ncasi technical bulletin

NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC., 260 MADISON AVENUE, NEW YORK, N.Y. 1001

A REVIEW OF VARIABILITY IN EFFLUENT QUALITY DISCHARGED BY SELECTED PULP AND PAPER INDUSTRY SOURCES

TECHNICAL BULLETIN NO. 355

AUGUST 1981

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Selection of the appropriate relationship between the annual average, maximum 30 day, or maximum daily effluent quality limitations for BOD and total suspended solids is of particular interest to the pulp and paper industry, since these values are commonly incorporated into discharge permits. The subject was addressed extensively by the National Council staff in the development of existing effluent guidelines, and continues to be an important element of the technical studies program.

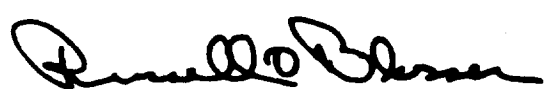
The attached technical bulletin is a review of the methods used by EPA, and described in the Development Document for the Phase III Effluent Guidelines. The review was carried out at the Northeast Regional Center under the direction of James J. McKeown, Regional Manager. The technical bulletin was prepared by David B. Buckely, Research Engineer, who has assisted in statistical program development by Dr. Linfield C. Brown, Tufts University, Department of Civil Engineering, and Karl T. Dussick, NCASI computer programmer. This portion of the study served as the basis for comments on the variability issue to EPA on the Phase III effluent guidelines new source performance standards. Additional studies are currently underway which will provide a basis for further comments to EPA on the variability issue.

The bulletin contents include a review and description of the methodology used by EPA to arrive at maximum 30 day and maximum daily limits, as well as alternate methods used by the Council staff. The data base draws upon a 33 mill "verification phase" data base common in part with that used by EPA but excluding a significant number in this total group of about 55 where the data were judged for one or more reasons to be inadequate for use in this study. It also draws upon, and uses extensively information in the Council's continuing treatment plant performance data collection program from 34 mills. In total about 75 years of data were examined.

The study suggested several modifications in the EPA methodology for developing maximum day and maximum 30 day averages which would more nearly reflect the variability in treatment plant performance for BOD and total suspended solids over the life span of permits. Among these were, (a) a change in the percentile selected for use in non-parametric statistical analysis, (b) the use of additional test procedures for goodness of fit, (c) statistical distributions capable of more nearly characterizing performance over the five year permit span from one year of data or a more extensive data base, and (d) the development of variability factors reflecting a probability of occurrence.

Your comments and questions on the contents of this technical bulletin are solicited and should be directed to this office or to Mr. McKeown or to Mr. Buckley at the Northeast Regional Center.

Yours very truly,



Russell O. Blosser
Technical Director

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A REVIEW OF VARIABILITY IN EFFLUENT QUALITY DISCHARGED BY SELECTED PULP AND PAPER INDUSTRY SOURCES

I INTRODUCTION

A. Background

Characterizing the variation in effluent quality from pulp and paper industry treatment systems has been a major activity in the development of effluent limitations. The publication of EPA's Development Document (1) in December 1980 represents a fourth attempt in assessing the varying nature of two wastewater constituents, biochemical oxygen demand (BOD_5) and total suspended solids (TSS). The initial effort occurred with the use of "interim" guidelines in the processing of discharge permits under the Refuse Act Permit Program while the second and third examinations of variability were developed during the Phase I and Phase II assessment of best practicable treatment (BPT) technology for the industry.

The Development Document (pp. 442-451) contains the methodology used in assembling and analyzing the treatment system performance data which provided the basis for the variability factors proposed for use in the Phase III Effluent Guidelines, Best Conventional Treatment (BCT) Options 1 and 4. These factors are being proposed for regulating effluent quality for all paper industry production categories although some difference in variability is being proposed for the nonintegrated tissue, lightweight, filter and nonwoven, and paperboard categories.

The variability referred to in the Development Document is the relationship of two periods of treatment system discharge quality to long-term performance; specifically, the ratio of maximum daily (MD) effluent quality to annual (or long-term) average (AA) performance and the ratio of the maximum thirty consecutive day (MA30CD) performance to the annual average. Inherent in the examination of these two periods of treatment system performance is the relationship of a third variability period, the ratio of the maximum daily (MD) discharge to the maximum thirty consecutive day (MA30CD) effluent quality. Table A1 contains the variability used in previous BPT effluent limitations and those proposed for BCT technology. Table A2 represents the effluent quality specified for BPT and proposed BCT technology. (Note: These Tables are contained in the Appendix.)

B. EPA Data Base

To adequately comment on the appropriateness of the variability proposed for BCT technology, the performance data used in the variability analysis were obtained from the E.C. Jordan Company in

IBM-Diskette form. The data were adapted for analysis at the NCASI Northeast Regional Center which uses a DEC-10 data processor and are referred to as "verification mill" data. Subsequent effort was required to properly identify the waste streams provided and the production category to which the data pertained. The treatment system data were identified by "308" numbers and no treatment process description was provided; however, additional information received by NCASI from the EPA public record (2) allowed a general description of the treatment processes used at each mill. Fifty-four mills are represented in this data base and production categories are classified as singular; i.e., no crossovers in production existed at these locations. Approximately 11-13 months of data were provided by each of the mills.

C. NCASI Data Base

To supplement the EPA data base, the National Council's treatment system performance program was reviewed for categorical pure mill candidates. Forty-two mill locations were initially selected for variability analysis. The extent of data provided by these mills ranged from nine months up to five years, although most of the data analyzed represented twelve months of performance. Multiple years of data, when available, were divided into increments of approximately twelve months to provide a time frame comparable to that used in the EPA variability analysis.

Table A3 contains the mills initially reviewed for variability analysis. Also indicated is the treatment process used at each mill and the time frame of the data provided by the individual mills.

II. STATISTICAL TECHNIQUES USED IN CHARACTERIZING VARIABILITY

A. EPA Approach

The Development Document contains two approaches to the estimation of the variability factors proposed for BCT effluent limitations. One technique is a nonparametric method used to estimate the maximum daily effluent quality. The other technique utilizes a "quasi-parametric" method for estimating the maximum thirty consecutive day discharge. These values divided by the long-term average discharge for the particular parameter (BOD_5 or TSS) result in MD and MA30CD variability factors. Both methods will be briefly discussed in the following.

(1) Maximum Daily Variability Factor - Initially, EPA examined the BOD_5 and TSS daily discharges to determine if the data conformed to classical statistical distributions such as the normal or log-normal distribution. If the data fit such a distribution, then a parametric method could be used to estimate a maximum daily discharge. The

Kolmogorov-Smirnov goodness-of-fit test (see Reference 3) was used to test the data to see if the daily data could be described by a normal or log-normal distribution. The Development Document cited that "in general, neither the normal nor log-normal distribution adequately represent the mill specific daily pollutant discharge value of BOD_5 and TSS." Analysis (2) supportive of this observation, however, did indicate that some 26 and 28 mill treatment systems did adhere to either the normal or log-normal distribution for daily BOD_5 and TSS discharges, respectively. The log-normal distribution predominated in the characterization of the individual mill discharges. Because the mill discharges did not completely adhere to one or the other distributions, EPA selected a nonparametric method.

The nonparametric method is a ranking technique where the daily discharges are assembled in order of magnitude. A specific percentile is selected along with a tolerance level (or confidence level) at the chosen percentile. The tolerance level indicates the degree of confidence surrounding the percentile. EPA utilized the 99th percentile at the 50 percent tolerance level in estimating the maximum daily discharges. It is not clear in the Development Document why the 99th percentile was chosen as this estimate produces a probability that 3 to 4 occurrences may exceed the 99th percentile in a year's time. In addition, why a lower tolerance level (i.e., a higher degree of confidence surrounding the estimate) was not selected is not specified in the Development Document. This oversight is particularly puzzling because the maximum daily discharges are really not-to-exceed levels. The 50 percent tolerance level at the 99th percentile indicates that there is a 50 percent probability that the 99th percentile is higher than the value selected. If, for example, a 5 percent tolerance level (or 95% confidence limit) were used, the degree of confidence surrounding the estimate of the 99th percentile would be increased. In other words, there would only be a 5 percent chance of making the wrong estimate for the 99th percentile rather than a 50 percent chance. Nonparametric methods are described in References 4 and 5; and the use of this technique will be demonstrated later in this report. In summary, the proposed maximum day variability factors for the discharge of BOD5 and TSS have been estimated by EPA with the following method:

$$\text{Maximum Day Variability Factor} = \frac{\text{99th Percentile @ the 50\% Level}}{\text{Long-Term Average}}$$

(2) Maximum Thirty Day Variability Factor - The method employed by EPA in developing the thirty day maximum variability factors was cited earlier as being "quasi" parametric in that it does utilize standard parametric methods. However, it can also be considered nonparametric in that no assumption is made concerning the distribution of the population (in this case the daily BOD_5 and TSS discharge data) from which the thirty day means are drawn. The "quasi" parametric approach has its basis in a theorem known as the Central Limit Theorem. Stated loosely, the theorem says that the sum of a

number of individual components, none of which dominate, tends to be a normal distribution as the number of components increases (3). For example, the cumulative annual effluent quality is being considered as the result of individual thirty day treatment system performances (or components) and according to the Central Limit Theorem, the individual thirty-day discharges would tend to be normally distributed around the mean of the thirty day values.

EPA assembled the individual daily discharge values into individual thirty consecutive value periods. If voids (missing data) existed in the daily data, the data record was "crunched" together to obtain the required thirty values. For example, if data were collected at a frequency of 15 observations per month, then a "crunched" thirty-day period could possibly extend over a sixty-day performance period. The impact of "crunching" the data on assessment of maximum thirty-day performance was not demonstrated. The individual thirty days of data at each mill were averaged and then subjected to a goodness-of-fit test (Lilliefors Test) to determine if the individual thirty successive days of data conformed to a normal distribution. When sufficient record length was available to construct at least five consecutive thirty-day averages, the Lilliefors Test, with the exception of one mill location, indicated that the thirty-day averages were normally distributed. This supported the use of the Central Limit Theorem. The 99th percentile level was then selected to estimate the maximum thirty day value at each mill using the following relationship:

$$\text{Max. 30 Consec Day Value} = \text{Mean}_{30} + 2.33\ \text{S.D.}_{30}$$

where, Mean_{30} and S.D._{30} represent the mean and standard deviation of the thirty-day values.

The maximum thirty consecutive day variability factor was then established in the following manner:

$$\text{Max. 30 Day Variability Factor} = \frac{\text{Mean}_{30} + 2.33\ \text{S.D.}_{30}}{\text{Long-Term Average}}$$

B. NCASI Approach

The NCASI analysis incorporated a similar approach as presented in the Development Document to estimate the maximum day and maximum thirty consecutive day variability factors. NCASI used (a) a non-parametric statistical technique to develop the maximum daily value for BOD_5 and TSS effluent quality and, (b) the Central Limit Theorem to estimate the maximum thirty consecutive day value. NCASI did expand on these two methods of estimating effluent variability as described in the following.

(1) Maximum Day Variability - NCASI included in its assessment of treatment process daily discharges effluent variation at the 99.7 percentile level, as this represents an estimate of a one day occurrence in a 365 day event. EPA's use of the 99 percentile level essentially truncates the maximum daily values to approximately 3-4 days out of a year. Further, a lower tolerance level, 5%, (which represents a 95% confidence limit) was also added to the analysis recognizing that a higher degree of confidence (i.e., greater than 50%) should be associated with the maximum daily variability factor as the maximum daily discharge effluent limitations are a not-to-exceed upper bound on treatment system performance.

In addition, where data were available, greater percentile levels were used to estimate the one-in-a-three year occurrence, 99.9 percentile, and a one-in-a-five year occurrence, the 99.95 percentile. This recognizes that NPDES discharge permits which incorporate effluent variation are normally written for periods greater than one year and often for five years.

The daily data for BOD_5 and TSS were tested for its adherence to a normal distribution using five goodness-of-fit tests rather than the one test used in the Development Document. Any decision to accept (or reject) the hypothesis that the daily data conformed to a normal, log normal, or shifted log normal distribution was based upon a majority agreement of the five tests at the five percent tolerance level. The goodness-of-fit tests used were the: (a) Anderson-Darling, (b) Watson, (c) Cramer von Mises, (d) Kolmogorov-Smirnov, and (e) Kuiper test procedures. Reference 6 contains the background for the use of these test procedures.

When daily discharge data were found to adhere to one of the previously cited distributions, it was used to project the maximum daily discharge at the following estimated frequencies of occurrence:

Probability of Occurrence	Percentile Level
3-4 days per 365 days	99 (M+2.33 S.D.)
1 day per 365 days	99.7 (M+2.75 S.D.)
1 day per 3x365 days	99.9 (M+3.10 S.D.)
1 day per 5x365 days	99.95 (M+3.27 S.D.)

M = Mean of Daily Data
SD = Standard Deviation of Data

Figure 1 illustrates the use of nonparametric analysis for a daily BOD_5 discharge at the 99 and 99.7 percentile levels. It should be noted that the values selected for analysis were those at the 0.50 and 0.05 tolerance levels. In many cases, a sufficient number of data were not available to estimate the 99.7 percentile level at the 0.05 tolerance level. These are indicated in tables which follow as a "greater than (>) value."

NCASI NON-PARAMETRIC TOLERANCE ANALYSIS
FOR MILL: 3032, Nov 1977-Nov 1978, 6S BOD (Klbs/day)

PART 1. ANALYSIS FOR 99TH PERCENTILE.

RANK (1=LOW)	VALUE OF VARIABLE	EXCEEDANCE PROBABILITY (WEIBULL)	PROB OF VALUE EXCEEDING 99.0 PERCENTILE
341	0.1256E+02	0.003	0.0325
340	0.1252E+02	0.006	0.1444
339	0.1177E+02	0.009	0.3365
338	0.1168E+02	0.012	0.5557
337	0.1156E+02	0.015	0.7429
336	0.1132E+02	0.018	0.8703
335	0.1129E+02	0.020	0.9424
334	0.1123E+02	0.023	0.9772
333	0.1118E+02	0.026	0.9919
332	0.1062E+02	0.029	0.9974
331	0.1056E+02	0.032	0.9992

TOLERANCE LEVEL FOR EXCEEDING 99.0 PERCENTILE	HIGHEST RANK EXCEEDING TOLERANCE LEVEL	VALUE OF VARIABLE	ACTUAL TOLERANCE LEVEL
0.01	341	0.1256E+02	0.0325
0.05	340	0.1252E+02	0.1444
0.10	340	0.1252E+02	0.1444
0.30	339	0.1177E+02	0.3365
0.50	338	0.1168E+02	0.5557
0.70	337	0.1156E+02	0.7429
0.90	335	0.1129E+02	0.9424
0.95	334	0.1123E+02	0.9772
0.99	333	0.1118E+02	0.9919

NCASI NON-PARAMETRIC TOLERANCE ANALYSIS
FOR MILL: 3032, Nov 1977-Nov 1978, 6S BOD (Klbs/day)

PART 2. ANALYSIS FOR 99.7TH PERCENTILE.

RANK (1=LOW)	VALUE OF VARIABLE	EXCEEDANCE PROBABILITY (WEIBULL)	PROB OF VALUE EXCEEDING 99.7 PERCENTILE
341	0.1256E+02	0.003	0.3590
340	0.1252E+02	0.006	0.7273
339	0.1177E+02	0.009	0.9157
338	0.1168E+02	0.012	0.9798
337	0.1156E+02	0.015	0.9960
336	0.1132E+02	0.018	0.9994

TOLERANCE LEVEL FOR EXCEEDING 99.7 PERCENTILE	HIGHEST RANK EXCEEDING TOLERANCE LEVEL	VALUE OF VARIABLE	ACTUAL TOLERANCE LEVEL
0.01	GT 341		
0.05	GT 341		
0.10	GT 341		
0.30	341	0.1256E+02	0.3590
0.50	340	0.1252E+02	0.7273
0.70	340	0.1252E+02	0.7273
0.90	339	0.1177E+02	0.9157
0.95	338	0.1168E+02	0.9798
0.99	337	0.1156E+02	0.9960

FIGURE 1 ILLUSTRATION OF NON PARAMETRIC ANALYSIS AT THE 99 AND 99.7 PERCENTILE LEVELS

Figure 2 demonstrates the use of the goodness-of-fit tests as applied to a daily BOD_5 discharge. A "yes" in the various goodness-of-fit test procedure columns rejects the hypothesis that the data comes from a normal distribution. A "no" does not reject the hypothesis that the data comes from a normal distribution. In this particular illustration, the daily BOD_5 discharge data adhere to a log-normal distribution at the 0.05 significance level.

The selection process for classifying whether data conforms to a normal, log-normal or shifted log-normal distribution, is as follows. The order of selection used in this report is 1) normal, 2) log-normal and 3) shifted-log normal and is based on choosing the simplest distribution which shows no rejection.

(2) Maximum Thirty Consecutive Day Analysis- NCASI adopted and expanded upon the approach presented in the Development Document. In addition to using the "crunched data" form of the daily BOD_5 and TSS data, the same data was left intact in its chronological order and a fixed, thirty-day window was used to scan the data for the thirty-day averages. This procedure is called the Fixed Start/ Fixed Window (FS/FW) technique. It generally resulted in at least one, to as many as seven additional, thirty-day observations over the crunched data method. In the FS/FW method, if there were less than twelve observations in the window, that estimate of thirty day performance was not included in the analysis. A feature of this method is it corresponds to the NPDES program, where the window may vary in size from 28 to 31 days. The fixed start (FS) aspect indicates that the analysis is initiated on the first day of the first month of the data record.

In addition to the use of the two procedures for estimating the maximum thirty consecutive day performance level, the BOD_5 and TSS data were analyzed for the maximum average thirty consecutive day (MA30CD) value that exists in the data. This value is derived by a thirty-day window moving on the data as chronologically collected (i.e., data not crunched). This value was then compared with the statistical estimates made for the maximum thirty consecutive day average values.

The five goodness-of-fit tests cited previously were then used to determine if the 30 consecutive data (or day) averages conformed to a normal distribution as projected by the use of the Central Limit Theorem. Figure 3 illustrates the use of the five tests to analyze thirty-day BOD_5 averages for normality at the 0.05 significance level. In this particular example, the data appeared to fit a log-normal distribution rather than a normal distribution.

(3) Selection of Performance Data for Variability Analysis - The 96 mills representing both the combined EPA and NCASI data bases were reduced to 67 mills where variability analysis was conducted.

NCASI EFFLUENT VARIABILITY ANALYSIS
MILL: 3032, Nov 1977-Nov 1978, 69 BOD (Klbs/day)

PART 1. ORGINAL DATA SET (CRUNCHED, ONLY NON-NEGATIVES)
SUMMARY OF GOODNESS OF FIT STATISTICS

UNTRANSFORMED DATA (NORMAL DISTRIBUTION)

NUM. OBS.	MEAN	STD DEV	SKEW COEF
341	0.5310E+01	0.2373E+01	0.7972E+00

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	5.759	0.735	0.924	1.735	2.962
SIGNIF LEVEL					
0.150	YES	YES	YES	YES	YES
0.100	YES	YES	YES	YES	YES
0.050	YES	YES	YES	YES	YES
0.025	YES	YES	YES	YES	YES
0.010	YES	YES	YES	YES	YES

LOG-10 TRANSFORMED DATA (LOG NORMAL DISTRIBUTION)

NUM. OBS.	MEAN	STD DEV	SKEW COEF
341	0.6822E+00	0.1954E+00	-0.8941E-01

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	0.700	0.105	0.106	0.745	1.452
SIGNIF LEVEL					
0.150	YES	YES	YES	NO	YES
0.100	YES	YES	YES	NO	YES
0.050	NO	NO	NO	NO	NO
0.025	NO	NO	NO	NO	NO
0.010	NO	NO	NO	NO	NO

SHIFTED LOG-10 TRANSFORMED DATA (SHIFTED LOG NORMAL DISTRIBUTION)

SHIFT CONSTANT = -0.433 SMALLEST VALUE = 1.268

NUM. OBS.	MEAN	STD DEV	SKEW COEF
341	0.7230E+00	0.1760E+00	-0.1920E-03

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	0.805	0.124	0.124	0.856	1.561
SIGNIF LEVEL					
0.150	YES	YES	YES	YES	YES
0.100	YES	YES	YES	YES	YES
0.050	YES	NO	YES	NO	YES
0.025	NO	NO	NO	NO	NO
0.010	NO	NO	NO	NO	NO

FIGURE 2 ILLUSTRATION OF GOODNESS-OF-FIT TEST FOR DAILY DATA

NCASI EFFLUENT VARIABILITY ANALYSIS
R MILL: 3005, Sep 1977-Sep 1978, 49 BOD (Klbs/day)

PART 2. 30-VALUE AVERAGES (BOUNCED DATA)
SUMMARY OF GOODNESS OF FIT STATISTICS

. UNTRANSFORMED DATA (NORMAL DISTRIBUTION)

NUM. OBS.	MEAN	STD DEV	SKEW COEF
11	0.5106E+01	0.2977E+01	0.1889E+01

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	1.003	0.132	0.145	0.780	1.521
SIGNIF LEVEL					
0.150	YES	YES	YES	YES	YES
0.100	YES	YES	YES	NO	YES
0.050	YES	YES	YES	NO	YES
0.025	YES	NO	YES	NO	NO
0.010	NO	NO	NO	NO	NO

. LOG-10 TRANSFORMED DATA (LOG NORMAL DISTRIBUTION)

NUM. OBS.	MEAN	STD DEV	SKEW COEF
11	0.6562E+00	0.2106E+00	0.9618E+00

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	0.413	0.049	0.053	0.509	0.994
SIGNIF LEVEL					
0.150	NO	NO	NO	NO	NO
0.100	NO	NO	NO	NO	NO
0.050	NO	NO	NO	NO	NO
0.025	NO	NO	NO	NO	NO
0.010	NO	NO	NO	NO	NO

. SHIFTED LOG-10 TRANSFORMED DATA (SHIFTED LOG NORMAL DISTRIBUTION)

SHIFT CONSTANT = 2.372 SMALLEST VALUE = 2.646

NUM. OBS.	MEAN	STD DEV	SKEW COEF
11	0.2102E+00	0.4835E+00	0.5288E-03

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	0.164	0.023	0.022	0.443	0.846
SIGNIF LEVEL					
0.150	NO	NO	NO	NO	NO
0.100	NO	NO	NO	NO	NO
0.050	NO	NO	NO	NO	NO
0.025	NO	NO	NO	NO	NO
0.010	NO	NO	NO	NO	NO

NCASI EFFLUENT VARIABILITY ANALYSIS
FOR MILL: 3005, Sep 1977-Sep 1978, 49 BOD (Klbs/day)

PART 3. 30-DAY AVERAGES (FIXED START, FIXED WINDOW)
SUMMARY OF GOODNESS OF FIT STATISTICS

A. UNTRANSFORMED DATA (NORMAL DISTRIBUTION)

NUM. OBS.	MEAN	STD DEV	SKEW COEF
12	0.5050E+01	0.2661E+01	0.1433E+01

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	1.099	0.148	0.161	0.797	1.518
SIGNIF LEVEL					
0.150	YES	YES	YES	YES	YES
0.100	YES	YES	YES	NO	YES
0.050	YES	YES	YES	NO	YES
0.025	YES	YES	YES	NO	NO
0.010	YES	NO	NO	NO	NO

B. LOG-10 TRANSFORMED DATA (LOG NORMAL DISTRIBUTION)

NUM. OBS.	MEAN	STD DEV	SKEW COEF
12	0.6568E+00	0.2010E+00	0.8313E+00

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	0.529	0.063	0.067	0.546	1.044
SIGNIF LEVEL					
0.150	NO	NO	NO	NO	NO
0.100	NO	NO	NO	NO	NO
0.050	NO	NO	NO	NO	NO
0.025	NO	NO	NO	NO	NO
0.010	NO	NO	NO	NO	NO

C. SHIFTED LOG-10 TRANSFORMED DATA (SHIFTED LOG NORMAL DISTRIBUTION)

SHIFT CONSTANT = 2.422 SMALLEST VALUE = 2.707

NUM. OBS.	MEAN	STD DEV	SKEW COEF
12	0.2035E+00	0.4725E+00	-0.7752E-04

	AND/DARLING	WATSON	CRAMER/VM	KOLMOGOROV	KUIPER
VALUE	0.212	0.026	0.025	0.450	0.859
SIGNIF LEVEL					
0.150	NO	NO	NO	NO	NO
0.100	NO	NO	NO	NO	NO
0.050	NO	NO	NO	NO	NO
0.025	NO	NO	NO	NO	NO
0.010	NO	NO	NO	NO	NO

FIGURE 3 ILLUSTRATION OF GOODNESS-OF-FIT TESTS FOR THIRTY DAY DATA

Mills providing primary treatment, or insufficient frequency of data, were not included in this variability analysis; therefore, all variability cited in this review is associated with biological treatment processes. Mills not included in the variability analysis are identified in Table A3. Not all 67 mills' data were examined for both BOD_5 and TSS effluent quality as some locations provided insufficient BOD_5 and TSS data to warrant variability analysis.

One mill in the EPA data base was not used (ID No. 040011, Mill No. 49, Table A3) due to limited or zero BOD removal during several months of performance.

In addition, one mill (ID No. 030030, Mill No. 4, Table 3), which was included in the original EPA "verification mill" data provided by the E.C. Jordan Co., did not appear in the EPA Development Document variability analysis. A review of this mill's data indicated that it provided sufficient frequency for both BOD_5 and TSS effluent quality to warrant its use in the variability analysis.

Table A4 contains those mills finally selected for variability analysis along with their effluent quality. The mills marked with an asterisk are those that appear in the Development Document variability analysis with the exception of Mill No. 4. Those mill numbers which are underlined represent the data base used in this review of variability.

III RESULTS AND DISCUSSION

A. Daily Effluent Quality

Table A5 presents the results of the goodness-of-fit tests applied to the daily BOD_5 and TSS discharges. Out of the 73 performance periods examined for BOD_5 daily discharge, 3 indicated that the data were normally (N) distributed. Also, of 77 performance periods for TSS effluent quality, 2 demonstrated adherence to a normal distribution. The remaining performance periods for BOD_5 and TSS indicated a similar distribution among the log normal (LN), shifted log normal (SLN) and nonidentified categories. These are summarized in Table 1.

TABLE 1 SUMMARY OF STATISTICAL DISTRIBUTIONS OF TREATED DAILY DISCHARGES

No. of Performance Periods	Parameter	N	LN	SLN	Non-Identified
73	BOD_5	3	19	20	31
77	TSS	2	21	24	30
12	BOD_5 & TSS	-	6	7	-

It should be noted that the term "performance periods" is used in contrast to mill location as a number of mills provided more than one year's data. The performance period reflects approximately 12 months of data.

Six performance periods demonstrated adherence to a log-normal distribution for both BOD_5 and TSS while seven periods indicate that a shifted log normal distribution fit both BOD_5 and TSS discharges. This was expected because NCASI believes the source of variability is different for each of these parameters.

As the daily data did not demonstrate a predominant adherence to any of the three distributions, the use of a nonparametric statistical analysis for the daily data is a reasonable alternate for estimating a maximum daily value. However, almost two-thirds of the performance periods fit at least one of the three distributions and this observation is used in subsequent analyses to compare with the nonparametric method.

Tables A6 and A7 summarize the analyses provided to estimate the maximum daily variability factors for both BOD_5 and TSS. The factors were derived from three analytical techniques: (a) the use of nonparametric analyses at the 50% and 5% tolerance limits at percentiles of 99, 99.7, 99.9 and 99.95, (b) the use of the distribution functions (i.e., N, LN, or SLN where applicable) to estimate the daily effluent quality at the same percentile levels, and (c) the use of the actual observed maximum daily values from the individual performance period data.

The variability factors were calculated by dividing the various maximum daily discharge values by the long-term means. Some observations made from these analyses are as follows:

(1) The use of a nonparametric analysis at the 99 percentile level with a 50% tolerance level (or 50% confidence limit) should be modified. By its very nature, the 99 percentile level provides a probability of occurrence that 3 to 4 days of a year will exceed this level. The shortcoming in this approach is evident when one compares this estimate with the

observed maximum daily values. In addition, the use of a 50% tolerance limit indicates that a variability factor based upon a specific percentile has a probability of being less than (low) 50 percent of the time. NCASI evaluated an appropriate alternate to the EPA technique by using the 99.7 percentile level, at the 5% tolerance level (or 95% confidence limit). The 99.7 represents a once-in-a-year occurrence while the 5% tolerance level suggests that the variability factor has a 95 percent probability of being correct.

(2) Maximum daily discharges for BOD_5 and/or TSS which adhered to one of the statistical distributions, insofar as they were tested, were projected for their occurrence at frequencies of once in a year (99.7), once in three years B99.9) and once in five years B99.95). NCASI determined that the maximum day variability factors calculated for these return periods were greater than the factors calculated using the EPA nonparametric method. This suggests that a data base for effluent quality of at least three to five years should be examined for variability especially since permitted effluent quality and its variation are typically specified for these periods in the NPDES program.

B. Thirty Consecutive Day Variability

The daily data for BOD_5 and TSS in thousands of pounds per day (klbs/day) were assembled in consecutive thirty day periods by two methods. One method, referred to as the "Crunched Data" (CD) technique, squeezed the data together when there were any voids or missing data in order to provide a continuous record. This is the procedure used by EPA in the Development Document. The consecutive thirty values were then averaged for each mill and examined by the five goodness-of-fit tests (previously cited) to see if the averaged thirty day values were normally distributed. As noted earlier, the Development Document analysis used one goodness-of-fit test, referred to as the Lilliefors Test, to assess the averaged thirty day values for normal distribution.

The second approach used by NCASI is referred to as the "Fixed Start/Fixed Window" (FS/FW) method for developing the consecutive thirty day averages. This method fixed the start of consecutive thirty day windows at the first day of the first month of the data record. The data that appeared in each window were then averaged to construct the 30 day estimates of effluent quality. These averages were then analyzed for normal distribution using the five goodness-of-fit tests. The reasons for considering the FS/FW approach were mentioned earlier in this report.

In addition, the data record for BOD_5 and TSS at each mill location was then analyzed for the actual maximum average thirty

consecutive day (MA30CD) value. Due to the procedure used in both the "crunched data" and "fixed start/ fixed window" methods, a possibility exists that the actual MA30CD value is split between consecutive windows in the averaging process. Basically, the actual MA30CD value is a logical test value for the adequacy of using the 99th percentile value for estimating the maximum thirty consecutive day value. Use of the 99th percentile is based upon a concern for committing, in statistical terms, a Type I error, which results from the rejection of a hypothesis, when indeed, the hypothesis is true. In this particular application, there was a concern for rejecting the hypothesis that the 30 day means were normally distributed, when indeed, it should be accepted (2). The Central Limit Theorem provides the basis that such means are normally distributed and for that reason, a high degree of confidence, 99th percentile, was used.

As noted earlier in this report, the goodness-of-fit tests were used to determine if the thirty day averaged value conformed to a normal distribution as proposed by the use of the Central Limit Theorem. Table A8 presents the results of the goodness-of-fit test procedures for the thirty consecutive day BOD_5 and TSS effluent quality. As can be seen, a substantial number of the thirty consecutive day performance periods adhere to a normal distribution. Essentially, all the remaining periods conformed to a normal distribution when the logarithm (with or without a shift constant) of the thirty day averages was examined. The following Table 2 is a summary of the individual distribution analysis appearing in Table A8.

TABLE 2 SUMMARY OF THIRTY DAY PERFORMANCE FOR SELECTED DISTRIBUTION FUNCTIONS

Performance Periods	Parameter	CD METHOD				FS/FW METHOD			
		N	LN	SLN	No FIT	N	LN	SLN	No FIT
72	BOD_5	58	10	4	-	57	12	3	-
77	TSS	68	5	3	1	62	12	1	1

As can be seen, agreement exists in most cases between the crunched data (CD) and fixed start/fixed window (FS/FW) methods of analysis. A greater number of the TSS 30 consecutive day averages conformed to a normal distribution than did the BOD data. NCASI's analysis did not produce the same degree of conformity to the normal distribution as the EPA analysis. In EPA's analysis one mill's data out of approximately thirty did not indicate a fit to a normal distribution. Therefore, analyses by both groups shows the Central Limit Theorem describes a majority of the cases.

Tables A9 and A10 contain the results of the statistical estimates for the thirty consecutive day effluent quality for BOD_5 and TSS, respectively. As noted previously, the estimate for the maximum thirty consecutive day value is calculated by adding the long-term average to the (2.33 x Standard Deviation) value. The variability factor is then calculated by dividing this value by the long-term average. In addition, the actual MA30CD values for the BOD_5 and TSS data were also included for comparison with the estimated values for maximum thirty consecutive days. Both the crunched data and fixed start/fired window methods are used. Three estimates for the thirty-day variability factors are presented for the combined EPA and NCASI data base.

As can be seen from Tables A9 and A10, an array of variability factors are developed from the three methods. Initially, the data appearing in these tables were reviewed for differences in the variability factors calculated using the crunched data (EPA) method and the fixed start/fixed window (NCASI) alternate method. This comparison is summarized in Table 3.

TABLE 3 MAXIMUM THIRTY-DAY VARIABILITY FACTORS
COMPARISON OF FS/FW METHOD WITH CD METHOD

Performance Periods	Parameter	FS/FW > CD	FS/FW=CD	FS/FW < CD
70	BOD_5	33	7	30
73	TSS	40	9	24

The performance periods represent the approximate twelve month data time frames in Tables A9 and A10 and do not include the multi-year data records. The NCASI FS/FW method produced greater maximum 30 consecutive day variability factors than the EPA CD method in 33 out of 70 performance periods for BOD_5 effluent quality and 40 out of 73 performance periods for TSS effluent quality.

The MA30CD values for BOD_5 and TSS data were used to test the adequacy of both CD and FS/FW methods to project (estimate at the 99th percentile) their respective estimates for maximum thirty consecutive day performance. Once again, the MA30CD value represents the actual value as contrasted to the statistical projections using the CD and FS/FW methods. Again Tables A9 and A10 were reviewed to determine the degree to which the variability factors estimated from the FS/FW and CD methods compared with actual performance. This is summarized in Table 4.

TABLE 4 COMPARISON OF VARIABILITY FACTORS ESTIMATED BY FS/FW AND CD METHODS WITH THE MA30CD VALUE

Periods	Parameter	CD Method			FS/FW Method		
		(>MA30CD)	(=MA30CD)	(<MA30CD)	(>MA30CD)	(=MA30CD)	(<MA30CD)
70	BOD_5	30	3	37	39	2	29
73	TSS	43	1	29	44	4	25

The FS/FW method, as indicated in Table 4 produced variability factors for BOD_5 which were greater than the MA30CD variability factors in 39 of the 70 performance periods as compared to 30 out of 70 for the CD method. The FS/FW technique calculated variability factors which were greater than the MA30CD values in 44 out of the 73 performance periods for TSS as compared to 43 out of 73 for the CD method.

The selection of the averaging method, CD vs FS/FW, appears to be an important element in estimating monthly variability for the data base used in this analysis. The fixed start/fixed window method (FS/FW) is certainly a viable alternate to the crunched data (CD) method used in the EPA analysis presented in the Development Document. The FS/FW method does not differ from the statistical treatment of the data in that its approach is based upon the Central Limit Theorem. Most importantly, the FS/FW method is similar to the NPDES reporting period where the actual "window" (i.e., monthly performance periods) varies from 28 to 31 days.

C. Development of EPA Proposed Variability Factors

EPA reviewed the data of the verification mills (30 and 31 mills for maximum thirty consecutive day variability for BOD_5 and TSS, respectively; and 35 mills for maximum day variability for both BOD_5 and TSS) and computed their performance on an annual average basis for BOD_5 and TSS. These annual averages were used to determine if the individual mill treatment systems met a specified level of performance such as BPT or the proposed BCT effluent limitations. The maximum day and maximum thirty consecutive day variability factors were then assembled for four levels of treated effluent quality, (a) mills with biotreatment, (b) mills with effluent quality better than BPT limitations, (c) mills with biotreatment discharging effluent quality better than BPT, and (d) mills with biotreatment exceeding BCT (proposed) limitations. The variability factors were then averaged within these four levels. The variability of mills falling into the preceding 2,3,and 4 categories was then reviewed and resulted in the following variability factors being proposed by EPA for BCT technology.

TABLE 5 VARIABILITY FACTORS
BCT TECHNOLOGY
(Options 1 & 4)

Production Subcategory	Maximum 30 Consecutive Day		Maximum Day	
	BOD_5	TSS	BOD_5	TSS
All Industry Subcategories with the exception of the following:	1.78	1.82	3.00	3.00
NonInt-Tiss. - Ligtwt. - Filt/NW - Papbd.	1.82	1.76	3.25	3.60

EPA concluded that the maximum thirty consecutive day values were similar to those developed for the previous Phase II BPT effluent limitation and therefore proposed that they be used for BCT technology. However, the maximum daily factors, developed from the variability analysis in the Phase III Development Document, were less than the existing BPT Phase II factors. EPA proposed the lower value of 3 (ratio of maximum day to annual average) for the maximum day variability factor. Exception to this approach were four subcategories in the nonintegrated subcategories shown in Table 5. The factors proposed for these mills are the same as BPT variability.

D. Summary of NCASI Analysis

The variability factors for the 70 plus performance periods presented in Tables A9 and A10 were averaged and summarized in Table A11. Several differences between the NCASI and EPA average factors are evident. First, the average maximum day variability factors produced by two of the analytical methods are greater than the proposed BCT factor of 3.00 for both BOD_5 and TSS discharges. The variability factors developed using the nonparametric analysis at the 50 percent tolerance level (NPA, 99%, 50% TL) are below EPA's proposed factors. However, EPA's method truncates the daily variability by its very nature in representing a probability of occurrence that is expected to be exceeded 3 to 4 days in a year at a 50% level of confidence. This becomes evident when EPA's value is compared with observed data derived from actual maximum daily values as shown in Table A11. Although the use of the nonparametric analysis at the 99.7 percentile at the 50% tolerance level produces a closer agreement with observed daily variability factors, it still results in variation less than observed in actual treatment system performance. Because maximum daily limitations are specified as a not-to-exceed upper bound in system performance, the use of the 99.7 percentile level at the 5% tolerance level (i.e., 95% confidence

limit) should be seriously considered. This would allow the development of a maximum daily variability factor representative of a once-in-a-year occurrence in which there is 95% confidence that the variation is less than projected. This analysis was attempted in this review; however, a year's data (365 observations) were generally insufficient to estimate the 5% tolerance level. (See Tables A6 and A7.)

The averaged maximum thirty consecutive day variability factors (see Table A11) resulting from NCASI analysis are greater than those proposed for BCT technology. Both crunched data (CD) and fixed start/fixed window (FS/FW) methods projected variability factors greater than that observed in actual treatment process performance. The FS/FW method produced a variability factor which was equal to or slightly greater than the CD (or EPA) method.

Since beginning this analysis, NCASI has received supplementary data from EPA's contractor. These data arrived too late in May to adequately test a number of longer term records for projection of 99.7% probability at the 5% tolerance level. However, these analyses will be performed following June 9, 1981 and will be submitted with comments on BCT methodology. In the meantime, NCASI has reviewed the variation in effluent quality for two mills meeting BPT which have long data records. Further, NCASI has examined the variation in effluent quality using the extreme values from the data base examined in this report. In other words, NCASI has examined the variation in the variability of biological treatment systems. Both of these analyses are presented in the following section.

IV DEMONSTRATED VARIATION IN EFFLUENT QUALITY VARIABILITY

A limited number of mills in the NCASI data base used in this review provided several years of process performance data. Mill No. 2, a bleached kraft dissolving pulp mill, provided five years of data while Mill No. 39, a semichemical mill contributed three years of data. Effluent quality from the treatment processes located at these two mills has been compared to BPT effluent limitations for the three specified time frames for system performance; annual average, maximum thirty day, and maximum day. This comparison is presented in Table A12, along with other mills used in this review. As indicated, Mill No. 2 met BPT effluent quality for both BOD_5 and TSS for all time frames during the five year period. Mill No. 39 met BPT requirements for the last two years of the data record.

The first year complied with BPT limitation for BOD_5 and missed compliance with TSS limitations by only 0.7 lb/ton in its MA30CD value; however, the maximum daily TSS limitations were attained during this period.

Table A13 presents a summary of the multiyear performance at Mills 2 and 39 along with the variation in effluent quality variability projected by the statistical procedures used in this review and the variability demonstrated in the actual BOD_5 and TSS effluent quality. Examination of the variability factors presented in the "Observed" columns indicates a range in variability factors experienced at these mill locations for both BOD_5 and TSS effluent quality.

Of particular interest at Mill No. 2 is that the performance period (2-2) producing the best effluent quality (annual average basis) had the highest variability factors for both BOD_5 and TSS discharge, exceeding those recommended in the EPA Development Document.

Mill No. 39 presents an interesting contrast in variability. Two separate years (39-2, 39-3) of almost identical annual average performance produced variability factors which were less than the proposed BCT factors in one and greater than the proposed factors in the other year.

The data appearing in Table A13 readily supports the need to examine multiyears of treatment system process performance data in order to adequately address the range in effluent quality experienced in treatment systems operating in the pulp and paper industry.

A preliminary analysis of the range in variability factors was conducted on the factors developed in this review. The data appearing in Tables A6, A7, A9, and A10 were analyzed to determine if the variability factors conformed to a statistical distribution which could be used to project to a given probability of occurrence, say the 95% level. The same goodness-of-fit test procedures as described earlier were used to test the variability data for adherence to a normal distribution. It is emphasized that this procedure was used as a projective technique to provide a degree of confidence in assigning a variability factor to process performance rather than simply averaging the variability factors as was done in the EPA analysis. The basis for this approach is the preceding discussion. The results of this analysis are summarized in Table 6.

TABLE 6 ESTIMATE OF 95% PROBABILITY OF OCCURRENCE OF VARIABILITY FACTORS

Analysis Method	Ratio of Max. Day to Long-Term Average				
	(AA)		(95%)		(Distribution Basis)
	BOD	TSS	BOD	TSS	
NPA (99%)	2.85	2.91	4.13	4.61	N/BOD, LN/TSS, 1% S.L.
NPA (99.7%)	3.35	3.42	5.45	4.92	LN/BOD, SLN/TSS, 1% S.L.
Observed Data	3.61	3.83	6.02	6.25	LN/BOD, SLN/TSS, 1% S.L.
	Ratio of Max. 30 Day to Long-Term Average				
	(AA)		(95%)		(Distribution Basis)
	BOD	TSS	BOD	TSS	
Crunched Data	1.98	1.91	2.33	2.05	SLN/BOD, LN/TSS, 1% S.L.
FS/FW	1.99	1.98	2.24	2.13	SLN/BOD, SLN/TSS, 1% S.L.
Observed	1.91	1.82	2.78	2.65	LN/BOD, SLN/TSS 1% S.L.

S.L. = Significance Level
AA = Arithmetric Average
95% = 95% Probability of Occurrence of Var. Factor Projected from Distribution Fit. Equals Mean + 1.65 (Standard Deviation)

The range in variability factors from greater than seventy performance periods fit at least one of the normal distributions used in the review, normal (N), log normal (LN), or shifted log normal (SLN). The fit of the data to the specific distribution was used to project the 95% probability of occurrence of the variability factors. The analysis of the maximum day variability factors indicates that a factor equal to or greater than four is to be expected with a 95% degree of confidence. Although this is higher than the maximum day variability factor (VF) of 3 proposed by EPA for BCT technology, a VF of four would still not represent all the observed variation of the mills providing multiyear data shown in Table A13.

The 95% probability of occurrence of the maximum thirty consecutive day variability factors was estimated to be at least 2.1 as shown in the table above. This degree of effluent variation was greater than the EPA proposed values of 1.78 for BOD_5 and 1.82 for TSS but, once again, does not reflect all the variability of the multiyear data presented in Table A13.

The preceding analysis indicates that the variability factors conform to a distribution which can be used to provide a greater degree of confidence than the average value approach used by EPA

in proposing variation for BCT technology. Estimating the probability of occurrence of variability factors should be expanded by EPA to the possible use of "extreme value" distribution functions such as the Gumble or log Pearson Type III.

V CONCLUSIONS

A review of more than 70 performance periods (each with approximately 12 months of data) for biological treatment processes operating in the pulp and paper industry suggests modifications to the EPA methodology used in developing maximum day and maximum thirty consecutive day variability factors for BOD_5 and TSS discharges as follows:

(1) The use of non-parametric statistical analysis (NPA) for maximum daily variation should at least incorporate the 99.7 percentile. This percentile level represents the approximate occurrence of one day in a year. The current use of the 99 percentile level by EPA provides a probability that a maximum daily value could be expected to be exceeded 3-4 days in a year.

(2) The use of a 5% tolerance level (or a 95% confidence limit) should be used in the nonparametric approach to daily variation. This would provide a 95% degree of confidence in the estimate of the variability factor rather than a 50% degree of confidence as presently proposed.

(3) The use of goodness-of-fit test procedures should be expanded to include additional test procedures. The use of one test procedure to determine if a series of events is normally distributed may be incomplete.

(4) Statistical distributions characterizing daily discharge quality should be used to project variability to time frames of greater than one year because NPDES permitted daily discharges are not-to-exceed values generally in effect for up to five years.

(5) The actual (observed) effluent quality (maximum day and maximum thirty day) should be compared to the values projected by statistical techniques and greater effort should be placed on rectifying predicted values which are lower than observed values.

(6) The Central Limit Theorem used by EPA appears to be an adequate approach to estimate maximum thirty day effluent quality variability. The "crunching of data" to provide thirty consecutive values should be replaced by a "fixed start/fixed window" alternate. Longer data sets should be examined for mills which require additional data to more fully describe monthly averages.

(7) Biological treatment processes exhibit a range of variability in effluent quality from year to year and from system to system. Averaging variability factors does not adequately account for the system to system and year to year situation.

(8) Variability factors should be developed to reflect a specific probability of occurrence, e.g. 95% confidence limit, to account for observed variability that can be expected to occur in a five year time period. Initial analysis of the range in variability factors indicates an adherence to statistical distributions, predominantly log-normal or shifted log-normal. Use of this observation suggests that a maximum daily variability factor equal to or greater than 4 and a maximum thirty consecutive day variability factor equal to or greater than 2.1, could be used to predict effluent variation at a 95% degree of confidence.

(9) Analysis of multiyear data provided by two mills, achieving BPT and approaching or exceeding proposed BCT limitations, shows that a range in variability factors exists from year to year. In these specific cases, variability factors exceeded the factors proposed for BCT technology.

VI LITERATURE REFERENCES

(1) "Development Document (Proposed) for Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard and the Builders' Paper and Board Mills - Point Source Categories," U.S. E.P.A., E.P.A. 440/1-80/025b, November-December 1980.

(2) "Technical Data Generation, Volume 117, Item 9-6, Statistical Analysis," Document obtained from EPA public record for proposed Effluent Guidelines for the Pulp and Paper industry.

(3) Ang, A.H.-S. and Tang, W.H., "Probability Concepts in Engineering Planning and Design, Volume I Basic Principles," John Wiley and Sons, 1975.

(4) Bradley, J.V., "Distribution-Free Statistical Tests," Prentice-Hall, 1968.

(5) Gibbons, J.D. "Nonparametric Statistical Inference," McGraw-Hill, 1971.

(6) Stephens, M.A., "EDF Statistics for Goodnes of Fit and Some Comparisons," Journal-American Statisticsl Association, Vol. 69, No. 3, September, 1974.

APPENDIX A

TABLES A1 THROUGH A13

TABLE A1 VARIABILITY EXPRESSED IN PULP AND PAPER INDUSTRY EFFLUENT LIMITATIONS

CATEGORY	BOD_5 RATIO OF: MD/AA	MA30CD/AA	MD/MA30CD	TSS RATIO OF: MD/AA	MA30CD/AA	MD/MA30CD
(PHASE-I)		BEST PRACTICABLE TREATMENT				
UBK	-	-	2.0	-	-	2.0
NSSC(Na)	-	-	2.0	-	-	2.0
NSSC(NH_3)	-	-	2.0	-	-	2.0
UBK-NSSC	-	-	2.0	-	-	2.0
PAP. BD	-	-	2.0	-	-	2.0
(PHASE-II)						
DISS KRAFT	3.44	1.78	1.93	3.38	1.81	1.86
BL.KR-MKT	3.43	1.79	1.92	3.38	1.82	1.85
BL.KR -BCT	3.41	1.78	1.92	3.38	1.82	1.86
BL.KR-FINE	3.48	1.80	1.93	3.36	1.80	1.86
SULF.-PAPER (BLOW PIT)	3.42	1.78	1.92	3.38	1.82	1.86
SULF.-DISS.	3.42	1.78	1.92	3.38	1.82	1.86
GROUND WOOD-CHEM/MECH.	3.42	1.78	1.91	3.38	1.82	1.85
GROUND WOOD-TMP	3.42	1.79	1.91	3.38	1.82	1.86
GROUND WOOD-CMN	3.39	1.77	1.91	3.40	1.83	1.83
GROUND WOOD-FINE	3.43	1.80	1.90	3.41	1.83	1.83
SODA	3.43	1.78	1.93	3.38	1.82	1.86
DEINK	3.42	1.77	1.93	3.38	1.82	1.86
NONINT-FINE	3.42	1.77	1.93	3.38	1.82	1.86
TISS	3.26	1.79	1.82	3.60	1.75	2.05
TISS (WST.PAP.)	3.43	1.78	1.93	3.38	1.82	1.85
SULF-PAPER(DRUM WASH)	3.42	1.78	1.92	3.38	1.82	1.86
SULF-MKT PULP	-	-	1.92	-	-	1.86
AVG-PHASE II	3.42	1.78	1.92	3.38	1.82	1.86
	PROPOSED BEST CONVENTIONAL TREATMENT (OPTIONS 1 & 4)					
Above Categories With the Exception of the Following	3.00	1.78	1.68	3.00	1.82	1.65
NONINT-TISS	3.25	1.79	1.82	3.60	1.76	2.05
" -LIGTWT	"	"	"	"	"	"
" -FILT/NW	"	"	"	"	"	"
" -PAPBD	"	"	"	"	"	"

AA = ANNUAL AVERAGE, MD = MAXIMUM DAY, MA30CD = MAXIMUM THIRTY CONSECUTIVE DAY AVERAGE

TABLE A2 BPT AND BCT (PROPOSED) EFFLUENT LIMITATIONS FOR THE PULP AND PAPER INDUSTRY

(LBS/TON)

Prod. Category	BOD_5 MD (BPT)	MD (BCT)	BOD_5 MA30CD (BPT)	MA30CD (BCT)	BOD_5 AA* (BPT)	AA* (BCT)	TSS MD (BPT)	MD (BCT)	TSS MA30CD (BPT)	MA30CD (BCT)	TSS AA* (BPT)	AA* (BCT)
BK-DISS	47.2	24.4	24.5	14.4	13.8	8.2	74.6	37.2	40.1	22.6	22.1	12.4
" - MKT	30.9	21.0	16.1	12.4	9.0	7.0	60.8	26.4	32.8	16.0	18.0	8.8
" - BCT	27.3	15.0	14.2	9.0	8.0	5.0	48.0	21.6	25.8	13.2	14.2	7.2
" - FINE	21.2	11.8	11.0	7.0	6.1	4.0	44.3	18.4	23.8	11.2	13.2	6.2
" - SODA	27.4	11.8	14.2	7.0	8.0	4.0	49.0	18.4	26.4	11.2	14.5	6.2
UBK-LNBD	11.2	7.0	5.6	4.0	-	2.4	24.0	13.4	12.0	7.4	-	4.1
" -CP	11.2	9.0	5.6	5.4	-	3.0	24.0	15.4	12.0	8.8	-	4.8
SEMI-Na.	17.4	10.6	8.7	6.2	-	3.6	22.0	14.4	11.0	8.8	-	4.8
CHEM NH_3	16.0	10.6	8.0	6.2	-	3.6	20.0	14.4	10.0	8.8	-	4.8
UBK/SEMI CHEM	16.0	10.6	8.0	6.2	-	3.6	25.0	17.4	12.5	10.6	-	5.8
SULF. DISS NIT	82.8	82.8	43.1	43.0	24.2	24.2	141.3	141.2	76.1	76.0	41.8	41.8
SULF. DISS VIS	"	88.6	"	46.2	"	26.0	"	"	"	"	"	"
SULF. DISS CELL	"	96.2	"	50.0	"	28.2	"	"	"	"	"	"
SULF. DISS ACE	"	104.0	"	54.2	"	30.4	"	"	"	"	"	"
SULF-PAP (100%)	-	53.0	-	32.4	-	18.2	-	88.6	-	53.0	-	29.1
SULF-PAP BLOW PIT	63.6	-	33.1	-	18.6	-	87.9	-	47.3	-	26.0	-
SULF-PAP DRUM WASH	53.4	-	27.8	-	15.6	-	87.9	-	47.3	-	26.0	-
SULF-PAP MKT	80.0	-	41.7	-	-	-	99.0	-	53.3	-	-	-
GNDWD-TMP	21.2	7.8	11.1	4.6	6.2	2.6	31.1	12.4	16.7	7.4	9.2	4.2
" CMN	14.9	9.0	7.8	5.4	4.4	3.0	25.5	12.6	13.7	9.0	7.5	4.2
" FINE	13.7	8.2	7.2	4.8	4.0	2.8	23.5	11.8	12.6	7.0	6.9	4.0
" CHEM-MECH	27.0	-	14.1	-	7.9	-	39.5	-	21.3	-	11.7	-
DEINK-FINE	36.2	17.8	18.8	10.6	10.6	6.0	48.1	25.0	25.9	15.2	14.2	8.4
" -TISS	"	19.6	"	11.6	"	6.6	"	30.0	"	18.2	"	10.0
WSTPAP-TISS	27.4	13.2	14.2	7.8	8.0	4.4	34.1	15.6	18.4	9.4	10.1	5.2
" -BD	6.0	2.4	3.0	1.48	-	0.84	10.0	3.0	5.0	1.78	-	0.98
" -MP	8.0	3.6	4.6	2.2	2.6	1.2	21.6	7.0	11.6	4.1	6.4	2.4
BLDG. PAP & ROOF.FLT.	-	10.00	-	6.0	-	3.2	-	10.0	-	6.0	-	3.2

TABLE A2 BPT AND BCT (PROPOSED) EFFLUENT LIMITATIONS FOR THE PULP AND PAPER INDUSTRY

(LBS/TON)
(Cont'd)

Prod. Category	BOD_5 MD (BPT)	MD (BCT)	BOD_5 MA30CD (BPT)	MA30CD (BCT)	BOD_5 AA* (BPT)	AA* (BCT)	TSS MD (BPT)	MD (BCT)	TSS MA30CD (BPT)	MA30CD (BCT)	TSS AA* (BPT)	AA* (BCT)
NONINT-FINE	16.4	7.8	8.5	4.6	4.8	2.6	22.0	8.2	11.8	5.0	6.5	2.8
" -TISS	22.8	18.8	12.5	10.4	7.0	5.8	20.5	17.0	10.0	8.2	5.7	4.8
" -LGHT	47.8	37.8	26.2	20.8	14.8	11.9	43.2	33.8	21.2	16.6	12.0	9.4
" -ELEC	75.8	65.5	41.6	36.2	23.2	20.2	68.0	59.0	33.4	28.8	19.0	16.4
" -FILT	58.8	46.8	32.4	25.8	18.2	14.4	53.2	42.0	26.0	20.6	15.8	11.8
" -BD	12.6	12.6	7.0	7.0	4.0	4.0	11.6	11.6	5.6	5.6	3.2	3.2

MD = Maximum Daily
MA30CD = Maximum Average for Thirty Consecutive Days
AA = Annual Average
* = Annual Average Values Apply to Non-Continuous Dischargers

TABLE A3

MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
1*[2]	032001	BL.KR.-DISS.	AST	7/78-7/79	
2	08501	" "	ASB/PS(ST)	1/76-12/80	
3	34403	" "	AST	9/77-7/79	
4*	030030	BL.KR.-MKT.	ASB/PS	8/77-8/78	
5*	030005	" "	ASB/PS	9/77-9/78	
6	08301	" "	ASP/PS(ST)	(1-12)/79	
7	19305	" "	AST(HYBRID)	(1-12)/79	
8	31107	" "	ASB/PS	4/76-2/77	
9	59414	" "	AST(HYBRID)/PS	8/78-7/79	
10*	030004	BL.KR.-BCT	ASB/PS	5/77-5/78	
11*	030047	" "	ASB/PS	6/77-6/78	
12*	030032	" "	ASB/PS	11/77-11/78	BOD Data Only
13	01205	" "	ASB/PS	(1-12)/79	
14	01203	" "	ASB/PS(ST)	4/78-2/79	
15	20601	" "	ASB/PS	(1-10)/79	

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

(cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
16*	030027	BL.KR.-FINE	AST	1/77-1/78	
17*	030046	" "	ASB/PS	7/77-7/78	
18*	030020	" "	ASB/QZ/LA	12/77-11/78	
19A	34411	" "	AST/HYBRID	(1-12)/78	
19B			" "/CAC	10/79-1/81	CAC in Separate Facilities
20	59407	" "	AST	(1-9)/78	BOD Data Only
21	74603	" "	AST	4/76-6/77	
22	74606	" "	ASB/PS	8/77-7/78	
23*	010019	UNBL.KR.-LNBD	ASB	9/77-10/78	
24	29902	" "	ASB/PS	1/76-4/79	
25	35201	" "	NSB	(1-11)/79	
26	52801	" "	ASB/PS	10/77-8/78	
27	58701	" "	ASB	(1-12)/79	
28	58902	" "	ASB/PS	1/76-2/77	
29	74005	" "	ASB	1/79-1/80	

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

(cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
30	74601	UNBL.KR/LNBD	AST	3/77-7/78	
31*	010055	UNBL.KR/CP	ASB/PS	10/77-10/78	
32*	010003	" "	ASB/QZ	11/77-11/78	
33	34416	" "	ASB/PS	1/78-4/79	
34	58916	" "	ASB	(1-12)/77	
35	45001	UNBL.KR/SPEC.	AST, PC		AST-PULP MILL PC-PAPER MILL
36*	020017	SEMI-CHEM.	ASB/PS	7/76-7/77	
37*	020002	" "	ASB/PS	10/77-10/78	
38	43202	" "	ASB/MECH. CLARIF./PS	(1-12)/78	
39	50202	" "	AST/HYBRID	1/78-12/80	
40*	015002	UNBL.KR/SEMI-CHEM.	ASB/INFIL. BASIN	11/77-11/78	
41*	015007	" "	AST	12/77-12/78	
42A	15506	" "	ASB/PS	10/77-7/78	INCLUDES INTERMITTENT DISCH. FROM PULP MILL SPILL CONTAINMENT BASIN
42B					CONTINUOUS DISCHARGE FROM ASB

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

(cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
43	69004	UNBL.KR/SEMI-CHEM. (cont'd)	ASB	(1-12)/77	
44*	046006	SULFITE-DISS.	ASB	7/78-7/79	
45*	046004	" "	AST	12/77-7/78	
46	35401	" "	ASB	5/78-6/79	
47*	040017	SULFITE-PAPER	AST	8/77-9/78	
48*	040013	"	PC, BIO-TREAT, PS		PC-Paper Mill, Bio-Treat-Pulp Mill, PS-Combined Disch.
49*	040011	"	UN-IDENTIFIED BIO-TREAT	8/77-8/78	Several Months of Limited or No BOD Removal, No Analysis Conducted
50*	040019	"	AST, PC		AST-Pulp Mill PC - Paper Mill
51	17412	"	ASB	(1-7)/78	Limited Data, No Variability Analysis Conducted
52	06505	"	ASB	(1-12)/77	
53*	052007	GNDWD-FINE	AST	1/77-1/78	
54*	052004	" "	AST	1/77-1/78	

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

(cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
55*	080054	INTEGRATED-MISC.	ASB/PS	7/77-7/78	
56*	150014	"	AST	7/77-7/78	Limited Data, No Variability Analysis Conducted
57*	054013	"	ASB/PS	9/77-10/78	Limited Data, No Variability Analysis Conducted
58*	060001	"	ASB/MECH. CLARIF./CAC	7/77-7/78	CAL in Secondary Clarifier
59*	140014	DEINK-TISS	AST	12/76-12/77	
60*	140015	"	AST	11/77-11/78	
61*	140007	DEINK-FINE	AST	7/77-7/78	7/77 Data Not Included, Start-up = ?
62*	085004	WSTPAP-TISS.	ASB	10/77-10/78	Limited Data, No Variability Analysis Conducted
63*	090014	" "	PC	10/77-10/78	" "
64*	100005	" "	ASB/PS	9/77-9/78	Limited BOD Data
65*	110052	WSTPAP-BD	UN-IDENTIFIED	9/77-9/78	Limited Data, No Variability Analysis Conducted
66*	110032	" "	UN-IDENTIFIED	11/77-11/78	" "

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

(cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
67*	110087	WSTPAP-BD (Cont'd)	PC	8/77-8/78	No Variability Analysis Conducted
68*	110020	" "	ASB/DAF	11/77-10/78	Limited Data, No Variability Analysis Conducted
69*	110031	" "	ASB/PS	10/77-10/78	
70*	110043	" "	ASB/PS	1/78-1/79	Limited Data, No Variability Analysis Conducted
71	13801	" "	ASB/PS	(1-9)/78	" " "
72	13802	" "	ASB/DAF	(1-8)/78	" " "
73	17408	" "	ASB/TF/LA/PS	3/77-2/78	Limited BOD Data
74	42902	" "	ASB	3/77-1/78	
75*	150011	WSTPAP-MOLD.PROD.	ASB	8/77-8/78	Limited Data, No Variability Analysis Conducted
76*	150024	"	POTW	12/77-12/78	Discharge to Municipal System, No Analysis Conducted
77*	120021	BLDG.PAP & ROOF FLT.	UNIDENTIFIED	6/77-6/78	No Analysis Conducted

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS (Cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
78*	080046	NONINT.-FINE	ASB	7/77-6/78	
79*	080007	" "	ASB/QZ	7/77-7/78	Limited Data, No Variability Analysis Conducted
80	28715	" "	ASB/QZ	(1-12)/79	" " "
81	31105	" "	ASB	1/78-1/79	
82	48102	" "	AST	5/77-4/78	
83*	090005	NONINT.-TISS	ASB	9/77-10/78	
84*	090022	" "	PC	9/77-9/78	No Variability Analysis Conducted
85	38004	" "	AST/PS	(1-12)/79	Limited BOD Data
86	105013	NONINT.-LWT.	AST/PS	10/77-9/7	Limited Data, No Variability Analysis Conducted
87*	105051	NONINT.-FILT & NON-WOVEN	PC	6/77-6/78	No Variability Analysis Conducted
88*	105055	" "	AST	9/77-9/78	Limited Data, No Variability Analysis Conducted

TABLE A3 MILL LOCATIONS PROVIDING DATA REVIEWED FOR VARIABILITY ANALYSIS

(Cont.)

Mill No.	ID No.[3]	Production Category	Treatment Process[1]	Data Time Frame	Comment
89*	110021	NONINT.-PAPBD.	ASB/QZ	8/77-8/78	Limited Data, No Variability Analysis Conducted
90*	085001	" "	ASB	10/77-10/78	" " "
91	10901	" "	ASB/QZ	1/79-1/80	Limited BOD Data
92*	105024	NONINT.-MISC.	PC	8/76-9/77	No Analysis Conducted
93*	105067	" "	PC	8/77-8/78	" " "
94*	105068	" "	NSB(ST)	9/77-9/78	Limited BOD Data
95	42916	" "	PC	1/79-1/80	No Analysis Conducted
96	59201	" "	NSB(ST)	(1-12)/77	Limited BOD Data

Note: 1) ASB = Aerated Stabilization Basin
AST = Activated Sludge Treatment
AST (HYBRID) = Biotreatment Process Using 2 to 4 days Aeration Followed by Mechanical Clarification for Separation and Return of Bio-mass to Aerated Basin
NSB = Natural Stabilization Basin
PS = Post Stabilization in a Separate Basin
ST = Short Term (less than one day)
PC = Primary Clarification
TF = Trickling Filter
LA = Land Application
QZ = Quiescent Zone at Effluent End of ASB
DAF = Dissolved Air Floatation
CAC = Chemically Assisted Clarification

2) Mill No. Indicated with an * is a "Verification Mill". Data from these Mills Reviewed for Variability and Presented in EPA's. Development Document, EPA 440/1-80/025-b, (Proposed).

3) Other ID Nos. are NCASI Code Numbers.

TABLE A4 EFFLUENT QUALITY FROM PULP AND PAPER INDUSTRY WASTEWATER TREATMENT SYSTEMS

No.	Mill Category	Nominal Production (TPD)	Water Usage(KGAL/TON) (AA)	BOD_5(lbs/Ton) (AA)[1]	(MA30CD)[2]	(MD)[3]	TSS (lbs/Ton) (AA)	(MA30CD)	(MD)
1*[4, 5]	BL.KR.-DISS.	975	34.4	37.3	81.2	215	55.3	110	532
2/1	" "	1100	53.5	8.2	11.9	21.8	12.5	17.4	37.1
2/2	" "	1100	48.4	6.3	12.3	22.0	9.5	17.2	43.1
2/3	" "	1150	46.8	7.4	9.8	13.3	10.8	15.3	32.8
2/4	" "	1200	44.6	7.6	8.9	22.3	12.3	16.1	28.6
2/5	" "	1175	48.3	7.9	10.7	20.0	13.4	21.0	55.8
2/(1-5)	" "	1150	48.3	7.5	12.3	21.8	11.8	21.0	55.8
3/1	" "	1100	32.9	24.8	40.7	161	45.5	64.1	284
3/2	" "	975	34.6	38.5	81.9	215	56.4	110	531
3/(1-2)	" "	1050	33.8	34.6	81.9	215	51.0	51.0	531
4*	BL.KR-MKT.	800	31.9	4.4	9.3	11.6	6.4	13.9	19.0
5*	" "	375	16.6	13.4	34.4	43.4	10.2	16.7	24.5
6	" "	1275	45.3	11.2	15.5	30.0	19.9	26.5	64.2
7	" "	475	37.2	15.1	26.2	42.1	43.6	63.3	89.6
8	" "	525	32.6	6.8	12.4	25.5	7.8	12.1	33.0
9	" "	725	30.2	4.5	7.8	23.4	14.8	55.9	180
10*	BL.KR-BCT	1025	40.9	5.9	9.9	18.6	7.8	9.6	15.8
11*	" "	575	34.0	11.8	33.4	55.7	11.1	18.6	34.0
12*	" "	975	39.6	5.4	9.7	15.5	12.8	-	-
13	" "	950	43.6	9.5	12.7	33.6	8.6	11.2	29.8
14	" "	325	43.2	5.0	10.0	12.8	7.8	15.0	28.3
15	" "	1350	37.6	9.0	15.6	19.6	4.8	9.6	22.8
16*	BL.KR-FINE	650	20.5	1.5	2.2	6.3	4.0	8.6	23.4
17*	" "	875	30.4	4.3	9.1	12.7	7.2	19.8	31.6
18*	" "	500	23.6	2.1	3.2	5.0	4.7	6.1	13.2
19A	" "	725	22.8	3.5	8.6	11.2	17.5	39.3	74.4
19B	" "	600	23.1	2.6	5.9	15.3	7.3	13.4	22.8
20	" "	500	33.6	6.7	10.9	87.3	21.8	-	-
21	" "	1150	17.8	9.8	13.9	17.3	21.2	31.3	55.4
22	" "	400	52.5	12.9	22.4	31.0	11.2	19.9	27.1
23*	UNBL.KR/LNBD	1125	12.2	2.6	4.3	6.7	5.4	6.7	11.7
24/1	" "	625	7.5	3.4	7.5	13.8	10.4	33.6	66.5
24/2	" "	650	8.3	4.7	9.3	12.6	6.7	9.6	13.7
24/3	" "	650	8.0	3.7	6.1	7.7	6.5	9.9	22.0
24/(1-3)	" "	650	7.9	3.9	9.3	12.6	7.8	33.6	66.5

TABLE A4 EFFLUENT QUALITY FROM PULP AND PAPER INDUSTRY WASTEWATER TREATMENT SYSTEMS (Cont'd)

No.	Mill Category	Nominal Production (TPD)	Water Usage(KGAL/TON) (AA)	BOD_5(lbs/Ton) (AA)[1]	BOD_5(lbs/Ton) (MA30CD)[2]	BOD_5(lbs/Ton) (MD)[3]	TSS(lbs/Ton) (AA)	TSS(lbs/Ton) (MA30CD)	TSS(lbs/Ton) (MD)
25	UNBL.KR/LNBD.	550	11.6	1.4	2.8	6.0	1.1	2.2	5.2
26	" "	950	12.1	2.1	2.9	5.3	4.0	4.6	8.1
27	" "	1200	28.2	4.2	8.8	15.0	10.5	20.1	31.8
28	" "	1525	14.8	3.6	6.5	12.0	5.1	8.9	12.6
29	" "	800	10.9	3.8	9.3	12.8	6.6	9.6	21.9
30	" "	1800	14.2	2.3	5.1	14.0	10.2	11.2	44.5
31*	UNBL.KR/CP	775	12.1	5.6	9.1	12.0	7.2	10.0	13.0
32*	" "	300	12.4	4.5	7.5	16.1	8.3	10.9	21.3
33	" "	675	13.9	7.3	12.8	17.6	12.3	26.9	30.3
34	" "	1250	13.6	4.5	7.0	16.4	11.8	18.8	22.2
35	UNBL.KR/SPEC, PAP	250	50.4	6.9	9.1	21.0	13.8	17.8	45.1
36*	SEMI-CHEM.	600	7.1	4.9	15.4	20.2	8.3	32.7	51.3
37*	" "	350	6.1	5.6	15.2	21.2	4.7	8.9	11.1
38	" "	325	2.0	7.2	16.1	26.8	7.0	10.9	17.7
39/1	" "	625	9.6	1.4	4.0	8.2	4.9	11.7	17.7
39/2	" "	650	9.6	0.8	1.2	2.2	3.0	4.7	5.9
39/3	" "	650	11.3	0.7	1.8	2.2	3.0	5.6	9.9
39/(1-3)*	"	650	10.2	1.0	4.0	8.2	3.6	11.7	17.7
40*	UNBL.KR/SEMI CHEM.	875	9.5	4.3	9.3	12.4	8.8	14.0	21.4
41*	" "	1800	11.7	4.5	9.5	36.1	7.7	12.7	39.8
42A	" "	1300	9.5	4.7	20.4	114.	3.4	16.6	79.8
42B	" "	1300	7.8	1.2	3.7	6.3	0.7	1.7	2.1
43	" "	2475	13.4	8.1	12.3	19.6	11.7	19.1	28.9
44*	SULFITE-DISS	450	36.4	55.0	79.4	106.	36.1	60.7	101.
45*	" "	625	39.9	33.3	44.7	110.	145.	174.	355.
46	" "	450	35.2	51.8	84.0	122.	33.1	64.9	98.4
47*	SULFITE-PAPER	525	21.1	9.1	15.2	30.0	18.7	26.0	67.5
48*	" "	350	22.6	30.2	46.5	84.1	16.5	29.2	44.2
49*	" "	Data not used - treatment system start-up condition?							
50*	" "	375	24.9	8.0	13.6	40.7	8.0	15.5	38.2
51	" "	75	34.2	27.8	Limited Data		25.0	Limited Data	
52	" "	250	60.0	21.7	54.6	67.0	29.3	63.3	100.
53*	GRNDWD-FINE	225	21.6	2.1	4.8	13.7	6.0	10.5	24.3
54*	" "	500	14.2	6.0	10.9	19.1	6.6	13.6	31.5

TABLE A4 EFFLUENT QUALITY FROM PULP AND PAPER INDUSTRY WASTEWATER TREATMENT SYSTEMS (Cont'd)

No.	Mill Category	Nominal Production (TPD)	Water Usage(KGAL/TON) (AA)	BOD_5(lbs/Ton) (AA)[1]	(MA30CD)[2]	(MD)[3]	TSS (lbs/Ton) (AA)	(MA30CD)	(MD)
55	INT-MISC.	50	7.7	4.5	9.8	13.1	3.6	6.7	17.5
56	" "	75	12.4	2.6	Limited Data		1.6	Limited Data	
57	" "	50	40.5	7.4	Limited Data		1.7	Limited Data	
58	INT-MISC.	75	22.7	2.7	5.7	10.8	1.9	2.9	5.1
59*	DEINK-TISS	850	21.5	6.9	10.1	27.0	13.6	24.5	89.4
60*	" "	50	19.3	5.0	9.4	19.1	7.1	11.0	24.2
61*	DEINK-FINE	375	11.1	12.4	42.1	65.3	13.0	30.7	172.
62*	WSTEPAPER-TISS	50	14.7	5.2	Limited Data		4.7	Limited Data	
63*	"	50	22.4	8.7	"	"	8.7	"	"
64*	"	50	5.4	2.8	"	"	2.4	5.6	9.9
65*	WSTEPAPER-BD	100	52.4	1.4	Limited Data		1.5	Limited Data	
66*	"	75	8.9	2.5	"	"	3.5	"	"
67*	"	450	0.7	20.5	P/C System		0.5	P/C System	
68*	"	75	11.2	1.9	Limited Data		3.4	Limited Data	
69*	"	150	1.9	0.3	0.6	0.8	0.4	0.7	0.9
70*	"	150	3.2	1.5	Limited Data		2.1	Limited Data	
71	"	75	7.4	1.5	"	"	2.0	"	"
72	"	75	10.9	1.9	"	"	3.4	"	"
73	"	175	1.6	1.6	"	"	1.6	5.7	11.9
74	"	200	2.7	1.9	3.5	4.9	1.5	2.4	4.9
75*	WSTEPAPER-MOLD PROD.	75	17.2	4.5	Limited Data		3.1	Limited Data	
76*	" "	100	19.0	11.8	Discharge to		32.1	POTW	
77*	BLDG PAP. &	175	0.1	2.6	Limited Data		0.2	Limited Data	
78*	NONINT-FINE	550	11.6	4.4	7.9	10.4	6.0	10.2	15.4
79*	" "	175	14.9	3.5	Limited Data		3.2	Limited Data	
80	" "	175	16.4	3.0	"	"	4.4	"	"
81	" "	525	12.6	5.2	8.4	11.8	5.1	7.4	10.5
82	" "	200	12.2	4.1	5.9	18.2	4.7	5.7	11.2
83*	NONINT-TISS.	40	5.5	0.8	1.7	2.1	1.1	0.9	2.7
84	" "	175	15.6	6.5	Limited Data		4.9	Limited Data	
85	" "	150	22.8	2.7	"	"	2.9	6.2	14.5
86*	NONINT-LTWT	10	112.	21.4	"	"	24.3	Limited Data	
87*	NONINT-FILT & NON WOVEN	10	42.3	2.7	P/C System		4.5	P/C System	

TABLE A4 EFFLUENT QUALITY FROM PULP AND PAPER INDUSTRY WASTEWATER TREATMENT SYSTEMS (Cont'd)

No.	Mill Category	Nominal Production (TPD)	Water Usage (KGAL/TON) (AA)	BOD_5 (lbs/Ton) (AA)[1]	(MA30CD)[2]	(MD)[3]	TSS (lbs/Ton) (AA)	(MA30CD)	(MD)
88*	NONINT-FILT & NON WOVEN	30	95.8	3.4	Limited Data		7.9	Limited Data	
89*	NONINT-PAPBD	75	14.4	2.6	"	"	4.3	"	"
90*	" "	75	6.1	1.7	"	"	0.2	"	"
91	" "	75	13.3	3.6	"	"	5.4	14.2	26.6
92*	NONINT-MISC.	200	23.6	1.4	P/C System		2.1	P/C System	
93*	"	40	35.8	3.5	P/C System		1.6	P/C System	
94*	"	75	20.2	4.3	Limited Data		2.1	4.2	8.3
95	"	40	33.6	5.0	P/C System		1.6	P/C System	
96	"	75	18.5	3.9	Limited Data		1.5	2.0	6.4

Notes:
1) AA = Annual or Long Term Average.
2) MA30CD = Maximum Average for Thirty Consecutive Days. The MA30CD value for BOD_5 and TSS is the actual MA30CD value in pounds per day divided by the average thirty day production for the same period.
3) MD = Maximum Day. The MD value is the MD value in pounds per day divided by the production that occurred on that day.
4) Mill numbers indentified with an * are the "verification mills" data provided by the EC Jordan Co. and used in the development of effluent variability factors.
5) Mill numbers which are underlined were used in variability analysis.

TABLE A5 ANALYSIS OF PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS FOR SELECTED DISTRIBUTION FUNCTIONS DAILY EFFLUENT QUALITY (KLBS/DAY)

Mill No.	Prod. Category	BOD_5 OBS.	BOD_5 N[1]	BOD_5 LN[2]	BOD_5 SLN[3]	TSS OBS	TSS N	TSS LN	TSS SLN
1	BK-DISS	363	-	-	Y[4]	374	-	-	-
2-1	" "	352	-	-	Y	354	-	-	Y
2-2	" "	356	-	-	-	356	-	Y	-
2-3	" "	354	-	Y	-	355	-	-	Y
2-4	" "	355	-	Y	-	356	-	-	Y
2-5	" "	354	-	Y	-	357	-	-	Y
2/(1-5)	" "	1771	-	-	-	1778	-	-	-
3-1	" "	300	-	-	Y	300	-	Y	-
3-2	" "	338	-	-	Y	350	-	-	-
3/(1-2)	" "	638	-	-	Y	650	-	Y	-
4	BK-MKT	178	-	-	Y	176	-	-	Y
5	" "	344	-	-	Y	356	-	-	-
6	" "	361	-	-	Y	361	-	-	-
7	" "	322	-	-	-	328	-	-	-
8	" "	277	-	-	-	312	-	-	Y
9	" "	337	-	Y	-	337	-	-	-
10	BK-BCT	385	-	-	Y	387	Y	-	-
11	" "	368	-	-	-	373	-	-	-
12	" "	341	-	Y	-	32	Limited TSS Data		
13	" "	350	-	-	Y	352	-	-	Y
14	" "	255	-	-	-	141	-	-	Y
15	" "	129	-	Y	-	129	-	-	Y
16	BK-FINE	376	-	-	-	381	-	Y	-
17	" "	373	-	-	Y	379	-	-	-
18	" "	356	-	-	-	356	-	-	Y
19A	" "	145	-	-	-	273	-	Y	-
19B	" "	196	-	Y	-	417	-	-	Y
20	" "	265	-	-	Y	89	Limited TSS Data		
21	" "	434	Y	-	-	446	-	-	Y
22	" "	242	-	-	Y	363	-	-	Y
23	UBK-LNBD	175	-	Y	-	172	-	Y	-
24-1	" "	159	-	-	Y	160	-	-	Y
24-2	" "	164	-	Y	-	164	-	Y	-
24-3	" "	177	Y	-	-	177	-	-	-
24/(1-3)	" "	500	-	-	Y	501	-	-	-
25	" "	292	-	-	-	286	-	Y	-
26	" "	273	-	-	-	310	-	Y	-
27	" "	333	-	Y	-	341	-	-	-
28	UBK-LNBD	385	-	-	Y	399	-	-	-
29	" "	166	-	Y	-	166	-	Y	-

TABLE A5 ANALYSIS OF PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS FOR SELECTED DISTRIBUTION FUNCTIONS DAILY EFFLUENT QUALITY (KLBS/DAY) (Cont'd)

Mill No.	Prod. Category	BOD_5 OBS.	BOD_5 N[1]	BOD_5 LN[2]	BOD_5 SLN[3]	TSS OBS	TSS N	TSS LN	TSS SLN
30	UBK-LNBD	306	-	Y	-	311	-	Y	-
31	UBK-CP	218	-	Y	-	218	Y	-	-
32	" "	257	-	-	-	239	-	-	Y
33	" "	315	-	Y	-	315	-	-	-
34	" "	354	-	-	-	354	-	-	-
35	UBK-SPEC. PAP.	355	-	Y	-	355	-	-	-
36	SEMI-CHEM	370	-	-	-	367	-	-	-
37	" "	362	-	-	-	369	-	-	Y
38	" "	310	-	-	Y	319	-	-	-
39-1	" "	333	-	-	-	333	-	-	-
39-2	" "	359	-	-	Y	360	-	-	-
39-3	" "	339	-	-	-	341	-	-	-
39/(1-3)	" "	1031	-	-	-	1034	-	-	-
40	UBK/SEM-CHEM.	159	-	-	-	159	-	Y	-
41	" "	347	-	-	-	347	-	-	-
42B	" "	298	-	-	-	298	-	-	-
43	" "	347	-	-	-	345	-	-	-
44	SULF-DISS	376	Y	-	-	376	-	-	Y
45	" "	221	-	-	Y	223	-	-	Y
46	" "	422	-	-	-	421	-	-	Y
47	SULF-PAP	421	-	-	-	421	-	Y	-
48	" "	370	-	-	-	370	-	-	-
50	" "	159	-	Y	-	384	-	Y	-
51	" "	89	Limited BOD_5 Data			33	Limited TSS Data		
52	" "	244	-	-	-	299	-	Y	-
53	GNDWD-FINE	384	-	-	-	387	-	-	-
54	" "	354	-	-	Y	353	-	-	-
55	INT-MISC.	317	-	-	-	317	-	-	-
58	" "	381	-	-	Y	379	-	-	Y
59	DEINK-TISS.	388	-	Y	-	391	-	-	-
60	" "	369	-	-	-	369	-	-	-
61	DEINK-FINE	357	-	-	-	361	-	-	-

TABLE A5 ANALYSIS OF PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS FOR SELECTED DISTRIBUTION FUNCTIONS DAILY EFFLUENT QUALITY (KLBS/DAY) (Cont'd)

Mill No.	Prod. Category	BOD_5 OBS.	BOD_5 N[1]	BOD_5 LN[2]	BOD_5 SLN[3]	TSS OBS	TSS N	TSS LN	TSS SLN
66	WSTPAP-TISS	105	Limited BOD_5 Data			106	Limited TSS Data		
69	" "	151	-	-	-	151	-	Y	-
73	" "	94	Limited BOD_5 Data			249	-	Y	-
74	" "	283	-	Y	-	293	-	Y	-
78	NONINT-FINE	350	-	-	Y	350	-	Y	-
81	" "	382	-	Y	-	382	-	-	-
82	" "	347	-	-	-	348	-	Y	-
83	NONINT-TISS	144	-	-	-	192	-	-	Y
85	" "	91	Limited BOD_5 Data			336	-	Y	-
89	NONINT-PAPBD	87	Limited BOD_5 Data			95	Limited TSS Data		
90	" "	100	Limited BOD_5 Data			100	Limited TSS Data		
91	" "	101	Limited BOD_5 Data			170	-	Y	-
94	NONINT-MISC.	83	Limited BOD_5 Data			271	-	Y	-
96	" "	76	Limited BOD_5 Data			223	-	-	Y

NOTE: 1) N = Normal Distribution

2) LN = Log Normal Distribution

3) SLN = Shifted Log Normal Distribution

4) Y = Indicates that the data adhere to the distribution cited at the top of the column.

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS

MAXIMUM DAY - BOD_5 (KLBS/DAY)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
1	99	150.1	190.7	146.9	SLN	198.2	36.57	4.10	5.21	4.02	5.42
	99.7	190.7	>198.2	194.3	"			5.21	>5.42	5.31	
	99.9	-	-	245.1	"			-	-	6.70	
	99.95	-	-	274.4	"			-	-	7.50	
2-1	99	20.87	25.50	20.19	SLN	27.83	8.951	2.33	2.85	2.26	3.11
	99.7	25.50	>27.83	23.02	"			2.85	>3.11	2.57	
	99.9	-	-	25.68	"			-	-	2.87	
	99.95	-	-	27.09	"			-	-	3.03	
2-2	99	22.06	22.97	No	FIT	23.38	6.974	3.16	3.29	-	3.35
	99.7	22.97	>23.38					3.29	>3.35	-	
2-3	99	15.19	15.69	15.17	LN	16.68	8.602	1.76	1.82	1.76	1.94
	99.7	15.69	>16.68	16.90	"			1.82	>1.94	1.96	
	99.9	-	-	18.50	"			-	-	2.15	
	99.95	-	-								
2-4	99	16.94	17.68	16.56	LN	17.78	9.032	1.88	1.95	1.83	1.96
	99.7	17.68	>17.79	18.60	"			1.95	>1.97	2.06	
	99.9	-	-	20.49	"			-	-	2.27	
	99.95	-	-	21.47	"			-	-	2.38	
2-5	99	20.53	23.05	19.58	LN	23.39	9.342	2.12	2.47	2.10	2.50
	99.7	23.05	>23.39	22.61	"			2.47	>2.50	2.42	
	99.9	-	-	25.49	"			-	-	2.73	
	99.95	-	-	27.02	"			-	-	2.89	
2/(1-5)	99	18.71	20.83			27.83	8.578	2.18	2.43	-	3.24
	99.7	23.05	23.39	No	FIT			2.69	2.73	-	
	99.9	23.39	>27.83					-	-	-	
	99.95	-	-					2.73	>3.24	-	
3-1	99	100.1	116.7	117.2	SLN	174.9	27.26	3.67	4.28	4.30	6.42
	99.7	116.7	>174.9	157.3	"			4.28	>6.42	5.77	
	99.9	-	-	201.0	"			-	-	7.37	
	99.95	-	-	226.3	"			-	-	8.30	
3-2	99	150.1	190.5	152.0	SLN	198.1	37.50	4.00	5.08	4.05	5.28
	99.7	190.5	>198.1	201.0	"			5.08	>5.28	5.36	
	99.9	-	-	253.7	"					6.77	
	99.95	-	-	284.0	"					7.57	
3/(1-2)	99	131.0	150.1	139.0	SLN	198.1	32.69	4.01	4.59	4.25	6.06
	99.7	174.9	>198.1	185.9	"			5.35	>6.06	5.69	
	99.9	198.1	>198.1	236.9	"			6.06	>6.06	7.25	
	99.95	-	-	266.5	"			-	-	8.15	
4	99	8.564	>9.641	12.00	SLN	9.64	3.56	2.40	>2.70	3.37	2.70
	99.7	9.641	>9.641	13.61	"			2.70	>2.70	3.82	
	99.9	-	-	15.10	"			-	-	4.24	
	99.95	-	-	15.88	"			-	-	4.45	
5	99	15.13	16.52	16.96	SLN	16.52	5.02	3.01	3.29	3.38	3.29
	99.7	16.11	>16.52	22.28	"			3.21	>3.29	4.44	
	99.9	-	-	27.96	"			-	-	5.57	
	99.95	-	-	31.22	"			-	-	6.22	
6	99	31.38	31.85	43.26	SLN	32.23	14.20	2.21	2.24	3.05	2.27
	99.7	31.85	>32.23	46.97	"			2.24	>2.27	3.31	
	99.9	-	-	50.30	"			-	-	3.54	
	99.95	-	-	52.00	"			-	-	3.66	
7	99	20.96	22.68	No	FIT	25.67	7.28	2.88	3.12	-	3.53
	99.7	22.68	25.67					3.12	>3.53	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
8	99	11.30	13.08	No	FIT	13.08	3.52	3.21	3.72	-	3.72
	99.7	12.66	>13.08					3.60	>3.72	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
9	99	13.26	17.66	12.29	LN	20.59	3.29	4.03	5.37	3.74	6.26
	99.7	17.66	>20.59	16.19	"			5.37	>6.26	4.92	

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS MAXIMUM DAY - BOD_5 (KLBS/DAY)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
10	99	12.91	14.36	16.75	SLN	17.75	6.04	2.14	2.38	2.77	2.94
	99.7	14.36	> 17.75	18.98	"			2.38	> 2.94	3.14	
	99.9	-	-	21.07	"			-	-	3.49	
	99.95	-	-	22.17	"			-	-	3.67	
11	99	28.20	30.02	No	FIT	31.02	6.71	4.20	4.47	-	4.62
	99.7	30.02	31.02					4.47	> 4.62	-	
	99.9							-	-	-	
	99.95							-	-	-	
12	99	11.68	12.52	13.72	LN	12.56	5.31	2.20	2.35	2.58	2.36
	99.7	12.52	> 12.56	16.58	"			2.35	> 2.36	3.12	
	99.9	-	-	19.41	"			-	-	3.65	
	99.95	-	-	20.95	"			-	-	3.95	
13	99	19.65	19.97	26.95	SLN	23.94	9.03	2.18	2.21	2.98	2.65
	99.7	19.97	> 23.94	29.98	"			2.21	> 2.65	3.32	
	99.9	-	-	32.76	"			-	-	3.63	
	99.95	-	-	34.20	"			-	-	3.79	
14	99	4.07	4.27	No	FIT	4.27	1.65	2.47	2.58	-	2.58
	99.7	4.13	> 4.27					2.50	> 2.58	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
15	99	24.35	> 26.95	27.52	LN	26.95	12.10	2.01	> 2.23	2.27	2.23
	99.7	26.95	> 26.95	32.34	"			2.23	> 2.23	2.67	
	99.9	-	-	37.01	"			-	-	3.06	
	99.95	-	-	39.51	"			-	-	3.27	
16	99	2.33	2.79	No	FIT	3.61	0.99	2.35	2.82	-	3.65
	99.7	2.79	> 3.61					2.82	> 3.65	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
17	99	9.88	12.73	11.69	SLN	13.16	3.82	2.58	3.33	3.06	3.45
	99.7	12.73	> 13.16	15.19	"			3.33	> 3.45	3.98	
	99.9	-	-	18.90	"			-	-	4.95	
	99.95	-	-	21.06	"			-	-	5.51	
18	99	2.70	2.79	No	FIT	2.82	1.04	2.60	2.68	-	2.71
	99.7	2.79	> 2.82					2.68	> 2.71	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
19A	99	8.51	> 8.86	No	FIT	8.86	2.58	3.30	> 3.43	-	3.43
	99.7	8.86	> 8.86					3.43	> 3.43	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
19B	99	6.31	> 9.19	6.96	LN	9.19	1.57	4.02	> 5.85	-	5.85
	99.7	9.19	> 9.19	9.59	"			5.85	> 5.85	-	
	99.9	-	-	12.53	"			-	-	-	
	99.95	-	-	14.27	"			-	-	-	
20	99	17.44	34.29	14.59	SLN	34.29	3.27	5.33	10.49	4.46	10.49
	99.7	34.29	> 34.29	21.18	"			10.49	> 10.49	6.48	
	99.9	-	-	28.88	"			-	-	8.83	
	99.95	-	-	33.58	"			-	-	10.27	
21	99	19.63	22.02	19.88	N	22.46	11.20	1.75	1.97	1.78	2.01
	99.7	22.02	> 22.46	21.45	"			1.97	> 2.01	1.92	
	99.9	-	-	22.76	"			-	-	2.03	
	99.95	-	-	23.39	"			-	-	2.09	
22	99	11.63	> 12.73	15.84	SLN	12.73	5.31	2.19	> 2.40	2.98	2.40
	99.7	11.90	12.73	17.57	"			2.24	2.40	3.31	
	99.9	-	-	19.16	"			-	-	3.61	
	99.95	-	-	19.97	"			-	-	3.76	

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS

MAXIMUM DAY - BOD_5 (KLBS/DAY)

(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
23	99	7.68	> 8.89	7.18	LN	8.89	2.93	2.62	> 3.03	2.45	3.03
	99.7	8.89	> 8.89	8.59	"			3.03	> 3.03	2.93	
	99.9	-	-	9.97	"			-	-	3.40	
	99.95	-	-	10.72	"			-	-	3.66	
24-1	99	> 7.30	7.74	6.53	SLN	7.74	2.13	3.42	> 3.63	3.07	3.63
	99.7	> 7.74	7.74	7.55	"			3.63	> 3.63	3.54	
	99.9	-	-	8.52	"			-	-	4.00	
	99.95	-	-	9.04	"			-	-	4.24	
24-2	99	6.98	> 8.87	7.79	LN	8.87	3.04	2.30	> 2.92	2.56	2.92
	99.7	8.87	> 8.87	9.39	"			2.92	> 2.92	3.09	
	99.9	-	-	10.97	"			-	-	3.60	
	99.95	-	-	11.83	"			-	-	3.89	
24-3	99	3.91	> 4.22	4.17	N	4.22	2.39	1.63	> 1.77	1.74	1.77
	99.7	4.22	> 4.22	4.46	"			1.77	> 1.77	1.87	
	99.9	"	"	4.72	"			-	-	1.97	
	99.95	"	"	4.85	"			-	-	2.02	
24/(1-3)	99	6.56	7.30	7.06	SLN	8.87	2.52	2.60	2.90	2.80	3.52
	99.7	7.74	> 8.87	8.03	"			3.07	> 3.52	3.19	
	99.9	8.87	> 8.87	8.95	"			3.52	> 3.52	3.51	
	99.95	-	-	9.43	"					3.74	
25	99	1.92	3.50	No	FIT	3.50	0.80	2.40	4.38	-	4.38
	99.7	2.05	> 3.50					2.56	> 4.38	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
26	99	4.16	5.40	No	FIT	5.40	2.04	2.04	2.65	-	2.65
	99.7	4.60	> 5.40					2.25	> 2.65	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
27	99	13.03	15.64	14.86	LN	16.38	4.86	2.68	3.22	3.06	3.37
	99.7	15.64	> 16.38	18.60	"			3.22	> 3.37	3.83	
	99.9	-	-	22.40	"			-	-	4.61	
	99.95	-	-	24.58	"			-	-	5.06	
28	99	15.18	17.31	18.45	SLN	17.39	5.44	2.79	3.18	3.39	3.19
	99.7	17.31	> 17.39	21.76	"			3.18	> 3.19	4.00	
	99.9	-	-	24.97	"			-	-	4.59	
	99.95	-	-	26.69	"			-	-	4.91	
29	99	11.09	> 11.09	8.33	LN	11.09	3.09	3.59	> 3.59	2.70	3.59
	99.7	11.09	> 11.09	10.19	"			3.59	> 3.59	3.30	
	99.9	-	-	12.02	"			-	-	3.89	
	99.95	-	-	13.03	"			-	-	4.22	
30	99	11.76	18.92	10.21	LN	18.92	4.13	2.85	4.58	2.47	4.58
	99.7	18.92	> 18.92	12.25	"			4.58	> 4.58	2.97	
	99.9	-	-	14.25	"			-	-	3.45	
	99.95	-	-	15.34	"			-	-	3.71	
31	99	9.25	> 10.06	10.18	LN	10.06	4.31	2.15	> 2.33	2.36	2.33
	99.7	10.06	> 10.06	12.04	"			2.33	> 2.33	2.79	
	99.9	-	-	13.86	"			-	-	3.22	
	99.95	-	-	14.84	"			-	-	3.44	
32	99	4.11	4.81	No	FIT	4.81	1.31	3.14	3.67	-	3.67
	99.7	4.20	> 4.81					3.21	> 3.67	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
33	99	9.05	10.06	11.56	LN	11.09	5.16	1.75	1.95	2.24	2.15
	99.7	10.06	> 11.09	13.54	"			1.95	> 2.15	2.62	
	99.9	-	-	15.45	"			-	-	2.99	
	99.95	-	-	16.47	"						

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS

MAXIMUM DAY - BOD_5 (KLBS/DAY)

(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
34	99	18.51	20.68	No	FIT	21.30	5.71	3.58	4.01	-	4.13
	99.7	20.68	> 21.30					4.01	> 4.13	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
35	99	4.65	5.12	4.28	LN	5.43	1.71	2.72	2.99	2.50	3.18
	99.7	5.12	> 5.43	5.09	"			2.99	> 3.18	2.98	
	99.9	-	-	5.87	"			-	-	3.43	
	99.95	-	-	6.29	"			-	-	3.68	
36	99	10.94	13.18	No	FIT	13.51	2.97	3.68	4.44	-	4.55
	99.7	13.18	> 13.51					4.44	> 4.55	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
37	99	7.04	7.53	No	FIT	7.62	1.85	3.81	4.07	-	4.12
	99.7	7.53	> 7.62					4.07	4.12	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
38	99	8.31	8.78	8.90	SLN	10.27	2.31	3.60	3.80	3.85	4.45
	99.7	8.78	> 10.27	11.53	"			3.80	> 4.45	4.99	
	99.9	-	-	14.32	"			-	-	6.20	
	99.95	-	-	15.90	"			-	-	6.88	
39-1	99	2.99	3.38	No	FIT	5.11	0.89	3.36	3.80	-	5.74
	99.7	3.38	> 5.11					3.80	> 5.74	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
39-2	99	1.28	1.43	1.58	SLN	1.47	0.50	2.56	2.86	3.16	2.94
	99.7	1.43	> 1.47	1.74	"			2.86	> 2.94	3.48	
	99.9	-	-	1.89	"			-	-	3.78	
	99.95	-	-	1.96	"			-	-	3.92	
39-3	99	1.43	1.50	No	FIT	1.57	0.46	3.11	3.26	-	3.41
	99.7	1.50	> 1.57					3.26	> 3.41	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
39/(1-3)	99	2.57	2.89	No	FIT	5.11	0.61	4.21	4.74	-	8.38
	99.7	2.99	3.38					4.90	5.54	-	
	99.9	3.38	> 5.11					5.54	> 8.38	-	
	99.95	-	-					-	-	-	
40	99	9.80	> 11.26	No	FIT	11.26	3.80	2.58	> 2.96	-	2.96
	99.7	11.26	> 11.26					2.96	> 2.96	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
41	99	34.68	51.83	No	FIT	52.67	8.06	4.30	6.43	-	6.43
	99.7	51.83	> 52.67					6.43	> 6.43	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
42B	99	5.51	6.11	No	FIT	6.11	1.52	3.63	4.02	-	4.02
	99.7	5.95	> 6.11					3.91	> 4.02	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
43	99	38.11	43.23	No	FIT	46.67	19.9	1.92	2.17	-	2.35
	99.7	43.23	> 46.67					2.17	> 2.35	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
44	99	46.42	53.55	46.73	N	55.11	24.80	1.87	2.16	1.88	2.22
	99.7	53.55	> 55.11	50.70	"			2.16	> 2.22	2.04	
	99.9	-	-	54.00	"			-	-	2.18	
	99.95	-	-	55.60	"			-	-	2.24	

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS

MAXIMUM DAY - BOD_5 (KLBS/DAY)

(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
45	99	43.28	53.05	58.87	SLN	53.05	20.50	2.11	2.59	2.87	2.59
	99.7	53.05	53.05	65.44	"			2.59	2.59	3.19	
	99.9	-	-	71.47	"			-	-	3.49	
	99.95	-	-	74.60	"			-	-	3.64	
46	99	47.19	53.55	No	FIT	55.11	23.30	2.03	2.30	-	2.37
	99.7	53.55	> 55.11					2.30	> 2.37	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
47	99	11.97	16.55	No	FIT	19.06	4.76	2.51	3.48	-	4.00
	99.7	16.55	> 19.06					3.48	> 4.00	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
48	99	21.83	24.56	No	FIT	25.28	10.20	2.14	2.41	-	2.48
	99.7	24.56	> 25.28					2.41	2.48	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
50	99	10.69	> 17.05	9.59	LN	17.05	2.98	3.59	> 5.72	3.22	5.72
	99.7	17.05	> 17.05	12.20	"			5.72	> 5.72	4.09	
	99.9	-	-	14.91	"			-	-	5.00	
	99.95	-	-	16.44				-	-	5.52	
52	99	16.69	18.12	No	FIT	18.12	5.64	2.96	3.21	-	3.21
	99.7	17.03	> 18.12					3.02	> 3.21	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
53	99	1.80	2.19	No	FIT	2.98	0.49	3.67	4.47	-	6.08
	99.7	2.19	> 2.98					4.47	> 6.08	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
54	99	9.70	9.78	9.50	SLN	10.98	3.01	3.22	3.25	3.16	3.65
	99.7	9.78	> 10.98	12.38	"			3.25	> 3.65	4.11	
	99.9	-	-	15.43	"			-	-	5.13	
	99.95	-	-	17.18	"			-	-	5.71	
55	99	0.69	0.77	No	FIT	0.84	0.26	2.65	2.96	-	3.23
	99.7	0.77	> 0.84					2.96	> 3.23	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
58	99	0.63	0.77	0.74	SLN	0.84	0.24	2.63	3.21	3.08	3.50
	99.7	0.77	> 0.84	0.88	"			3.21	> 3.50	3.67	
	99.9	-	-	1.02	"			-	-	4.25	
	99.95	-	-	1.10	"			-	-	4.58	
59	99	15.45	18.92	11.34	LN	19.78	5.81	2.67	3.26	1.95	3.40
	99.7	18.92	>19.78	12.91	"			3.26	> 3.40	2.22	
	99.9	-	-	14.38	"			-	-	2.48	
	99.95	-	-	15.16	"			-	-	2.61	
60	99	0.75	1.02	No	FIT	1.03	0.26	2.88	3.92	-	3.92
	99.7	1.02	>1.03					3.92	> 3.92	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
61	99	21.41	24.64	No	FIT	26.45	4.64	4.61	5.30	-	5.70
	99.7	24.64	>26.45					5.31	>5.70	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
69	99	0.13	>0.14	No	FIT	0.14	0.04	3.25	>3.50	-	3.50
	99.7	0.14	>0.14					3.50	>3.50	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
MAXIMUM DAY - BOD_5 (KLBS/DAY)
(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
74	99	1.11	1.14	1.29	LN	1.14	0.38	2.92	3.00	3.39	3.00
	99.7	1.12	>1.14	1.65	"			2.95	>3.00	4.34	
	99.9	-	-	2.04	"			-	-	5.34	
	99.95	-	-	2.26	"			-	-	5.94	
78	99	5.60	5.96	6.64	SLN	6.00	2.46	2.28	2.42	2.70	2.44
	99.7	5.96	>6.00	7.49	"			2.42	>2.44	3.04	
	99.9	-	-	8.27	"			-	-	3.36	
	99.95	-	-	8.68	"			-	-	3.53	
81	99	5.60	5.96	6.27	LN	6.00	2.72	2.05	2.19	2.31	2.19
	99.7	5.96	>6.00	7.40	"			2.19	>2.21	2.72	
	99.9	-	-	8.48	"			-	-	3.12	
	99.95	-	-	9.06	"			-	-	3.33	
82	99	2.15	2.79	No	FIT	3.91	0.83	2.59	3.36	-	4.71
	99.7	2.79	>3.91					3.36	>4.71	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
83	99	0.086	>0.092	No	FIT	0.092	0.03	2.86	>3.07	-	3.07
	99.7	0.092	>0.092					3.07	>3.07	-	
	99.9	-	-					-	-		
	99.95	-	-					-	-	-	

NOTE: 1) Variability is the ratio of the indicated value to the long term average.

TABLE A7 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
MAXIMUM DAY - TSS (KLBS/DAY)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability Based Upon 50% TL	Variability Based Upon 5% TL	Variability Based Upon D.F.	Variability Based Upon M.D.V.
1	99	188.4	391.5	No	FIT	609.1	54.3	3.47	7.21	-	11.2
	99.7	391.5	>609.1					7.21	>11.2	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
2-1	99	35.43	43.58	41.96	SLN	43.74	13.69	2.59	3.18	3.07	3.20
	99.7	43.58	>43.74	48.27	"			3.18	>3.20	3.53	
	99.9	-	-	54.26	"			-	-	3.96	
	99.95	-	-	57.43	"			-	-	4.20	
2-2	99	32.09	35.22	38.17	LN	44.74	10.55	3.04	3.34	3.62	4.24
	99.7	35.22	>44.74	49.78	"			3.24	>4.24	4.72	
	99.9	-	-	62.11	"			-	-	5.89	
	99.95	-	-	69.16	"			-	-	6.56	
2-3	99	25.33	36.34	37.65	SLN	40.35	12.59	2.01	2.89	2.99	3.20
	99.7	36.34	>40.35	41.71	"			2.89	>3.20	3.31	
	99.9	-	-	45.42	"			-	-	3.61	
	99.95	-	-	47.34	"			-	-	3.76	
2-4	99	32.35	34.48	43.09	SLN	36.77	14.77	2.19	2.33	2.92	2.49
	99.7	34.48	>36.77	46.77	"			2.33	>2.49	3.17	
	99.9	-	-	50.07	"			-	-	3.39	
	99.95	-	-	1.76	"			-	-	3.50	
2-5	99	38.49	53.82	41.60	SLN	53.82	15.82	2.43	3.40	2.63	3.40
	99.7	53.82	>53.82	48.82	"			3.40	>3.40	3.09	
	99.9	-	-	55.80	"			-	-	3.53	
	99.95	-	-	59.54	"			-	-	3.76	
2/(1-5)	99	34.20	36.34	No	FIT	53.82	13.48	2.53	2.69	-	3.99
	99.7	43.74	45.54					3.24	3.38	-	
	99.9	45.54	>53.82					3.38	>3.99	-	
	99.95	-	-					-	-	-	
3-1	99	149.2	241.8	143.8	LN	295.0	50.21	2.97	4.82	2.86	5.88
	99.7	241.8	>295.0	178.2	"			4.82	>5.88	3.55	
	99.9	-	-	213.1	"			-	-	4.24	
	99.95	-	-	232.4	"			-	-	4.63	
3-2	99	217.8	391.6	No	FIT	608.4	55.03	3.95	7.12	-	11.06
	99.7	391.6	>608.4					7.12	>11.06	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
3/(1-2)	99	188.6	295.0	159.1	LN	608.4	52.81	3.57	5.59	3.01	11.5
	99.7	343.3	>608.0	199.9	"			6.50	>11.5	3.78	
	99.9	608.4	>608.4	241.8	"			11.5	>11.5	4.58	
	99.95	-	-	265.3	"			-	-	5.02	
4	99	16.26	>16.88	20.93	SLN	16.88	5.171	3.14	>3.26	4.04	3.26
	99.7	16.88	>16.88	26.11	"			3.26	>3.26	5.05	
	99.9	-	-	31.40	"			-	-	6.07	
	99.95	-	-	34.35	"			-	-	6.64	
5	99	8.06	8.23	No	FIT	9.50	3.83	2.10	2.15	-	2.48
	99.7	8.23	>9.50					2.15	>2.48	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
6	99	57.05	57.08	No	FIT	71.31	25.15	2.27	2.27	-	2.84
	99.7	57.08	>71.31					2.27	>2.84	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	

TABLE A7 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
MAXIMUM DAY - TSS (KLBS/DAY)
(Cont'd)

% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability Based Upon 50% TL	Variability Based Upon 5% TL	Variability Based Upon D.F.	Variability Based Upon M.D.V.
99	41.82	43.91	No	FIT	45.47	21.05	1.99	2.09	-	2.16
99.7	43.91	>45.47					2.09	>2.16	-	
99.9	-	-					-	-	-	
99.95	-	-					-	-	-	
99	12.93	18.51	14.09	SLN	18.51	4.05	3.19	4.57	3.48	4.57
99.7	18.51	>18.51	17.38	"			4.57	>4.57	4.29	
99.9	-	-	20.64	"			-	-	5.10	
99.95	-	-	22.52	"			-	-	5.56	
99	93.16	104.5	No	FIT	157.3	10.84	8.59	9.64	-	14.50
99.7	104.5	>157.3					9.64	>14.5	-	
99.9	-	-					-	-	-	
99.95	-	-					-	-	-	
99	17.16	17.89	16.36	N	19.49	7.98	2.15	2.24	2.05	2.44
99.7	17.89	>19.49	17.87	"			2.24	>2.44	2.24	
99.9	-	-	19.13	"			-	-	2.40	
99.95	-	-	19.74	"			-	-	2.47	
99	13.06	21.47	No	FIT	21.47	6.35	2.06	3.38	-	3.38
99.7	18.68	>21.47					2.94	>3.38	-	
99.9	-	-					-	-	-	
99.95	-	-					-	-	-	
99	18.35	18.97	26.64	SLN	21.20	8.16	2.25	2.32	3.26	2.60
99.7	18.97	>21.20	29.43	"			2.32	>2.60	3.61	
99.9	-	-	31.98	"			-	-	3.92	
99.95	-	-	33.30	"			-	-	4.08	
99	7.11	>7.96	7.93	SLN	7.96	2.58	2.76	3.09	3.07	3.09
99.7	7.96	>7.96	9.45	"			3.09	>3.09	3.66	
99.9	-	-	10.94	"			-	-	4.24	
99.95	-	-	11.75	"			-	-	4.55	
99	20.94	>21.37	19.85	SLN	21.37	6.52	3.21	>3.28	3.04	3.28
99.7	21.37	>21.37	23.74	"			3.28	>3.28	3.64	
99.9	-	-	27.56	"			-	-	4.22	
99.95	-	-	29.63	"			-	-	4.54	
99	10.40	13.49	8.56	LN	14.87	2.60	4.00	5.18	3.29	5.72
99.7	13.49	>14.87	10.98	"			5.18	>5.72	4.22	
99.9	-	-	13.49	"			-	-	5.19	
99.95	-	-	14.92	"			-	-	5.74	
99	21.99	24.28	No	FIT	27.79	6.36	3.45	3.82	-	4.37
99.7	24.28	>27.79					3.82	>4.37	-	
99.9	-	-					-	-	-	
99.95	-	-					-	-	-	
99	5.11	5.87	7.40	SLN	6.34	2.31	2.21	2.54	3.20	2.74
99.7	5.87	>6.34	8.18	"			2.54	>2.74	3.54	
99.9	-	-	8.89	"			-	-	3.85	
99.95	-	-	9.27	"			-	-	4.01	
99	43.23	52.29	40.42	LN	52.29	12.70	3.38	4.09	3.16	4.09
99.7	51.13	>52.29	51.22	"			4.00	>4.09	4.00	
99.9	-	-	62.40	"			-	-	4.88	
99.95	-	-	68.68	"			-	-	5.37	
99	11.40	13.61	13.51	SLN	13.66	4.40	2.59	3.09	3.07	3.10
99.7	13.61	>13.66	15.72	"			3.09	>3.10	3.57	
99.9	-	-	17.84	"			-	-	4.05	
99.95	-	-	18.97	"			-	-	4.31	
99	53.67	55.90	78.76	SLN	65.51	24.06	2.23	2.32	3.27	2.72
99.7	55.90	>65.51	88.73	"			2.32	>2.72	3.69	
99.9	-	-	98.00	"			-	-	4.07	
99.95				"					4.27	

TABLE A7 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
MAXIMUM DAY - TSS (KLBS/DAY)
(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability Based Upon 50% TL	Variability Based Upon 5% TL	Variability Based Upon D.F.	Variability Based Upon M.D.V.
22	99	10.01	10.70	14.52	SLN	11.18	4.63	2.16	2.31	3.13	2.41
	99.7	10.70	>11.18	16.02	"			2.31	>2.41	3.46	
	99.9	-	-	17.40	"			-	-	3.76	
	99.95	-	-	18.11	"			-	-	3.91	
23	99	10.07	>11.08	10.86	LN	11.08	6.12	1.65	>1.81	1.77	1.81
	99.7	11.08	>11.08	12.12	"			1.81	>1.81	1.98	
	99.9	-	-	13.27	"			-	-	2.17	
	99.95	-	-	13.88	"			-	-	2.27	
24-1	99	34.82	>36.34	29.21	SLN	36.34	6.61	5.26	>5.50	4.42	5.50
	99.7	36.34	>36.34	39.12	"			5.50	>5.50	5.92	
	99.9	-	-	49.92	"			-	-	7.55	
	99.95	-	-	56.19	"			-	-	8.50	
24-2	99	10.00	>10.68	11.68	LN	10.68	4.31	2.32	>2.48	2.71	2.48
	99.7	10.68	>10.68	14.26	"			2.48	>2.48	3.30	
	99.9	-	-	16.83	"			-	-	3.90	
	99.95	-	-	18.25	"			-	-	4.23	
24-3	99	11.01	>13.99	No	FIT	13.99	4.15	2.65	>3.37	-	3.37
	99.7	13.99	>13.99					3.37	>3.37	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
24/(1-3)	99	21.42	24.35	No	FIT	36.34	4.99	4.99	4.87	-	7.28
	99.7	34.82	>36.34					6.98	>7.28	-	
	99.9	36.34	>36.34					7.28	>7.28	-	
	99.95	-	-					-	-	-	
25	99	1.97	3.05	2.86	LN	3.05	0.61	3.23	5.00	4.69	5.00
	99.7	3.05	>3.05	3.98	"			5.00	>5.00	6.52	
	99.9	-	-	5.24	"			-	-	8.59	
	99.95	-	-	5.99	"			-	-	9.82	
26	99	6.01	6.97	6.12	LN	7.04	3.74	1.61	1.86	1.64	1.88
	99.7	6.97	>7.04	6.72	"			1.86	>1.88	1.80	
	99.9	-	-	7.26	"			-	-	1.94	
	99.95	-	-	7.54	"			-	-	2.02	
27	99	34.68	38.58	No	FIT	43.35	12.18	2.85	3.17	-	3.56
	99.7	38.58	>43.35					3.17	>3.56	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
28	99	19.02	19.92	No	FIT	20.02	7.83	2.43	2.54	-	2.56
	99.7	19.92	>20.02					2.54	>2.56	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
29	99	9.21	>9.41	10.32	LN	9.41	5.27	1.75	>1.79	1.96	1.79
	99.7	9.41	>9.41	11.75	"			1.79	>1.79	2.23	
	99.9	-	-	13.09	"			-	-	2.48	
	99.95	-	-	13.79	"			-	-	2.62	
30	99	33.91	39.77	33.32	LN	46.80	10.42	3.25	3.82	3.20	4.49
	99.7	39.77	>46.80	42.34	"			3.82	>4.49	4.06	
	99.9	-	-	51.70	"			-	-	4.96	
	99.95	-	-	56.96	"			-	-	5.47	

TABLE A7 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
MAXIMUM DAY - TSS (KLBS/DAY)
(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability Based Upon 50% TL	Variability Based Upon 5% TL	Variability Based Upon D.F.	Variability Based Upon M.D.V.
31	99	10.56	>11.53	10.67	N	11.53	5.61	1.88	2.06	1.90	2.06
	99.7	11.53	>11.53	11.63	"			2.06	> 2.06	2.07	
	99.9	-	-	12.34	"			-	-	2.20	
	99.95	-	-	12.71	"			-	-	2.27	
32	99	6.21	7.29	8.03	SLN	7.29	2.42	2.57	3.01	3.32	3.01
	99.7	6.29	>7.29	9.18	"			2.60	> 3.01	3.79	
	99.9	-	-	10.27	"			-	-	4.24	
	99.95	-	-	10.84	"			-	-	4.48	
33	99	19.77	21.26	No	FIT	21.97	8.74	2.26	2.43	-	2.51
	99.7	21.26	> 21.97					2.43	> 2.51	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
34	99	27.89	32.81	No	FIT	33.64	14.91	1.87	2.20	-	2.26
	99.7	32.81	> 33.64					2.20	> 2.26	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
35	99	9.58	10.62	No	FIT	11.10	3.58	2.67	2.97	-	3.10
	99.7	10.62	> 11.10					2.97	> 3.10	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
36	99	28.95	33.68	No	FIT	34.21	5.01	5.78	6.72	-	6.82
	99.7	33.68	> 34.21					6.72	> 6.82	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
37	99	3.26	3.54	4.26	SLN	3.74	1.55	2.10	2.27	2.75	2.41
	99.7	3.54	> 3.74	4.77	"			2.28	> 2.41	3.08	
	99.9	-	-	5.24	"			-	-	3.38	
	99.95	-	-	5.49	"			-	-	3.54	
38	99	4.82	5.12	No	FIT	5.52	2.25	2.14	2.28	-	2.45
	99.7	5.12	> 5.52					2.28	> 2.45	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
39-1	99	8.46	10.17	No	FIT	10.57	3.04	2.78	3.35	-	3.48
	99.7	10.17	> 10.57					3.35	> 3.48	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
39-2	99	3.78	4.09	No	FIT	4.18	1.93	1.96	2.12	-	2.17
	99.7	3.87	> 4.18					2.01	> 2.17	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
39-3	99	5.88	6.63	No	FIT	6.91	1.94	3.03	3.42	-	3.56
	99.7	6.63	> 6.91					3.42	> 3.56	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
39/(1-3)	99	7.96	8.42	No	FIT	10.57	2.29	3.47	3.67	-	4.62
	99.7	9.58	10.57					4.18	4.62	-	
	99.9	10.57	> 10.57					4.62	> 4.62	-	
	99.95	-	-					-	-	-	
40	99	16.16	> 16.81	19.49	LN	16.81	7.75	2.09	> 2.17	2.51	2.17
	99.7	16.81	> 16.81	23.37	"			2.17	> 2.17	3.02	
	99.9	-	-	27.19	"			-	-	3.51	
	99.95	-	-	29.27	"			-	-	3.78	
41	99	56.89	63.49	No	FIT	63.49	13.9	4.09	4.56	-	4.56
	99.7	63.49	> 63.49					4.56	> 4.56	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	

TABLE A7 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS

MAXIMUM DAY - TSS (KLBS/DAY)

(Cont'd)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability Based Upon 50% TL	Variability Based Upon 5% TL	Variability Based Upon D.F.	Variability Based Upon M.D.V.
42B	99	2.89	3.15	No	FIT	3.15	0.85	3.40	3.71	-	3.71
	99.7	3.05	> 3.15					3.59	> 3.71	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
43	99	66.01	68.35	78.89	SLN	73.20	28.84	2.29	2.37	2.74	2.54
	99.7	68.35	> 73.20	87.90	"			2.37	> 2.54	3.05	
	99.9	-	-	96.21	"			-	-	3.34	
	99.95	-	-	100.5	"			-	-	3.48	
44	99	36.53	39.59	51.02	SLN	44.29	16.31	2.24	2.43	3.13	2.72
	99.7	39.59	> 44.29	56.76	"			2.43	> 2.72	3.48	
	99.9	-	-	62.03	"			-	-	3.80	
	99.95	-	-	64.77	"			-	-	3.97	
45	99	246.7	>251.3	303.5	SLN	251.3	89.25	2.76	> 2.82	3.40	2.82
	99.7	251.3	>251.3	355.1	"			2.82	> 2.82	3.98	
	99.9	-	-	404.7	"			-	-	4.53	
	99.95	-	-	431.4	"			-	-	4.83	
46	99	36.53	39.59	51.24	SLN	44.29	14.88	2.45	2.66	3.44	2.98
	99.7	39.59	> 44.29	57.38	"			2.66	> 2.98	3.86	
	99.9	-	-	63.05	"			-	-	4.24	
	99.95	-	-	66.01	"			-	-	4.44	
47	99	25.45	29.48	24.93	LN	30.32	9.78	2.60	3.01	2.54	3.10
	99.7	29.48	> 30.32	30.04	"			3.01	> 3.10	3.07	
	99.9	-	-	35.09	"			-	-	3.59	
	99.95	-	-	37.84	"			-	-	3.87	
48	99	12.25	13.15	No	FIT	13.97	5.57	2.20	2.36	-	2.51
	99.7	13.15	> 13.97					2.36	> 2.51	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
50	99	9.56	11.33	7.78	LN	11.51	2.97	3.21	3.81	2.62	3.88
	99.7	11.33	> 11.51	9.44	"			3.81	> 3.88	3.18	
	99.9	-	-	10.85	"			-	-	3.65	
	99.95	-	-	11.74	"			-	-	3.95	
52	99	19.70	23.44	25.27	LN	24.82	7.61	2.59	3.08	3.32	3.26
	99.7	23.44	> 24.82	32.25	"			3.08	> 3.26	4.24	
	99.9	-	-	39.51	"			-	-	5.19	
	99.95	-	-	43.61	"			-	-	5.73	
53	99	4.39	5.41	No	FIT	5.42	1.37	3.20	3.95	-	3.96
	99.7	5.41	> 5.42					3.95	> 3.96	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
54	99	14.01	17.11	No	FIT	18.16	3.30	4.25	5.18	-	5.50
	99.7	17.11	> 18.16					5.18	> 5.50	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
55	99	0.65	0.66	0.76	SLN	0.84	0.21	3.10	3.14	3.62	4.00
	99.7	0.66	> 0.84	0.93	"			3.14	> 4.00	4.43	
	99.9	-	-	1.11	"			-	-	5.29	
	99.95	-	-	1.21	"			-	-	5.76	
58	99	0.41	0.45	0.59	SLB	0.45	0.17	2.41	2.64	3.47	2.64
	99.7	0.45	> 0.45	0.66	"			2.64	> 2.64	3.88	
	99.9	-	-	0.72	"			-	-	4.23	
	99.95	-	-	0.75	"			-	-	4.41	
59	99	45.00	54.60	No	FIT	72.53	11.53	3.90	4.74	-	6.29
	99.7	54.60	> 72.53					4.74	> 6.29	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
60	99	1.04	1.23	No	FIT	1.28	0.37	2.81	3.32	-	3.46
	99.7	1.23	> 1.28					3.32	> 3.46	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	

TABLE A7 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
MAXIMUM DAY - TSS (KLBS/DAY)
(Cont'd)

61	99	24.77	35.68	No	FIT	59.47	4.88	5.08	7.31	-	12.19
	99.7	35.68	> 59.47					7.31	> 12.19	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
64	99	0.17	> 0.18	No	FIT	0.17	0.06	2.83	3.00	-	2.83
	99.7	0.18	> 0.18					3.00	> 3.00	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
69	99	0.14	0.15	No	FIT	0.15	0.06	2.33	2.50	-	2.50
	99.7	0.15	0.15					2.50	2.50	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
73	99	1.82	2.02	1.24	LN	2.02	0.29	6.28	6.97	4.28	6.97
	99.7	1.99	> 2.02	1.71	"			6.86	> 6.97	5.90	
	99.9	-	-	2.24	"			-	-	7.72	
	99.95	-	-	2.55	"			-	-	8.79	
74	99	0.97	1.02	1.47	LN	1.02	0.31	3.13	3.29	4.74	3.29
	99.7	0.99	> 1.02	2.04	"			3.19	> 3.29	6.58	
	99.9	-	-	2.67	"			-	-	8.61	
	99.95	-	-	3.05	"			-	-	9.84	
78	99	8.41	8.62	9.74	LN	8.63	3.48	2.42	2.47	2.80	2.48
	99.7	8.62	> 8.63	11.97	"			2.47	> 2.48	3.44	
	99.9	-	-	14.21	"			-	-	4.08	
	99.95	-	-	15.45	"			-	-	4.44	
81	99	4.92	5.20	No	FIT	5.37	2.67	1.84	1.95	-	2.01
	99.7	5.20	> 5.37					1.95	> 2.01	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
82	99	2.07	2.33	2.31	LN	2.37	0.94	2.20	2.48	2.46	3.52
	99.7	2.33	> 2.37	2.76	"			2.48	> 2.52	2.94	
	99.9	-	-	3.20	"			-	-	3.40	
	99.95	-	-	3.44	"			-	-	3.66	
83	99	0.10	> 0.10	0.13	SLN	0.10	0.04	2.50	> 2.50	3.25	2.50
	99.7	0.10	> 0.10	0.16	"			2.50	> 2.50	4.00	
	99.9	-	-	0.19	"			-	-	4.75	
	99.95	-	-	0.20	"			-	-	5.00	
85	99	1.62	1.99	2.23	LN	2.13	0.46	3.52	4.33	4.84	4.63
	99.7	1.99	> 2.13	3.14	"			4.33	> 4.63	6.83	
	99.9	-	-	4.18	"			-	-	9.09	
	99.95	-	-	4.80	"			-	-	10.43	
91	99	1.41	> 1.78	2.24	LN	1.78	0.46	3.07	> 3.87	4.87	3.87
	99.7	1.78	> 1.78	3.14	"			3.87	> 3.87	6.83	
	99.9	-	-	4.16	"			-	-	9.04	
	99.95	-	-	4.76	"			-	-	10.35	
94	99	0.61	0.69	0.88	LN	0.69	0.17	3.58	4.06	5.18	4.06
	99.7	0.69	> 0.69	1.25	"			4.06	> 4.06	7.35	
	99.9	-	-	1.69	"			-	-	9.94	
	99.95	-	-	1.95	"			-	-	11.47	
96	99	0.37	> 0.45	0.44	SLN	0.45	0.12	3.08	> 3.75	3.67	3.75
	99.7	0.45	> 0.45	0.56	"			3.75	> 3.75	4.67	
	99.9	-	-	0.69	"			-	-	5.75	
	99.95	-	-	0.77	"			-	-	6.42	

Note: Variability is the ratio of the indicated value to the long term average.

TABLE A8 ANALYSIS OF PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS FOR SELECTED DISTRIBUTION FUNCTIONS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY (KLBS/DAY)

		BOD_5						TSS					
		Crunched Data			Fix. Start Fix. Window			Crunched Data			Fix. Start. Fix. Window		
Mill No.	Prod. Category	N[1]	LN[2]	SLN[3]	N	LN	SLN	N	LN	SLN	N	LN	SLN
1	BK-DISS.	-	Y[4]	-	-	Y	Y	Y	-	-	Y	-	-
2-1	" "	Y	-	-	Y	-		Y	-	-	Y	-	-
2-2	" "	Y	-	-	-	-		Y	Y	-	Y	-	-
2-3	" "	Y	-	-	Y	Y	-	Y	-	-	Y	-	-
2-4	" "	Y	-	-	Y	-	-	Y	-		Y	-	-
2-5	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
2/(1-5)	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
3-1	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
3-2	" "	-	Y	-	-	Y	-	Y	-	-	Y	-	-
3/(1-2)	" "	-	Y	-	-	Y	-	Y	-	-	Y	-	-
4	BK-MKT	Y	-	-	Y	-	-	Y	-	-	Y	-	-
5	" "	-	Y	-	-	Y	-	Y	-	-	Y	-	-
6	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
7	BK-MKT	Y	-	-	Y	-	-	Y	-	-	Y	-	-
8	" "	Y	-	-	Y	-	-	Y	-	-	-	-	-
9	" "	Y	-	-	Y	Y	-	Y	-	-	-	Y	-
10	BK-BCT	Y	-	-	Y	Y	-	Y	-	-	Y	-	-
11	" "	-	-	Y	-	-	Y	-	Y	-	Y	Y	-
12	" "	Y	Y	-	Y	Y	-	Limited TSS Data					
13	" "	Y	-	-	Y	-	-	Y	-	-	Y	Y	-
14	" "	-	Y	-	Y	Y	-	Y	Y	-	Y	-	
15	" "	Y	Y	-	Y	Y	-	Y	Y	Y	-	-	-
16	BK-FINE	Y	-	-	Y	-	-	Y	Y	-	Y	Y	-
17	" "	-	-	Y	-	Y	-	-	-	Y	-	-	Y
18	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
19A	" "	Y	Y	-	Y	Y	-	-	Y	-	-	Y	-
19B	" "	Y	Y		-	Y	-	Y	Y	-	Y	Y	-
20	BK-FINE	Y	Y	-	Y	Y	-	Limited TSS Data					
21	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
22	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-

TABLE A8 ANALYSIS OF PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS FOR SELECTED DISTRIBUTION FUNCTIONS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY (KLBS/DAY)
(Cont'd)

		BOD_5						TSS					
		Crunched Data			Fix. Start Fix. Window			Crunched Data			Fix. Start. Fix. Window		
Mill No.	Prod. Category	N[1]	LN[2]	SLN[3]	N	LN	SLN	N	LN	SLN	N	LN	SLN
23	UBK-LNBD	Y	-	-	Y	Y	-	Y	Y	-	Y	-	-
24-1	" "	Y	Y	-	Y	Y	-	Y	Y	-	-	Y	-
24-2	" "	Y	-	-	Y	-	-	Y	Y	-	Y	-	-
24-3	" "	Y	Y	-	Y	-	-	Y	-	-	-	Y	-
24/(1-3)	" "	Y	Y	-	Y	Y	-	-	Y	-	-	Y	-
25	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	-	-
26	" "	Y	-	-	Y	-	-	Y	Y	-	Y	Y	-
27	" "	-	Y	-	-	Y	-	-	-	-	-	Y	-
28	" "	Y	-	-	Y	-	-	Y	Y	-	Y	Y	-
29	" "	Y	-	-	Y	-	-	Y	Y	-	Y	Y	-
30	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
31	UBK-CP	Y	-	-	Y	Y	-	Y	-	-	Y	-	-
32	" "	-	-	Y	Y	Y	-	Y	-	-	Y	-	-
33	" "	Y	-	-	Y	Y	-	Y	Y	-	-	Y	-
34	" "	Y	Y	-	Y	Y	-	Y	-	-	Y	-	-
35	UBK-SPEC. PAP	Y	-	-	Y	-	-	Y	Y	-	Y	-	-
36	SEMI-CHEM	Y	Y	-	Y	Y	-	-	Y	-	-	Y	-
37	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
38	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	-	-
39-1	" "	-	Y	-	-	Y	-	-	-	Y	-	Y	-
39-2		Y	-	-	Y	Y	-	Y	Y	-	Y	-	-
39-3		-	Y	-	-	-	Y	Y	Y	-	Y	Y	-
39/(1-3)		-	Y	-	-	Y	-	-	Y	-	-	Y	-
40	UBK/SEMI CHEM	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
41	" "	-	Y	-	-	Y	-	Y	Y	-	Y	Y	-
42B	" "	-	Y	-	-	Y	-	-	Y	-	-	Y	-
43	" "	Y	-	-	Y	Y	-	Y	Y	-	-	Y	-
44	SULF-DISS	Y	-	-	Y	Y	-	Y	Y	-	Y	Y	-
45	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
46	" "	Y	-	-	Y	Y	-	Y	Y	-	Y	Y	-
47	SULF-PAP	Y	-	-	Y	-	-	Y	-	-	Y	-	-
48	" "	Y	-	-	Y	-	-	Y	Y	-	Y	Y	-

TABLE A8 ANALYSIS OF PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS FOR SELECTED DISTRIBUTION FUNCTIONS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY (KLBS/DAY)
(Cont'd)

		BOD_5						TSS					
		Crunched Data			Fix. Start Fix. Window			Crunched Data			Fix. Start. Fix. Window		
Mill No.	Prod. Category	N[1]	LN[2]	SLN[3]	N	LN	SLN	N	LN	SLN	N	LN	SLN
50	SULF-PAP	Y	-	-	Y	Y	-	Y	Y	-	Y	Y	-
52	" "	-	-	Y	-	Y	-	Y	-	-	Y	Y	-
53	GNDWD-FINE	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
54	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
55	INT-MISC.	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
58	" "	Y	Y	-	-	Y	-	Y	Y	-	Y	Y	-
59	DEINK-TISS	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
60	" "	Y	-	-	Y	-	-	Y	-	-	Y	-	-
61	DEINK-FINE	-	Y	-	-	Y	-	Y	Y	-	Y	Y	-
64	WSTPAP-TISS	Limited BOD Data						Y	Y	-	Y	Y	-
69	WSTPAP-BD	Y	Y	-	Y	Y	-	Y	Y	-	Y	Y	-
73	" "	Limited BOD Data						-	-	Y	-	-	Y
74	" "	Y	Y	-	Y	Y	-	Y	Y	-	Y	-	-
78	NONINT-FINE	Y	-	-	Y	Y	-	Y	Y	-	Y	Y	-
81	"	Y	Y	-	Y	Y	-	Y	Y	-	-	Y	-
82	"	Y	-	-	Y	-	-	Y	Y	-	Y	-	-
83	NONINT-TISS	Limited BOD Data						Y	-	-	Y	-	-
85	"	Limited BOD Data						Y	Y	-	Y	Y	-
91	NONINT-BD	Limited BOD Data						Y	Y	-	Y	Y	-
94	NONINT-MISC.	Limited BOD Data						Y	Y	-	-	Y	-
96	"	Limited BOD Data						Y	-		Y	-	-

Note: 1) N = Normal Distribution

2) LN = Log Normal Distribution

3) SLN = Shifted Log Normal Distribution

4) Y = Yes, Data adheres to Distribution Indicated at Top of Column

TABLE A9 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY - BOD (KLBS/DAY)

Mill No.	Prod. Category	OBS.	No. of 30 Day OBS (CD)	(FS/FW)	Long Term Avg.	Est. of 99th Percentile (CD)	(FS/FW)	MA30CD Value	Variability C.D.	Variability Based Upon F.S./F.W.	Variability MA30CD
1	BK-DISS	363	12	13	36.66	79.54	79.26	84.7	2.17	2.16	2.31
2-1	" "	352	11	12	8.95	13.60	13.74	13.59	1.52	1.54	1.52
2-2	" "	356	11	12	6.97	12.24	15.90	13.92	1.76	2.28	2.00
2-3	" "	354	11	12	8.60	10.58	10.56	11.01	1.23	1.23	1.28
2-4	" "	355	11	12	9.03	12.21	11.97	11.04	1.35	1.33	1.23
2-5	" "	354	11	12	9.34	14.32	13.76	12.90	1.53	1.47	1.38
2/(1-5)	" "	1771	59	61	8.56	12.98	13.22	13.92	1.52	1.54	1.63
3-1	" "	300	10	11	27.26	48.55	45.67	44.80	1.78	1.67	1.64
3-2	" "	338	11	12	37.50	83.43	95.24	84.69	2.22	2.54	2.26
3/(1-2)	" "	638	21	23	32.70	72.83	73.62	84.69	2.22	2.25	2.58
4	BK-MKT	178	5	8	3.56	5.58	5.78	7.61	1.57	1.62	2.14
5	" "	344	11	12	5.02	14.02	13.33	12.94	2.79	2.67	2.58
6	" "	361	12	12	14.20	21.58	21.79	19.80	1.52	1.53	1.39
7	" "	322	10	11	7.28	14.46	14.79	13.50	1.99	2.03	1.85
8	" "	277	9	11	3.52	6.11	6.41	6.77	1.74	1.82	1.92
9	" "	337	11	12	3.29	5.80	5.79	6.15	1.76	1.76	1.87
10	BK-BLT	385	12	13	6.04	9.65	9.86	10.03	1.60	1.63	1.66
11	" "	368	12	13	6.71	18.51	18.37	20.02	2.78	2.74	2.98
12	" "	341	11	13	5.31	9.89	10.14	9.51	1.86	1.91	1.79
13	" "	350	11	12	9.03	13.48	13.45	12.42	1.49	1.49	1.38
14	" "	255	8	11	1.65	3.37	3.20	2.94	2.04	1.94	1.78
15	" "	129	4	9	12.10	-	22.24	21.83	-	1.83	1.80
16	BK-FINE	376	12	13	0.99	1.38	1.34	1.39	1.39	1.35	1.40
17	" "	373	12	13	3.82	12.11	8.40	8.33	3.17	2.20	2.18
18	" "	356	11	12	1.04	1.79	1.78	1.74	1.72	1.72	1.67
19A	" "	145	4	9	2.58	-	3.91	-	-	1.52	-
19B	" "	196	6	13	1.57	2.56	4.35	3.57	1.63	2.71	2.27
20	" "	265	8	9	3.27	5.65	5.46	5.52	1.73	1.67	1.69
21	" "	434	14	15	11.2	16.07	15.76	16.15	1.43	1.41	1.44
22	" "	242	8	12	5.31	8.70	9.29	9.21	1.64	1.75	1.73

TABLE A9 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY - BOD (KLBS/DAY)
(Cont'd)

Mill No.	Prod. Category	OBS.	No. of 30 Day OBS (CD)	(FS/FW)	Long Term Avg.	Est. of 99th Percentile (CD)	(FS/FW)	MA30CD Value	Variability Based Upon C.D.	F.S./F.W.	MA30CD
23	UBK-LNBD	175	5	12	2.92	4.75	5.20	5.15	1.63	1.78	1.76
24-1	" "	159	5	9	2.13	3.32	3.73	4.18	1.56	1.75	1.96
24-2	" "	164	5	12	3.04	4.96	5.54	5.59	1.63	1.82	1.84
24-3	" "	177	5	13	2.39	3.57	3.83	3.59	1.49	1.60	1.50
24/(1-3)	" "	500	16	32	2.52	4.61	4.83	5.59	1.83	1.92	2.22
25	" "	292	9	11	0.80	1.71	1.69	1.47	2.14	2.11	1.84
26	" "	273	9	11	2.04	2.66	2.75	2.53	1.30	1.35	1.24
27	" "	333	11	12	4.86	10.26	10.19	9.87	2.11	2.01	2.03
28	" "	385	12	14	5.44	9.66	9.65	9.30	1.78	1.77	1.71
29	" "	166	5	11	3.09	4.35	4.52	7.17	1.41	1.46	2.32
30	" "	306	10	11	4.13	7.31	7.51	8.39	1.77	1.82	2.03
31	UBK-CP	218	7	12	4.31	7.28	7.68	7.57	1.68	1.78	1.77
32	" "	257	8	12	1.31	3.50	2.16	2.34	2.67	1.65	1.77
33	" "	315	10	15	5.16	7.98	7.91	7.80	1.55	1.53	1.51
34	" "	354	11	12	5.71	8.44	8.94	9.00	1.48	1.57	1.58
35	UBK-SPEC PAP	355	11	12	1.79	2.45	2.42	2.42	1.37	1.35	1.35
36	SEMI-CHEM	370	12	13	2.97	8.01	8.03	8.80	2.70	2.70	2.96
37	" "	362	12	13	1.85	4.35	4.05	5.02	2.35	2.19	2.71
38	" "	310	10	11	2.31	4.57	4.87	5.44	1.98	2.11	2.35
39-1	" "	333	11	11	0.89	3.79	3.87	2.47	4.26	4.35	2.78
39-2	" "	359	12	12	0.50	0.94	0.87	0.70	1.88	1.74	1.40
39-3	" "	339	11	12	0.46	1.55	1.99	1.11	3.37	4.32	2.41
39/(1-3)	" "	1031	34	35	0.61	2.05	2.04	2.47	3.36	3.36	4.05
40	UBK/SEMI-CHEM	159	5	9	3.80	7.87	8.35	8.12	2.07	2.20	2.14
41	" "	347	11	13	8.06	16.99	17.24	16.97	2.11	2.14	2.11
42	" "	298	9	10	1.52	7.28	6.44	5.08	4.79	4.23	3.34
43	" "	347	11	12	19.9	27.54	26.91	27.77	1.38	1.35	1.40
44	SULF-DISS	376	12	13	24.80	37.99	39.28	39.18	1.53	1.58	1.58
45	" "	221	7	8	20.50	25.40	25.25	24.26	1.24	1.23	1.18
46	" "	422	14	14	23.30	35.26	35.61	37.80	1.51	1.53	1.62

TABLE A9 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY - BOD (KLBS/DAY)
(Cont'd)

Mill No.	Prod. Category	OBS.	No. of 30 Day OBS (CD)	(FS/FW)	Long Term Avg.	Est. of 99th Percentile (CD)	(FS/FW)	MA30CD Value	Variability Based Upon C.D.	F.S./F.W.	MA30CD
47	SULF-PAP	421	14	14	4.76	7.13	7.08	7.65	1.50	1.49	1.61
48	" "	370	12	13	10.2	17.58	17.08	16.21	1.72	1.67	1.60
50	" "	159	5	9	2.98	5.31	5.22	4.82	1.78	1.75	1.62
52	" "	244	-	12	5.64	-	13.44	13.98	-	2.38	2.48
53	GNDWD-FINE	384	12	13	0.49	0.96	0.95	1.11	1.96	1.94	2.27
54	" "	354	11	13	3.01	6.17	6.00	5.64	2.05	1.99	1.87
55	INT.-MISC	317	10	13	0.26	0.54	0.54	0.55	2.08	2.08	2.12
58	" "	381	12	13	0.24	0.48	0.50	0.51	2.00	2.08	2.13
59	DEINK-TISS	388	12	13	5.81	7.28	8.42	8.26	1.25	1.45	1.42
60	" "	369	12	13	0.26	0.53	0.52	0.48	2.04	2.00	1.85
61	DEINK-FINE	357	11	12	4.64	32.72	30.54	16.55	7.05	6.58	3.57
69	WSTPAP-BD	151	5	8	0.04	0.09	0.11	0.10	2.25	2.75	2.50
74	" "	283	9	11	0.38	0.73	0.80	0.73	1.92	2.11	1.92
78	NONINT-FINE	350	11	12	2.46	4.23	4.34	4.41	1.72	1.76	1.79
81	" "	382	12	13	2.72	4.48	4.80	4.38	1.65	1.76	1.61
82	" "	347	11	12	0.83	1.03	1.02	1.07	1.24	1.23	1.29
83	NONINT-TISS	144	4	10	0.03	0.06	0.06	0.07	2.00	2.00	2.33

NOTE: 1) Estimate equals: Long Term Average + 2.33 (Standard Deviation).

2) MA30CD = Maximum Average for 30 Consecutive Days Derived from Data.

3) Variability = The Ratio of the Thirty Day Values to the Long Term Average.

TABLE A10 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS

THIRTY CONSECUTIVE DAY EFFLUENT QUALITY - TSS (KLBS/DAY)

Mill No.	Prod. Category	OBS.	No. of 30 Day OBS (CD)	(FS/FW)	Long Term Avg.	Est. of 99th Percentile (CD)	(FS/FW)	MA30CD[2] Value	Variability[3] Based Upon C.D.	F.S./F.W.	MA30CD
1	BK-DISS	374	12	13	54.3	96.85	96.80	104.5	1.78	1.78	1.92
2-1	" "	354	11	12	13.7	19.60	19.31	19.71	1.43	1.41	1.44
2-2	" "	356	11	12	10.5	17.17	18.40	19.56	1.64	1.75	1.86
2-3	" "	355	11	12	12.6	17.37	17.32	17.22	1.38	1.37	1.37
2-4	" "	356	11	12	14.8	19.73	19.37	19.76	1.33	1.31	1.34
2-5	" "	357	11	12	15.8	23.73	23.41	23.60	1.50	1.48	1.49
2/(1-5)	" "	1778	59	61	13.5	20.83	21.03	23.60	1.54	1.56	1.75
3-1	" "	300	10	11	50.2	80.52	78.00	75.57	1.60	1.55	1.51
3-2	" "	350	11	12	55.0	89.16	96.29	104.5	1.62	1.75	1.90
3/(1-2)	" "	650	21	23	52.8	84.73	93.54	104.5	1.60	1.77	1.98
4	BK-MKT	176	5	9	5.17	10.40	10.58	12.07	2.01	2.05	2.33
5	" "	356	11	13	3.83	5.19	5.40	5.74	1.36	1.41	1.50
6	" "	360	12	12	25.20	42.05	42.40	33.40	1.67	1.68	1.33
7	" "	328	10	11	21.00	36.74	38.04	30.90	1.75	1.81	1.47
8	" "	312	10	11	4.05	6.44	No Fit	6.46	1.59	-	1.60
9	" "	337	11	12	10.80	29.40	35.26	33.40	1.67	1.68	1.33
10	BK-BCT	387	12	13	7.98	11.21	11.68	10.36	1.40	1.46	1.30
11	" "	373	12	13	6.35	12.05	10.40	10.20	1.89	1.64	1.61
13	" "	352	11	12	8.16	10.81	10.79	10.40	1.32	1.32	1.27
14	" "	141	4	10	2.58	4.83	5.17	4.38	1.87	2.00	1.70
15	" "	129	4	9	6.52	9.96	11.84	12.62	1.53	1.82	1.94
16	BK-FINE	381	12	13	2.60	4.65	4.94	4.75	1.79	1.90	1.83
17	" "	379	12	13	6.36	33.28	30.01	18.04	5.23	4.72	2.84
18	" "	356	11	12	2.31	3.38	3.28	3.33	1.46	1.42	1.44
19A	" "	273	9	12	12.8	26.42	26.88	28.97	2.06	2.10	2.26
19B	" "	417	13	16	4.40	8.32	7.73	8.04	1.89	1.76	1.83
21	" "	446	14	15	24.10	40.96	40.20	34.59	1.70	1.67	1.44
22	" "	363	12	12	4.63	7.93	7.97	8.20	1.71	1.72	1.77
23	UBK-LNBD	172	5	12	6.12	7.35	8.21	7.73	1.20	1.34	1.26
24-1	" "	160	5	10	6.61	17.84	20.26	20.28	2.70	3.07	3.07
24-2	" "	164	5	12	4.31	6.24	7.15	6.73	1.45	1.66	1.56
24-3	" "	177	5	13	4.15	4.83	7.99	7.53	1.16	1.93	1.31
24/(1-3)	" "	501	16	33	4.99	11.73	13.32	20.28	2.35	2.67	4.06
25	" "	286	9	11	0.61	1.26	1.30	1.19	2.07	2.13	1.95

TABLE A6 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS MAXIMUM DAY - BOD_5 (KLBS/DAY)

Mill No.	% - Tile	Non Parametric Estimate at 50% TL	Non Parametric Estimate at 5% TL	Distrib. Function Estimate Value	Distrib. Function Estimate Basis	Max. Daily Value	Long Term Avg.	Variability[1]-Based Upon 50% TL	Variability[1]-Based Upon 5% TL	Variability[1]-Based Upon D.F.	Variability[1]-Based Upon M.D.V.
10	99	12.91	14.36	16.75	SLN	17.75	6.04	2.14	2.38	2.77	2.94
	99.7	14.36	> 17.75	18.98	"			2.38	> 2.94	3.14	
	99.9	-	-	21.07	"			-	-	3.49	
	99.95	-	-	22.17	"			-	-	3.67	
11	99	28.20	30.02	No	FIT	31.02	6.71	4.20	4.47	-	4.62
	99.7	30.02	31.02					4.47	> 4.62	-	
	99.9							-	-	-	
	99.95							-	-	-	
12	99	11.68	12.52	13.72	LN	12.56	5.31	2.20	2.35	2.58	2.36
	99.7	12.52	> 12.56	16.58	"			2.35	> 2.36	3.12	
	99.9	-	-	19.41	"			-	-	3.65	
	99.95	-	-	20.95	"			-	-	3.95	
13	99	19.65	19.97	26.95	SLN	23.94	9.03	2.18	2.21	2.98	2.65
	99.7	19.97	> 23.94	29.98	"			2.21	> 2.65	3.32	
	99.9	-	-	32.76	"			-	-	3.63	
	99.95	-	-	34.20	"			-	-	3.79	
14	99	4.07	4.27	No	FIT	4.27	1.65	2.47	2.58	-	2.58
	99.7	4.13	> 4.27					2.50	> 2.58	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
15	99	24.35	> 26.95	27.52	LN	26.95	12.10	2.01	> 2.23	2.27	2.23
	99.7	26.95	> 26.95	32.34	"			2.23	> 2.23	2.67	
	99.9	-	-	37.01	"			-	-	3.06	
	99.95	-	-	39.51	"			-	-	3.27	
16	99	2.33	2.79	No	FIT	3.61	0.99	2.35	2.82	-	3.65
	99.7	2.79	> 3.61					2.82	> 3.65	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
17	99	9.88	12.73	11.69	SLN	13.16	3.82	2.58	3.33	3.06	3.45
	99.7	12.73	> 13.16	15.19	"			3.33	> 3.45	3.98	
	99.9	-	-	18.90	"			-	-	4.95	
	99.95	-	-	21.06	"			-	-	5.51	
18	99	2.70	2.79	No	FIT	2.82	1.04	2.60	2.68	-	2.71
	99.7	2.79	> 2.82					2.68	> 2.71	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
19A	99	8.51	> 8.86	No	FIT	8.86	2.58	3.30	> 3.43	-	3.43
	99.7	8.86	> 8.86					3.43	> 3.43	-	
	99.9	-	-					-	-	-	
	99.95	-	-					-	-	-	
19B	99	6.31	> 9.19	6.96	LN	9.19	1.57	4.02	> 5.85	-	5.85
	99.7	9.19	> 9.19	9.59	"			5.85	> 5.85	-	
	99.9	-	-	12.53	"			-	-	-	
	99.95	-	-	14.27	"			-	-	-	
20	99	17.44	34.29	14.59	SLN	34.29	3.27	5.33	10.49	4.46	10.49
	99.7	34.29	> 34.29	21.18	"			10.49	> 10.49	6.48	
	99.9	-	-	28.88	"			-	-	8.83	
	99.95	-	-	33.58	"			-	-	10.27	
21	99	19.63	22.02	19.88	N	22.46	11.20	1.75	1.97	1.78	2.01
	99.7	22.02	> 22.46	21.45	"			1.97	> 2.01	1.92	
	99.9	-	-	22.76	"			-	-	2.03	
	99.95	-	-	23.39	"			-	-	2.09	
22	99	11.63	> 12.73	15.84	SLN	12.73	5.31	2.19	> 2.40	2.98	2.40
	99.7	11.90	12.73	17.57	"			2.24	2.40	3.31	
	99.9	-	-	19.16	"			-	-	3.61	
	99.95	-	-	19.97	"			-	-	3.76	

TABLE A10 ESTIMATE OF VARIABILITY IN PULP AND PAPER INDUSTRY BIOLOGICALLY TREATED EFFLUENTS
THIRTY CONSECUTIVE DAY EFFLUENT QUALITY - TSS (KLBS/DAY)
(Cont'd)

Mill No.	Prod. Category	OBS.	No. of 30 Day OBS (CD)	No. of 30 Day OBS (FS/FW)	Long Term Avg.	Est.[1] of 99th Percentile (CD)	Est.[1] of 99th Percentile (FS/FW)	MA30CD[2] Value	Variability[3] Based Upon C.D.	Variability[3] Based Upon FS/FW	Variability[3] Based Upon MA30CD
59	DEINK-TISS	391	13	13	11.50	19.95	20.93	20.14	1.73	1.82	1.75
60	" "	369	12	13	0.37	0.65	0.65	0.57	1.76	1.76	1.54
61	DEINK-FINE	361	12	12	4.88	11.67	11.43	11.56	2.39	2.34	2.37
64	WSTPAP-TISS	192	6	10	0.06	0.14	0.13	0.13	2.33	2.17	2.17
69	WSTPAP-BD	151	5	8	0.06	0.12	0.13	0.11	2.00	2.17	1.83
73	" "	249	8	12	0.29	1.51	1.56	1.00	5.21	5.38	3.45
74	" "	293	9	11	0.31	0.52	0.56	0.49	1.68	1.81	1.58
78	" "	350	11	12	3.48	6.49	6.47	5.97	1.86	1.86	1.72
81	" "	382	12	13	2.67	4.02	4.27	3.87	1.51	1.60	1.45
82	" "	348	11	12	0.94	1.28	1.31	1.27	1.36	1.39	1.35
83	NONINT-TISS	192	6	10	0.04	0.07	0.07	0.06	1.75	1.75	1.50
85	" "	336	11	12	0.46	1.03	1.02	0.99	2.24	2.22	2.15
94	NONINT-MISC	271	9	13	0.17	0.31	0.34	0.32	1.82	2.00	1.88
96	" "	223	7	11	0.12	0.17	0.17	0.17	1.42	1.42	1.42

Note: 1) Estimate equals: Long Term Average + 2.33 (Standard Deviation)

2) MA30CD - Maximum Average for 30 Consecutive Days Derived from Data

3) Variability: The Ratio of the Thirty Day Values to the Long Term Average

TABLE A11 SUMMARY OF NCASI ANALYSIS OF VARIABILITY FACTORS

Analysis Method	Maximum Day Variability Factors (BOD_5)	Maximum Day Variability Factors (TSS)	Analysis Method	Maximum 30 Consecutive Day Variability Factors (BOD_5)	Maximum 30 Consecutive Day Variability Factors (TSS)
NPA(99%, 50% TL)[1]	2.84	2.91	Crunched Data	1.98	1.91
NPA(99.7%, 50% TL)	3.35	3.42	FS/FW[2]	1.98	1.98
Observed Data	3.61	3.83	Observed Data	1.91	1.82
EPA(Proposed)BCT	3.00	3.00	EPA(Proposed)BCT	1.78	1.82

NOTE: 1) NPA(99%, 50% TL) = Non Parametric Analysis at the 99th Percentile With a 50% Tolerence Level

2) FS/FW = Fixed Start/Fixed Window Technique, See Text for Definition

TABLE A12 MILLS ANALYZED FOR VARIABILITY EFFLUENT QUALITY COMPARED TO BPT LIMITATIONS (LBS/TON BASIS)

Prod. Category	BOD_5 AA (1)	BOD_5 30CD + MD (2)	BOD_5 AA+30CD + MD (3)	TSS AA (4)	TSS 30CD + MD (5)	TSS AA+30CD+MD (6)	BOD_5 + TSS AA+30CD+MD (7)	BOD_5 + TSS 30CD+MD (8)
BK-DISS.							2-1, 2-2, 2-3, 2-4, 2-5	
BK-MKT.			9			5*	4*	6
BK-BCT			12*	12*		11*, 13, 15	10*, 14	
BK-FINE			19A			22	16, 17, 18, 19B	
UBK-LNBD					24-2, 24-3 28, 29		23*,25 26	
UBK-CP					31*, 32*			
UBK-SPEC. PAP					None			
SEMI-CHEM.		39-1			37*		39-2, 39-3	
UBK/SEMI								42-B
SULF-DISS.						44*, 46		
SULF-PAP						48*	47*, 50	
GRNWD-FINE			54				53*	
INT. MISC			Not Applicable					
DEINK-TISS			59*	59*			60*	
DEINK-FINE				61*				
WSTPAP-TISS	64*					64*		
WSTBAP-BD					74			69*
NONINT-FINE	82			81		82	78*	81
NONINT-TISS							83*	
NONINT-BD	91							
NONINT-MISC			Not Applicable					

NOTES: AA = Annual (or Long Term) Average
30CD = Maximum 30 Consecutive Day Average
MD = Maximum Day

* Numbers with an asterisk data mills appearing in EPA-Development Document Variability Analysis, other mills are from NCASI Data Base.

Column 1: Mills which meet the AA BOD limitations but don't meet 30CD and MD limitations.

Column 2: Mills which meet the 30CD and MD limitations but do not meet AA limitation for BOD.

Column 3: Mills which meet the AA, 300CD and MD limitations for BOD but do not meet all three TSS limitations given in Column 6.

Column 4: Mills which meet the AA TSS limitations but do not meet 30CD and MD limitations.

Column 5: Mills which meet the 30CD and MD TSS limitations but do not meet the AA limitations for TSS.

Column 6: Mills which meet the AA, 30CD, and MD limitations for TSS but do not meet the three BOD limitations given in Column 3.

Column 7: Mills which meet all three limitations for both BOD and TSS.

TABLE A13 VARIATION IN EFFLUENT QUALITY VARIABILITY AT SELECTED MILLS PROVIDING MULTI YEAR DATA

Mill No.	Ann. Avg. Perf. BOD (#/T)	Ann. Avg. Perf. TSS (#/T)	Maximum Day Variability Factors Based Upon 99%(50% TL) (BOD)	99%(50% TL) (TSS)	99.7%(50% TL) (BOD)	99.7%(50% TL) (TSS)	Observed Max. Day (BOD)	Observed Max. Day (TSS)	Maximum 30 Day Variability Factors Based Upon C.D. (BOD)	C.D. (TSS)	FS/FW (BOD)	FS/FW (TSS)	Observed MA30CD (BOD)	Observed MA30CD (TSS)
-1	8.2	12.5	2.33	2.59	2.85	3.18	3.11	3.20	1.52	1.43	1.54	1.44	1.52	1.44
-2	6.3	9.5	3.16	3.04	3.29	3.29	3.35	4.24	1.76	1.64	2.28	1.75	2.00	1.86
-3	7.4	10.8	1.76	2.01	1.82	2.89	1.94	3.20	1.23	1.38	1.23	1.37	1.28	1.37
-4	7.6	12.3	1.88	2.19	1.95	2.33	1.96	2.49	1.35	1.33	1.33	1.31	1.28	1.34
-5	7.9	13.4	2.12	2.43	2.47	3.40	2.50	3.40	1.53	1.54	1.47	1.56	1.38	1.75
9-1	1.4	4.9	3.36	2.78	3.80	3.35	5.74	3.48	4.26	-	4.35	3.62	2.78	2.39
9-2	0.8	3.0	2.56	1.96	2.86	2.01	2.94	2.17	1.88	1.55	1.74	1.55	1.40	1.63
9-3	0.7	3.0	3.11	3.03	3.26	3.43	3.41	3.56	3.37	2.20	4.32	2.16	2.41	1.95

OTE: 2-1, 2-2, etc. represent 1, 2, etc. years of performance at Mill No. 2.