Appendix C

A & C Canal Level Analysis

US Army Corps
of Engineers
Norfolk District

Chesapeake
VIRGINIA
Department of Public Works

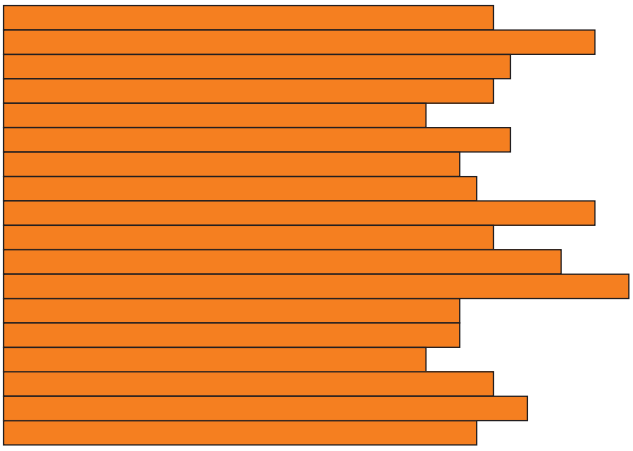
URS

Project: Albemarle & Chesapeake Canal, North Landing River Bridge
User: John N. Paine, PE, PH, CFM
Date: 24 August 2005, Wednesday
Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

This data is an ANNUAL MAXIMUM series.

DATA ENTERED

Water Year	PEAK STAGE h ft
1988	2.9
1989	3.5
1990	3.0
1991	2.9
1992	2.5
1993	3.0
1994	2.7
1995	2.8
1996	3.5
1997	2.9
1998	3.3
1999	3.7
2000	2.7
2001	2.7
2002	2.5
2003	2.9
2004	3.1
2005	2.8



End of Data Series ==========
This series contains 18 years of data.

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DATA AS CONTAINED IN: C:\CAHH\A_AND_C_CANAL.HDF

UNSORTED

h (ft)	Rank	Plotting Position	Plotted Period (yrs)
2.9	8	.4211	2.375
3.5	2	.1053	9.500
3.0	6	.3158	3.167
2.9	8	.4211	2.375
2.5	17	.8947	1.118
3.0	6	.3158	3.167
2.7	14	.7368	1.357
2.8	12	.6316	1.583
3.5	2	.1053	9.500
2.9	8	.4211	2.375
3.3	4	.2105	4.750
3.7	1	.0526	19.000
2.7	14	.7368	1.357
2.7	14	.7368	1.357
2.5	17	.8947	1.118
2.9	8	.4211	2.375
3.1	5	.2632	3.800
2.8	12	.6316	1.583

SORTED

h (ft)	Rank	Plotting Position	Plotted Period (yrs)
3.7	1	.0526	19.000
3.5	2	.1053	9.500
3.5	3	.1579	6.333
3.3	4	.2105	4.750
3.1	5	.2632	3.800
3.0	6	.3158	3.167
3.0	7	.3684	2.714
2.9	8	.4211	2.375
2.9	9	.4737	2.111
2.9	10	.5263	1.900
2.9	11	.5789	1.727
2.8	12	.6316	1.583
2.8	13	.6842	1.462
2.7	14	.7368	1.357
2.7	15	.7895	1.267
2.7	16	.8421	1.188
2.5	17	.8947	1.118
2.5	18	.9474	1.056

Note that the UNSORTED listing will give the same rank to identical values occuring in the input data file. The SORTED listing shows all ranks.

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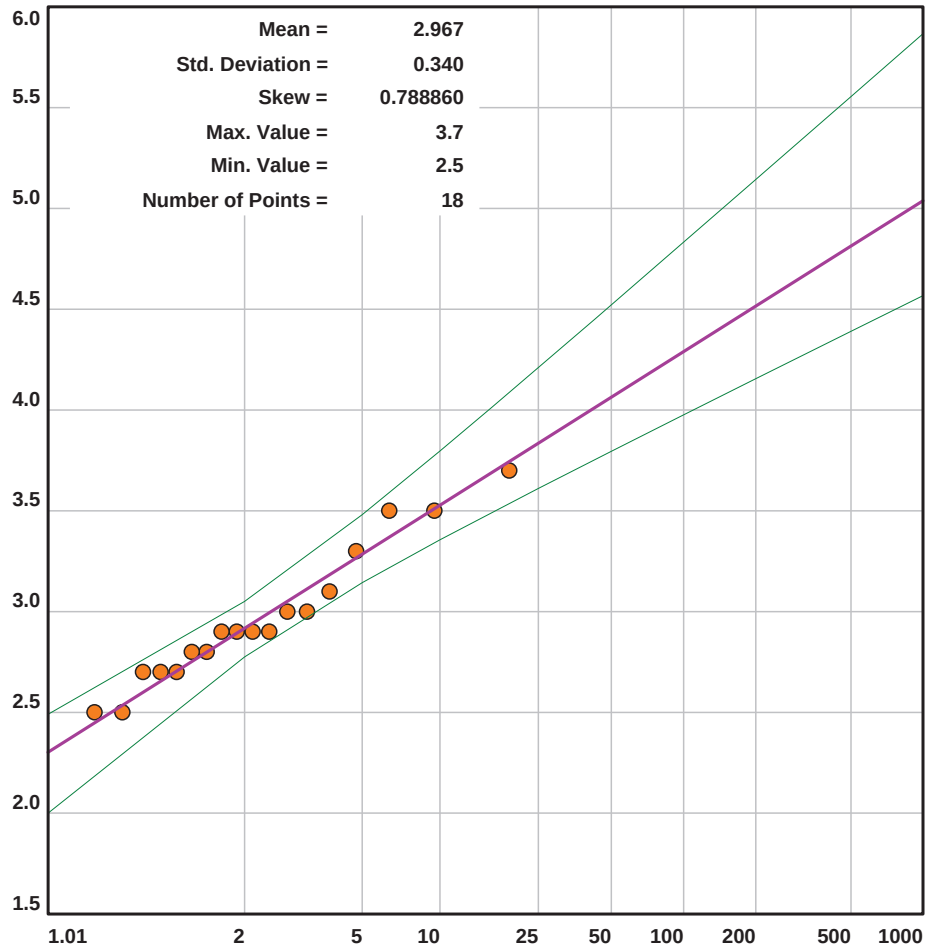
Output: C:\CAHH\A_AND_C_CANAL.OUT

EXTREME VALUE TYPE I (GUMBEL) DISTRIBUTION

PEAK STAGE (ft)

Tr (yrs)	h ft
1.01	2.3
2	2.9
5	3.3
10	3.5
25	3.8
50	4.1
100	4.3
200	4.5
500	4.8
1000	5.0



PASSED
Chi-Square Test

Albemarle & Chesapeake Canal, North Landing River Bridge **RETURN PERIOD (yrs)**

Project: Albemarle & Chesapeake Canal, North Landing River Bridge
User: John N. Paine, PE, PH, CFM
Date: 24 August 2005, Wednesday
Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean =	2.967	Maximum Input Value =	3.7
Std. Deviation =	0.340	Minimum Input Value =	2.5
Skew =	0.78885950	Number of Points =	18

EXTREME VALUE TYPE I (GUMBEL) DISTRIBUTION

RETURN PERIOD (yrs)	h (ft)	FREQUENCY FACTOR	h 90% CONFIDENCE LIMITS Lower (ft)	Upper (ft)
1.01	2.3	-1.9564	2.0	2.5
2	2.9	-0.1459	2.8	3.1
5	3.3	0.9365	3.1	3.5
10	3.5	1.6532	3.4	3.8
25	3.8	2.5586	3.6	4.2
50	4.1	3.2304	3.8	4.5
100	4.3	3.8971	4.0	4.8
200	4.5	4.5615	4.2	5.1
500	4.8	5.4380	4.4	5.6
1,000	5.0	6.1004	4.6	5.9

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Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean =	2.967	Maximum Input Value =	3.7
Std. Deviation =	0.340	Minimum Input Value =	2.5
Skew =	0.78885950	Number of Points =	18

EXTREME VALUE TYPE I (GUMBEL) DISTRIBUTION
CHI-SQUARE TEST FOR GOODNESS-OF-FIT

	CLASS LIMITS		NUMBER OF VALUES		
CLASS	Lower (ft)	Upper (ft)	Expected "Ei"	Observed "Oi"	$\frac{(Oi-Ei)^2}{Ei}$
1	0.0	2.6	3.0000	2	0.3333
2	2.6	2.8	3.0000	3	0.0000
3	2.8	2.9	3.0000	6	3.0000
4	2.9	3.1	3.0000	2	0.3333
5	3.1	3.4	3.0000	2	0.3333
6	3.4	Infinity	3.0000	3	0.0000
				COMPUTED CHI-SQUARE =	4.0000
				CHI-SQUARE FROM TABLE =	6.2500

CONCLUDE: Based on Chi-Square (Goodness-of-Fit) results,
the EXTREME VALUE TYPE I (GUMBEL) DISTRIBUTION DOES apply to the input data.
Note that Chi-Square results are dependent upon the number of class intervals used.

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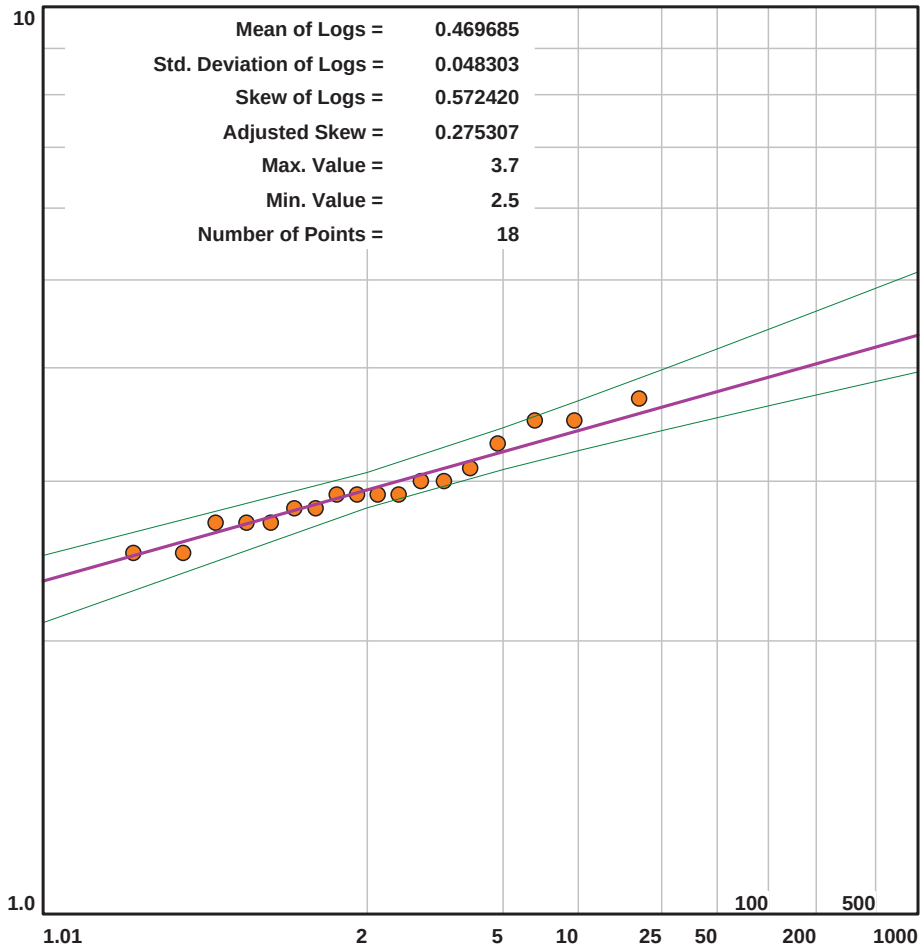
Date: 24 August 2005, Wednesday
Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

LOG-PEARSON TYPE III DISTRIBUTION

PEAK STAGE (ft)

Tr (yrs)	h ft
1.01	2.3
2	2.9
5	3.2
10	3.4
25	3.6
50	3.8
100	3.9
200	4.0
500	4.2
1000	4.3



FAILED
Chi-Square Test

Albemarle & Chesapeake Canal, North Landing River Bridge

RETURN PERIOD (yrs)

Project: Albemarle & Chesapeake Canal, North Landing River Bridge
User: John N. Paine, PE, PH, CFM
Date: 24 August 2005, Wednesday
Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean of Logs =	0.469685	Maximum Input Value =	3.7
Std. Deviation of Logs =	0.048303	Minimum Input Value =	2.5
Skew of Logs =	0.572420	Number of Points =	18
Adjusted Skew =	0.275307	Generalized Map Skew =	0.0

LOG-PEARSON TYPE III DISTRIBUTION

RETURN PERIOD (yrs)	h (ft)	FREQUENCY FACTOR	h 90% CONFIDENCE LIMITS Lower (ft)	Upper (ft)
1.01	2.3	-2.1262	2.1	2.5
2	2.9	-0.0458	2.8	3.1
5	3.2	0.8254	3.1	3.4
10	3.4	1.3073	3.2	3.7
25	3.6	1.8416	3.4	4.0
50	3.8	2.1981	3.5	4.2
100	3.9	2.5264	3.6	4.4
200	4.0	2.8333	3.7	4.6
500	4.2	3.2136	3.9	4.9
1,000	4.3	3.4857	4.0	5.1

Project: Albemarle & Chesapeake Canal, North Landing River Bridge
User: John N. Paine, PE, PH, CFM
Date: 24 August 2005, Wednesday
Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean of Logs =	0.469685	Maximum Input Value =	3.7
Std. Deviation of Logs =	0.048303	Minimum Input Value =	2.5
Skew of Logs =	0.572420	Number of Points =	18
Adjusted Skew =	0.275307	Generalized Map Skew =	0.0

LOG-PEARSON TYPE III DISTRIBUTION
CHI-SQUARE TEST FOR GOODNESS-OF-FIT

	CLASS LIMITS		NUMBER OF VALUES		
CLASS	Lower (ft)	Upper (ft)	Expected "Ei"	Observed "Oi"	$\frac{(Oi-Ei)^2}{Ei}$
1	0.0	2.6	3.0000	2	0.3333
2	2.6	2.8	3.0000	3	0.0000
3	2.8	2.9	3.0000	6	3.0000
4	2.9	3.1	3.0000	2	0.3333
5	3.1	3.3	3.0000	1	1.3333
6	3.3	Infinity	3.0000	4	0.3333
				COMPUTED CHI-SQUARE =	5.3333
				CHI-SQUARE FROM TABLE =	4.6100

CONCLUDE: Based on Chi-Square (Goodness-of-Fit) results,
the LOG-PEARSON TYPE III DISTRIBUTION does NOT apply to the input data.
Note that Chi-Square results are dependent upon the number of class intervals used.

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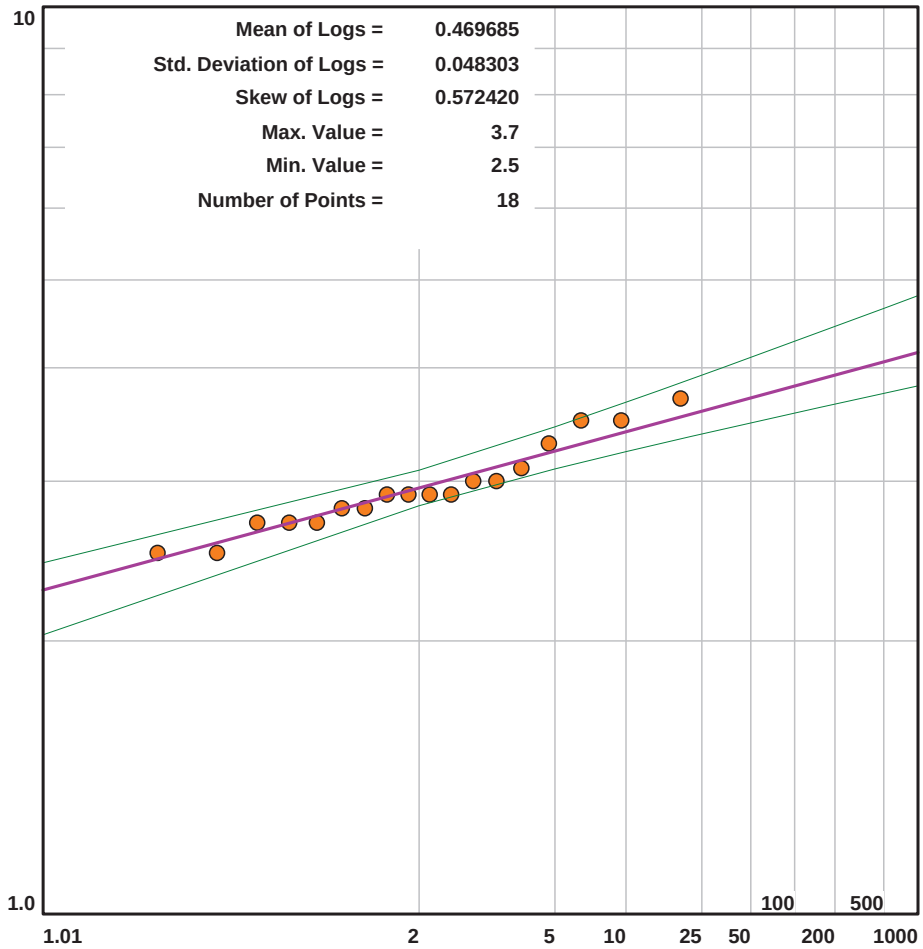
Output: C:\CAHH\A_AND_C_CANAL.OUT

LOG-NORMAL DISTRIBUTION

PEAK STAGE (ft)

Tr (yrs)	h ft
1.01	2.3
2	2.9
5	3.2
10	3.4
25	3.6
50	3.7
100	3.8
200	3.9
500	4.1
1000	4.2



PASSED
Chi-Square Test

Albemarle & Chesapeake Canal, North Landing River Bridge **RETURN PERIOD (yrs)**

Project: Albemarle & Chesapeake Canal, North Landing River Bridge
User: John N. Paine, PE, PH, CFM
Date: 24 August 2005, Wednesday
Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean of Logs =	0.469685	Maximum Input Value =	3.7
Std. Deviation of Logs =	0.048303	Minimum Input Value =	2.5
Skew of Logs =	0.572420	Number of Points =	18

LOG-NORMAL DISTRIBUTION

RETURN PERIOD (yrs)	h (ft)	FREQUENCY FACTOR	h 90% CONFIDENCE LIMITS Lower (ft)	Upper (ft)
1.01	2.3	-2.3305	2.0	2.4
2	2.9	0.0000	2.8	3.1
5	3.2	0.8415	3.1	3.4
10	3.4	1.2817	3.2	3.7
25	3.6	1.7511	3.4	3.9
50	3.7	2.0542	3.5	4.1
100	3.8	2.3268	3.6	4.3
200	3.9	2.5762	3.6	4.4
500	4.1	2.8785	3.7	4.7
1,000	4.2	3.0905	3.8	4.8

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Time: 10:18 am
Input: C:\CAHH\A_AND_C_CANAL.HDF
Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean of Logs =	0.469685	Maximum Input Value =	3.7
Std. Deviation of Logs =	0.048303	Minimum Input Value =	2.5
Skew of Logs =	0.572420	Number of Points =	18

LOG-NORMAL DISTRIBUTION
CHI-SQUARE TEST FOR GOODNESS-OF-FIT

	CLASS LIMITS		NUMBER OF VALUES		
CLASS	Lower (ft)	Upper (ft)	Expected "Ei"	Observed "Oi"	$\frac{(Oi-Ei)^2}{Ei}$
1	0.0	2.6	3.0000	2	0.3333
2	2.6	2.8	3.0000	5	1.3333
3	2.8	2.9	3.0000	4	0.3333
4	2.9	3.1	3.0000	2	0.3333
5	3.1	3.3	3.0000	1	1.3333
6	3.3	Infinity	3.0000	4	0.3333
				COMPUTED CHI-SQUARE =	4.0000
				CHI-SQUARE FROM TABLE =	6.2500

CONCLUDE: Based on Chi-Square (Goodness-of-Fit) results,
the LOG-NORMAL DISTRIBUTION DOES apply to the input data.
Note that Chi-Square results are dependent upon the number of class intervals used.

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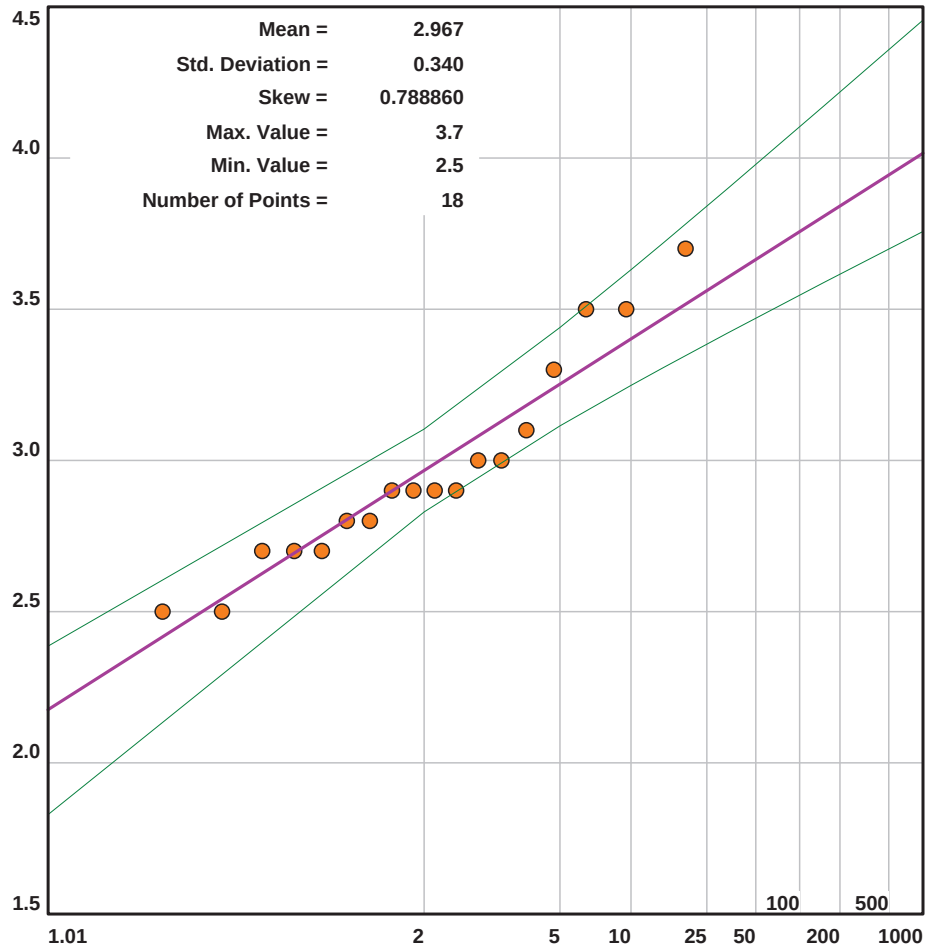
NORMAL DISTRIBUTION

PEAK STAGE (ft)

Tr (yrs)	h ft
1.01	2.2
2	3.0
5	3.3
10	3.4
25	3.6
50	3.7
100	3.8
200	3.8
500	3.9
1000	4.0



PASSED
Chi-Square Test

Albemarle & Chesapeake Canal, North Landing River Bridge **RETURN PERIOD (yrs)**

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User: John N. Paine, PE, PH, CFM
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Std. Deviation =	0.340	Minimum Input Value =	2.5
Skew =	0.78885950	Number of Points =	18

NORMAL DISTRIBUTION

RETURN PERIOD (yrs)	h (ft)	FREQUENCY FACTOR	h 90% CONFIDENCE LIMITS Lower (ft)	Upper (ft)
1.01	2.2	-2.3305	1.8	2.4
2	3.0	0.0000	2.8	3.1
5	3.3	0.8415	3.1	3.4
10	3.4	1.2817	3.2	3.6
25	3.6	1.7511	3.4	3.8
50	3.7	2.0542	3.5	4.0
100	3.8	2.3268	3.5	4.1
200	3.8	2.5762	3.6	4.2
500	3.9	2.8785	3.7	4.4
1,000	4.0	3.0905	3.8	4.5

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Std. Deviation =	0.340	Minimum Input Value =	2.5
Skew =	0.78885950	Number of Points =	18

NORMAL DISTRIBUTION
CHI-SQUARE TEST FOR GOODNESS-OF-FIT

	CLASS LIMITS		NUMBER OF VALUES		
CLASS	Lower (ft)	Upper (ft)	Expected "Ei"	Observed "Oi"	$\frac{(Oi-Ei)^2}{Ei}$
1	0.0	2.6	3.0000	2	0.3333
2	2.6	2.8	3.0000	5	1.3333
3	2.8	3.0	3.0000	4	0.3333
4	3.0	3.1	3.0000	3	0.0000
5	3.1	3.3	3.0000	0	3.0000
6	3.3	Infinity	3.0000	4	0.3333
				COMPUTED CHI-SQUARE =	5.3333
				CHI-SQUARE FROM TABLE =	6.2500

CONCLUDE: Based on Chi-Square (Goodness-of-Fit) results,
the NORMAL DISTRIBUTION DOES apply to the input data.
Note that Chi-Square results are dependent upon the number of class intervals used.

Project: Albemarle & Chesapeake Canal, North Landing River Bridge
User: John N. Paine, PE, PH, CFM
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Output: C:\CAHH\A_AND_C_CANAL.OUT

Mean =	2.967	Maximum Input Value =	3.7
Std. Deviation =	0.340	Minimum Input Value =	2.5
Skew =	0.78885950	Number of Points =	18
Mean of Logs =	0.469685	Generalized Map Skew =	0.0
Std. Deviation of Logs =	0.048303		
Skew of Logs =	0.572420		
Adjusted Skew =	0.275307		

COMPARISON OF STATISTICAL DISTRIBUTIONS

Number of Chi-Square class intervals used = 6

DISTRIBUTION	CHI-SQUARE COMPUTED	CHI-SQUARE TABULATED	
EXTREME VALUE TYPE I (GUMBEL)	4.000	6.250	Passed
LOG-PEARSON TYPE III	5.333	4.610	FAILED
LOG-NORMAL	4.000	6.250	Passed
NORMAL	5.333	6.250	Passed

BASED ON A 10-PERCENT SIGNIFICANCE LEVEL, THE
EXTREME VALUE TYPE I (GUMBEL)
DISTRIBUTION RESULTS IN THE BEST FIT OF THE DATA.