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ISR Wellfield Background and Restoration Ground Water Quality Data: Collection, Statistical Analysis and Public Access

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US Nuclear Regulatory Commission

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NRC Regulation of Ground Water at ISR Wellfields

NRC Objective: Protect the public health, safety and the environment

To prevent contamination of ground water at ISR wellfields, NRC regulates source and 11e(2) byproduct fluids to ensure the licensee:

- **Characterizes, Sites and Designs ISR wellfields to ensure conditions are adequate to contain source and byproduct fluids within the wellfield**
- **Establishes background water quality to determine the ground water protection standards (GWPS) for the ore zone , overlying and underlying aquifers**
- **Operates ISR wellfields so that all source and byproduct fluids are contained within the wellfield**
- **Monitors ISR wellfields so that any ground water contamination outside wellfield from source and byproduct fluids is detected and corrected.**
- **Restores ISR wellfields to approved ground water protection standards (GWPS) and demonstrates the restored water quality is stable.**

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What are the GWPS that must be established before operation and met after restoration of an ISR wellfield?

NRC Regulatory Information Summary RIS 90-05.

Licensees and applicants must commit to achieve the ground water quality standards in 10 CFR Part 40, Appendix A Criterion 5B (5) for all restored aquifers which conforms to the standards promulgated by EPA in 40 CFR Part 192 Subpart D 192.32 (2).

These standards state the concentration of a hazardous constituent (Criterion 13) must not exceed :

(a) the Commission approved background concentration of that constituent in ground water;

(b) the respective value in the table in paragraph 5C if the constituent is listed in the table and if the background level of the constituent is below the value listed or;

(c) an alternative concentration limit established by the Commission.

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I. ISR Wellfield Background Ground Water Quality Collection

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What ground water quality is collected in the ISR wellfield?

- The background water quality of all constituents of concern (COC) in the ore zone aquifer and ore zone perimeter ring monitoring wells in the ISR wellfield.
- The background water quality of all constituents of concern (COC) in the overlying and underlying aquifers in the ISR wellfields.

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Where is the ground water quality collected before operation of an ISR wellfield?

Example of ISR Wellfield

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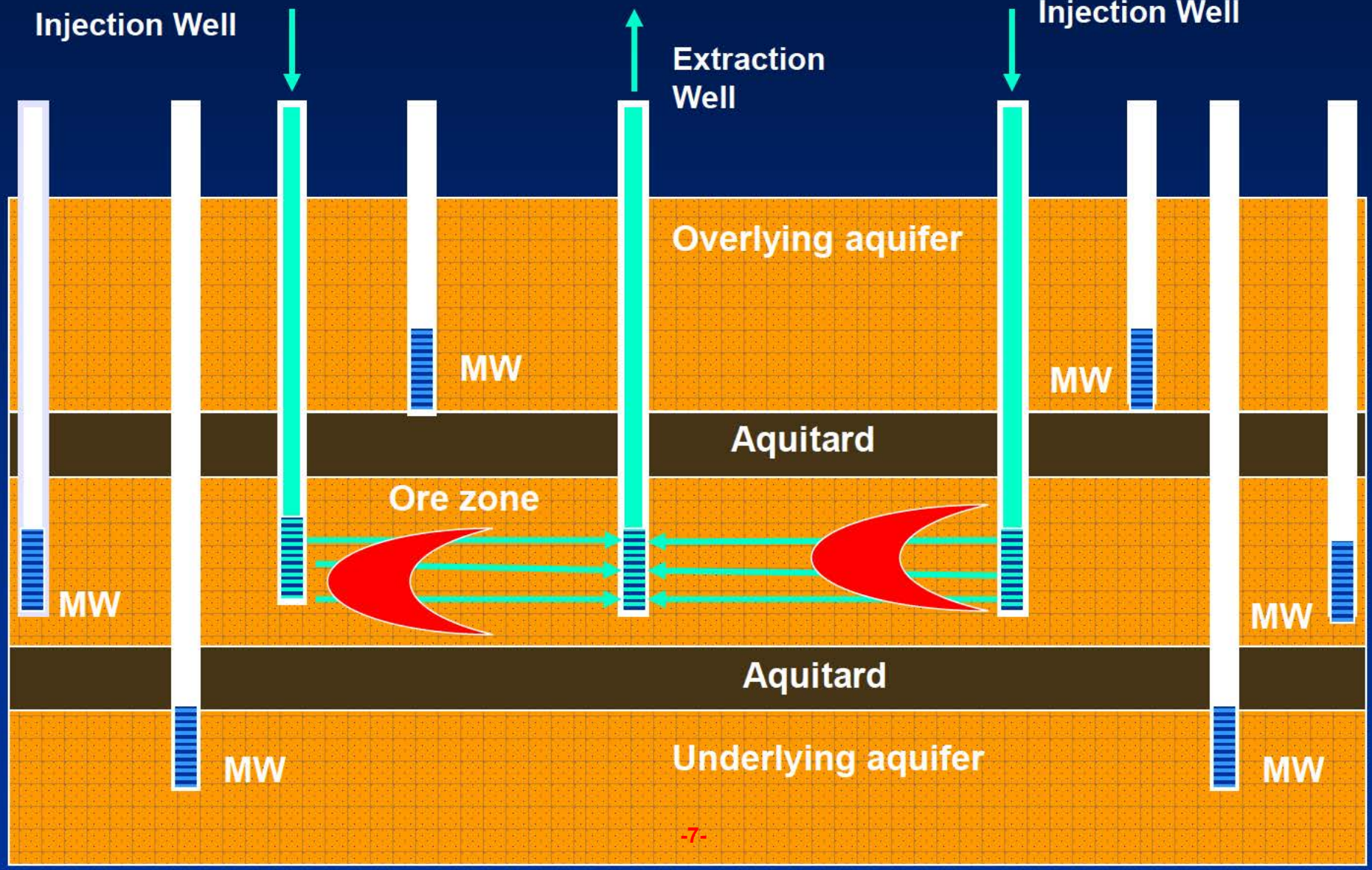
ISR Extraction, Injection and Overlying, Underlying and Perimeter Monitoring Wells



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How many samples are collected to assess the background ground water quality in an ISR wellfield?

- Production Ore Zone Aquifer (s) - 4 samples/well, at least 2 weeks apart
- Perimeter Monitoring Ring Wells- 4 samples/well, at least 2 weeks apart
- Overlying Aquifer(s) - 4 samples/well, at least 2 weeks apart
- Underlying Aquifer(s) –4 samples/well, at least 2 weeks apart
- Example: For a forty acre ISR wellfield, the production ore zone aquifer would have 40 samples for each parameter (1 well/4 acres basis).

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What parameters are measured to establish the background ground water quality in an ISR wellfield?

Typically measure NUREG- 1569 Table 2.7.3-1 parameters in each sample, unless non-detect in first two samples

Table 2.7.3-1. Typical Baseline Water Quality Indicators to be Determined During Pre-operational Data Collection		
A. Trace and Minor Elements		
Arsenic	Iron	Selenium
Barium	Lead	Silver
Boron	Manganese	Uranium
Cadmium	Mercury	Vanadium
Chromium	Molybdenum	Zinc
Copper	Nickel	
Fluoride	Radium-226@	
B. Common Constituents		
Alkalinity	Chloride	Sodium
Bicarbonate	Magnesium	Sulfate
Calcium	Nitrate	
Carbonate	Potassium	
C. Physical Indicators		
Specific Conductivity*		Total Dissolved Solids#
pH*		
D. Radiological Parameters		
Gross Alpha†	Gross Beta	

*Field and Laboratory determination.
#Laboratory only.
†Excluding radon, radium, and uranium.
@ If site initial sampling indicates the presence of Th-232 then Ra-228 should be considered in the base line sampling or an alternative may be proposed.

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II. Statistical Analysis of ISR Wellfield Water Quality

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How should the ISR wellfield water quality be analyzed?

- Apply appropriate statistics to ground water quality measurements
  - Graphical analysis of data distribution to assess if water quality parameter is from same population in a wellfield or different water zones (different sample populations).
  - Graphical and other tests for same population and outlier determination
  - General statistics- mean, median, standard deviation, etc.
  - Goodness of Fit (GOF) tests to select appropriate probability distribution
  - Upper Tolerance Limits (UTLs) and upper percentiles
  - Upper Confidence Limits (UCLs) of the Mean
- Accepted statistical methods can be found in EPA-530-R-09-007, "Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance," March 2009.

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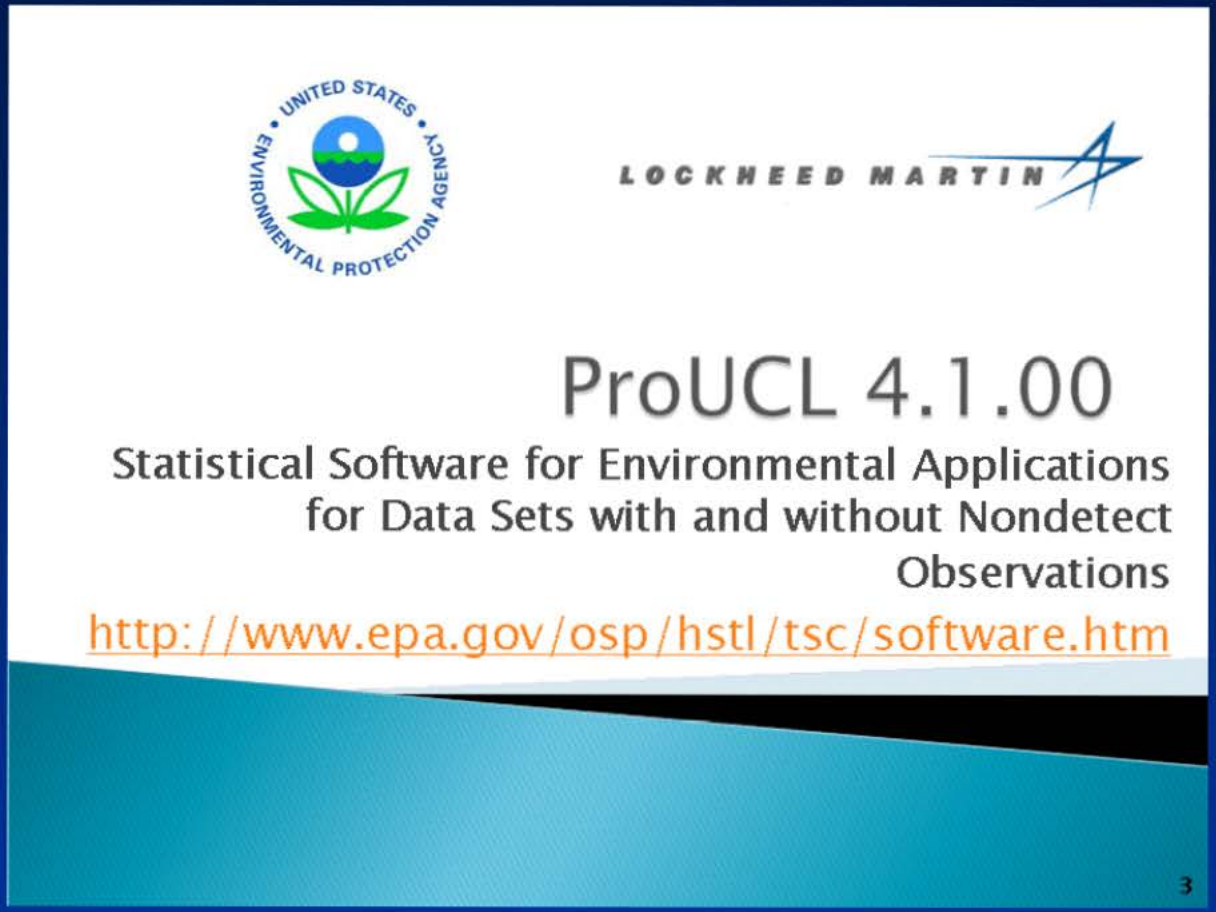
What software applications are useful for statistical analysis of ISR wellfield ground water quality?



Free Download ProUCL 4.1 (http://www.epa.gov/osp/hstl/tsc/software.htm),

Free Webinar Training can be found at http://www.clu-in.org/conf/tio/ProUCLBasic_030911/prez/1280x1024/ppframe.cfm?date=504&simul=1

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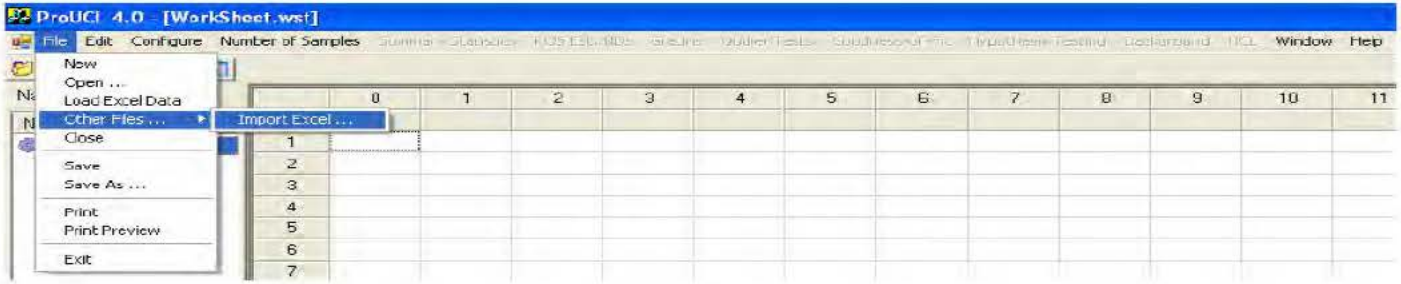
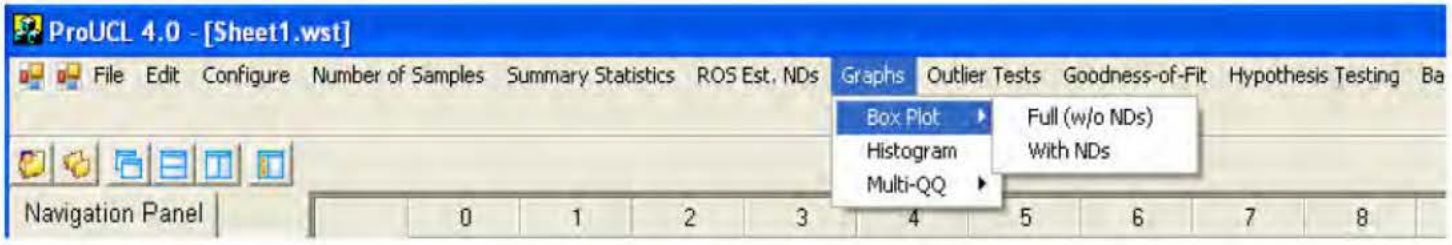
ProUCL 4.1 Features
User Friendly Spreadsheet Interface

Import Excel files (Excel 2003 *.xls format) and export output files



Spreadsheet pull-down menus to perform statistical analyses



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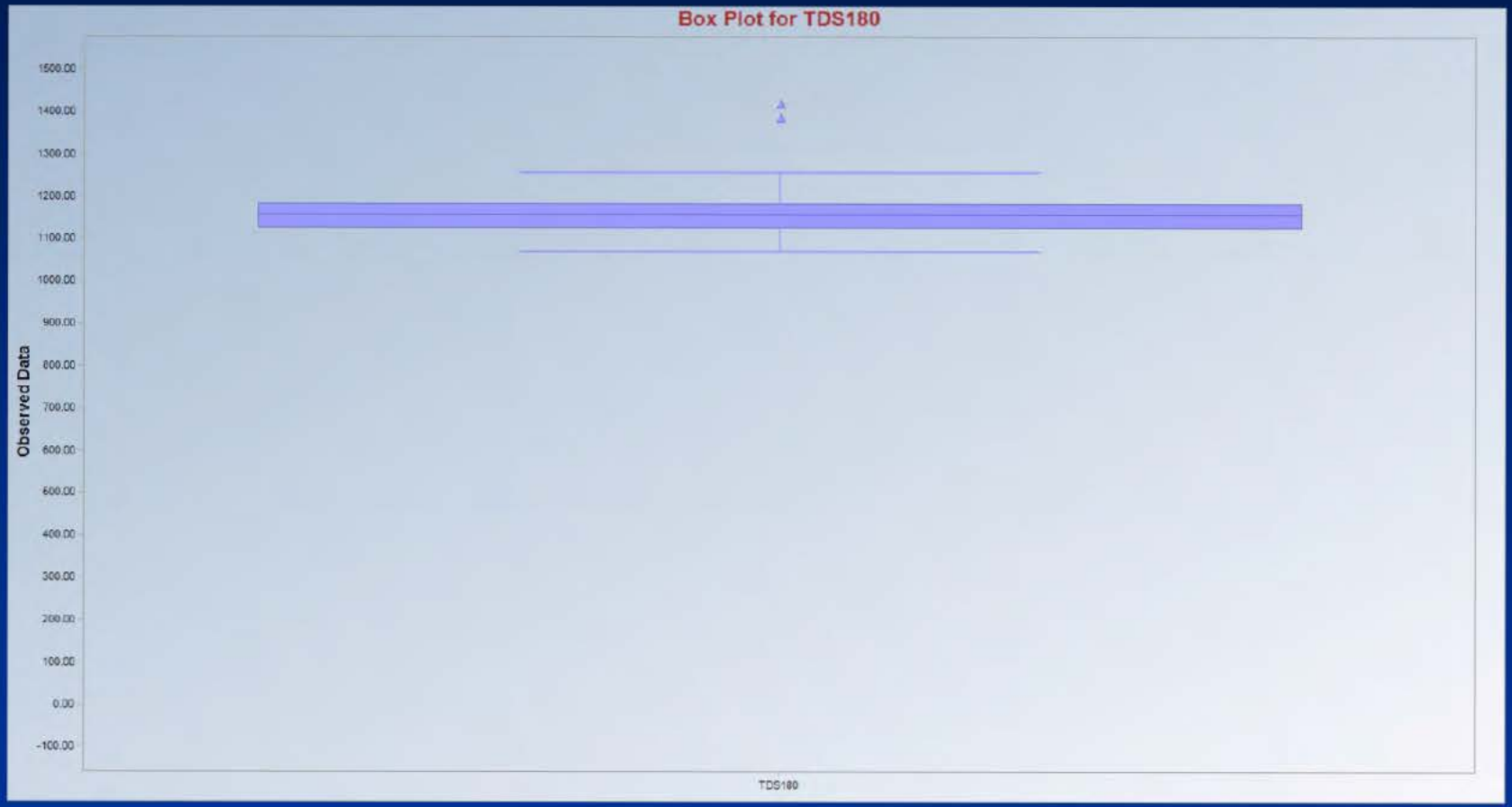
Pro UCL 4.1 Example
ISR Wellfield Ore Zone TDS data set
Box plot to demonstrate distribution, median and presence of outliers



- Apparent normal probability distribution
- Presence of two potential outliers
- TDS appears to come from same water zone (population)

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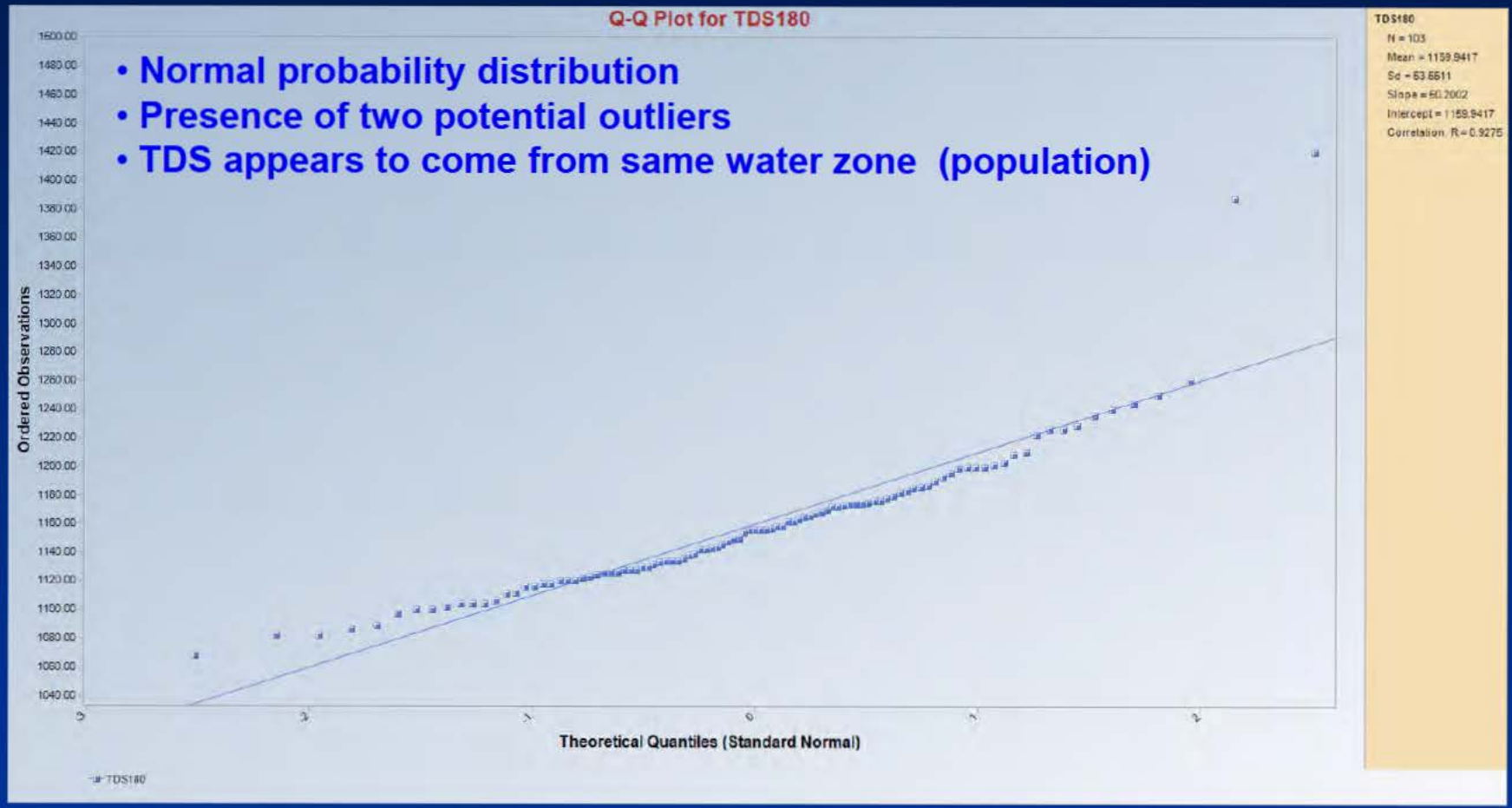
ProUCL 4.1 Example
ISR Wellfield Ore Zone TDS data set
QQ plot to demonstrate probability distribution and presence of outliers



Conclusion - can use normal probability distribution to evaluate outliers, mean , standard deviation, etc. for ISR wellfield TDS

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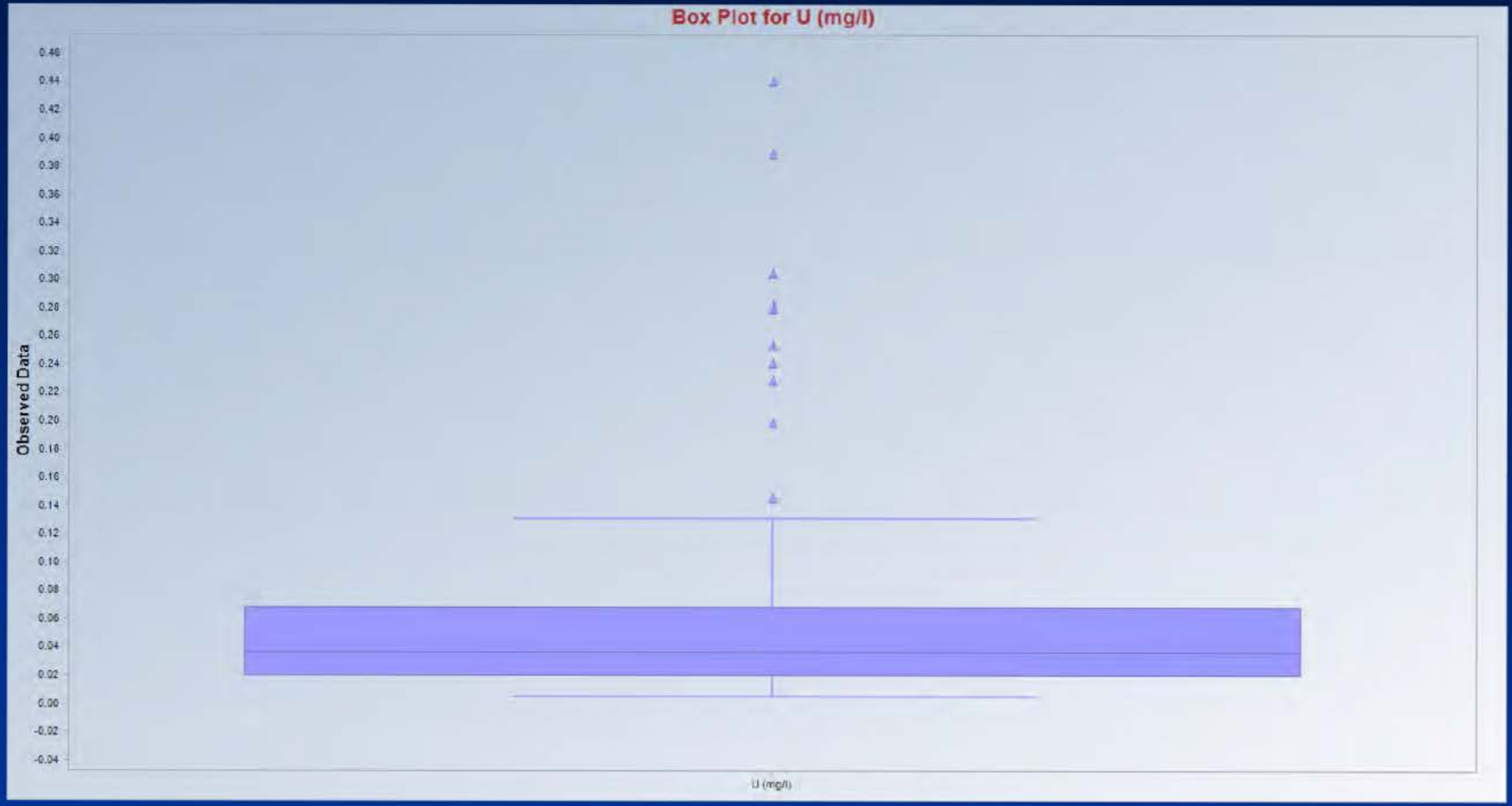
ProUCL 4.1 Example
ISR Wellfield Ore Zone Uranium data set
Box Plot for uranium distribution and outliers



- Uranium data do not appear to follow a normal distribution - data skewed
- Appear to be numerous potential outliers
- Appear to have different water zones (populations)

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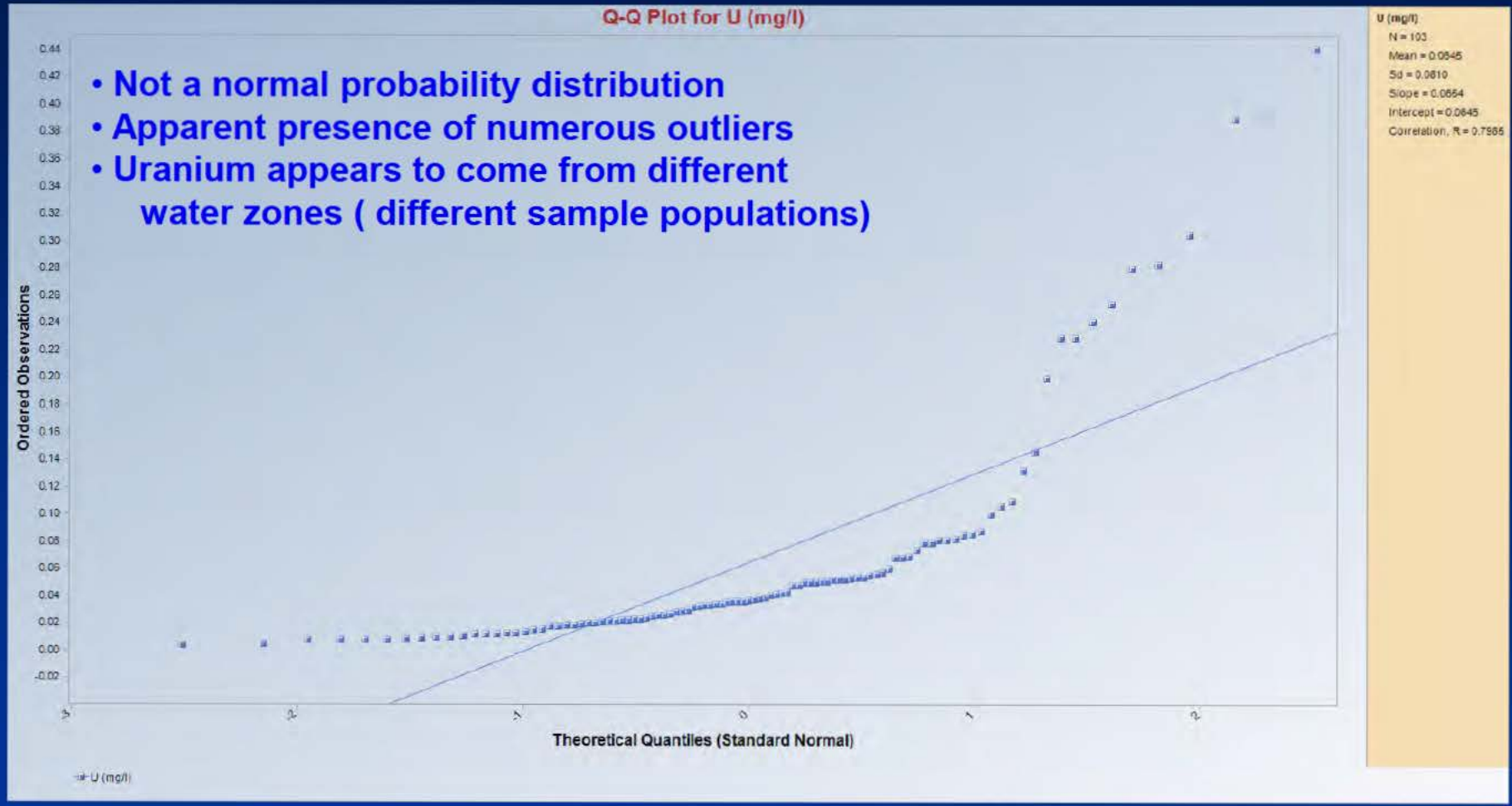
ProUCL 4.1 Example
ISR Wellfield Ore Zone Uranium data set
QQ plot to demonstrate probability distribution and presence of outliers



Question – Does that make sense when compared to same TDS data for same ISR Wellfield?

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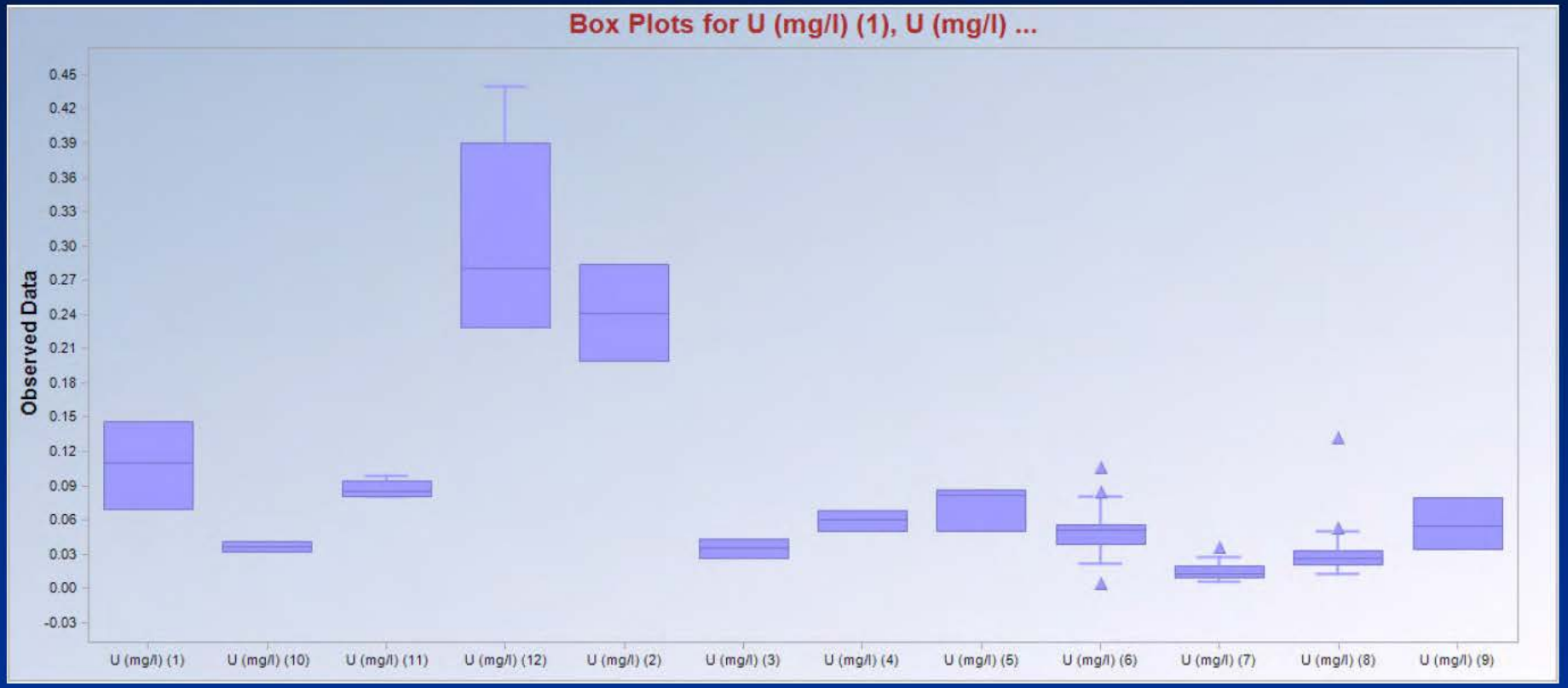
ProUCL 4.1 Example
ISR Wellfield Ore Zone Uranium data set
Box Plot for uranium distribution and outliers for individual wells



Answer: Yes –would expect large heterogeneity in uranium- individual well data show ore zones are naturally heterogeneous in the wellfield

Conclusion- should not use statistics which use normal probability distribution for uranium

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ProUCL 4.1 Example ISR Wellfield Ore Zone Uranium data set- General background statistics and probability distribution for uranium

Provides min, max, mean, quartiles, median, standard deviation, etc.

Provides normal, lognormal and Gaussian distribution goodness of fit to choose appropriate probability distribution

Provides nonparametric statistics for skewed data and no underlying distribution

General Background Statistics for Full Data Sets

User Selected Options			
From File	Baseline ore body.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Coverage	90%		
Different or Future K Values	1		
Number of Bootstrap Operations	2000		

U (mg/l)

General Statistics			
Total Number of Observations	103	Number of Distinct Observations	90
Tolerance Factor	1.52		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.0044	Minimum	-5.426
Maximum	0.441	Maximum	-0.819
Second Largest	0.39	Second Largest	-0.942
First Quartile	0.0205	First Quartile	-3.888
Median	0.037	Median	-3.297
Third Quartile	0.0682	Third Quartile	-2.685
Mean	0.0645	Mean	-3.25
Geometric Mean	0.0388	SD	0.978
SD	0.081		
Coefficient of Variation	1.255		
Skewness	2.672		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.265	Lilliefors Test Statistic	0.075
Lilliefors Critical Value	0.0873	Lilliefors Critical Value	0.0873
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% UTL with 90% Coverage	0.188	95% UTL with 90% Coverage	0.172
95% UPL (t)	0.2	95% UPL (t)	0.198
90% Percentile (z)	0.168	90% Percentile (z)	0.136
95% Percentile (z)	0.198	95% Percentile (z)	0.194
99% Percentile (z)	0.253	99% Percentile (z)	0.378
Gamma Distribution Test		Data Distribution Test	
k star	1.093	Data appear Lognormal at 5% Significance Level	
Theta Star	0.059		
MLE of Mean	0.0645		
MLE of Standard Deviation	0.0617		
nu star	225.2		
A-D Test Statistic	3.023	**Nonparametric Statistics**	
5% A-D Critical Value	0.78	90% Percentile	0.143
K-S Test Statistic	0.151	95% Percentile	0.253
5% K-S Critical Value	0.0911	99% Percentile	0.388
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution		95% UTL with 90% Coverage	0.241
90% Percentile	0.145	95% Percentile Bootstrap UTL with 90% Coverage	0.241
95% Percentile	0.187	95% BCA Bootstrap UTL with 90% Coverage	0.241
99% Percentile	0.284	95% UPL	0.275
		95% Chebyshev UPL	0.419
95% WH Approx. Gamma UPL	0.181	Upper Threshold Limit Based upon IQR	0.14
95% HW Approx. Gamma UPL	0.182		
95% WH Approx. Gamma UTL with 90% Coverage	0.164		
95% HW Approx. Gamma UTL with 90% Coverage	0.164		

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ProUCL 4.1 Example
ISR Wellfield Uranium Data Set
Upper Tolerance Limit (UTL)

Upper Tolerance Limit (UTL)- A UTL 95%-90% represents a 95% Upper Confidence Limit (UCL) of the value of the upper 90th percentile.

WHAT DOES IT MEAN?

This is upper limit of the interval which contains the measured value for which 90% of the samples will be less, 95% of the time (WY Guideline 4 outlier "k test" which is based on normal distribution).

Lognormal uranium probability distribution gives UTL95%90% =0.172 mg/l

Non-parametric – no underlying distribution gives UTL95%90% =0.241 mg/l

Choice: You can say with 95% confidence that 90% of the measured values will be less than 0.241 or 0.172 mg/l.

General Background Statistics for Full Data Sets

User Selected Options			
From File	Baseline ore body.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Coverage	90%		
Different or Future K Values	1		
Number of Bootstrap Operations	2000		
U (mg/l)			
General Statistics			
Total Number of Observations	103	Number of Distinct Observations	90
Tolerance Factor	1.52		
Raw Statistics		**Log-Transformed Statistics**	
Minimum	0.0044	Minimum	-5.426
Maximum	0.441	Maximum	-0.819
Second Largest	0.39	Second Largest	-0.942
First Quartile	0.0205	First Quartile	-3.888
Median	0.037	Median	-3.297
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Mean	0.0645	Mean	-3.25
Geometric Mean	0.0388	SD	0.978
SD	0.081		
Coefficient of Variation	1.255		
Skewness	2.672		
Background Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.265	Lilliefors Test Statistic	0.075
Lilliefors Critical Value	0.0873	Lilliefors Critical Value	0.0873
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% UTL with 90% Coverage	0.188	95% UTL with 90% Coverage	0.172
95% UPL (t)	0.2	95% UPL (t)	0.198
90% Percentile (z)	0.168	90% Percentile (z)	0.136
95% Percentile (z)	0.198	95% Percentile (z)	0.194
99% Percentile (z)	0.253	99% Percentile (z)	0.378
Gamma Distribution Test		Data Distribution Test	
k star	1.093	Data appear Lognormal at 5% Significance Level	
Theta Star	0.059		
MLE of Mean	0.0645		
MLE of Standard Deviation	0.0617		
nu star	225.2		
A-D Test Statistic	3.023	**Nonparametric Statistics**	
5% A-D Critical Value	0.78	90% Percentile	0.143
K-S Test Statistic	0.151	95% Percentile	0.253
5% K-S Critical Value	0.0911	99% Percentile	0.388
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution		95% UTL with 90% Coverage	0.241
90% Percentile	0.145	95% Percentile Bootstrap UTL with 90% Coverage	0.241
95% Percentile	0.187	95% BCA Bootstrap UTL with 90% Coverage	0.241
99% Percentile	0.284	95% UPL	0.275
		95% Chebyshev UPL	0.419
95% WH Approx. Gamma UPL	0.181	Upper Threshold Limit Based upon IQR	0.14
95% HW Approx. Gamma UPL	0.182		
95% WH Approx. Gamma UTL with 90% Coverage	0.164		
95% HW Approx. Gamma UTL with 90% Coverage	0.164		

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ProUCL 4.1 Example
ISR Wellfield Ore Zone Uranium Data Set
Upper Confidence Limit (UCL) of the Mean

Upper Confidence Limit (UCL) of the mean is the upper limit of the interval which contains the mean at some confidence level (e.g. 95%)

Normal Distribution Students t UCL95 of the mean =0.0777 mg/l (not appropriate)

Lognormal Distribution H-UCL95 of the mean = 0.0773 mg/l (not recommended in ProUCL)

Non-parametric Chebyshev UCL of the mean = 0.0993 mg/l (recommended for skewed datasets In ProUCL)

General UCL Statistics for Full Data Sets

User Selected Options	
From File	Baseline ore body.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

U (mg/l)

General Statistics

Number of Valid Observations	103	Number of Distinct Observations	90

Raw Statistics		Log-transformed Statistics	
Minimum	0.0044	Minimum of Log Data	-5.425
Maximum	0.441	Maximum of Log Data	-0.819
Mean	0.0645	Mean of log Data	-3.25
Geometric Mean	0.0388	SD of log Data	0.978
Median	0.037		
SD	0.081		
Std. Error of Mean	0.00798		
Coefficient of Variation	1.255		
Skewness	2.672		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.265	Lilliefors Test Statistic	0.075
Lilliefors Critical Value	0.0873	Lilliefors Critical Value	0.0873
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	0.0777	95% H-UCL	0.0773
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	0.0933
95% Adjusted-CLT UCL (Chen-1995)	0.0799	97.5% Chebyshev (MVUE) UCL	0.107
95% Modified-t UCL (Johnson-1978)	0.0781	99% Chebyshev (MVUE) UCL	0.133

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	1.093	Data appear Lognormal at 5% Significance Level	
Theta Star			
nu star	225.2		
Approximate Chi Square Value (.05)	191.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0477	95% CLT UCL	0.0776
Adjusted Chi Square Value	191	95% Jackknife UCL	0.0777
		95% Standard Bootstrap UCL	0.0774
Anderson-Darling Test Statistic	3.023	95% Bootstrap-t UCL	0.0815
Anderson-Darling 5% Critical Value	0.76	95% Hall's Bootstrap UCL	0.0802
Kolmogorov-Smirnov Test Statistic		95% Percentile Bootstrap UCL	0.0788
Kolmogorov-Smirnov 5% Critical Value	0.0911	95% BCA Bootstrap UCL	0.08
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0993
		97.5% Chebyshev(Mean, Sd) UCL	0.114
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.144
Approximate Gamma UCL (Use when n >= 40)	0.0759		
95% Adjusted Gamma UCL (Use when n < 40)	0.076		
Potential UCL to Use		Use 95% H-UCL	0.0773

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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ProUCL 4.1 Example
ISR Wellfield Ore Zone Uranium Data Set
Comparison of Mean, UCL, and UTL

General Rule: Sample Mean < UCL 95% of Mean < UTL 95%-90%

1. **Normal Distribution for Uranium (not indicated by GOF test):**

   0.0645 mg/l < 0.0777 mg/l < 0.198 mg/l

2. **Lognormal Distribution for Uranium (indicated by GOF test) :**

   0.0388 mg/l < 0.0773 mg/l < 0.172 mg/l

3. **Non Parametric – No Distribution for Uranium (recommended for skewed data sets):**

   0.037 (median) mg/l< 0.0993 mg/l < 0.241 mg/l

* Question: Which is acceptable for GWPS?

* Answer: NRC accepts GWPS which can be technically justified

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How is restoration ground water quality data collected and analyzed?

The licensee collects :

- **Restoration ground water quality of all constituents of concern (COC) at all Point of Compliance Wells (POC) for at least four quarters**

The licensee demonstrates and NRC reviews that:

- **COC meets GWPS – background GWPS previously approved.**
- **No Statistically Significant Increasing (SSI) trend for at least four consecutive quarters to demonstrate each COC GWPS will not be exceeded in POC wells after the restoration is deemed complete**

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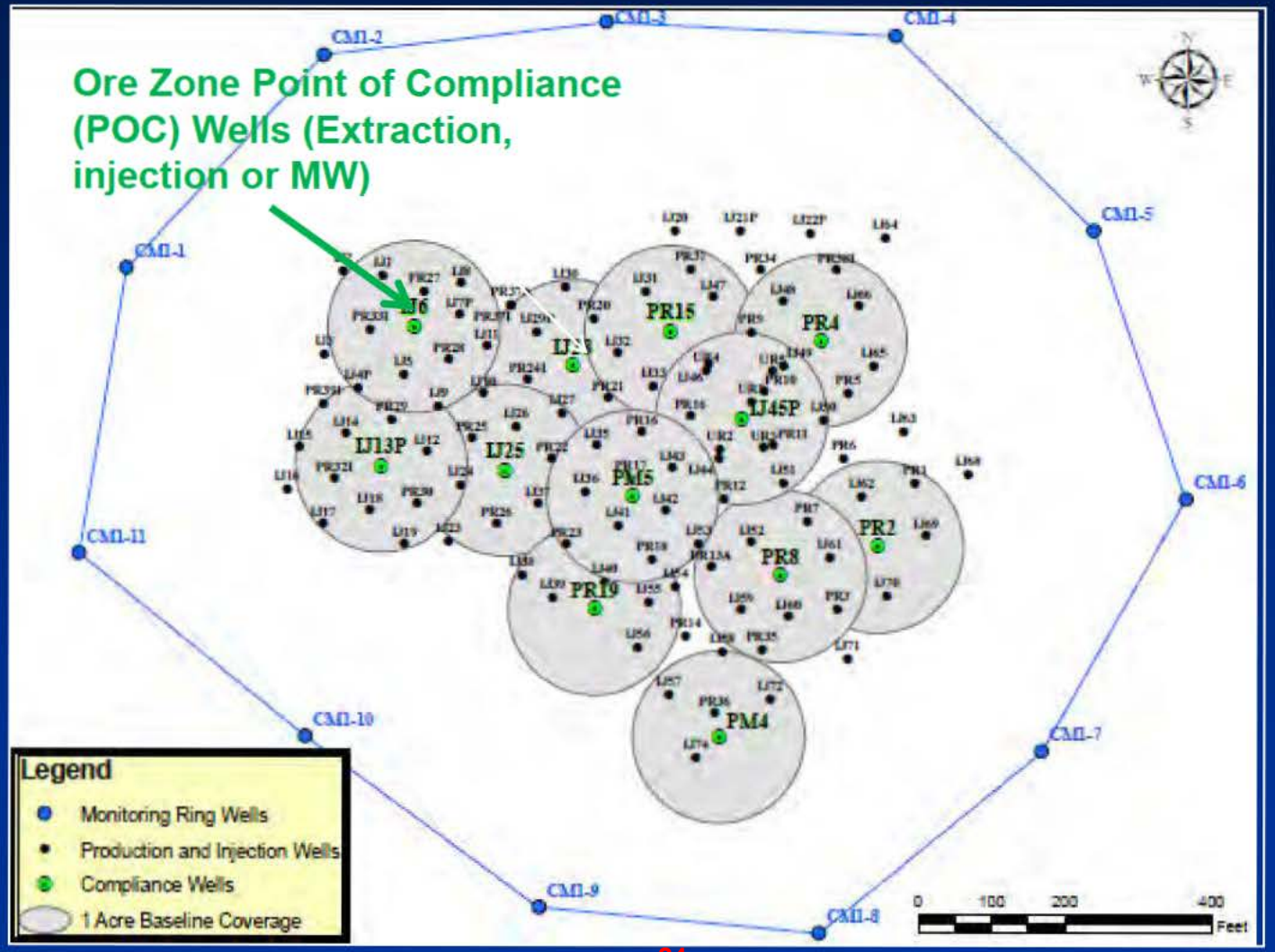
Where are the restoration water quality data collected in an ISR wellfield?



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How is restoration ground water quality data reviewed?

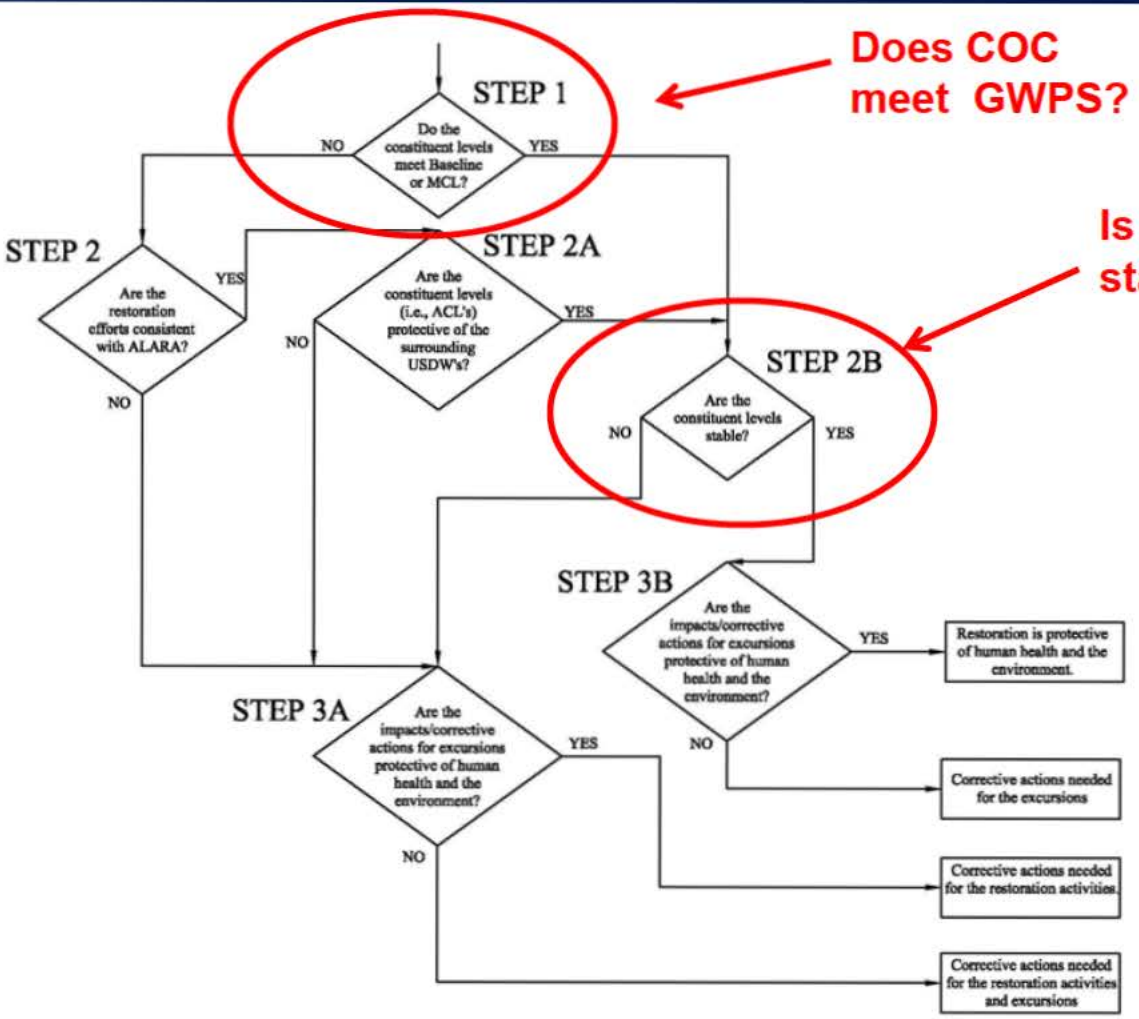

Figure 2. Flow chart depicting Staff's review process for evaluation of a restoration report.

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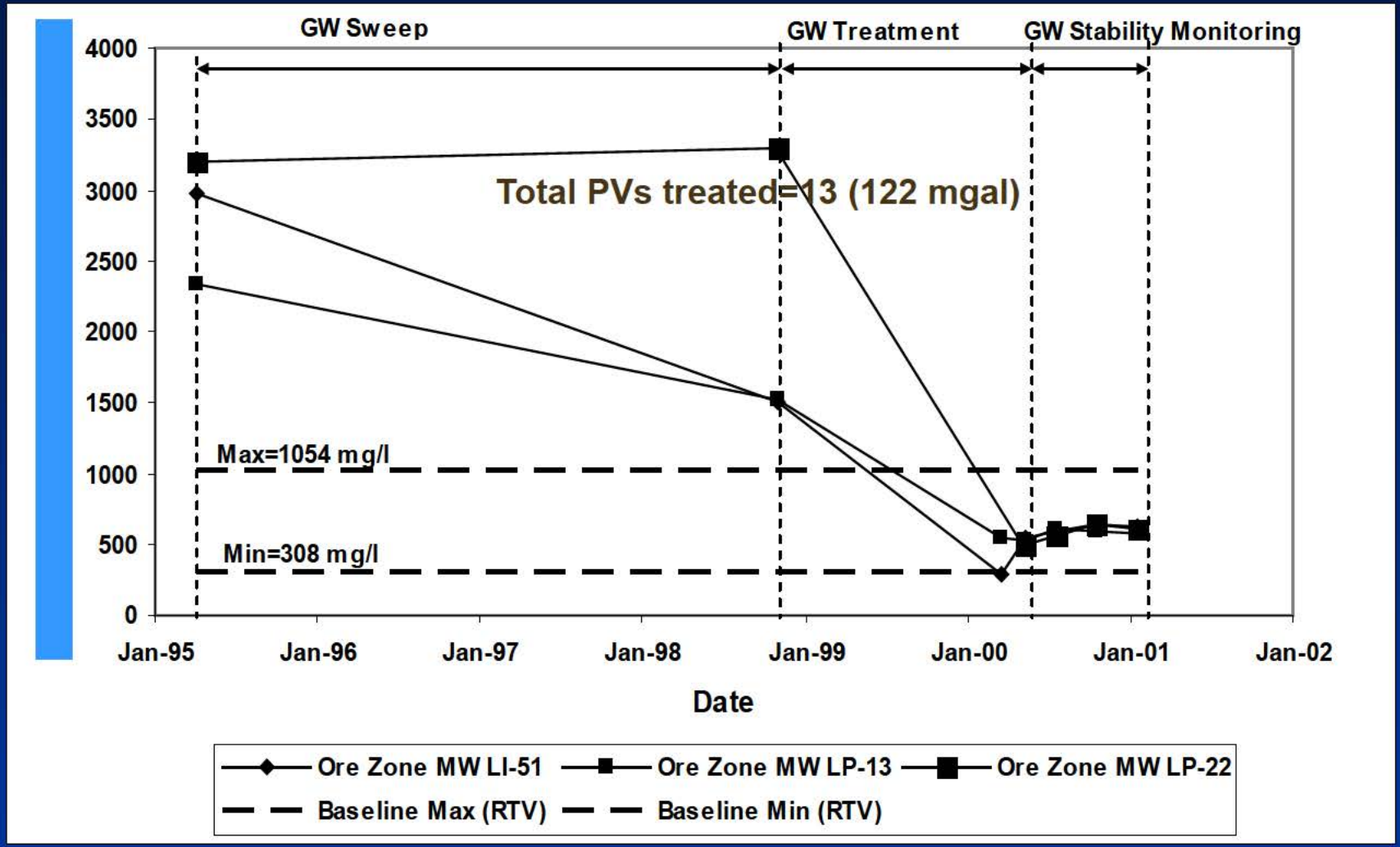
How is restoration stability at ISR Wellfield POCs demonstrated?



Show no statistically significant increase in constituent for at least four quarters of monitoring

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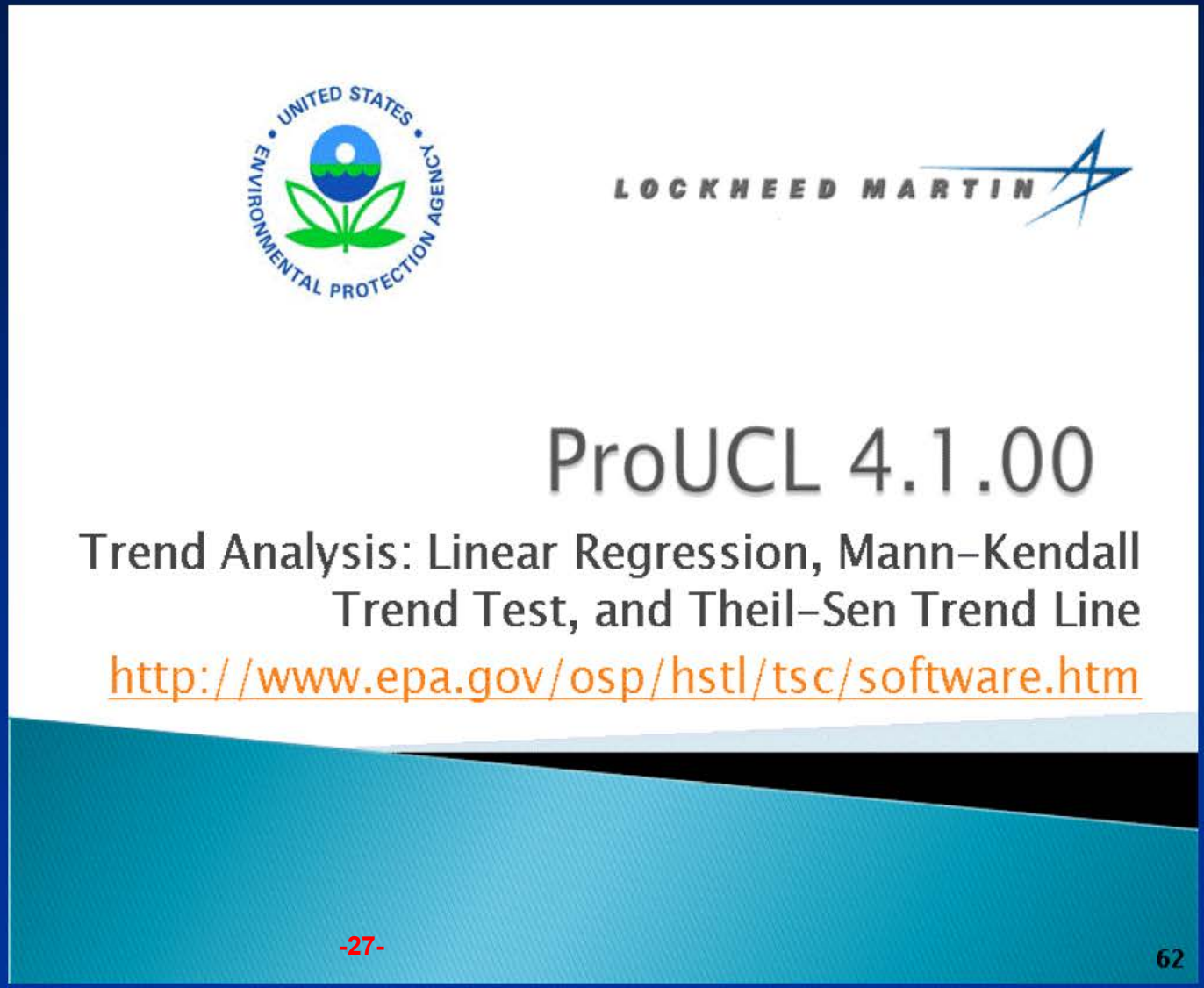
What are acceptable methods to determine the presence of a Statistically Significant Increase (SSI) trend in a COC?

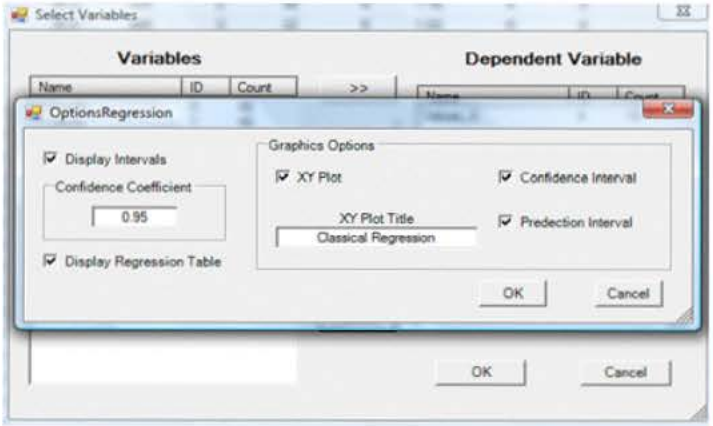
Pro UCL 4.1
Trend Analysis



ProUCL 4.1
Trend Analysis using Linear Regression Test

Linear Regression Line

- Linear regression Line Test



Slope of line determines trend in data

Significant positive slope suggests upward trend

Significant negative slope suggests downward trend

Insignificant slope suggests no evidence of trend in data

Significance is determined using p-value of slope test

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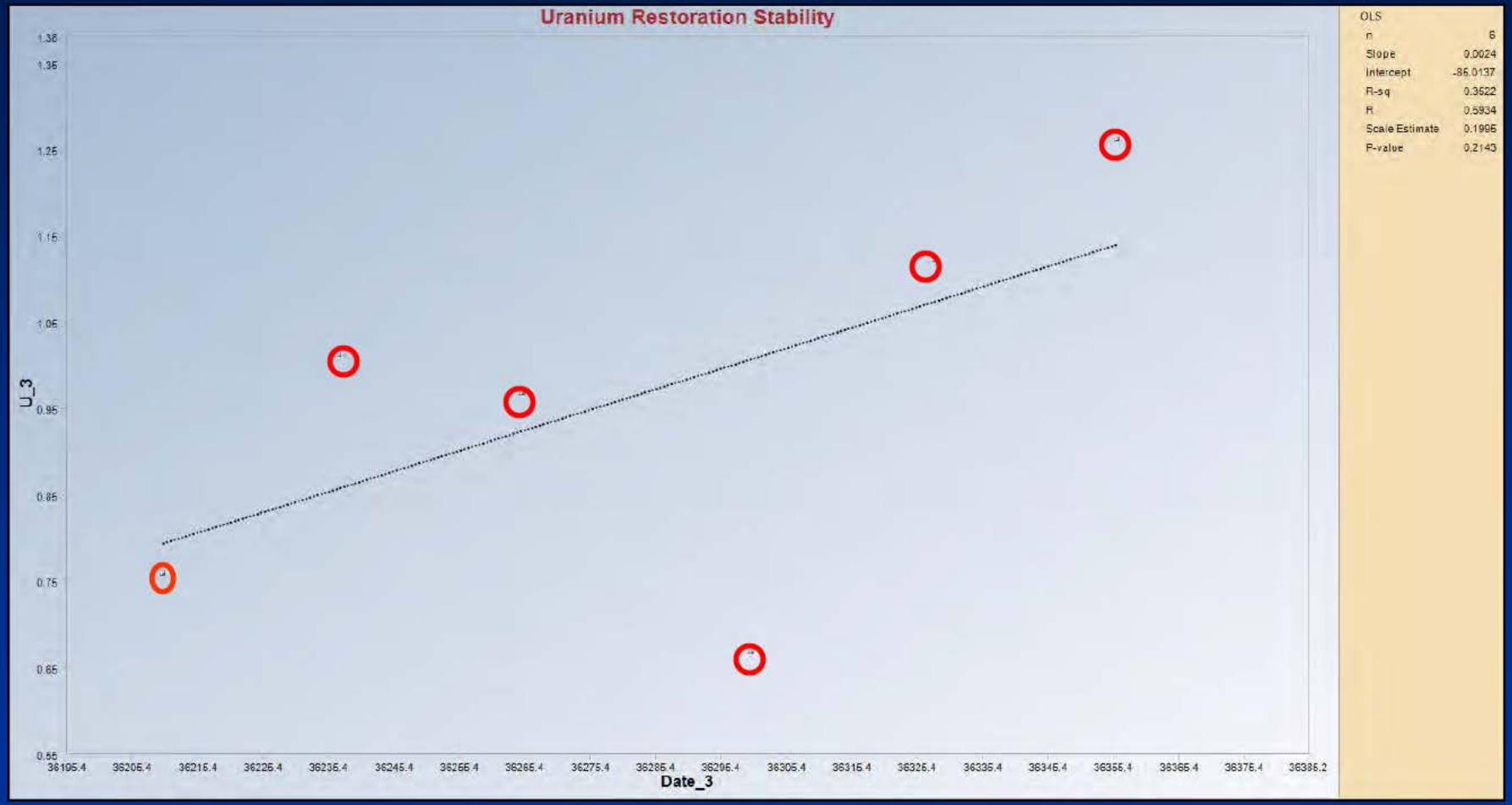
ProUCL 4.1 Example
ISR Wellfield Uranium Restoration Stability
Data Trend Analysis
No Statistically Significant Increase



Slope is not significantly different than zero (p=0.214)

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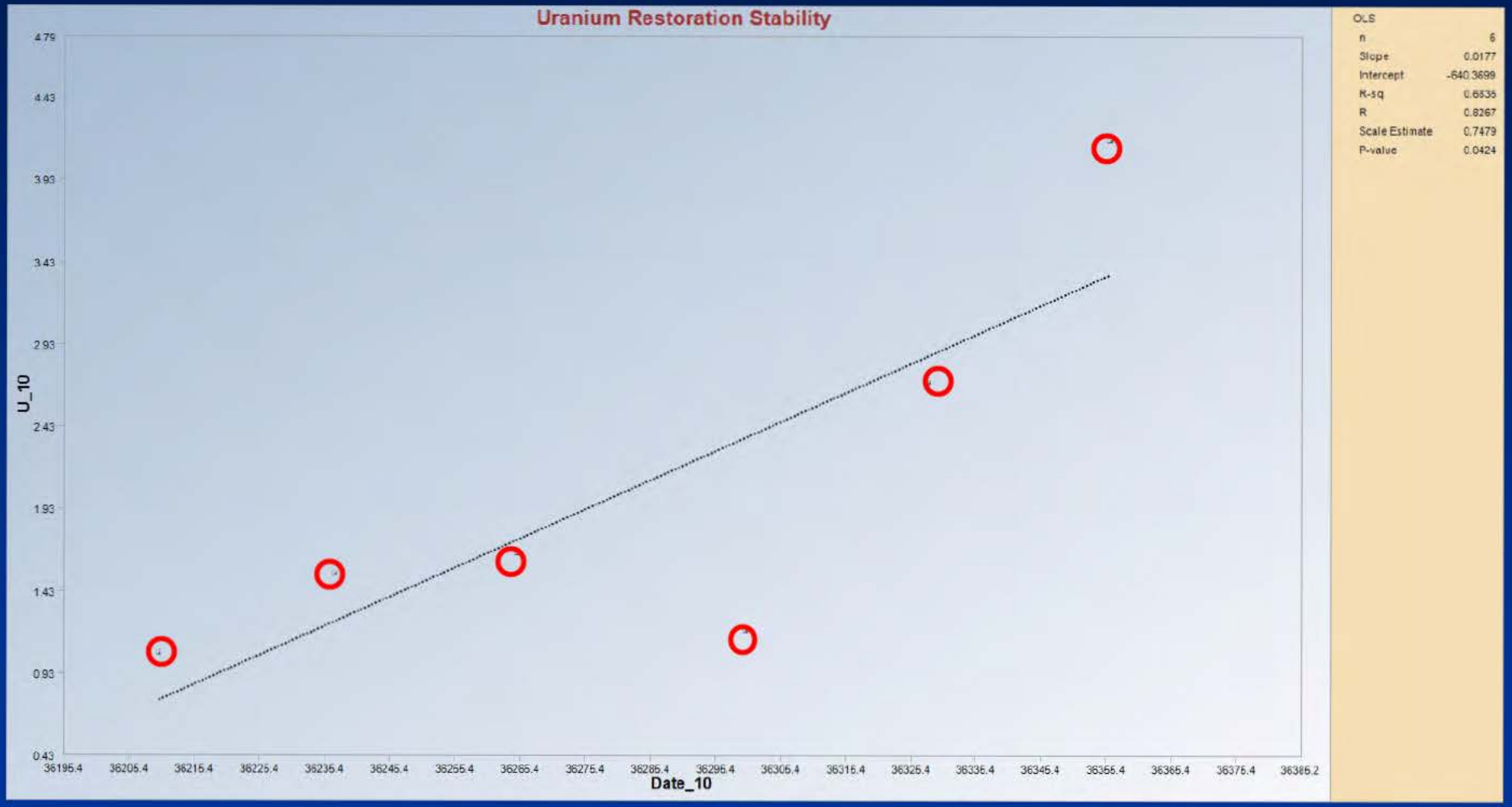
ProUCL 4.1 Example
ISR Wellfield Uranium Restoration Data
Stability Trend Analysis
Statistically Significant Increase



Slope is significantly different than zero (p=.0424)

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III. Public Access: Excel Spreadsheets for ISR Wellfield Background and Restoration Ground Water Quality

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Public Access
Excel Spreadsheets for ISR Wellfield Background and Restoration Ground Water Quality

Issue:

Perception by public and others that ISR wellfield ground water quality data has not been measured or is not publicly available.

Facts:

- Large amounts of ISR wellfield ground water quality data has been provided by the licensees to NRC.
- This reported ISR wellfield ground water quality is publicly available in documents in ADAMs.
- Public and others have found access to ISR wellfield ground water quality data difficult as it must be "mined" out of ADAMs documents.

NRC Objective: Improve Public Access

- Develop "user friendly" Excel standard format spreadsheets of publicly available ISR wellfield background and restoration water quality data from NRC licensed sites
- Post Excel spreadsheets to public NRC website to improve PUBLIC ACCESS to already publicly available data

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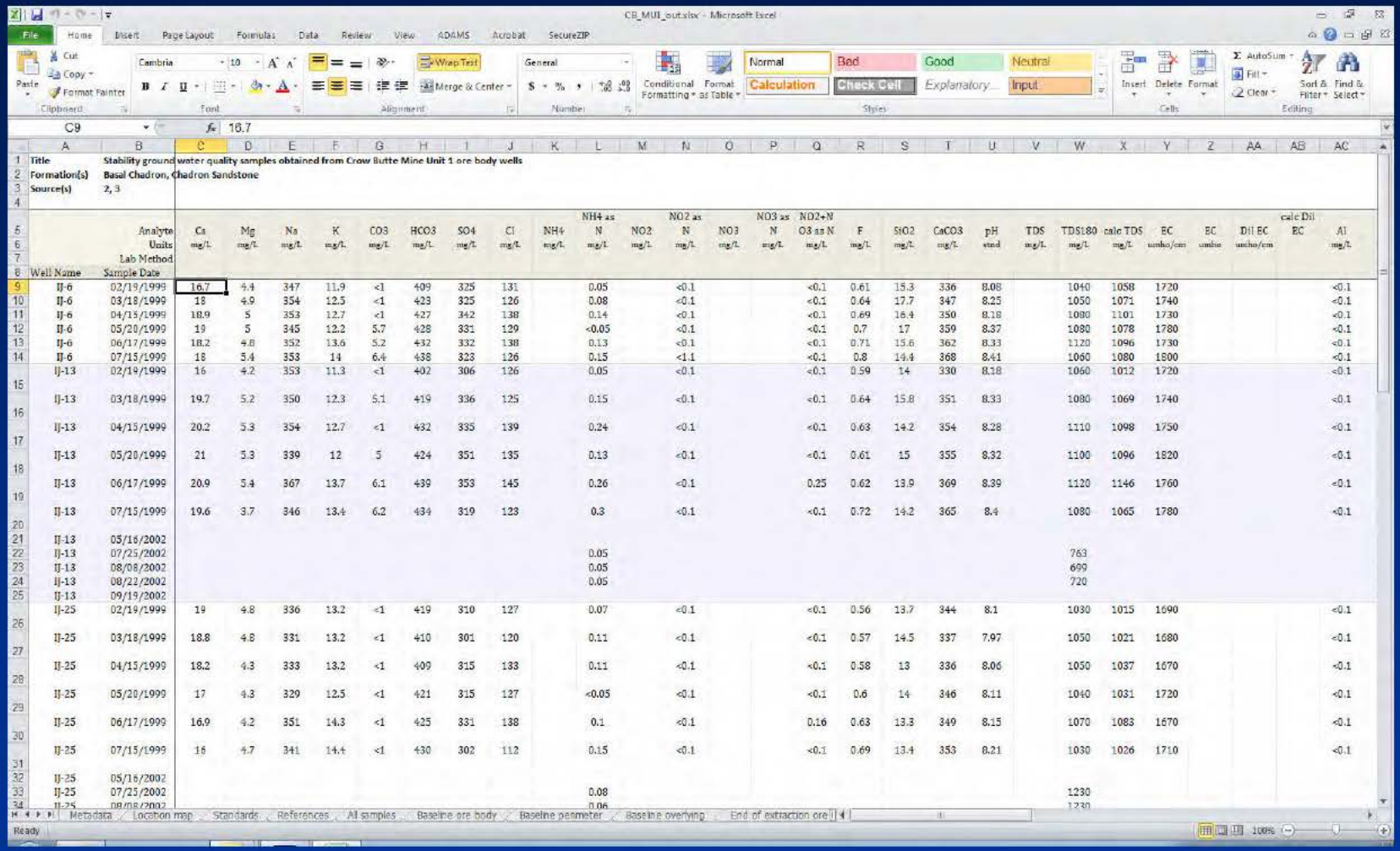
Public Access
Excel Spreadsheets
ISR Wellfield Ground Water Quality Data Format



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	Title	Stability ground water quality samples obtained from Crow Butte Mine Unit 1 ore body wells																											
2	Formation(s)	Basal Chadron, Chadron Sandstone																											
3	Source(s)	2, 3																											
4																													
5		Analyte	Ca	Mg	Na	K	CO3	HCO3	SO4	Cl	NH4	NH4 as N	NO2	NO2 as N	NO3	NO3 as N	ND2+N O3 as N	F	SiO2	CaCO3	pH	TDS	TDS180	calc TDS	EC	EC	Dil EC	calc Dil EC	Al
6		Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	stnd	mg/L	mg/L	mg/L	umho/cm	umho	umho/cm		mg/L
7		Lab Method																											
8	Well Name	Sample Date																											
9	IJ-6	02/19/1999	16.7	4.4	347	11.9	<1	409	325	131		0.05		<0.1			<0.1	0.61	15.3	336	8.08		1040	1058	1720				<0.1
10	IJ-6	03/18/1999	18	4.9	354	12.5	<1	423	325	126		0.08		<0.1			<0.1	0.64	17.7	347	8.25		1050	1071	1740				<0.1
11	IJ-6	04/15/1999	18.9	5	353	12.7	<1	427	342	138		0.14		<0.1			<0.1	0.69	16.4	350	8.18		1080	1101	1730				<0.1
12	IJ-6	05/20/1999	19	5	345	12.2	5.7	428	331	129		<0.05		<0.1			<0.1	0.7	17	359	8.37		1080	1078	1780				<0.1
13	IJ-6	06/17/1999	18.2	4.8	352	13.6	5.2	432	332	138		0.13		<0.1			<0.1	0.71	15.6	362	8.33		1120	1096	1730				<0.1
14	IJ-6	07/15/1999	18	5.4	353	14	6.4	438	323	126		0.15		<1.1			<0.1	0.8	14.4	368	8.41		1060	1080	1800				<0.1
15	IJ-13	02/19/1999	16	4.2	353	11.3	<1	402	306	126		0.05		<0.1			<0.1	0.59	14	330	8.18		1060	1012	1720				<0.1
16	IJ-13	03/18/1999	19.7	5.2	350	12.3	5.1	419	336	125		0.15		<0.1			<0.1	0.64	15.8	351	8.33		1080	1069	1740				<0.1
17	IJ-13	04/15/1999	20.2	5.3	354	12.7	<1	432	335	139		0.24		<0.1			<0.1	0.63	14.2	354	8.28		1110	1098	1750				<0.1
18	IJ-13	05/20/1999	21	5.3	339	12	5	424	351	135		0.13		<0.1			<0.1	0.61	15	355	8.32		1100	1096	1820				<0.1
19	IJ-13	06/17/1999	20.9	5.4	367	13.7	6.1	439	353	145		0.26		<0.1			0.25	0.62	13.9	369	8.39		1120	1146	1760				<0.1
20	IJ-13	07/15/1999	19.6	3.7	346	13.4	6.2	434	319	123		0.3		<0.1			<0.1	0.72	14.2	365	8.4		1080	1065	1780				<0.1
21	IJ-13	05/16/2002																											
22	IJ-13	07/25/2002										0.05											763						
23	IJ-13	08/08/2002										0.05											699						
24	IJ-13	08/22/2002										0.05											720						
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26	IJ-25	02/19/1999	19	4.8	336	13.2	<1	419	310	127		0.07		<0.1			<0.1	0.56	13.7	344	8.1		1030	1015	1690				<0.1
27	IJ-25	03/18/1999	18.8	4.8	331	13.2	<1	410	301	120		0.11		<0.1			<0.1	0.57	14.5	337	7.97		1050	1021	1680				<0.1
28	IJ-25	04/15/1999	18.2	4.3	333	13.2	<1	409	315	133		0.11		<0.1			<0.1	0.58	13	336	8.06		1050	1037	1670				<0.1
29	IJ-25	05/20/1999	17	4.3	329	12.5	<1	421	315	127		<0.05		<0.1			<0.1	0.6	14	346	8.11		1040	1031	1720				<0.1
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31	IJ-25	07/15/1999	16	4.7	341	14.4	<1	430	302	112		0.15		<0.1			<0.1	0.69	13.4	353	8.21		1030	1026	1710				<0.1
32	IJ-25	05/16/2002																											
33	IJ-25	07/25/2002										0.08											1230						
34	IJ-25	08/08/2002										0.06											1230						

Metadata | Location map | Standards | References | Al samples | Baseline ore body | Baseline perimeter | Baseline overlying | End of extraction ore

Spreadsheet Tabs for wellfield map, references, background, overlying, underlying, restoration and restoration water quality data, well completion information, etc.

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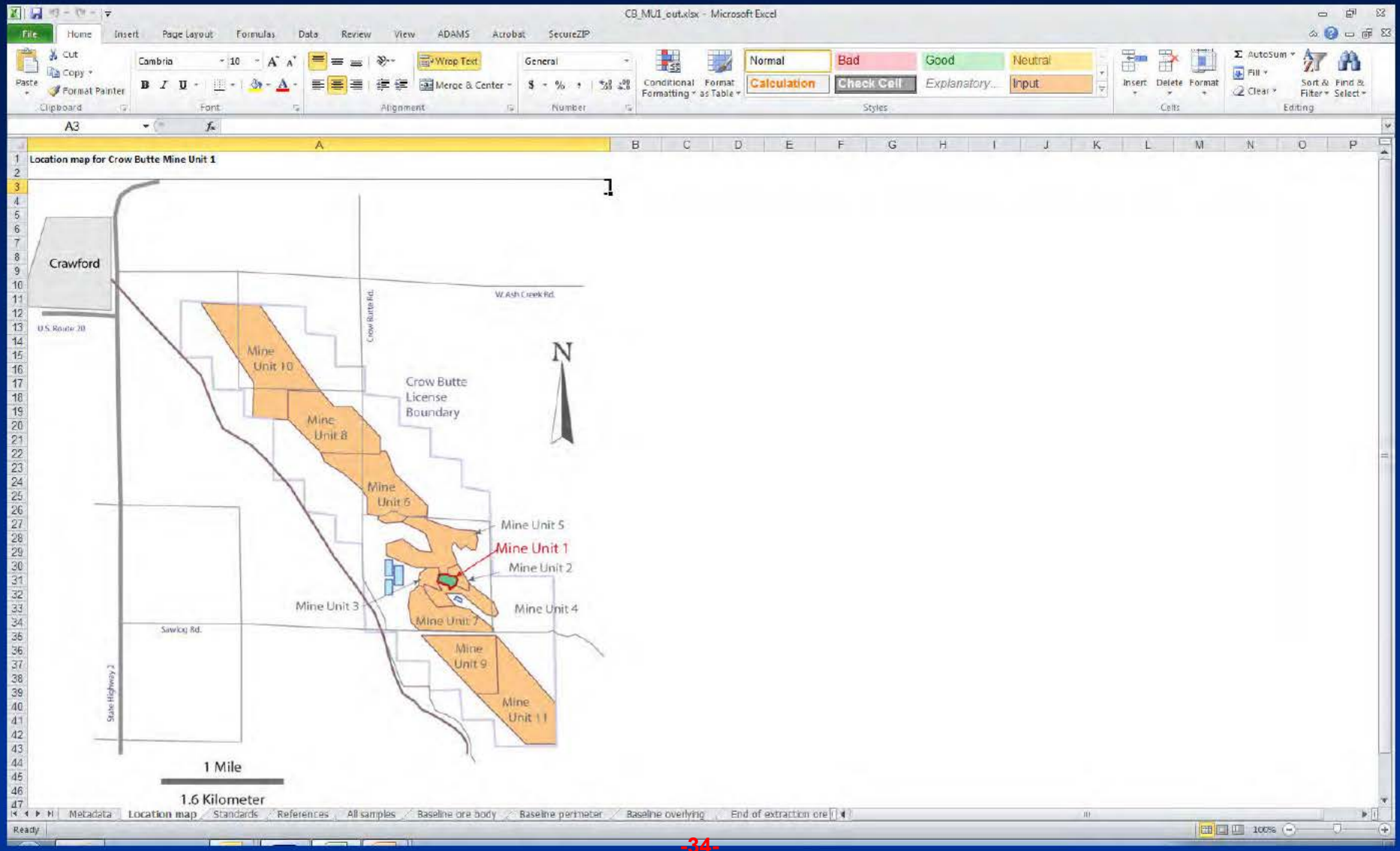
Public Access
Excel Spreadsheets
ISR Wellfield Map



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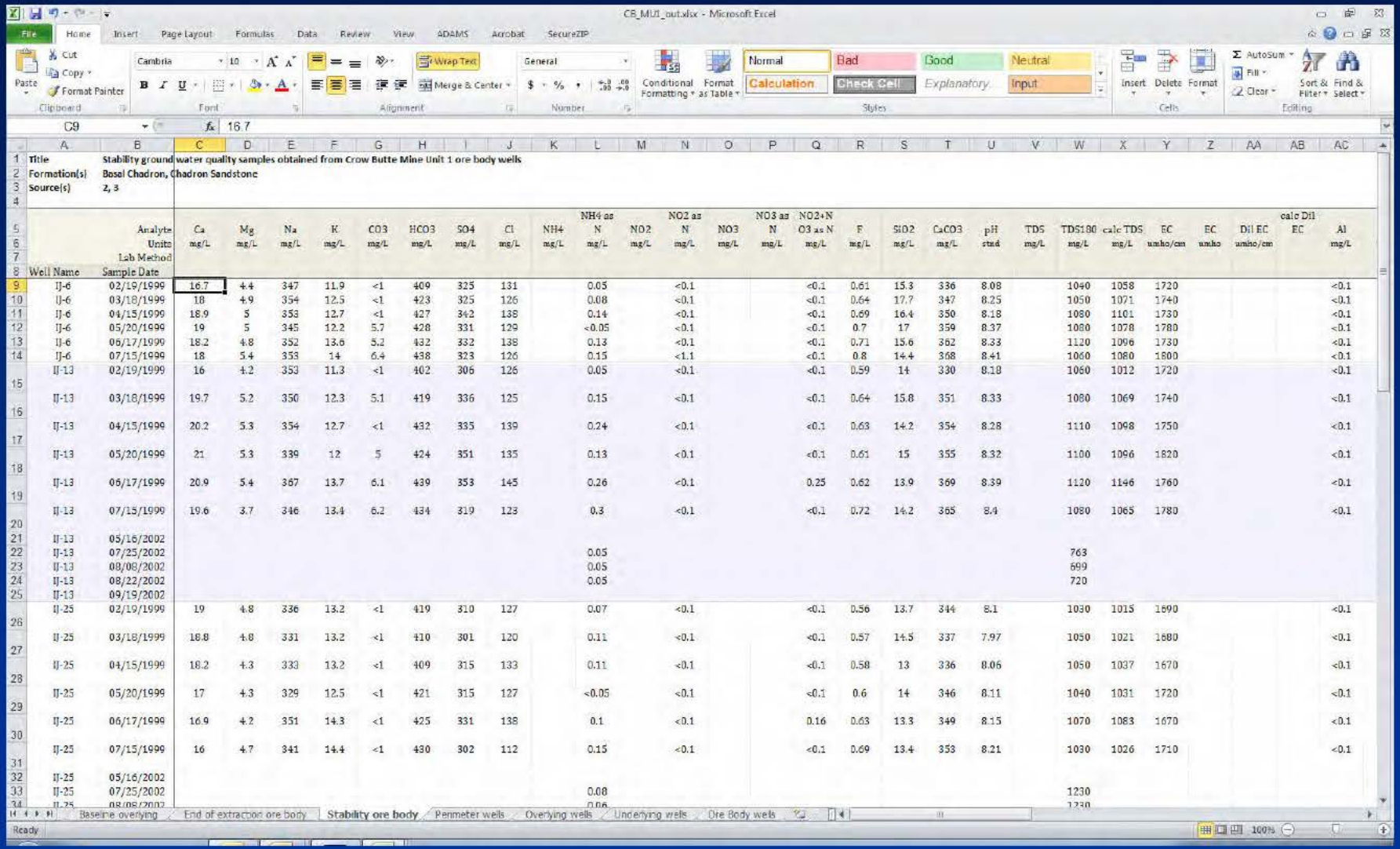
Public Access
Excel Spreadsheets
ISR Wellfield Restoration Stability Water Quality



CB_MUI_out.xlsx - Microsoft Excel

C9: 16.7

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6		Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	stnd	mg/L	mg/L	mg/L	umho/cm	umho	umho/cm		mg/L
7		Lab Method																											
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Baseline overlying | End of extraction ore body | Stability ore body | Perimeter wells | Overlying wells | Underlying wells | Ore Body wells

Ready

Public Access
Excel Spreadsheets
ISR Wellfield Perimeter Monitoring Ring Well Descriptions

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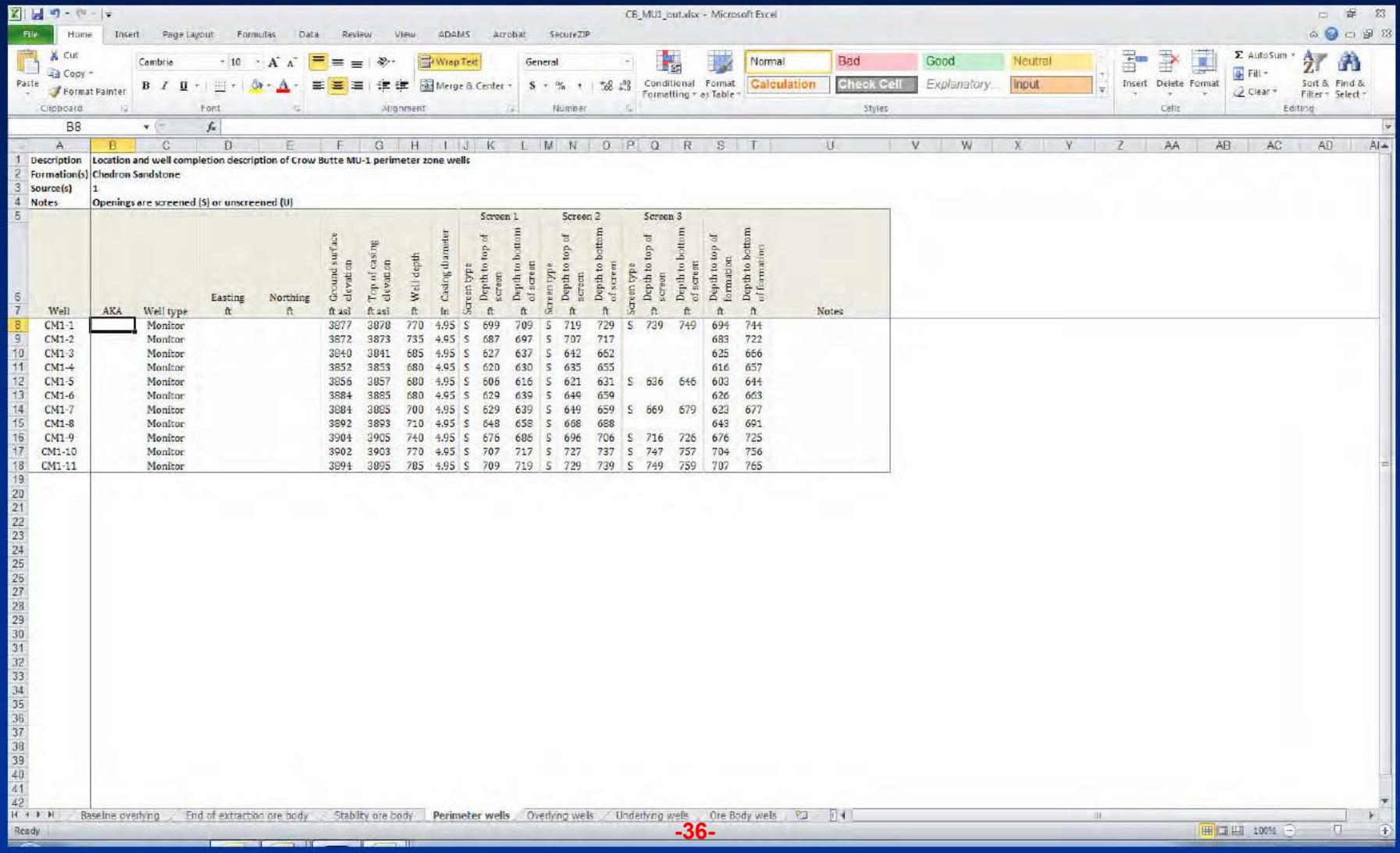

CB_MU1_out.xlsx - Microsoft Excel

Description	Location and well completion description of Crow Butte MU-1 perimeter zone wells
Formation(s)	Chadron Sandstone
Source(s)	1
Notes	Openings are screened (S) or unscreened (U)

									Screen 1			Screen 2			Screen 3					
Well	AKA	Well type	Easting ft	Northing ft	Ground surface elevation ft asl	Top of casing elevation ft asl	Well depth ft	Casing diameter in	Screen type	Depth to top of screen ft	Depth to bottom of screen ft	Screen type	Depth to top of screen ft	Depth to bottom of screen ft	Screen type	Depth to top of screen ft	Depth to bottom of screen ft	Depth to top of formation ft	Depth to bottom of formation ft	Notes
CM1-1		Monitor			3877	3878	770	4.95	S	699	709	S	719	729	S	739	749	694	744	
CM1-2		Monitor			3872	3873	735	4.95	S	687	697	S	707	717				683	722	
CM1-3		Monitor			3840	3841	685	4.95	S	627	637	S	642	662				625	666	
CM1-4		Monitor			3852	3853	680	4.95	S	620	630	S	635	655				616	657	
CM1-5		Monitor			3856	3857	680	4.95	S	606	616	S	621	631	S	636	646	603	644	
CM1-6		Monitor			3884	3885	680	4.95	S	629	639	S	649	659				626	663	
CM1-7		Monitor			3884	3885	700	4.95	S	629	639	S	649	659	S	669	679	623	677	
CM1-8		Monitor			3892	3893	710	4.95	S	648	658	S	668	688				643	691	
CM1-9		Monitor			3904	3905	740	4.95	S	676	686	S	696	706	S	716	726	676	725	
CM1-10		Monitor			3902	3903	770	4.95	S	707	717	S	727	737	S	747	757	704	756	
CM1-11		Monitor			3894	3895	785	4.95	S	709	719	S	729	739	S	749	759	707	765	

Baseline overlying | End of extraction ore body | Stability ore body | Perimeter wells | Overlying wells | Underlying wells | Ore Body wells

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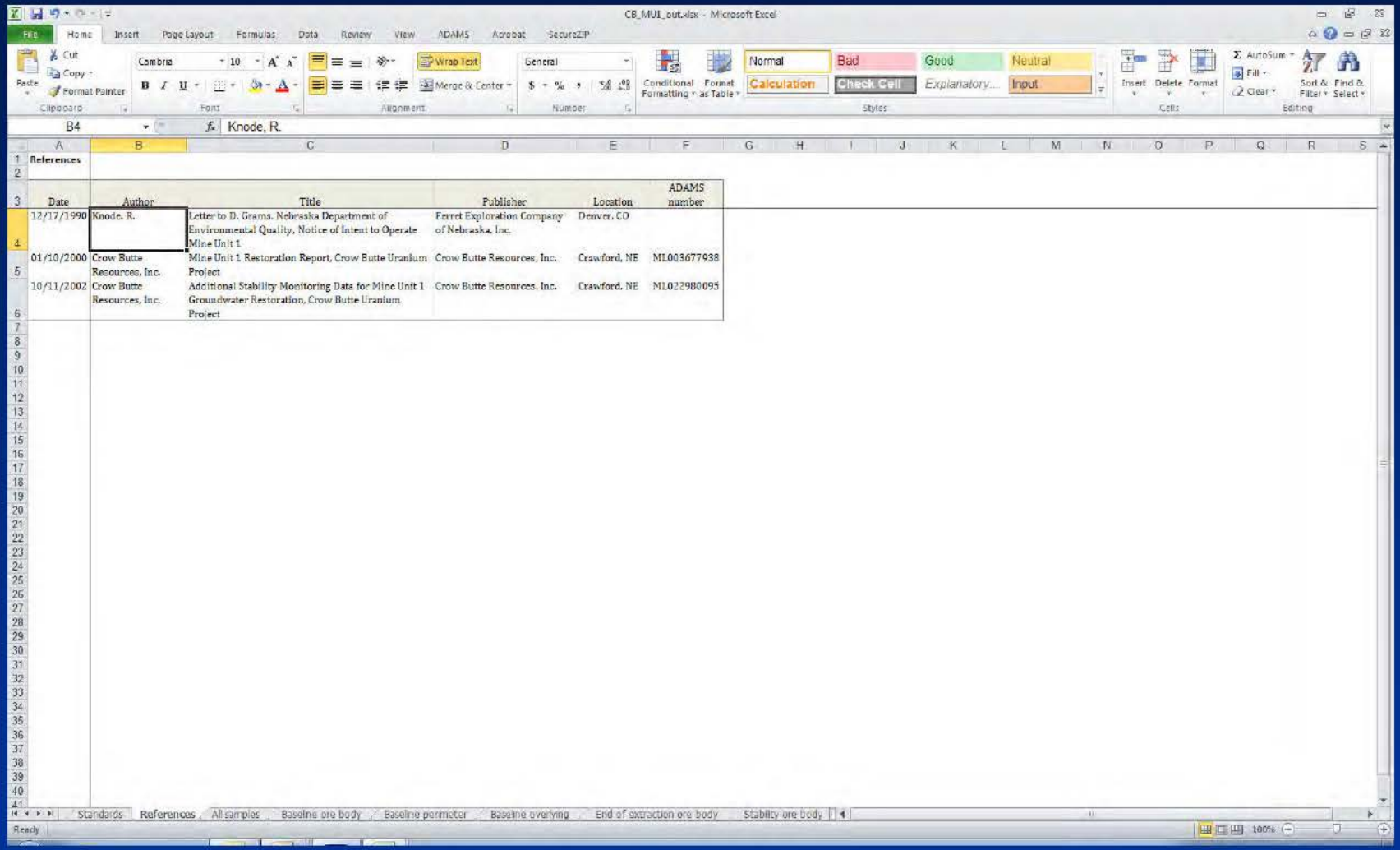
Public Access
Excel Spreadsheets
ISR Wellfield Data References



CB_MUL_out.xlsx - Microsoft Excel

B4: Knode, R.

References

Date	Author	Title	Publisher	Location	ADAMS number
12/17/1990	Knode, R.	Letter to D. Grams, Nebraska Department of Environmental Quality, Notice of Intent to Operate Mine Unit 1	Ferret Exploration Company of Nebraska, Inc.	Denver, CO	
01/10/2000	Crow Butte Resources, Inc.	Mine Unit 1 Restoration Report, Crow Butte Uranium Project	Crow Butte Resources, Inc.	Crawford, NE	ML003677938
10/11/2002	Crow Butte Resources, Inc.	Additional Stability Monitoring Data for Mine Unit 1 Groundwater Restoration, Crow Butte Uranium Project	Crow Butte Resources, Inc.	Crawford, NE	ML022980095

Standards | References | All samples | Baseline ore body | Baseline perimeter | Baseline overlying | End of extraction ore body | Stability ore body

Ready

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Public Access
Excel Spreadsheets
ISR Wellfield Ground Water Quality Status

- 90% of publically available background and restoration ground water quality data for three NRC licensed ISR facilities has been entered into the spreadsheets
- Final data entry ongoing
- All data undergoing extensive quality assurance checks
- Anticipated date for posting of all spreadsheets to NRC public website - September 2013.

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Public Access
Excel Spreadsheets
ISR Wellfield Ground Water Quality
Future Actions

Uranium Recovery Briefing to the Commission February 2013
NRC Staff Requirements Memorandum (SRM) (ML13067A365)

> The staff should continue to collect groundwater monitoring well sampling data for in-situ recovery facilities. The staff should make these data publicly available and evaluate these data for insights on performance issues related to groundwater restoration and excursions events.

1. **Background and restoration stability water quality data will continue to be added to Excel spreadsheets for existing and new licensees.**

2. **Excursion water quality data will be added to Excel spreadsheets for all existing and new licensees.**

3. **All ISR water quality in the spreadsheets will be posted on the NRC public web site for improved public access .**

4. **Staff will evaluate the data for insights on performance issues with respect to meeting GWPS and protecting ground water at ISR wellfields**

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Conclusions
ISR Wellfield Ground Water Quality Data Collection, Statistical Analysis and Public Access

NRC Primary Regulatory Objective: Protect the public health, safety and the environment

- Collect adequate ISR wellfield background water quality data
- Use appropriate statistics (e.g. ProUCL4.1) to establish GWPS
- Collect adequate ISR restoration water quality data
- Use appropriate statistics (e.g. ProUCL4.1) to demonstrate restoration meets GWPS
- Use appropriate statistics (e.g. ProUCL4.1) to demonstrate restoration stability

Public Access- ISR wellfield background, restoration and excursion ground water quality provided to NRC by licensees will be posted to NRC public website in Excel spreadsheets