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CNC CHARLESTON
5090.3a

BACKGROUND/ STATISTICAL METHODS REFERENCE MATERIAL FOR IDENTIFYING CONTAMINATED SITES CNC CHARLESTON SC

6/2/1995

ENSAFE

BACKGROUND / STATISTICAL METHODS
REFERENCE MATERIAL

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a joint venture for professional services

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June 2, 1995

VIA HAND DELIVERY

Commanding Officer
Attn: Matthew A. Hunt, Code 1877
Southern Division, Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, SC 29411-0068

Re: NAVBASE Charleston RFI, Contract Number: N62467-89-D-0318, Technical Memo: *Proposed Method for Comparing Site Sample Values to Background Values for Surface and Subsurface Soils*

Dear Mr. Hunt:

EnSafe/Allen & Hoshall (E/A&H) is pleased to submit a copy of the technical memo discussing E/A&H's proposed statistical methods for comparison of sites to background, concurrently with copies to US EPA and SC DHEC. Many sections of the Zone H report are dependent upon resolution of the background issue, and it is our hope that an agreement on an acceptable approach may be obtained as soon as possible.

If you have any questions or if I can be of assistance please do not hesitate to call me at 884-0029.

Sincerely,
EnSafe/Allen & Hoshall
A Joint Venture in Professional Services

By: Bradley Venner

Attachments

cc: Doyle Brittan, US EPA
Joe Bowers, SC DHEC

May 12, 1995

Memorandum

SUBJECT: Proposed method for comparing site sample values to background values for surface and subsurface soils.

I. Inorganics

This memorandum addresses the issue of identifying contaminated sites at the Charleston Naval Base by comparing chemical concentrations in soil samples taken at the sites with concentrations in samples taken at background locations. Data from Zone H have been used to assess the utility of various statistical approaches in attempting to determine the most appropriate means of characterizing background concentrations and comparing them with concentrations at sites. Potentially contaminated sites in Zone H include ten Solid Waste Management Units (SWMUs) and sixteen Areas of Concern (AOCs). This memo documents a five-step procedure that is being developed and implemented using data from Zone H. Discussion of the methodology is followed by application of the method to lead (Pb) data from surface soils (Level 1). The lead example is included to demonstrate the procedure; results should be considered preliminary and are not intended to support risk assessment or management decisions.

A. Develop rules for dealing with nondetect (ND) data

Following guidelines presented in various USEPA documents, one-half of the sample quantitation limit (SQL) is used for nondetect values. In practice, this means using one-half of the "U" values reported by the lab and confirmed by the validator. For the metals datasets examined so far, this approach appears reasonable. Organic compounds, to be addressed later, may require a somewhat different approach.

B. Establish background for each chemical of interest

The background dataset for Zone H consists of 96 samples labelled GDH (GDHSB001-GDHSB093, GDHSB104-GDHSB107) and 8 samples labelled SGC (SGCSB001-SGCSB008), for a total of up to 104 samples at Level 1 (surface: 0-1 foot) and 63 at Level 2 (subsurface: 3-5 feet). Level 2 samples could not be taken at many locations because of a high water table. The available data values for each chemical are assembled into datasets at each soil level.

Descriptive statistics are obtained for the original data values, including frequency distribution histograms and probability plots. Results are examined and, where appropriate (i.e., histogram positively skewed, probability plot concave upward), data are transformed into natural logarithms (LN) of their original values to provide a closer approximation to a normal distribution. Descriptive statistics of the LN-transformed data are compared to those of the originals. All of the metals datasets examined thus far have distributions that are more nearly lognormal than normal, as illustrated by the Pb_1 example included here (Figures 1-4).

It has been suggested that lognormal data indicate the presence of contamination in the samples at the high end of the range. However, "EPA's experience with environmental concentration data...suggests that a Lognormal distribution is generally more appropriate as a default statistical model than the Normal distribution, a conclusion shared by researchers at the United States Geological Survey" (EPA, 1992, p.2). The fourteen background datasets examined so far are approximately lognormal. It is more reasonable to assume that lognormal background distributions of chemical concentrations are the norm for the Naval Base, than to assume that the datasets document a background that is contaminated in comparable fashion by seven chemicals at two different depths in the soil. Nevertheless, a few potential data outliers do appear at the high end for some compounds, and it is important that the extreme values for each parameter are not considered in the estimation process so that they do not unduly influence estimated background means and variances. Normally, outliers should be removed from a dataset only in unusual circumstances, and with specific reasons for each removal. In a lognormal distribution, even apparently extreme values may fit a straight line on a probability plot of LN-transformed data. Statistical rules of thumb for outlier removal generally are based on the variance of the sample, and include methods such as the "rule of the huge error" (Taylor, 1990, p.88), in which all values greater than four standard deviations above the mean are discarded.

Because of concerns about inadvertently including contaminated samples in the background datasets, outliers here are eliminated more readily than many standard statistical guidelines would suggest. A cutoff of "mean + 2 (standard deviation)" is applied to the LN-transformed data values for each chemical. This is the same standard used in Section D.1 below, where it is discussed. Outliers are removed on a chemical-by-chemical basis, descriptive statistics are recalculated for each chemical's dataset, and the results are used to calculate the tolerance limits described in Section D.1.

C. Develop datasets for sites

Results of analyses of soil samples at the 29 identified sites are assembled into datasets for each chemical of interest at Level 1 and Level 2, for comparison with background.

D. Compare site values to background

The comparison of site to background can best be understood within the context of statistical hypothesis testing. A hypothesis test involves the creation of two hypotheses, a "null" and an "alternative" hypothesis. "In the context of background contamination at hazardous waste sites, the null hypothesis can be expressed as 'there is no difference between contaminant concentrations in background areas and onsite,' and the alternative hypothesis can be expressed as 'concentrations are higher onsite'" (RAGS, EPA, 1989a, p.4-8). Under the assumption that there is no contamination, the likelihood of any observed difference between site and background can be calculated. If the probability of the observed difference is smaller than some predetermined level, a decision is made that since the observed site samples are not likely to be from the same population as the background samples, the site is considered contaminated for a particular chemical.

There are two possible errors that can be made in this situation. The first is that a site will be considered dirty when in fact it is clean, which is called a false positive. The probability of this error, α, is controlled by specifying the level at which the null hypothesis is considered unlikely. The other possible error, the false negative rate, β, can be seen as the probability of concluding from a test that no difference exists when in reality such a difference does exist: the site will be considered clean when in fact it is dirty. The "power" of the test ($1-\beta$), which is the complement of the false negative rate, is a measure of the strength of the conclusion that a difference does exist; it can be thought of as the probability of correctly identifying a contaminated site. The calculation of β and power is somewhat more difficult, and depends upon the magnitude of the actual differences, the size of the sample, and the form of the probability distribution for the measurement process.

Table 1: Probability of Possible Conclusions of a Hypothesis Test

Test	Reality	
	Same as Background (clean)	Greater than Background (contaminated)
Same as Background	$1-\alpha$	β
Greater than Background	α	$1-\beta$

There is a trade-off, in general, between the false positive and false negative rate, given a certain sample size. A test which rarely rejects the hypothesis of "no contamination" will be more prone to make the mistake of missing an actual difference. A test which frequently concludes that contamination is present, on the other hand, will be more likely to make the mistake of concluding that a difference arising by chance is a real difference. The total amount of error can be minimized in two ways: by increasing the sample size and by using a test which is "most powerful." The choice of the form of the hypothesis test is crucial to minimizing the total error.

EPA Region IV often suggests a "2 x background" test: If the maximum detected concentration of a chemical at a site exceeds twice the mean background level, the chemical should be considered a COPC and should be the subject of a detailed risk analysis (i.e., the chemical is a contaminant at the site). What is often not recognized is that this proceedure is a statistical one, and is subject to the same errors as a hypothesis test. The problem with this approach is that background levels are never level; that is, the nature of the background data greatly affects the result of applying the "2 x background" criterion. For a normally distributed variable with a coefficient of variation (CV) of 0.25, less than 0.01% of the population is greater than twice the mean; if the CV is 1.25, 21.2% of the population exceeds the standard. In the latter case, 21.2% of the presumably uncontaminated background population would be rated contaminated by the test (false positive rate = 21.2%). Of the 14 datasets that have been examined as of the date of this memo, fully half (7) have CVs above 1.0; the range of CVs is from 0.71 to 1.41. This test neglects the information about variation which is present in the background samples, and therefore cannot be the most statistically powerful test since it does not make the most effective use of the available data.

Hypothesis tests should be suited to the type of decision that needs to be made, as well as to the type of data available. Any method for comparing site to background must be capable of detecting two different kinds of site contamination. The first type involves localized "hot spots" within the site; for example, one or two site samples out of nine or ten might test well above the highest background samples, while the rest are low or even nondetect. This situation will be modeled as a mixture of two distributions — some of the samples from a given site come from a distribution similar to the background samples while others from the same site come from a second distribution with a higher mean/median. The other type of contamination occurs when most or all of the site samples are above the mean of background samples, but none are necessarily above the high end of the background range. This situation will be modeled assuming that the distribution of site samples is similar to background, but with a higher mean/median. The first scenario will be referred to as the mixture scenario, and the second as the shift scenario. Two complementary tests are proposed for these two situations respectively — a tolerance interval test and a Wilcoxon rank sum test.

D.1. Mixture Scenario: Test Individual Samples vs. Background

Individual data values from a site can be compared to a high percentile (95th, 98th, 99th) of background values. This operation can be done parametrically by comparing to a percentile of the distribution of background values, obtained either from a probability chart of LN-transformed values or by using standard methods of estimating quantiles (e.g., Gilbert, 1987, p.175, Eqn. 13.24). It can also be done nonparametrically by comparing to a percentile of the background data values themselves, rather than to an assumed distribution of the values.

Rather than comparing site values to specific percentiles of the background data, it is possible to compare them to estimated tolerance intervals that enclose a specified percentage of the background population. A one-sided tolerance interval with 95% coverage and 95% confidence signifies that approximately 95% of individual population values fall below the upper limit, with 95% confidence. Once the interval is constructed, each site sample is compared to the upper tolerance limit (EPA, 1992, p.51). Any value that exceeds the limit is considered evidence of contamination at that point.

A roughly lognormal distribution of background values allows the use of parametric tolerance intervals, using LN-transformed values, when the nondetect percentage is low. This is the approach favored by both the Ohio Environmental Protection Agency and the Texas Natural Resource Conservation Commission to determine whether onsite contamination is greater than background. Individual sample values are compared to an upper tolerance limit that is calculated using the expression

$$\exp[X + k (s)]$$

where:

X = mean of LN-transformed background values
s = standard deviation of LN-transformed values
k = tolerance factor (Ohio EPA, 1991)

The tolerance factor k is obtained from tables with specified levels of α and P_0, where $(1 - P_0)$ equals the proportion of the population contained within the tolerance intervals. For a given set of α and P_0, k depends on the sample size n. For n = 63 (the sample size for Level 2 of background), k = 2.007 when $\alpha = 0.05$ and $P_0 = 0.05$ (coverage = 95%, confidence = 95%); under the same conditions of α and P_0, k = 1.917 when n = 105 (the sample size for Level 1 of background). For the sake of simplicity, a tolerance factor of k = 2 is applied to the background datasets for metals, yielding a cutoff value of

$$\text{mean} + 2\ (\text{standard deviation})$$

to determine whether a site value will be considered contaminated. In the case of a site sample contaminated with lead, for example, this method allows us to say, "We are 95% confident that this individual sample contains more lead than 95% of the population of background samples."

When a significant proportion of the samples are nondetect, it may be necessary to employ nonparametric tolerance intervals. In practice, this means using either the largest or the second largest observed background value as the standard of comparison (EPA, 1992, p.54). For a sample size of 63, using the largest background value gives coverage of over 95% with 95% confidence; for a sample size of 105, using the second largest value gives equivalent coverage and confidence levels. When nondetects reach 85-90% or more, background values may be modeled with a Poisson distribution, and Poisson tolerance limits can be constructed (EPA, 1992, p.38).

The power of this tolerance-limit test will vary based upon several factors, such as the number of samples that are assumed to have come from the distribution with the larger mean, the magnitude of the shift in the mean, and the distribution of the background samples. It also depends upon the sample size of each site and the sample size of the background. Therefore, power will depend upon the sampling strategy for each zone, and cannot be specified in a general memo. A detailed power analysis will be conducted for each zone to be included in the RFI report.

D.2. Shift Scenario: Test Entire Site vs. Background

For the situation in which the majority of samples at a site are higher than the mean background value, but none are dramatically higher, the site samples as a group must be shown to be significantly higher than the group of background samples, for contamination to be identified at the site. Figure 2.1 (enclosed) from an EPA guidance document on soils and solid media (EPA, 1989b, p.2-4) was borrowed from another document on groundwater monitoring but specifically applied to soil contamination. The upper part of the figure shows that, starting with an initial null hypothesis of "no contamination," the lower limit (confidence or tolerance) around the mean or median of the distribution of site samples must be shown to exceed the corresponding upper limit of the background distribution for the site to be considered contaminated. (As illustrated in the figure, the lower limit of the site distribution must also exceed a risk-based standard before triggering corrective action.) Depending on the nature of the data used, the upper and lower limits can be obtained using either parametric or nonparametric procedures. For a dataset with any significant number of nondetects, unfortunately, a calculated lower limit will tend to be inaccurate because it is based on the lowest data values, which must be estimated from the "U" values in the original data. Because of this limitation, the approach was rejected.

The most commonly prescribed method for comparing two populations is the *t* test, which determines whether the two population means differ significantly. The *t* test is not being used to compare site values to background because it is parametric. Although the background data values are approximately normally distributed after being LN-transformed, there is no reason to expect that the site values will be. In addition, the presence of estimated values for the nondetects calls into question the accuracy of the calculated means that are being compared.

A nonparametric counterpart to the *t* test is the Wilcoxon rank sum test, also known as the Mann-Whitney U test. Since it is nonparametric, the two datasets that are compared need not be drawn from normal or even symmetric distributions, and the test can accomodate a moderate number of nondetect values by treating them as ties (Gilbert, 1987, p.248). The method for handling nondetect values is important because it affects their ranks. "Detected but not quantified values" (J's) should receive higher ranks than nondetects. Since the ranks of the data values are evaluated and compared rather than the values themselves, the test is not sensitive to minor inaccuracies in estimated values and does not require an estimate of the mean, nor do the data values need to be LN-transformed. The Wilcoxon test is superior to some other nonparametric tests such as the sign test or the test of proportions because it takes account of differences in concentrations, and therefore has more statistical power to detect differences in those concentrations.

The Wilcoxon rank sum test operates by combining the site and background data values and ranking them by concentration. The ranks of the site samples are then compared to the background ranks. If the site ranks as a group are significantly higher than those of the background, the null hypothesis that the site and background values came from the same population is rejected at a chosen confidence level (EPA, 1992, p.46). Each group should contain at least four data values. The test is available within the Minitab® statistical program for PCs.

The Wilcoxon test is very similar in power to the t-test when samples are normally distributed, and is more powerful when a large number of outlying values are to be expected. The power of this test will vary based upon several factors, such as the magnitude of the shift in the median, and the distribution of the background samples, the sample size of each site and the sample size of the background. Therefore, power will depend upon the sampling strategy for each zone, and cannot be specified in a general memo. A detailed power analysis will be conducted for each zone to be included in the RFI report.

Summary of Section D: Choose techniques that allow the use of statistical inference. Methods must be capable of detecting situations where (a) a small number of site values are much higher than background, and (b) site values are generally higher than background. For situation (a), LN-transform all data values where appropriate to approximate normal distributions, then compare site values to an upper tolerance limit of "mean plus two standard deviations" of the background data. Where the percentage of nondetects is high, use nonparametric tolerance limits; above 85-90% nondetects, consider using Poisson tolerance limits. For situation (b), apply the Wilcoxon rank sum test to compare each group of site values to background.

E. Combine results of D.1 and D.2

Methods described in section D.1 identify individual samples with concentrations that are significantly higher than background, while the method in section D.2 identifies entire sites. If the results from either test are positive (i.e., significantly higher than background), the sample and/or site values are compared to the corresponding EPA risk-based concentration limit for soils and, where appropriate, carried forward into detailed risk assessment.
Example: Lead values at Level 1

The results of 104 analyses of background samples were assembled into a dataset and descriptive statistics were obtained for both the original and LN-transformed data, including histograms and probability plots (Figures 1-4). When the upper tolerance limit of "mean plus two standard deviations" was applied to the transformed data to identify outliers, three values were found to be above the cutoff. In terms of the original data, the tolerance limit was 143.5 ppm, while the three outliers were 172, 151, and 320 ppm. Recalculation after deletion of the outliers yielded an upper tolerance limit of 113.9 ppm, which was greater than any of the remaining data values. Figures 5-8 are histograms and probability plots of the 101 values remaining in the dataset.

Eliminating the three highest values had the following effect on parameters of the original (untransformed) data:

	Before	After
Mean	28.93	23.43
Standard deviation	40.94	22.24
CV	1.41	0.95
Skewness	4.32	1.67
Kurtosis	27.65	5.48

Parameters of the LN-transformed data changed as follows:

	Before	After
Mean	2.79	2.72
Standard deviation	1.09	1.01
CV	0.39	0.37
Skewness	-0.10	-0.40
Kurtosis	3.17	2.95

Since the greatest relative effect on the transformed data was to increase the absolute value of the skewness from 0.1 to 0.4 (away from 0.0, which is the skewness of a perfectly normal distribution), it is possible that eliminating outliers in this case was overly conservative.

Sample analysis results were assembled into datasets for individual AOCs and SWMUs, and their values were compared to the upper tolerance limit of 113.9 ppm. Eleven of the sites had values that exceeded the cutoff value:

014: 6 of 11 samples
019: 7 of 13
121: 9 of 11
136: 1 of 3
650: 4 of 9
653: 2 of 4
655: 2 of 8
666: 1 of 7
670: 4 of 26
684: 1 of 22
690: 1 of 10

Sample values that exceed the cutoff are marked with arrows on the enclosed sample list. ("U" and "UJ" values on the list have already been divided by 2.)

Site datasets were compared to the background dataset using the Wilcoxon rank sum test (see enclosed results). At seven of the nineteen sites tested, the null hypothesis of "no significant difference" (i.e., no contamination) was rejected, indicating that overall site values were significantly higher than background. The seven sites with overall elevated values were: 014, 019, 121, 650, 653, 670, and 684. Several sites were not tested because their data values were obviously lower than background values.

The importance of using a statistical approach to comparing sites to background is evident upon examination of the results of the Wilcoxon test on AOCs 684 and 690. Although only 1 of 22 samples at AOC 684 exceeded the upper tolerance limit of the background samples, the test found that the group of site sample values was significantly higher than background at $\alpha = 0.03$. At AOC 690, 1 of 10 samples was above the upper tolerance limit, and the median data value was virtually identical to that of AOC 684 (28.15 ppm vs. 28.60 ppm); yet the test resulted in accepting the null hypothesis of "no significant difference" because the calculated difference was not significant at the prescribed level of $\alpha = 0.05$ (the test was significant at $\alpha = 0.072$). In this case, the difference in results of the two tests was probably due to the difference in the number of samples at the two sites; the larger number at AOC 684 increased the certainty of the observed differences in concentration.

The overall approach documented in this memo is considered extremely conservative for a number of reasons: (1) the number of background samples is well above the minimum recommended in various guideline documents (RAGS, EPA, 1989a, p.4-9; Ohio EPA, 1991, p.3-9), producing greater confidence in the ability to characterize background, and to distinguish background concentrations from those at sites; (2) following methodology developed in section B, high values are removed from the background datasets whether or not they are true outliers in a conventional sense, thereby lowering the total background to which the sites are compared; and (3) the use of two complementary tests increases the likelihood that any contamination will be identified and addressed further, since a positive result from either test can trigger a detailed risk assessment.

References:

Gilbert, R.O. (1987): *Statistical Methods for Environmental Pollution Monitoring.* Van Nostrand Reinhold, New York.

Ohio Environmental Protection Agency, Division of Emergency and Remedial Response (1991): *How Clean is Clean.* DERR-00-RR-009

Taylor, J.K. (1990): *Statistical Techniques for Data Analysis.* Lewis Publishers, Inc., Chelsea, MI.

USEPA (1989a): *Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual (Part A).* EPA/540/1-89/002 (RAGS).

USEPA (1989b): *Methods for Evaluating the Attainment of Cleanup Standards, Vol. 1: Soils and Solid Media.* PB89-234959.

USEPA (1992): *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Draft Addendum to Interim Final Guidance.*

ENVIRONMENTAL SAFETY & DESIGNS

2909-00002 - CHARLESTON ZONE I QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
012-G-W003-04	012GW00304	Water	09/09/96	4.3000	J	UG/L	26836	VAL
671-G-W001-04	671GW00104	Water	08/30/96	5.5000	J	UG/L	26768	VAL
671-G-W003-04	671GW00304	Water	08/30/96	6.6000	J	UG/L	26768	VAL
677-G-W002-04	677GW00204	Water	09/10/96	4.6000	J	UG/L	26836	VAL
687-G-W001-04	687GW00104	Water	09/10/96	5.2000	J	UG/L	26836	VAL
687-G-W002-04	687GW00204	Water	09/10/96	2.7000	J	UG/L	26836	VAL
GDI-G-W001-03	GDIGW00103	Water	05/15/96	5.5000	J	UG/L	25623	VAL
GDI-G-W002-02	GDIGW00202	Water	12/12/95	6.6000	J	UG/L	24276	VAL
GDI-G-W002-03	GDIGW00203	Water	05/16/96	3.5000	J	UG/L	25623	VAL
GDI-G-W003-03	GDIGW00303	Water	05/20/96	2.8000	J	UG/L	25623	VAL
GDI-G-W005-03	GDIGW00503	Water	05/20/96	3.0000	J	UG/L	25623	VAL
GDI-G-W009-02	GDIGW00902	Water	12/11/95	7.5000	J	UG/L	24276	VAL
GDI-G-W011-04	GDIGW01104	Water	08/29/96	4.1000	J	UG/L	26768	VAL
GDI-G-W012-02	GDIGW01202	Water	12/12/95	5.9000	J	UG/L	24276	VAL
GDI-G-W017-02	GDIGW01702	Water	12/05/95	5.4000	J	UG/L	24229	VAL
GDI-H-W019-02	GDIHW01902	Water	12/13/95	5.9000	J	UG/L	24310	VAL
GDI-H-W019-04	GDIHW01904	Water	08/28/96	3.5000	J	UG/L	26768	VAL
GDI-G-W01D-02	GDIGW01D02	Water	12/13/95	5.1000	J	UG/L	24310	VAL
GDI-G-W02D-03	GDIGW02D03	Water	05/20/96	4.2000	J	UG/L	25623	VAL
GDI-G-W05D-02	GDIGW05D02	Water	12/08/95	5.5000	J	UG/L	24229	VAL
GDI-G-W07D-02	GDIGW07D02	Water	12/13/95	5.6000	J	UG/L	24310	VAL
GDI-G-W08D-02	GDIGW08D02	Water	12/12/95	5.5000	J	UG/L	24276	VAL
GDI-G-W09D-02	GDIGW09D02	Water	12/11/95	6.9000	J	UG/L	24276	VAL
GDI-G-W10D-02	GDIGW10D02	Water	12/11/95	8.6000	J	UG/L	24276	VAL
GDI-G-W10D-04	GDIGW10D04	Water	08/26/96	3.1000	J	UG/L	26711	VAL
GDI-G-W11D-04	GDIGW11D04	Water	08/30/96	5.7000	J	UG/L	26768	VAL
GDI-G-W12D-02	GDIGW12D02	Water	12/12/95	5.6000	J	UG/L	24276	VAL
GDI-G-W15D-03	GDIGW15D03	Water	05/24/96	7.1000	J	UG/L	25724	VAL
GDI-G-W17D-02	GDIGW17D02	Water	12/05/95	6.3000	J	UG/L	24229	VAL
GDI-G-W17D-04	GDIGW17D04	Water	08/27/96	15.4000	J	UG/L	26711	VAL
GDI-G-W18D-02	GDIGW18D02	Water	12/06/95	5.2000	J	UG/L	24229	VAL
GDI-G-W18D-03	GDIGW18D03	Water	05/29/96	5.2000	J	UG/L	25724	VAL
GDI-G-W18D-04	GDIGW18D04	Water	08/29/96	6.1000	J	UG/L	26768	VAL

*** End of Report ***

Zone I

Thallium in GW samples – all detections

Thallium was not detected in any first-round samples.

ENVIRONMENTAL SAFETY & DESIGNS

2908-00005 - CHARLESTON ZONE H QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
009-G-FMW4-01		CSYGFMW401	Water	11/08/94	4.6000	J	UG/L	CHS25	VAL
009-G-W002-04		009GW00204	Water	03/19/96	7.4000	J	UG/L	24968	VAL
009-G-W003-01		009GW00301	Water	11/18/94	1.0000	J	UG/L	CHS26	VAL
009-G-W005-04		009GW00504	Water	04/10/96	3.6000	J	UG/L	25191	VAL
009-G-W007-03		009GW00703	Water	09/14/95	16.8000	J	UG/L	CHS48	VAL
009-G-W007-04		009GW00704	Water	03/20/96	2.7000	J	UG/L	24968	VAL
009-G-W008-04		009GW00804	Water	04/08/96	6.2000	J	UG/L	25191	VAL
009-G-W009-01		009GW00901	Water	11/19/94	1.4000	J	UG/L	CHS26	VAL
009-G-W011-04		009GW01104	Water	04/10/96	4.0000	J	UG/L	25191	VAL
009-G-W013-01		009GW01301	Water	11/18/94	1.0000	J	UG/L	CHS26	VAL
009-G-W013-03		009GW01303	Water	10/02/95	16.0000	J	UG/L	CHS52	VAL
009-G-W013-04		009GW01304	Water	04/12/96	5.4000	J	UG/L	25236	VAL
009-G-W014-04		009GW01404	Water	04/12/96	4.7000	J	UG/L	25236	VAL
009-G-W015-04		009GW01504	Water	04/12/96	4.4000	J	UG/L	25236	VAL
009-G-W02D-03		009GW02D03	Water	09/14/95	17.3000	J	UG/L	CHS48	VAL
009-G-W04D-01		009GW04D01	Water	11/21/94	160.0000	J	UG/L	CHS26	VAL
009-G-W06D-03		009GW0GD03	Water	10/02/95	55.6000	J	UG/L	CHS52	VAL
009-G-W07D-03		009GW07D03	Water	09/15/95	17.2000	J	UG/L	CHS50	VAL
009-G-W121-01		121GW00101	Water	11/09/94	6.4000	J	UG/L	CHS25	VAL
013-G-W001-04		013GW00104	Water	03/19/96	4.2000	J	UG/L	24968	VAL
014-G-W002-04		014GW00204	Water	03/20/96	5.2000	J	UG/L	24968	VAL
014-G-W003-04		014GW00304	Water	03/12/96	2.8000	J	UG/L	24897	VAL
014-G-W01D-03		014GW01D03	Water	09/13/95	21.8000	J	UG/L	CHS48	VAL
014-G-W02D-01		014GW02D01	Water	11/15/94	1.2000	J	UG/L	APX13	VAL
014-G-W02D-03		014GW02D03	Water	09/13/95	15.9000	J	UG/L	CHS48	VAL
014-G-W03D-03		014GW03D03	Water	09/12/95	18.3000	J	UG/L	CHS48	VAL
014-G-W04D-03		014GW04D03	Water	09/12/95	22.4000	J	UG/L	CHS48	VAL
014-G-W05D-01		014GW05D01	Water	11/17/94	1.2000	J	UG/L	APX13	VAL
014-G-W05D-03		014GW05D03	Water	09/12/95	28.8000	J	UG/L	CHS48	VAL
014-G-W05D-04		014GW05D04	Water	03/14/96	5.2000	J	UG/L	24897	VAL
017-G-W002-04		017GW00204	Water	03/26/96	3.1000	J	UG/L	25067	VAL
121-G-W001-04		121GW00104	Water	04/02/96	3.0000	J	UG/L	25067	VAL
653-G-W001-01		653GW00101	Water	11/04/94	1.2000	J	UG/L	CHS25	VAL
653-G-W001-04		653GW00104	Water	03/27/96	2.8000	J	UG/L	25067	VAL
655-G-W001-04		655GW00104	Water	03/26/96	2.9000	J	UG/L	25067	VAL
656-G-W001-04		656GW00104	Water	03/19/96	4.2000	J	UG/L	24968	VAL
656-G-W002-04		656GW00204	Water	03/19/96	4.5000	J	UG/L	24968	VAL
656-G-W003-02		656GW00302	Water	04/03/95	4.1000	J	UG/L	CHS41	VAL
656-G-W003-03		656GW00303	Water	09/14/95	23.2000	J	UG/L	CHS48	VAL
656-G-W003-04		656GW00304	Water	03/20/96	3.3000	J	UG/L	24968	VAL
660-G-W001-04		660GW00104	Water	03/27/96	3.7000	J	UG/L	25067	VAL
662-G-W001-04		662GW00104	Water	04/02/96	4.0000	J	UG/L	25067	VAL
662-G-W002-04		662GW00204	Water	04/02/96	3.1000	J	UG/L	25067	VAL
666-G-W002-04		666GW00204	Water	04/02/96	3.1000	J	UG/L	25067	VAL
FMW-G-W004-04		FMWGW00404	Water	04/10/96	5.5000	J	UG/L	25191	VAL
GDH-G-W003-04		GDHGW00304	Water	04/08/96	4.0000	J	UG/L	25191	VAL
GDH-G-W004-01		GDHGW00401	Water	11/17/94	1.9000	J	UG/L	CHS26	VAL
GDH-G-W004-04		GDHGW00404	Water	04/09/96	5.3000	J	UG/L	25191	VAL
GDH-G-W006-01		GDHGW00601	Water	11/18/94	2.2000	J	UG/L	CHS26	VAL

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2908-00005 - CHARLESTON ZONE H QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDH-G-W006-04		GDHGW00604	Water	04/10/96	3.5000	J	UG/L	25191	VAL
GDH-G-W009-01		GDHGW00901	Water	11/21/94	105.0000	J	UG/L	CHS26	VAL
GDH-G-W009-04		GDHGW00904	Water	04/12/96	4.4000	J	UG/L	25236	VAL
GDH-G-W010-04		GDHGW01004	Water	04/12/96	2.7000	J	UG/L	25236	VAL
GDH-G-W04D-04		GDHGW04D04	Water	04/09/96	5.9000	J	UG/L	25191	VAL
GDH-G-W08D-01		GDHGW08D01	Water	11/09/94	5.6000	J	UG/L	CHS25	VAL
GDH-G-W09D-04		GDHGW09D04	Water	04/12/96	5.8000	J	UG/L	25236	VAL

*** End of Report ***

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2909-00002 - CHARLESTON ZONE I QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
012-G-W003-04		012GW00304	Water	09/09/96	4.3000	B	UG/L	26836	VAL
671-G-W001-04		671GW00104	Water	08/30/96	5.5000	B	UG/L	26768	VAL
671-G-W003-04		671GW00304	Water	08/30/96	6.6000	B	UG/L	26768	VAL
676-G-W001-04		676GW00104	Water	09/12/96	4.0000	B	UG/L	26925	VAL
677-G-W002-04		677GW00204	Water	09/10/96	4.6000	B	UG/L	26836	VAL
687-G-W001-04		687GW00104	Water	09/10/96	5.2000	B	UG/L	26836	VAL
687-G-W002-04		687GW00204	Water	09/10/96	2.7000	B	UG/L	26836	VAL
GDI-G-W001-03		GDIGW00103	Water	05/15/96	5.5000	J	UG/L	25623	VAL
GDI-G-W002-02		GDIGW00202	Water	12/12/95	6.6000	J	UG/L	24276	VAL
GDI-G-W002-03		GDIGW00203	Water	05/16/96	3.5000	J	UG/L	25623	VAL
GDI-G-W003-03		GDIGW00303	Water	05/20/96	2.8000	J	UG/L	25623	VAL
GDI-G-W005-03		GDIGW00503	Water	05/20/96	3.0000	J	UG/L	25623	VAL
GDI-G-W009-02		GDIGW00902	Water	12/11/95	7.5000	J	UG/L	24276	VAL
GDI-G-W011-04		GDIGW01104	Water	08/29/96	4.1000	B	UG/L	26768	VAL
GDI-G-W012-02		GDIGW01202	Water	12/12/95	5.9000	J	UG/L	24276	VAL
GDI-G-W017-02		GDIGW01702	Water	12/05/95	5.4000	J	UG/L	24229	VAL
GDI-H-W019-02		GDIHW01902	Water	12/13/95	5.9000	J	UG/L	24310	VAL
GDI-H-W019-04		GDIHW01904	Water	08/28/96	3.5000	B	UG/L	26768	VAL
GDI-G-W01D-02		GDIGW01D02	Water	12/13/95	5.1000	J	UG/L	24310	VAL
GDI-G-W02D-03		GDIGW02D03	Water	05/20/96	4.2000	J	UG/L	25623	VAL
GDI-G-W05D-02		GDIGW05D02	Water	12/08/95	5.5000	J	UG/L	24229	VAL
GDI-G-W07D-02		GDIGW07D02	Water	12/13/95	5.6000	J	UG/L	24310	VAL
GDI-G-W08D-02		GDIGW08D02	Water	12/12/95	5.5000	J	UG/L	24276	VAL
GDI-G-W09D-02		GDIGW09D02	Water	12/11/95	6.9000	J	UG/L	24276	VAL
GDI-G-W10D-02		GDIGW10D02	Water	12/11/95	8.6000	J	UG/L	24276	VAL
GDI-G-W10D-04		GDIGW10D04	Water	08/26/96	3.1000	J	UG/L	26711	VAL
GDI-G-W11D-04		GDIGW11D04	Water	08/30/96	5.7000	B	UG/L	26768	VAL
GDI-G-W12D-02		GDIGW12D02	Water	12/12/95	5.6000	J	UG/L	24276	VAL
GDI-G-W15D-03		GDIGW15D03	Water	05/24/96	7.1000	J	UG/L	25724	VAL
GDI-G-W17D-02		GDIGW17D02	Water	12/05/95	6.3000	J	UG/L	24229	VAL
GDI-G-W17D-04		GDIGW17D04	Water	08/27/96	15.4000	J	UG/L	26711	VAL
GDI-G-W18D-02		GDIGW18D02	Water	12/06/95	5.2000	J	UG/L	24229	VAL
GDI-G-W18D-03		GDIGW18D03	Water	05/29/96	5.2000	J	UG/L	25724	VAL
GDI-G-W18D-04		GDIGW18D04	Water	08/29/96	6.1000	B	UG/L	26768	VAL

*** End of Report ***

No 1st round GW hits

No Zone K GW hits

No Zone W GW hits

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2901-00001 - CHARLESTON ZONE A - SOIL & 1ST GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for UG/L - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
038-G-W002-01	038GW00201	Water	12/07/95	4.0000	J	UG/L	L5997	VAL
GDA-G-W03D-01	GDAGW03D01	Water	12/08/95	163.0000	J	UG/L	L6008	VAL

*** End of Report ***

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2901-00002 - CHARLESTON ZONE A - QUARTERLY GW
Samples by Chemical Report
7440-28-0 - Thallium (Tl)
>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDA-G-W03D-02	GDAGW03D02	Water	04/29/96	23.0000	J	UG/L	L6926W	VAL
GDA-G-W03D-03	GDAGW03D03	Water	06/25/96	17.0000	J	UG/L	L7317M	VAL

*** End of Report ***

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S
2902-00002 - CHARLESTON ZONE B - QUARTERLY GW
Samples by Chemical Report
7440-28-0 - Thallium (Tl)
>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDB-G-W003-03	GDBGW00303	Water	06/25/96	3.4000	J	UG/L	L7320M	VAL

*** End of Report ***

No Tl in 1st-round GW samples

VCHEM_R
03/14/97

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

Page: 1
Time: 10:25

2903-00002 - CHARLESTON ZONE C - QUARTERLY GW
Samples by Chemical Report
7440-28-0 - Thallium (Tl)
>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
044-G-W001-04	044GW00104	Water	06/11/96	34.5000	J	UG/L	25931	VAL
044-G-W003-04	044GW00304	Water	06/07/96	8.4000	J	UG/L	25931	VAL
044-G-W005-04	044GW00504	Water	06/10/96	3.8000	J	UG/L	25931	VAL
044-G-W007-03	044GW00703	Water	05/10/96	3.1000	B	UG/L	25568	VAL
047-G-W002-04	047GW00204	Water	06/07/96	3.9000	J	UG/L	25931	VAL
047-G-W005-03	047GW00503	Water	05/13/96	4.3000	B	UG/L	25568	VAL
047-G-W007-03	047GW00703	Water	05/14/96	3.9000	B	UG/L	25568	VAL
047-G-W015-03	047GW01503	Water	05/10/96	2.8000	B	UG/L	25568	VAL
523-G-W001-03	523GW00103	Water	05/13/96	4.3000	B	UG/L	25568	VAL

*** End of Report ***

No Tl in 1ST-round GW samples

No Tl in Zone D GW samples

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2905-00002 - CHARLESTON ZONE E - QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
021-G-W003-03	021GW00303	Water	12/04/96	3.2000	J	UG/L	27827	VAL
053-G-W001-03	053GW00103	Water	12/13/96	4.8000	J	UG/L	27955	VAL
054-G-W002-01	054GW00201	Water	04/16/96	5.0000	J	UG/L	25297	VAL
054-G-W002-03	054GW00203	Water	12/04/96	3.6000	J	UG/L	27827	VAL
063-G-W001-03	063GW00103	Water	12/12/96	5.3000	J	UG/L	27955	VAL
063-G-W002-03	063GW00203	Water	12/13/96	5.7000	J	UG/L	27955	VAL
065-G-W002-03	065GW00203	Water	12/11/96	2.8000	J	UG/L	27955	VAL
067-G-W002-03	067GW00203	Water	12/03/96	4.0000	J	UG/L	27827	VAL
070-G-W001-03	070GW00103	Water	12/03/96	3.2000	J	UG/L	27827	VAL
070-G-W01D-01	070GW01D01	Water	04/26/96	9.5000	J	UG/L	25361	VAL
070-G-W01D-03	070GW01D03	Water	12/03/96	10.6000	J	UG/L	27827	VAL
083-G-W001-04	083GW00104	Water	01/24/97	5.1000	B	UG/L	28253	NV
084-G-W002-03	084GW00203	Water	11/15/96	8.2000	J	UG/L	27639	VAL
097-G-W001-04	097GW00104	Water	01/15/97	3.9000	B	UG/L	28179	NV
102-G-W001-03	102GW00103	Water	11/04/96	3.1000	J	UG/L	27488	VAL
106-G-W001-02	106GW00102	Water	07/09/96	3.7000	J	UG/L	26253	VAL
106-G-W01D-02	106GW01D02	Water	07/09/96	5.0000	J	UG/L	26253	VAL
145-G-W01D-04	145GW01D04	Water	01/17/97	7.0000	B	UG/L	28210	NV
172-G-W001-04	172GW00104	Water	01/27/97	3.1000	B	UG/L	28301	NV
172-G-W02D-03	172GW02D03	Water	11/14/96	4.0000	J	UG/L	27639	VAL
172-G-W02D-04	172GW02D04	Water	01/27/97	3.4000	B	UG/L	28301	NV
530-G-W001-03	530GW00103	Water	12/10/96	4.4000	J	UG/L	27868	VAL
530-G-W002-03	530GW00203	Water	12/11/96	2.9000	J	UG/L	27955	VAL
530-G-W01D-03	530GW01D03	Water	12/10/96	3.5000	J	UG/L	27868	VAL
530-G-W02D-03	530GW02D03	Water	12/11/96	3.8000	J	UG/L	27955	VAL
538-G-W001-02	538GW00102	Water	08/06/96	3.8000	J	UG/L	26515	VAL
538-G-W01D-03	538GW01D03	Water	12/09/96	3.9000	J	UG/L	27868	VAL
539-G-W001-03	539GW00103	Water	12/13/96	3.5000	J	UG/L	27955	VAL
539-G-W01D-03	539GW01D03	Water	12/13/96	2.8000	J	UG/L	27955	VAL
542-G-W001-03	542GW00103	Water	12/04/96	3.3000	J	UG/L	27827	VAL
542-G-W003-02	542GW00302	Water	08/05/96	4.2000	J	UG/L	26515	VAL
542-G-W004-03	542GW00403	Water	12/05/96	3.3000	J	UG/L	27868	VAL
550-G-W001-03	550GW00103	Water	12/04/96	4.0000	J	UG/L	27827	VAL
556-G-W01D-04	566GW01D04	Water	01/22/97	5.3000	B	UG/L	28253	NV
559-G-W03D-01	559GW03D01	Water	05/09/96	3.9000	J	UG/L	25532	VAL
566-G-W001-04	566GW00104	Water	01/22/97	5.8000	B	UG/L	28253	NV
569-H-W002-04	569HW00204	Water	02/06/97	3.3000	B	UG/L	28394	
569-G-W01D-01	569GW01D01	Water	05/09/96	5.5000	J	UG/L	25532	VAL
569-H-W01D-01	569HW01D01	Water	05/09/96	3.0000	J	UG/L	25532	VAL
570-G-W001-04	570GW00104	Water	01/31/97	4.7000	B	UG/L	28346	NV
570-G-W002-04	570GW00204	Water	02/03/97	5.9000	B	UG/L	28346	NV
570-G-W02D-03	570GW02D03	Water	11/19/96	6.1000	J	UG/L	27678	VAL
570-G-W02D-04	570GW02D04	Water	01/31/97	5.3000	B	UG/L	28346	NV
572-G-W001-03	572GW00103	Water	11/18/96	3.1000	J	UG/L	27678	VAL
572-G-W001-04	572GW00104	Water	01/30/97	10.8000		UG/L	28346	NV
572-G-W002-02	572GW00202	Water	07/23/96	4.9000	J	UG/L	26382	VAL
572-G-W002-04	572GW00204	Water	01/31/97	5.4000	B	UG/L	28346	NV
572-G-W003-04	572GW00304	Water	01/31/97	4.9000	B	UG/L	28346	NV
573-G-W001-02	573GW00102	Water	07/22/96	3.2000	J	UG/L	26382	VAL

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2905-00002 - CHARLESTON ZONE E - QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
573-G-W001-04		573GW00104	Water	01/29/97	3.8000	B	UG/L	28301	NV
573-H-W001-04		573HW00104	Water	01/29/97	3.8000	B	UG/L	28301	NV
574-G-W001-02		574GW00102	Water	07/17/96	3.4000	J	UG/L	26304	VAL
574-G-W01D-02		574GW01D02	Water	07/17/96	8.3000	J	UG/L	26304	VAL
574-G-W01D-04		574GW01D04	Water	01/23/97	4.1000	B	UG/L	28253	NV
576-G-W001-04		576GW00104	Water	01/23/97	4.6000	B	UG/L	28253	NV
576-G-W002-04		576GW00204	Water	01/22/97	5.3000	B	UG/L	28253	NV
580-G-W001-02		580GW00102	Water	07/10/96	4.5000	J	UG/L	26253	VAL
580-G-W002-04		580GW00204	Water	01/21/97	2.9000	B	UG/L	28210	NV
580-H-W002-04		580HW00204	Water	01/21/97	2.8000	B	UG/L	28210	NV
580-G-W01D-04		580GW01D04	Water	01/21/97	5.6000	B	UG/L	28210	NV
583-G-W003-02		583GW00302	Water	07/17/96	5.4000	J	UG/L	26304	VAL
583-G-W02D-02		583GW02D02	Water	07/17/96	5.5000	J	UG/L	26304	VAL
590-G-W001-04		590GW00104	Water	01/14/97	4.5000	B	UG/L	28149	NV
590-G-W01D-03		590GW01D03	Water	11/01/96	3.1000	J	UG/L	27488	VAL
590-G-W01D-04		590GW01D04	Water	01/14/97	5.2000	B	UG/L	28149	NV
596-G-W003-04		596GW00304	Water	01/13/97	6.7000	B	UG/L	28149	NV
596-G-W04D-04		596GW04D04	Water	01/13/97	7.0000	B	UG/L	28149	NV
598-G-W001-03		598GW00103	Water	12/16/96	8.2000	J	UG/L	27955	VAL
599-G-W001-03		599GW00103	Water	12/17/96	3.3000	J	UG/L	27955	VAL
GDE-G-W001-03		GDEGW00103	Water	10/28/96	5.4000	J	UG/L	27441	VAL
GDE-G-W001-04		GDEGW00104	Water	01/07/97	4.2000	B	UG/L	28100	NV
GDE-G-W005-02		GDEGW00502	Water	07/10/96	5.8000	J	UG/L	26253	VAL
GDE-H-W005-02		GDEHW00502	Water	07/10/96	3.9000	J	UG/L	26253	VAL
GDE-G-W005-03		GDEGW00503	Water	12/03/96	5.4000	J	UG/L	27827	VAL
GDE-H-W005-03		GDEHW00503	Water	12/03/96	4.8000	J	UG/L	27827	VAL
GDE-G-W007-04		GDEGW00704	Water	01/22/97	3.7000	B	UG/L	28253	NV
GDE-G-W008-04		GDEGW00804	Water	01/13/97	4.2000	B	UG/L	28149	NV
GDE-G-W010-02		GDEGW01002	Water	07/22/96	5.0000	J	UG/L	26382	VAL
GDE-G-W010-04		GDEGW01004	Water	01/21/97	4.5000	B	UG/L	28210	NV
GDE-G-W012-01		GDEGW01201	Water	04/03/96	5.3000	J	UG/L	25153	VAL
GDE-G-W013-02		GDEGW01302	Water	07/23/96	3.4000	J	UG/L	26382	VAL
GDE-G-W013-04		GDEGW01304	Water	01/24/97	3.9000	B	UG/L	28253	NV
GDE-G-W014-04		GDEGW01404	Water	01/28/97	3.4000	B	UG/L	28301	NV
GDE-G-W015-04		GDEGW01504	Water	01/28/97	3.0000	B	UG/L	28301	NV
GDE-G-W016-04		GDEGW01604	Water	01/31/97	9.1000	B	UG/L	28346	NV
GDE-G-W017-04		GDEGW01704	Water	01/31/97	4.6000	B	UG/L	28346	NV
GDE-G-W019-04		GDEGW01904	Water	02/03/97	5.6000	B	UG/L	28346	NV
GDE-G-W01D-03		GDEGW01D03	Water	10/29/96	3.3000	J	UG/L	27441	VAL
GDE-G-W01D-04		GDEGW01D04	Water	01/15/97	6.4000	B	UG/L	28179	NV
GDE-G-W022-02		GDEGW02202	Water	08/02/96	3.2000	J	UG/L	26515	VAL
GDE-G-W023-02		GDEGW02302	Water	08/06/96	4.1000	J	UG/L	26515	VAL
GDE-G-W02D-02		GDEGW02D02	Water	07/09/96	3.6000	J	UG/L	26253	VAL
GDE-G-W03D-02		GDEGW03D02	Water	07/09/96	6.0000	J	UG/L	26253	VAL
GDE-G-W03D-04		GDEGW03D04	Water	01/15/97	4.3000	B	UG/L	28179	NV
GDE-G-W04D-04		GDEGW04D04	Water	01/15/97	4.8000	B	UG/L	28179	NV
GDE-H-W04D-04		GDEHW04D04	Water	01/15/97	7.5000	B	UG/L	28179	NV
GDE-G-W05D-04		GDEGW05D04	Water	01/16/97	2.9000	B	UG/L	28179	NV
GDE-G-W06D-02		GDEGW06D02	Water	07/17/96	2.8000	J	UG/L	26304	VAL

2905-00002 - CHARLESTON ZONE E - QUARTERLY GW
Samples by Chemical Report
7440-28-0 - Thallium (Tl)
>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDE-G-W06D-04		GDEGW06D04	Water	01/16/97	3.1000	B	UG/L	28179	NV
GDE-G-W07D-03		GDEGW07D03	Water	11/04/96	3.2000	J	UG/L	27488	VAL
GDE-G-W08D-04		GDEGW08D04	Water	01/14/97	6.5000	B	UG/L	28149	NV
GDE-G-W09D-03		GDEGW09D03	Water	11/01/96	6.3000	J	UG/L	27488	VAL
GDE-G-W10D-04		GDEGW10D04	Water	01/21/97	4.4000	B	UG/L	28210	NV
GDE-G-W11D-04		GDEGW11D04	Water	01/17/97	5.3000	B	UG/L	28210	NV
GDE-G-W13D-02		GDEGW13D02	Water	07/23/96	3.4000	J	UG/L	26382	VAL
GDE-G-W13D-04		GDEGW13D04	Water	01/24/97	2.7000	B	UG/L	28253	NV
GDE-G-W14D-03		GDEGW14D03	Water	11/14/96	3.6000	J	UG/L	27639	VAL
GDE-G-W14D-04		GDEGW14D04	Water	01/27/97	3.9000	B	UG/L	28301	NV
GDE-G-W15D-01		GDEGW15D01	Water	05/10/96	4.7000	J	UG/L	25532	VAL
GDE-G-W15D-03		GDEGW15D03	Water	11/14/96	4.4000	J	UG/L	27639	VAL
GDE-G-W15D-04		GDEGW15D04	Water	01/28/97	3.9000	B	UG/L	28301	NV
GDE-G-W16D-04		GDEGW16D04	Water	01/30/97	4.2000	B	UG/L	28346	NV
GDE-G-W17D-04		GDEGW17D04	Water	01/31/97	3.6000	B	UG/L	28346	NV
GDE-G-W19D-04		GDEGW19D04	Water	02/03/97	4.8000	B	UG/L	28346	NV
GDE-H-W19D-04		GDEHW19D04	Water	02/03/97	4.9000	B	UG/L	28346	NV
GDE-G-W22D-02		GDEGW22D02	Water	08/02/96	3.6000	J	UG/L	26515	VAL
GDE-G-W22D-04		GDEGW22D04	Water	02/06/97	2.9000	B	UG/L	28394	
GDE-G-W23D-02		GDEGW23D02	Water	08/06/96	6.0000	J	UG/L	26515	VAL
GDE-G-W24D-02		GDEGW24D02	Water	08/05/96	4.5000	J	UG/L	26515	VAL
GDE-G-W25D-03		GDEGW25D03	Water	12/03/96	7.4000	J	UG/L	27827	VAL

*** End of Report ***

ENVIRONMENTAL SAFETY & DESIGNS

2906-00002 - CHARLESTON ZONE F GW (ONLY)
Samples by Chemical Report
7440-28-0 - Thallium (Tl)
>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
109-G-W001-01		109GW00101	Water	11/04/96	3.5000	J	UG/L	27502	VAL
619-G-W001-01		619GW00101	Water	11/10/96	3.4000	J	UG/L	27502	VAL
619-G-W003-01		619GW00301	Water	11/09/96	6.6000	J	UG/L	27502	VAL
620-G-W001-01		620GW00101	Water	11/08/96	11.0000		UG/L	27502	VAL
620-G-W002-01		620GW00201	Water	11/04/96	2.8000	J	UG/L	27502	VAL
GDF-G-W001-01		GDFGW00101	Water	11/07/96	4.8000	J	UG/L	27502	VAL
GDF-G-W01D-01		GDFGW01D01	Water	11/07/96	6.6000	J	UG/L	27502	VAL
GEL-G-W007-01		GELGW00701	Water	11/10/96	4.4000	J	UG/L	27502	VAL
GEL-G-W008-01		GELGW00801	Water	11/10/96	6.9000	J	UG/L	27502	VAL

*** End of Report ***

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2907-00002 - CHARLESTON ZONE G QUARTERLY GW

Samples by Chemical Report

7440-28-0 - Thallium (Tl)

>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
003-G-W001-01		003GW00101	Water	11/20/96	3.5000	J	UG/L	27715	VAL
003-G-W002-01		003GW00201	Water	11/21/96	2.9000	J	UG/L	27715	VAL
003-G-W003-01		003GW00301	Water	11/20/96	2.8000	J	UG/L	27715	VAL
008-G-W002-01		008GW00201	Water	11/15/96	3.9000	J	UG/L	27651	VAL
008-G-W004-01		008GW00401	Water	11/15/96	4.6000	J	UG/L	27651	VAL
636-S-B013-02		636SB01302	Soil	01/10/97	0.9000	J	UG/L	28146	
636-S-B014-02		636SB01402	Soil	01/10/97	0.5400	J	UG/L	28146	
637-G-W001-01		637GW00101	Water	11/15/96	3.0000	J	UG/L	27651	VAL
FDS-G-W01D-01		FDSGW01D01	Water	01/14/97	8.7000	J	UG/L	28185	VAL
FDS-H-W01D-01		FDSHW01D01	Water	01/14/97	9.6000	J	UG/L	28185	VAL
FDS-G-W02A-01		FDSGW02A01	Water	01/16/97	5.8000	J	UG/L	28185	VAL
FDS-H-W02A-01		FDSHW02A01	Water	01/16/97	7.7000	J	UG/L	28185	VAL
FDS-G-W02C-01		FDSGW02C01	Water	01/16/97	5.1000	J	UG/L	28185	VAL
FDS-G-W03B-01		FDSGW03B01	Water	01/15/97	3.0000	J	UG/L	28185	VAL
FDS-G-W03C-01		FDSGW03C01	Water	01/15/97	5.7000	J	UG/L	28185	VAL
FDS-G-W05B-01		FDSGW05B01	Water	01/17/97	5.6000	J	UG/L	28185	VAL
FDS-G-W07B-01		FDSGW07B01	Water	01/17/97	8.0000	J	UG/L	28185	VAL
FDS-G-W07C-01		FDSGW07C01	Water	01/17/97	9.9000	J	UG/L	28185	VAL
FDS-G-W07D-01		FDSGW07D01	Water	01/24/97	7.1000	J	UG/L	28249	VAL
FDS-G-W08A-01		FDSGW08A01	Water	01/24/97	4.1000	J	UG/L	28249	VAL
FDS-G-W08B-01		FDSGW08B01	Water	01/25/97	5.8000	J	UG/L	28249	VAL
FDS-G-W08C-01		FDSGW08C01	Water	01/24/97	9.0000	J	UG/L	28249	VAL
FDS-H-W08C-01		FDSHW08C01	Water	01/24/97	7.7000	J	UG/L	28249	VAL
FDS-G-W12A-01		FDSGW12A01	Water	01/27/97	4.3000	J	UG/L	28249	VAL
FDS-H-W12A-01		FDSHW12A01	Water	01/27/97	4.7000	J	UG/L	28249	VAL
FDS-G-W12B-01		FDSGW12B01	Water	01/27/97	3.2000	J	UG/L	28249	VAL
FDS-G-W13A-01		FDSGW13A01	Water	01/27/97	5.7000	J	UG/L	28249	VAL
FDS-G-W13B-01		FDSGW13B01	Water	01/27/97	7.1000	J	UG/L	28249	VAL
FDS-G-W13D-01		FDSGW13D01	Water	01/27/97	4.2000	J	UG/L	28249	VAL
FDS-G-W14A-01		FDSGW14A01	Water	01/27/97	3.5000	J	UG/L	28249	VAL
FDS-G-W14B-01		FDSGW14B01	Water	01/27/97	3.2000	J	UG/L	28249	VAL
FDS-G-W14C-01		FDSGW14C01	Water	01/22/97	5.3000	J	UG/L	28249	VAL
FDS-G-W15C-01		FDSGW15C01	Water	01/28/97	3.3000	J	UG/L	28308	VAL
FDS-G-W16B-01		FDSGW16B01	Water	01/29/97	6.4000	J	UG/L	28308	VAL
FDS-G-W16C-01		FDSGW16C01	Water	01/29/97	4.6000	J	UG/L	28308	VAL

*** End of Report ***

A comparison of background values for surface soil at Charleston Naval Base.

I. Surface soil (mg/kg) 4-28-97

Inorganic chemical	Zone A (n=13)	Zone B (n=15)	Zone C (n=44)	Zone D (n=6)	Zone E (n=25)	Zone F (n=6)	Zone G (n=6)	Zone H (n=104)	Zone I (n=15)
Aluminum	12800 P	15500P			26600 P			26000 P	
Antimony	ND	X			1.77 N			X	
Arsenic	9.44 P	17.1 P			23.9 N			15.6 P	
Barium	53.0 P	98.7 P			130 P			40.3 P	
Beryllium	X	1.23 P			1.7 P			1.37 P	
Cadmium	X	ND			1.5 N			1.05 N	
Chromium	50.4 P	75.7 P			94.6 P			59.1 P	
Cobalt	4.4 N	21.9 P			19.0 P			5.86 P	
Copper	165 P	225 P			66.0 P			27.6 P	
Lead	140 P	114 P			265 N			118 P	
Manganese	98.1 P	464 P			302 N			583 P	
Mercury	0.3 N	1.55 N			2.6 P			0.485 P	
Nickel	13.55 P	43.6 P			77.1 P			33.4 P	
Selenium	1.2 N	2.8 N			1.7 N			2.0 N	
Silver	ND	1.7 N			X			X	
Thallium	ND	ND			2.8 N			1.1 N	
Tin	ND	14.8 N			59.4 P			X	
Vanadium	29.24 P	52.6 P			94.3 P			73.0 P	
Zinc	207.6 P	366 P			827 P			214 P	
Cyanide	ND	ND			0.5 N			ND	

Notes:

P Parametric UTL
N Nonparametric UTL
X No UTL calculated (ND>90%)
M Twice the mean
ND Not detected

A comparison of background values for subsurface soil at Charleston Naval Base.

II. Subsurface soil (mg/kg) 4-28-97

Inorganic chemical	Zone A (n=12)	Zone B (n=14)	Zone C (n=29)	Zone D (n=6)	Zone E (n=24)	Zone F (n=6)	Zone G (n=4)	Zone H (n=63)	Zone I (n=6)
Aluminum	28,240 P	17,700 P			41,100 P			46,200 P	
Antimony	ND	X			1.6 N			X	
Arsenic	9.836 P	10.8 N			19.9 P			22.5 P	
Barium	40.01 P	65.0 N			94.1 P			43.8 P	
Beryllium	ND	1.61 P			2.71 P			1.62 P	
Cadmium	ND	ND			0.96 N			1.1 N	
Chromium	63.4 P	48.1 N			75.2 N			84.2 P	
Cobalt	1.7 N	10.6 N			14.9 N			14.9 P	
Copper	33.69 P	47.0 P			152 P			31.6 P	
Lead	22.01 P	145 P			173 N			68.7 P	
Manganese	85.54 P	288 N			881 P			1,410 P	
Mercury	ND	2.0 N			1.59 P			0.735 P	
Nickel	35.0 P	29.9 N			57.0 P			29.9 P	
Selenium	1.74 P	3.8 N			2.4 N			2.7 N	
Silver	X	1.8 N			X			X	
Thallium	ND	ND			X			1.3 N	
Tin	X	1.3 N			9.23 P			ND	
Vanadium	77.32 P	102 N			155 P			132 P	
Zinc	164.6 P	238 N			886 P			130 P	
Cyanide	ND	ND			X			ND	

Notes:

P Parametric UTL
N Nonparametric UTL
X No UTL calculated (ND>90%)
M Twice the mean
ND Not detected

A comparison of background values for shallow groundwater at Charleston Naval Base.

III. Shallow groundwater (µg/L) 4-28-97

Inorganic chemical	Zone A (n=3)	Zone B (n=4)	Zone C (n=2)	Zone D (n=1)	Zone E (n=25)	Zone F (n=2)	Zone G* (n=2)	Zone H (n=11)	Zone I (n=18)
Aluminum	3,210 M							X	
Antimony	ND							ND	
Arsenic	7.4 N							21.5 P	
Barium	104 M							323 P	
Beryllium	ND							ND	
Cadmium	ND							ND	
Chromium	8.7 M							ND	
Cobalt	ND							X	
Copper	15.7 M							ND	
Lead	4.7 M							4.7 P	
Manganese	577 N							2,440 P	
Mercury	ND							ND	
Nickel	ND							X	
Selenium	ND							3.2 P	
Silver	ND							ND	
Thallium	ND							5.3? N	
Tin	NA							ND	
Vanadium	5.4 M							X	
Zinc	83.2 M							ND	
Cyanide	ND							X	

Notes:

P Parametric UTL
N Nonparametric UTL
X No UTL calculated (ND>90%)
M Twice the mean
ND Not detected
NA Not analyzed

A comparison of background values for deep groundwater at Charleston Naval Base.

IV. Deep groundwater (μg/L) 4-28-97

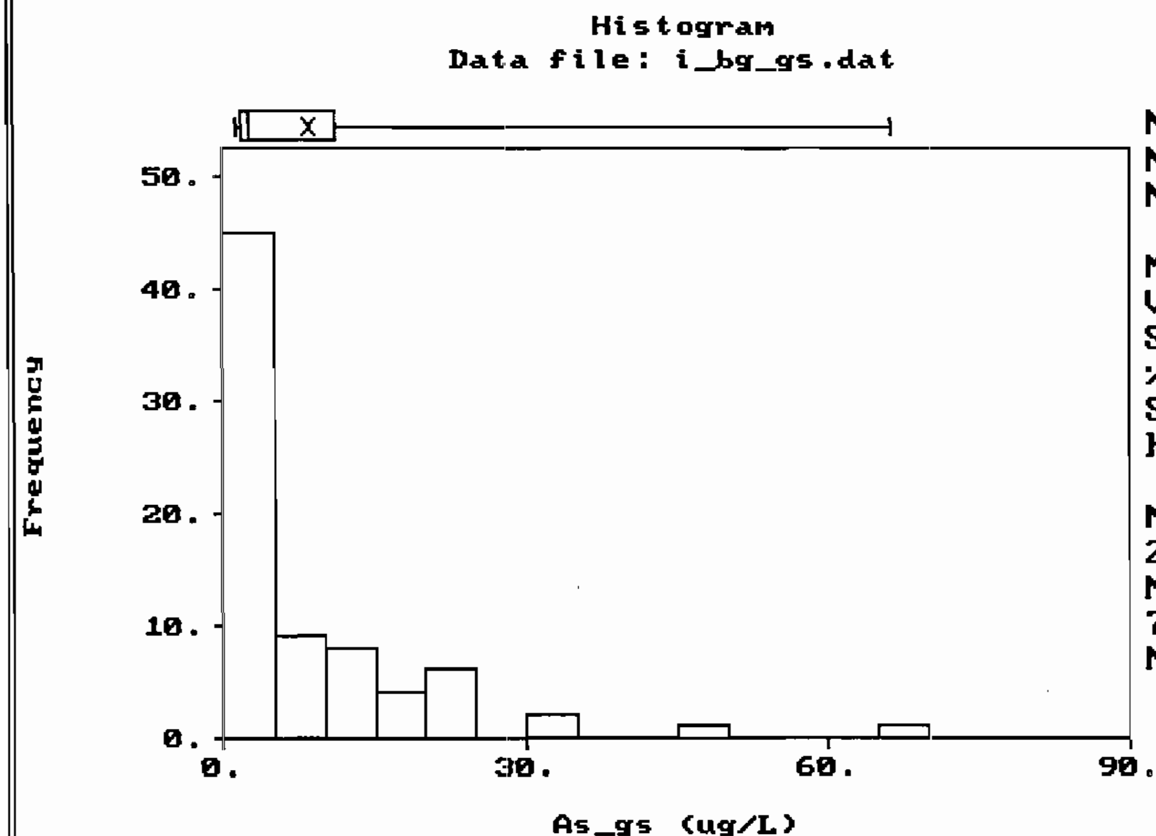
Inorganic chemical	Zone A (n=3)	Zone B (n=2)	Zone C (n=2)	Zone D (n=1)	Zone E (n=25)	Zone F (n=2)	Zone G (n=2)	Zone H (n=11)	Zone I (n=19)
Aluminum	245 M							723 MNP	
Antimony	ND							ND	
Arsenic	11.1 N							8.2 N	
Barium	179 N							237 P	
Beryllium	ND							ND	
Cadmium	ND							X	
Chromium	7.3 N							X	
Cobalt	12.1 M							3.2 MNP	
Copper	5.8 M							ND	
Lead	ND							4.3 MNP	
Manganese	2,690 N							998 P	
Mercury	ND							X	
Nickel	21.1 M							X	
Selenium	ND							2.1 MNP	
Silver	ND							ND	
Thallium	?							X	
Tin	NA							ND	
Vanadium	10.9 M							9.3 MNP	
Zinc	66.2 M							X	
Cyanide	0.05 M							ND	

Notes:

P Parametric UTL
N Nonparametric UTL
MNP Modified nonparametric UTL
X No UTL calculated (ND>90%)
M Twice the mean
ND Not detected
NA Not analyzed

Zone I
Arsenic in shallow GW grid samples.
Original dataset (N = 76)
Original values

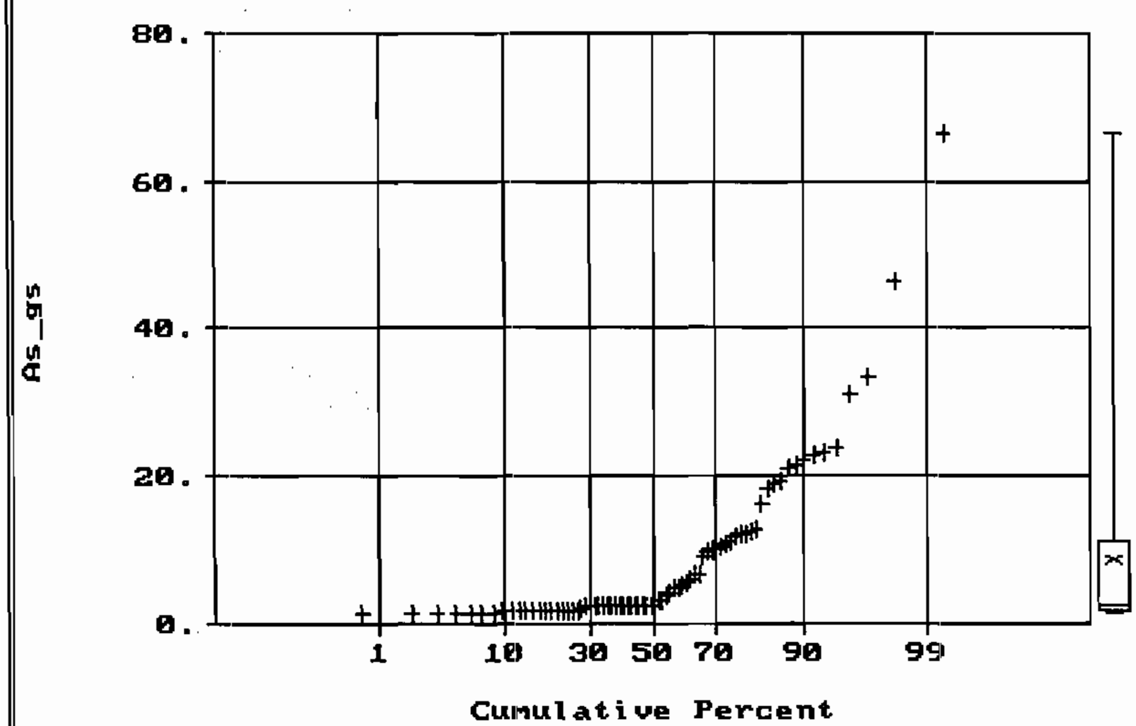
/a



Statistics

N Total	:	76
N Miss	:	0
N Used	:	76
Mean	:	8.476
Variance	:	124.764
Std. Dev	:	11.170
% C.V.	:	131.776
Skewness	:	2.723
Kurtosis	:	12.324
Minimum	:	1.250
25th %	:	1.600
Median	:	2.500
75th %	:	11.100
Maximum	:	66.300

Normal Probability Plot for As_gs
Data file: i_bg_gs.dat

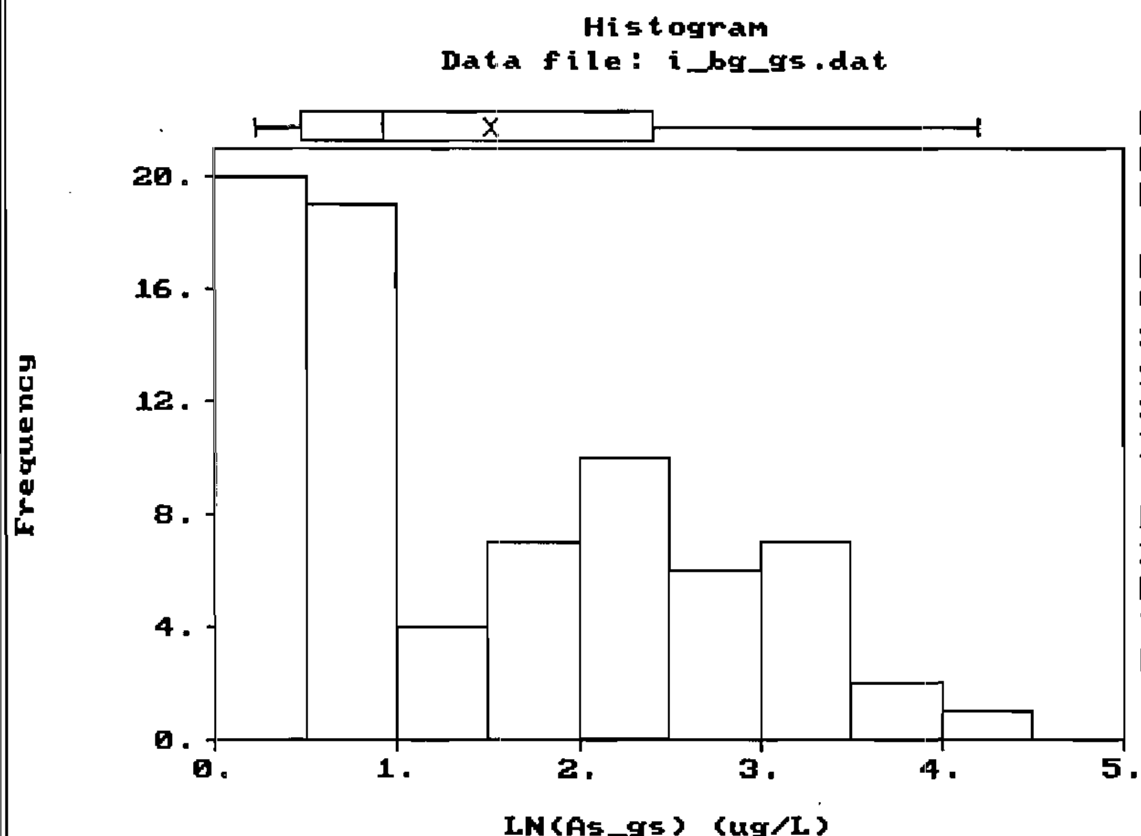


S t a t i s t i c s

N Total :	76
N Miss :	0
N Used :	76
Mean :	8.476
Variance:	124.764
Std. Dev:	11.170
% C.V. :	131.776
Skewness:	2.723
Kurtosis:	12.324
Minimum :	1.250
25th % :	1.600
Median :	2.500
75th % :	11.100
Maximum :	66.300

Zone I
Arsenic in shallow GW grid samples
Original dataset (n = 76)
LN-transformed values

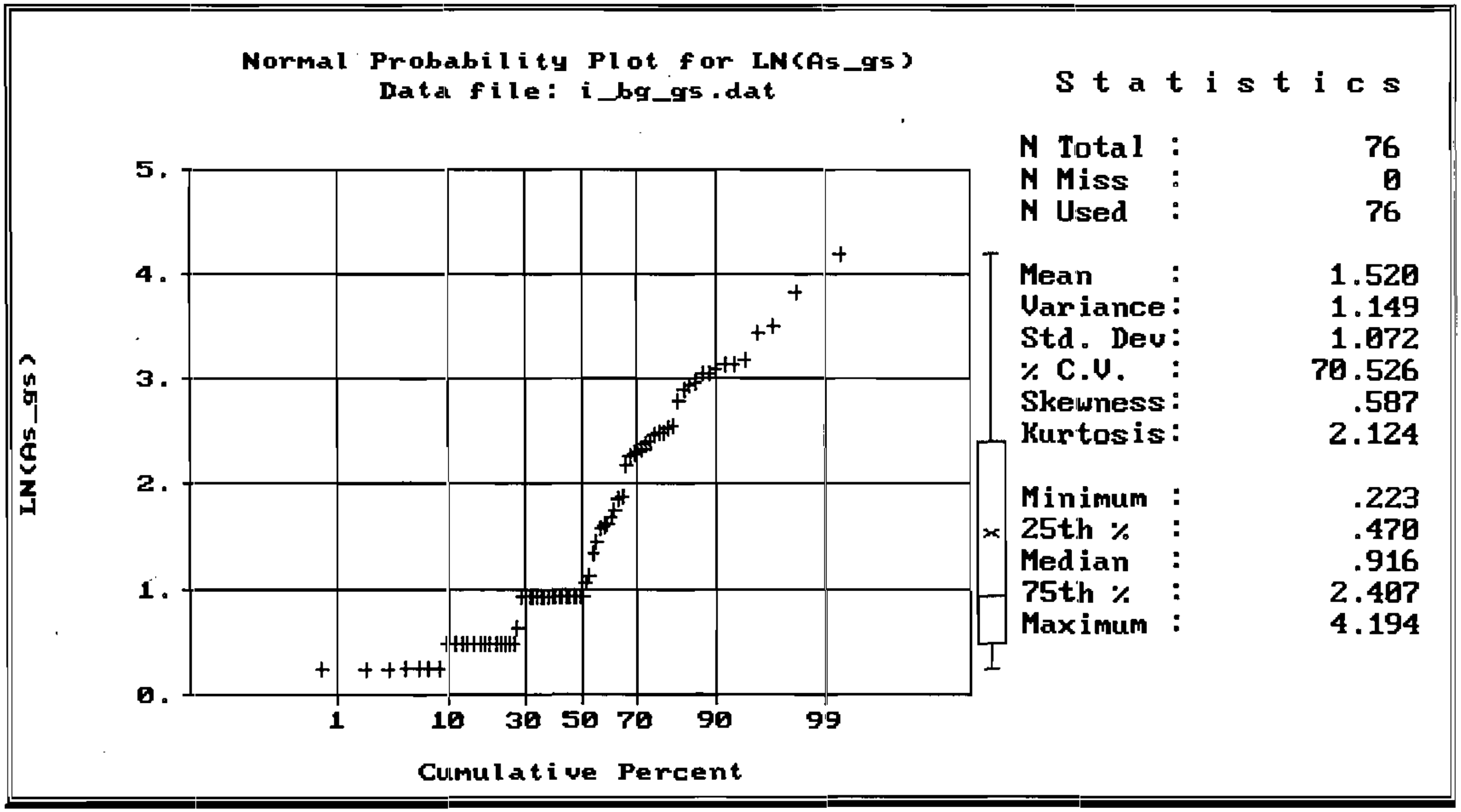
2a



Statistics

N Total :	76
N Miss :	0
N Used :	76
Mean :	1.520
Variance:	1.149
Std. Dev:	1.072
% C.V. :	70.526
Skewness:	.587
Kurtosis:	2.124
Minimum :	.223
25th % :	.470
Median :	.916
75th % :	2.407
Maximum :	4.194

2b



Normal Probability Plot for LN(As_gs)
Data file: i_bg_gs.dat
LN(As_gs)
0.
1.
2.
3.
4.
5.
1
10
30
50
70
90
99
Cumulative Percent
Statistics
N Total : 76
N Miss : 0
N Used : 76
Mean : 1.520
Variance: 1.149
Std. Dev: 1.072
% C.V. : 70.526
Skewness: .587
Kurtosis: 2.124
Minimum : .223
25th % : .470
Median : .916
75th % : 2.407
Maximum : 4.194

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2909-00001 - CHARLESTON ZONE I ~~SOIL~~ & 1ST GW

Samples by Chemical Report

7440-38-2 - Arsenic (As)

>= 0.0000 for UG/L - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
012-G-W002-01		012GW00201	Water	06/08/95	177.0000		UG/L	05710M	VAL
671-G-W003-01		671GW00301	Water	06/02/95	31.4000		UG/L	00578M	VAL
671-G-W004-01		671GW00401	Water	06/02/95	17.2000		UG/L	00578M	VAL
687-G-W001-01		687GW00101	Water	06/08/95	38.6000		UG/L	05710M	VAL
687-G-W002-01		687GW00201	Water	06/08/95	33.2000		UG/L	05710M	VAL
687-G-W004-01		687GW00401	Water	06/08/95	6.3000	J	UG/L	05710M	VAL
DMA-R-0001-01		DMAR000101	Water	04/04/95	26.3000		UG/L	0573MI	VAL
GDI-G-W002-01		GRDGW00201	Water	04/24/95	6.4000	J	UG/L	00575M	VAL
GDI-G-W004-01		GRDGW00401	Water	04/21/95	10.0000		UG/L	00575M	VAL
GDI-G-W009-01		GRDGW00901	Water	05/02/95	25.9000		UG/L	00575M	VAL
GDI-H-W009-01		GRDHN00901	Water	05/05/95	20.0000		UG/L	00575M	VAL
GDI-G-W011-01		GDIGW01101	Water	05/19/95	16.1000		UG/L	00577M	VAL
GDI-G-W013-01		GRDGW01301	Water	04/26/95	9.7000	J	UG/L	00575M	VAL
GDI-G-W017-01		GDIGW01701	Water	05/23/95	20.9000		UG/L	00577M	VAL
GDI-G-W19D-01		GD1GW19D01	Water	06/01/95	14.2000		UG/L	00578M	VAL

*** End of Report ***

Zone I

Arsenic detections in GW samples

Round 1 samples

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2909-00002 - CHARLESTON ZONE I QUARTERLY GW

Samples by Chemical Report

7440-38-2 - Arsenic (As)

>= 0.0000 for All Concentration Units - Hits Only

Zone I

Arsenic detections in GW samples — Rounds 2, 3, and 4

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
012-G-W002-02	012GW00202	Water	01/16/96	220.0000		UG/L	24492	VAL
012-G-W002-03	012GW00203	Water	05/31/96	188.0000		UG/L	25814	VAL
012-G-W002-04	012GW00204	Water	09/04/96	253.0000	J	UG/L	26836	VAL
671-G-W001-03	671GW00103	Water	06/03/96	10.1000		UG/L	25814	VAL
671-G-W003-02	671GW00302	Water	01/16/96	42.0000		UG/L	24492	VAL
671-G-W003-03	671GW00303	Water	06/03/96	28.8000		UG/L	25814	VAL
671-G-W003-04	671GW00304	Water	08/30/96	38.9000		UG/L	26768	VAL
671-G-W004-02	671GW00402	Water	01/16/96	9.9000	J	UG/L	24492	VAL
671-H-W004-02	671HW00402	Water	01/16/96	9.1000	J	UG/L	24492	VAL
671-G-W004-03	671GW00403	Water	06/04/96	9.9000	J	UG/L	25866	VAL
671-H-W004-04	671HW00404	Water	09/04/96	10.4000		UG/L	26836	VAL
675-G-W002-04	675GW00204	Water	09/13/96	7.1000	J	UG/L	26925	VAL
677-G-W002-03	677GW00203	Water	06/06/96	6.1000	J	UG/L	25866	VAL
678-G-W001-03	678GW00103	Water	06/04/96	11.6000		UG/L	25866	VAL
687-G-W002-02	687GW00202	Water	01/16/96	73.7000		UG/L	24492	VAL
687-G-W002-04	687GW00204	Water	09/10/96	39.3000		UG/L	26836	VAL
687-G-W003-03	687GW00303	Water	06/05/96	5.6000	J	UG/L	25866	VAL
GDI-G-W001-02	GDIGW00102	Water	12/12/95	9.8000	J	UG/L	24276	VAL
GDI-G-W001-03	GDIGW00103	Water	05/15/96	11.7000		UG/L	25623	VAL
GDI-G-W001-04	GDIGW00104	Water	08/19/96	6.5000	J	UG/L	26670	VAL
GDI-G-W002-02	GDIGW00202	Water	12/12/95	10.4000		UG/L	24276	VAL
GDI-G-W002-03	GDIGW00203	Water	05/16/96	11.9000		UG/L	25623	VAL
GDI-G-W002-04	GDIGW00204	Water	08/20/96	5.4000	J	UG/L	26670	VAL
GDI-G-W003-03	GDIGW00303	Water	05/20/96	2.9000	J	UG/L	25623	VAL
GDI-G-W003-04	GDIGW00304	Water	08/21/96	4.9000	J	UG/L	26670	VAL
GDI-G-W004-02	GDIGW00402	Water	12/13/95	19.2000		UG/L	24310	VAL
GDI-G-W004-03	GDIGW00403	Water	05/21/96	22.1000		UG/L	25623	VAL
GDI-G-W006-03	GDIGW00603	Water	05/17/96	4.8000	J	UG/L	25623	VAL
GDI-G-W006-04	GDIGW00604	Water	08/20/96	5.8000	J	UG/L	26670	VAL
GDI-G-W007-04	GDIGW00704	Water	08/21/96	3.8000	J	UG/L	26670	VAL
GDI-G-W009-02	GDIGW00902	Water	12/11/95	31.0000		UG/L	24276	VAL
GDI-G-W009-03	GDIGW00903	Water	05/30/96	18.2000		UG/L	25814	VAL
GDI-G-W009-04	GDIGW00904	Water	08/23/96	23.0000		UG/L	26711	VAL
GDI-G-W010-03	GDIGW01003	Water	05/31/96	5.1000	J	UG/L	25814	VAL
GDI-G-W013-02	GDIGW01302	Water	12/06/95	12.0000		UG/L	24229	VAL
GDI-G-W013-03	GDIGW01303	Water	05/28/96	19.0000		UG/L	25724	VAL
GDI-G-W013-04	GDIGW01304	Water	09/04/96	23.8000		UG/L	26836	VAL
GDI-G-W014-02	GDIGW01402	Water	01/15/96	12.4000		UG/L	24492	VAL
GDI-G-W014-03	GDIGW01403	Water	05/24/96	11.1000		UG/L	25724	VAL
GDI-G-W017-02	GDIGW01702	Water	12/05/95	66.3000		UG/L	24229	VAL
GDI-G-W017-03	GDIGW01703	Water	05/28/96	33.5000		UG/L	25724	VAL
GDI-G-W017-04	GDIGW01704	Water	08/27/96	46.2000		UG/L	26711	VAL
GDI-G-W019-02	GDIGW01902	Water	12/13/95	12.5000		UG/L	24310	VAL
GDI-H-W019-02	GDIHW01902	Water	12/13/95	13.2000		UG/L	24310	VAL
GDI-G-W019-03	GDIGW01903	Water	05/30/96	11.0000		UG/L	25814	VAL
GDI-H-W019-03	GDIHW01903	Water	05/30/96	10.5000		UG/L	25814	VAL
GDI-G-W019-04	GDIGW01904	Water	08/28/96	21.2000		UG/L	26768	VAL
GDI-H-W019-04	GDIHW01904	Water	08/28/96	21.3000		UG/L	26768	VAL
GDI-G-W01D-04	GDIGW01D04	Water	08/19/96	2.6000	J	UG/L	26670	VAL

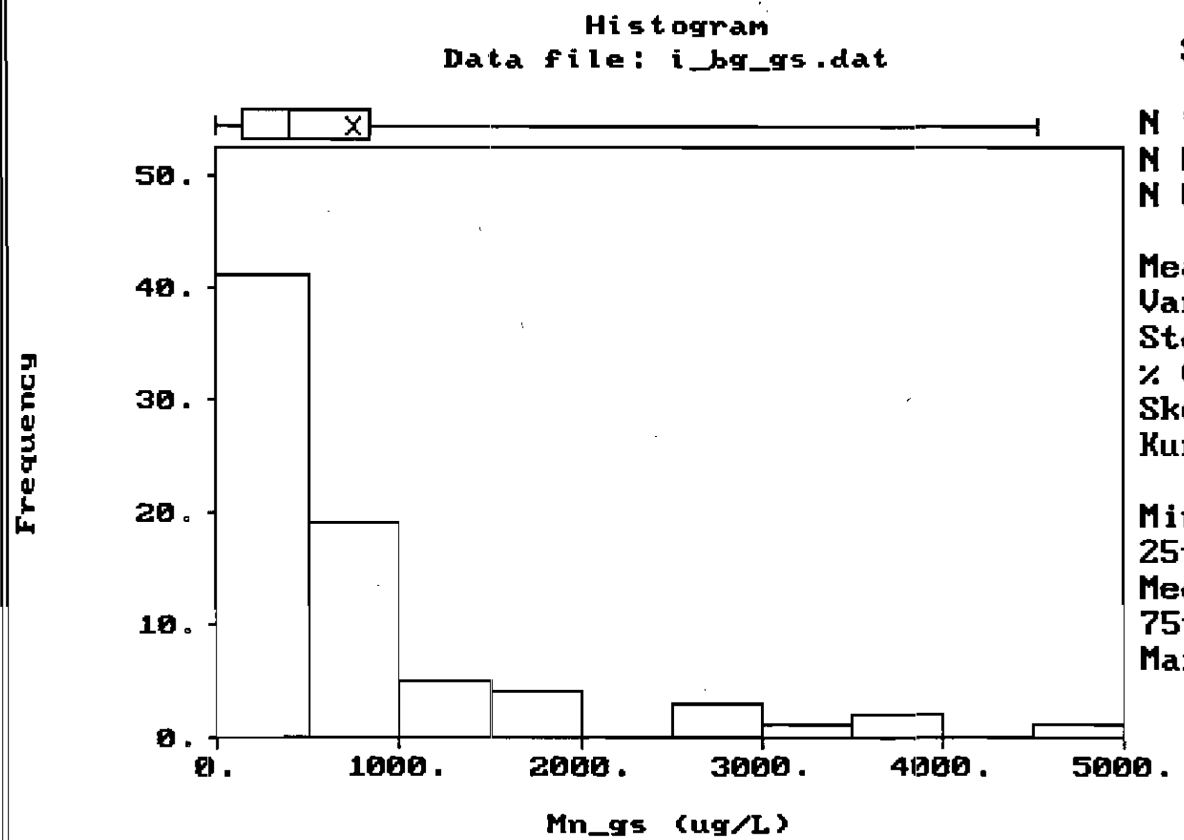
E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S
2909-00002 - CHARLESTON ZONE I QUARTERLY GW
Samples by Chemical Report
7440-38-2 - Arsenic (As)
>= 0.0000 for All Concentration Units - Hits Only

Sample ID	Ext. Orig. ID	Type	Date	Result	VQual	Units	SDG #	
GDI-G-W03D-04	GDIGW03D04	Water	08/21/96	3.3000	J	UG/L	26670	VAL
GDI-G-W04D-03	GDIGW04D03	Water	05/23/96	6.0000	J	UG/L	25724	VAL
GDI-G-W06D-03	GDIGW06D03	Water	05/16/96	3.5000	J	UG/L	25623	VAL
GDI-G-W07D-02	GDIGW07D02	Water	12/13/95	5.2000	J	UG/L	24310	VAL
GDI-G-W10D-02	GDIGW10D02	Water	12/11/95	7.2000	J	UG/L	24276	VAL
GDI-G-W11D-03	GDIGW11D03	Water	05/24/96	5.2000	J	UG/L	25724	VAL
GDI-G-W13D-03	GDIGW13D03	Water	05/28/96	6.5000	J	UG/L	25724	VAL
GDI-G-W17D-04	GDIGW17D04	Water	08/27/96	24.8000	J	UG/L	26711	VAL
GDI-G-W19D-02	GDIGW19D02	Water	12/13/95	13.3000		UG/L	24310	VAL
GDI-G-W19D-03	GDIGW19D03	Water	05/30/96	11.9000		UG/L	25814	VAL

*** End of Report ***

Zone I
Manganese in shallow GW grid samples
Original dataset (N = 76)
Original values

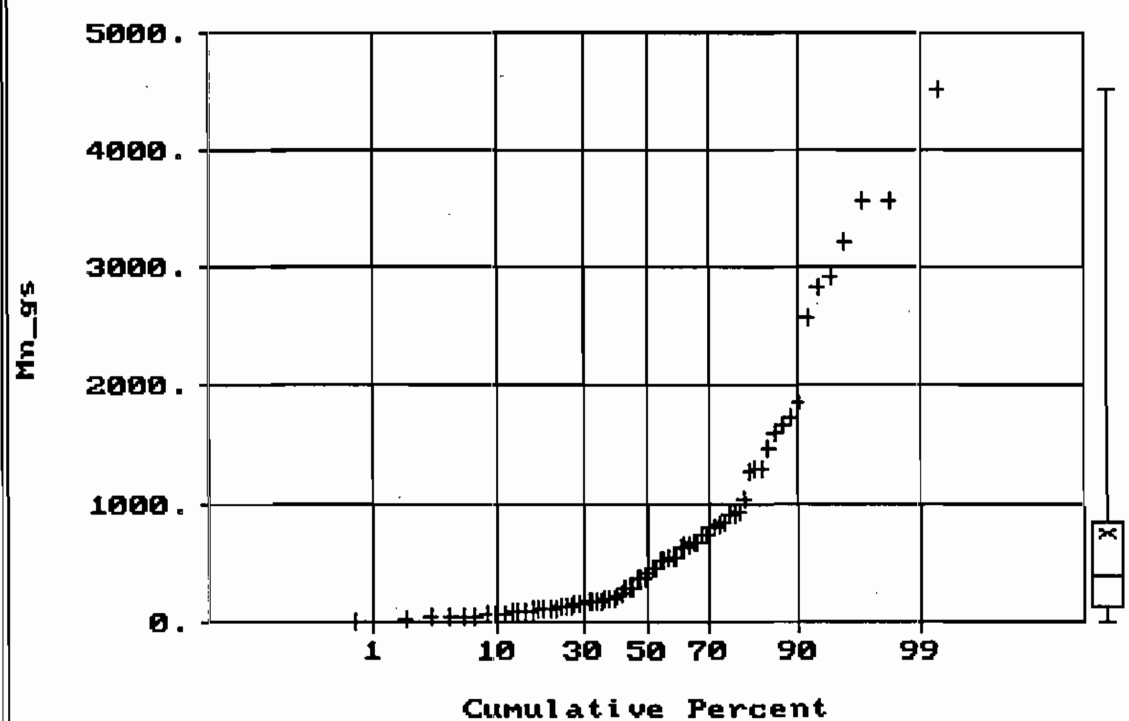
1a



Statistics

N Total :	76
N Miss :	0
N Used :	76
Mean :	745.983
Variance:	915171.500
Std. Dev:	956.646
% C.V. :	128.240
Skewness:	2.072
Kurtosis:	6.934
Minimum :	1.800
25th % :	133.000
Median :	390.500
75th % :	832.000
Maximum :	4525.000

Normal Probability Plot for Mn_gs
Data file: i_bg_gs.dat



S t a t i s t i c s

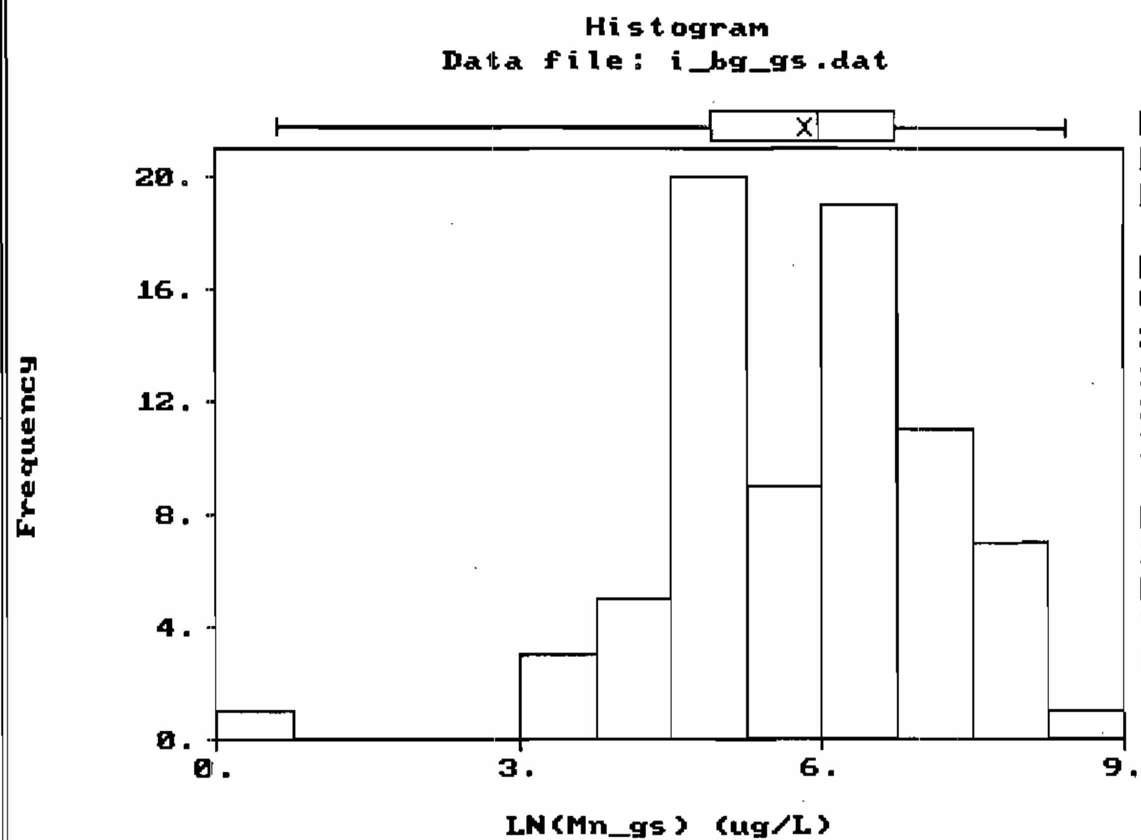
N Total	:	76
N Miss	:	0
N Used	:	76
Mean	:	745.983
Variance	:	915171.500
Std. Dev	:	956.646
% C.V.	:	128.240
Skewness	:	2.072
Kurtosis	:	6.934
Minimum	:	1.800
25th %	:	133.000
Median	:	390.500
75th %	:	832.000
Maximum	:	4525.000

Zone I 2a

Manganese in shallow GW grid samples

Original dataset (N = 76)

LN-transformed values

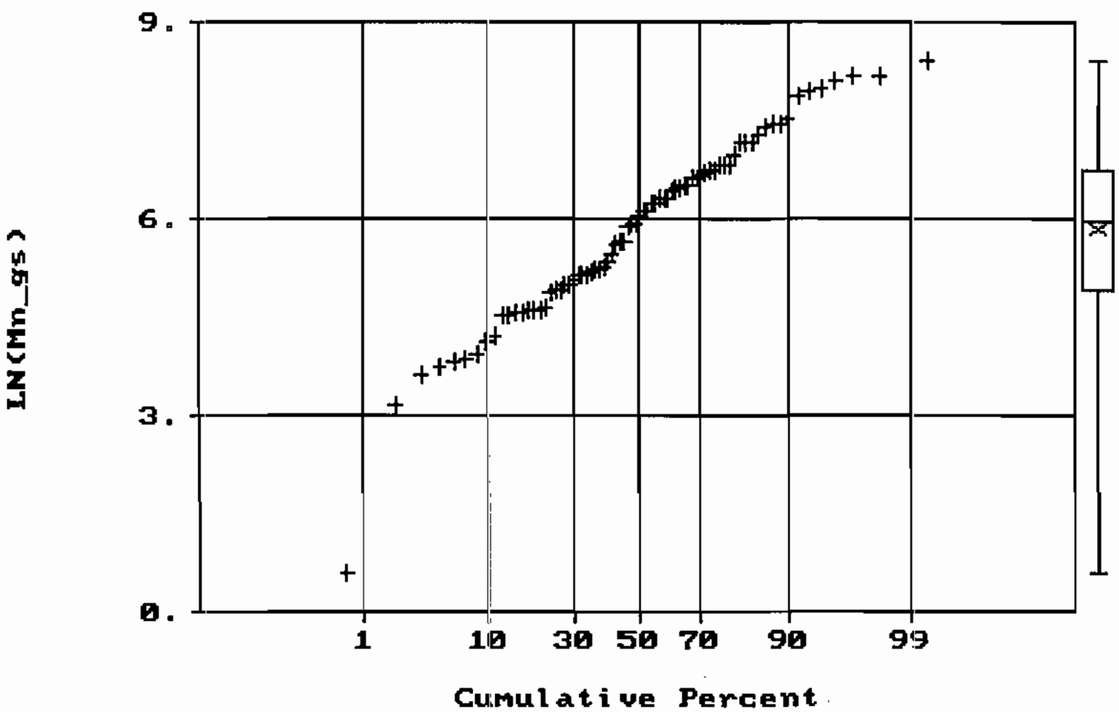


S t a t i s t i c s

N Total :	76
N Miss :	0
N Used :	76
Mean :	5.833
Variance:	1.971
Std. Dev:	1.404
% C.V. :	24.070
Skewness:	-.587
Kurtosis:	4.099
Minimum :	.588
25th % :	4.890
Median :	5.966
75th % :	6.724
Maximum :	8.417

2b

Normal Probability Plot for LN(Mn_gs)
Data file: i_bg_gs.dat

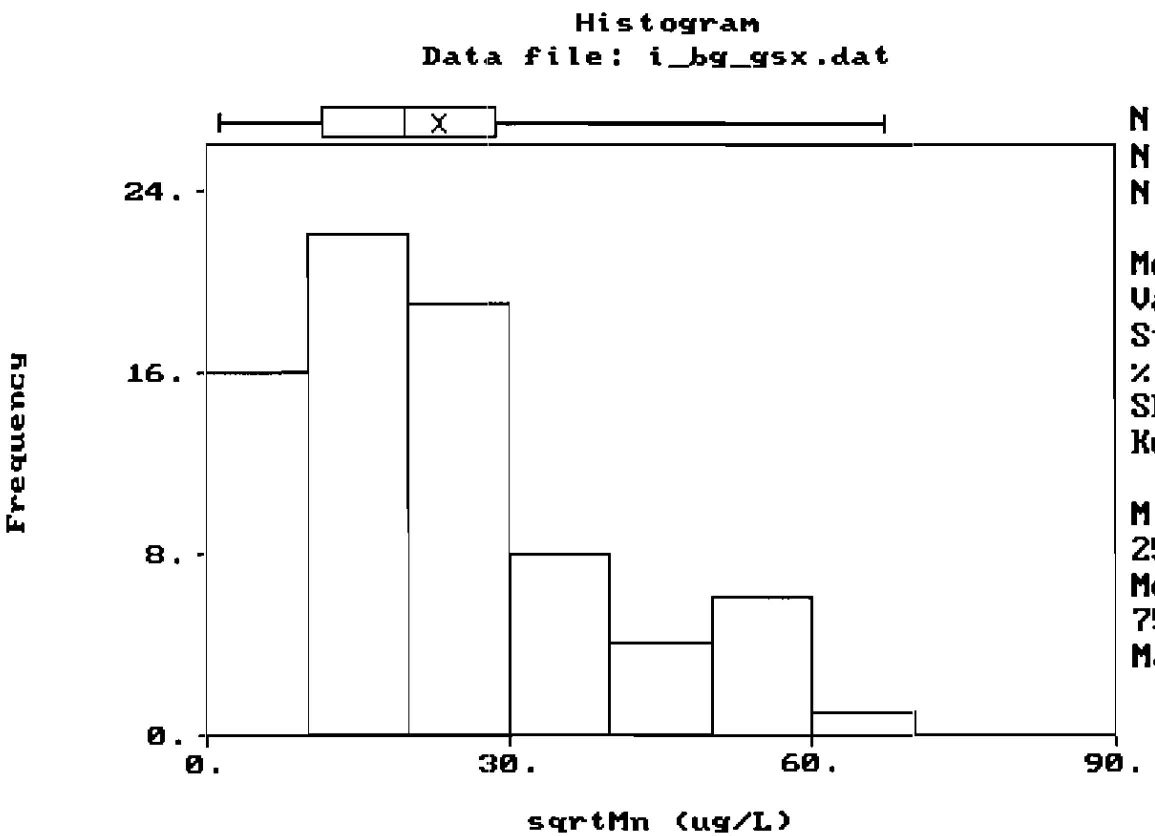


S t a t i s t i c s

N Total :	76
N Miss :	0
N Used :	76
Mean :	5.833
Variance:	1.971
Std. Dev:	1.404
% C.V. :	24.070
Skewness:	-.587
Kurtosis:	4.099
Minimum :	.588
25th % :	4.890
Median :	5.966
75th % :	6.724
Maximum :	8.417

Zone I
Manganese in shallow GW grid samples
Original dataset (n = 76)
Square-root transformed values

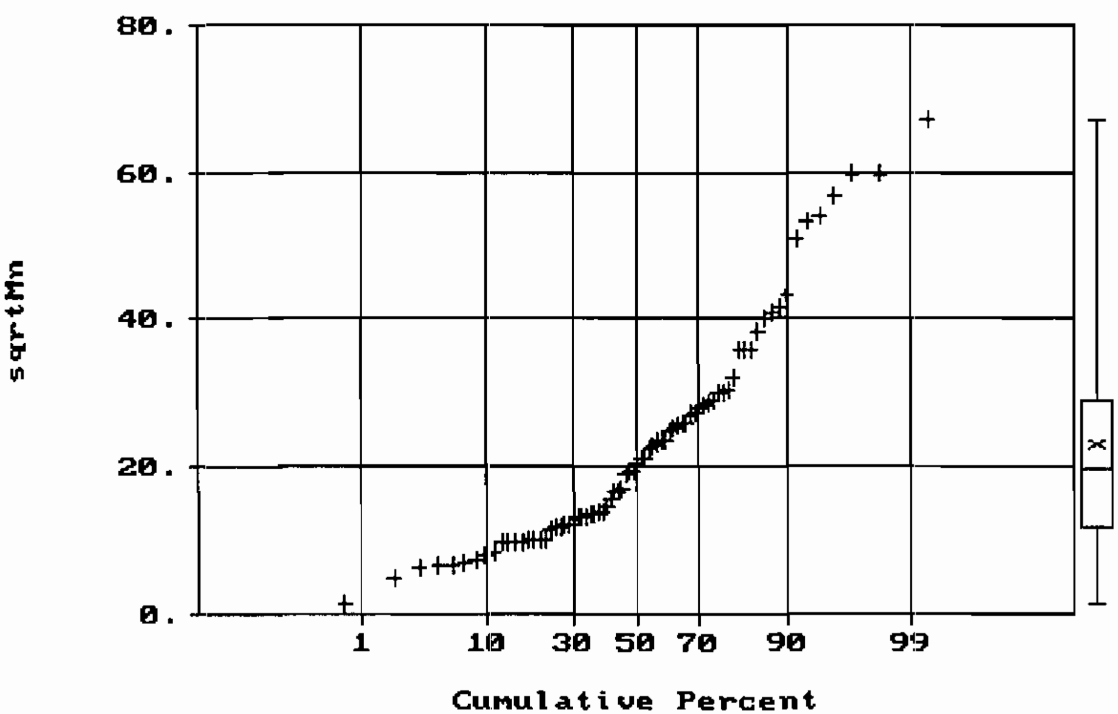
3a



Statistics

N Total :	76
N Miss :	0
N Used :	76
Mean :	22.952
Variance:	222.096
Std. Dev:	14.903
% C.V. :	64.930
Skewness:	1.068
Kurtosis:	3.561
Minimum :	1.342
25th % :	11.533
Median :	19.756
75th % :	28.844
Maximum :	67.268

Normal Probability Plot for sqrtMn
Data file: i_bg_gsx.dat



Statistics

N Total :	76
N Miss :	0
N Used :	76
Mean :	22.952
Variance:	222.096
Std. Dev:	14.903
% C.V. :	64.930
Skewness:	1.068
Kurtosis:	3.561
Minimum :	1.342
25th % :	11.533
Median :	19.756
75th % :	28.844
Maximum :	67.268

VCHEM_R
06/08/97

Page: 1
Time: 18:21

E N V I R O N M E N T A L   S A F E T Y   &   D E S I G N S

2909-00001 - CHARLESTON ZONE I SOIL & 1ST GW

Samples by Chemical Report

7439-96-5 - Manganese (Mn)

>= 1000.0000 for UG/L - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
012-G-W002-01		012GW00201	Water	06/08/95	4870.0000		UG/L	05710M	VAL
677-G-W002-01		677GW00201	Water	06/06/95	1690.0000	J	UG/L	00578M	VAL
687-G-W001-01		687GW00101	Water	06/08/95	1330.0000		UG/L	05710M	VAL
687-G-W004-01		687GW00401	Water	06/08/95	1040.0000		UG/L	05710M	VAL
DMA-W-0001-01		DMAW000101	Water	04/04/95	3250.0000		UG/L	0573MI	VAL
DMA-R-0001-01		DMAR000101	Water	04/04/95	3560.0000		UG/L	0573MI	VAL
* DMA-W-0002-01		DMAW000201	Water	04/04/95	3410.0000		UG/L	0573MI	VAL
* DMA-W-0003-01		DMAW000301	Water	04/04/95	3540.0000		UG/L	0573MI	VAL
* DMA-W-0004-01		DMAW000401	Water	04/04/95	3430.0000		UG/L	0573MI	VAL
* DMA-W-0005-01		DMAW000501	Water	04/04/95	1650.0000		UG/L	0573MI	VAL
GDI-G-W001-01		GRDGW00101	Water	04/24/95	3060.0000		UG/L	00575M	VAL
GDI-G-W002-01		GRDGW00201	Water	04/24/95	1470.0000		UG/L	00575M	VAL
GDI-G-W008-01		GRDGW00801	Water	05/02/95	1630.0000		UG/L	00576M	VAL
GDI-H-W008-01		GRDHW00801	Water	05/02/95	1580.0000		UG/L	00576M	VAL
GDI-G-W009-01		GRDGW00901	Water	05/02/95	4850.0000		UG/L	00575M	VAL
GDI-H-W009-01		GRDHN00901	Water	05/05/95	4200.0000		UG/L	00575M	VAL

*** End of Report ***

Zone I
Manganese in GW samples
Concentrations above 1000 μg/L
First sampling round

* "W" in ID indicates surface water sample

ENVIRONMENTAL SAFETY & DESIGNS

2909-00002 - CHARLESTON ZONE I QUARTERLY GW

Samples by Chemical Report

7439-96-5 - Manganese (Mn)

>= 1000.0000 for All Concentration Units - Hits Only

Sample ID	Ext.	Orig. ID	Type	Date	Result	VQual	Units	SDG #	
012-G-W002-02		012GW00202	Water	01/16/96	4920.0000		UG/L	24492	VAL
012-G-W002-03		012GW00203	Water	05/31/96	2860.0000		UG/L	25814	VAL
012-G-W002-04		012GW00204	Water	09/04/96	2770.0000	J	UG/L	26836	VAL
671-G-W001-02		671GW00102	Water	01/16/96	1000.0000		UG/L	24492	VAL
677-G-W002-03		677GW00203	Water	06/06/96	1080.0000	J	UG/L	25866	VAL
687-G-W001-02		687GW00102	Water	01/16/96	3290.0000		UG/L	24492	VAL
687-G-W003-03		687GW00303	Water	06/05/96	1750.0000	J	UG/L	25866	VAL
687-G-W004-02		687GW00402	Water	01/17/96	2240.0000		UG/L	24513	VAL
GDI-G-W001-02		GDIGW00102	Water	12/12/95	2920.0000	J	UG/L	24276	VAL
GDI-G-W001-03		GDIGW00103	Water	05/15/96	3230.0000		UG/L	25623	VAL
GDI-G-W001-04		GDIGW00104	Water	08/19/96	1280.0000	J	UG/L	26670	VAL
GDI-G-W002-02		GDIGW00202	Water	12/12/95	2580.0000	J	UG/L	24276	VAL
GDI-G-W002-03		GDIGW00203	Water	05/16/96	1860.0000	J	UG/L	25623	VAL
GDI-G-W002-04		GDIGW00204	Water	08/20/96	1300.0000	J	UG/L	26670	VAL
GDI-G-W008-02		GDIGW00802	Water	12/12/95	1720.0000	J	UG/L	24276	VAL
GDI-G-W008-03		GDIGW00803	Water	05/22/96	1670.0000		UG/L	25724	VAL
GDI-G-W009-02		GDIGW00902	Water	12/11/95	3560.0000	J	UG/L	24276	VAL
GDI-G-W009-03		GDIGW00903	Water	05/30/96	2830.0000		UG/L	25814	VAL
GDI-G-W009-04		GDIGW00904	Water	08/23/96	3560.0000		UG/L	26711	VAL
GDI-G-W010-02		GDIGW01002	Water	12/11/95	1300.0000	J	UG/L	24276	VAL
GDI-G-W019-02		GDIGW01902	Water	12/13/95	1010.0000	J	UG/L	24310	VAL
GDI-H-W019-02		GDIHW01902	Water	12/13/95	1070.0000		UG/L	24310	VAL

*** End of Report ***

Zone I
Manganese in GW samples
Concentrations above 1000 μg/L
Rounds 2, 3, and 4

FAX COVER SHEET

EnSafe

DATE: 6-10-97

5540 Centerview Drive, Suite 205
Raleigh, North Carolina 27606
Phone: (919) 851-1886
Fax: (919) 851-4043

TO: Dave Backus
Jay Bassett
Paul Bergstrand
Daryle Fontenot
Todd Haverkost
Tony Hunt
Johnny Tapia

FROM: Barry Doll

FAX:

SUBJECT: BG values for all zones so far

DOCUMENTS ATTACHED: | TOTAL PAGES FAXED: 5

COMMENTS:

Here are the latest accepted numbers. Values for As, Mn, and CN in Zone E groundwater are pending acceptance by Jay (after he sees the maps showing distribution of detections). Values for Cr in Zone C subsurface soil and Zone I surface soil apply to non-clay-rich samples only.

A comparison of background reference values for surface soil at Charleston Naval Base.

I. Surface soil (mg/kg) 6-9-97

Inorganic chemical	Zone A (n=13)	Zone B (n=15)	Zone C (n=45)	Zone D (n=6)	Zone E (n=25)	Zone F (n=6)	Zone G (n=6)	Zone H (n=104)	Zone I (n=15)
Aluminum	12800 P	15500P	9990 P	8700 M	26600 P			26000 P	27400 N
Antimony	ND	X	0.55 N	0.92 M	1.77 N			X	ND
Arsenic	9.44 P	17.1 P	14.2 P	5.55 M	23.9 N			15.6 P	21.6 P
Barium	53.0 P	98.7 P	77.2 P	30.1 M	130 P			40.3 P	54.2 P
Beryllium	X	1.23 P	X	0.19 M	1.7 P			1.37 P	0.95 N
Cadmium	X	ND	0.65 N	0.07 M	1.5 N			1.05 N	0.61 N
Chromium	50.4 P	75.7 P	26.4 P	12.4 M	94.6 P			59.1 P	34.5 P
Cobalt	4.4 N	21.9 P	3.22 P	9.46 M	19.0 P			5.86 P	5.8 N
Copper	165 P	225 P	34.7 P	40.6 M	66.0 P			27.6 P	240 P
Lead	140 P	114 P	330 P	18.8 M	265 N			118 P	203 N
Manganese	98.1 P	464 P	92.5 P	28.6 M	302 N			583 P	419 N
Mercury	0.3 N	1.55 N	0.24 N	0.05 M	2.60 P			0.485 P	0.47 N
Nickel	13.55 P	43.6 P	12.3 P	4.68 M	77.1 P			33.4 P	23.9 P
Selenium	1.2 N	2.8 N	1.44 P	0.91 M	1.7 N			2.0 N	1.49 P
Silver	ND	1.7 N	X	0.43 M	X			X	X
Thallium	ND	ND	ND	ND	2.8 N			1.1 N	ND
Tin	ND	14.8 N	2.95 P	ND	59.4 P			X	7.5 N
Vanadium	29.24 P	52.6 P	23.4 P	9.73 M	94.3 P			73.0 P	113 P
Zinc	207.6 P	366 P	159 P	25.1 M	827 P			214 P	206 P
Cyanide	ND	ND	ND	0.18 M	0.5 N			ND	ND

Notes:

P Parametric UTL
N Nonparametric UTL
X No UTL calculated (ND>90%)
M Twice the mean
ND Not detected

A comparison of background reference values for subsurface soil at Charleston Naval Base.

II. Subsurface soil (mg/kg) 6-9-97

Inorganic chemical	Zone A (n=12)	Zone B (n=14)	Zone C (n=30)	Zone D (n=6)	Zone E (n=24)	Zone F (n=6)	Zone G (n=4)	Zone H (n=63)	Zone I (n=6)
Aluminum	28240 P	17700 P	23700 P	10300 M	41100 P			46200 P	18900 M
Antimony	ND	X	0.92 N	ND	1.6 N			X	ND
Arsenic	9.836 P	10.8 N	14.1 N	4.08 M	19.9 P			22.5 P	6.45 M
Barium	40.01 P	65.0 N	68.5 P	29.7 M	94.1 P			43.8 P	36.0 M
Beryllium	ND	1.61 P	0.98 N	0.75 M	2.71 P			1.62 P	0.67 M
Cadmium	ND	ND	0.28 N	0.38 M	0.96 N			1.1 N	0.54 M
Chromium	63.4 P	48.1 N	12.5 P	22.3 M	75.2 N			84.2 P	51.3 M
Cobalt	1.7 N	10.6 N	7.1 N	2.89 M	14.9 N			14.9 P	3.48 M
Copper	33.69 P	47.0 P	42.2 P	ND	152 P			31.6 P	11.5 M
Lead	22.01 P	145 P	73.2 P	7.87 M	173 N			68.7 P	12.3 M
Manganese	85.54 P	288 N	106 P	29.9 M	881 P			1,410 P	118 M
Mercury	ND	2.0 N	0.30 N	0.05 M	1.59 P			0.735 P	ND
Nickel	35.0 P	29.9 N	16.7 P	6.76 M	57.0 P			29.9 P	15.7 M
Selenium	1.74 P	3.8 N	2.90 N	1.46 M	2.4 N			2.7 N	1.77 M
Silver	X	1.8 N	ND	0.36 M	ND			X	ND
Thallium	ND	ND	X	0.57 M	ND			1.3 N	ND
Tin	X	1.3 N	2.37 P	ND	9.23 P			ND	ND
Vanadium	77.32 P	102 N	56.9 N	15.1 M	155 P			132 P	38.1 M
Zinc	164.6 P	238 N	243 P	30.1 M	886 P			130 P	36.2 M
Cyanide	ND	ND	ND	0.16 M	X			ND	ND

Notes:

P Parametric UTL
N Nonparametric UTL
X No UTL calculated (ND>90%)
M Twice the mean
ND Not detected