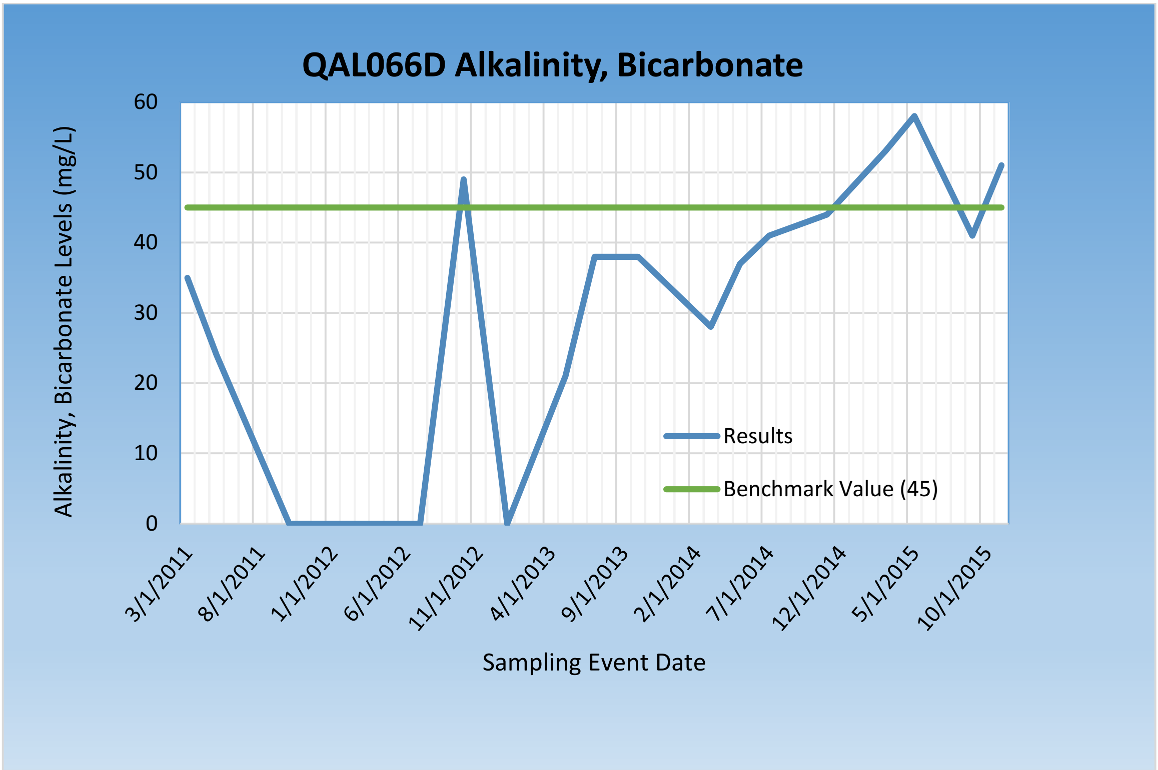

QAL062A Sodium
Sodium Levels (mg/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Results
Benchmark Value (0.76)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

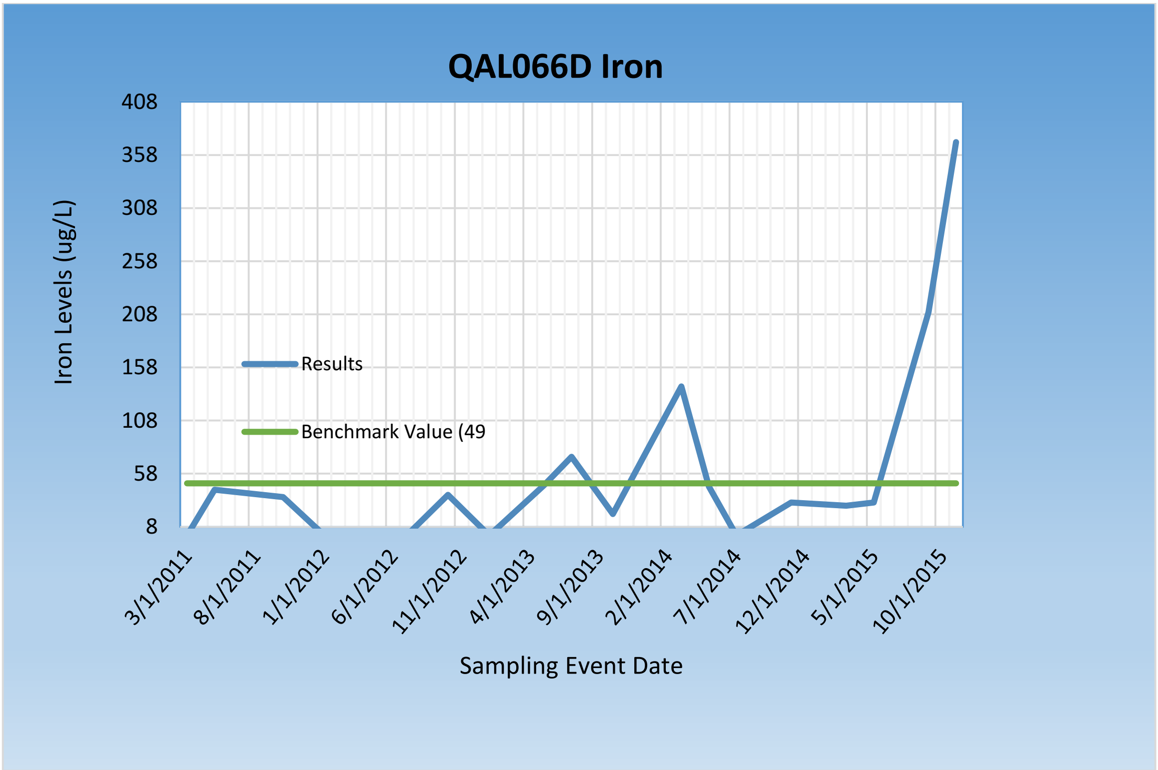

QAL063A Alkalinity, Bicarbonate
Alkalinity, Bicarbonate Levels (mg/L)
80
70
60
50
40
30
20
10
0
Results
Benchmark Value (42)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

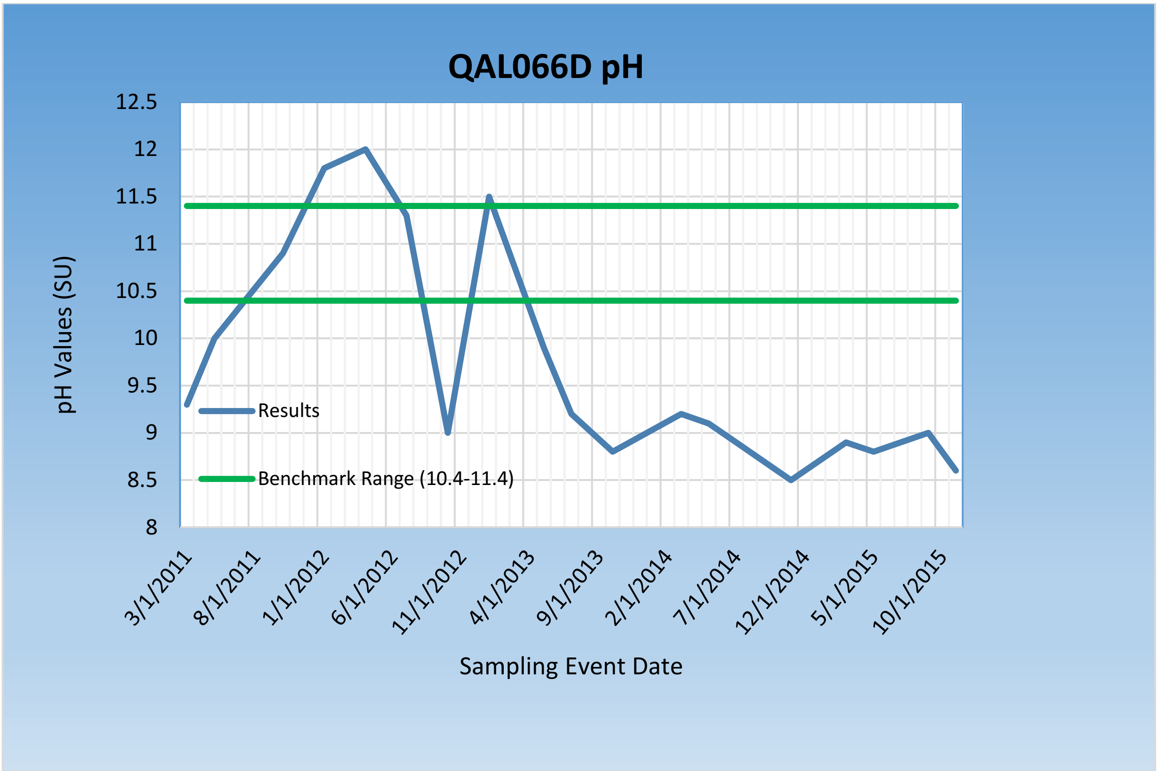

QAL063A Chloride
Chloride Levels (mg/L)
3.5
3
2.5
2
1.5
1
0.5
0
Results
Benchmark Value (1.7)
QAL063A
Sampling Event Date

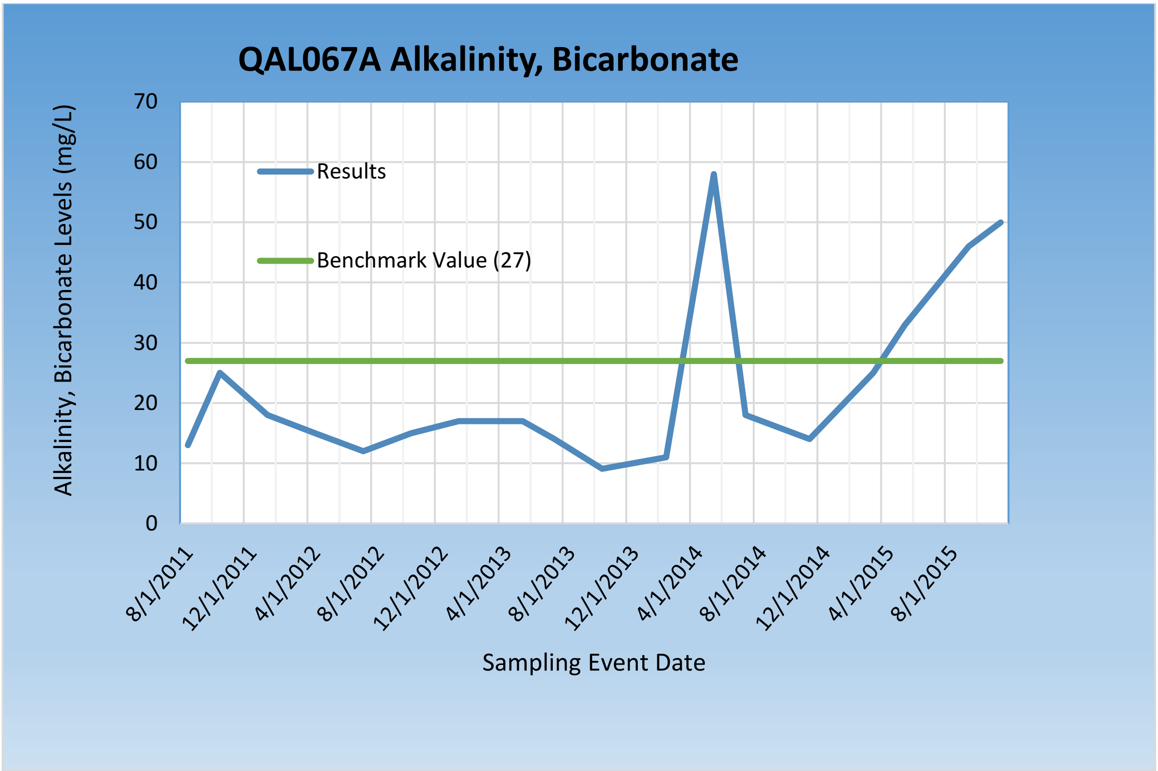

QAL063A Sodium
Sodium Levels (mg/L)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Results
Benchmark Value (0.78)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

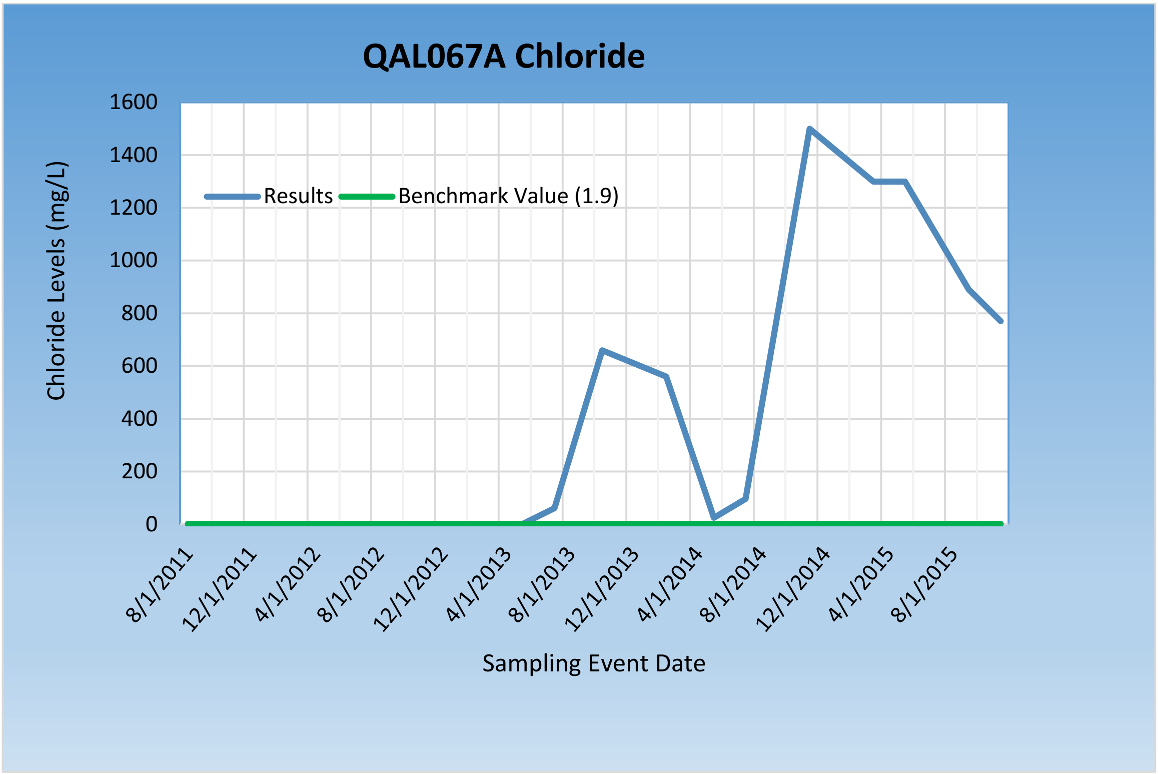

QAL064D Alkalinity, Bicarbonate
Alkalinity, Bicarbonate Levels (mg/L)
95
90
85
80
75
70
65
60
Results
Benchmark Value (69)
3/1/2011
8/1/2011
1/1/2012
6/1/2012
11/1/2012
4/1/2013
9/1/2013
2/1/2014
7/1/2014
12/1/2014
5/1/2015
10/1/2015
Sampling Event Date

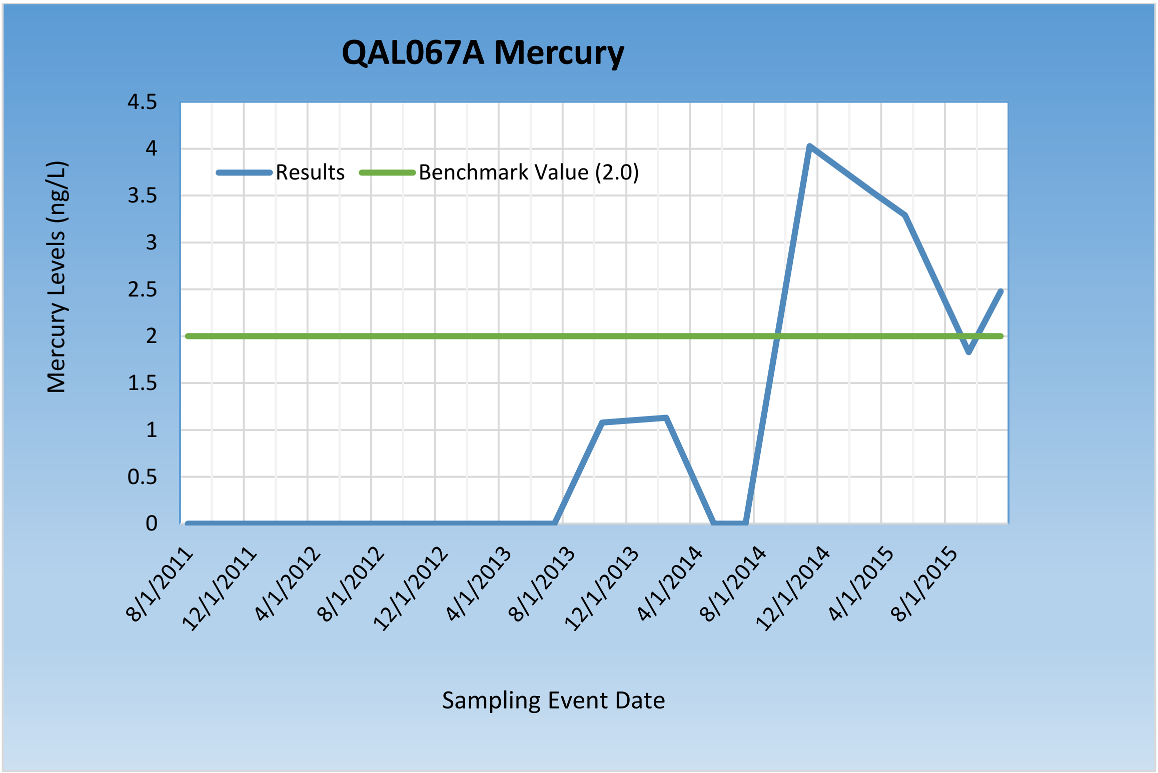

QAL066D Alkalinity, Bicarbonate
Alkalinity, Bicarbonate Levels (mg/L)
60
50
40
30
20
10
0
Results
Benchmark Value (45)
3/1/2011
8/1/2011
1/1/2012
6/1/2012
11/1/2012
4/1/2013
9/1/2013
2/1/2014
7/1/2014
12/1/2014
5/1/2015
10/1/2015
Sampling Event Date

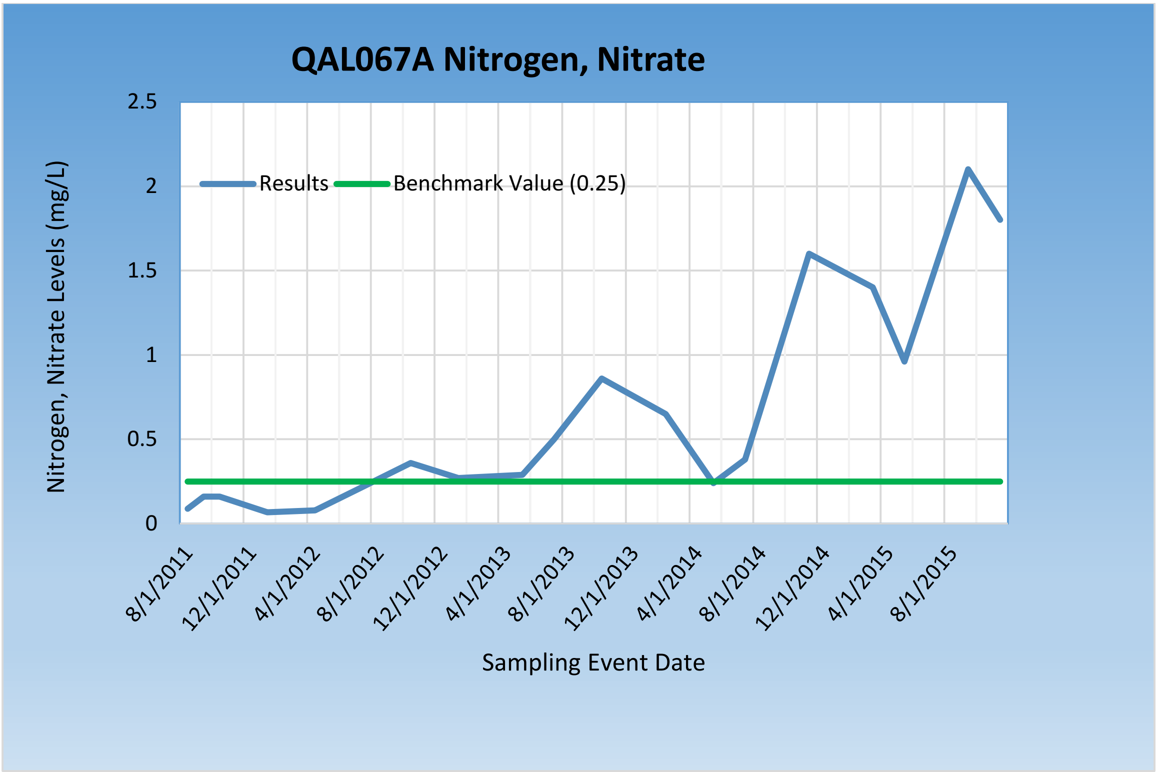

QAL066D Iron
Iron Levels (ug/L)
408
358
308
258
208
158
108
58
8
Results
Benchmark Value (49
3/1/2011
8/1/2011
1/1/2012
6/1/2012
11/1/2012
4/1/2013
9/1/2013
2/1/2014
7/1/2014
12/1/2014
5/1/2015
10/1/2015
Sampling Event Date

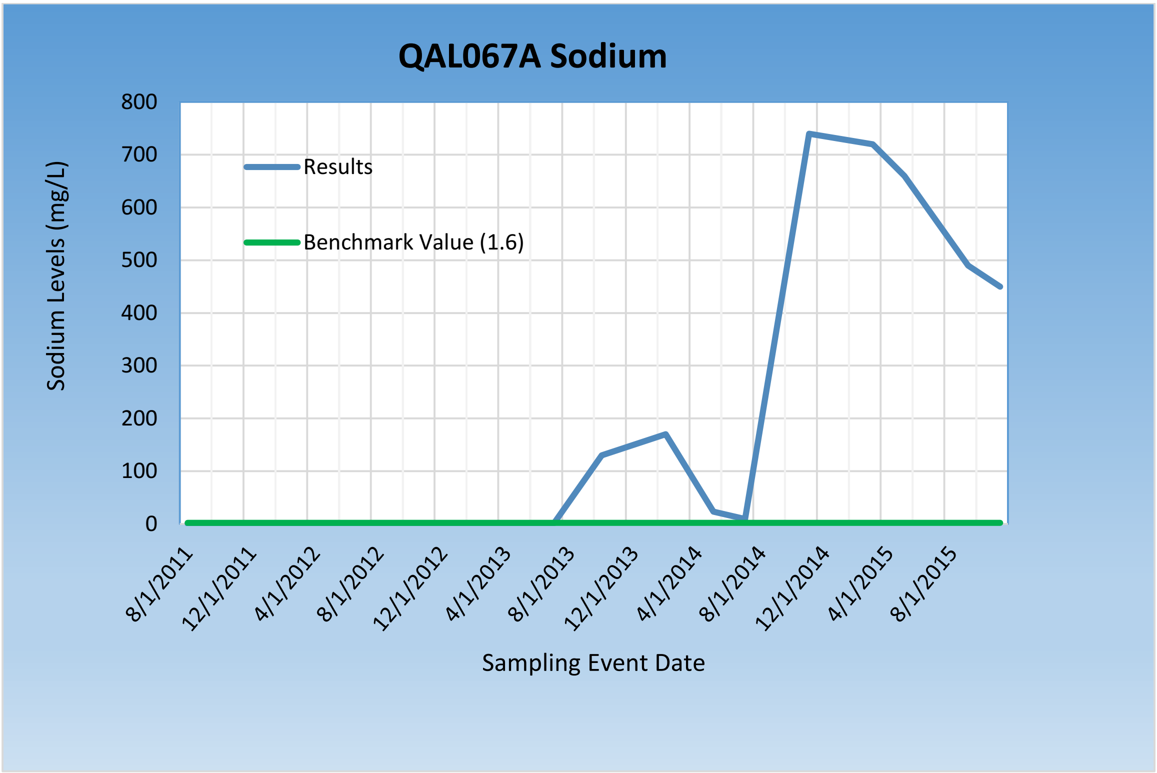

QAL066D pH
pH Values (SU)
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
Results
Benchmark Range (10.4-11.4)
3/1/2011
8/1/2011
1/1/2012
6/1/2012
11/1/2012
4/1/2013
9/1/2013
2/1/2014
7/1/2014
12/1/2014
5/1/2015
10/1/2015
Sampling Event Date

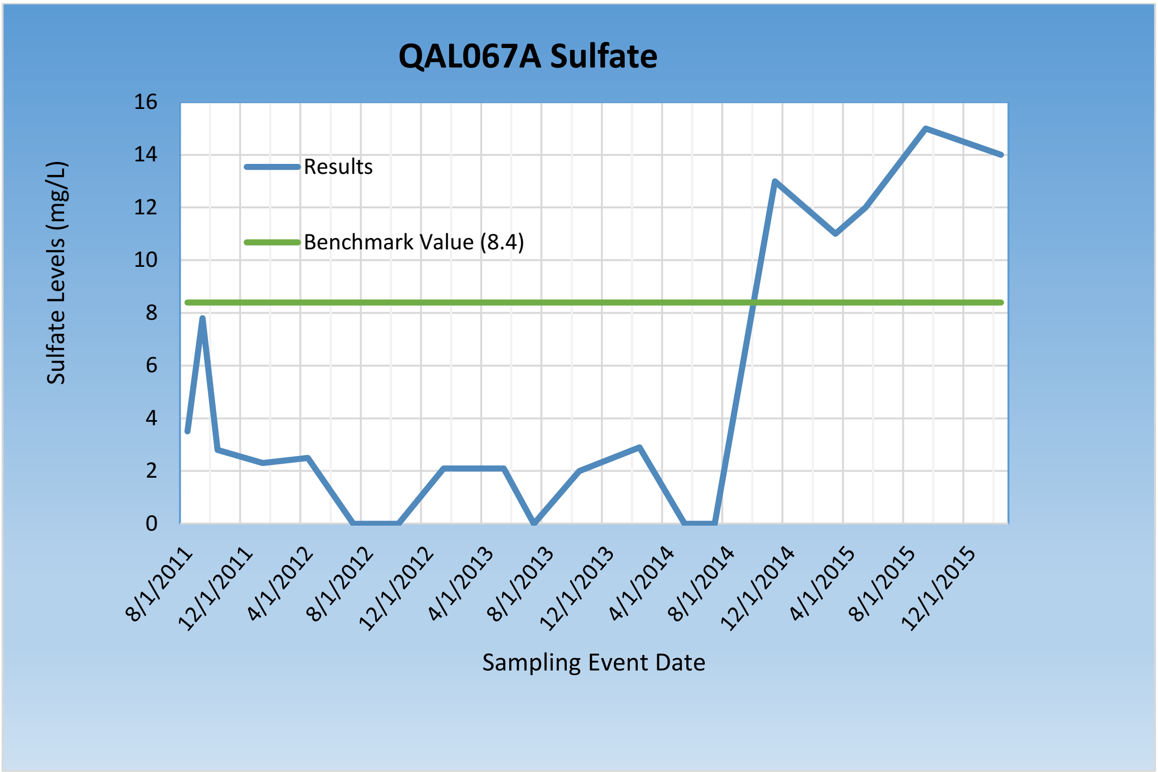

QAL067A Alkalinity, Bicarbonate
Alkalinity, Bicarbonate Levels (mg/L)
70
60
50
40
30
20
10
0
Results
Benchmark Value (27)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date


QAL067A Chloride
Chloride Levels (mg/L)
1600
1400
1200
1000
800
600
400
200
0
Results
Benchmark Value (1.9)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

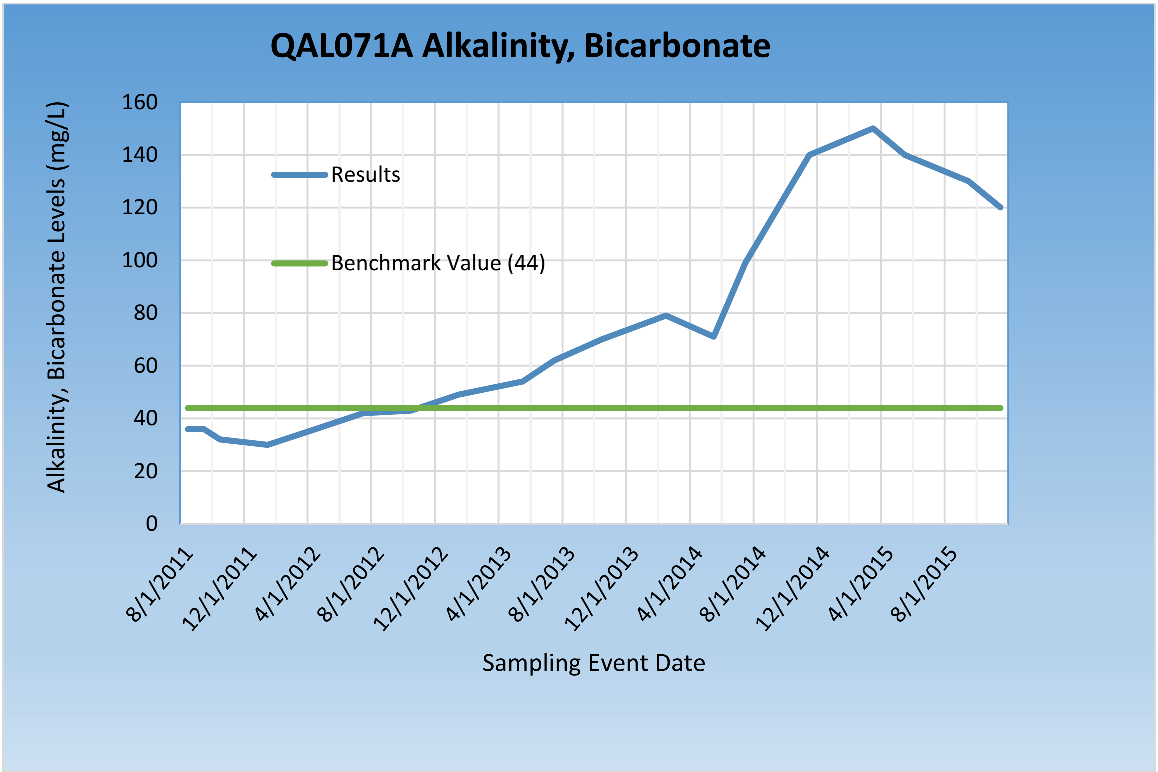

QAL067A Mercury
Mercury Levels (ng/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Results
Benchmark Value (2.0)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date


QAL067A Nitrogen, Nitrate
Nitrogen, Nitrate Levels (mg/L)
2.5
2
1.5
1
0.5
0
Results
Benchmark Value (0.25)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

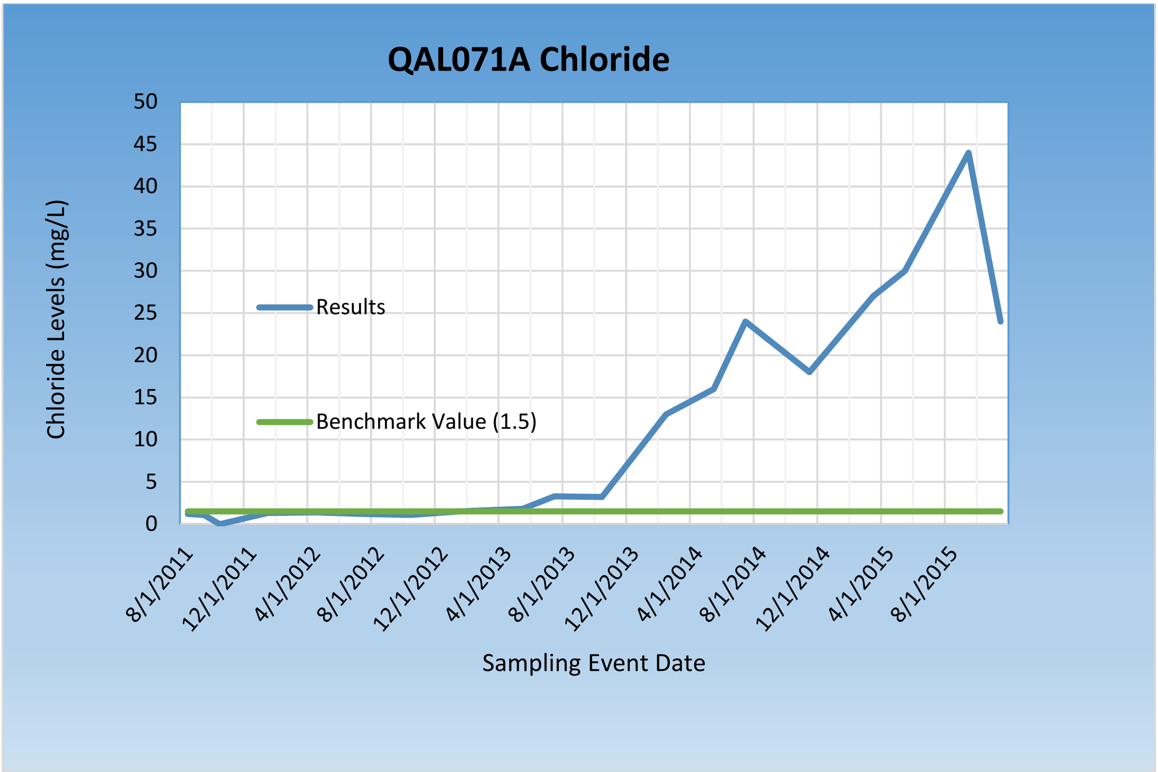

QAL067A Sodium
Sodium Levels (mg/L)
800
700
600
500
400
300
200
100
0
Results
Benchmark Value (1.6)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date



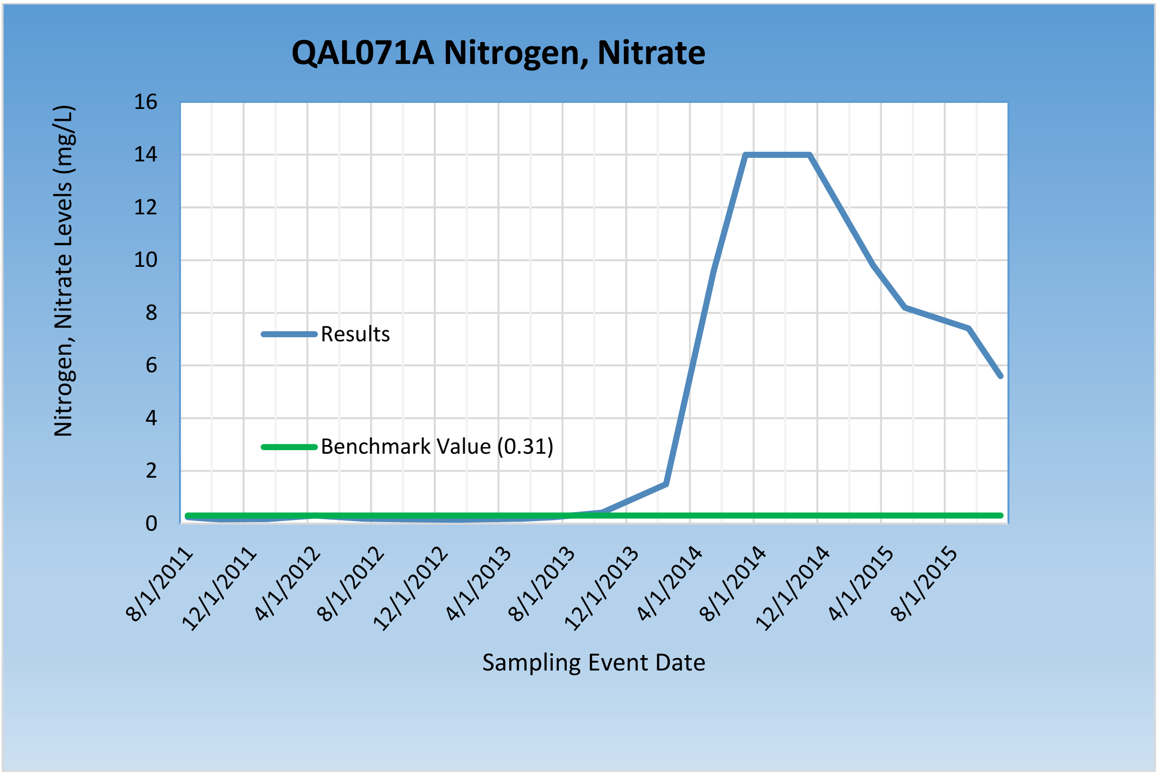
QAL067A Sulfate
Results
Benchmark Value (8.4)
Sulfate Levels (mg/L)
16
14
12
10
8
6
4
2
0
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
12/1/2015
Sampling Event Date



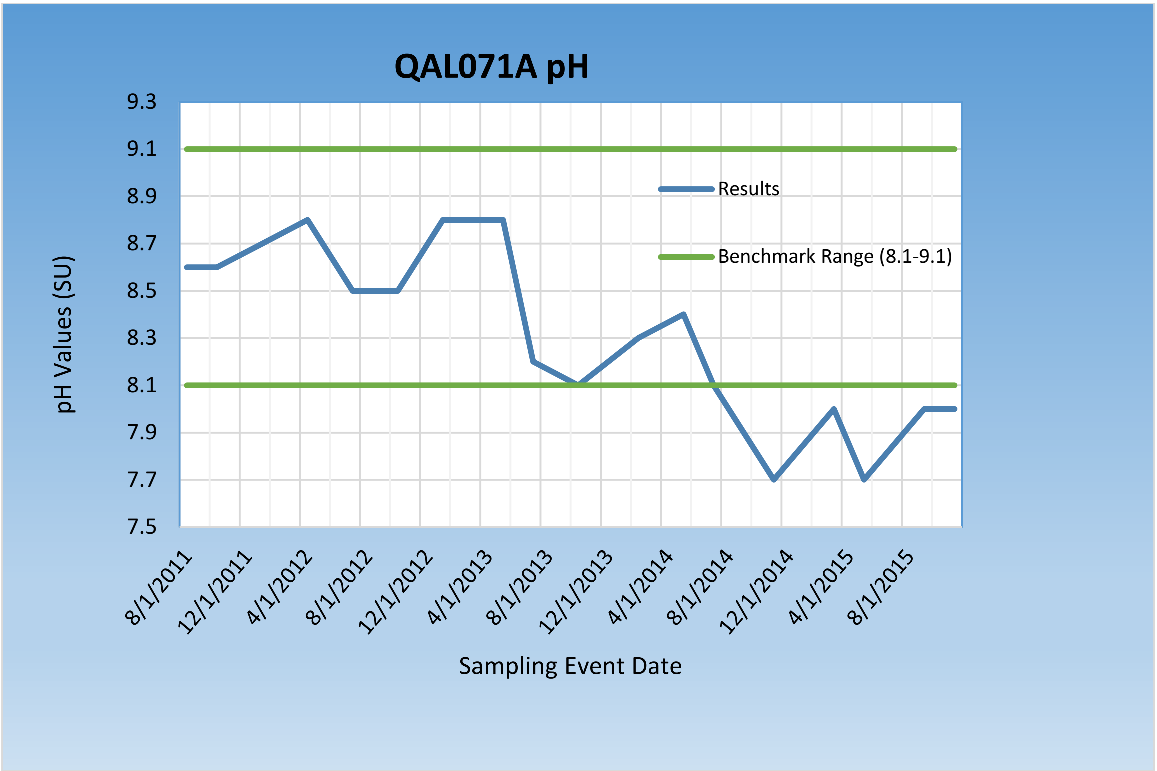
QAL071A Alkalinity, Bicarbonate
Results
Benchmark Value (44)
Alkalinity, Bicarbonate Levels (mg/L)
160
140
120
100
80
60
40
20
0
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date

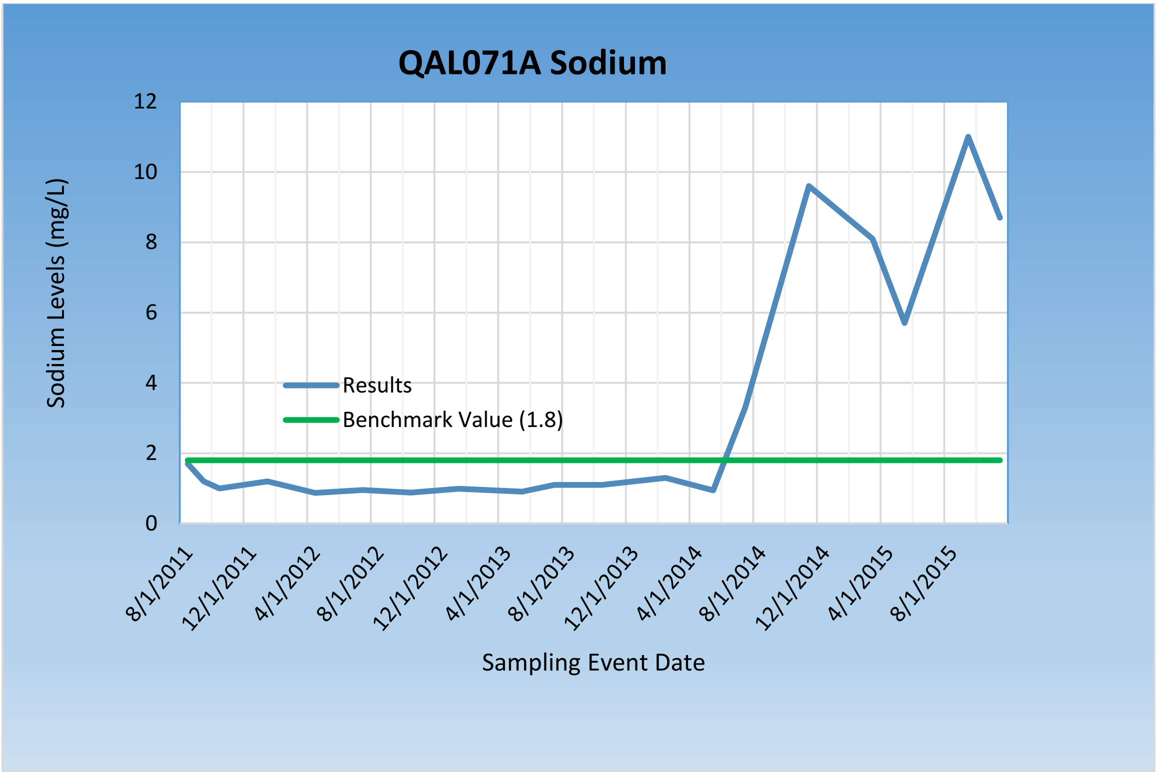


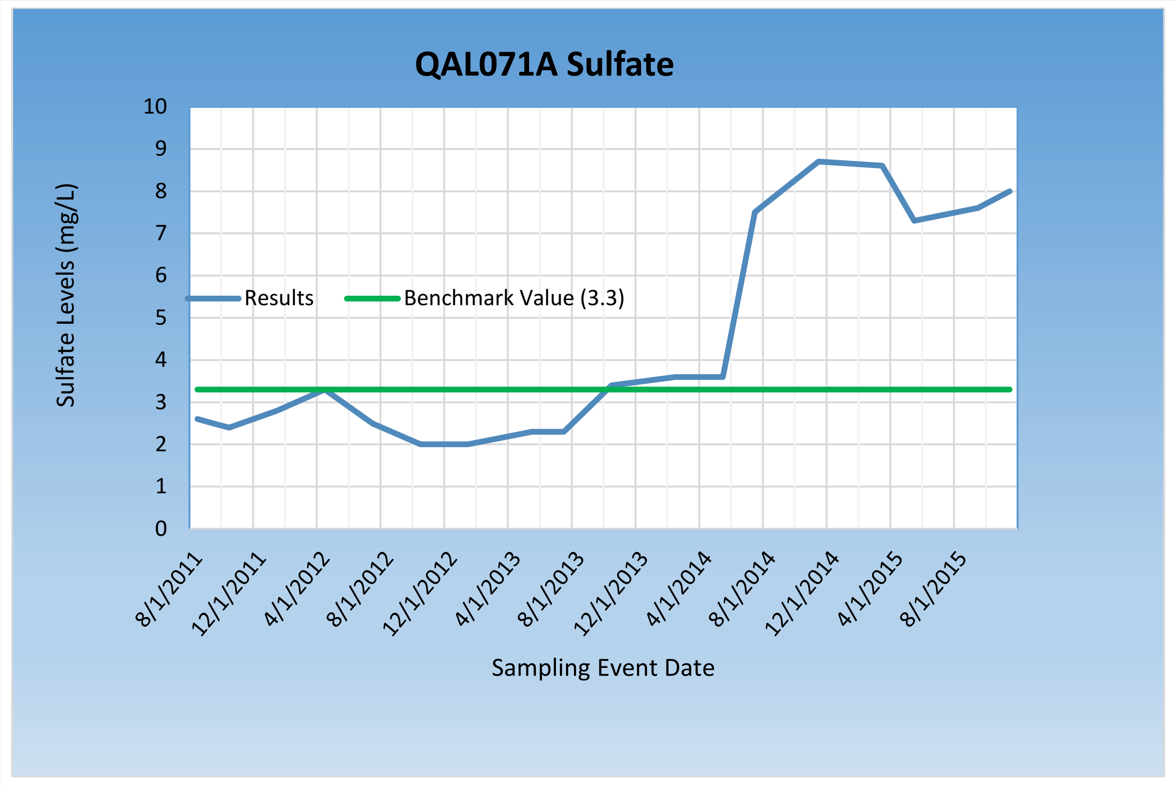
QAL071A Chloride
Chloride Levels (mg/L)
50
45
40
35
30
25
20
15
10
5
0
Results
Benchmark Value (1.5)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date



QAL071A Nitrogen, Nitrate
Nitrogen, Nitrate Levels (mg/L)
16
14
12
10
8
6
4
2
0
Results
Benchmark Value (0.31)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date


QAL071A pH
9.3
9.1
8.9
8.7
8.5
8.3
8.1
7.9
7.7
7.5
pH Values (SU)
Results
Benchmark Range (8.1-9.1)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date


QAL071A Sodium
12
10
8
6
4
2
0
Sodium Levels (mg/L)
Results
Benchmark Value (1.8)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date


QAL071A Sulfate
Sulfate Levels (mg/L)
10
9
8
7
6
5
4
3
2
1
0
Results
Benchmark Value (3.3)
8/1/2011
12/1/2011
4/1/2012
8/1/2012
12/1/2012
4/1/2013
8/1/2013
12/1/2013
4/1/2014
8/1/2014
12/1/2014
4/1/2015
8/1/2015
Sampling Event Date