

# **Ambient Ammonia in Cache Valley**

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## Introduction

Northern Utah and Southeast Idaho’s Cache Valley have a well-documented wintertime PM<sub>2.5</sub> issue. The main component of the local PM<sub>2.5</sub> is also well-known as ammonium nitrate (NH<sub>4</sub>NO<sub>3</sub>). Previous studies in 2006, 2016, and 2017 found Valley-wide ambient, wintertime ammonia (NH<sub>3</sub>) concentrations of 42, 56, and 75 ppb, respectively.

In April 2022, due to an outbreak of Avian Influenza (AI), a large local poultry facility had to depopulate more than 1.4 million birds. It was hypothesized that the sudden removal of one of Cache Valley’s more significant NH<sub>3</sub> sources could allow for an unusual opportunity to assess the atmospheric impacts of such an unplanned source reduction scenario. As such, a study was initiated for the winter of 2022/2023 to determine the spatial variability of ambient NH<sub>3</sub> using a network of 21 Ogawa passive NH<sub>3</sub> samplers and to examine potential changes in the area’s NH<sub>3</sub> distributions. The collected passives samples were analyzed at the Utah Water Research Laboratory (UWRL) via Ammonia Indophenol Low-Level Analysis. Additionally, a Picarro G2103 Cavity Ring Down Spectrometer (CRDS) and an AirMetrics MiniVol PM<sub>2.5</sub> sampler were collocated at one of the sites (Smithfield).

Unfortunately, during the field experiments, it was learned that the poultry facility had already begun repopulating the chickens. Regardless, three-week-long field studies running from Jan. 13<sup>th</sup> to Feb. 3<sup>rd</sup> were completed. Also, during the study period, NH<sub>3</sub> levels at three indoor locations were examined, as were 24-hr personal exposures from four volunteers.

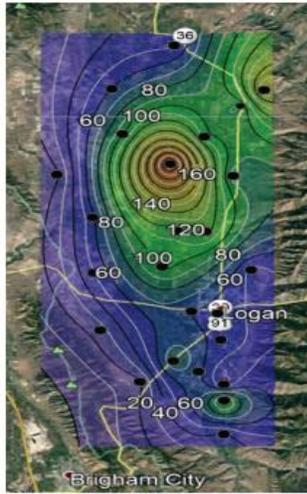
## Materials and Methods

Cache Valley is known to have the highest concentration of ammonia in the nation. In Cache Valley, agricultural activities such as livestock, chickens, and meek are primary sources of ammonia emissions. During the wintertime, when wintertime inversions can trap pollutants in the valley, ammonia levels can increase and contribute to poor air quality. An inversion is when a layer of warm air acts as a lid, trapping cooler air and pollutants near the surface. Cache Valley is surrounded by mountains, which can easily have the meteorological phenomenon of an inversion to trap the cold air and pollutants in the valley.

Previous studies done in 2006, 2016, 2017, and 2022 found Valley-wide ambient, wintertime ammonia (NH<sub>3</sub>) concentrations of 41, 153, 78, and 57 ppb, as shown in Table 1. 2006, 2016, and 2017 studies deployed network sampler around the valley, while 2022 study focused on the Smithfield site. The 2017 study shows the highest concentration in northern Cache Valley, shown in Figure 1.

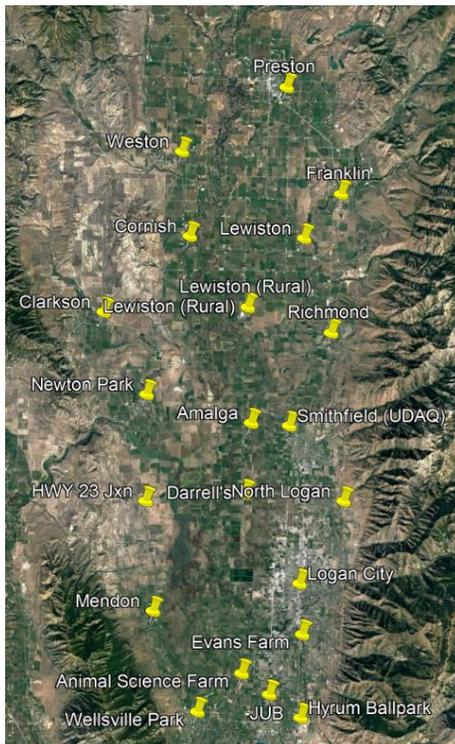
**Table 1.** Avg Cache valley winter NH<sub>3</sub> (Martin 2022)

<b>Year</b>	<b>Study Period (weeks)</b>	<b>ppb</b>
<b>2006</b>	<b>3</b>	<b>41</b>
<b>2016</b>	<b>5</b>	<b>153</b>
<b>2017</b>	<b>3</b>	<b>78</b>
<b>2022</b>	<b>7</b>	<b>57</b>



**Figure 1.** Avg NH<sub>3</sub> winter 2017 (Martin 2022)

Three different studies were done to find the concentration of ammonia. The three studies are outside Cache Valley ammonia, indoor ammonia, and volunteer personal ammonia study. The Cache Valley ammonia study was a three-week-long sample period from January 13, 2023, to February 3, 2023. This three-week study includes 21 outdoor sites around Cache Valley, shown in Figure 2. Additionally, during the same three weeks, three indoor sites were held. The volunteer personal exposure study was done for 24 hours from the days of February 2, 2023, to February 3, 2023.



**Figure 2.** Sample locations throughout Cache Valley

All the studies used the Ogawa Passive NH<sub>3</sub> samplers to find the ammonia concentrations, shown in Figure 3 and Figure 4. Figure 3 shows the passive sampler without the rain cover. Figure 4 shows the passive sampler with rain cover. These samplers are cost-effective, easy to deploy, and provide accurate measurements of ammonia concentrations over time. The analytical methodology was done using the NH<sub>3</sub> Indophenol Low Level with spectrophotometry. NH<sub>3</sub> Indophenol Low Level is a colorimetric method for measuring low concentrations of ammonia in the sample collected. All the analysis was done in a 24-hr after putting the reagents in.



**Figure 3.** Passive sampler without rain cover



**Figure 4.** Passive sampler without rain cover

## Results and Discussion

The following results are shown from the analysis of the data collected from the Cache Valley Ammonia study, indoor ammonia study, and volunteer-personal study. Information collection can be used to identify the concentrations of ammonia and the areas of concern. Additionally, the error for the measurements is included in the data. Calculations are shown in the appendix.

### Standardization

The Ammonia Indophenol Low-Level laboratory test was used to measure the concentration of ammonia in a sample. The concentration used in the laboratory was 10, 20, 50, 100, and 200 ml, as shown in Figure 5. During the test, the sample was mixed with reagents that react with the ammonia to form a blue-color compound. The intensity of the blue color is proportional to the amount of ammonia present in the sample, which can be measured using a spectrophotometer. Figure 6 shows the sample ready for measuring in the spectrophotometer.



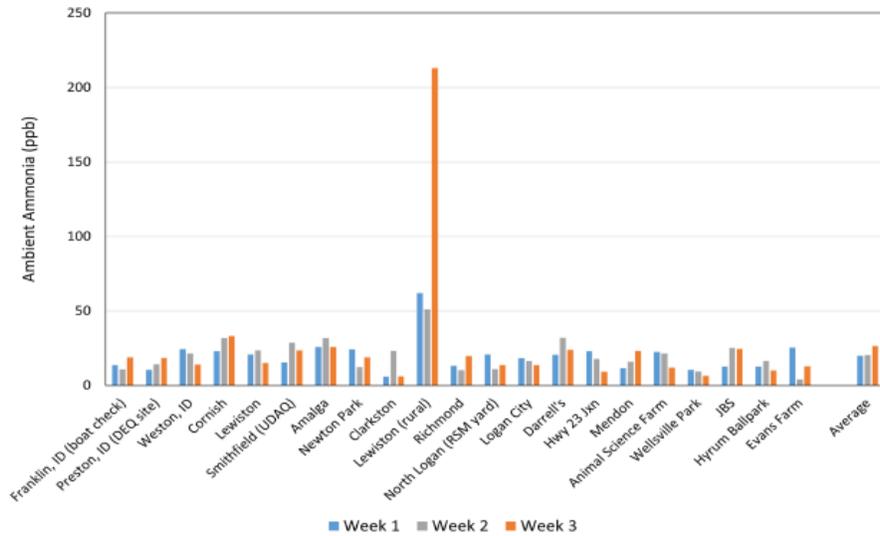
**Figure 5.** Known Ammonia concentration standards.



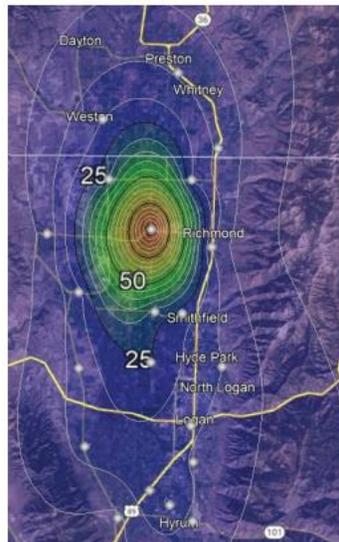
**Figure 6.** Sampler ready for Spectrophotometer

### **Cache Valley Ammonia study**

The Cache Valley Ammonia Study includes 21 locations around Cache Valley during a 3-week study period. The locations range from Preston, Idaho to Hyrum, Utah. During the second week study period, a storm occurred, which moved air throughout the valley, and many of the sites decreased. In the third week, there was an inversion, which caused many of the sites to increase. Figure 7 shows the winter 2023 Cache Valley ammonia through the valley. Figure 8 shows the ammonia spatial concentration throughout the valley.



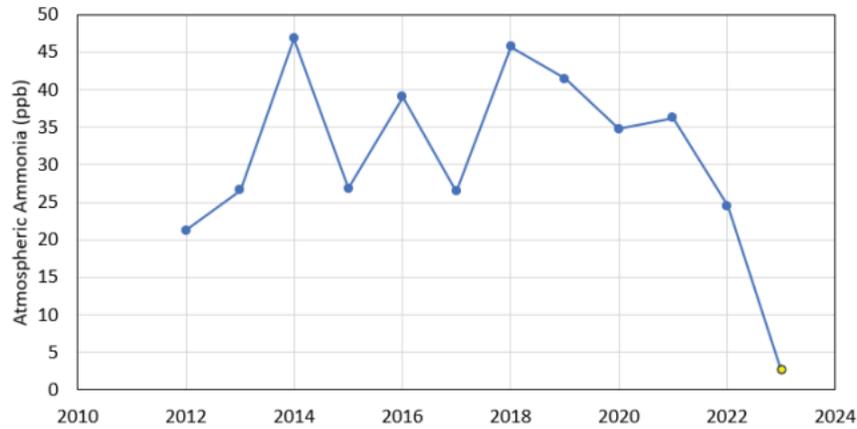
**Figure 7.** Winter 2023 Cache Valley Ammonia sample over a 3-week period



**Figure 8.** Ammonia spatial concentration

As seen in Figure 7 and Figure 8 the highest concentration is around Lewiston (rural). Lewiston (rural) is located near a poultry facility with a maximum concentration of  $108 \pm 74$  ppb. This poultry facility was affected by the Avian Flu outbreak in April 2022, which means they lost all their birds. Unknowing until doing the study, the poultry facility was repopulating the flock. In January 2023 the poultry facility was back to 71% of its 2017 population. Knowing they were not at full capacity, the study continued to see the ammonia concentrations around the valley.

Surprisingly, the average concentration for Cache Valley Winter 2023 was  $22.2 \pm 20$  ppb. This number was surprisingly lower than in previous years. NADP AMoN UT01 has a site near the Animal Science Building and is compared with the Cache Valley data to confirm accuracy. Figure 9 shows the NADP AMoN UT01 data from 2012 to 2023 in the month of January average concentration of ammonia.

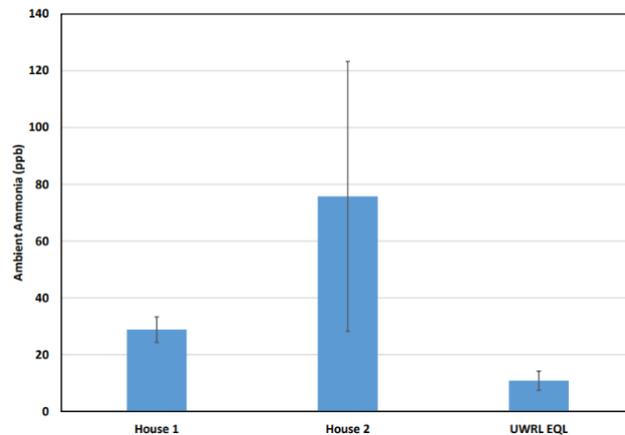


**Figure 9.** NADP AMoN UT01 Average January concentration of ammonia from 2012 to 2023.

The NADP AMoN shows higher ammonia values compared to the 2023 number. The average January ammonia from 2012 to 2022 was  $33.6 \pm 8.5$  ppb. The average January ammonia in 2023 is 2.6 ppb from preliminary data. Having the lower amount of ammonia in the atmosphere from the NADP AMoN site confirms the accuracy of the Cache Valley data.

### Indoor Ammonia Study

The indoor ammonia study includes three locations: house 1, house 2, and the Utah Water Research Laboratory Environmental Quality Lab (UWRL EQL). House 1 only has two adults living in the house. House 2 has 1 dog, 1 cat, and 2 adults living in the house. The UWRL EQL has many students and professors working in the lab during the day. Figure 9 shows the winter 2023 Cache Valley indoor ammonia level.

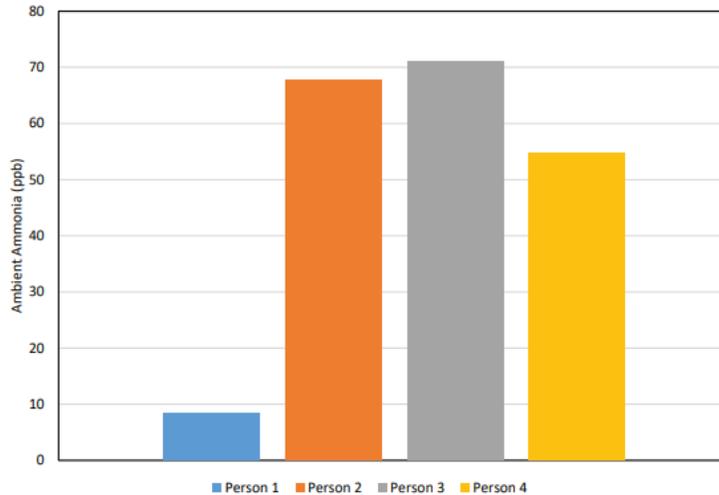


**Figure 10.** Winter 2023 Cache Valley Indoor ammonia

The average indoor ammonia levels are  $38.5 \pm 18.5$  ppb. The average for house 2 ammonia levels is  $75.8 \pm 48$  ppb. Indoor ammonia air sources can vary from cleaning products, fertilizers, and animal waste. House 2 has pets which is why there is a higher amount of ammonia, compared to the other indoor locations.

## Volunteer-Personal Study

The volunteer-personal study includes four volunteers wearing the Ogawa Passive NH<sub>3</sub> samplers for 24 hours. During the 24-hour period, most of the volunteers spent their time inside rather than outside. Also, person one lives in house 1 from the indoor ammonia study. Then person 4 lives in house 2 from the indoor ammonia study. Figure 11 shows the 24-hour personal ammonia exposure.



**Figure 11.** 24-hour personal ammonia exposure study

## Summary and Conclusion

In conclusion, there was a decrease in ammonia compared to previous winters. The average ammonia concentration for winter 2023 is 22 ppb. The potential decrease in agriculture industry production could be the result of the decrease in ammonia in the atmosphere. The local poultry facility had an Avian flu outbreak in April 2022 and is now back to 71% of its 2017 population. The Cache County Agriculture Office stated a likelihood of the number of cattle being down from past years due to drought and cold winter. The mink industry has also decreased since the industry is struggling. The high variability in indoor measurements could possibly be because of the number of pets in house 2. Personal exposure is like indoor air because house 1 and person 1 show lower concentrations, while house 2 and person 4 have high concentrations. Furthermore, this data strongly suggests the need to update Cache Valleys' ammonia emission inventory for a better understanding of the sources and impacts of atmospheric ammonia in Cache Valley.

## Reference

Martin, Randy. "Revisiting Cache valley Ambient Ammonia: Winter 2021/2022". *Utah State University: Utah Water Research Laboratory*. 2022

## Appendix

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## Appendix A: Ambient NH3 Compilation Winter Data 2022-2023

	Latitude	Longitude	UTM Zone 12		Elevation	Week 1	Week 2	Week 3	Average			
			UTM-N	UTM-E								
	(°)	(°)	(m)	(m)	(ft ASL)	NH <sub>3</sub> (ppb)	NH <sub>3</sub> (ppb)	NH <sub>3</sub> (ppb)	NH <sub>3</sub> (ppb)			
Franklin, ID (boat check)	42.00808	-111.80891	433,016	433,016	4506	13.7	10.7	18.8	14.4			
Preston, ID (DEQ site)	42.08274	-111.86355	428,575	428,575	4704	10.4	14.2	18.5	14.3			
Weston, ID	42.03509	-111.96168	420,399	420,399	4594	24.3	21.3	14.1	19.9			
Cornish	41.97529	-111.95195	421,131	421,131	4483	23.1	31.8	33.1	29.3			
Lewiston	41.97596	-111.84291	430,166	430,166	4509	20.7	23.5	15.0	19.7			
Smithfield (UDAQ)	41.84264	-111.85221	429,248	429,248	4525	15.3	28.6	23.5	22.5			
Amalga	41.84390	-111.88849	426,237	426,237	4448	25.7	31.8	25.8	27.8			
Newton Park	41.86213	-111.98863	417,947	417,947	4533	24.2	12.2	18.8	18.4			
Clarkston	41.91961	-112.03165	414,453	414,453	4803	5.9	23.1	6.1	11.7			
Lewiston (rural)	41.92589	-111.89482	425,807	425,807	4455	61.9	51.1	213.1	108.7	73.93492		
Richmond	41.90932	-111.81486	432,419	432,419	4613	13.2	10.1	19.7	14.3			
North Logan (RSM yard)	41.79028	-111.79864	433,641	433,641	4788	20.7	10.8	13.7	15.1			
Logan City	41.73095	-111.83820	430,290	430,290	4534	18.3	16.4	13.7	16.1			
Darrell's	41.79348	-111.89235	425,859	425,859	4433	20.6	32.0	23.8	25.5			
Hwy 23 Jxn	41.78644	-111.98669	425,861	425,861	4447	23.0	17.9	9.1	16.7			
Mendon	41.70855	-111.97659	418,753	418,753	5	11.5	15.9	23.1	16.9		Average	Std Dev
Animal Science Farm	41.66600	-111.89080	425,841	425,841	4492	22.5	21.5	11.9	18.6			
Wellsville Park	41.63800	-111.93170	422,403	422,403	4540	10.4	9.3	6.4	8.7		22.2	20.0
JBS	41.65170	-111.86410	428,048	428,048	4552	12.6	25.2	24.5	20.7			
Hyrum Ballpark	41.63610	-111.83380	430,554	430,554	4798	12.5	16.4	10.0	13.0			
Evans Farm	41.69500	-111.83450	430,559	430,559	4521	25.4	4.0	12.8	14.1			
											Residential Houses only	
Average						19.8	20.4	26.4	22.2		52.3	45.0
											Avg	Std Dev
House 1						23.8	34.8	27.9	28.8	4.5		
House 2			4,626,792	433,646	4791	8.7	112.6	106.0	75.8	47.5		
UWRL EQL			4,621,157	433,983	4669	15.3	10.1	7.2	10.9	3.4		
										38.5	18.5	
Person 1									8.4			
Person 2									67.7			
Person 3									71.2			
Person 4									54.8			
									Avg	50.5	29.0	
									Avg bottom 3	64.5	8.64	9.8
										74.3	54.8	
									UL			
									LL			
									Std Dev	95% CI		

Spectrophotometer calibration (12-19-22) - see below4

Sample ID (if applicable)	Location	Start	Start	End	End	Sample Duration		Ambient	Pbar	DNH3	mPEC	mSSS	QNH3 Diff	Spectro NH4	Spectro NH4	Sample NH4	Sample NH3	mass	Amb NH3	Amb NH3
		Date	Time	Date	Time	(Days)	(Minutes)	T (°C)	(atm)	(cm²/s)	(cm²/s)	(cm²/s)	(c m²/min)	(Absorbance)	(µg/L)	(mg/L)	(µg)	(µg/m³)	(ppb)	
RSM Inside		11/30/2022	18:51	12/7/2022	20:33	7.07	10,182	20	0.845	0.226	0.295	1.716	15.1	0.549	491.3	6.1413	46.4	301.3	504.6	
ML (Lambright)		12/1/2022	10:50	12/8/2022	12:20	7.06	10,170	20	0.845	0.226	0.295	1.716	15.1	0.092	1.1	0.0142	0.1	0.7	1.2	
RKD (Dupont)		11/30/2022	18:00	12/7/2022	18:24	7.02	10,104	22	0.845	0.229	0.299	1.737	15.3	0.200	117.4	1.4673	11.1	71.7	120.8	

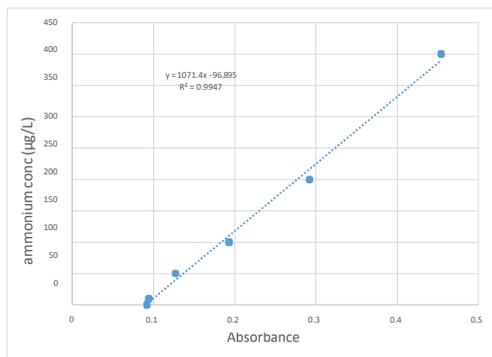
T(indoor) assumed to be 20°C

P(Bar) average obtained from weather.usu.edu (climate data)

Of the original 8 mL from the Ogawa pad elution, 4 mL was diluted to 50 mL for the Spectrographic analysis

-- therefore,  $C_{\text{sample}} = (50/4) * C_{\text{spectr}} = 12.5 * C_{\text{spectr}}$

0	0.092
10	0.094
50	0.127
100	0.193
200	0.292
400	0.454



Week 1 – 1/13/2023 through 1/20/2023

Locatio	Start Date	Start Time	End Date	End Time	Sample Duration (Days)	Sample Duration (Minutes)	Ambient T	Pbar (atm)	DNH3 (cm <sup>2</sup> /s)	mPEC (cm <sup>3</sup> /s)	mSSS (cm <sup>3</sup> /s)	QN <sub>H3</sub> (cm <sup>3</sup> /min)	Elution Vol (mL): 8				
													IC (mg/L)	NH <sub>3</sub> mass NH <sub>3</sub>	Amb NH <sub>3</sub>	NH <sub>3</sub> Amb	
UWRL Room 329	1/1/2023	----	----	----									blanks accounted for in absorbance spreadsheet				
Franklin, ID (boat check)	1/13/2023	14:02	1/20/2023	13:17	6.97	10,035							0.0770				
Preston, ID (DEQ site)	1/13/2023	14:16	1/20/2023	13:32	6.97	10,036	-2.4	0.848	0.196	0.256	1.486	13.1	0.1547	1.2	8.9	13.7	
Weston, ID	1/13/2023	14:41	1/20/2023	13:58	6.97	10,037	-2.4	0.848	0.196	0.256	1.486	13.1	0.1172	0.9	6.7	10.4	
Cornish	1/13/2023	14:54	1/20/2023	14:08	6.97	10,034	-2.4	0.848	0.196	0.256	1.486	13.1	0.2740	2.1	15.7	24.3	
Lewiston	1/13/2023	15:07	1/20/2023	14:21	6.97	10,034	-2.4	0.848	0.196	0.256	1.486	13.1	0.2602	2.0	15.0	23.1	
Smithfield (UDAQ)	1/13/2023	19:50	1/20/2023	13:52	6.75	9,722	-2.4	0.848	0.196	0.256	1.486	13.1	0.2331	1.8	13.4	20.7	
Amalga	1/13/2023	10:28	1/20/2023	16:15	7.24	10,427	-2.4	0.848	0.196	0.256	1.486	13.1	0.1675	1.3	9.9	15.3	
Newton Park	1/13/2023	10:45	1/20/2023	16:26	7.24	10,421	-2.4	0.848	0.196	0.256	1.486	13.1	0.3018	2.3	16.7	25.7	
Clarkston	1/13/2023	11:02	1/20/2023	16:38	7.23	10,416	-2.4	0.848	0.196	0.256	1.486	13.1	0.2838	2.1	15.7	24.2	
Lewiston (rural)	1/13/2023	11:16	1/20/2023	16:52	7.23	10,416	-2.4	0.848	0.196	0.256	1.486	13.1	0.0688	0.5	3.8	5.9	
Richmond	1/13/2023	11:39	1/20/2023	17:05	7.23	10,406	-2.4	0.848	0.196	0.256	1.486	13.1	0.7256	5.5	40.2	61.9	
North Logan (RSM yard)	1/13/2023	11:58	1/20/2023	17:27	7.23	10,409	-2.4	0.848	0.196	0.256	1.486	13.1	0.1547	1.2	8.6	13.2	
Logan City	1/13/2023	16:14	1/20/2023	15:11	6.96	10,017	-2.4	0.848	0.196	0.256	1.486	13.1	0.2060	1.6	11.9	18.3	
Darrell's	1/13/2023	16:30	1/20/2023	16:09	6.99	10,059	-2.4	0.848	0.196	0.256	1.486	13.1	0.2331	1.8	13.4	20.6	
Hwy 23 Jxn	1/13/2023	16:42	1/20/2023	15:55	6.97	10,033	-2.4	0.848	0.196	0.256	1.486	13.1	0.2597	2.0	14.9	23.0	
Mendon	1/13/2023	16:56	1/20/2023	15:40	6.95	10,004	-2.4	0.848	0.196	0.256	1.486	13.1	0.1296	1.0	7.5	11.5	
Animal Science Farm	1/13/2023	17:21	1/20/2023	16:36	6.97	10,035	-2.4	0.848	0.196	0.256	1.486	13.1	0.2534	1.9	14.6	22.5	
Wellsville Park	1/13/2023	17:11	1/20/2023	16:49	6.98	10,058	-2.4	0.848	0.196	0.256	1.486	13.1	0.1172	0.9	6.7	10.4	
JBS	1/13/2023	17:34	1/20/2023	17:05	6.98	10,051	-2.4	0.848	0.196	0.256	1.486	13.1	0.1421	1.1	8.2	12.6	
Hyrum Ballpark	1/13/2023	17:47	1/20/2023	17:47	7.00	10,080	-2.4	0.848	0.196	0.256	1.486	13.1	0.1421	1.1	8.1	12.5	
Evans Farm	1/13/2023	17:55	1/20/2023	17:38	6.99	10,063	-2.4	0.848	0.196	0.256	1.486	13.1	0.2880	2.2	16.5	25.4	
ML Home	1/14/2023	19:00	1/20/2023	14:53	5.83	8,393	20	0.848	0.226	0.295	1.716	15.1	0.2398	1.8	14.3	23.8	
RSM Home	1/13/2023	19:20	1/20/2023	17:31	6.92	9,971	20	0.848	0.226	0.295	1.716	15.1	0.1040	0.8	5.2	8.7	
UWRL EQL	1/13/2023	18:34	1/20/2023	14:02	6.81	9,808	20	0.848	0.226	0.295	1.716	15.1	0.18040	1.4	9.2	15.3	

Week 2 – 1/20/2023 through 1/27/2023

Elution Vol (mL): 8

Location	Start Date	Start Time	End Date	End Time	Sample Duration (Days) (Minutes)	Ambient	P <sub>bar</sub>	D <sub>NH3</sub>	m <sub>PEC</sub>	m <sub>SSS</sub>	Q <sub>NH3 Diff</sub>	IC NH <sub>4</sub> NH <sub>3</sub> mass Amb NH <sub>3</sub> Amb NH <sub>3</sub> (mg/L)			
						T (°C)	(atm)	(cm <sup>3</sup> /s)	(cm <sup>3</sup> /s)	(cm <sup>3</sup> /min)	(µg)	(µg/m <sup>3</sup> )	(ppb)		
UWRL Room 329	1/19/2023		1/27/2023									blanks accounted for in absorbance spreadsheet			
Franklin, ID (boat check)	1/20/2023	13:17	1/27/2023	14:36	7.05 10,159	-7.942	0.86	0.188	0.246	1.432	12.6	0.122	0.9	7.2	10.7
Preston, ID (DEQ site)	1/20/2023	13:32	1/27/2023	14:47	7.05 10,155	-7.942	0.86	0.188	0.246	1.432	12.6	0.1617	1.2	9.5	14.2
Weston, ID	1/20/2023	13:58	1/27/2023	15:08	7.05 10,150	-7.942	0.86	0.188	0.246	1.432	12.6	0.2430	1.8	14.3	21.3
Cornish	1/20/2023	14:08	1/27/2023	15:18	7.05 10,150	-7.942	0.86	0.188	0.246	1.432	12.6	0.3615	2.7	21.3	31.8
Lewiston	1/20/2023	14:21	1/27/2023	15:30	7.05 10,149	-7.942	0.86	0.188	0.246	1.432	12.6	0.2679	2.0	15.8	23.5
Smithfield (UDAQ)	1/20/2023	13:53	1/27/2023	15:38	7.07 10,185	-7.942	0.86	0.188	0.246	1.432	12.6	0.3271	2.5	19.2	28.6
Amalga	1/20/2023	16:16	1/27/2023	15:56	6.99 10,060	-7.942	0.86	0.188	0.246	1.432	12.6	0.3583	2.7	21.3	31.8
Newton Park	1/20/2023	16:26	1/27/2023	16:07	6.99 10,061	-7.942	0.86	0.188	0.246	1.432	12.6	0.1379	1.0	8.2	12.2
Clarkston	1/20/2023	16:38	1/27/2023	16:21	6.99 10,063	-7.942	0.86	0.188	0.246	1.432	12.6	0.2609	2.0	15.5	23.1
Lewiston (rural)	1/20/2023	16:52	1/27/2023	16:37	6.99 10,065	-7.942	0.86	0.188	0.246	1.432	12.6	0.5772	4.4	34.3	51.1
Richmond	1/20/2023	17:02	1/27/2023	16:48	6.99 10,066	-7.942	0.86	0.188	0.246	1.432	12.6	0.1143	0.9	6.8	10.1
North Logan (RSM yard)	1/20/2023	17:29	1/27/2023	17:14	6.99 10,065	-7.942	0.86	0.188	0.246	1.432	12.6	0.1221	0.9	7.3	10.8
Logan City	1/20/2023	15:13	1/27/2023	15:15	7.00 10,082	-7.942	0.86	0.188	0.246	1.432	12.6	0.1858	1.4	11.0	16.4
Darrell's	1/20/2023	16:10	1/27/2023	16:07	7.00 10,077	-7.942	0.86	0.188	0.246	1.432	12.6	0.3615	2.7	21.5	32.0
Hwy 23 Jxn	1/20/2023	15:55	1/27/2023	15:55	7.00 10,080	-7.942	0.86	0.188	0.246	1.432	12.6	0.2020	1.5	12.0	17.9
Mendon	1/20/2023	15:41	1/27/2023	15:40	7.00 10,079	-7.942	0.86	0.188	0.246	1.432	12.6	0.1803	1.4	10.7	15.9
Animal Science Farm	1/20/2023	16:37	1/27/2023	16:49	7.01 10,092	-7.942	0.86	0.188	0.246	1.432	12.6	0.2430	1.8	14.4	21.5
Wellsville Park	1/20/2023	16:50	1/27/2023	17:01	7.01 10,091	-7.942	0.86	0.188	0.246	1.432	12.6	0.1050	0.8	6.2	9.3
JBS	1/20/2023	17:06	1/27/2023	17:17	7.01 10,091	-7.942	0.86	0.188	0.246	1.432	12.6	0.2847	2.2	16.9	25.2
Hyrum Ballpark	1/20/2023	17:21	1/27/2023	17:32	7.01 10,091	-7.942	0.86	0.188	0.246	1.432	12.6	0.1852	1.4	11.0	16.4
Evans Farm	1/20/2023	17:39	1/27/2023	17:44	7.00 10,085	-7.942	0.86	0.188	0.246	1.432	12.6	0.0450	0.3	2.7	4.0
ML Home	1/20/2023	18:23	1/27/2023	15:57	6.90 9,934	-7.942	0.86	0.188	0.246	1.432	12.6	0.3876	2.9	23.4	34.8
RSM Home	1/22/2023	15:40	1/27/2023	19:52	5.17 7,452	-7.942	0.86	0.188	0.246	1.432	12.6	0.9411	7.1	75.6	112.6
UWRL EQL	1/20/2023	14:04	1/27/2023	14:44	7.03 10,120	-7.942	0.86	0.188	0.246	1.432	12.6	0.11430	0.9	6.8	10.1

Week 3 – 1/27/2023 through 2/3/2023

Location	Start Date	Start Time	End Date	End Time	Sample Duration (Days) (Minutes)	Ambient T (°C)	P <sub>bar</sub> (atm)	D <sub>NH3</sub> (cm <sup>2</sup> /s)	m <sub>PEC</sub> (cm <sup>3</sup> /s)	m <sub>SSS</sub> (cm <sup>3</sup> /s)	Q <sub>NH3 Diff</sub> (cm <sup>3</sup> /min)	IC NH <sub>4</sub> (mg/L)	NH <sub>3</sub> mass (µg)	Amb NH <sub>3</sub> (µg/m <sup>3</sup> )	Amb NH <sub>3</sub> (ppb)
UWRLRoom329	1/26/2023											blanks accounted for in absorbance spreadsheet			
Franklin, ID (boat check)	1/27/2023	14:36	2/3/2023	13:40	6.96 10,024	-14.6	0.86	0.180	0.235	1.367	12.0	0.2067	1.6	12.9	18.8
Preston, ID (DEQ site)	1/27/2023	14:47	2/3/2023	13:54	6.96 10,027	-14.6	0.86	0.180	0.235	1.367	12.0	0.2029	1.5	12.7	18.5
Weston, ID	1/27/2023	15:08	2/3/2023	14:15	6.96 10,027	-14.6	0.86	0.180	0.235	1.367	12.0	0.1547	1.2	9.7	14.1
Cornish	1/27/2023	15:18	2/3/2023	14:27	6.96 10,029	-14.6	0.86	0.180	0.235	1.367	12.0	0.3637	2.7	22.7	33.1
Lewiston	1/27/2023	15:30	2/3/2023	14:40	6.97 10,030	-14.6	0.86	0.180	0.235	1.367	12.0	0.1650	1.2	10.3	15.0
Smithfield (UDAQ)	1/27/2023	15:39	2/3/2023	15:40	7.00 10,081	-14.6	0.86	0.180	0.235	1.367	12.0	0.2596	2.0	16.1	23.5
Amalga	1/27/2023	15:56	2/3/2023	16:03	7.00 10,087	-14.6	0.86	0.180	0.235	1.367	12.0	0.2854	2.2	17.7	25.8
Newton Park	1/27/2023	16:07	2/3/2023	16:12	7.00 10,085	-14.6	0.86	0.180	0.235	1.367	12.0	0.2073	1.6	12.9	18.8
Clarkston	1/27/2023	16:21	2/3/2023	16:23	7.00 10,082	-14.6	0.86	0.180	0.235	1.367	12.0	0.0675	0.5	4.2	6.1
Lewiston (rural)	1/27/2023	16:37	2/3/2023	16:38	7.00 10,081	-14.6	0.86	0.180	0.235	1.367	12.0	2.3549	17.8	146.5	213.1
Richmond	1/27/2023	16:48	2/3/2023	16:47	7.00 10,079	-14.6	0.86	0.180	0.235	1.367	12.0	0.2173	1.6	13.5	19.7
North Logan (RSM yard)	1/27/2023	17:14	2/3/2023	17:07	7.00 10,073	-14.6	0.86	0.180	0.235	1.367	12.0	0.1513	1.1	9.4	13.7
Logan City	1/27/2023	15:15	2/3/2023	15:42	7.02 10,107	-14.6	0.86	0.180	0.235	1.367	12.0	0.1513	1.1	9.4	13.7
Darrell's	1/27/2023	16:07	2/3/2023	16:35	7.02 10,108	-14.6	0.86	0.180	0.235	1.367	12.0	0.2636	2.0	16.4	23.8
Hwy 23 Jxn	1/27/2023	15:55	2/3/2023	16:20	7.02 10,105	-14.6	0.86	0.180	0.235	1.367	12.0	0.1006	0.8	6.2	9.1
Mendon	1/27/2023	15:40	2/3/2023	16:08	7.02 10,108	-14.6	0.86	0.180	0.235	1.367	12.0	0.2564	1.9	15.9	23.1
Animal Science Farm	1/27/2023	16:50	2/3/2023	16:35	6.99 10,065	-14.6	0.86	0.180	0.235	1.367	12.0	0.1308	1.0	8.1	11.9
Wellsville Park	1/27/2023	17:02	2/3/2023	16:46	6.99 10,064	-14.6	0.86	0.180	0.235	1.367	12.0	0.0708	0.5	4.4	6.4
JBS	1/27/2023	17:18	2/3/2023	17:00	6.99 10,062	-14.6	0.86	0.180	0.235	1.367	12.0	0.2705	2.0	16.9	24.5
Hyrum Ballpark	1/27/2023	17:33	2/3/2023	17:13	6.99 10,060	-14.6	0.86	0.180	0.235	1.367	12.0	0.1106	0.8	6.9	10.0
Evans Farm	1/27/2023	17:45	2/3/2023	17:23	6.98 10,058	-14.6	0.86	0.180	0.235	1.367	12.0	0.1410	1.1	8.8	12.8
ML Home	1/27/2023	16:00	2/3/2023	15:13	6.97 10,033	-14.6	0.86	0.180	0.235	1.367	12.0	0.3073	2.3	19.2	27.9
RSM Home	1/27/2023	17:52	2/3/2023	17:09	6.97 10,037	-14.6	0.86	0.180	0.235	1.367	12.0	1.1660	8.8	72.9	106.0
UWRL EQL	1/27/2023	14:44	2/3/2023	17:53	7.13 10,269	-14.6	0.86	0.180	0.235	1.367	12.0	0.08070	0.6	4.9	7.2

Personal 24-hour Data: 2/2/2023/ through 2/3/2023

Elution Vol (mL): 8

Location	Start Date	Start Time	End Date	End Time	Sample Duration		Ambient Diff T (°C)	Pbar (atm)	DNH3 (cm <sup>2</sup> /s)	mPEC (cm <sup>3</sup> /s)	mSSS (cm <sup>3</sup> /s)	QN <sub>H3</sub> (cm <sup>3</sup> /min)	IC NH <sub>3</sub> (mg/L)	NH <sub>3</sub> mass (µg)	Amb NH <sub>3</sub> (µg/m <sup>3</sup> )	Amb NH <sub>3</sub> (ppb)
					(Days)	(Minutes)										
Lab Blank	2/2/2023		2/3/2023		1.00	1,440										
1	2/2/2023	15:57	2/3/2023	15:40	0.99	1,423	-15.67	0.86	0.179	0.234	1.357	12.0	0.0130	0.1	5.8	8.4
2	2/3/2023		2/4/2023		1.00	1,440	-15.67	0.86	0.179	0.234	1.357	12.0	0.1065	0.8	46.7	67.7
3	2/4/2023	15:57	2/5/2023	16:15	1.01	1,458	-15.67	0.86	0.179	0.234	1.357	12.0	0.1134	0.9	49.1	71.2
4	2/5/2023	15:45	2/6/2023	17:37	1.08	1,552	-15.67	0.86	0.179	0.234	1.357	12.0	0.0929	0.7	37.8	54.8

# Appendix B: Lab Data Ammonia Levels

Cache Valley Ammonia Stud

Date: Friday, January 27, 2023

Duplicates: HWY23, North Logan, Logan City, Evan's Farm, and Newton park

Equation:  $1224.2x^2 + 321.82x + 0.423 R^2=0.9961$

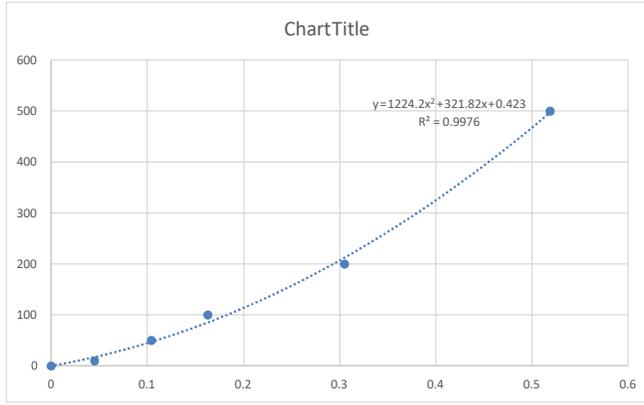
Locations of Sample	Cuvette	Absorbance	Vol from vial (mL)	Concentration ug/L	Dilution	Corrected ug/L	Dil. Corr'd (mg/L)	Blank Conc (ug/L)	Blank Corr'd Conc (mg/L)
Lab Blank	5	0.05	4	19.575		244.68	0.245		
Wellsville Park	1	0.07	4	28.949		361.86	0.362	117.18	0.1172
Richmond	2	0.076	4	31.952		399.40	0.399	154.72	0.1547
Smithfield	3	0.078	4	32.973		412.16	0.412	167.48	0.1675
Westin	4	0.094	4	41.491		518.64	0.519	273.96	0.2740
Mendon	1	0.072	4	29.940		374.25	0.374	129.57	0.1296
Hyrum Ballpark	2	0.074	4	30.941		386.77	0.387	142.09	0.1421
RSM home	3	0.053	3	20.918		348.71	0.349	104.03	0.1040
HWY23 1	4	0.062	3	25.082		418.11	0.418	173.43	0.1734
HWY23 1	1	0.063	3	25.557		426.03	0.426	181.35	0.1813
HWY23 2	5	0.089	3	38.762		646.16	0.646	401.48	0.4015
HWY23 2	1	0.075	3	31.446		524.20	0.524	279.52	0.2795
HWY23 2	1	0.073	3	30.440		507.43	0.507	262.75	0.2627
lewiston	1	0.088	4	38.223		477.79	0.478	233.11	0.2331
Animal Science	2	0.091	4	39.846		498.08	0.498	253.40	0.2534
UWEL EQC Indoors	3	0.08	4	34.003		425.04	0.425	180.36	0.1804
Megan L home	4	0.089	4	38.762		484.52	0.485	239.84	0.2398
Franklin	5	0.076	4	31.952		399.40	0.399	154.72	0.1547
Logan City 1	1	0.076	3	31.952		532.64	0.533	287.96	0.2880
Logan City 1	3	0.063	3	25.557		426.03	0.426	181.35	0.1813
Logan City 2	2	0.063	3	25.557		426.03	0.426	181.35	0.1813
Logan City 2	4	0.062	3	25.082		418.11	0.418	173.43	0.1734
Evan's Farm 1	3	0.076	3	31.952		532.64	0.533	287.96	0.2880
Evan's Farm 2	4	0.076	3	31.952		532.64	0.533	287.96	0.2880
Darrels	5	0.088	4	38.223		477.79	0.478	233.11	0.2331
Preston	1	0.07	4	28.949		361.86	0.362	117.18	0.1172
Clarkston	2	0.062	4	25.082		313.52	0.314	68.84	0.0688
Cornish	3	0.092	4	40.392		504.90	0.505	260.22	0.2602
JBS	4	0.074	4	30.941		386.77	0.387	142.09	0.1421
Amalga	5	0.098	4	43.719		546.48	0.546	301.80	0.3018
Lewison Rural	1	0.152	4	77.624		970.29	0.970	725.61	0.7256
North Logan 1	2	0.082	3	35.044		584.18	0.584	339.50	0.3395
North Logan 1	4	0.072	3	29.940		499.10	0.499	254.42	0.2544
North Logan 1	2	0.071	3	29.443		490.82	0.491	246.14	0.2461
North Logan 2	3	0.063	3	25.557		426.03	0.426	181.35	0.1813
North Logan 2	5	0.064	3	26.034		433.98	0.434	189.30	0.1893
Newton Park 1	4	0.074	3	30.941		515.79	0.516	271.11	0.2711
Newton Park 2	5	0.077	3	32.461		541.13		296.45	0.2965

Standards

Absorbance	ug/L
0	0
0.045	10
0.104	50
0.163	100
0.305	200
0.519	500

StdDev	SD (%)
0.2597	0.0826
0.2060	0.0474

Std Dev	SD (%)
0.2060	0.0474
0.2880	0.0000



Std Dev	SD (%)
0.2421	0.0568
0.2838	0.0127

Cache Valley Ammonia Stud

Date: Friday, February 3, 2023

Duplicates: Amalya, Mendon, Clarkson, Wellsville, and Hyrum Ball park

Equation: absorbance = 0.0007 (conc) + 0.0792 R<sup>2</sup>=0.9937

Equation 2: absorbance=0.0009(conc)+0.0076 R<sup>2</sup>=0.996

Locations of Sample	Cuvette	Absorbance	Vol from vial		Concentration ug/L	Dilution Corrected ug/L	Blank Corr'd Blank Corr'd		
			(mL)				Dil. Corr'd (mg/L)	Conc (mg/L)	Conc (ug/L)
Lab Blank	1	0.045	4		10.73	137.33	0.137		
Lewiston Rural	1	0.114	4		55.83	714.56	0.715	577.23	0.5772
Darrel's	2	0.09	4		38.97	498.81	0.499	361.48	0.3615
Megan L home	3	0.093	4		41.01	524.91	0.525	387.58	0.3876
HWY23 Jxn	4	0.071	4		26.51	339.34	0.339	202.01	0.2020
Newton	1	0.063	4		21.50	275.18	0.275	137.85	0.1379
JBS	5	0.081	4		32.97	422.02	0.422	284.69	0.2847
Amalya 1	2	0.08	3		32.31	538.69	0.539	401.36	0.4014
Amalya 2	3	0.072	3		27.15	452.54	0.453	315.21	0.3152
Mendon 1	4	0.056	3		17.23	287.17	0.287	149.84	0.1498
Mendon 2	5	0.062	3		20.88	348.10	0.348	210.77	0.2108
Clarkson 1	1	0.074	3		28.43	473.86	0.474	336.53	0.3365
Clarkson 1	4	0.074	3		28.43	473.86	0.474	336.53	0.3365
Clarkson 2	3	0.057	3		17.83	297.24	0.297	159.91	0.1599
Clarkson 2	5	0.062	3		20.88	348.10	0.348	210.77	0.2108
Wellsville 1	3	0.051	3		14.24	237.39	0.237	100.06	0.1001
Wellsville 2	4	0.052	3		14.83	247.28	0.247	109.95	0.1099
North Logan	5	0.061	4		20.27	259.42	0.259	122.09	0.1221
Evan Farm	1	0.051	4		14.24	182.28	0.182	44.95	0.0450
Animal Science Farm	2	0.076	4		29.71	380.33	0.380	243.00	0.2430
Richmond	3	0.06	4		19.65	251.58	0.252	114.25	0.1143
Weston	4	0.076	4		29.71	380.33	0.380	243.00	0.2430
Franklin	5	0.061	4		20.27	259.42	0.259	122.09	0.1221
Hyrum Ball Park 1	1	0.06	3		19.65	327.65	0.328	190.32	0.1903
Hyrum Ball Park 2	2	0.059	3		19.04	317.47	0.317	180.15	0.1801
Cornish	3	0.09	4		38.97	498.81	0.499	361.48	0.3615
Preston	5	0.066	4		23.36	299.03	0.299	161.70	0.1617
UWRL ERL Inside	1	0.06	4		19.65	251.58	0.252	114.25	0.1143
RSM Home	2	0.151	4		84.26	1078.47	1.078	941.14	0.9411
Logan City	3	0.069	4		25.24	323.13	0.323	185.80	0.1858
Smithfield	4	0.086	4		36.28	464.40	0.464	327.08	0.3271
Lewiston	5	0.079	4		31.66	405.26	0.405	267.93	0.2679

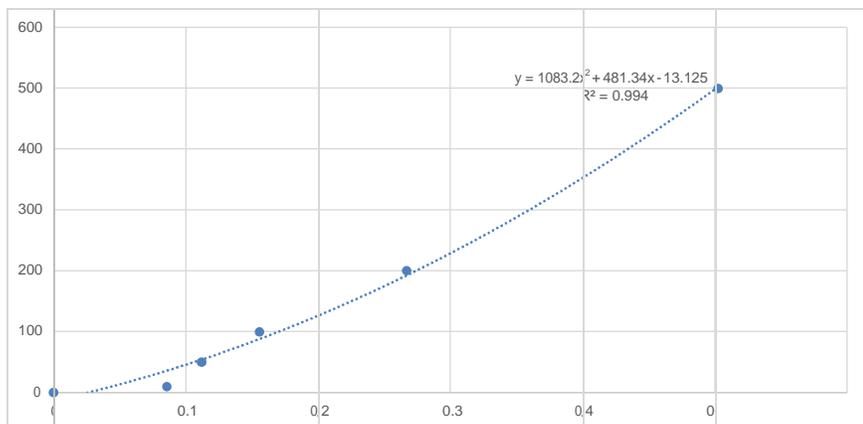
Standards  
ug/L Absorbance

ug/L	Absorbance							
0								0
10	0.085	0.09	0.085	0.085	0.083	0.085	0.0855	
50	0.104	0.115	0.112	0.114	0.114	0.113	0.112	
100	0.156	0.155	0.156	0.153	0.156	0.157	0.1555	
200	0.247	0.27	0.271	0.273	0.271	0.27	0.267	
500	0.446	0.514	0.515	0.513	0.514	0.513	0.5025	

	Std Dev	SD (%)
0.3583	43.0744	12022.4
0.1803	30.4640	16895.4

	Std Dev	SD (%)
0.2609	77.7035	29778.9
0.1050	4.9419	4706.3

	Std Dev	SD (%)
0.1852	5.0864	2745.9



Cache Valley Ammonia Stud

Date: Friday, February 10, 2023

Duplicates: JBS, Smithfield, Preston, Newton, and Cornish

Equation: absorbance=0.001(conc)+0.0652 R<sup>2</sup>=0.9914

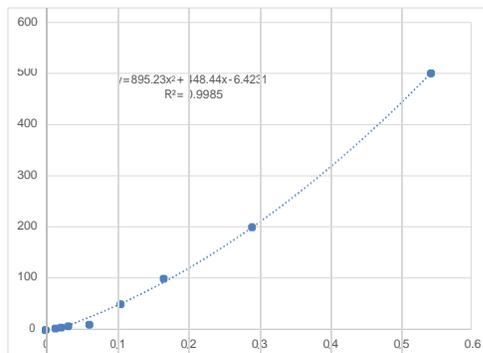
Equation: absorbance=915.17(conc)+28.364 R<sup>2</sup>=0.9769

Locations of Sample	Vol from vial			Blank Corr'd Blank Corr'd					
	Cuvette	Absorbance	(mL)	Concentration ug/L	Dilution	Corrected ug/L	Dil. Corr'd (mg/L)	Conc (ug/L)	Conc (mg/L)
Lab Blank	1	0.025	4	5.35		68.45	0.068		
JBS 1	2	0.049	3	17.70		295.06	0.295	226.61	0.2266
JBS 1	2	0.048	3	17.16		286.13	0.286	217.69	0.2177
JBS 1	2	0.05	3	18.24		304.01	0.304	235.56	0.2356
JBS 2	3	0.058	3	22.60		376.71	0.377	308.26	0.3083
JBS 2	3	0.06	3	23.71		395.18	0.395	326.73	0.3267
JBS 2	3	0.058	3	22.60		376.71	0.377	308.26	0.3083
Mendon	4	0.063	4	25.38		324.89	0.325	256.44	0.2564
Smithfield 1	5	0.053	3	19.86		331.05	0.331	262.60	0.2626
Smithfield 1	5	0.053	3	19.86		331.05	0.331	262.60	0.2626
Smithfield 1	5	0.053	3	19.86		331.05	0.331	262.60	0.2626
Smithfield 2	1	0.053	3	19.86		331.05	0.331	262.60	0.2626
Smithfield 2	1	0.052	3	19.32		322.01	0.322	253.56	0.2536
Smithfield 2	1	0.052	3	19.32		322.01	0.322	253.56	0.2536
Preston 1	2	0.047	3	16.63		277.24	0.277	208.79	0.2088
Preston 1	2	0.047	3	16.63		277.24	0.277	208.79	0.2088
Preston 1	2	0.048	3	17.16		286.13	0.286	217.69	0.2177
Preston 2	3	0.045	3	15.57		259.54	0.260	191.10	0.1911
Preston 2	3	0.045	3	15.57		259.54	0.260	191.10	0.1911
Preston 2	3	0.046	3	16.10		268.38	0.268	199.93	0.1999
Newton 1	4	0.047	3	16.63		277.24	0.277	208.79	0.2088
Newton 1	4	0.047	3	16.63		277.24	0.277	208.79	0.2088
Newton 1	4	0.047	3	16.63		277.24	0.277	208.79	0.2088
Newton 2	5	0.047	3	16.63		277.24	0.277	208.79	0.2088
Newton 2	5	0.046	3	16.10		268.38	0.268	199.93	0.1999
Newton 2	5	0.047	3	16.63		277.24	0.277	208.79	0.2088
Lewiston Rural	1	0.28	4	189.33		2423.37	2.423	2354.93	2.3549
EQL UWRL	2	0.0375	4	11.65		149.15	0.149	80.70	0.0807
Wellsville Park	3	0.036	4	10.88		139.28	0.139	70.83	0.0708
North Logan	4	0.048	4	17.16		219.71	0.220	151.26	0.1513
Weston	5	0.0485	4	17.43		223.13	0.223	154.68	0.1547
Richmond	1	0.0575	4	22.32		285.72	0.286	217.28	0.2173
Animal Science Farm	2	0.045	4	15.57		199.29	0.199	130.84	0.1308
Cornish 1	3	0.073	3	31.08		518.17	0.518	449.72	0.4497
Cornish 1	3	0.073	3	31.08		518.17	0.518	449.72	0.4497
Cornish 1	3	0.073	3	31.08		518.17	0.518	449.72	0.4497
Cornish 2	4	0.055	3	20.95		349.22	0.349	280.78	0.2808
Cornish 2	4	0.055	3	20.95		349.22	0.349	280.78	0.2808
Cornish 2	4	0.054	3	20.40		340.12	0.340	271.67	0.2717
Clarkston	5	0.0355	4	10.62		136.00	0.136	67.55	0.0675
Logan City	1	0.048	3	17.16		219.71	0.220	151.26	0.1513
Evan's Farm	1	0.0465	4	16.37		209.47	0.209	141.03	0.1410
HWY 23	2	0.0405	4	13.21		169.05	0.169	100.60	0.1006
Franklin	3	0.056	4	21.50		275.16	0.275	206.71	0.2067
Megan L Home	4	0.07	4	29.35		375.74	0.376	307.29	0.3073
Amalga	5	0.067	4	27.64		353.81	0.354	285.36	0.2854
Lewiston	1	0.05	4	18.24		233.43	0.233	164.99	0.1650
RSM Home	2	0.171	4	96.44		1234.40	1.234	1165.95	1.1660
Hyrum Ballpark	3	0.042	4	13.99		179.08	0.179	110.63	0.1106
Darrell's	4	0.064	4	25.94		332.08	0.332	263.64	0.2636

Standards

ug/L	Absorbance							
10	0.062	0.061	0.062	0.061	0.061	0.062	0.063	0.061714
50	0.106	0.106	0.105					0.105667
100	0.166	0.167	0.166					0.166333
200	0.291	0.29	0.291					0.290667
500	0.543	0.543	0.542					0.542667

0	0
0.014	3
0.022	5
0.032	7
0.0617	10
0.1057	50
0.1663	100
0.2907	200
0.5427	500



Std Dev	SD (%)
0.2705	44.6283 16497.3

Std Dev	SD (%)
0.2596	4.2627 1642.1

Std Dev	SD (%)
0.2029	9.7943 4827.2

Std Dev	SD (%)
0.2073	3.3032 1593.3

Std Dev	SD (%)
0.3637	86.0418 23655.4

# Person Cache Valley Ammonia Study

Date: Friday, February 10, 2023

Equation:  $\text{absorbance} = 0.001 (\text{conc}) + 0.0652$   $R^2=0.9914$

	Absorbance	(mL)	Concentration ug/L	Dilution Corrected ug/L	Dil. Corr'd (mg/L)	Conc (ug/L)	Conc (mg/L)
Lab Blank	0.032	4	8.84	113.20	0.113		
	0.034	4	9.86	126.19	0.126	12.99	0.013
	0.048	4	17.16	219.71	0.220	106.51	0.107
	0.049	4	17.70	226.56	0.227	113.36	0.113
	0.046	4	16.10	206.07	0.206	92.87	0.093

## Appendix C: UT01 AMoN NADP 2011-2022

NADPID	SITEID	REPLICATE	startDate	endDate	EXPTIME	AIRVOL
N1100100	UT01	A	11/8/2011 16:46	11/22/2011 16:52	20166	4.74
N1100100	UT01	T	11/8/2011 16:46	11/22/2011 16:52	20166	4.74
N1100105	UT01	A	11/22/2011 16:52	12/6/2011 16:50	20158	4.74
N1100105	UT01	T	11/22/2011 16:52	12/6/2011 16:50	20158	4.74
N1100110	UT01	A	12/6/2011 16:50	12/20/2011 16:45	20155	4.74
N1100110	UT01	T	12/6/2011 16:50	12/20/2011 16:45	20155	4.74
N1200004	UT01	A	12/20/2011 16:45	1/3/2012 16:38	20153	4.74
N1200004	UT01	T	12/20/2011 16:45	1/3/2012 16:38	20153	4.74
N1200010	UT01	A	1/3/2012 16:40	1/17/2012 16:43	20163	4.74
N1200010	UT01	T	1/3/2012 16:40	1/17/2012 16:43	20163	4.74
N1200016	UT01	A	1/18/2012 16:20	1/31/2012 17:10	18770	4.41
N1200016	UT01	T	1/18/2012 16:20	1/31/2012 17:10	18770	4.41
N1200021	UT01	A	1/31/2012 17:10	2/14/2012 15:40	20070	4.72
N1200021	UT01	T	1/31/2012 17:10	2/14/2012 15:40	20070	4.72
N1200027	UT01	A	2/14/2012 15:40	2/28/2012 16:59	20239	4.76
N1200027	UT01	T	2/14/2012 15:40	2/28/2012 16:59	20239	4.76
N1200032	UT01	A	2/28/2012 17:01	3/13/2012 18:00	20219	4.75
N1200032	UT01	T	2/28/2012 17:01	3/13/2012 18:00	20219	4.75
N1200038	UT01	A	3/13/2012 18:00	3/27/2012 17:44	20144	4.73
N1200038	UT01	T	3/13/2012 18:00	3/27/2012 17:44	20144	4.73
N1200043	UT01	A	3/27/2012 17:45	4/10/2012 17:15	20130	4.73
N1200043	UT01	T	3/27/2012 17:45	4/10/2012 17:15	20130	4.73
N1200049	UT01	A	4/10/2012 17:17	4/24/2012 15:16	20039	4.71
N1200049	UT01	T	4/10/2012 17:17	4/24/2012 15:16	20039	4.71
N1200054	UT01	A	4/24/2012 15:19	5/8/2012 16:42	20243	4.76
N1200054	UT01	B	4/24/2012 15:19	5/8/2012 16:42	20243	4.76
N1200054	UT01	C	4/24/2012 15:19	5/8/2012 16:42	20243	4.76
N1200054	UT01	T	4/24/2012 15:19	5/8/2012 16:42	20243	4.76
N1200059	UT01	A	5/8/2012 16:43	5/22/2012 16:35	20152	4.74
N1200059	UT01	T	5/8/2012 16:43	5/22/2012 16:35	20152	4.74
N1200064	UT01	A	5/22/2012 16:36	6/5/2012 16:40	20164	4.74
N1200064	UT01	T	5/22/2012 16:36	6/5/2012 16:40	20164	4.74
N1200070	UT01	A	6/5/2012 16:40	6/19/2012 16:46	20166	4.74
N1200070	UT01	T	6/5/2012 16:40	6/19/2012 16:46	20166	4.74
N1200075	UT01	A	6/19/2012 16:49	7/3/2012 17:11	20182	4.74
N1200075	UT01	T	6/19/2012 16:49	7/3/2012 17:11	20182	4.74
N1200082	UT01	A	7/3/2012 17:12	7/17/2012 16:42	20130	4.73
N1200082	UT01	T	7/3/2012 17:12	7/17/2012 16:42	20130	4.73
N1200087	UT01	A	7/17/2012 16:42	7/31/2012 16:35	20153	4.74
N1200087	UT01	T	7/17/2012 16:42	7/31/2012 16:35	20153	4.74
N1200093	UT01	A	7/31/2012 16:35	8/14/2012 17:15	20200	4.75
N1200093	UT01	T	7/31/2012 16:35	8/14/2012 17:15	20200	4.75
N1200099	UT01	A	8/14/2012 17:15	8/28/2012 18:50	20255	4.76
N1200099	UT01	T	8/14/2012 17:15	8/28/2012 18:50	20255	4.76
N1200104	UT01	A	8/28/2012 18:50	9/11/2012 17:05	20055	4.71
N1200104	UT01	T	8/28/2012 18:50	9/11/2012 17:05	20055	4.71
N1200110	UT01	A	9/11/2012 17:05	9/28/2012 16:59	24474	5.75
N1200110	UT01	T	9/11/2012 17:05	9/28/2012 16:59	24474	5.75
N1200116	UT01	A	9/28/2012 16:59	10/9/2012 16:46	15827	3.72
N1200116	UT01	T	9/28/2012 16:59	10/9/2012 16:46	15827	3.72

N1200122	UT01	A	10/9/2012 16:46	10/23/2012 18:35	20269	4.76
N1200122	UT01	T	10/9/2012 16:46	10/23/2012 18:35	20269	4.76
N1200127	UT01	A	10/23/2012 18:35	11/6/2012 17:12	20077	4.72
N1200127	UT01	T	10/23/2012 18:35	11/6/2012 17:12	20077	4.72
N1200134	UT01	A	11/6/2012 17:12	11/20/2012 17:55	20203	4.75
N1200134	UT01	T	11/6/2012 17:12	11/20/2012 17:55	20203	4.75
N1200140	UT01	A	11/20/2012 17:55	12/4/2012 18:27	20192	4.75
N1200140	UT01	T	11/20/2012 17:55	12/4/2012 18:27	20192	4.75
N1200145	UT01	A	12/4/2012 18:27	12/18/2012 16:36	20049	4.71
N1200145	UT01	T	12/4/2012 18:27	12/18/2012 16:36	20049	4.71
N1300004	UT01	A	12/18/2012 16:36	1/1/2013 16:41	20165	4.74
N1300004	UT01	T	12/18/2012 16:36	1/1/2013 16:41	20165	4.74
N1300011	UT01	A	1/3/2013 16:23	1/15/2013 14:49	17186	4.04
N1300011	UT01	T	1/3/2013 16:23	1/15/2013 14:49	17186	4.04
N1300019	UT01	A	1/15/2013 14:49	1/29/2013 16:01	20232	4.75
N1300019	UT01	T	1/15/2013 14:49	1/29/2013 16:01	20232	4.75
N1300025	UT01	A	1/29/2013 16:01	2/12/2013 17:00	20219	4.75
N1300031	UT01	A	2/12/2013 17:00	2/26/2013 16:50	20150	4.74
N1300037	UT01	A	2/26/2013 16:50	3/12/2013 16:36	20146	4.73
N1300043	UT01	A	3/12/2013 16:36	3/26/2013 16:44	20168	4.74
N1300050	UT01	A	3/26/2013 16:44	4/9/2013 17:07	20183	4.74
N1300062	UT01	A	4/23/2013 15:11	5/7/2013 16:39	20248	4.76
N1300068	UT01	A	5/7/2013 16:40	5/21/2013 16:26	20146	4.73
N1300074	UT01	A	5/21/2013 16:26	6/4/2013 17:02	20196	4.75
N1300080	UT01	A	6/4/2013 17:02	6/18/2013 16:43	20141	4.73
N1300080	UT01	T	6/4/2013 17:02	6/18/2013 16:43	20141	4.73
N1300087	UT01	A	6/18/2013 16:43	7/2/2013 16:33	20150	4.74
N1300093	UT01	A	7/2/2013 16:33	7/16/2013 18:30	20277	4.77
N1300099	UT01	A	7/16/2013 18:30	7/30/2013 16:30	20040	4.71
N1300099	UT01	T	7/16/2013 18:30	7/30/2013 16:30	20040	4.71
N1300105	UT01	A	7/30/2013 16:30	8/13/2013 17:11	20201	4.75
N1300112	UT01	A	8/13/2013 17:11	8/27/2013 16:37	20126	4.73
N1300118	UT01	A	8/27/2013 16:37	9/10/2013 16:49	20172	4.74
N1300125	UT01	A	9/10/2013 16:49	9/24/2013 16:40	20151	4.74
N1300129	UT01	A	9/24/2013 16:40	10/8/2013 17:00	20180	4.74
N1300136	UT01	A	10/8/2013 17:00	10/22/2013 20:00	20340	4.78
N1300142	UT01	A	10/22/2013 20:00	11/5/2013 16:30	19950	4.69
N1300150	UT01	A	11/5/2013 16:30	11/19/2013 16:55	20185	4.74
N1300150	UT01	T	11/5/2013 16:30	11/19/2013 16:55	20185	4.74
N1300155	UT01	A	11/19/2013 16:55	12/3/2013 17:19	20184	4.74
N1300155	UT01	B	11/19/2013 16:55	12/3/2013 17:19	20184	4.74
N1300155	UT01	C	11/19/2013 16:55	12/3/2013 17:19	20184	4.74
N1300155	UT01	T	11/19/2013 16:55	12/3/2013 17:19	20184	4.74
N1300163	UT01	A	12/3/2013 17:19	12/17/2013 17:20	20161	4.74
N1400004	UT01	A	12/17/2013 17:20	12/31/2013 16:20	20100	4.72
N1400012	UT01	A	12/31/2013 16:20	1/14/2014 15:40	20120	4.73
N1400012	UT01	T	12/31/2013 16:20	1/14/2014 15:40	20120	4.73
N1400018	UT01	A	1/14/2014 15:40	1/28/2014 17:52	20292	4.77
N1400026	UT01	A	1/28/2014 17:52	2/11/2014 17:00	20108	4.73
N1400032	UT01	A	2/12/2014 20:05	2/25/2014 16:44	18519	4.35
N1400037	UT01	A	2/25/2014 16:44	3/11/2014 17:23	20199	4.75
N1400045	UT01	A	3/11/2014 17:23	3/25/2014 15:30	20047	4.71
N1400052	UT01	A	3/25/2014 15:30	4/8/2014 17:10	20260	4.76
N1400059	UT01	A	4/8/2014 17:10	4/22/2014 17:15	20165	4.74
N1400066	UT01	A	4/22/2014 17:15	5/6/2014 17:04	20149	4.74
N1400072	UT01	A	5/6/2014 17:04	5/20/2014 16:53	20149	4.74
N1400079	UT01	A	5/20/2014 16:53	6/3/2014 17:20	20187	4.74

N1400085	UT01	A	6/3/2014 17:20	6/17/2014 16:45	20125	4.73
N1400093	UT01	A	6/17/2014 16:45	7/1/2014 17:55	20230	4.75
N1400093	UT01	T	6/17/2014 16:45	7/1/2014 17:55	20230	4.75
N1400099	UT01	A	7/1/2014 17:55	7/15/2014 16:30	20075	4.72
N1400099	UT01	T	7/1/2014 17:55	7/15/2014 16:30	20075	4.72
N1400106	UT01	A	7/15/2014 16:30	7/29/2014 16:40	20170	4.74
N1400106	UT01	T	7/15/2014 16:30	7/29/2014 16:40	20170	4.74
N1400112	UT01	A	7/29/2014 16:40	8/12/2014 16:45	20165	4.74
N1400112	UT01	T	7/29/2014 16:40	8/12/2014 16:45	20165	4.74
N1400127	UT01	A	8/12/2014 16:45	8/26/2014 14:40	20035	4.71
N1400127	UT01	T	8/12/2014 16:45	8/26/2014 14:40	20035	4.71
N1400126	UT01	A	8/26/2014 14:40	9/9/2014 16:10	20250	4.76
N1400131	UT01	A	9/9/2014 16:10	9/23/2014 15:45	20135	4.73
N1400139	UT01	A	9/23/2014 15:45	10/7/2014 15:40	20155	4.74
N1400145	UT01	A	10/7/2014 15:40	10/21/2014 15:45	20165	4.74
N1400153	UT01	A	10/21/2014 15:45	11/4/2014 15:30	20145	4.73
N1400161	UT01	A	11/4/2014 15:30	11/18/2014 15:35	20165	4.74
N1400166	UT01	A	11/18/2014 15:35	12/2/2014 15:40	20165	4.74
N1400174	UT01	A	12/2/2014 15:40	12/16/2014 16:40	20220	4.75
N1500005	UT01	A	12/16/2014 16:40	12/30/2014 16:00	20120	4.73
N1500012	UT01	A	12/31/2014 16:00	1/13/2015 15:10	18670	4.39
N1500021	UT01	A	1/13/2015 15:10	1/27/2015 15:00	20150	4.74
N1500030	UT01	A	1/27/2015 15:00	2/10/2015 14:45	20145	4.73
N1500040	UT01	A	2/10/2015 14:45	2/24/2015 17:00	20295	4.77
N1500047	UT01	A	2/24/2015 17:00	3/10/2015 18:00	20220	4.75
N1500047	UT01	B	2/24/2015 17:00	3/10/2015 18:00	20220	4.75
N1500047	UT01	C	2/24/2015 17:00	3/10/2015 18:00	20220	4.75
N1500047	UT01	T	2/24/2015 17:00	3/10/2015 18:00	20220	4.75
N1500058	UT01	A	3/10/2015 18:00	3/24/2015 15:20	20000	4.7
N1500066	UT01	A	3/24/2015 15:20	4/7/2015 14:00	20080	4.72
N1500076	UT01	A	4/7/2015 14:00	4/21/2015 14:15	20175	4.74
N1500083	UT01	A	4/21/2015 14:15	5/5/2015 14:00	20145	4.73
N1500083	UT01	T	4/21/2015 14:15	5/5/2015 14:00	20145	4.73
N1500095	UT01	A	5/5/2015 14:00	5/19/2015 15:00	20220	4.75
N1500105	UT01	A	5/19/2015 8:00	6/2/2015 8:00	20160	4.74
N1500112	UT01	A	6/2/2015 15:00	6/16/2015 14:30	20130	4.73
N1500120	UT01	A	6/16/2015 14:30	6/30/2015 14:00	20130	4.73
N1500131	UT01	A	6/30/2015 14:00	7/14/2015 14:00	20160	4.74
N1500141	UT01	A	7/14/2015 14:00	7/28/2015 14:00	20160	4.74
N1500152	UT01	A	7/28/2015 14:00	8/11/2015 16:30	20310	4.77
N1500161	UT01	A	8/11/2015 16:30	8/25/2015 13:40	19990	4.7
N1500169	UT01	A	8/25/2015 13:40	9/8/2015 13:35	20155	4.74
N1500180	UT01	A	9/8/2015 13:35	9/22/2015 13:30	20155	4.74
N1500180	UT01	T	9/8/2015 13:35	9/22/2015 13:30	20155	4.74
N1500190	UT01	A	9/22/2015 13:30	10/6/2015 17:00	20370	4.79
N1500190	UT01	T	9/22/2015 13:30	10/6/2015 17:00	20370	4.79
N1500199	UT01	A	10/6/2015 17:00	10/20/2015 13:40	19960	4.69
N1500208	UT01	A	10/20/2015 13:40	11/3/2015 13:45	20165	4.74
N1500217	UT01	A	11/3/2015 13:45	11/17/2015 13:30	20145	4.73
N1500230	UT01	A	11/17/2015 13:30	12/1/2015 13:40	20170	4.74
N1500238	UT01	A	12/1/2015 13:40	12/15/2015 13:50	20170	4.74
N1600007	UT01	A	12/15/2015 13:50	12/29/2015 13:40	20150	4.74
N1600017	UT01	A	12/29/2015 13:40	1/12/2016 13:40	20160	4.74
N1600017	UT01	T	12/29/2015 13:40	1/12/2016 13:40	20160	4.74
N1600027	UT01	A	1/12/2016 13:40	1/26/2016 13:40	20160	4.74
N1600027	UT01	T	1/12/2016 13:40	1/26/2016 13:40	20160	4.74
N1600038	UT01	A	1/26/2016 13:40	2/9/2016 13:45	20165	4.74

N1600047 UT01	A	2/9/2016 13:45	2/23/2016 13:40	20155	4.74
N1600056 UT01	A	2/23/2016 13:40	3/8/2016 13:30	20150	4.74
N1600066 UT01	A	3/8/2016 13:30	3/22/2016 13:50	20180	4.74
N1600074 UT01	A	3/22/2016 13:50	4/5/2016 13:45	20155	4.74
N1600074 UT01	T	3/22/2016 13:50	4/5/2016 13:45	20155	4.74
N1600085 UT01	A	4/5/2016 13:45	4/19/2016 13:40	20155	4.74
N1600094 UT01	A	4/19/2016 13:40	5/3/2016 13:45	20165	4.74
N1600103 UT01	A	5/3/2016 13:45	5/17/2016 13:15	20130	4.73
N1600114 UT01	A	5/17/2016 13:15	5/31/2016 13:10	20155	4.74
N1600123 UT01	A	5/31/2016 13:10	6/14/2016 13:20	20170	4.74
N1600123 UT01	B	5/31/2016 13:10	6/14/2016 13:20	20170	4.74
N1600123 UT01	C	5/31/2016 13:10	6/14/2016 13:20	20170	4.74
N1600123 UT01	T	5/31/2016 13:10	6/14/2016 13:20	20170	4.74
N1600134 UT01	A	6/14/2016 13:20	6/28/2016 13:20	20160	4.74
N1600134 UT01	T	6/14/2016 13:20	6/28/2016 13:20	20160	4.74
N1600143 UT01	A	6/28/2016 13:20	7/12/2016 13:20	20160	4.74
N1600157 UT01	A	7/12/2016 13:20	7/26/2016 18:45	20485	4.81
N1600165 UT01	A	7/26/2016 18:45	8/9/2016 13:15	19830	4.66
N1600175 UT01	A	8/9/2016 13:15	8/23/2016 13:10	20155	4.74
N1600186 UT01	A	8/23/2016 13:10	9/6/2016 13:10	20160	4.74
N1600198 UT01	A	9/6/2016 13:10	9/20/2016 15:15	20285	4.77
N1600198 UT01	T	9/6/2016 13:10	9/20/2016 15:15	20285	4.77
N1600206 UT01	A	9/20/2016 15:15	10/4/2016 13:30	20055	4.71
N1600216 UT01	A	10/4/2016 13:30	10/18/2016 13:40	20170	4.74
N1600226 UT01	A	10/18/2016 13:40	11/1/2016 13:45	20165	4.74
N1600236 UT01	A	11/1/2016 13:45	11/15/2016 13:41	20156	4.74
N1600249 UT01	A	11/15/2016 13:41	11/29/2016 13:45	20164	4.74
N1600249 UT01	B	11/15/2016 13:41	11/29/2016 13:45	20164	4.74
N1600249 UT01	C	11/15/2016 13:41	11/29/2016 13:45	20164	4.74
N1600249 UT01	T	11/15/2016 13:41	11/29/2016 13:45	20164	4.74
N1600259 UT01	A	11/29/2016 13:45	12/13/2016 13:45	20160	4.74
N1600259 UT01	T	11/29/2016 13:45	12/13/2016 13:45	20160	4.74
N1700004 UT01	A	12/13/2016 13:45	12/27/2016 16:45	20340	4.78
N1700014 UT01	A	12/27/2016 16:45	1/10/2017 14:40	20035	4.71
N1700025 UT01	A	1/10/2017 14:40	1/24/2017 14:45	20165	4.74
N1700035 UT01	A	1/24/2017 14:45	2/7/2017 14:40	20155	4.74
N1700043 UT01	A	2/7/2017 14:40	2/21/2017 16:15	20255	4.76
N1700055 UT01	A	2/21/2017 16:15	3/7/2017 14:30	20055	4.71
N1700055 UT01	T	2/21/2017 16:15	3/7/2017 14:30	20055	4.71
N1700064 UT01	A	3/7/2017 14:30	3/21/2017 14:00	20130	4.73
N1700074 UT01	A	3/21/2017 14:00	4/4/2017 14:30	20190	4.74
N1700084 UT01	A	4/4/2017 14:30	4/18/2017 14:30	20160	4.74
N1700095 UT01	A	4/18/2017 14:30	5/2/2017 14:35	20165	4.74
N1700106 UT01	A	5/2/2017 14:35	5/16/2017 14:35	20160	4.74
N1700106 UT01	B	5/2/2017 14:35	5/16/2017 14:35	20160	4.74
N1700106 UT01	C	5/2/2017 14:35	5/16/2017 14:35	20160	4.74
N1700106 UT01	T	5/2/2017 14:35	5/16/2017 14:35	20160	4.74
N1700114 UT01	A	5/16/2017 14:35	5/30/2017 15:00	20185	4.74
N1700114 UT01	T	5/16/2017 14:35	5/30/2017 15:00	20185	4.74
N1700125 UT01	A	5/30/2017 15:00	6/13/2017 14:30	20130	4.73
N1700137 UT01	A	6/13/2017 14:30	6/27/2017 14:30	20160	4.74
N1700147 UT01	A	6/27/2017 14:30	7/11/2017 14:40	20170	4.74
N1700158 UT01	A	7/11/2017 14:40	7/25/2017 14:50	20170	4.74
N1700168 UT01	A	7/25/2017 14:50	8/8/2017 13:45	20095	4.72
N1700179 UT01	A	8/8/2017 13:45	8/22/2017 16:30	20325	4.78
N1700179 UT01	T	8/8/2017 13:45	8/22/2017 16:30	20325	4.78
N1700191 UT01	A	8/22/2017 16:30	9/5/2017 16:30	20160	4.74

N1700203	UT01	A	9/5/2017 16:30	9/26/2017 16:30	30240	7.11
N1700213	UT01	A	9/26/2017 16:45	10/3/2017 16:15	10050	2.36
N1700222	UT01	A	10/3/2017 16:15	10/17/2017 15:00	20085	4.72
N1700244	UT01	A	10/31/2017 18:15	11/14/2017 16:15	20040	4.71
N1700244	UT01	T	10/31/2017 18:15	11/14/2017 16:15	20040	4.71
N1700254	UT01	A	11/14/2017 16:15	11/28/2017 18:15	20280	4.77
N1700262	UT01	A	11/28/2017 18:15	12/12/2017 17:00	20085	4.72
N1800009	UT01	A	12/12/2017 17:00	12/26/2017 18:00	20220	4.75
N1800019	UT01	A	12/26/2017 18:00	1/9/2018 19:00	20220	4.75
N1800030	UT01	A	1/9/2018 19:00	1/23/2018 18:00	20100	4.72
N1800039	UT01	A	1/23/2018 18:00	2/6/2018 19:30	20250	4.76
N1800039	UT01	T	1/23/2018 18:00	2/6/2018 19:30	20250	4.76
N1800050	UT01	A	2/6/2018 19:30	2/20/2018 17:00	20010	4.7
N1800058	UT01	A	2/20/2018 17:00	3/6/2018 17:15	20175	4.74
N1800070	UT01	A	3/6/2018 17:15	3/20/2018 18:15	20220	4.75
N1800080	UT01	A	3/20/2018 18:15	4/3/2018 17:15	20100	4.72
N1800090	UT01	A	4/3/2018 17:15	4/17/2018 19:15	20280	4.77
N1800090	UT01	B	4/3/2018 17:15	4/17/2018 19:15	20280	4.77
N1800090	UT01	C	4/3/2018 17:15	4/17/2018 19:15	20280	4.77
N1800090	UT01	T	4/3/2018 17:15	4/17/2018 19:15	20280	4.77
N1800100	UT01	A	4/17/2018 19:15	5/1/2018 17:15	20040	4.71
N1800100	UT01	T	4/17/2018 19:15	5/1/2018 17:15	20040	4.71
N1800107	UT01	A	5/1/2018 17:15	5/15/2018 15:33	20058	4.71
N1800119	UT01	A	5/15/2018 15:36	5/29/2018 17:30	20274	4.76
N1800119	UT01	B	5/15/2018 15:36	5/29/2018 17:30	20274	4.76
N1800119	UT01	T	5/15/2018 15:36	5/29/2018 17:30	20274	4.76
N1800509	UT01	A	5/29/2018 17:30	6/12/2018 18:30	20220	4.75
N1800519	UT01	A	6/12/2018 18:30	6/26/2018 18:30	20160	4.74
N1800519	UT01	T	6/12/2018 18:30	6/26/2018 18:30	20160	4.74
N1800526	UT01	A	6/26/2018 18:30	7/10/2018 16:15	20025	4.71
N1800539	UT01	A	7/10/2018 16:15	7/24/2018 18:00	20265	4.76
N1800549	UT01	A	7/24/2018 18:00	8/7/2018 17:45	20145	4.73
N1800557	UT01	A	8/7/2018 17:45	8/21/2018 18:00	20175	4.74
N1800557	UT01	B	8/7/2018 17:45	8/21/2018 18:00	20175	4.74
N1800557	UT01	C	8/7/2018 17:45	8/21/2018 18:00	20175	4.74
N1800557	UT01	T	8/7/2018 17:45	8/21/2018 18:00	20175	4.74
N1800568	UT01	A	8/21/2018 18:00	9/4/2018 18:00	20160	4.74
N1800578	UT01	A	9/4/2018 18:00	9/18/2018 16:45	20085	4.72
N1800587	UT01	A	9/18/2018 16:45	10/2/2018 16:30	20145	4.73
N1800598	UT01	A	10/2/2018 16:30	10/16/2018 15:00	20070	4.72
N1800598	UT01	T	10/2/2018 16:30	10/16/2018 15:00	20070	4.72
N1800609	UT01	A	10/16/2018 15:00	10/30/2018 15:15	20175	4.74
N1800620	UT01	A	10/30/2018 15:15	11/13/2018 15:15	20160	4.74
N1800629	UT01	A	11/13/2018 15:15	11/27/2018 15:30	20175	4.74
N1800638	UT01	A	11/27/2018 15:30	12/11/2018 15:45	20175	4.74
N1800638	UT01	B	11/27/2018 15:30	12/11/2018 15:45	20175	4.74
N1800638	UT01	C	11/27/2018 15:30	12/11/2018 15:45	20175	4.74
N1800638	UT01	T	11/27/2018 15:30	12/11/2018 15:45	20175	4.74
N1900008	UT01	A	12/11/2018 15:45	12/25/2018 17:00	20235	4.76
N1900016	UT01	A	12/25/2018 17:00	1/8/2019 17:15	20175	4.74
N1900025	UT01	A	1/8/2019 17:15	1/22/2019 17:00	20145	4.73
N1900034	UT01	A	1/22/2019 17:00	2/5/2019 17:30	20190	4.74
N1900045	UT01	A	2/5/2019 17:30	2/19/2019 16:15	20085	4.72
N1900056	UT01	A	2/19/2019 16:15	3/5/2019 17:30	20235	4.76
N1900056	UT01	B	2/19/2019 16:15	3/5/2019 17:30	20235	4.76
N1900056	UT01	C	2/19/2019 16:15	3/5/2019 17:30	20235	4.76
N1900056	UT01	T	2/19/2019 16:15	3/5/2019 17:30	20235	4.76

N1900065	UT01	A	3/5/2019 17:30	3/19/2019 16:30	20100	4.72
N1900074	UT01	A	3/19/2019 16:30	4/2/2019 15:15	20085	4.72
N1900085	UT01	A	4/2/2019 15:15	4/16/2019 16:15	20220	4.75
N1900097	UT01	A	4/16/2019 16:15	4/30/2019 18:45	20310	4.77
N1900097	UT01	T	4/16/2019 16:15	4/30/2019 18:45	20310	4.77
N1900107	UT01	A	4/30/2019 18:45	5/14/2019 16:00	19995	4.7
N1900116	UT01	A	5/14/2019 16:00	5/28/2019 16:15	20175	4.74
N1900127	UT01	A	5/28/2019 16:15	6/11/2019 16:45	20190	4.74
N1900146	UT01	A	6/11/2019 16:45	6/25/2019 16:45	20160	4.74
N1900146	UT01	B	6/11/2019 16:45	6/25/2019 16:45	20160	4.74
N1900146	UT01	C	6/11/2019 16:45	6/25/2019 16:45	20160	4.74
N1900146	UT01	T	6/11/2019 16:45	6/25/2019 16:45	20160	4.74
N1900146	UT01	A	6/25/2019 16:45	7/9/2019 17:00	20175	4.74
N1900158	UT01	A	7/9/2019 17:00	7/23/2019 17:00	20160	4.74
N1900168	UT01	A	7/23/2019 17:00	8/6/2019 17:30	20190	4.74
N1900177	UT01	A	8/6/2019 17:15	8/20/2019 17:00	20145	4.73
N1900188	UT01	A	8/20/2019 17:00	9/3/2019 17:00	20160	4.74
N1900199	UT01	A	9/3/2019 17:00	9/17/2019 17:45	20205	4.75
N1900208	UT01	A	9/17/2019 17:45	10/1/2019 17:15	20130	4.73
N1900219	UT01	A	10/1/2019 17:15	10/15/2019 17:15	20160	4.74
N1900219	UT01	B	10/1/2019 17:15	10/15/2019 17:15	20160	4.74
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N1900219	UT01	T	10/1/2019 17:15	10/15/2019 17:15	20160	4.74
N1900230	UT01	A	10/15/2019 17:15	10/29/2019 17:30	20175	4.74
N1900239	UT01	A	10/29/2019 17:30	11/12/2019 17:30	20160	4.74
N1900262	UT01	A	11/26/2019 18:00	12/10/2019 16:30	20070	4.72
N1900262	UT01	T	11/26/2019 18:00	12/10/2019 16:30	20070	4.72
N2000005	UT01	A	12/10/2019 18:00	12/24/2019 17:30	20130	4.73
N2000015	UT01	A	12/24/2019 17:30	1/7/2020 17:00	20130	4.73
N2000026	UT01	A	1/7/2020 17:00	1/21/2020 17:30	20190	4.74
N2000036	UT01	A	1/21/2020 17:30	2/4/2020 17:00	20130	4.73
N2000056	UT01	A	2/4/2020 17:00	2/18/2020 17:30	20190	4.74
N2000058	UT01	A	2/18/2020 17:30	3/3/2020 18:00	20190	4.74
N2000068	UT01	A	3/3/2020 18:00	3/17/2020 18:15	20175	4.74
N2000078	UT01	A	3/17/2020 18:15	3/31/2020 17:00	20085	4.72
N2000078	UT01	B	3/17/2020 18:15	3/31/2020 17:00	20085	4.72
N2000078	UT01	T	3/17/2020 18:15	3/31/2020 17:00	20085	4.72
N2000088	UT01	A	3/31/2020 17:00	4/14/2020 18:15	20235	4.76
N2000099	UT01	A	4/14/2020 18:15	4/28/2020 18:45	20190	4.74
N2000109	UT01	A	4/28/2020 18:45	5/12/2020 18:30	20145	4.73
N2000119	UT01	A	5/12/2020 18:30	5/26/2020 18:15	20145	4.73
N2000130	UT01	A	5/26/2020 18:15	6/9/2020 19:00	20205	4.75
N2000141	UT01	A	6/9/2020 18:45	6/23/2020 19:15	20190	4.74
N2000152	UT01	A	6/23/2020 19:15	7/7/2020 19:00	20145	4.73
N2000163	UT01	A	7/7/2020 19:00	7/21/2020 19:15	20175	4.74
N2000173	UT01	A	7/21/2020 19:15	8/4/2020 18:00	20085	4.72
N2000185	UT01	A	8/4/2020 18:00	8/18/2020 17:30	20130	4.73
N2000196	UT01	A	8/18/2020 17:30	9/1/2020 19:45	20295	4.77
N2000196	UT01	B	8/18/2020 17:30	9/1/2020 19:45	20295	4.77
N2000196	UT01	T	8/18/2020 17:30	9/1/2020 19:45	20295	4.77
N2000208	UT01	A	9/1/2020 19:45	9/15/2020 18:30	20085	4.72
N2000219	UT01	A	9/15/2020 18:30	9/29/2020 19:00	20190	4.74
N2000228	UT01	A	9/29/2020 19:00	10/13/2020 19:00	20160	4.74
N2000240	UT01	A	10/13/2020 19:00	10/27/2020 19:00	20160	4.74
N2000253	UT01	A	10/27/2020 19:00	11/11/2020 19:15	21615	5.08
N2000262	UT01	A	11/11/2020 19:15	11/24/2020 19:00	18705	4.4
N2000262	UT01	B	11/11/2020 19:15	11/24/2020 19:00	18705	4.4

N2000262	UT01	T	11/11/2020 19:15	11/24/2020 19:00	18705	4.4
N2000275	UT01	A	11/24/2020 19:30	12/8/2020 17:15	20025	4.71
N2100006	UT01	A	12/8/2020 17:15	12/22/2020 20:45	20370	4.79
N2100012	UT01	A	12/22/2020 20:45	1/7/2021 19:30	22965	5.4
N2100024	UT01	A	1/7/2021 19:30	1/19/2021 19:45	17295	4.06
N2100035	UT01	A	1/19/2021 19:45	2/2/2021 19:00	20115	4.73
N2100045	UT01	A	2/2/2021 19:00	2/16/2021 19:15	20175	4.74
N2100057	UT01	A	2/16/2021 19:15	3/2/2021 19:30	20175	4.74
N2100057	UT01	B	2/16/2021 19:15	3/2/2021 19:30	20175	4.74
N2100057	UT01	T	2/16/2021 19:15	3/2/2021 19:30	20175	4.74
N2100068	UT01	A	3/2/2021 19:30	3/16/2021 19:30	20160	4.74
N2100079	UT01	A	3/16/2021 19:30	3/30/2021 19:15	20145	4.73
N2100110	UT01	A	3/30/2021 19:30	4/13/2021 19:30	20160	4.74
N2100103	UT01	A	4/13/2021 19:30	4/27/2021 17:00	20010	4.7
N2100113	UT01	A	4/27/2021 17:00	5/11/2021 16:30	20130	4.73
N2100123	UT01	A	5/13/2021 15:45	5/25/2021 15:15	17250	4.05
N2100133	UT01	A	5/25/2021 15:15	6/8/2021 15:30	20175	4.74
N2100147	UT01	A	6/8/2021 15:30	6/22/2021 14:30	20100	4.72
N2100147	UT01	B	6/8/2021 15:30	6/22/2021 14:30	20100	4.72
N2100147	UT01	T	6/8/2021 15:30	6/22/2021 14:30	20100	4.72
N2100158	UT01	A	6/22/2021 14:30	7/6/2021 17:00	20310	4.77
N2100172	UT01	A	7/6/2021 17:00	7/20/2021 15:30	20070	4.72
N2100186	UT01	A	7/20/2021 15:30	8/3/2021 15:40	20170	4.74
N2100198	UT01	A	8/3/2021 15:40	8/17/2021 18:30	20330	4.78
N2100214	UT01	A	8/17/2021 18:30	8/31/2021 16:30	20040	4.71
N2100224	UT01	A	8/31/2021 16:30	9/14/2021 19:00	20310	4.77
N2100238	UT01	A	9/14/2021 19:00	9/28/2021 18:30	20130	4.73
N2100249	UT01	A	9/28/2021 18:30	10/12/2021 18:15	20145	4.73
N2100249	UT01	B	9/28/2021 18:30	10/12/2021 18:15	20145	4.73
N2100260	UT01	A	10/12/2021 18:15	10/26/2021 18:30	20175	4.74
N2100274	UT01	A	10/26/2021 18:30	11/9/2021 16:30	20040	4.71
N2100274	UT01	T	10/26/2021 18:30	11/9/2021 16:30	20040	4.71
N2100281	UT01	A	11/9/2021 16:30	11/23/2021 17:00	20190	4.74
N2100309	UT01	A	11/23/2021 17:00	12/7/2021 18:30	20250	4.76
N2200013	UT01	A	12/7/2021 18:30	12/21/2021 19:45	20235	4.76
N2200014	UT01	A	12/21/2021 19:45	1/4/2022 18:30	20085	4.72
N2200026	UT01	A	1/4/2022 18:30	1/18/2022 20:30	20280	4.77
N2200047	UT01	A	1/18/2022 19:00	2/1/2022 20:30	20250	4.76
N2200051	UT01	A	2/1/2022 20:30	2/15/2022 18:30	20040	4.71
N2200063	UT01	A	2/15/2022 18:30	3/1/2022 21:00	20310	4.77
N2200076	UT01	A	3/1/2022 21:00	3/15/2022 15:30	19830	4.66
N2200088	UT01	A	3/15/2022 15:30	3/29/2022 16:30	20220	4.75
N2200099	UT01	A	3/29/2022 16:30	4/12/2022 17:30	20220	4.75
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N2200099	UT01	T	3/29/2022 16:30	4/12/2022 17:30	20220	4.75
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N2200136	UT01	A	5/10/2022 18:45	5/24/2022 18:00	20115	4.73
N2200156	UT01	A	5/24/2022 18:00	6/7/2022 16:30	20070	4.72
N2200156	UT01	A	6/7/2022 16:30	6/21/2022 15:15	20085	4.72
N2200165	UT01	A	6/21/2022 15:15	7/5/2022 15:30	20175	4.74
N2200195	UT01	A	7/5/2022 15:30	8/19/2022 15:40	64810	15.23
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N2200191	UT01	A	8/2/2022 16:00	8/16/2022 16:30	20190	4.74
N2200191	UT01	B	8/2/2022 16:00	8/16/2022 16:30	20190	4.74
N2200191	UT01	T	8/2/2022 16:00	8/16/2022 16:30	20190	4.74
N2200209	UT01	A	8/30/2022 19:30	9/13/2022 15:20	19910	4.68

N2200219 UT01	A	9/13/2022 15:20	9/27/2022 16:00	20200	4.75
N2200226 UT01	A	9/27/2022 16:00	10/11/2022 15:30	20130	4.73

EXTRACTVOL	NH4	CONC	QR	NOTES	chngdate
9.96	5.686	11.28	B	cy	Dec 1 2011 10:03AM
9.97	0.137	0.27	B	cy	Dec 1 2011 10:03AM
9.98	6.297	12.52	A		Dec 15 2011 8:00AM
9.99	0.172	0.34	A		Dec 15 2011 8:00AM
9.98	7.432	14.78	A		Jan30 2012 10:53AM
10.01	0.164	0.33	A		Jan30 2012 10:53AM
10	6.641	13.24	B	c	Feb 20 2012 1:40PM
10.01	0.015	0.03	B	cd	Feb 20 2012 1:40PM
10	9.406	18.74	B	c	Feb20 2012 11:52AM
9.97	0.132	0.26	B	c	Feb20 2012 11:52AM
10.02	4.325	9.28	B	c	Feb 29 2012 9:38AM
10.05	0.197	0.42	B	c	Feb 29 2012 9:38AM
9.96	7.172	14.3	A		Apr 10 2012 4:54PM
9.96	0.241	0.48	B	t	Apr 10 2012 4:54PM
10.04	1.326	2.64	B	cy	Mar 6 2012 9:35AM
10.05	0.094	0.19	B	cy	Mar 6 2012 9:35AM
9.97	5.887	11.66	A		Mar 20 2012 9:41AM
10.03	0.114	0.23	A		Mar 20 2012 9:41AM
10.03	7.194	14.39	B	c	Apr 4 2012 10:31AM
9.99	0.104	0.21	B	c	Apr 4 2012 10:31AM
10.01	6.35	12.69	B	cy	Apr 17 2012 10:35AM
9.99	0.082	0.16	B	cy	Apr 17 2012 10:35AM
9.98	7.343	14.69	B	c	May 1 2012 10:50AM
10.02	0.131	0.26	B	c	May 1 2012 10:50AM
9.99	5.406	10.72	B	c	Jun 18 2012 1:52PM
9.99	5.789	11.48	B	c	Jun 18 2012 1:52PM
9.99	5.708	11.32	B	c	Jun 18 2012 1:52PM
10	0.147	0.29	B	c	Jun 18 2012 1:52PM
9.98	8.554	17.02	B	c	May30 2012 10:09AM
10.01	0.199	0.4	B	c	May30 2012 10:09AM
9.99	6.47	12.88	B	c	Jun13 2012 10:45AM
9.99	0.199	0.4	B	c	Jun13 2012 10:45AM
9.97	6.025	11.97	B	c	Jun26 2012 10:18AM
9.98	0.038	0.07	B	cd	Jun26 2012 10:18AM
9.96	4.839	9.59	B	c	Jul 11 2012 10:25AM
10	0.144	0.29	B	c	Jul 11 2012 10:25AM
10.02	11.002	22	B	c	Jul 24 2012 11:16AM
10.03	0.193	0.39	B	c	Jul 24 2012 11:16AM
10	10.094	20.12	B	c	Aug 7 2012 10:41AM
10.05	0.125	0.25	B	c	Aug 7 2012 10:41AM
9.98	9.739	19.33	B	c	Aug 21 2012 9:48AM
10.09	0.163	0.33	B	c	Aug 21 2012 9:48AM
10.02	11.075	22.01	B	c	Nov 15 2012 11:12PM
10.05	0.082	0.16	B	c	Nov 15 2012 11:12PM
10.04	8.885	17.87	B	c	Sep 18 2012 10:28AM
9.99	0.116	0.23	B	c	Sep 18 2012 10:28AM
10.01	9.856	16.19	B	c	Oct 2 2012 9:33AM
10	0.147	0.24	B	c	Oct 2 2012 9:33AM
9.99	7.598	19.27	B	cs	Dec 11 2012 3:27PM
10.04	0.122	0.31	B	cs	Dec 11 2012 3:27PM
10.02	8.155	16.2	B	c	Oct 31 2012 10:05AM
10.03	0.059	0.12	B	c	Oct 31 2012 10:05AM
10	8.986	17.98	B	c	Nov 13 2012 10:10AM

10.01	0.152	0.31 B	c	Nov 13 2012 10:10AM
10	8.155	16.22 B	c	Nov 29 2012 9:35AM
10	0.035	0.07 B	cd	Nov 29 2012 9:35AM
9.99	8.141	16.18 B	c	Feb 4 2013 10:22PM
9.99	0.076	0.15 B	c	Feb 4 2013 10:22PM
10.01	4.932	9.89 B	cy	Dec 27 2012 10:09AM
10	0.04	0.08 B	cdy	Dec 27 2012 10:09AM
10.02	8.116	16.2 B	c	Jan 9 2013 12:02PM
10.02	0.148	0.3 B	c	Jan 9 2013 12:02PM
9.99	7.141	16.68 B	cs	Jan 22 2013 11:19AM
9.98	0.069	0.16 B	cs	Jan 22 2013 11:19AM
9.99	8.931	17.72 B	c	Feb 6 2013 11:54AM
10	0.056	0.11 B	c	Feb 6 2013 11:54AM
9.98	14.635	29.02 B	c	Feb 21 2013 9:11AM
10.01	13.309	26.56 B	c	Mar 6 2013 10:21AM
10	13.631	27.18 B	c	Apr 17 2013 1:29PM
9.99	10.43	20.75 B	c	Apr 17 2013 3:10PM
9.98	9.799	19.46 B	cy	May 10 2013 3:18PM
9.98	6.405	12.68 B	c	Jun 27 2013 2:24PM
10	10.216	20.37 B	c	May 29 2013 10:51AM
10	5.538	11.02 B	c	Jun 11 2013 10:23AM
9.96	7.411	14.72 B	c	Jun 27 2013 2:50PM
9.97	0.269	0.53 B	ct	Jun 27 2013 2:50PM
10	8.273	16.49 B	c	Jul 10 2013 1:09PM
10	8.39	16.62 B	c	Jul 23 2013 10:55AM
9.94	11.167	22.25 B	c	Aug 28 2013 10:37AM
9.95	0.064	0.13 B	c	Aug 28 2013 10:37AM
10	9.687	19.26 B	c	Aug 20 2013 10:14AM
9.98	8.298	16.53 B	c	Sep 4 2013 10:55AM
10.01	10.614	21.16 B	c	Sep 18 2013 10:19AM
10	7.888	15.73 B	c	Oct 1 2013 10:48AM
9.97	6.32	12.54 B	c	Oct 15 2013 10:20AM
9.99	8.011	15.81 B	c	Oct 29 2013 10:44AM
9.99	8.083	16.26 B	c	Nov 12 2013 10:09AM
9.99	10.092	20.07 B	cy	Jan 3 2014 11:10AM
9.99	0.257	0.51 B	cyt	Jan 3 2014 11:10AM
9.98	8.444	16.77 B	c	Jan 3 2014 11:18AM
9.98	8.554	16.99 B	c	Jan 3 2014 11:18AM
9.98	8.285	16.46 B	c	Jan 3 2014 11:18AM
9.99	0.145	0.29 B	c	Jan 3 2014 11:18AM
10	7.8	15.54 B	cy	Dec 30 2013 1:55PM
10	13.667	27.32 B	c	Jan 8 2014 2:12PM
10	13.695	27.34 B	c	Jan 22 2014 8:44AM
10	0.233	0.47 B	ct	Jan 22 2014 8:44AM
9.97	16.881	33.32 B	c	Feb 4 2014 9:49AM
9.98	6.853	13.66 B	c	Feb 18 2014 11:03AM
9.96	6.515	14.08 B	cs	Mar 26 2014 9:38AM
9.98	5.576	11.07 B	c	Mar 17 2014 11:33AM
9.99	5.847	11.71 B	c	Mar 31 2014 11:18AM
9.97	6.572	12.99 B	c	Apr 14 2014 1:08PM
10	7.826	15.59 B	c	Apr 29 2014 11:56AM
9.97	5.905	11.74 B	c	May 13 2014 11:58AM
9.96	7.551	14.99 B	c	May 28 2014 11:12AM
9.99	6.49	12.9 B	cy	Jun 10 2014 10:23AM
9.98	4.958	9.88 B	h	Jul 10 2014 2:39PM
9.99	7.732	15.34 B	cy	Jul 22 2014 3:48PM
9.97	0.081	0.16 B	cy	Jul 22 2014 3:48PM

9.97	9.4	18.76 B	c	Jul 22 2014 9:55AM
9.98	0.192	0.38 B	c	Jul 22 2014 9:55AM
9.98	9.556	18.99 B	c	Aug 5 2014 10:49AM
9.98	0.297	0.59 B	ct	Aug 5 2014 10:49AM
9.98	7.638	15.19 B	c	Aug 20 2014 9:37AM
9.99	0.117	0.23 B	c	Aug 20 2014 9:37AM
9.97	0.087	0.17 B	cy	Sep 19 2014 8:10AM
9.98	0.377	0.75 B	cyt	Sep 19 2014 8:10AM
9.98	9.883	19.57 B	c	Sep 16 2014 11:42AM
9.98	8.653	17.23 B	c	Sep 30 2014 9:15AM
9.98	7.107	14.14 B	c	Oct 13 2014 11:47AM
10	8.42	16.78 B	c	Oct 28 2014 8:56AM
9.97	11.826	23.51 B	c	Nov 10 2014 10:13AM
10	6.436	12.82 B	cy	Nov 26 2014 10:55AM
9.96	7.896	15.67 B	c	Dec 8 2014 1:34PM
9.97	10.22	20.25 B	cy	Dec 23 2014 9:26AM
10.01	5.267	10.53 B	cy	Jan 9 2015 8:54AM
9.98	8.686	18.65 B	cs	Jan 21 2015 9:38AM
9.97	8.911	17.71 B	c	Feb 2 2015 2:15PM
9.98	7.892	15.71 B	c	Feb 16 2015 11:39AM
9.97	6.437	12.7 B	c	Mar 3 2015 11:29AM
9.99	6.573	13.05 B	ch	Apr 2 2015 1:50PM
9.98	6.296	12.48 B	ch	Apr 2 2015 1:50PM
9.98	6.285	12.46 B	ch	Apr 2 2015 1:50PM
9.98	0.069	0.14 B	c	Apr 2 2015 1:50PM
10	7.495	15.06 B	c	Mar 30 2015 2:37PM
9.97	1.409	2.81 B	c	Apr 28 2015 11:13AM
10	5.599	11.15 B	c	Apr 27 2015 11:11AM
9.99	6.434	12.82 B	c	May 11 2015 9:57AM
9.96	0.027	0.05 B	cd	May 11 2015 9:57AM
9.98	3.834	7.6 B	c	May 26 2015 10:43AM
10.05	4.682	9.38 B	c	Jun 8 2015 10:47AM
9.95	5.983	11.88 B	c	Jun 22 2015 12:44PM
9.98	8.002	15.94 B	c	Jul 6 2015 12:15PM
10	7.891	15.72 B	c	Jul 31 2015 3:08PM
9.99	6.994	13.92 B	c	Aug 3 2015 11:48AM
9.97	4.631	9.13 B	c	Aug 18 2015 9:57AM
9.96	7.585	15.18 B	c	Sep 18 2015 3:21PM
9.99	7.307	14.55 B	c	Sep 14 2015 10:29AM
10.01	6.252	12.47 B	cy	Sep 29 2015 3:57PM
9.98	0.063	0.12 B	cy	Sep 29 2015 3:57PM
10	9.725	19.18 B	c	Oct 12 2015 10:18AM
9.98	0.053	0.1 B	c	Oct 12 2015 10:18AM
10.01	9.157	18.45 B	c	Oct 26 2015 11:05AM
9.97	8.992	17.86 B	c	Nov 9 2015 10:01AM
9.97	5.214	10.37 B	c	Nov 23 2015 9:34AM
9.99	7.333	14.59 B	c	Dec 10 2015 9:40AM
9.96	0.011	0.02 B	cd	Feb 25 2016 3:18PM
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10	13.507	26.92 B	c	Jan 19 2016 10:38AM
10	0.028	0.06 B	cd	Jan 19 2016 10:38AM
10.01	14.357	28.64 B	c	Feb 17 2016 2:31PM
10	0.046	0.09 B	cd	Feb 17 2016 2:31PM
9.99	10.186	20.27 B	c	Feb 18 2016 10:33AM
10	9.538	19.01 B	c	Mar 1 2016 10:07AM
10.01	10.736	21.43 B	c	Mar 14 2016 10:45AM
9.99	6.584	13.09 B	c	Mar 28 2016 11:18AM

9.98	4.947	9.84 B	c	Apr 11 2016 10:43AM
9.97	0.038	0.08 B	cd	Apr 11 2016 10:43AM
9.98	6.715	13.36 B	c	Apr 25 2016 11:00AM
9.98	5.71	11.35 B	c	May 9 2016 9:54AM
10.01	7.004	13.99 B	c	May 23 2016 10:06AM
9.98	4.647	9.24 B	c	Jun 6 2016 10:59AM
10	6.609	13.16 B	c	Jun 20 2016 9:34AM
10.01	6.567	13.09 B	c	Jun 20 2016 9:34AM
9.97	6.634	13.17 B	c	Jun 20 2016 9:34AM
10	0.038	0.08 B	cd	Jun 20 2016 9:34AM
10	6.635	13.22 B	c	Jul 5 2016 10:09AM
10.01	0.061	0.12 B	c	Jul 5 2016 10:09AM
10.01	7.865	15.69 B	c	Jul 18 2016 10:29AM
10.02	7.23	14.21 B	c	Aug 3 2016 10:42AM
9.95	8.54	17.21 B	c	Aug 31 2016 4:19PM
9.98	7.588	15.09 B	c	Aug 29 2016 9:24AM
10	8.785	17.51 B	c	Sep 12 2016 10:35AM
10	6.701	13.27 B	c	Sep 28 2016 10:11AM
9.93	0.057	0.11 B	c	Sep 28 2016 10:11AM
10.03	6.917	13.9 B	c	Oct 10 2016 10:03AM
10	7.952	15.84 B	c	Oct 24 2016 10:04AM
9.98	8.693	17.28 B	c	Nov 7 2016 9:52AM
10.01	11.981	23.9 B	c	Nov 21 2016 10:19AM
10	7.153	14.25 B	c	Dec 7 2016 9:56AM
9.96	7.031	13.95 B	c	Dec 7 2016 9:56AM
9.97	7.23	14.36 B	c	Dec 7 2016 9:56AM
9.99	0.066	0.13 B	c	Dec 7 2016 9:56AM
10.01	4.95	9.87 B	cy	Dec 20 2016 9:58AM
9.98	0.07	0.14 B	cy	Dec 20 2016 9:58AM
9.97	6.035	11.88 B	cy	Jan 6 2017 10:45AM
10.01	5.972	11.99 B	c	Jan 17 2017 11:07AM
10.04	8.849	17.7 B	cy	Feb 1 2017 9:42AM
10	10.839	21.6 B	c	Feb 14 2017 10:29AM
9.98	7.458	14.76 B	cy	Feb 27 2017 10:00AM
9.99	5.694	11.39 B	c	Mar 14 2017 10:09AM
10	0.073	0.15 B	c	Mar 14 2017 10:09AM
9.99	9.665	19.27 B	c	Mar 27 2017 11:04AM
10.01	5.616	11.19 B	c	Apr 10 2017 10:49AM
10	5.621	11.2 B	c	Apr 24 2017 9:55AM
9.99	6.138	12.22 B	c	May 8 2017 10:16AM
9.99	7.15	14.23 B	c	May 22 2017 1:25PM
9.99	7.411	14.75 B	c	May 22 2017 1:25PM
10.02	7.274	14.52 B	c	May 22 2017 1:25PM
10	0.062	0.12 B	c	May 22 2017 1:25PM
9.97	6.312	12.53 B	c	Jun 5 2017 9:56AM
10.05	0.05	0.1 B	c	Jun 5 2017 9:56AM
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10.01	8.644	17.24 B	c	Jul 3 2017 10:02AM
10.03	9.587	19.15 B	c	Jul 17 2017 11:38AM
9.99	11.641	23.16 B	c	Jul 31 2017 11:14AM
10	11.145	22.28 B	c	Aug 14 2017 11:31AM
10.03	11.165	22.13 B	c	Aug 28 2017 11:40AM
10.04	0.084	0.17 B	c	Aug 28 2017 11:40AM
10.01	12.072	24.08 B	c	Sep 13 2017 11:40AM
10.02	9.646	12.84 B	c	Oct 24 2017 2:53PM
10.01	3.5	14.01 B	cs	Oct 12 2017 10:54AM
10	7.868	15.74 B	c	Oct 24 2017 9:54AM

10.03	7.708	15.5 B	c	Nov222017 10:23AM
10.01	0.076	0.15 B	c	Nov222017 10:23AM
9.99	10.336	20.45 B	c	Dec 5 2017 11:40AM
10.01	9.334	18.69 B	c	Dec 18 2017 1:17PM
9.99	12.386	24.58 B	c	Jan 16 2018 4:07PM
9.98	21.241	42.12 B	cy	Jan 17 2018 9:55AM
10.01	10.198	20.4 B	c	Feb 2 2018 9:31AM
10.01	13.203	26.22 B	c	Feb 14 2018 9:51AM
10	0.087	0.17 B	c	Feb 14 2018 9:51AM
10.01	5.784	11.62 B	c	Feb282018 11:12AM
10	6.056	12.06 B	c	Mar 13 2018 9:39AM
10.01	10.701	21.28 B	c	Apr 3 2018 11:00AM
10.01	6.064	12.13 B	c	Apr 11 2018 10:08AM
10	5.518	10.93 B	c	Apr 25 2018 11:11AM
9.99	5.516	10.92 B	c	Apr 25 2018 11:11AM
10	5.696	11.28 B	c	Apr 25 2018 11:11AM
10	0.032	0.06 B	cd	Apr 25 2018 11:11AM
10.01	7.321	14.69 B	c	May 10 2018 9:56AM
9.99	0.043	0.09 B	cd	May 10 2018 9:56AM
10	8.688	17.4 B	c	May 21 2018 9:25AM
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10.01	7.348	14.57 B	c	Jun 27 2018 3:23PM
10	0.073	0.14 B	c	Jun 27 2018 3:23PM
9.98	6.444	12.78 B	c	Jun202018 10:59AM
10	7.556	15.06 B	c	Nov282018 10:32AM
9.99	0.031	0.06 B	cdh	Nov282018 10:32AM
9.99	9.03	18.1 B	c	Jul 16 2018 2:37PM
10	10.296	20.41 B	c	Aug 1 2018 9:15AM
9.99	10.306	20.53 B	c	Aug 17 2018 9:24AM
10	10.578	21.06 B	c	Jan 4 2019 9:07AM
10	10.374	20.66 B	c	Jan 4 2019 9:07AM
10	10.508	20.92 B	c	Jan 4 2019 9:07AM
10.02	0.037	0.07 B	cdh	Jan 4 2019 9:07AM
10	8.14	16.22 B	c	Sep 11 2018 9:45AM
9.99	8.33	16.64 B	c	Sep 25 2018 9:07AM
9.99	9.043	18.02 B	c	Oct 8 2018 3:14PM
9.99	5.716	11.43 B	c	Oct 23 2018 11:16AM
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10.01	6.565	13.1 B	c	Nov272018 10:59AM
10.03	9.183	18.34 B	c	Dec 5 2018 10:11AM
10	7.986	15.9 B	c	Dec192018 11:06AM
10	8.291	16.51 B	c	Dec192018 11:06AM
9.99	8.029	15.97 B	c	Dec192018 11:06AM
10.01	0.04	0.08 B	cd	Dec192018 11:06AM
10.01	13.918	27.66 B	c	Jan 9 2019 2:35PM
10.01	9.05	18.04 B	c	Jan 16 2019 10:04AM
10.01	11.56	23.08 B	c	Jan 31 2019 4:11PM
10	19.78	39.36 B	c	Feb 12 2019 11:30AM
9.99	6.259	12.51 B	c	Feb 27 2019 11:21AM
10	6.174	12.26 B	cy	Aug 6 2019 9:58AM
9.96	6.318	12.49 B	cy	Aug 6 2019 9:58AM
10	5.85	11.61 B	cy	Aug 6 2019 9:58AM
10	0.026	0.05 B	cd	Aug 6 2019 9:58AM
9.97	5.5	10.96 B	c	Mar 27 2019 1:43PM
10.02	5.442	10.91 B	c	Sep 4 2019 10:51AM
9.99	4.301	8.54 B	c	Apr 24 2019 11:55AM

9.99	5.95	11.76 B	c	May 15 2019 10:17AM
9.98	0.04	0.08 B	cd	May 15 2019 10:17AM
10	7.471	15.01 B	c	May 28 2019 3:35PM
9.97	7.372	14.64 B	ch	Nov 25 2019 2:28PM
10	6.607	13.15 B	cy	Jun 20 2019 3:50PM
10.01	6.72	13.4 B	cy	Dec 9 2019 11:05AM
9.99	6.71	13.36 B	cy	Dec 9 2019 11:05AM
10	6.758	13.47 B	cy	Dec 9 2019 11:05AM
9.99	0.02	0.04 B	cdhy	Dec 9 2019 11:05AM
10	7.237	14.41 B	c	Jul 16 2019 11:35AM
10.02	10.021	20.01 B	c	Aug 6 2019 2:44PM
9.97	9.186	18.22 B	cy	Aug 14 2019 2:11PM
9.99	8.931	17.79 B	c	Aug 27 2019 2:02PM
9.99	9.619	19.15 B	c	Sep 10 2019 4:42PM
9.98	8.9	17.66 B	c	Sep 26 2019 1:19PM
9.97	6.169	12.28 B	c	Oct 8 2019 1:42PM
10	5.976	11.91 B	ch	Mar 2 2020 3:00PM
10	5.877	11.71 B	ch	Mar 2 2020 3:00PM
9.99	5.712	11.37 B	ch	Mar 2 2020 3:00PM
10	0.033	0.07 B	cd	Mar 2 2020 3:00PM
9.97	6.918	13.73 B	cy	Nov 7 2019 3:26PM
10.01	10.652	21.25 B	c	Nov 19 2019 11:16AM
9.99	7.865	15.73 B	cy	Dec 20 2019 1:10PM
9.97	0.038	0.08 B	cdy	Dec 20 2019 1:10PM
9.99	12.477	24.88 B	cy	Aug 6 2020 10:23AM
10	9.589	19.14 B	cy	Jan 15 2020 10:53AM
9.99	11.035	21.94 B	c	Jan 29 2020 11:34AM
10.01	13.208	26.39 B	c	Feb 12 2020 2:22PM
10	8.981	17.87 B	cy	Sep 3 2020 9:27AM
10.03	11.738	23.43 B	c	Mar 12 2020 1:45PM
10.01	8.909	17.76 B	c	Mar 26 2020 10:59AM
10.02	3.725	7.47 B	c	Apr 9 2020 11:48AM
10.01	3.819	7.65 B	c	Apr 9 2020 11:48AM
10.05	0.046	0.09 B	cd	Apr 9 2020 11:48AM
10.03	5.464	10.88 B	c	Apr 24 2020 3:46PM
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10.02	8.005	16 B	c	May 21 2020 3:42PM
9.99	6.101	12.15 B	c	Jun 4 2020 1:58PM
10.05	8.577	17.14 B	c	Jun 18 2020 9:36AM
10.02	6.233	12.43 B	c	Jul 2 2020 1:56PM
10.04	8.348	16.71 B	c	Jul 15 2020 2:27PM
10.06	9.21	18.45 B	cy	Jul 30 2020 1:30PM
10.02	10.603	21.25 B	c	Aug 12 2020 11:51AM
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10.06	13.767	27.41 B	c	Sep 11 2020 4:11PM
10.04	0.062	0.12 B	cd	Sep 11 2020 4:11PM
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10.08	12.651	25.37 B	c	Oct 9 2020 2:15PM
10.01	12.63	25.19 B	c	Jan 14 2021 3:42PM
10.05	9.782	19.59 B	c	Nov 3 2020 1:06PM
10.06	11.071	20.7 B	c	Nov 20 2020 2:08PM
10.03	7.543	16.25 B	c	Dec 1 2020 11:59AM
10.02	7.441	16.01 B	c	Dec 1 2020 11:59AM
10.03	0.026	0.06 B	cd	Dec 1 2020 11:59AM
10.02	11.015	22.14 B	chy	Mar 26 2021 3:01PM
10.02	10.755	21.25 B	cy	Jan 8 2021 1:57PM

10.08	13.193	23.26 B	c	Jan 15 2021 12:45PM
10.06	13.42	31.36 B	cs	Feb 3 2021 11:10AM
10.01	7.875	15.74 B	c	Feb 15 2021 2:07PM
10.01	7.186	14.32 B	cy	Mar 1 2021 4:52PM
9.98	4.542	9.03 B	cy	Mar 16 2021 3:11PM
10.01	4.735	9.44 B	cy	Mar 16 2021 3:11PM
10.02	0.013	0.03 B	cdy	Mar 16 2021 3:11PM
9.99	8.52	16.96 B	cy	Mar 29 2021 11:39AM
10.01	5.478	10.94 B	cy	Apr 9 2021 12:47PM
9.99	6.181	12.31 B	cy	May 17 2021 4:05PM
10	5.315	10.67 B	cy	May 11 2021 1:03PM
9.98	8.014	15.96 B	cy	Sep 7 2021 11:38AM
10.01	6.295	14.67 B	cs	Oct 5 2021 10:09AM
9.98	8.981	17.85 B	c	Oct 5 2021 11:04AM
9.99	9.255	18.48 B	c	Oct 5 2021 12:48PM
10.02	9.595	19.22 B	c	Oct 5 2021 12:48PM
10	0.075	0.15 B	c	Oct 5 2021 12:48PM
9.99	9.68	19.13 B	cy	Oct 29 2021 10:58AM
10	10.96	21.94 B	c	Jul 27 2021 11:37AM
10.02	11.165	22.28 B	c	Aug 11 2021 1:43PM
10.04	13.007	25.81 B	cy	Aug 26 2021 3:43PM
10.03	9.952	20.01 B	cy	Jan 5 2022 10:04AM
10.01	13.058	25.86 B	chy	Jan 5 2022 10:57AM
10	9.424	18.81 B	cy	Oct 14 2021 12:44PM
10.01	7.403	14.78 B	chy	Jan 28 2022 12:37PM
10	6.954	13.87 B	chy	Jan 28 2022 12:37PM
9.99	6.733	13.39 B	c	Nov 3 2021 11:33AM
9.99	8.092	16.2 B	cy	Nov 23 2021 11:35AM
10	0.032	0.06 B	cdy	Nov 23 2021 11:35AM
10	8.738	17.39 B	ch	Mar 2 2022 10:43AM
10.01	12.856	25.53 B	cy	Dec 30 2021 9:05AM
10	9.896	19.65 B	c	Jun 2 2022 10:25AM
9.98	7.859	15.69 B	c	Feb 9 2023 1:36PM
10.02	6.246	12.4 B	c	Jan 31 2022 12:00PM
10.02	9.781	19.44 B	ch	Jun 8 2022 3:57PM
10	17.517	35.12 B	c	Mar 1 2022 3:11PM
10.03	9.606	19.06 B	c	Mar 9 2022 1:51PM
10.01	0.758	1.54 B	ch	Aug 17 2022 1:01PM
10	9.852	19.57 B	c	Apr 13 2022 1:13PM
10.03	6.984	13.92 B	c	Apr 22 2022 1:13PM
10.02	7.594	15.12 B	c	Apr 22 2022 1:13PM
10.03	0.039	0.08 B	cd	Apr 22 2022 1:13PM
10.01	7.209	14.36 B	c	May 10 2022 3:17PM
10.01	7.669	15.26 B	c	May 25 2022 2:22PM
10.03	7.344	14.71 B	c	Jun 8 2022 2:13PM
10.01	7.483	14.99 B	c	Jul 1 2022 11:23AM
9.98	8.416	16.8 B	c	Jul 1 2022 11:24AM
10.02	9.245	18.45 B	c	Jul 15 2022 2:48PM
10.04	9.556	5.95 B	ceh	Feb 2 2023 3:53PM
10	11.02	21.94 B	ch	Feb 2 2023 3:53PM
10.03	11.357	22.67 B	c	Aug 23 2022 3:32PM
10.03	11.254	22.46 B	c	Aug 23 2022 3:32PM
9.94	0.056	0.11 B	cd	Aug 23 2022 3:32PM
9.99	11.014	22.2 B	c	Feb 2 2023 4:04PM
10.03	7.738	15.44 B	c	Feb 6 2023 4:55PM
10	9.211	18.38 B	c	Oct 18 2022 11:13AM

## Cache Valley

AvgJanTemp(°C) -2.8  
 Avg JanPress (mmHg) 642

	Avg Jan NH3 (ug/m3)	Avg Jan NH3 (ppb)	
2012	13.8	21.2	
2013	17.2	26.6	
2014	30.3	46.9	
2015	17.4	26.8	
2016	25.3	39.0	
2017	17.1	26.4	
2018	29.6	45.7	
2019	26.8	41.4	
2020	22.5	34.7	
2021	23.5	36.2	
2022	15.8	24.5	
2023	1.7	2.6	Preliminary data, personal communication D. Gay, NADP AMoN, Mar. 25, 2023
	33.6	8.551761908	

NADP AMoN UT01 Average January NH3

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