ATTACHMENT P

TECHNICAL MEMORANDUM
STATISTICAL CALIBRATION AND VERIFICATION

GEOMORPH® SITE CHARACTERIZATION
UPPER TITTABAWASSEE RIVER

Limno-Tech, Inc.
Excellence in Environmental Solutions Since 1975

DATE: **February 1, 2007**

Memorandum

FROM: **Carrie Graff and John Wolfe**

CC:

PROJECT:

TO: Peter Simon, Ann Arbor Technical Services, Inc.

SUBJECT: Statistical Calibration and Verification of *GeoMorph*® Site Characterization

Summary

This technical memorandum summarizes the results of a statistical analysis of dioxin and furan data, expressed as the toxicity equivalency quotient (TEQ), collected along the Upper Tittabawassee River (UTR) floodway and sediment bed. The objective of this analysis was to evaluate the biased *GeoMorph*® sampling design against more traditional sampling designs, including a random-on-grid and a fixed interval approach.

Statistical methods specified in the *GeoMorph*® Sampling and Analysis Plan, Upper Tittabawassee River (SAP) were used. Results from this analysis validate the efficiency of biased sampling designs in fluvial settings, where the concentration of dioxin and furan are closely associated with geomorphic features.

Results indicate that:

- The overall mean of ln(TEQ) is much higher in pooled *GeoMorph*® floodway samples for Reach L (5.3, geomean = 210 ppt) than in fixed interval samples for Reach L (3.6, geomean = 37 ppt). The overall mean of ln(TEQ) for the *GeoMorph*® floodway samples for Reach N/O (6.4, geomean = 616 ppt) is much higher than for random-on-grid samples in Reach N/O (4.7, geomean = 106 ppt). These order-of-magnitude differences in overall means reflect *GeoMorph*®'s intentional bias toward identifying and sampling areas of higher concentration.
- *GeoMorph*® characterizations of sample locations help to explain the variation and pattern of concentrations with a very high level of confidence ($p < 0.0001$).
- In both Reach L and Reach N/O samples, *GeoMorph*® characterization of samples identifies sets of geomorphic floodway features having relatively high mean concentrations and sets of geomorphic features having relatively low mean concentrations.
- Overall mean values from both fixed interval transect and random-on-grid sampling schemes are intermediate to these higher and lower ranges, reflecting a pooling of data from heterogeneous geomorphic regions.

- The means of individual transects oriented parallel to the stream in the fixed interval sampling scheme generally decrease with distance from the river bank, reflecting a different set of geomorphic features in each transect. Confidence limits around the means for these transects are narrowest for the transects that are most homogeneous in terms of floodway features sampled. Confidence limits around the mean for the transect taken perpendicular to the river bank are widest, reflecting the heterogeneity of floodway features sampled along this transect.

Introduction

This technical memorandum summarizes the results of statistical analysis of dioxin and furan data collected along the Upper Tittabawassee River (UTR) floodway and sediment bed. The objective of this analysis was to evaluate the *GeoMorph*®sampling design. A principle of the *GeoMorph*®sampling design is that the variation in furan and dioxin concentrations in the floodway soils is strongly associated with distinct fluvial deposition areas. This is based on the relationship between fluvial systems and sediment deposition that is best characterized through geomorphologic principles and fluvial processes. The *GeoMorph*®sampling design is based on collecting representative soil samples from distinct fluvial geomorphic features to characterize the furan and dioxin (TEQ) concentrations associated with the soils from these geomorphic features.

The Michigan Department of Environmental Quality (MDEQ) recognizes that biased and random sampling strategies may be utilized as the basis for a sampling design. In some cases random sampling is preferred, while in other cases where extensive knowledge of site conditions is available, biased sampling provides the most accurate characterization of environmental media. MDEQ has expressed a desire to statistically evaluate the *GeoMorph*®sample design by comparing the results generated by the *GeoMorph*®process to more traditional sampling designs. The following approaches are used to evaluate the *GeoMorph*®sampling design:

- Outliers in furan and dioxin concentrations within geomorphic features (*GeoMorph*® features) are identified graphically and numerically and addressed as needed;

- Analysis of Variance (ANOVA) is used to test whether the variation in the concentrations of furans and dioxins in floodway soils can be explained by accounting for fluvial deposition areas in the floodway (*GeoMorph*® features); and

- The biased *GeoMorph*® sampling design is compared to two more traditional random sampling plans, namely:

    - fixed interval transect; and

    - random-on-grid methods.

Methods and Findings

Datasets

The data are from soil sample locations in Reach L and Reach N/O where samples were analyzed for furans and dioxins. Three datasets are compared: 1) *GeoMorph*® features from Reach L and Reach N/O; 2) Fixed interval transect data from Reach L; and 3) random-on-grid data from Reach N/O. Furan and dioxin data were combined at each sample location and a toxicity equivalency (TEQ) was assigned to that data point. Some of the data were below the reporting limit of 10 ppt estimated total TEQ. In these cases, values of 0 ppt and 10 ppt were assigned to alternating data points. When sample duplicates occurred, the maximum detected concentration was used to represent the concentration at that location. The data also include categorical variables identifying geomorphic surface types. The data for the fixed interval transects were generated from a sampling design prepared by the MDEQ and provided surface concentrations of furan and dioxin. To ensure comparability between the three datasets, only surface concentrations of dioxins and furans were used.

GeoMorph® in-channel sediment data were also included in the tabulations below, because comparisons of in-channel and floodway data are also of interest. They were not used in the comparisons of *GeoMorph*® and traditional sampling approaches, however, because the fixed-interval transects and random-on-grid sampling did not include in-channel samples.

Log Transformation and Screening for Outliers in Geomorphic Features

All of the TEQ data were lognormally transformed, and the validity of the lognormal assumption was evaluated using probability plots and the Shapiro-Francia Goodness of Fit test. Every 10^{th} percentile and skewness values for each of the distributions were also tabulated.

Table 1 shows the results of the normality tests by dataset. The normality assumption was accepted in most cases for datasets that were disaggregated by geomorphic feature or by individual transect: this was true of 11 of 13 *GeoMorph*® floodway features and 2 of 4 fixed-interval transects, as well as for the full random-on-grid dataset. The lognormal transformation was deemed appropriate on the basis of the overall weight of these test results, facilitating a fair statistical comparison of the three sampling approaches. Graphical comparisons for all datasets are attached in Appendix A, and original source data are tabulated in Appendix B.

TEQ concentrations from each geomorphic surface within Reach L and Reach N/O were graphically screened for outliers using box plots of each population (i.e., each geomorphic feature and similarly mapped geomorphic features within a given reach.) When potential outliers were identified, tests were performed to determine whether these were true outliers and should be removed from the datasets, as proposed in the SAP and reported below.

The side-by-side box plots in Figures 1 and 2 summarize the distributions of points in each *GeoMorph*® surface. The extreme values accepted as nonoutliers without further testing are defined as the largest and smallest values within the following bounds:

- 75^{th} quartile + 1.5*(interquartile range); and
- 25^{th} quartile – 1.5*(interquartile range).

Data points that lie outside these "whiskers" can be considered possible outliers. Figure 1 and Figure 2 show that the only geomorphic surfaces that have apparent outliers are the in-channel samples. In Figure 2 for Reach L, there are also two potential outliers on the transect farthest from the river bank. In order to test whether these data are true outliers, the Grubb's test was performed on in-channel and farthest transects samples in Reach L and Rosner's test was performed on in-channel samples in Reach N/O. The two different tests were used due to the different numbers of suspected outliers in each group (see SAP). The results of those tests indicated that there were no true outliers in the datasets and therefore none of the data were removed before ANOVA.

ANOVA to Evaluate *GeoMorph*® Stratification

ANOVA analyzes the variation in a variable of interest (in this case TEQ concentrations) and assigns portions of the variation to each member of a set of explanatory variables (in this case *GeoMorph*® features), leaving a residual that is associated with a random or unexplained component. With ANOVA, it is possible to test the null hypothesis of "no effect" of the explanatory variables, where the alternative hypothesis is that there is a relationship between concentration and at least one of the explanatory variables. The hypothesis is tested by constructing an F statistic from the explained and unexplained portions of variation in concentration. ANOVA analysis was performed using the SAS based software JMP 6.0.

ANOVA results show that for both Reach N/O (Table 2) and Reach L (Table 3), the null hypothesis of "no effect" can be rejected at the $p = 0.0001$ confidence level. This means that the *GeoMorph*® features help to explain the variability we see in mean ln(TEQ) concentrations, with a high level of confidence. Because there are no in-channel samples in the fixed interval and random-on-grid datasets, it was determined that ANOVA should be repeated after excluding the in-channel samples, in order to evaluate whether the presence of in-channel data was the reason the null hypothesis of no effect was rejected. For both Reach L and Reach N/O, the F-ratio was virtually unchanged when in-stream samples were removed, and the hypothesis of "no effect" was rejected at the same confidence level.

Tables 2 and 3 and Figures 1 and 2 show that the mean ln(TEQ)s associated with *GeoMorph*® features tend to be divided into two groups. (Overall means for *GeoMorph*® floodway samples are shown in Figures 1 and 2 as end-to-end horizontal lines.) In Reach N/O, the levees, low and intermediate terraces, and wetlands tend to have higher-than-average floodway concentrations, whereas upland and high terrace areas have lower-than-average concentrations. Results are similar for Reach L, except that the mean concentration in high terrace areas is above average. In general (except in cases where sample sizes were less than 10), upper and lower 25% confidence limits of means for *GeoMorph*® features are within one order of magnitude of the mean.

After excluding the in-channel samples, the mean ln(TEQ) values were 6.4 for Reach N/O and 5.3 for Reach L, respectively. These means and associated standard errors and confidence limits are shown in Table 5**.** As Tables 2 and 3 show, the corresponding means of Reach N/O and Reach L in-channel samples were much lower, 2.6 and 2.7, respectively (both geomeans = 14 ppt).

Comparison of *GeoMorph*® to Random-on-Grid and Fixed-Interval Sampling Designs

The objective of this evaluation is to compare the data generated from a *GeoMorph*® biased transect sample design to the data generated from the random-on-grid and fixed-interval sample design. The differences in distributions of mean predicted concentrations using the different sampling strategies were compared, including comparisons of 95 percent upper and lower confidence limits of means. To facilitate comparisons, the geomean of the data is used in the discussion.

The geomeans of the distributions are much lower for the two random sampling designs (37 and 106 ppt TEQ for Reach L fixed interval and Reach N/O random-on-grid respectively) (see Table 4) than the pooled *GeoMorph*® data in Reach L (210 ppt TEQ) and Reach N/O (616 ppt TEQ) floodplains (see Table 5). This reflects *GeoMorph*®'s intentional bias toward identifying and oversampling areas of higher concentration. As mentioned above, the *GeoMorph*® results tend to be grouped by features into an above-average and a below-average set. In contrast, the traditional sampling methods tend to produce overall means that are intermediate in magnitude, as seen in Figures 1 and 2. This reflects the fact that computing a mean using either of the traditional sampling approaches combines data from multiple geomorphologic regimes.

The data distributions for the three transects oriented parallel to the river show a decrease in mean concentrations with increasing distance from the river (see Table 6 and Figure 2). Results also indicate that the mid-level transect has a smaller confidence interval (CI) than the near-stream, farthest, and perpendicular transects. The smaller CI is the result of the fact that this transect is mainly limited to upper high terrace and high terrace sample locations. For this reason there is less variability than in the other longitudinal transects, which traverse more geomorphologic features. In general, wider confidence intervals for the mean are found for transects that cut through multiple features, and this is especially so for the transect that is oriented perpendicular to the river.

Conclusions

The average surface concentration of dioxins and furans (TEQ) is lower for random-on-grid and fixed interval sampling designs than for the *GeoMorph*® samples, indicating that the *GeoMorph*® approach is successful in identifying and focusing sampling on areas of relatively high concentration.

The fixed interval sampling method is able to identify a trend in concentration with distance from the river, but the *GeoMorph*® approach identifies the same trend and provides a more detailed explanation based on floodplain geomorphology.

ANOVA documents that for *GeoMorph*® samples in both Reach L and Reach N/O, the *GeoMorph*® characterization of samples helps to explain the variability in ln(TEQ) concentrations, with a high degree of statistical confidence. Furthermore, ANOVA plots indicate that there are at least two distinct sets of *GeoMorph*® populations, with higher and lower means, a distinction that is not captured by the random sampling strategies.

Table 1: Normality Test Results for Datasets Used in Statistical Evaluation

Reach	Sampling approach	Dataset	p value	Normal?
N/O	Random-on-grid	All	0.382	accept
N/O	*GeoMorph*®	All	0.000	reject
N/O	*GeoMorph*®	In-channel	0.005	reject
N/O	*GeoMorph*®	Floodway only	0.353	accept
N/O	*GeoMorph*®	Natural levee	0.570	accept
N/O	*GeoMorph*®	Historic natural levee	0.252	accept
N/O	*GeoMorph*®	Low terrace	0.333	accept
N/O	*GeoMorph*®	Intermediate terrace	0.729	accept
N/O	*GeoMorph*®	High terrace	0.209	accept
N/O	*GeoMorph*®	Wetland	0.920	accept
N/O	*GeoMorph*®	Upland	0.386	accept
L	Fixed interval	All	0.001	reject
L	Fixed interval	Near	0.415	accept
L	Fixed interval	Mid	0.112	accept
L	Fixed interval	Far	0.012	reject
L	Fixed interval	Perpendicular	0.015	reject
L	*GeoMorph*®	All	0.001	reject
L	*GeoMorph*®	In-channel	0.098	accept
L	*GeoMorph*®	Floodway only	0.000	reject
L	*GeoMorph*®	Natural levee	0.375	accept
L	*GeoMorph*®	Low terrace	0.721	accept
L	*GeoMorph*®	Intermediate terrace	0.180	accept
L	*GeoMorph*®	High terrace	0.027	reject
L	*GeoMorph*®	Upper high terrace	0.003	reject
L	*GeoMorph*®	Wetland	0.879	accept

Table 2: Means for Oneway ANOVA for Reach N/O *GeoMorph*® Samples

Level	Number	Mean	Geomean ppt TEQ	Std Error	Lower 95%	Upper 95%
high terrace	24	5.37681	216.331	0.32788	4.7290	6.0247
historic natural levee	7	7.23732	1390.362	0.60711	6.0377	8.4369
in-channel	32	2.61912	13.7236	0.28395	2.0581	3.1802
intermediate terrace	20	6.82433	919.959	0.35917	6.1146	7.5340
low terrace	41	6.60682	740.125	0.25086	6.1111	7.1025
natural levee	16	7.10852	1222.337	0.40157	6.3151	7.9020
upland	8	4.94528	140.51	0.56790	3.8232	6.0674
wetland	10	6.60454	738.440	0.50795	5.6009	7.6082
F Ratio	23.5642	Prob >F < 0.0001				
Rsquare	0.523					

Table 3: Means for Oneway ANOVA for Reach L *GeoMorph*® Samples

Level	Number	Mean	Geomean ppt TEQ	Std Error	Lower 95%	Upper 95%
high terrace	6	6.53929	691.795	0.50726	5.5250	7.5536
in-channel	17	2.67231	14.473	0.30136	2.0697	3.2749
intermediate terrace	13	6.17412	480.1602	0.34462	5.4850	6.8632
low terrace	14	5.39051	219.315	0.33208	4.7265	6.0546
natural levee	6	6.59980	734.948	0.50726	5.5855	7.6141
upper high terrace	8	1.93335	6.9126	0.43930	1.0549	2.8118
wetland	4	5.67748	292.2121	0.62127	4.4352	6.9198
F Ratio	22.8642	Prob> F < 0.0001				
Rsquare	0.692					

Table 4: Moments for Reach L (Fixed Interval Samples) and N/O (Random-on-Grid)

Reach L	
Mean	3.6160633
Median	2.8332
Geomean ppt TEQ	37.18
Std Dev	1.723797
Std Err Mean	0.2514416
Upper 95% Mean	4.1221891
Lower 95% Mean	3.1099376
N	47
Reach N/O	
Mean	4.6639865
Median	4.5689
Geomean ppt TEQ	106.04
Std Dev	1.8492135
Std Err Mean	0.2428136
Upper 95% Mean	5.1502124
Lower 95% Mean	4.1777606
N	58

Table 5: Moments for Reach L and Reach N/O *GeoMorph®* samples, with and without in-channel samples included.

Reach L, including in-channel		**Reach L, floodway only**	
Mean	4.6789888	Mean	5.347882
Median	5.4806	Median	5.9402
Std Dev	2.1370197	Std Dev	1.8508228
Geomean ppt TEQ	107.55	Geomean ppt TEQ	209.97
Std Err Mean	0.2591517	Std Err Mean	0.259167
upper 95% Mean	5.1962577	upper 95% Mean	5.8684343
lower 95% Mean	4.1617198	lower 95% Mean	4.8273296
N	68	N	51
Reach N/O, including in-channel		**Reach N/O, floodway only**	
Mean	5.657	Mean	6.4234924
Median	5.657	Median	6.39
Geomean ppt TEQ	214.00	Geomean ppt TEQ	615.84
Std Dev	2.2765895	Std Dev	1.6346064
Std Err Mean	0.1511026	Std Err Mean	0.1450479
upper 95% Mean	6.01442	upper 95% Mean	6.7105379
lower 95% Mean	5.3012454	lower 95% Mean	6.136447
N	159	N	127

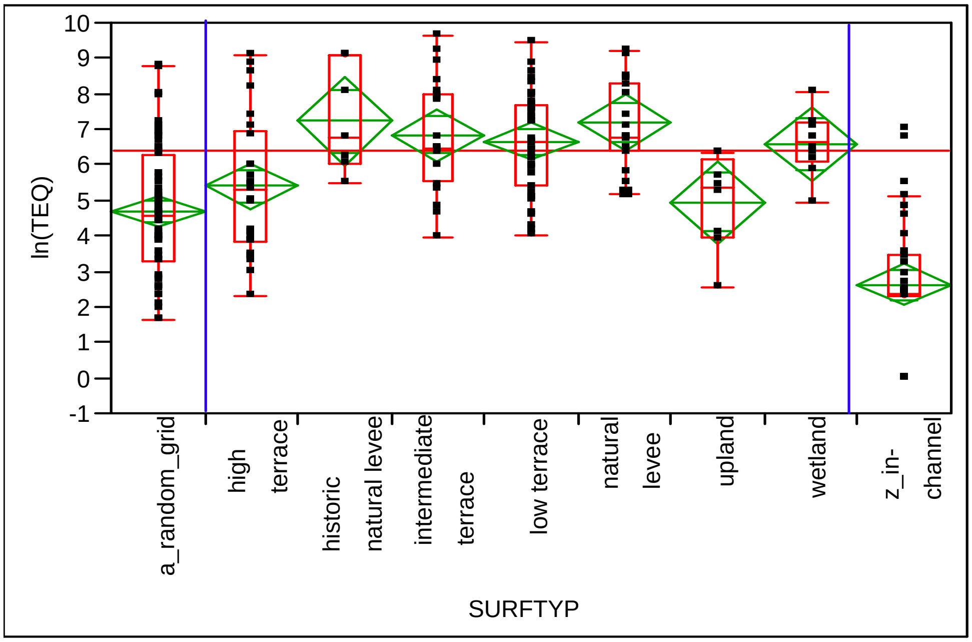
Table 6: Moments of individual transect data for Reach L.

Near Stream	
Mean	5.9343697
Median	5.9661
Geomean ppt TEQ	377.66
Std Dev	0.5519198
Std Err Mean	0.1839733
Upper 95% Mean	6.3586129
Lower 95% Mean	5.5101266
N	9
Mid-level	
Mean	2.6001439
Median	2.4849
Geomean ppt TEQ	13.465
Std Dev	0.25604
Std Err Mean	0.077199
upper 95% Mean	2.7721539
lower 95% Mean	2.4281339
N	11
Farthest	
Mean	2.5310404
Median	2.5649
Geomean ppt TEQ	12.566
Std Dev	1.0063358
Std Err Mean	0.3034217
upper 95% Mean	3.207106
lower 95% Mean	1.8549748
N	11
Perpendicular	
Mean	3.6160633
Median	2.5858
Geomean ppt TEQ	37.188
Std Dev	1.723797
Std Err Mean	0.2514416
upper 95% Mean	4.1221891
lower 95% Mean	3.1099376
N	47

Table 7: Percentiles of Cumulative Distributions and Skewedness for Fixed Interval, Random-on-Grid, and *GeoMorph*® data for Reach L and Reach N/O.

Percentile	Fixed Interval	Fixed Interval Near Stream	Fixed Interval Mid-level	Fixed Interval Farthest	Fixed Interval Perpendicular	Random-On-Grid	Reach L *GeoMorph*® with In-channel	Reach N/O *GeoMorph*® with In-channel	Reach L *GeoMorph*® without In-channel	Reach N/O *GeoMorph*® without In-channel
10	2.3026	5.3240	2.3979	2.3026	2.3026	2.3026	2.3026	2.3026	2.6391	4.0943
20	2.4849	5.6172	2.3979	2.3026	2.3598	2.7968	2.5946	3.8328	3.8712	5.0752
30	2.4849	5.7366	2.4849	2.4849	2.6149	3.8089	3.3740	4.7875	5.0106	5.4806
40	2.6391	5.7825	2.4849	2.4849	2.6658	4.0484	4.5612	5.4025	5.5984	6.1612
50	2.8332	5.9661	2.4849	2.5649	2.8585	4.5689	5.4806	6.0162	5.9402	6.3969
60	3.1610	6.1963	2.5649	2.5649	3.5197	4.9554	5.7550	6.4551	6.1944	6.7754
70	4.8675	6.3397	2.6391	2.7081	4.4036	5.4624	6.1944	7.0553	6.5653	7.3778
80	5.4381	6.4289	2.8332	3.0445	5.1402	6.4457	6.6819	7.6683	6.7685	7.9654
90	6.2906	6.4889	2.8332	3.1355	5.8077	7.0292	6.8139	8.3521	7.1701	8.5359
100	7.1701	6.5367	3.1781	4.2485	7.1701	8.7948	7.8240	9.6158	7.8240	9.6158
Skewness	0.1345	-0.8049	1.2441	-1.2964	1.0174	0.2887	-0.664	-0.6084	-1.225	-0.2200

Figure 1: Comparison of means from *GeoMorph®* features and random-on-grid sampling methods for Reach N/O.



Key:

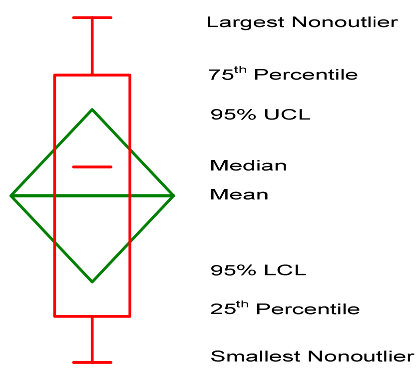
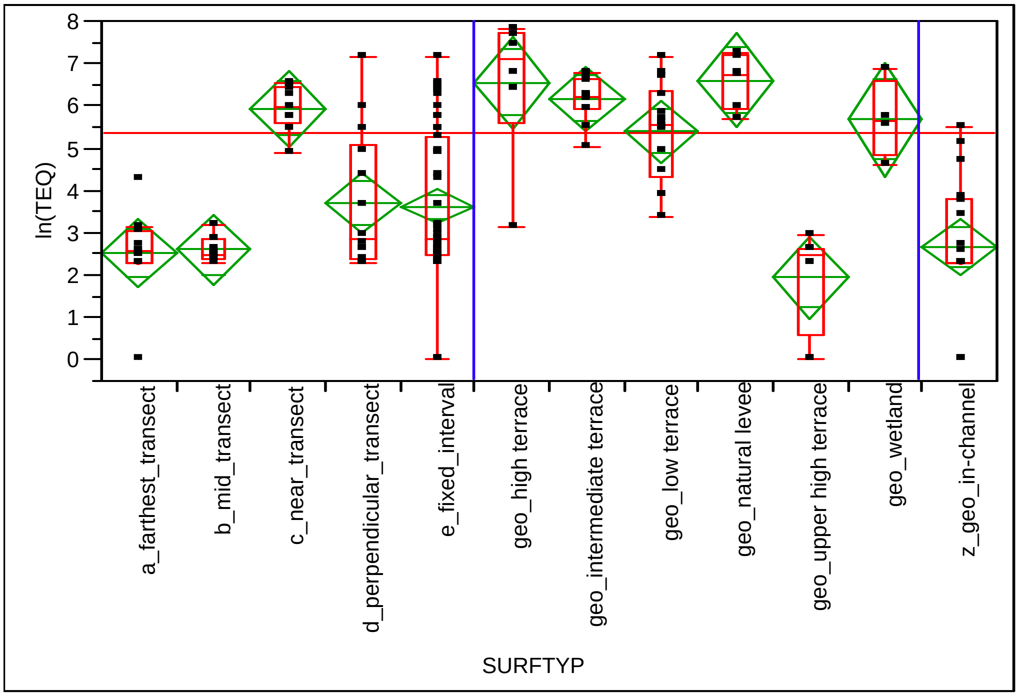


Figure 2: Comparison of means from *GeoMorph*® and fixed interval transects from Reach L.



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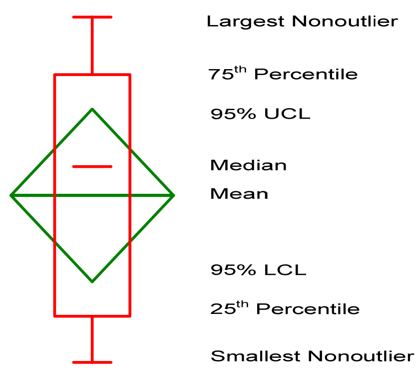
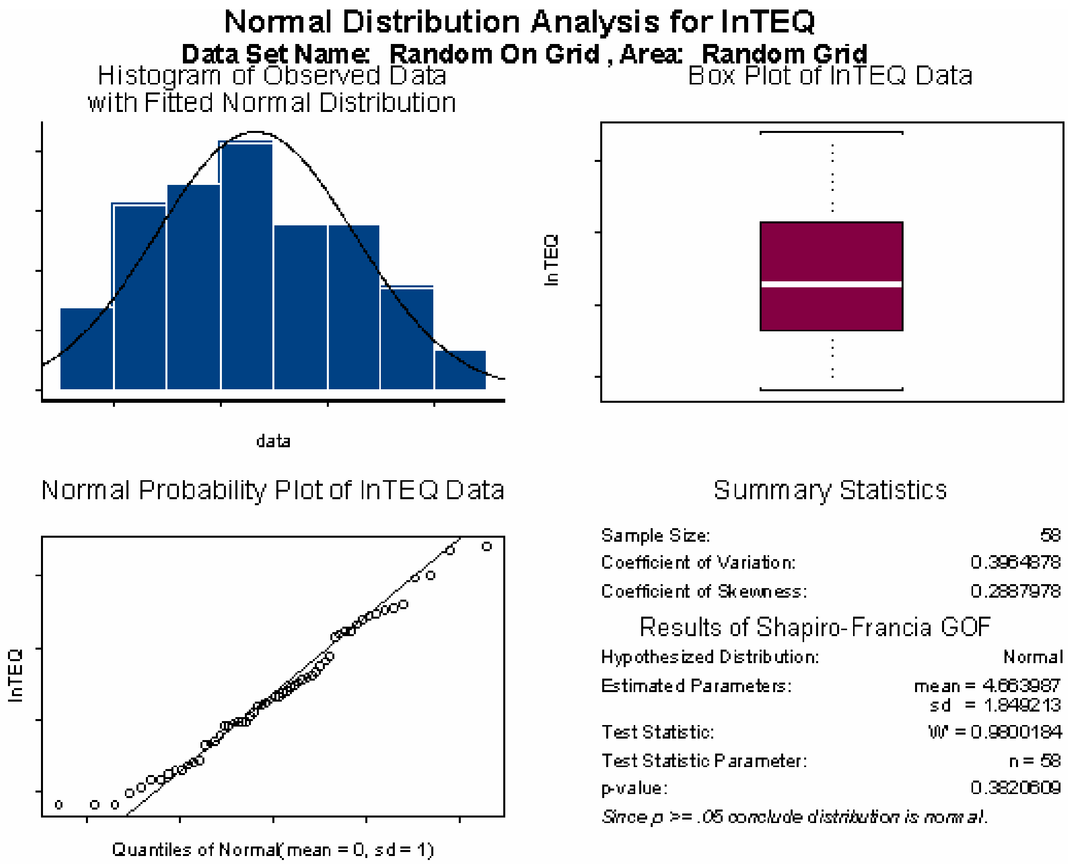
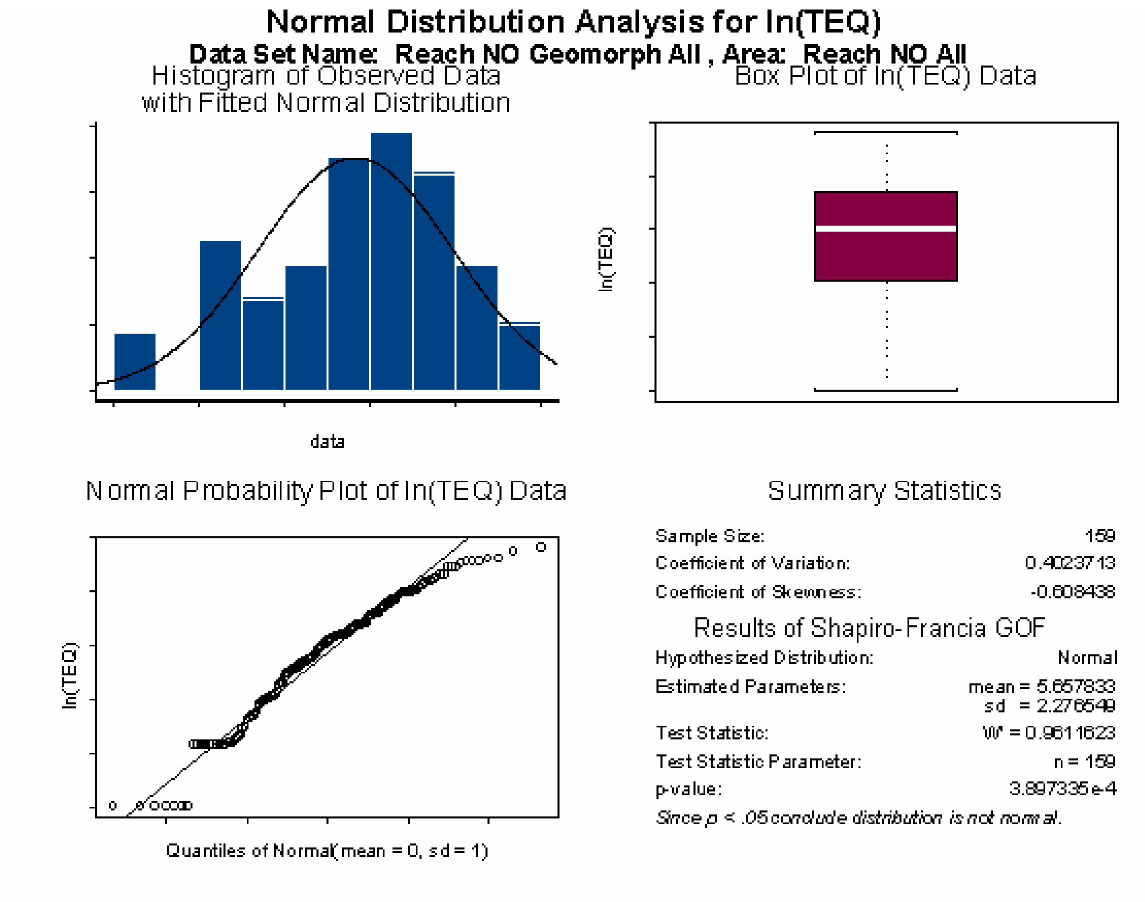
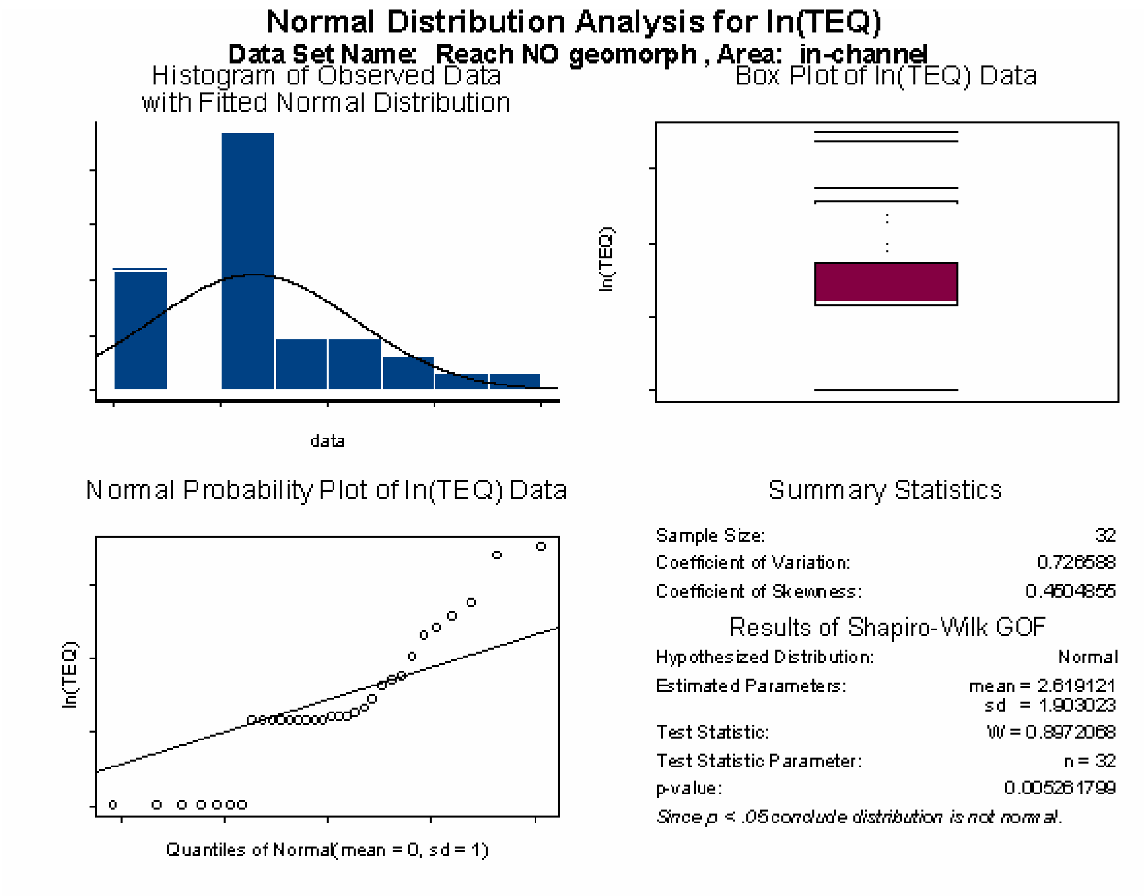


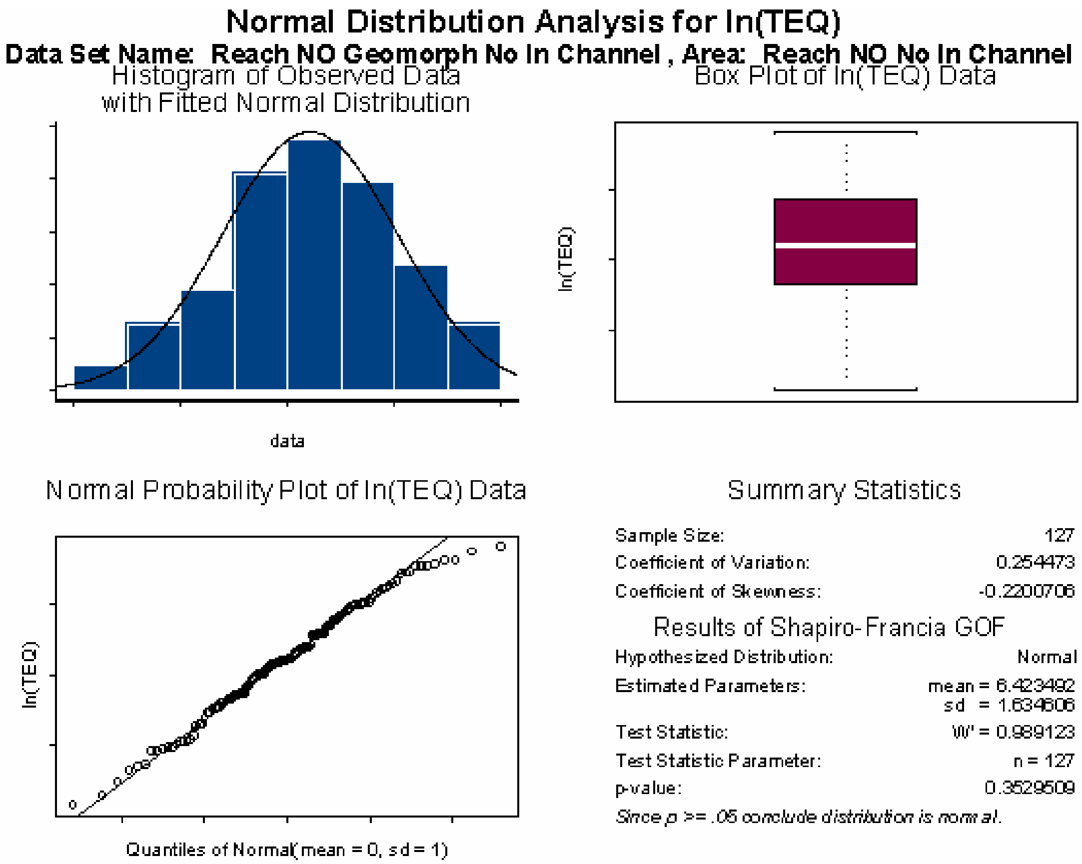
Appendix A:

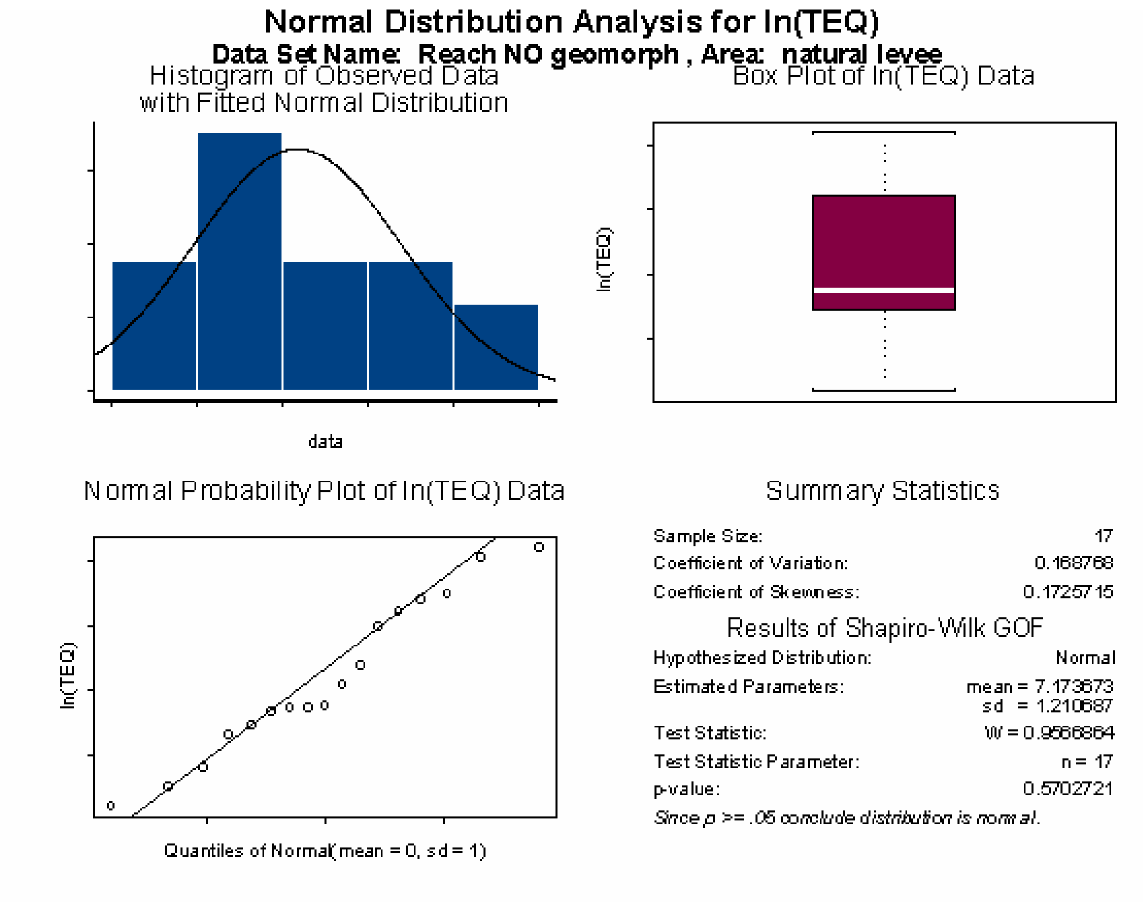
Probability Plots and Normality Tests

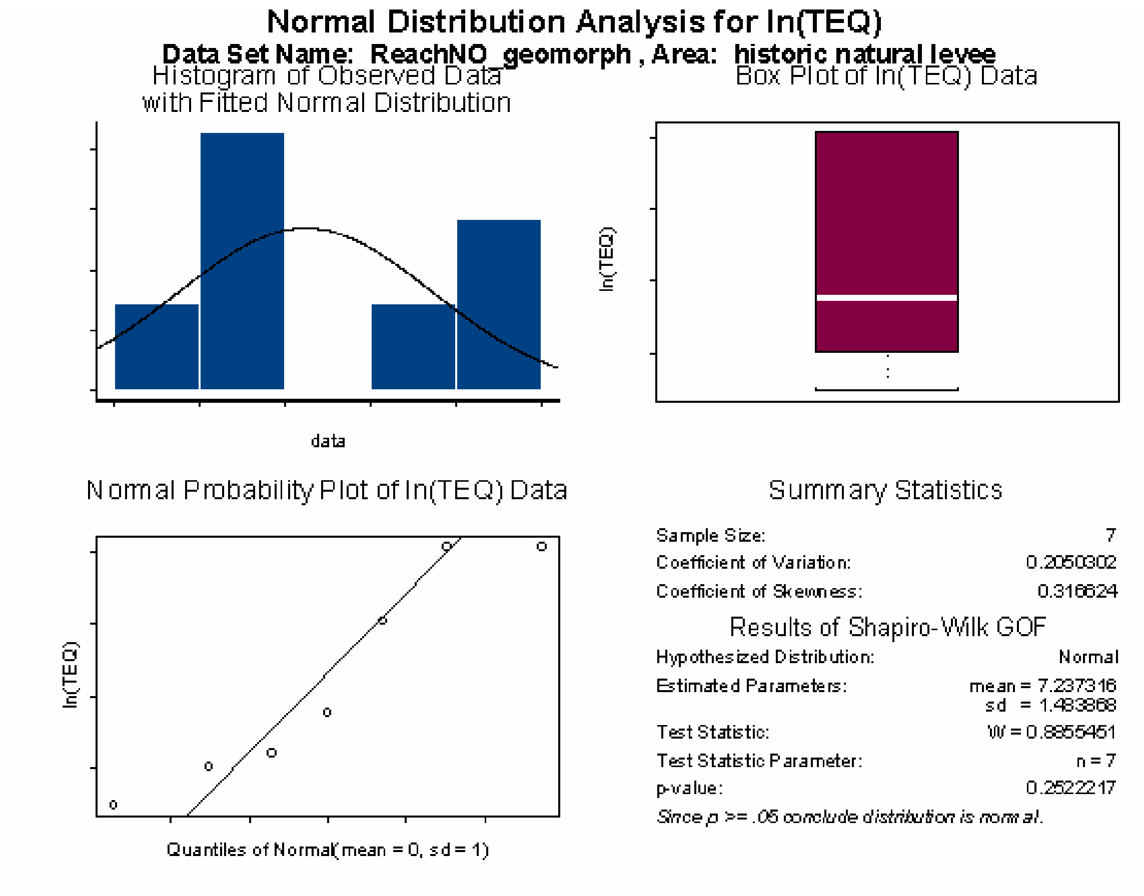

Normal Distribution Analysis for lnTEQ
Data Set Name: Random On Grid , Area: Random Grid
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of lnTEQ Data
lnTEQ
Normal Probability Plot of lnTEQ Data
lnTEQ
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 58
Coefficient of Variation: 0.3964878
Coefficient of Skewness: 0.2887978
Results of Shapiro-Francia GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 4.663987
sd = 1.849213
Test Statistic: W' = 0.9800184
Test Statistic Parameter: n = 58
p-value: 0.3820609
Since p >= .05 conclude distribution is normal.

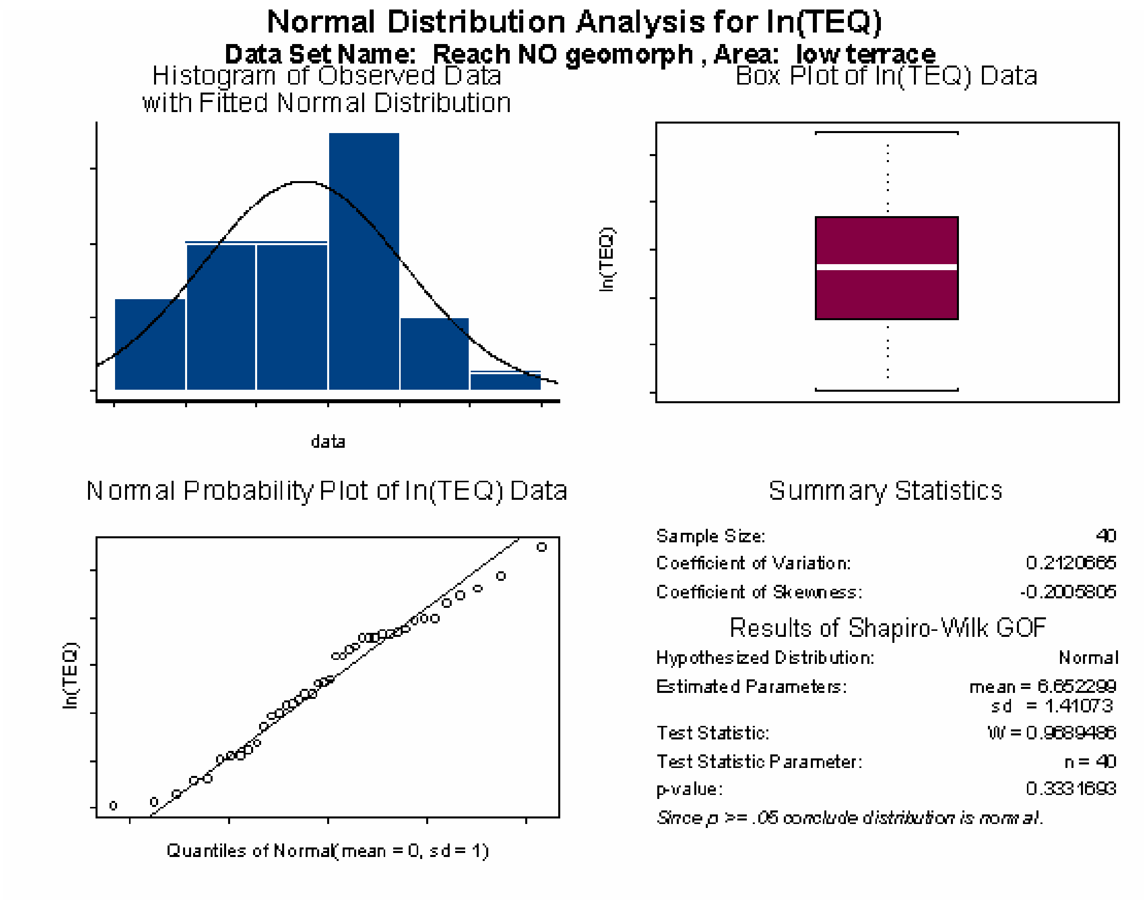

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO Geomorph All , Area: Reach NO All
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 159
Coefficient of Variation: 0.4023713
Coefficient of Skewness: -0.608438
Results of Shapiro-Francia GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 5.657833
sd = 2.276549
Test Statistic: W' = 0.9611623
Test Statistic Parameter: n = 159
p-value: 3.897335e-4
Since p < .05 conclude distribution is not normal.

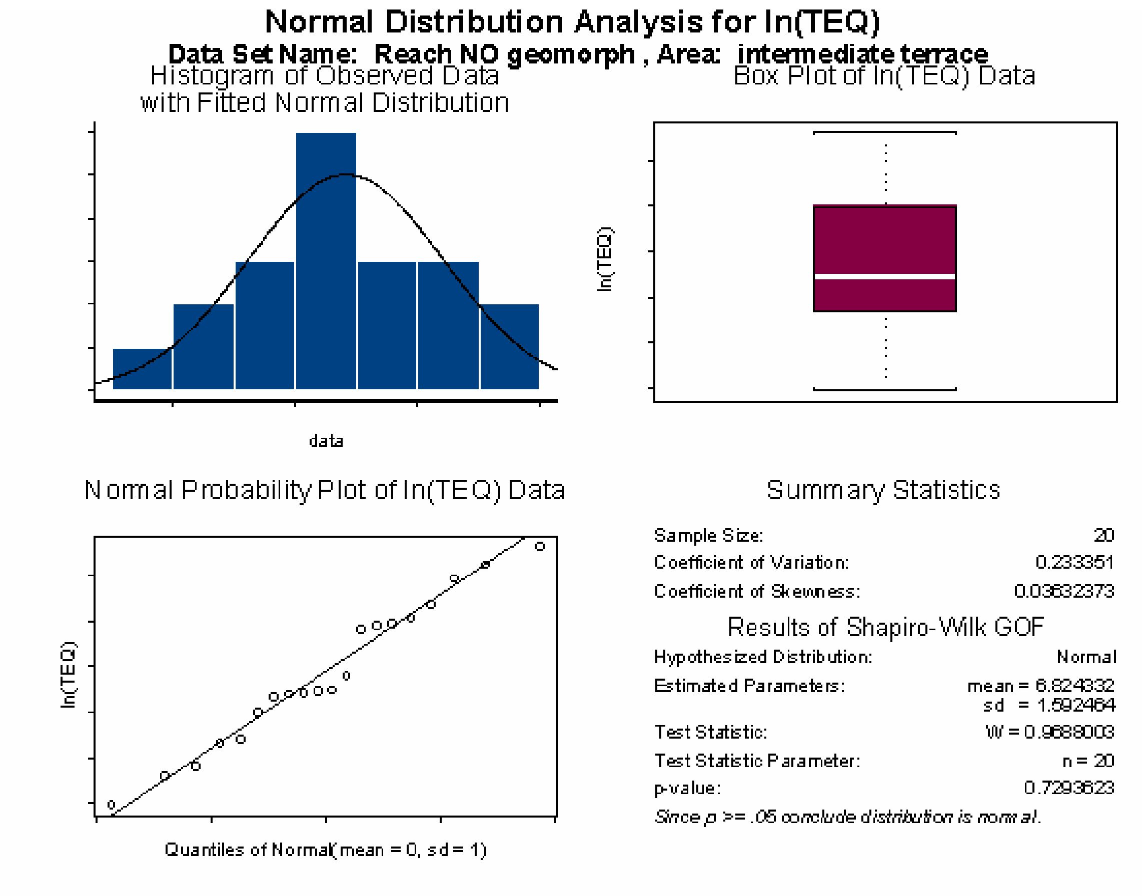

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO geomorph , Area: in-channel
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 32
Coefficient of Variation: 0.726588
Coefficient of Skewness: 0.4604855
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 2.619121
sd = 1.903023
Test Statistic: W = 0.8972068
Test Statistic Parameter: n = 32
p-value: 0.005261799
Since p < .05 conclude distribution is not normal.

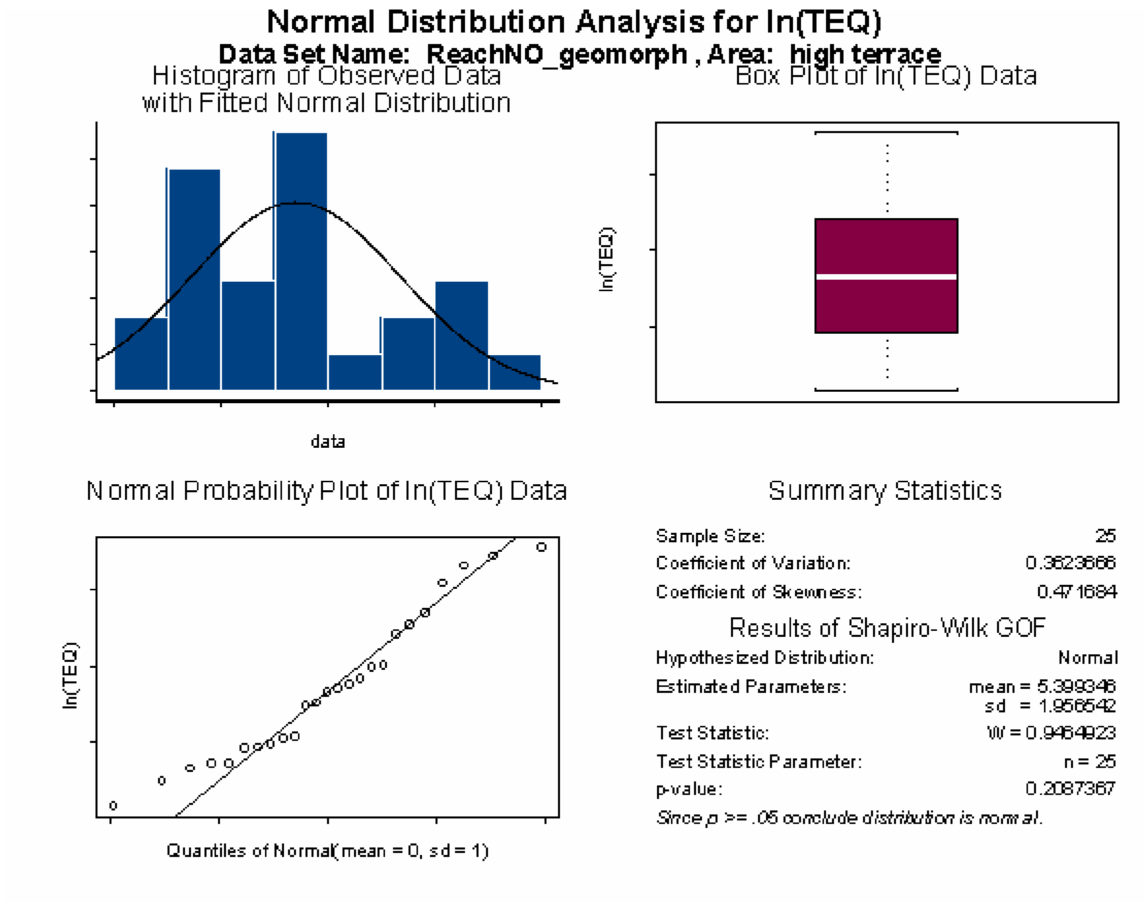

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO Geomorph No In Channel , Area: Reach NO No In Channel
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 127
Coefficient of Variation: 0.254473
Coefficient of Skewness: -0.2200706
Results of Shapiro-Francia GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.423492
sd = 1.634606
Test Statistic: W' = 0.989123
Test Statistic Parameter: n = 127
p-value: 0.3529509
Since p >= .05 conclude distribution is normal.

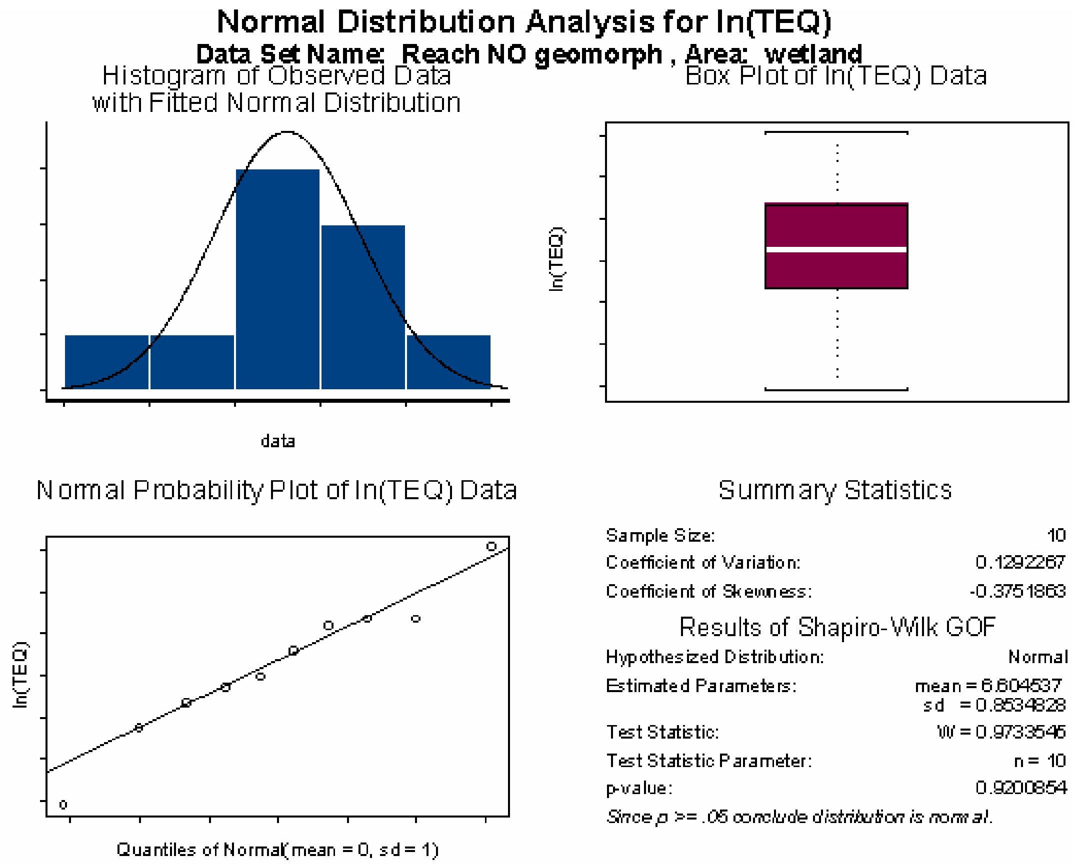

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO geomorph , Area: natural levee
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 17
Coefficient of Variation: 0.168768
Coefficient of Skewness: 0.1725715
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 7.173673
sd = 1.210687
Test Statistic: W = 0.9566864
Test Statistic Parameter: n = 17
p-value: 0.5702721
Since p >= .05 conclude distribution is normal.

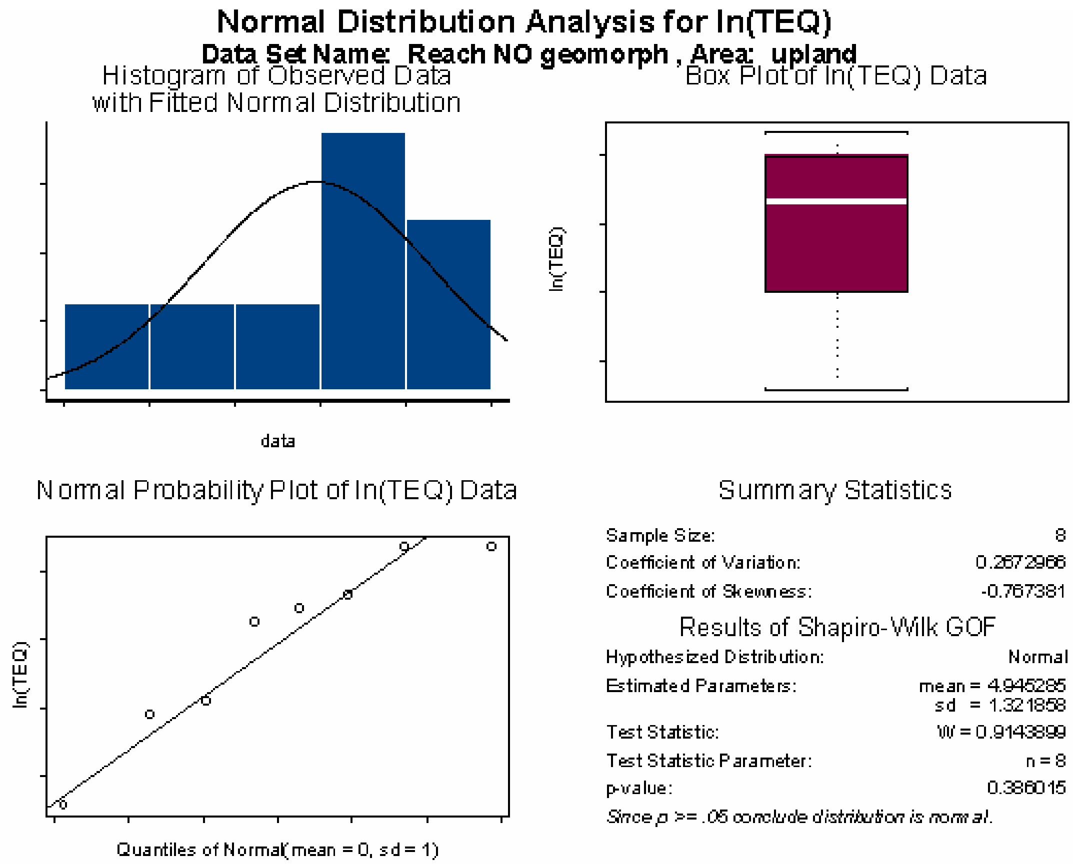

Normal Distribution Analysis for ln(TEQ)
Data Set Name: ReachNO_geomorph , Area: historic natural levee
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 7
Coefficient of Variation: 0.2050302
Coefficient of Skewness: 0.316624
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 7.237316
sd = 1.483868
Test Statistic: W = 0.8855451
Test Statistic Parameter: n = 7
p-value: 0.2522217
Since p >= .05 conclude distribution is normal.

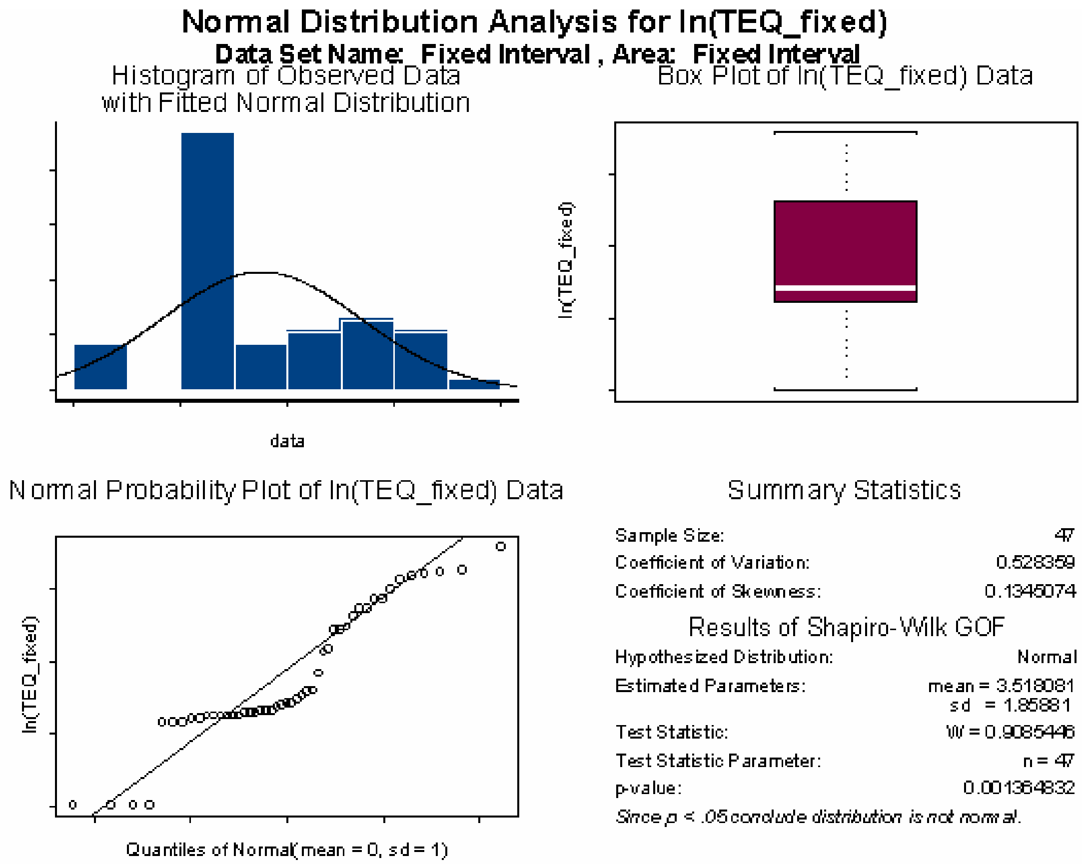

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO geomorph , Area: low terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 40
Coefficient of Variation: 0.2120665
Coefficient of Skewness: -0.2005805
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.652299
sd = 1.41073
Test Statistic: W = 0.9689486
Test Statistic Parameter: n = 40
p-value: 0.3331693
Since p >= .05 conclude distribution is normal.

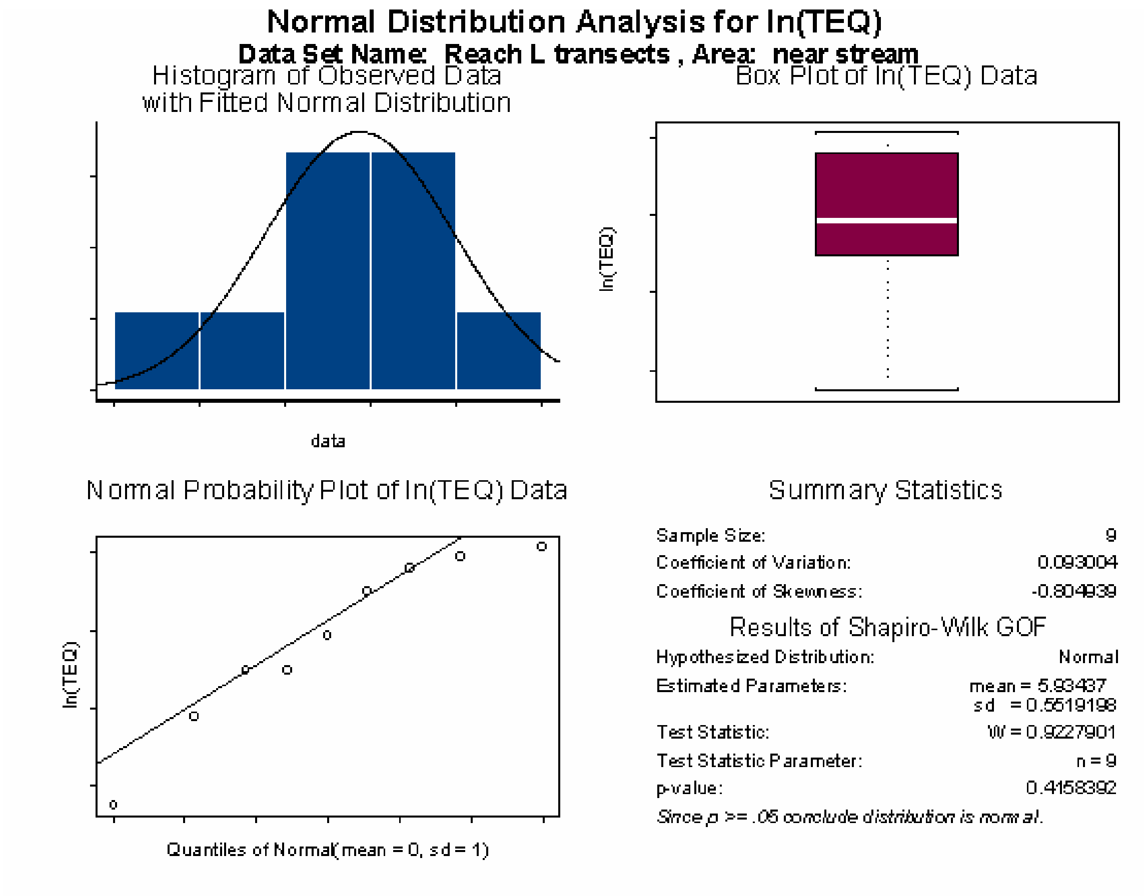

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO geomorph , Area: intermediate terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 20
Coefficient of Variation: 0.233351
Coefficient of Skewness: 0.03632373
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.824332
sd = 1.592464
Test Statistic: W = 0.9688003
Test Statistic Parameter: n = 20
p-value: 0.7293623
Since p >= .05 conclude distribution is normal.

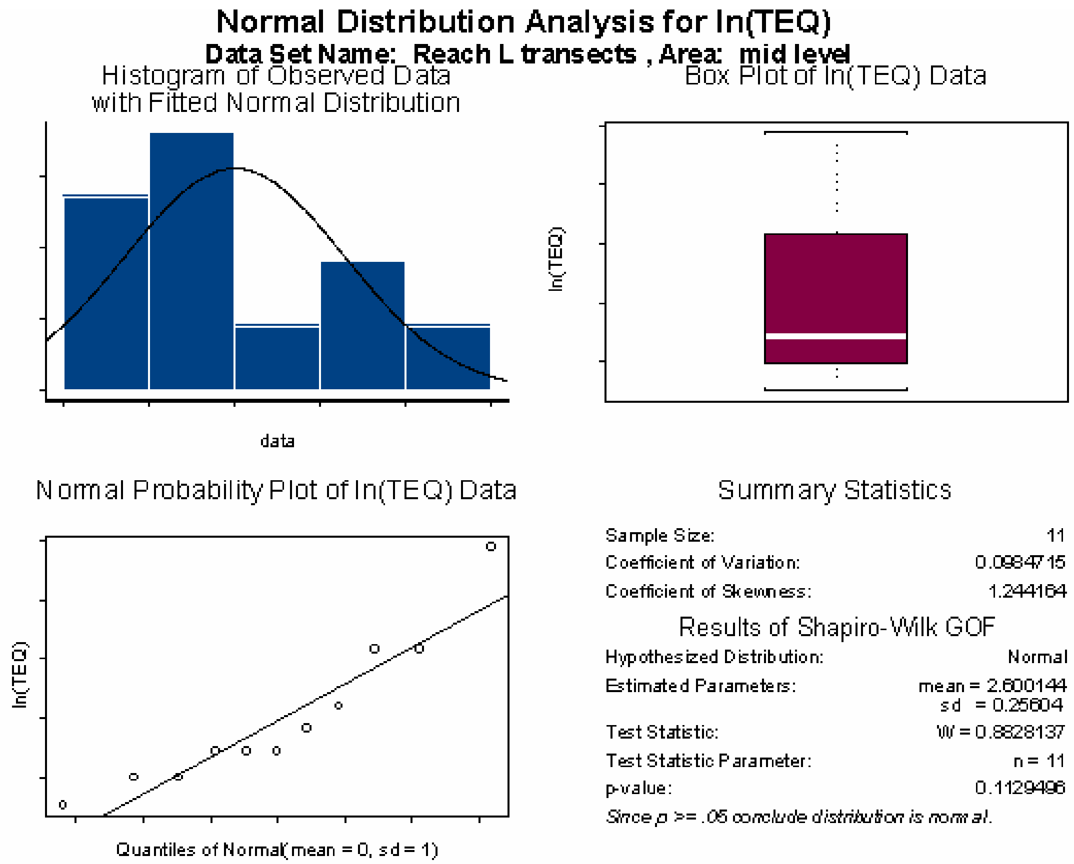

Normal Distribution Analysis for ln(TEQ)
Data Set Name: ReachNO_geomorph , Area: high terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 25
Coefficient of Variation: 0.3623666
Coefficient of Skewness: 0.471684
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 5.399346
sd = 1.956542
Test Statistic: W = 0.9464923
Test Statistic Parameter: n = 25
p-value: 0.2087367
Since p >= .05 conclude distribution is normal.

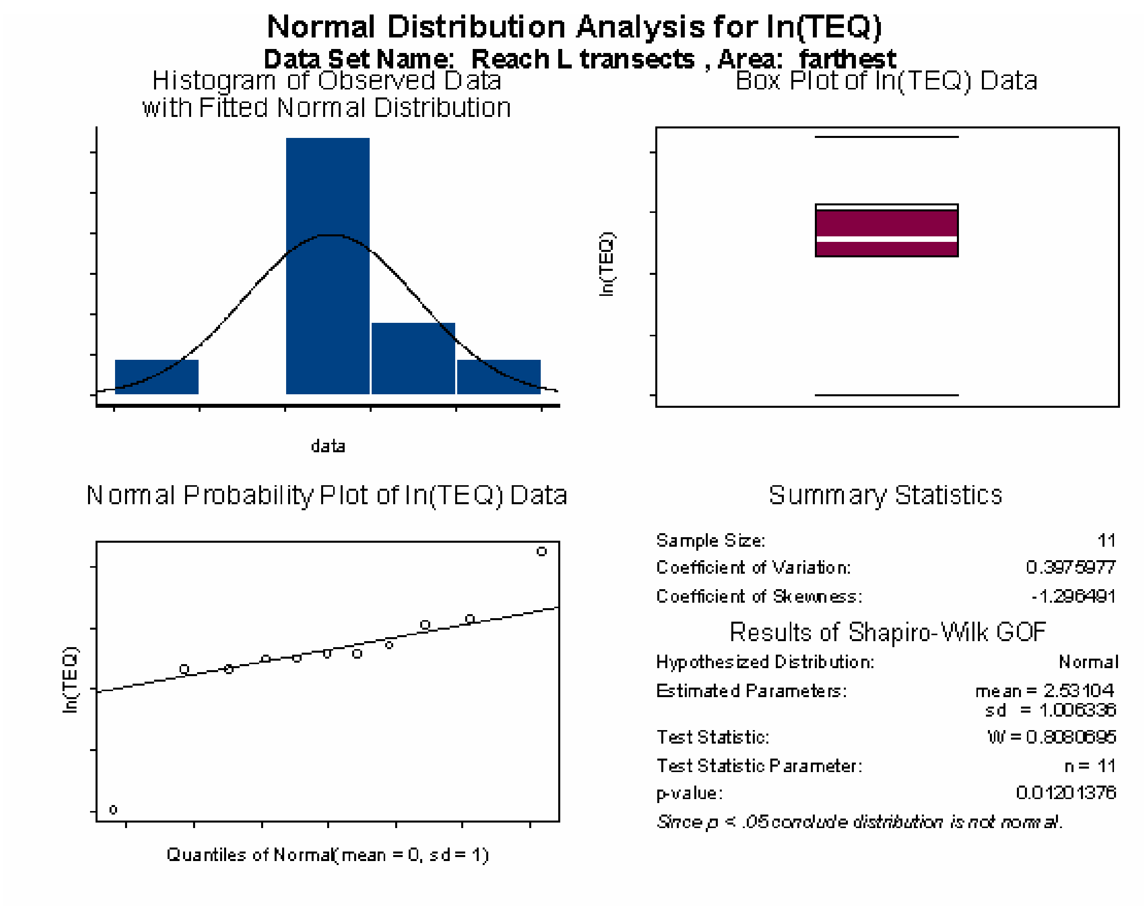

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO geomorph , Area: wetland
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 10
Coefficient of Variation: 0.1292267
Coefficient of Skewness: -0.3751863
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.604537
sd = 0.8534828
Test Statistic: W = 0.9733546
Test Statistic Parameter: n = 10
p-value: 0.9200854
Since p >= .05 conclude distribution is normal.


Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach NO geomorph , Area: upland
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 8
Coefficient of Variation: 0.2672966
Coefficient of Skewness: -0.767381
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 4.945285
sd = 1.321858
Test Statistic: W = 0.9143899
Test Statistic Parameter: n = 8
p-value: 0.386015
Since p >= .05 conclude distribution is normal.


Normal Distribution Analysis for ln(TEQ_fixed)
Data Set Name: Fixed Interval , Area: Fixed Interval
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ_fixed) Data
ln(TEQ_fixed)
Normal Probability Plot of ln(TEQ_fixed) Data
ln(TEQ_fixed)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 47
Coefficient of Variation: 0.528359
Coefficient of Skewness: 0.1345074
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 3.518081
sd = 1.85881
Test Statistic: W = 0.9085446
Test Statistic Parameter: n = 47
p-value: 0.001364832
Since p < .05 conclude distribution is not normal.

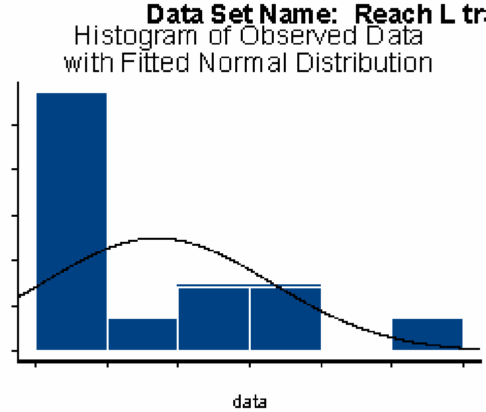

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L transects , Area: near stream
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 9
Coefficient of Variation: 0.093004
Coefficient of Skewness: -0.804939
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 5.93437
sd = 0.5519198
Test Statistic: W = 0.9227901
Test Statistic Parameter: n = 9
p-value: 0.4158392
Since p >= .05 conclude distribution is normal.

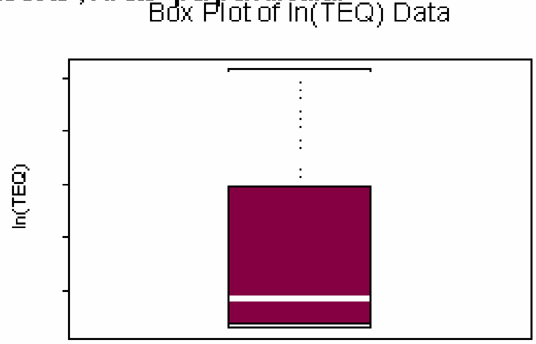

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L transects , Area: mid level
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 11
Coefficient of Variation: 0.0984715
Coefficient of Skewness: 1.244164
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 2.600144
sd = 0.25604
Test Statistic: W = 0.8828137
Test Statistic Parameter: n = 11
p-value: 0.1129496
Since p >= .05 conclude distribution is normal.

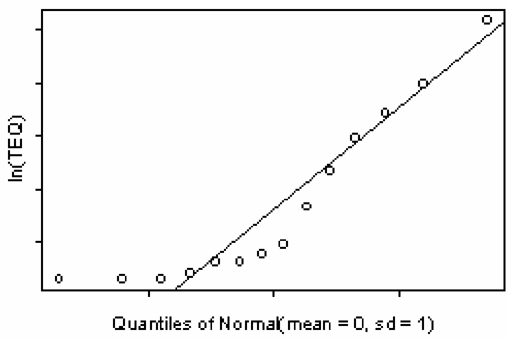

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L transects , Area: farthest
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 11
Coefficient of Variation: 0.3975977
Coefficient of Skewness: -1.296491
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 2.53104
sd = 1.006336
Test Statistic: W = 0.8080695
Test Statistic Parameter: n = 11
p-value: 0.01201376
Since p < .05 conclude distribution is not normal.

Normal Distribution Analysis for ln(TEQ)

Data Set Name: Reach L transects , Area: perpendicular







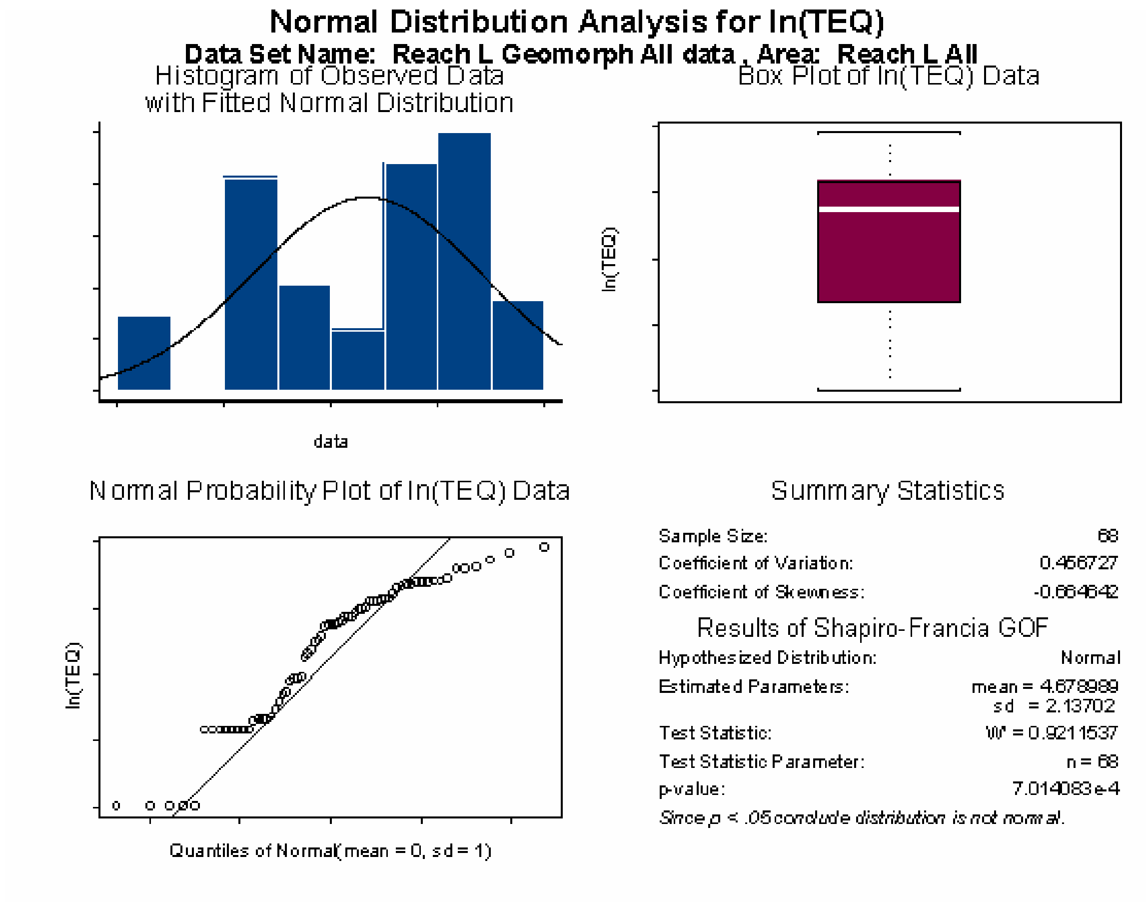
Summary Statistics

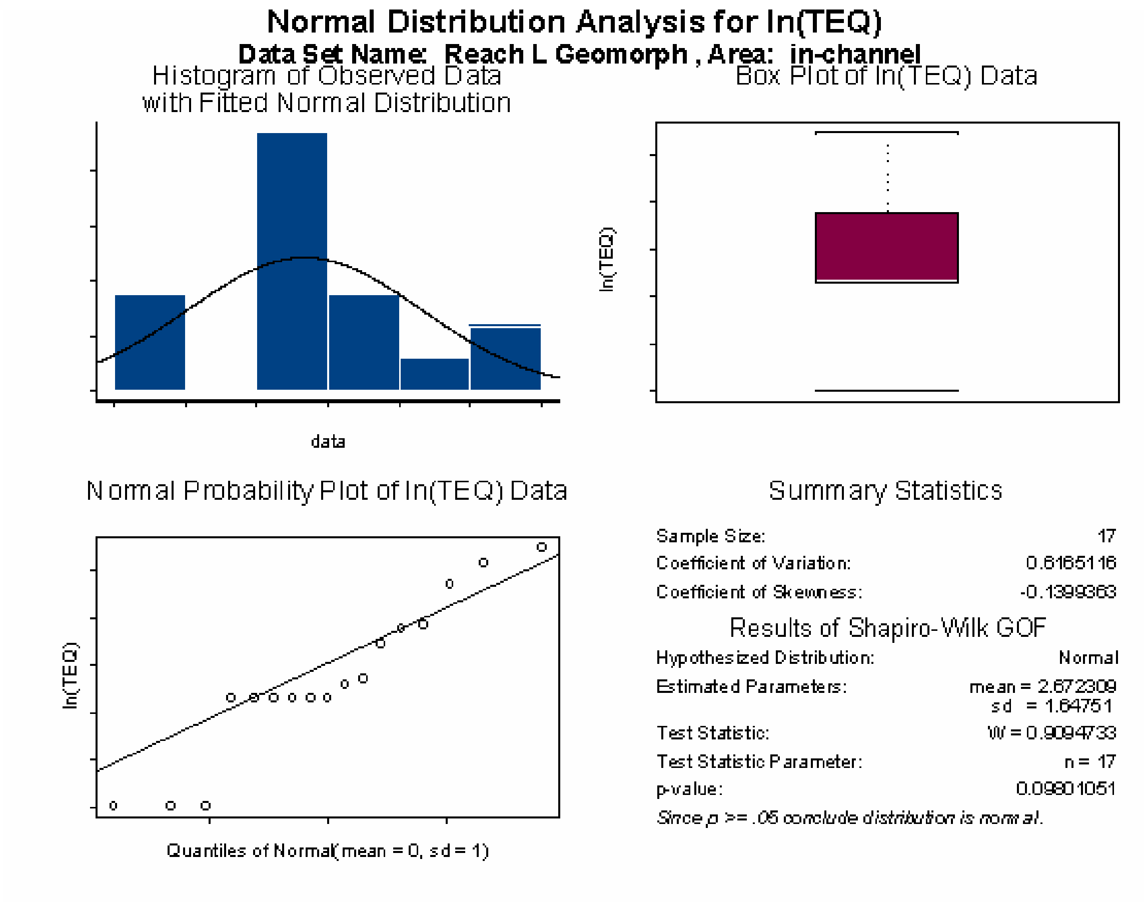
Sample Size:	14
Coefficient of Variation:	0.432954
Coefficient of Skewness:	1.017451

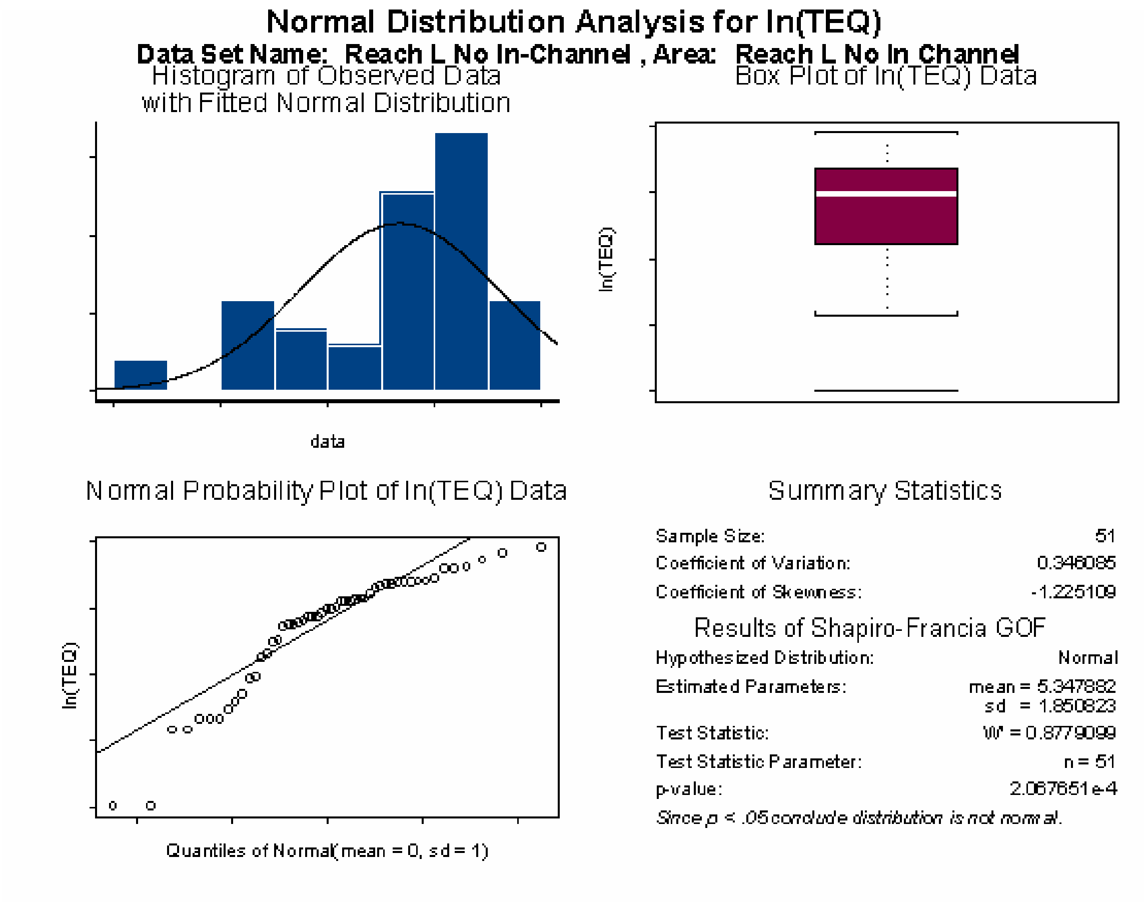
Results of Shapiro-Wilk GOF

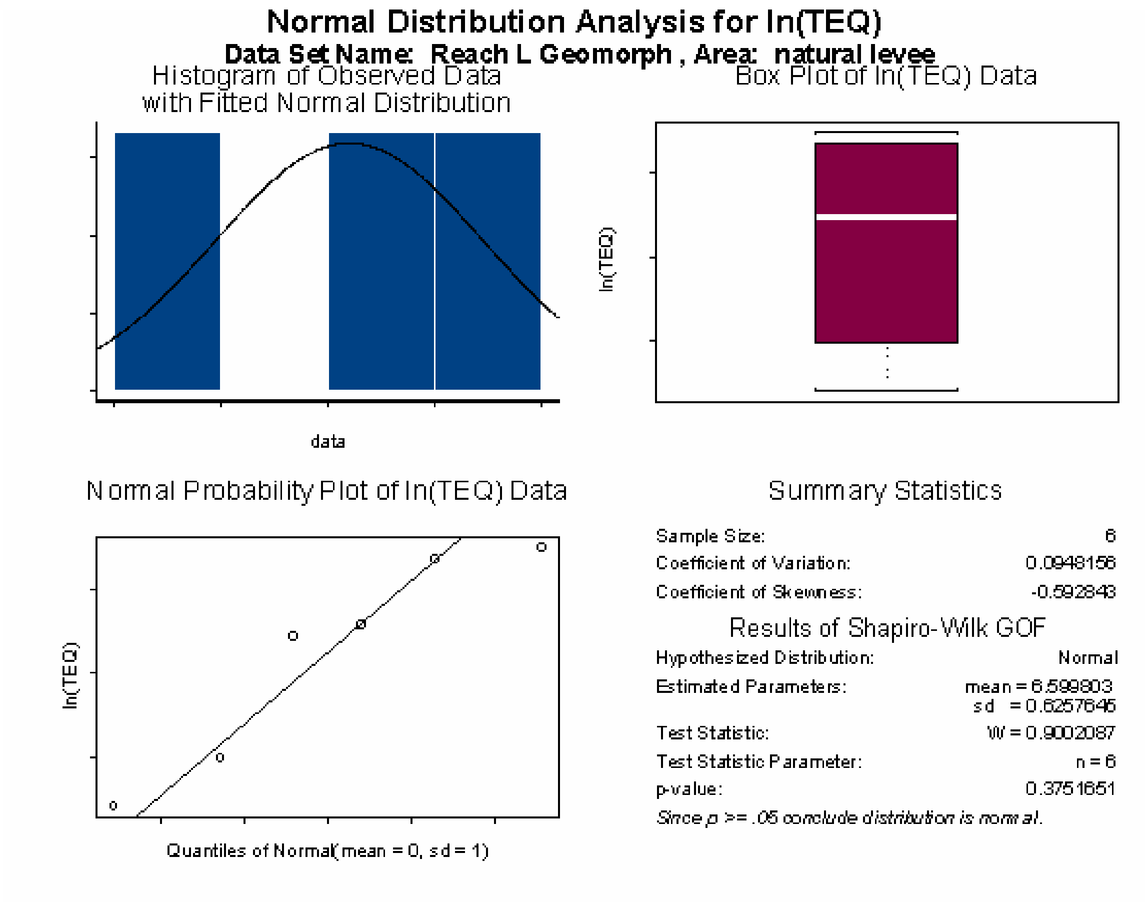
Hypothesized Distribution:	Normal
Estimated Parameters:	mean = 3.701725 sd = 1.602677
Test Statistic:	W = 0.8387478
Test Statistic Parameter:	n = 14
p-value:	0.01567874

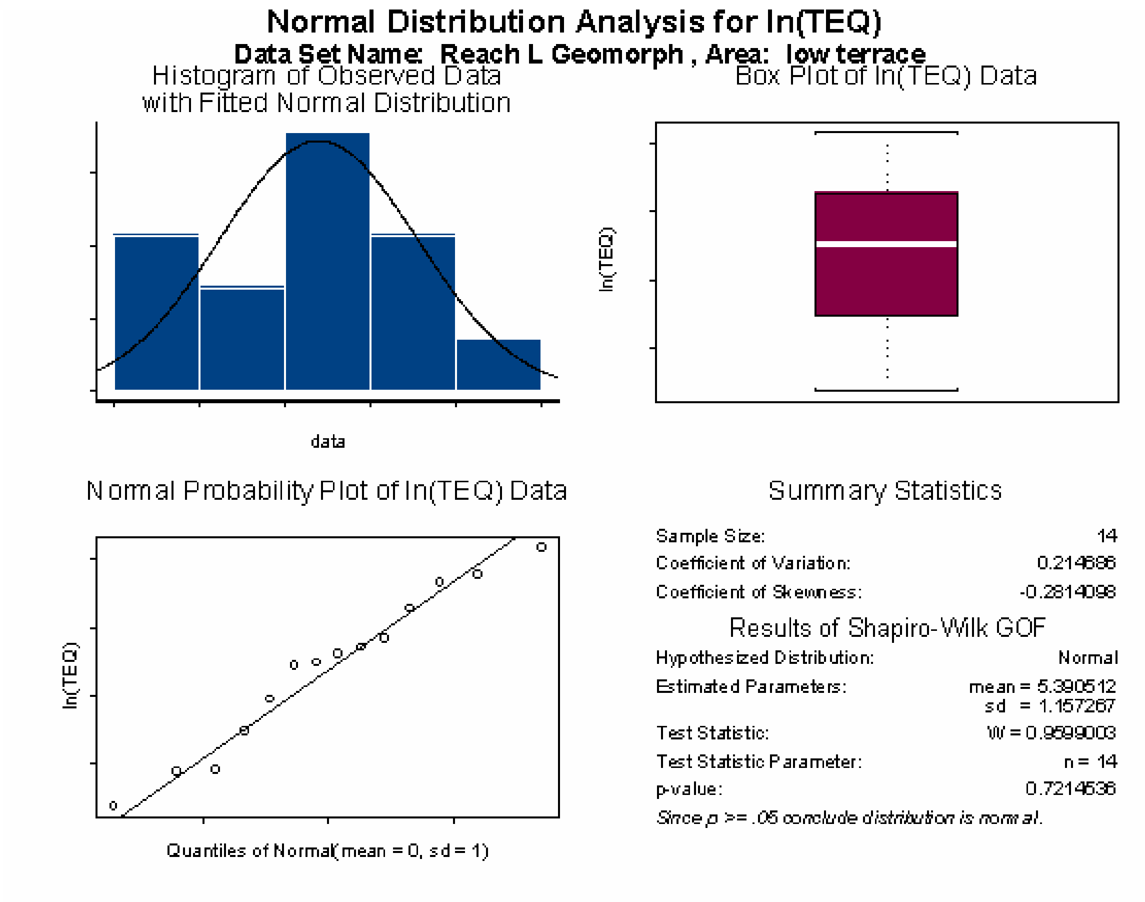
Since p < .05 conclude distribution is not normal.

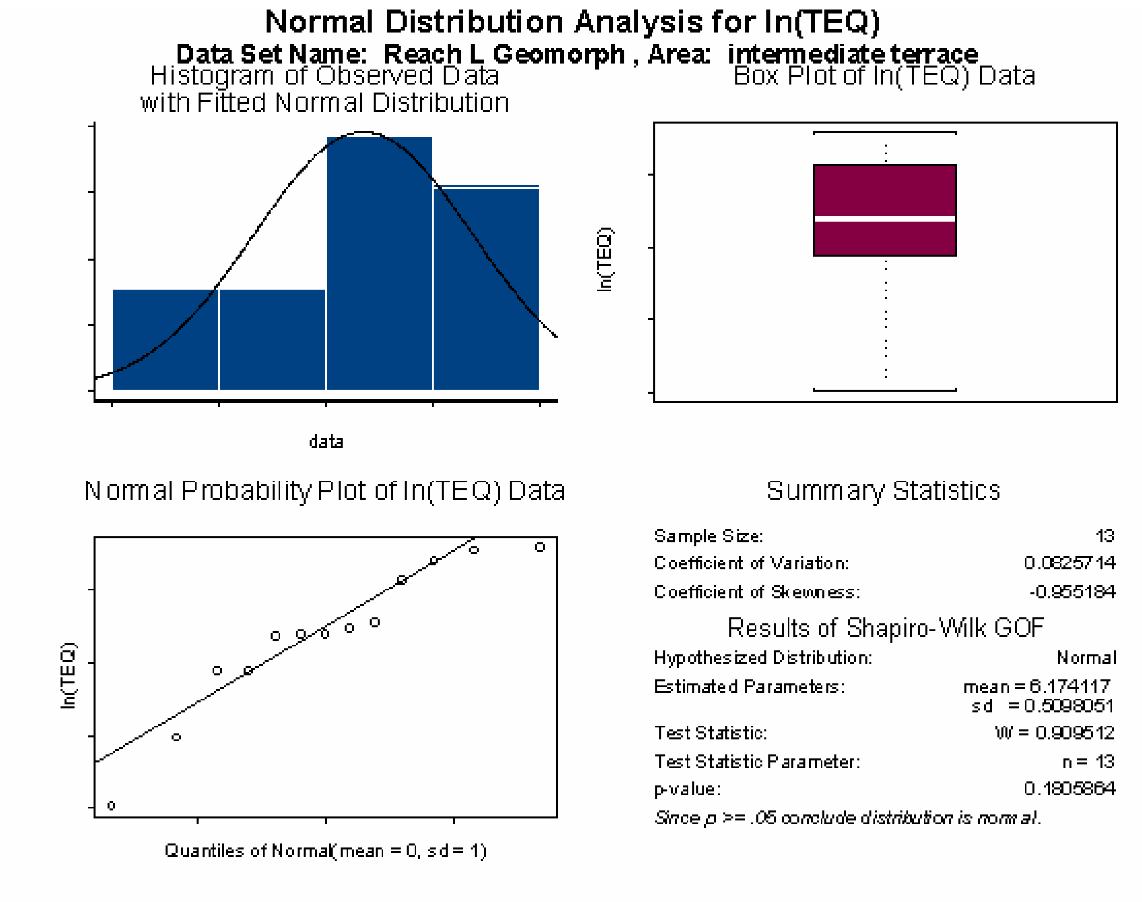

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph All data , Area: Reach L All
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 68
Coefficient of Variation: 0.456727
Coefficient of Skewness: -0.664642
Results of Shapiro-Francia GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 4.678989
sd = 2.13702
Test Statistic: W' = 0.9211537
Test Statistic Parameter: n = 68
p-value: 7.014083e-4
Since p < .05 conclude distribution is not normal.

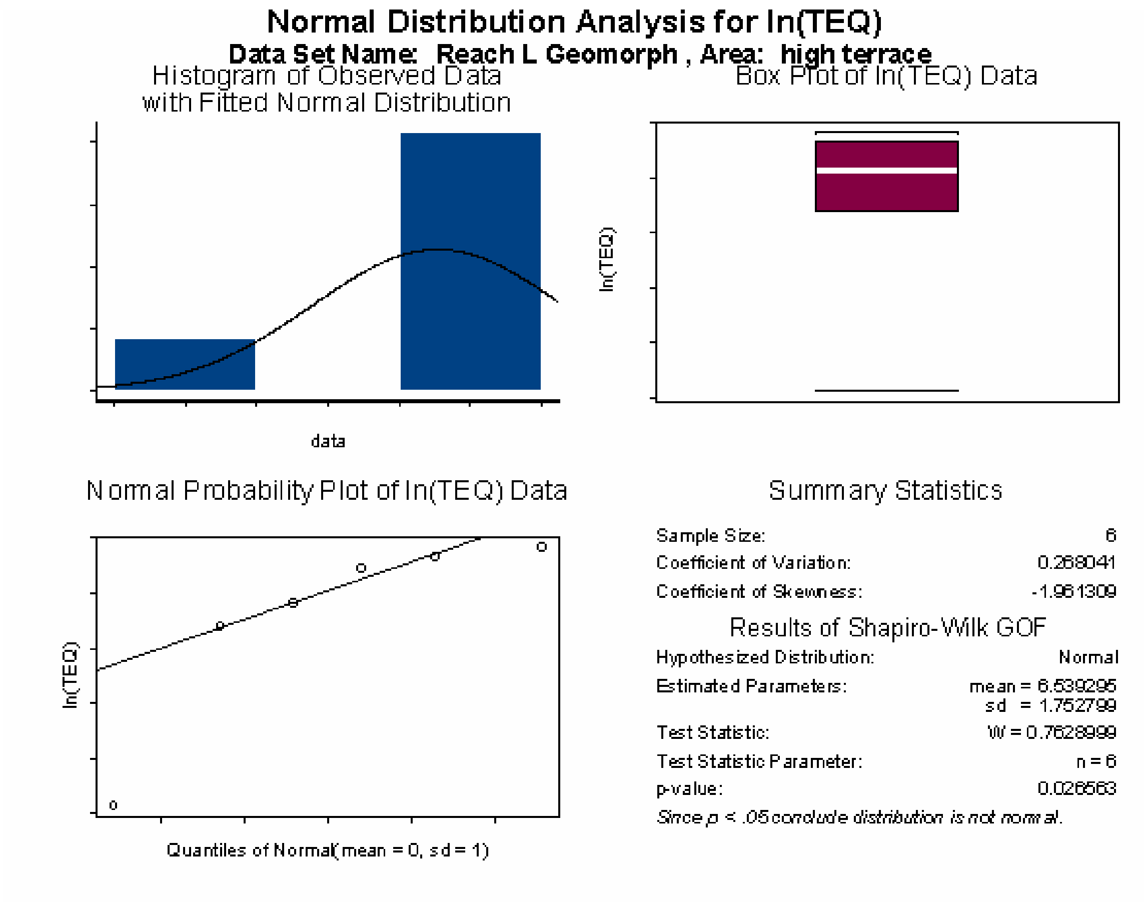

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: in-channel
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 17
Coefficient of Variation: 0.6165116
Coefficient of Skewness: -0.1399363
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 2.672309
sd = 1.64751
Test Statistic: W = 0.9094733
Test Statistic Parameter: n = 17
p-value: 0.09801051
Since p >= .05 conclude distribution is normal.

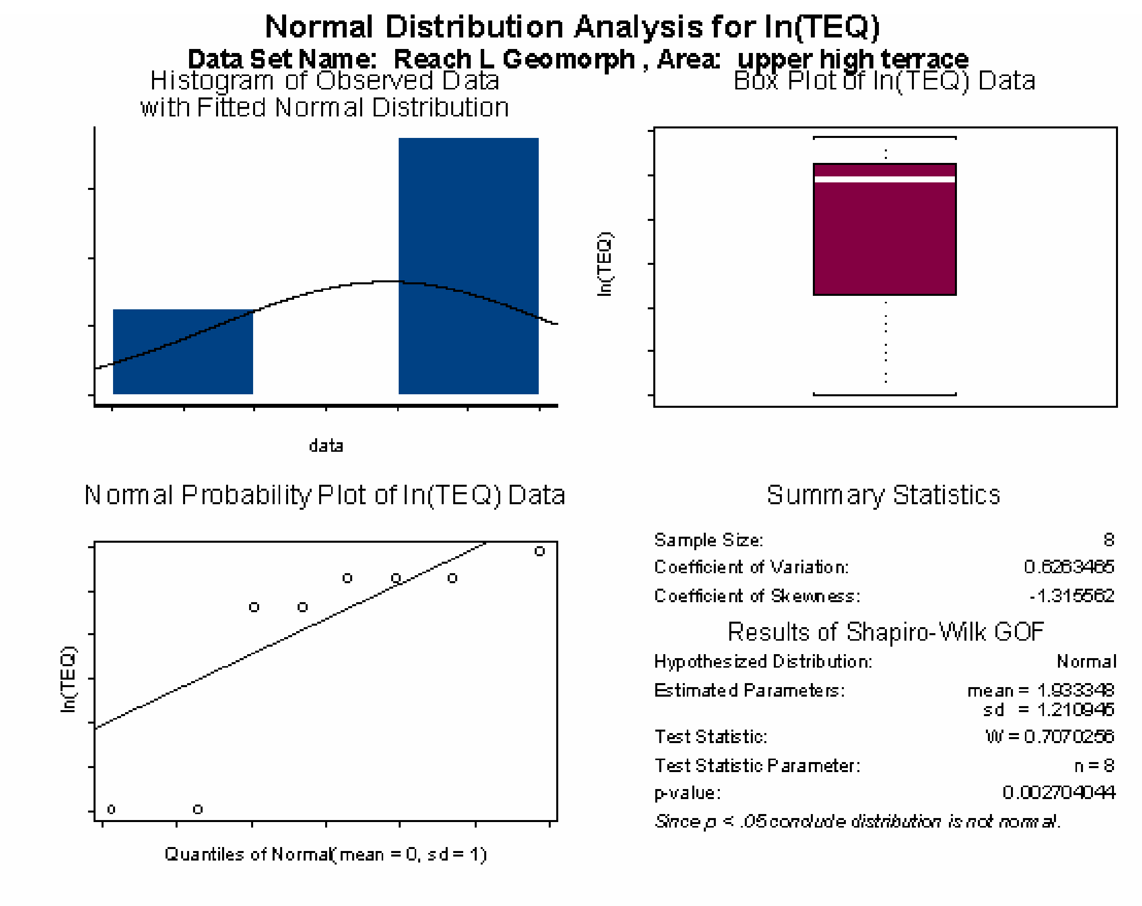

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L No In-Channel , Area: Reach L No In Channel
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 51
Coefficient of Variation: 0.346085
Coefficient of Skewness: -1.225109
Results of Shapiro-Francia GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 5.347882
sd = 1.850823
Test Statistic: W' = 0.8779099
Test Statistic Parameter: n = 51
p-value: 2.067651e-4
Since p < .05 conclude distribution is not normal.

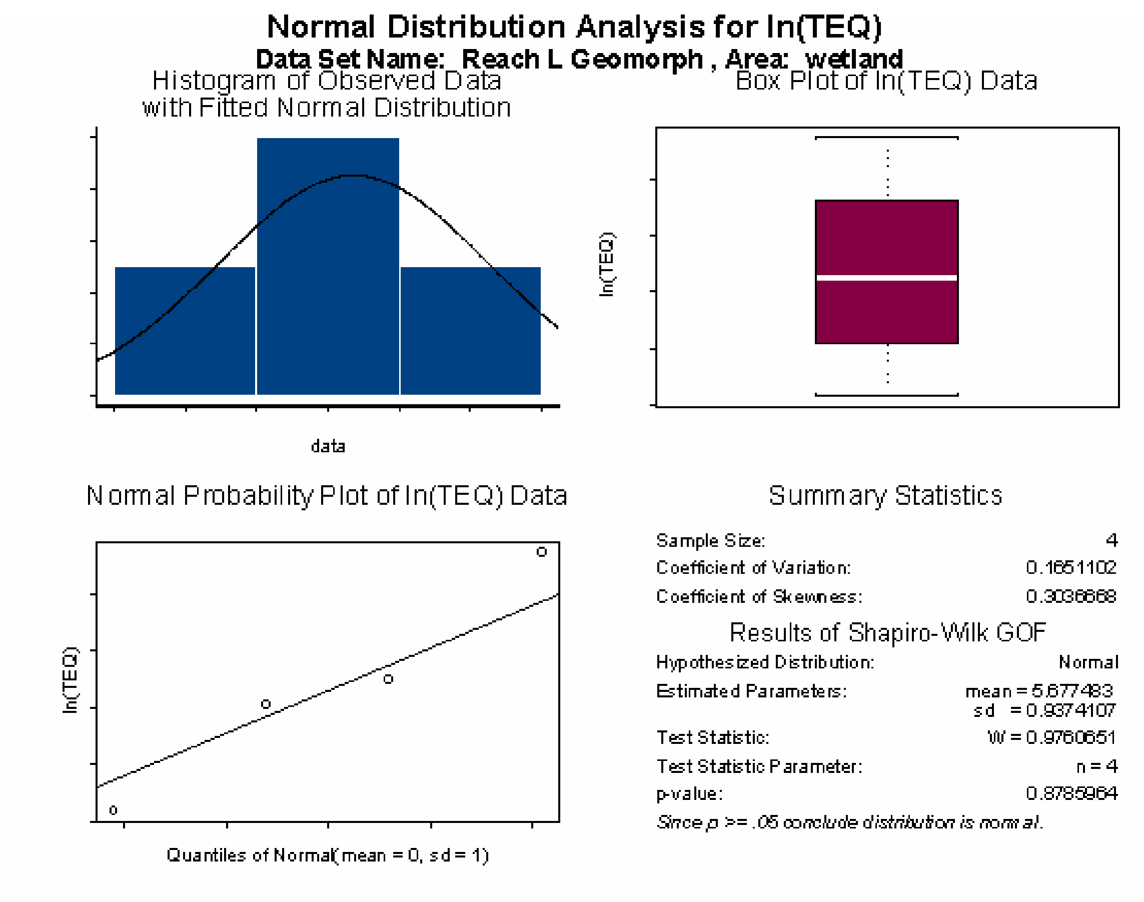

Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: natural levee
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 6
Coefficient of Variation: 0.0948156
Coefficient of Skewness: -0.592843
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.599803
sd = 0.6257646
Test Statistic: W = 0.9002087
Test Statistic Parameter: n = 6
p-value: 0.3751651
Since p >= .05 conclude distribution is normal.


Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: low terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 14
Coefficient of Variation: 0.214686
Coefficient of Skewness: -0.2814098
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 5.390512
sd = 1.157267
Test Statistic: W = 0.9599003
Test Statistic Parameter: n = 14
p-value: 0.7214536
Since p >= .05 conclude distribution is normal.


Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: intermediate terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 13
Coefficient of Variation: 0.0825714
Coefficient of Skewness: -0.955184
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.174117
sd = 0.5098051
Test Statistic: W = 0.909512
Test Statistic Parameter: n = 13
p-value: 0.1805864
Since p >= .05 conclude distribution is normal.


Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: high terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 6
Coefficient of Variation: 0.268041
Coefficient of Skewness: -1.961309
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 6.539295
sd = 1.752799
Test Statistic: W = 0.7628999
Test Statistic Parameter: n = 6
p-value: 0.026563
Since p < .05 conclude distribution is not normal.


Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: upper high terrace
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 8
Coefficient of Variation: 0.6263465
Coefficient of Skewness: -1.315562
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 1.933348
sd = 1.210945
Test Statistic: W = 0.7070256
Test Statistic Parameter: n = 8
p-value: 0.002704044
Since p < .05 conclude distribution is not normal.


Normal Distribution Analysis for ln(TEQ)
Data Set Name: Reach L Geomorph , Area: wetland
Histogram of Observed Data
with Fitted Normal Distribution
data
Box Plot of ln(TEQ) Data
ln(TEQ)
Normal Probability Plot of ln(TEQ) Data
ln(TEQ)
Quantiles of Normal(mean = 0, sd = 1)
Summary Statistics
Sample Size: 4
Coefficient of Variation: 0.1651102
Coefficient of Skewness: 0.3036668
Results of Shapiro-Wilk GOF
Hypothesized Distribution: Normal
Estimated Parameters: mean = 5.677483
sd = 0.9374107
Test Statistic: W = 0.9760651
Test Statistic Parameter: n = 4
p-value: 0.8785964
Since p >= .05 conclude distribution is normal.

Appendix B:

Source Data

Reach NO GeoMorph Samples

LOCID	Beginning depth (ft)	Ending depth (ft)	EstTotTEQ	SURFTYP	ln(TEQ)
RN-288+00-NE100	0	0.7	410	historic natural levee	6.01615716
RN-288+00-NE100	0	0.7	500	historic natural levee	6.214608098
RN-288+00-SW30	0	0.5	640	natural levee	6.461468176
RN-288+00-SW75	0	0.4	1200	high terrace	7.090076836
RN-290+50-IC-C	0	1.1	10	in-channel	2.302585093
RN-290+50-IC-NE	0	0.6	1	in-channel	0
RN-290+50-IC-SW	0	0.7	97	in-channel	4.574710979
RN-290+50-NE100	0	1.3	870	historic natural levee	6.768493212
RN-290+50-NE1160	0	1.5	10	high terrace	2.302585093
RN-290+50-NE130	0	1.4	150	high terrace	5.010635294
RN-290+50-NE1320	0	0.8	94	low terrace	4.543294782
RN-290+50-NE15	0	1	590	intermediate terrace	6.380122537
RN-290+50-NE40	0	2.3	7000	low terrace	8.853665428
RN-290+50-NE465	0	1.4	47	high terrace	3.850147602
RN-290+50-NE510	0	1.2	60	upland	4.094344562
RN-290+50-SW280	0	1.2	600	low terrace	6.396929655
RN-290+50-SW30	0	0.5	2600	intermediate terrace	7.863266724
RN-290+50-SW30	0	0.5	2800	intermediate terrace	7.937374696
RN-290+50-SW40	0	1.4	790	natural levee	6.672032945
RN-290+50-SW75	0	0.4	390	high terrace	5.966146739
RN-290+55-NE15	0	2.9	640	intermediate terrace	6.461468176
RN-292+00-SW250	0	1	2800	low terrace	7.937374696
RN-293+00-NE10	0	1.3	840	natural levee	6.733401892
RN-297+00-IC-C	0	1.3	10	in-channel	2.302585093
RN-297+00-IC-NE	0	0.6	11	in-channel	2.397895273
RN-297+00-IC-SW	0	0.3	14	in-channel	2.63905733
RN-297+00-NE1020	0	0.8	51	high terrace	3.931825633
RN-297+00-NE110	0	0.3	240	historic natural levee	5.480638923
RN-297+00-NE1270	0	0.2		low terrace	4.26267988
RN-297+00-NE1370	0	1.2	100	low terrace	4.605170186
RN-297+00-NE165	0	1.3	400	low terrace	5.991464547
RN-297+00-NE240	0	0.9	13	upland	2.564949357
RN-297+00-NE25	0	0.8	550	natural levee	6.309918278
RN-297+00-NE70	0	1.1	1500	low terrace	7.313220387
RN-297+00-NE890	0	1.1	27	high terrace	3.295836866
RN-297+00-SW100	0	0.3	2100	low terrace	7.649692624
RN-297+00-SW150	0	0.3	3500	high terrace	8.160518247
RN-297+00-SW20	0	2.2	180	natural levee	5.192956851

RN-297+00-SW200	0	0.3	5400	low terrace	8.594154233
RN-297+00-SW370	0	0.3	1300	wetland	7.170119543
RN-297+00-SW40	0	1.1	240	high terrace	5.480638923
RN-297+00-SW590	0	0.3	370	low terrace	5.913503006
RN-302+00-SW25	0	1.1	840	natural levee	6.733401892
RN-302+00-SW250	0	0.6	1300	low terrace	7.170119543
RN-302+00-SW475	0	0.6	1300	wetland	7.170119543
RN-305+00-IC-C	0	1.1	25	in-channel	3.218875825
RN-305+00-IC-NE	0	0.4	1	in-channel	0
RN-305+00-IC-SW	0	0.6	56	in-channel	4.025351691
RN-305+00-NE145	0	1.1	49	upland	3.891820298
RN-305+00-NE25	0	0.7	8600	natural levee	9.059517482
RN-305+00-NE45	0	0.9	7400	intermediate terrace	8.909235279
RN-305+00-NE80	0	1.6	30	high terrace	3.401197382
RN-305+00-SW100	0	1	8700	historic natural levee	9.071078305
RN-305+00-SW100	0	1	8700	historic natural levee	9.071078305
RN-305+00-SW135	0	0.8	2900	low terrace	7.972466016
RN-305+00-SW210	0	1.2	1600	high terrace	7.377758908
RN-305+00-SW275	0	1.1	800	low terrace	6.684611728
RN-305+00-SW30	0	1.1	910	high terrace	6.8134446
RN-305+00-SW520	0	1.1	570	wetland	6.345636361
RN-310+00-NE150	0	0.2	220	high terrace	5.393627546
RN-311+00-NE15	0	0.4	2900	natural levee	7.972466016
RN-316+00-IC-C	0	0.3	10	in-channel	2.302585093
RN-316+00-IC-NE	0	0.4	120	in-channel	4.787491743
RN-316+00-IC-SW	0	1.1	1	in-channel	0
RN-316+00-NE110	0	1.3	3100	historic natural levee	8.03915739
RN-316+00-NE1315	0	0.6	61	low terrace	4.110873864
RN-316+00-NE215	0	0.6	10000	intermediate terrace	9.210340372
RN-316+00-NE295	0	0.4	7100	high terrace	8.867850063
RN-316+00-NE30	0	1.2	1200	natural levee	7.090076836
RN-316+00-NE30N	0	1	15000	intermediate terrace	9.61580548
RN-316+00-NE30S	0	0.5	5500	high terrace	8.612503371
RN-316+00-NE395	0	0.8	3100	intermediate terrace	8.03915739
RN-316+00-NE495	0	0.7	290	high terrace	5.669880923
RN-316+00-NE885	0	0.9	63	high terrace	4.143134726
RN-316+00-SW100	0	0.3	220	intermediate terrace	5.393627546
RN-316+00-SW175	0	0.3	480	low terrace	6.173786104
RN-316+00-SW290	0	0.5	650	wetland	6.476972363
RN-316+00-SW30	0	1.1	330	natural levee	5.799092654
RN-316+00-SW570	0	0.5	140	wetland	4.941642423
RN-316+00-T-NE850	0	1.5	11	in-channel	2.397895273
RN-318+00-SW10	0	1.2	860	natural levee	6.756932389
RN-319+00-T-NE135	0	1	860	in-channel	6.756932389

RO-320+00-NE10	0	0.2	210	low terrace	5.347107531
RO-320+00-NE1130	0	0.8	60	high terrace	4.094344562
RO-320+00-NE1375	0	0.4	180	low terrace	5.192956851
RO-320+00-NE160	0	0.4	2300	low terrace	7.740664402
RO-320+00-NE2000	0	0.4	100	intermediate terrace	4.605170186
RO-320+00-NE25	0	0.5	10000	natural levee	9.210340372
RO-320+00-NE40	0	0.3	4600	low terrace	8.433811582
RO-320+00-NE420	0	0.2	1300	low terrace	7.170119543
RO-320+00-NE500	0	0.3	570	upland	6.345636361
RO-320+00-NE60	0	0.4	4000	low terrace	8.29404964
RO-320+00-NE635	0	0.9	570	upland	6.345636361
RO-320+00-NE765	0	1.4	140	high terrace	4.941642423
RO-320+00-NE85	0	0.5	2400	intermediate terrace	7.783224016
RO-320+00-SW10	0	0.7	3700	natural levee	8.216088099
RO-320+00-SW120	0	1.1	550	intermediate terrace	6.309918278
RO-320+00-SW210	0	0.7	480	wetland	6.173786104
RO-320+00-SW25	0	0.5	400	high terrace	5.991464547
RO-320+00-SW275	0	0.5	350	wetland	5.857933154
RO-320+00-SW45	0	0.9	200	intermediate terrace	5.298317367
RO-320+00-SW450	0	0.6	56	low terrace	4.025351691
RO-320+00-SW80	0	0.6	150	low terrace	5.010635294
RO-321+50-NE450	0	1	1600	low terrace	7.377758908
RO-321+50-NE50	0	0.3	9000	high terrace	9.104979856
RO-322+00-IC-SW75	0	0.2	10	in-channel	2.302585093
RO-322+00-T-SW205	0	0.8	1100	in-channel	7.003065459
RO-322+00-T-SW80	0	0.8	170	in-channel	5.135798437
RO-322+50-IC-C	0	0.5	240	in-channel	5.480638923
RO-322+50-IC-NE	0	0.2	10	in-channel	2.302585093
RO-322+50-IC-SW	0	0.8	1	in-channel	0
RO-322+50-IC-SW125	0	0.6	30	in-channel	3.401197382
RO-322+50-IC-SW25	0	0.2	33	in-channel	3.496507561
RO-322+50-IC-SW50	0	0.3	10	in-channel	2.302585093
RO-322+50-IC-SW75	0	0.6	1	in-channel	0
RO-323+00-IC-SW75	0	0.6	12	in-channel	2.48490665
RO-323+00-SW10	0	1	4400	natural levee	8.38935982
RO-323+50-IC-SW75	0	0.3	10	in-channel	2.302585093
RO-325+50-NE10	0	0.3	4900	natural levee	8.496990484
RO-325+50-NE1340	0	0.7	31	high terrace	3.433987204
RO-325+50-NE1730	0	0.2	160	low terrace	5.075173815
RO-325+50-NE2210	0	0.7	52	intermediate terrace	3.951243719
RO-325+50-NE385	0	0.2	2100	low terrace	7.649692624
RO-325+50-NE45	0	0.3	13000	low terrace	9.472704636
RO-325+50-NE450	0	0.3	880	wetland	6.779921907
RO-325+50-NE515	0	0.5	3100	wetland	8.03915739
RO-325+50-NE560	0	1.9	280	upland	5.634789603

RO-325+50-NE70	0	0.3	1900	low terrace	7.549609165
RO-325+50-NE840	0	0.8	200	high terrace	5.298317367
RO-325+50-NE90	0	0.2	2900	low terrace	7.972466016
RO-325+50-SW190	0	1.1	120	intermediate terrace	4.787491743
RO-325+50-SW20	0	0.6	530	low terrace	6.272877007
RO-325+50-SW245	0	0.3	19	high terrace	2.944438979
RO-325+50-SW40	0	0.2	470	low terrace	6.152732695
RO-327+50-IC-C	0	0.4	18	in-channel	2.890371758
RO-327+50-IC-NE	0	0.7	11	in-channel	2.397895273
RO-327+50-IC-SW	0	0.3	1	in-channel	0
RO-329+00-NE100	0	0.4	4200	intermediate terrace	8.342839804
RO-329+00-NE20	0	0.8	1600	natural levee	7.377758908
RO-329+00-NE240	0	0.4	2200	low terrace	7.696212639
RO-329+00-NE500	0	1.1	750	low terrace	6.620073207
RO-330+00-SW10	0	0.3	240	natural levee	5.480638923
RO-333+00-IC-C	0	0.3	10	in-channel	2.302585093
RO-333+00-IC-NE	0	0.3	1	in-channel	0
RO-333+00-IC-SW	0	0.6	10	in-channel	2.302585093
RO-333+00-NE1000	0	0.8	45	high terrace	3.80666249
RO-333+00-NE160	0	0.2	620	intermediate terrace	6.429719478
RO-333+00-NE300	0	0.2	1200	wetland	7.090076836
RO-333+00-NE440	0	0.3	740	low terrace	6.606650186
RO-333+00-NE505	0	0.3	590	low terrace	6.380122537
RO-333+00-NE590	0	0.2	190	upland	5.247024072
RO-333+00-NE680	0	0.4	230	upland	5.438079309
RO-333+00-SW10	0	0.2	400	intermediate terrace	5.991464547
RO-333+00-SW240	0	0.2	1900	low terrace	7.549609165
RO-333+00-SW240	0	0.2	1900	low terrace	7.549609165
RO-333+00-SW30	0	0.5	600	intermediate terrace	6.396929655
RO-333+00-SW315	0	0.4	160	low terrace	5.075173815
RO-333+00-SW315	0	0.4	300	low terrace	5.703782475
RO-333+00-SW60	0	0.2	880	intermediate terrace	6.779921907

Reach L Geomorph Samples

LOCID	Beginning depth (ft)	Ending depth (ft)	SURFTYP	ln(TEQ)
RL-235+50-SW10	0	0.5	low terrace	5.703782475
RL-235+50-SW130	0	0.5	intermediate terrace	6.768493212
RL-235+50-SW165	0	1.2	high terrace	6.791221463
RL-235+50-SW360	0	0.6	intermediate terrace	5.480638923
RL-235+50-SW460	0	1.4	low terrace	6.65929392
RL-235+50-SW525	0	0.6	high terrace	3.135494216
RL-235+50-SW615	0	0.6	upper high terrace	2.63905733
RL-235+50-SW70	0	0.3	intermediate terrace	6.791221463
RL-236+00-SW10	0	0.4	intermediate terrace	6.234410726
RL-236+00-SW70	0	1.6	natural levee	7.170119543
RL-239+00-IC-C	0	0.4	in-channel	2.302585093
RL-239+00-IC-SW	0	0.7	in-channel	5.135798437
RL-239+00-SW10	0	0.4	intermediate terrace	6.56526497
RL-239+00-SW110	0	0.6	intermediate terrace	6.194405391
RL-239+00-SW150	0	0.5	low terrace	5.598421959
RL-239+00-SW170	0	0.3	intermediate terrace	6.697034248
RL-239+00-SW220	0	0.3	low terrace	7.170119543
RL-239+00-SW335	0	0.3	intermediate terrace	6.194405391
RL-239+00-SW455	0	0.6	low terrace	5.480638923
RL-239+00-SW560	0	0.6	upper high terrace	2.302585093
RL-239+00-SW70	0	0.5	high terrace	6.396929655
RL-239+00-SW905	0	0.6	upper high terrace	0
RL-239+00-SW905	0	0.6	upper high terrace	2.302585093
RL-242+00-SW15	0	1	natural levee	5.991464547
RL-243+00-SW70	0	0.3	natural levee	7.244227516
RL-243+50-SW15	0	0.6	natural levee	5.703782475
RL-244+00-SW1025	0	0.5	in-channel	2.302585093
RL-245+00-SW1025	0	0.8	in-channel	2.302585093
RL-246+00-IC-C	0	0.9	in-channel	3.828641396
RL-246+00-IC-SW	0	1.6	in-channel	0
RL-246+00-SW1025	0	0.7	in-channel	2.302585093
RL-246+00-SW130	0	0.3	low terrace	4.941642423
RL-246+00-SW20	0	0.6	intermediate terrace	5.010635294
RL-246+00-SW265	0	0.8	wetland	6.866933284
RL-246+00-SW330	0	0.7	low terrace	6.272877007
RL-246+00-SW475	0	0.7	low terrace	5.438079309
RL-246+00-SW540	0	0.6	upper high terrace	0
RL-246+00-SW725	0	1.2	upper high terrace	2.63905733
RL-246+00-SW825	0	0.5	in-channel	0
RL-246+00-SW85	0	0.6	high terrace	7.649692624
RL-246+00-SW925	0	1.2	in-channel	3.761200116
RL-246+05-SW20	0	0.6	intermediate terrace	5.940171253
RL-249+00-SW10	0	0.6	natural levee	6.70930434
RL-249+00-SW420	0	0.4	low terrace	4.465908119
RL-252+00-IC-C	0	0.3	in-channel	2.302585093

RL-252+00-IC-NE	0	0.3	in-channel	3.433987204
RL-252+00-IC-SW	0	1.5	in-channel	2.708050201
RL-252+00-SW30	0	0.3	high terrace	7.824046011
RL-252+00-SW320	0	1.1	wetland	5.736572297
RL-252+00-SW410	0	1	low terrace	3.36729583
RL-252+00-SW495	0	0.9	upper high terrace	2.63905733
RL-252+00-SW70	0	1.5	intermediate terrace	5.940171253
RL-252+00-SW730	0	1.1	low terrace	3.871201011
RL-252+05-SW5	0	0.4	low terrace	3.912023005
RL-255+00-SW15	0	0.5	natural levee	6.779921907
RL-256+00-SW120	0	0.9	low terrace	5.828945618
RL-256+00-SW275	0	0.9	wetland	5.521460918
RL-258+50-IC-C	0	1.2	in-channel	0
RL-258+50-IC-NE	0	0.5	in-channel	2.302585093
RL-258+50-IC-SW	0	0.6	in-channel	2.564949357
RL-258+50-SW125	0	1.1	low terrace	6.756932389
RL-258+50-SW15	0	1.3	intermediate terrace	6.173786104
RL-258+50-SW285	0	0.8	wetland	4.584967479
RL-258+50-SW435	0	0.8	upper high terrace	2.944438979
RL-258+50-SW45	0	1.5	high terrace	7.43838353
RL-258+55-SW15	0	1.3	intermediate terrace	6.272877007
RL-260+50-T-SW320	0	1.1	in-channel	4.700480366
RL-260+50-T-SW70	0	1.1	in-channel	5.480638923

Fixed Interval Transect Samples

Transect Location/Sample Identification Reach L	Depth Interval (ft)	Estimated Total TEQ (ppt)
RL-241+00-SW1020	0.0-1.0	12
RL-241+00-SW20	0.0-1.0	130
RL-241+00-SW520	0.0-1.0	17
RL-242+00-SW1020	0.0-1.0	13
RL-242+00-SW20	0.0-1.0	230
RL-242+00-SW520	0.0-1.0	24
RL-243+00-SW1020	0.0-1.0	12
RL-243+00-SW20	0.0-1.0	130
RL-243+00-SW520	0.0-1.0	12
RL-244+00-SW1025	0.0-0.5	10
RL-244+00-SW20	0.0-1.0	310
RL-244+00-SW520	0.0-1.0	12
RL-245+00-SW1025	0.0-0.8	1
RL-245+00-SW20	0.0-1.0	690
RL-245+00-SW520	0.0-1.0	12
RL-246+00-SW1025	0.0-0.7	10
RL-246+00-SW1120	0.0-1.0	10
RL-246+00-SW120	0.0-1.0	77
RL-246+00-SW1220	0.0-1.0	19
RL-246+00-SW1320	0.0-1.0	16
RL-246+00-SW1420	0.0-1.0	12
RL-246+00-SW1520	0.0-1.0	1
RL-246+00-SW20	0.0-1.0	570
RL-246+00-SW220	0.0-1.0	1300
RL-246+00-SW320	0.0-1.0	230
RL-246+00-SW420	0.0-1.0	140
RL-246+00-SW5	0.0-1.0	390
RL-246+00-SW520	0.0-1.0	11
RL-246+00-SW620	0.0-1.0	14
RL-246+00-SW720	0.0-1.0	14
RL-246+00-SW825	0.0-0.5	10
RL-246+00-SW925	0.0-1.2	39
RL-247+00-SW1020	0.0-1.0	21
RL-247+00-SW20	0.0-1.0	190
RL-247+00-SW520	0.0-1.0	10
RL-248+00-SW1020	0.0-1.0	70
RL-248+00-SW20	0.0-1.0	520
RL-248+00-SW520	0.0-1.0	11
RL-249+00-SW1020	0.0-1.0	15
RL-249+00-SW20	0.0-1.0	650
RL-249+00-SW520	0.0-1.0	14
RL-250+00-SW1020	0.0-1.0	13
RL-250+00-SW20	0.0-1.0	310
RL-250+00-SW520	0.0-1.0	13
RL-251+00-SW1020	0.0-1.0	23
RL-251+00-SW20	0.0-1.0	600
RL-251+00-SW520	0.0-1.0	17

Random on Grid Samples

Location/Sample Identification Reach NO	Depth Interval (ft)	Estimated Total TEQ (ppt)
FRE-03156	0.0-1.0	1000
FRE-04726	0.0-1.0	930
FRE-04740	0.0-1.0	130
FRE-04745	0.0-1.0	120
FRE-04760	0.0-1.0	870
FRE-04762	0.0-1.0	49
FRE-04767	0.0-1.0	180
FRE-04768	0.0-1.0	1100
FRE-04893	0.0-1.0	10
FRE-04935	0.0-1.0	13
FRE-04981	0.0-1.0	750
MIC-04729	0.0-1.0	93
MIC-04739	0.0-1.0	51
MIC-04742	0.0-1.0	10
MIC-04743	0.0-1.0	46
MIC-04744	0.0-1.0	79
MIC-04747	0.0-1.0	64
MIC-04748	0.0-1.0	45
MIC-04749	0.0-1.0	34
MIC-04750	0.0-1.0	270
MIC-04751	0.0-1.0	530
MIC-04752	0.0-1.0	630
MIC-04753	0.0-1.0	51
MIC-04756	0.0-1.0	59
MIC-04757	0.0-1.0	110
MIC-04758	0.0-1.0	51
MIC-04759	0.0-1.0	6000
MIC-04763	0.0-1.0	630
MIC-04764	0.0-1.0	16
MIC-04771	0.0-1.0	2900
MIC-04774	0.0-1.0	2700
MIC-04882	0.0-1.0	1200
MIC-04894	0.0-1.0	12
MIC-04895	0.0-1.0	5
MIC-04903	0.0-1.0	6600
MIC-04943	0.0-1.0	17
MIC-04944	0.0-1.0	15
MIC-04945	0.0-1.0	30
MIC-04946	0.0-1.0	8
MIC-04947	0.0-1.0	5
MIC-04948	0.0-1.0	7
MIC-04949	0.0-1.0	13
MIC-04950	0.0-1.0	5
FRE-04766	0.0-1.0	150
FRE-04770	0.0-1.0	100
FRE-04728	0.0-1.0	160

FRE-04738	0.0-1.0	100
FRE-04746	0.0-1.0	82
FRE-04754	0.0-1.0	140
FRE-04755	0.0-1.0	240
FRE-04936	0.0-1.0	26
FRE-04937	0.0-1.0	87
FRE-04938	0.0-1.0	27
FRE-04777	0.0-1.0	200
FRE-04765	0.0-1.0	310
FRE-04775	0.0-1.0	170
FRE-04761	0.0-1.0	570
FRE-04808	0.0-1.0	1300