STATE OF COLORADO

Simmons - DNR, Leigh <leigh.simmons@state.co.us>

C1981019, Colowyo Mine, TR-148

Simmons - DNR, Leigh <leigh.simmons@state.co.us> Thu, Jul 15, 2021 at 7:45 PM
To: "Trujillo - DNR, Zach" <zach.trujillo@state.co.us>
Cc: Jason Musick <jason.musick@state.co.us>

Zach,

I have reviewed the response to the initial adequacy review of TR-148.

I recommend the approval of TR-148, my detailed memo is attached. Let me know if you need a copy of the word document.

Leigh Simmons
Environmental Protection Specialist

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

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COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

Interoffice Memorandum

July 15, 2021

From: Leigh Simmons
To: Zach Trujillo

Subject: **Colowyo Mine (Permit No. C-1981-019)**
TR-148

Colowyo Coal Company (CCC) responded to the Division's initial adequacy review on June 15, 2021. In the cover letter to their response CCC declined to submit a copy of the historical monitoring data used to derive the UTLs for Manganese, Sulfate and Total Dissolved Solids that are proposed as estimates of existing ambient quality to be used as alternatives to the Reg. 41 table values, citing the fact that it had already been submitted in Annual Hydrology Reports. CCC also stated that the methodology and assumptions had already been described in the AECOM report.

The reason for my original request, and the goal of my review, was to:

i. Verify the calculations made by AECOM; and
ii. Assess the quality and validity of the data used in the calculations.

I used data copied from Exhibit 4 of the 1995 combined ARR/AHR document, available to the public at https://dnrweblink.state.co.us/drms/0/doc/816256/Page1.aspx?searchid=4e8804e5-e337-456e-ab12-5c532c3132b9 to populate a spreadsheet (see Appendix 1).

I downloaded a copy of ProUCL 5.1, and the accompanying documentation from https://www.epa.gov/land-research/proucl-software

I analyzed the pooled data from the Gossard and NGSW wells collected earlier than January 31, 1994, using the "Upper Limits/BTV's" module of ProUCL. The results showed that the data for each parameter does not fit a discernable distribution. The computed values of the Upper Tolerance Limit, at the 95% confidence interval* matched those calculated by AECOM (see Appendix 2), confirming that the analysis presented to the Division is reproducible.

Historical data from the NGSW well is the best source available to assess "existing ambient quality as of January 31, 1994" in the alluvium of Goodspring Creek. As can be seen from the plot in Appendix 2, the data shows considerable temporal variation, and is suggestive of water that has already been impacted by mining activities. According to the RN-1 Findings document for the C1981019 permit:

> *The initial mining operations at Colowyo began in 1976 along the southern face of Streeter Draw. Box cut overburden material was placed in the Streeter Fill…*

It is unfortunate that no baseline groundwater monitoring took place before the disturbance in Streeter Draw. NGSW would be adequately located for the purpose, immediately downstream of the point where Streeter Draw meets Goodspring Creek (though it is on the east side of the creek, when the west side would have been preferable), but was first monitored in 1989 meaning that 13 years of mining related impacts to the Goodspring Creek alluvium had the potential to occur before monitoring began.

Similarly, historical data from the Gossard well is the best source available to assess "existing ambient quality as of January 31, 1994" in the alluvium of Wilson Creek upstream of the confluence with Taylor Creek. Although monitoring of the Gossard Well began earlier than of the NGSW well, in 1983, it was still considerably after the area was subject to the impacts of mining activities.

The Basic Standards for Groundwater make explicit that the purpose of the interim narrative standard, when applied to contaminated groundwater is to prevent further contamination. The following passage is duplicated from 41.5.C.6.b.ii:

> *The interim standard shall not be interpreted or applied as defining or limiting the potential need for remediation of contaminated groundwater where remedial requirements are established under state or federal law. It is the Commission's intent that, to the maximum degree technically feasible and economically reasonable, remedial efforts should be directed at cleaning up groundwater contaminated by human activities to a degree such that it is usable for all existing and potential beneficial uses; this interim narrative standard is not intended to define when such remediation is or is not feasible. Where contamination already exists, this interim standard is merely intended to assure that conditions are not allowed to deteriorate further pending remedial action. The appropriate level of clean-up to be achieved may be addressed by this Commission in a future classification and standard-setting proceeding, or by other agencies with jurisdiction over remedial actions.*

This review is focused on the establishment of numerical values for the Interim Narrative Standard at the new POC wells, not on the need or otherwise for remedial action, however no remedial action is recommended at this time.

*The calculation of an Upper Tolerance Limit at the 95% confidence interval is a widely accepted statistical method of determining a Background Threshold Value from an environmental data set. The method relies on a data set of adequate size for its validity; for non-parametric data, such as we are dealing with here, the required sample size is greater than would be the case if the data fit a distribution model. As the reports included in Appendix 2 show, the combined sample size is not large enough to calculate the Upper Tolerance Limit with 95% confidence – in fact the "Approximate Actual Confidence Coefficient achieved by UTL" values given in the ProUCL reports shows that the statistical confidence with the pooled data set is more like 82%. If the data sets for the two wells are separated, the statistical confidence in the calculated value decreases further to around 62%. In this situation I concur with AECOM's approach; the best compromise is to pool the two sets of data.

Summary

With TR-148 CCC and their consultant AECOM have proposed the establishment of two new POC wells, and numerical parameter values that implement the applicable interim narrative standard at those POC wells. The methods used to determine the proposed locations and values have been presented to the Division in the form of a report which is proposed to be added to the PAP as an Exhibit, and are both defensible and reproducible. I recommend the approval of TR-148 and the recognition that the operator has complied with the requirements of Stipulation 7.

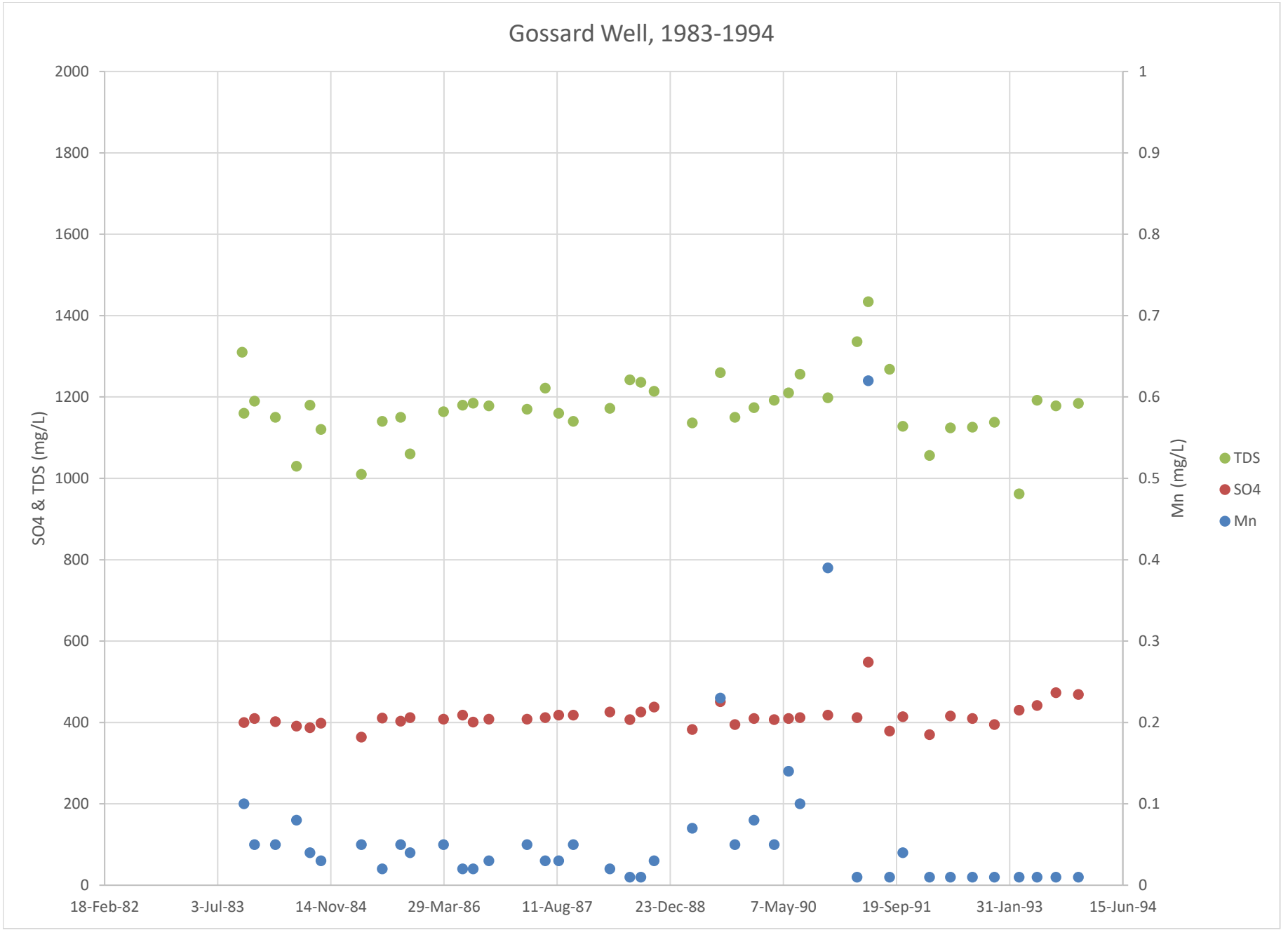
Appendix 1: Historical monitoring data from the Gossard and NGSW wells

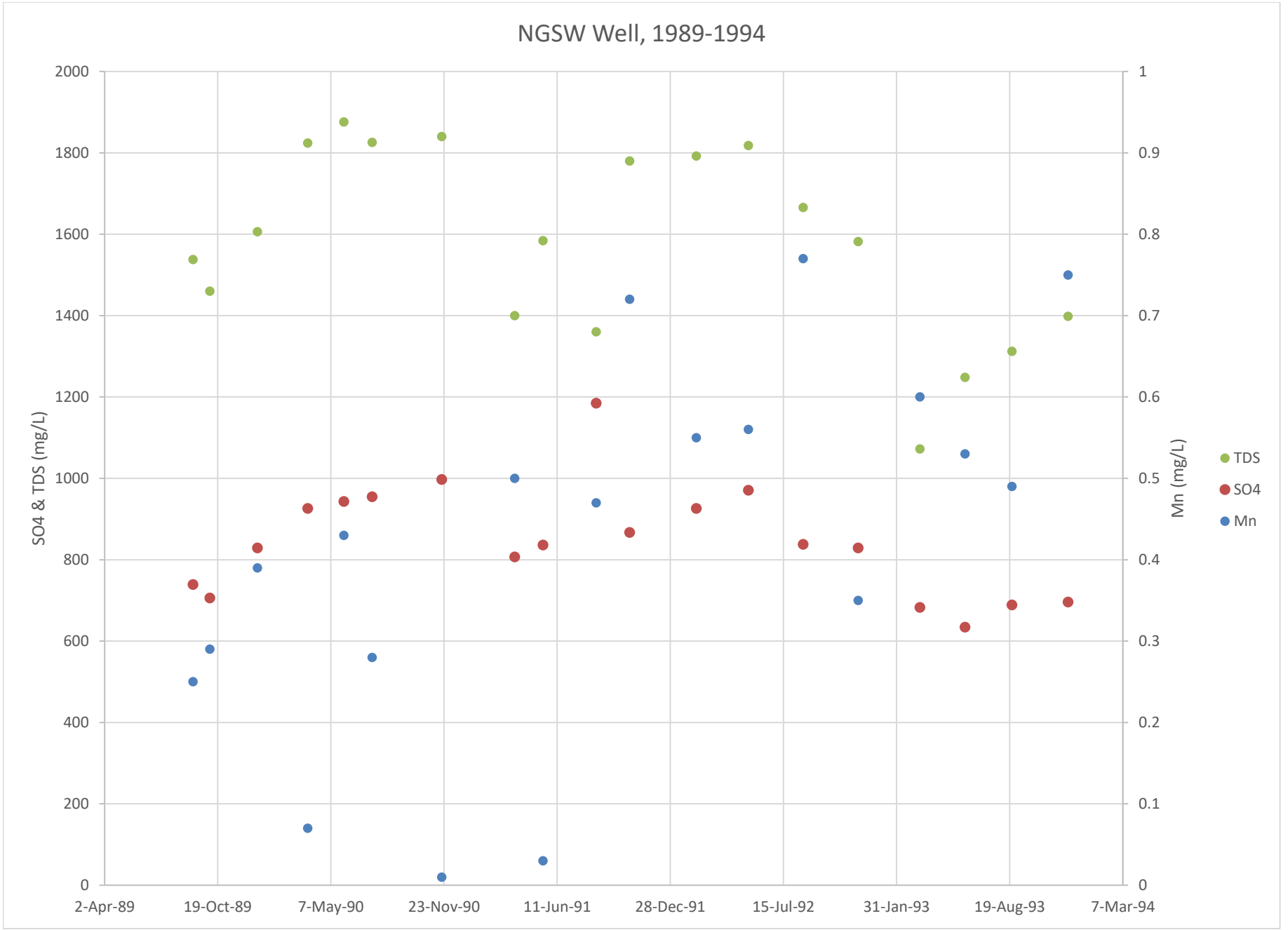
Gossard Well

Date	Mn (mg/L)	SO4 (mg/L)	TDS (mg/L)
19-Oct-83			1310
27-Oct-83	0.1	400	1160
12-Dec-83	0.05	410	1190
14-Mar-84	0.05	402	1150
15-Jun-84	0.08	391	1030
13-Aug-84	0.04	387	1180
5-Sep-84			
1-Oct-84	0.03	398	1120
29-Mar-85	0.05	364	1010
29-Jun-85	0.02	411	1140
22-Jul-85			
20-Aug-85			
18-Sep-85	0.05	403	1150
19-Sep-85			
16-Oct-85			
30-Oct-85	0.04	412	1060
27-Mar-86	0.05	408	1164
19-Jun-86	0.02	418	1180
24-Jul-86			
5-Aug-86	0.02	401	1185
10-Sep-86			
13-Oct-86	0.03	408	1178
31-Mar-87	0.05	408	1170
19-Jun-87	0.03	412	1222
18-Aug-87	0.03	418	1160
21-Oct-87	0.05	418	1140
31-Mar-88	0.02	426	1172
27-Jun-88	0.01	407	1242
15-Aug-88	0.01	426	1236
12-Oct-88	0.03	438	1214
30-Mar-89	0.07	383	1136
1-Aug-89	0.23	451	1260
4-Oct-89	0.05	395	1150
28-Dec-89	0.08	410	1174
27-Mar-90	0.05	407	1192
30-May-90	0.14	410	1210
19-Jul-90	0.1	412	1256
19-Nov-90	0.39	418	1198
28-Mar-91	0.01	412	1336
17-May-91	0.62	548	1434
19-Aug-91	0.01	379	1268
17-Oct-91	0.04	414	1128
12-Feb-92	0.01	370	1056
14-May-92	0.01	416	1124
19-Aug-92	0.01	410	1126
24-Nov-92	0.01	395	1138
13-Mar-93	0.01	430	962
1-Jun-93	0.01	442	1192
23-Aug-93	0.01	473	1178
30-Nov-93	0.01	469	1184

NGSW Well

Date	Mn (mg/L)	SO4 (mg/L)	TDS (mg/L)
5-Sep-89	0.25	739	1538
5-Oct-89	0.29	706	1460
28-Dec-89	0.39	829	1606
27-Mar-90	0.07	926	1824
30-May-90	0.43	943	1876
19-Jul-90	0.28	955	1826
19-Nov-90	0.01	997	1840
28-Mar-91	0.5	807	1400
17-May-91	0.03	836	1584
19-Aug-91	0.47	1185	1360
17-Oct-91	0.72	867	1780
12-Feb-92	0.55	926	1792
14-May-92	0.56	971	1818
19-Aug-92	0.77	838	1666
24-Nov-92	0.35	829	1582
13-Mar-93	0.6	683	1072
1-Jun-93	0.53	634	1248
23-Aug-93	0.49	689	1312
30-Nov-93	0.75	696	1398


Gossard Well, 1983-1994
SO4 & TDS (mg/L)
Mn (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
18-Feb-82
3-Jul-83
14-Nov-84
29-Mar-86
11-Aug-87
23-Dec-88
7-May-90
19-Sep-91
31-Jan-93
15-Jun-94
TDS
SO4
Mn


NGSW Well, 1989-1994
SO4 & TDS (mg/L)
Mn (mg/L)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2-Apr-89
19-Oct-89
7-May-90
23-Nov-90
11-Jun-91
28-Dec-91
15-Jul-92
31-Jan-93
19-Aug-93
7-Mar-94
TDS
SO4
Mn

Appendix 2: ProUCL reports showing calculated UTLs for Mn, SO_4, and TDS using pooled data from Gossard and NGSW wells

			Background Statistics for Uncensored Full Data Sets								
	User Selected Options										
	Date/Time of Computation		ProUCL 5.17/15/2021 2:13:19 PM								
	From File		G:\My Drive\Documents\01_Mines\Colowyo\TR148\Pre1994_Combined.xlsx								
	Full Precision		OFF								
	Confidence Coefficient		95%								
	Coverage		95%								
	New or Future K Observations		1								
	Number of Bootstrap Operations		2000								
Mn (mg/L)											
General Statistics											
		Total Number of Observations	61			Number of Distinct Observations	27				
						Number of Missing Observations	1				
		Minimum	0.01			First Quartile	0.02				
		Second Largest	0.75			Median	0.05				
		Maximum	0.77			Third Quartile	0.29				
		Mean	0.177			SD	0.228				
		Coefficient of Variation	1.29			Skewness	1.287				
		Mean of logged Data	-2.707			SD of logged Data	1.479				
			Critical Values for Background Threshold Values (BTVs)								
		Tolerance Factor K (For UTL)	2.013			d2max (for USL)	3.033				
			Normal GOF Test								
		Shapiro Wilk Test Statistic	0.724			Normal GOF Test					
		5% Shapiro Wilk P Value	6.439E-15			Data Not Normal at 5% Significance Level					
		Lilliefors Test Statistic	0.304			Lilliefors GOF Test					
		5% Lilliefors Critical Value	0.113			Data Not Normal at 5% Significance Level					
			Data Not Normal at 5% Significance Level								
			Background Statistics Assuming Normal Distribution								
		95% UTL with 95% Coverage	0.635			90% Percentile (z)	0.468				
		95% UPL (t)	0.56			95% Percentile (z)	0.551				
		95% USL	0.867			99% Percentile (z)	0.706				
			Gamma GOF Test								
		A-D Test Statistic	3.057			Anderson-Darling Gamma GOF Test					
		5% A-D Critical Value	0.804			Data Not Gamma Distributed at 5% Significance Level					
		K-S Test Statistic	0.222			Kolmogorov-Smirnov Gamma GOF Test					
		5% K-S Critical Value	0.119			Data Not Gamma Distributed at 5% Significance Level					
			Data Not Gamma Distributed at 5% Significance Level								
			Gamma Statistics								
		k hat (MLE)	0.631			k star (bias corrected MLE)	0.611				
		Theta hat (MLE)	0.28			Theta star (bias corrected MLE)	0.289				
		nu hat (MLE)	76.95			nu star (bias corrected)	74.5				
		MLE Mean (bias corrected)	0.177			MLE Sd (bias corrected)	0.226				
			Background Statistics Assuming Gamma Distribution								
		95% Wilson Hilferty (WH) Approx. Gamma UPL	0.609			90% Percentile	0.457				
		95% Hawkins Wixley (HW) Approx. Gamma UPL	0.633			95% Percentile	0.631				

54				95% WH Approx. Gamma UTL with	95% Coverage	0.788				99% Percentile		1.051
55				95% HW Approx. Gamma UTL with	95% Coverage	0.849						
56					95% WH USL	1.559				95% HW USL		1.877
57												
58						Lognormal GOF Test						
59					Shapiro Wilk Test Statistic	0.88		Shapiro Wilk Lognormal GOF Test				
60					5% Shapiro Wilk P Value	2.1135E-6		Data Not Lognormal at 5% Significance Level				
61					Lilliefors Test Statistic	0.151		Lilliefors Lognormal GOF Test				
62					5% Lilliefors Critical Value	0.113		Data Not Lognormal at 5% Significance Level				
63					Data Not Lognormal at 5% Significance Level							
64												
65						Background Statistics assuming Lognormal Distribution						
66				95% UTL with	95% Coverage	1.312				90% Percentile (z)		0.445
67					95% UPL (t)	0.807				95% Percentile (z)		0.761
68					95% USL	5.931				99% Percentile (z)		2.085
69												
70						Nonparametric Distribution Free Background Statistics						
71						Data do not follow a Discernible Distribution (0.05)						
72												
73						Nonparametric Upper Limits for Background Threshold Values						
74					Order of Statistic, r	60		95% UTL with	95% Coverage			0.75
75				Approx, f used to compute achieved CC		1.579		pproximate Actual Confidence Coefficient achieved by UTL				0.816
76								Approximate Sample Size needed to achieve specified CC				93
77				95% Percentile Bootstrap UTL with	95% Coverage	0.75		95% BCA Bootstrap UTL with	95% Coverage			0.75
78					95% UPL	0.71				90% Percentile		0.55
79					90% Chebyshev UPL	0.865				95% Percentile		0.62
80					95% Chebyshev UPL	1.177				99% Percentile		0.758
81					95% USL	0.77						
82												
83	Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.											
84	Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers											
85	and consists of observations collected from clean unimpacted locations.											
86	The use of USL tends to provide a balance between false positives and false negatives provided the data											
87	represents a background data set and when many onsite observations need to be compared with the BTV.											
88												

			Background Statistics for Uncensored Full Data Sets								
	User Selected Options										
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	Full Precision		OFF								
	Confidence Coefficient		95%								
	Coverage		95%								
	New or Future K Observations		1								
	Number of Bootstrap Operations		2000								
SO4 (mg/L)											
General Statistics											
		Total Number of Observations	61				Number of Distinct Observations	45			
							Number of Missing Observations	1			
		Minimum	364				First Quartile	408			
		Second Largest	997				Median	418			
		Maximum	1185				Third Quartile	696			
		Mean	548.6				SD	216.1			
		Coefficient of Variation	0.394				Skewness	1.206			
		Mean of logged Data	6.244				SD of logged Data	0.344			
			Critical Values for Background Threshold Values (BTVs)								
		Tolerance Factor K (For UTL)	2.013				d2max (for USL)	3.033			
			Normal GOF Test								
		Shapiro Wilk Test Statistic	0.734				Normal GOF Test				
		5% Shapiro Wilk P Value	2.243E-14				Data Not Normal at 5% Significance Level				
		Lilliefors Test Statistic	0.314				Lilliefors GOF Test				
		5% Lilliefors Critical Value	0.113				Data Not Normal at 5% Significance Level				
			Data Not Normal at 5% Significance Level								
			Background Statistics Assuming Normal Distribution								
		95% UTL with 95% Coverage	983.7				90% Percentile (z)	825.6			
		95% UPL (t)	912.6				95% Percentile (z)	904.1			
		95% USL	1204				99% Percentile (z)	1051			
			Gamma GOF Test								
		A-D Test Statistic	6.931				Anderson-Darling Gamma GOF Test				
		5% A-D Critical Value	0.752				Data Not Gamma Distributed at 5% Significance Level				
		K-S Test Statistic	0.304				Kolmogorov-Smirnov Gamma GOF Test				
		5% K-S Critical Value	0.114				Data Not Gamma Distributed at 5% Significance Level				
			Data Not Gamma Distributed at 5% Significance Level								
			Gamma Statistics								
		k hat (MLE)	7.989				k star (bias corrected MLE)	7.607			
		Theta hat (MLE)	68.67				Theta star (bias corrected MLE)	72.12			
		nu hat (MLE)	974.7				nu star (bias corrected)	928.1			
		MLE Mean (bias corrected)	548.6				MLE Sd (bias corrected)	198.9			
			Background Statistics Assuming Gamma Distribution								
		95% Wilson Hilferty (WH) Approx. Gamma UPL	915.1				90% Percentile	814			
		95% Hawkins Wixley (HW) Approx. Gamma UPL	915.9				95% Percentile	911.4			

54				95% WH Approx. Gamma UTL with	95% Coverage	1009				99% Percentile	1114	
55				95% HW Approx. Gamma UTL with	95% Coverage	1013						
56					95% WH USL	1339				95% HW USL	1365	
57												
58						Lognormal GOF Test						
59					Shapiro Wilk Test Statistic	0.757		Shapiro Wilk Lognormal GOF Test				
60					5% Shapiro Wilk P Value	3.307E-13		Data Not Lognormal at 5% Significance Level				
61					Lilliefors Test Statistic	0.294		Lilliefors Lognormal GOF Test				
62					5% Lilliefors Critical Value	0.113		Data Not Lognormal at 5% Significance Level				
63					Data Not Lognormal at 5% Significance Level							
64												
65						Background Statistics assuming Lognormal Distribution						
66				95% UTL with	95% Coverage	1029				90% Percentile (z)	800	
67					95% UPL (t)	919				95% Percentile (z)	906.6	
68					95% USL	1462				99% Percentile (z)	1146	
69												
70						Nonparametric Distribution Free Background Statistics						
71						Data do not follow a Discernible Distribution (0.05)						
72												
73						Nonparametric Upper Limits for Background Threshold Values						
74					Order of Statistic, r	60		95% UTL with	95% Coverage	997		
75				Approx, f used to compute achieved CC		1.579		pproximate Actual Confidence Coefficient achieved by UTL		0.816		
76								Approximate Sample Size needed to achieve specified CC		93		
77				95% Percentile Bootstrap UTL with	95% Coverage	997		95% BCA Bootstrap UTL with	95% Coverage	997		
78					95% UPL	969.4				90% Percentile	926	
79					90% Chebyshev UPL	1202				95% Percentile	955	
80					95% Chebyshev UPL	1498				99% Percentile	1072	
81					95% USL	1185						
82												
83	Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.											
84	Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers											
85	and consists of observations collected from clean unimpacted locations.											
86	The use of USL tends to provide a balance between false positives and false negatives provided the data											
87	represents a background data set and when many onsite observations need to be compared with the BTV.											
88												

			Background Statistics for Uncensored Full Data Sets								
	User Selected Options										
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	Full Precision		OFF								
	Confidence Coefficient		95%								
	Coverage		95%								
	New or Future K Observations		1								
	Number of Bootstrap Operations		2000								
TDS (mg/L)											
General Statistics											
			Total Number of Observations	62				Number of Distinct Observations	55		
			Minimum	962				First Quartile	1150		
			Second Largest	1840				Median	1192		
			Maximum	1876				Third Quartile	1389		
			Mean	1298				SD	237.4		
			Coefficient of Variation	0.183				Skewness	1.233		
			Mean of logged Data	7.153				SD of logged Data	0.169		
			Critical Values for Background Threshold Values (BTVs)								
			Tolerance Factor K (For UTL)	2.01				d2max (for USL)	3.039		
				Normal GOF Test							
			Shapiro Wilk Test Statistic	0.817				Normal GOF Test			
			5% Shapiro Wilk P Value	3.521E-10				Data Not Normal at 5% Significance Level			
			Lilliefors Test Statistic	0.227				Lilliefors GOF Test			
			5% Lilliefors Critical Value	0.112				Data Not Normal at 5% Significance Level			
			Data Not Normal at 5% Significance Level								
			Background Statistics Assuming Normal Distribution								
			95% UTL with 95% Coverage	1775				90% Percentile (z)	1602		
			95% UPL (t)	1697				95% Percentile (z)	1688		
			95% USL	2019				99% Percentile (z)	1850		
				Gamma GOF Test							
			A-D Test Statistic	3.778				Anderson-Darling Gamma GOF Test			
			5% A-D Critical Value	0.748				Data Not Gamma Distributed at 5% Significance Level			
			K-S Test Statistic	0.208				Kolmogorov-Smirnov Gamma GOF Test			
			5% K-S Critical Value	0.113				Data Not Gamma Distributed at 5% Significance Level			
			Data Not Gamma Distributed at 5% Significance Level								
				Gamma Statistics							
			k hat (MLE)	33.99				k star (bias corrected MLE)	32.36		
			Theta hat (MLE)	38.17				Theta star (bias corrected MLE)	40.1		
			nu hat (MLE)	4215				nu star (bias corrected)	4013		
			MLE Mean (bias corrected)	1298				MLE Sd (bias corrected)	228.1		
				Background Statistics Assuming Gamma Distribution							
			95% Wilson Hilferty (WH) Approx. Gamma UPL	1698				90% Percentile	1597		
			95% Hawkins Wixley (HW) Approx. Gamma UPL	1698				95% Percentile	1694		
			95% WH Approx. Gamma UTL with 95% Coverage	1787				99% Percentile	1886		

54	95% HW Approx. Gamma UTL with 95% Coverage				1789						
55				95% WH USL	2088					95% HW USL	2099
56											
57					Lognormal GOF Test						
58			Shapiro Wilk Test Statistic		0.861		Shapiro Wilk Lognormal GOF Test				
59			5% Shapiro Wilk P Value		1.2682E-7		Data Not Lognormal at 5% Significance Level				
60			Lilliefors Test Statistic		0.197		Lilliefors Lognormal GOF Test				
61			5% Lilliefors Critical Value		0.112		Data Not Lognormal at 5% Significance Level				
62					Data Not Lognormal at 5% Significance Level						
63											
64					Background Statistics assuming Lognormal Distribution						
65			95% UTL with 95% Coverage		1795					90% Percentile (z)	1587
66				95% UPL (t)	1699					95% Percentile (z)	1688
67				95% USL	2136					99% Percentile (z)	1894
68											
69					Nonparametric Distribution Free Background Statistics						
70					Data do not follow a Discernible Distribution (0.05)						
71											
72					Nonparametric Upper Limits for Background Threshold Values						
73				Order of Statistic, r	61				95% UTL with 95% Coverage		1840
74		Approx, f used to compute achieved CC			1.605		pproximate Actual Confidence Coefficient achieved by UTL				0.823
75							Approximate Sample Size needed to achieve specified CC				93
76	95% Percentile Bootstrap UTL with 95% Coverage				1839				95% BCA Bootstrap UTL with 95% Coverage		1840
77				95% UPL	1826					90% Percentile	1769
78				90% Chebyshev UPL	2015					95% Percentile	1824
79				95% Chebyshev UPL	2341					99% Percentile	1854
80				95% USL	1876						
81											
82	Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.										
83	Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers										
84	and consists of observations collected from clean unimpacted locations.										
85	The use of USL tends to provide a balance between false positives and false negatives provided the data										
86	represents a background data set and when many onsite observations need to be compared with the BTV.										
87											