# Analysis and Prevention of Usable Fiber Loss From a Fine Paper Mill

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(ABSTRACT)

Reducing losses of usable waste fiber from paper mills conserves valuable resources and has the capacity to produce considerable economic returns to the manufacturer. The purpose of this research effort was to evaluate the potential for the prevention of loss and/or recovery of usable waste fiber from paper machines within a fine paper mill. Further, a preliminary evaluation of fiber loss prevention strategies and fiber recovery technologies was conducted.

The paper mill in question experienced losses of usable waste fiber to the sewer in amounts approaching, and sometimes exceeding 40 tons/day. An existing database of usable fiber test results was analyzed to determine patterns of fiber loss. Further testing showed that the most significant fiber losses resulted from centrifugal cleaner cones. These cones, designed to remove foreign material from stock, are one step in a series of mechanical cleaning devices in the stock preparation area of the paper mill. Cleaner cone systems on two of the paper machines were found to contribute most significantly to total fiber loss.

Contrary to cleaner cone design, the dirt content of fiber rejects from cones experiencing excessive loss was very low. Cleaner cones on other machines operated normally. These rejects were extremely dirty and quantities of fiber were low. These results indicate poor operating efficiency of two of the cleaner cone systems in question. By adding cones where space is available, system capacity and efficiency will increase, fiber losses will decrease, and the dirt content of rejects will increase. This will result in substantial resource and financial savings to the paper mill.

Technologies have been developed to recover usable fiber from paper mill sludge. However, prior to further investigation of the use of such innovations at this paper mill, efforts should focus on the reduction of fiber loss from point sources.

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# LITERATURE REVIEW

## 1.0 Introduction

Enhancing the performance of stock preparation equipment in paper mills has long been the focus of much work. Increased efficiency of screening and cleaning equipment not only generates a better product, but helps to conserve resources and prevent pollution. Very little work has been directed toward minimizing usable fiber loss from cleaners, but studies have been conducted to demonstrate strategies of higher cleaner efficiency. This review will summarize these findings.

## 2.0 Centrifugal Cleaner Cone Theory

Understanding the theory of cleaner cone operation forms a basis for developing strategies to increase cleaning efficiency. A cleaner cone is an inverted cone that uses a combination of centrifugal force and fluid shear to remove unwanted material from stock (Smook, 1992). Stock, under pressure, enters the top of the cone tangentially, and begins a free vortex generated by a pressure drop (Smook, 1992). This action creates two distinct flow patterns within the cone: a free vortex and a force vortex within the free vortex (Franko, 1984). Figure 1 illustrates a typical cleaner cone.

Rotating stock velocity increases as the cone diameter decreases, and heavier particles are carried toward the edge of the cleaner (Smook, 1992). Clean fiber passes into the forced vortex and is carried up and out of the cone (Smook, 1992). Clean fiber is allowed to move up by a continual shearing effect which ensures that dirt particles move down the wall of the cone (Grimes, 1994). With the decreasing cone diameter, centrifugal force increases by several Gs, concentrating dirt and other foreign material in the free vortex (Smook, 1992). Some material, fiber included, is not transitioned into the forced vortex, and is rejected out of the botton of the cone (Franko, 1984).

This reject is stored and pumped through cleaner cones with smaller diameters to further clean the stock. If no further cleaners are available, the rejected stock is sewered.

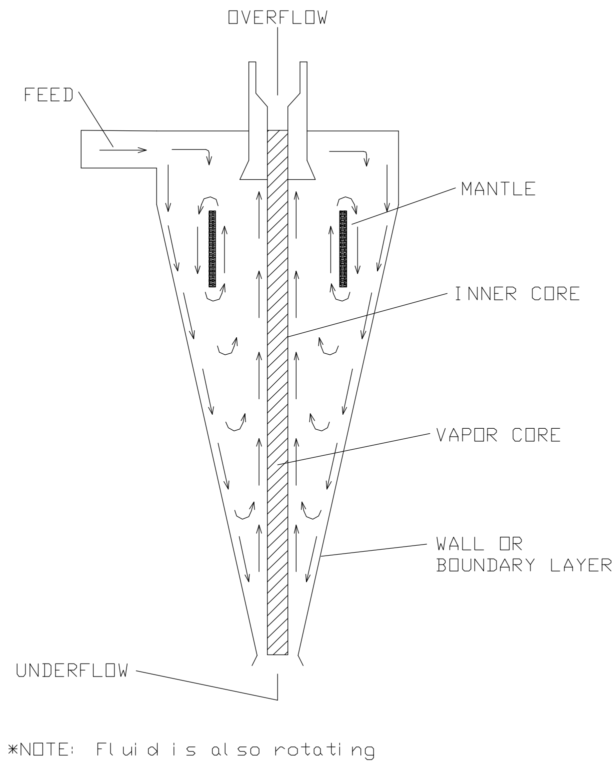


*Figure 1:* Typical Cleaner Cone (Franko, 1984)

Hydraulic energy is often wasted by numerous eddies that occur within the cone (Smook, 1992). This turbulence leads to a decrease in cleaning efficiency (Smook, 1992). Cleaner efficiency is defined by the following equation:

$$\%\ \text{Efficiency} = \frac{\text{Dirt Count}_{\text{(Feed)}} - \text{Dirt Count}_{\text{(Accept)}}}{\text{Dirt Count}_{\text{(Feed)}}} * 100 \qquad \text{(Smook, 1992)}$$

Dirt removal efficiency is directly affected by the quantity of stock being rejected (Smook, 1992). As a result, it can be misleading to compare performance characteristics of cleaners operating at different reject rates (Smook, 1992).

## 3.0 Cleaner Cone Arrangement

Since fiber is rejected from cleaner cones along with unwanted material, additional cones are required to remove this good fiber and return it to the system (Smook, 1992). A cascading arrangement of cleaner cones is typically used (Smook, 1992). Figure 2 illustrates a typical three-stage cleaner system. Rejected fiber usually amounts to less than 1% (Smook, 1992).

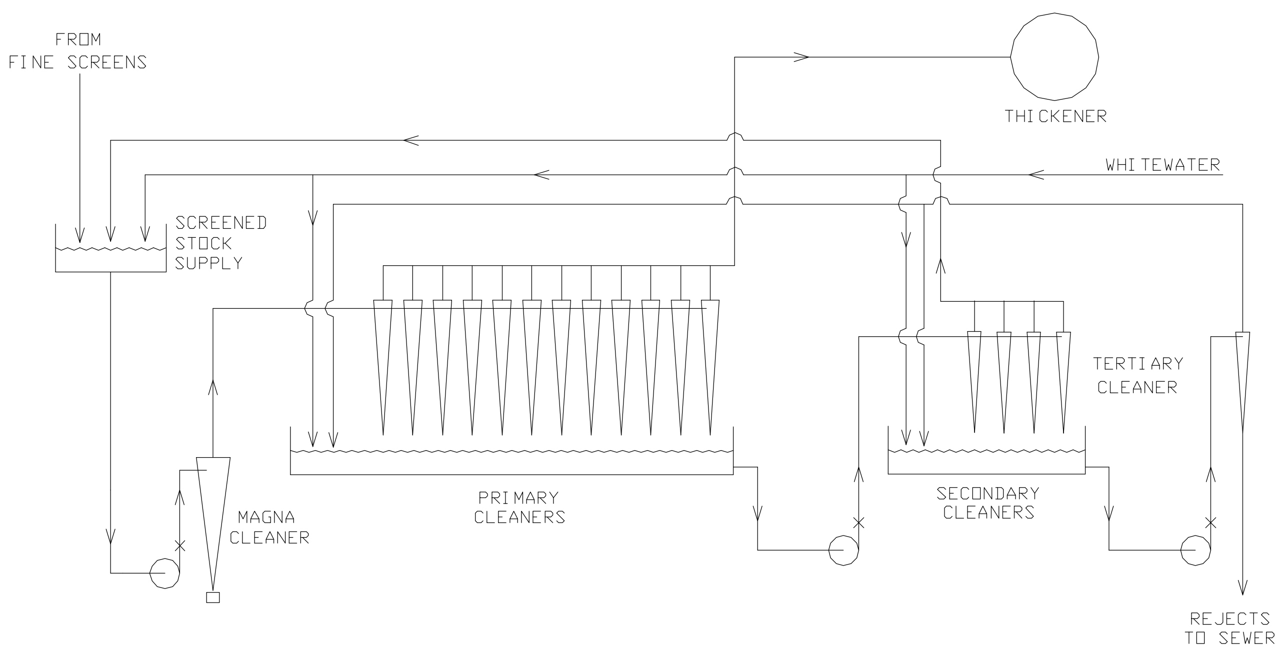


*Figure 2:* Three-Stage Cleaner Cone System (Smook, 1992*)*

# 4.0 Factors Affecting Cleaner Cone Performance

## 4.1 Pressure Drop

The major factor that affects cleaner efficiency is the pressure drop, $\Delta$ P, from the feed pressure to the accept pressure (Grimes, 1994). With an extremely low pressure drop, stock rotates too slowly and contaminants are not easily separated from good fiber (Grimes, 1994). Conversely, the wear rate of the cleaner will increase if the $\Delta$ P is too high; stock passes through the cleaner too quickly and efficiency suffers (Grimes, 1994). $\Delta$ P should be maintained by opening or closing cleaners on a particular stage to adjust for flow variations (Grimes, 1994).

## 4.2 Reject Rate

Since the reject rate is independent of feed or accept pressure, the best way to control the reject rate is by varying the reject orifice size (Franko, 1984). A smaller opening will allow less material to pass through, but plugging may result (Franko, 1984). The body of the cleaner can be cut by accumulated sand and grit if the cleaner is allowed to plug (Grimes, 1994). This can happen in as little as one or two days (Grimes, 1994).

## 4.3 Stock Consistency

Feed stock is mixed with makeup water, usually whitewater from the wire pit, to lower the consistency of stock for cleaning. Whitewater is water that has been removed from the stock during paper-making. It contains a small amount of filler and fine fibers.

In general, the lower the consistency of the feed stock, the higher the efficiency of the cleaner (Grimes, 1994). Clean fiber can transition more easily to the inner vortex when the stock is thinner. Consistency is often dependent on the nature of the contaminants (Grimes, 1994). Light material that will easily entangle on the fiber will require a low consistency to gain higher removal (Grimes, 1994.) Consistency can be raised when contaminants are heavier (Grimes, 1994).

Plugging is also attributable to consistency problems (Grimes, 1994). Consistency is most likely too high if plugging persists (Grimes, 1994).

Fluctuations in stock flow can also affect consistency in cleaner operations (Grimes, 1994). System capacity can be reduced when feed tank levels drop and excess makeup water is used, causing consistency to fall (Grimes, 1994). Likewise, consistency becomes extremely high and efficiency suffers when too little flow is drawn and there is a lack of makeup whitewater (Grimes, 1994). Cleaners can be added or removed accordingly to adjust for stock flow (Grimes, 1994).

### 4.4 Cleaner Cone Diameter

Opinions differ on the diameter of cleaner cones and their performance characteristics. One study comparing the performance of a 3 inch cone operating at 26 gpm versus an 8 inch cone operating at 140 gpm determined efficiencies to be 69% and 79%, respectively (Franko, 1984). Grimes states that efficiencies above 70% for fine dirt are acceptable (1994). These results are based solely on flowrate, as the 3 inch cone operated at 12 gpm achieved an efficiency of 84% (Franko, 1984).

Smaller cones, however, do have many disadvantages (Franko, 1984). They must have small reject orifices, and thus, they are prone to plugging (Franko, 1984). Hence, lower consistencies or higher reject rates are required with smaller cones to avoid plugging (Franko, 1984). Since smaller cleaners have a much lower capacity, many cones must be used to achieve the same throughput of just a few larger cones (Franko, 1984).

Luigi Silveri of Beloit Fiber Systems states that good cleaner efficiencies are not achieved with cleaners above 4 inches in diameter (Young, 1994). It is becoming more common to have as many as six stages of cleaning, whereas three stages was generally considered standard practice (Young, 1994).

The decision of a paper mill to use many smaller cones or a few large cones is often based on availability of space for cleaning equipment.

## 5.0 Fiber Recovery

While it is important to minimize losses in the paper mill, it is inevitable that some good fiber will be wasted. A few systems have been developed to recover fiber from paper mill sludge, thus conserving resources and limiting costly hauling and landfill fees.

One such system dries the sludge, reduces it to an appropriate particle size distribution, and separates it based on cellulose fiber and mineral fillers (Bunster, 1996). As much as 30 to 70% of the fiber is recoverable and can be reintroduced into the papermaking process or sold to other mills as furnish or filler (Bunster, 1996).

Another system consists of a pressure screen, a centrifugal cleaner, and a fractionation washer, installed on the discharge from the primary clarifier underflow (Moss and Kovacs, 1994). Landfill tonnage can be reduced by as much as 60%, landfill volume by 90%, and up to 85% of usable fiber can be recovered (Moss and Kovacs, 1994). Such as system could be installed for less than $500,000 and could recover less than 60% of the good fiber for a mill to realize a short payback time (Moss and Kovacs, 1994).

# MANUSCRIPT

## 1.0 Introduction

Moderate fiber losses have long been accepted as normal operating procedure in fine paper mills. This is largely due to cleaning techniques in stock preparation. With the foremost goal of stock preparation being the removal of foreign material, it is inevitable that a small amount of usable fiber will be wasted along with the foreign material.

The coordination and efficient operation of all steps of stock preparation is essential to making use of all available paper-making resources. When operating efficiency falters, larger amounts of usable waste fiber can easily be generated and may even go undetected. Reducing these losses not only becomes a matter of resource conservation, but pollution prevention (P2) as well. P2 is defined as measures that eliminate or reduce off-site recycling or treatment.

The purpose of this research effort was to evaluate the potential for the prevention of loss and/or recovery of usable waste fiber from paper machines within a fine paper mill. Further, a preliminary evaluation of fiber loss prevention strategies and fiber recovery technologies was conducted. The prevention of loss and/or recovery of usable waste fiber has the potential to produce considerable economic returns to the manufacturer if waste streams can be identified that contain sufficient usable fiber content to produce a favorable return on investment.

Prior to this project, the paper mill in question experienced losses of usable waste fiber to the sewer in amounts approaching, and sometimes exceeding 40 tons per day. The project objectives can be broken into two distinct phases: (1) locate and evaluate fiber losses from individual paper machines, and (2) prevent or reduce fiber loss and/or recover wasted fiber.

The paper mill's existing database of usable fiber test results was examined to observe any noticeable trends or excessive fiber losses. The design of each paper machine and its respective sewer system was understood so that likely sources of fiber could be identified, and up-the-pipe sampling could be logically approached. Losses were examined to determine if they were normal for the age and condition of that piece of equipment or sub-system. The quality of wasted fiber was also analyzed for dirt content.

The development of an appropriate set of criteria to define the usable fraction of waste fiber was investigated. Onsite sampling was conducted throughout the plant to provide a "fiber inventory" for those machines experiencing above average usable fiber losses. This sampling was conducted in conjunction with personnel from the plant to insure that all potential fiber sources were appropriately evaluated. Flowrates were obtained to calculate the mass of fiber being wasted Sample analysis was conducted by the primary researcher at both the paper mill and Virginia Tech laboratory facilities.

The second phase of this project focused on fiber loss minimization through adjusting standard operating procedures and increasing the efficiency of stock preparation equipment. Such non-capital intensive changes may significantly reduce usable fiber loss; however, other preventative strategies and recovery options were examined as well.

Consideration was given to more selective stock preparation equipment that, by design, sewers more dirt and less fiber. Such a solution may make additional recovery unnecessary or cost prohibitive. However, should recovery of lost fiber be proven a viable option, testing of separation technologies will be conducted in the future.

# 2.0 Background

## 2.1 Paper Mill Layout

The paper mill consists of six paper machines, arranged parallel to one another. Each machine consists of a “wet” end, where all stock preparation equipment is located, and a “dry” end where the finished product is produced. The wet ends of all machines are on the north side of the paper mill; the dry end of the paper mill is on the south side.

This project focused on paper machines number 3, 4, 5, and 6, as their fiber losses have been noted to contribute most significantly. Each paper machine has its own sewer system, with the exception of a combined sewer for paper machine (PM) numbers 1 and 3. Each sewer is a series of grated floor drains in the basement of the paper mill that channel flow to a single point at the end of each PM. At this point of each PM sewer, a composite automatic sampler collects waste samples to be analyzed for fiber loss. These samplers are responsible for the database of usable waste fiber to be discussed later. A flowmeter at this same point collects flow data that is automatically stored in a database for later use.

PM sewers, however, are not independent of one another. Significant usable fiber loss from PM number 3, enters the sewer for PM number 4. Occasionally, the sewer of PM number 4 overflows into that of PM number 5. Therefore, results from the usable fiber analysis for each PM are somewhat skewed.

Figure 2.1 is a schematic of the paper mill floor drain system. Sampling locations are numbered as ‘X-Y’. X denotes the PM, and Y is the location number. The fixed automatic sampler is located at sites indicated by X-0. PM number 3 is not represented in Figure 2.1 because important fiber losses from PM number 3 are sewered to the floor drain system of PM number 4. A more detailed schematic of floor drains relative to machinery for PMs 4, 5, and 6 is in the Appendix.

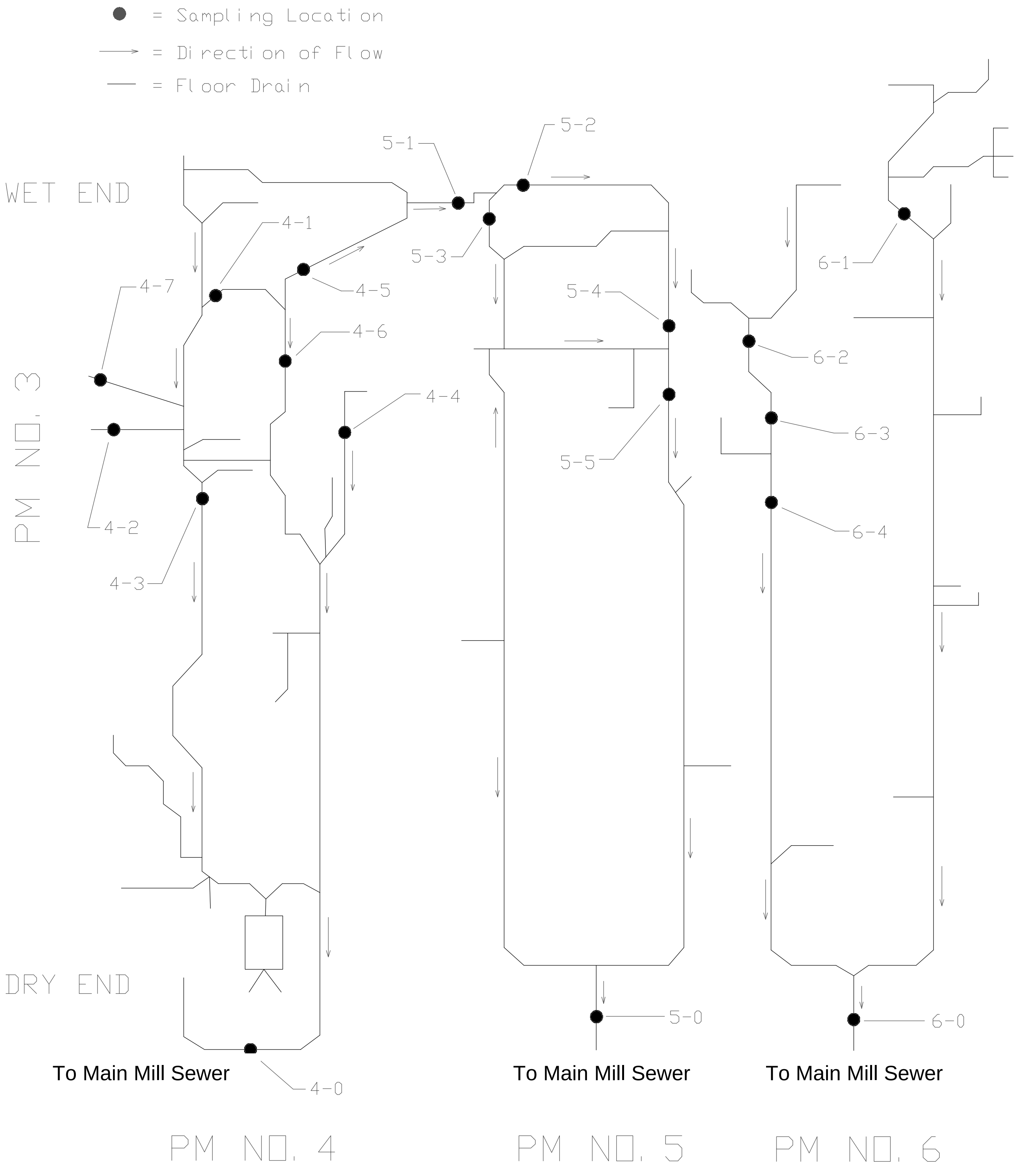


*Figure 2.1:* Paper Mill Floor Drain Schematic

## 2.2 Fiber Processing Overview

It is critical to understand the stock preparation process in the paper mill to explain why certain losses of fiber occur. All pulp processing prior to the paper mill (chipping, cooking, bleaching, and washing) occurs in the pulp mill. The product that enters the paper mill is still not ready for papermaking, however. It must be further refined by a wide array of mechanical stock preparation equipment. Stock preparation equipment described here is as would appear on a single PM unless otherwise noted.

### 2.2.1 Thick Stock Screening

The first step of stock processing in the paper mill is screening. These are referred to as thick stock screens, or pressure screens, as they operate under full line pressure. Stock, at a consistency of approximately 3% solids, passes through a cylindrical, perforated plate in a pressure screen, allowing accepted flow to pass through the screen and rejected flow to remain behind, or continue to the next stage of screening (Smook, 1992). Pressure screens are cleaned by a rotating foil within the screen that pushes stock through the openings at the leading edge; a negative pulse is momentarily created at the trailing edge to reverse flow and purge screen openings (Smook, 1992).

Thick stock screening systems in this particular paper mill are arranged “counter-currently” , such that stock reject from one of the two primary screens is sent to a secondary screen to further concentrate contaminants and remove acceptable fiber. Accepted stock from the second stage of screening is reintroduced into the first stage of screening. This is often the case for up to four stages of screening. The third stage of screening, in the case of this paper mill, is a single centrifugal cleaner cone, the mechanics of which will be discussed later. The only way in which acceptable fiber will continue through the paper-making process is to be accepted through the primary stage of screening.

At a predetermined frequency, each stage of thick stock screens will purge a portion of stock to the sewer in order to remove any buildup of contaminants within the cylinder. These purges occur at full line pressure and last for a few seconds.

Of the PMs of concern, only PM number 4 does not have thick stock screens.

### 2.2.2 Centrifugal Cleaner Cones

The second stage of stock preparation in the paper mill is centrifugal cleaning. A centrifugal cleaner works on the principle of a free vortex. Each cleaner consists of a cylindrical head and a hollow cone body. Thick stock from primary screening is diluted to less than 1% consistency, most often with whitewater, to allow for easier removal of foreign particles during cleaning. Whitewater is water removed under vacuum from fiber on the wire rack during the paper-making process. It is termed “whitewater” because it contains a small portion of filler and fine fiber.

Stock enters the top of the cleaner tangentially and begins a rotary path down the tapering cone body. The speed of the stock increases as the cone tapers, thus increasing the centrifugal force. The pressure drop, from top to bottom, generates this vortex that forces heavier particles to be thrown to the outside of the cone. Accepted fiber spirals upward in the center of the cone through the header, and foreign particles are rejected through the bottom of the cone, along with a portion of good fiber. Figure 2.2 is a schematic of a typical centrifugal cleaner cone.

A single stage of cleaner cones will consist of multiple cones of like size arranged in one or more banks that are fed from a tapering manifold. In much the same cascading manner as thick stock screens, rejects from one stage make up the input for the following stage. Succeeding stages consist of fewer cones with smaller diameters. The smaller the cone diameter, the greater the centrifugal force becomes, and the ability to separate contaminants from good fiber becomes easier. Fiber accepts from the primary stage are pumped to the headbox of the paper machine. Fiber accepts from all other stages are most often combined and reintroduced into the primary stage of cleaning. A more recent development in cleaning returns accepts from each stage to the feed of the previous stage. This is likely a more efficient method of cleaning fiber as it optimizes system capacity. Reject from the final stage of cleaning enters the sewer. However, reject from each stage is capable of being directed to the sewer instead of to the next stage of cleaning. The only source of fiber that will continue through the paper-making process is the accepted fiber from the primary stage of cleaning. Figure 2.2 is a schematic of a typical three stage centrifugal cleaning system.

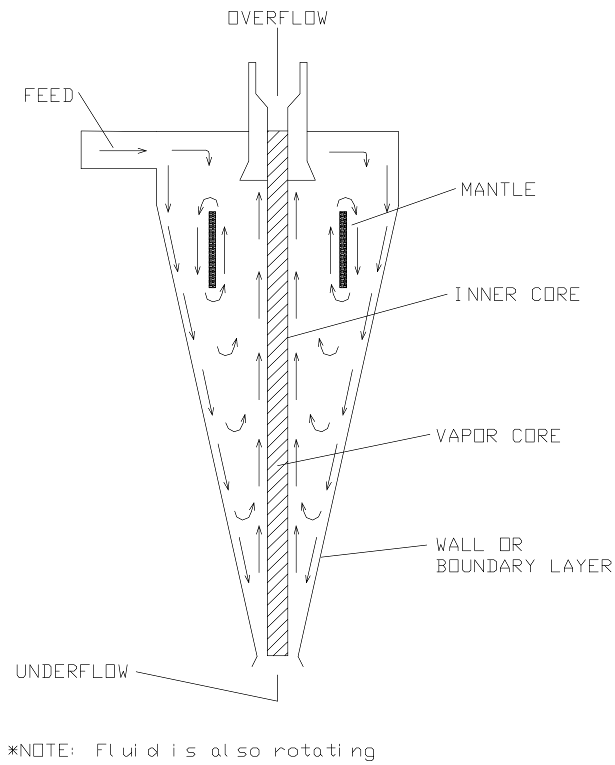


*Figure 2.2*: Typical Cleaner Cone (Franko, 1984)

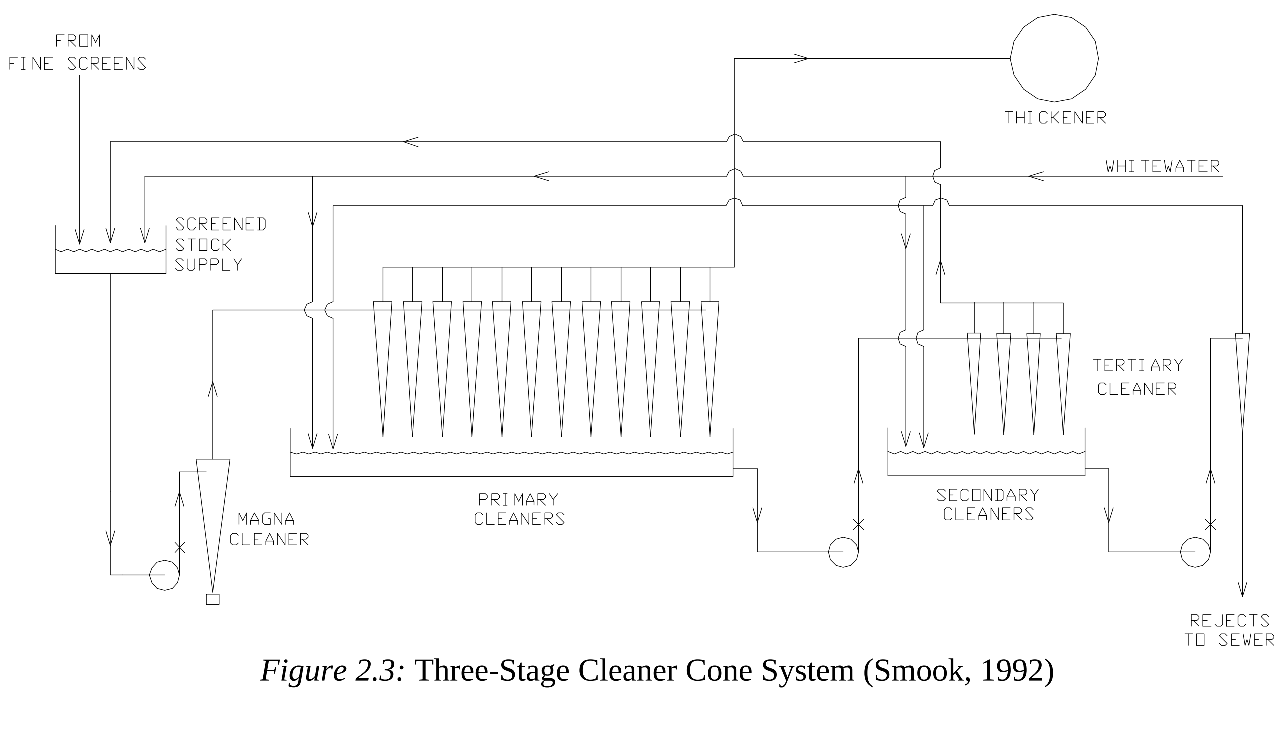


*Figure 2.3:* Three-Stage Cleaner Cone System (Smook, 1992)

On a monthly basis, paper technicians perform a cleaner balance around all cleaner stages of each PM. Using predetermined formulas from the manufacturer, pressure drops and consistencies are measured at each stage of cleaners to calculate appropriate reject rates.

PM numbers 3, 5, and 6 use three stages of cleaner cones supplied by Bauer, Inc. PM number 4, uses four stages of cleaner cones also supplied by Bauer, Inc. It is important to note that both PMs 1 and 2 use cleaner cones supplied by Knoss, Inc. These cones are arranged differently, but operate under the same principle.

### 2.2.3 Thin Stock Screens

The final stage of stock preparation consists of passing the low consistency stock through additional rotating pressure screens. These serve to remove any further dirt, fiber lumps, slivers, pipe scale and other foreign material that may get into the sheet (Stock Preparation Training Manual). These screens also straighten, comb, and separate individual fibers (SPTM). This process will ensure the formation of a good sheet of paper. Fiber reject from these screens is minimal. Stock from these screens is pumped to the headbox for sheet formation.

# 3.0 Location and Evaluation of Usable Waste Fiber

## 3.1 Usable Fiber Definition

The test used by the paper mill to analyze samples taken from PM sewers for usable fiber is solely based on fiber length. A defined sample volume is screened on a Tyler No. 60 Sieve, rinsed under cold tap water for approximately 30 seconds, and oven dried at 105 °C for at least one hour. A concentration of usable fiber can be calculated from this test.

This test is sufficient for quantifying masses of wasted fiber and fiber losses of each paper machine relative to one another. However, in order for fiber to be deemed truly "usable", many other properties must be taken into account (e.g. strength, freeness, degree of bleaching). This will only become an issue if the paper mill considers fiber recovery. Fiber distributions were conducted with the research and development branch of the paper mill in an attempt to better define "usable" fiber for purposes of recovery. These efforts were an aside to the project, as the focus shifted to fiber loss reduction and not recovery.

For purposes of this study, usable fiber (UF) will be defined as indicated in the above test.

## 3.2 Usable Fiber Database

Since March, 1997, the paper mill has been measuring usable fiber with samples taken from composite samplers at each PM sewer. Using the database of flowrates for each PM sewer, a loading of usable fiber is calculated in units of tons/day. This test is conducted on a daily basis. Figure 3.1 represents total usable fiber loss from the paper mill from March, 1997, to April, 1998. Large spikes indicate a stock spill, or the emptying of a stock chest. Smaller, frequent spikes are indicative of grade changes, especially when switching from white to brown kraft on PM number 4. Table 3.1 lists ranges and average fiber losses over this same period by PM and the paper mill as a whole.

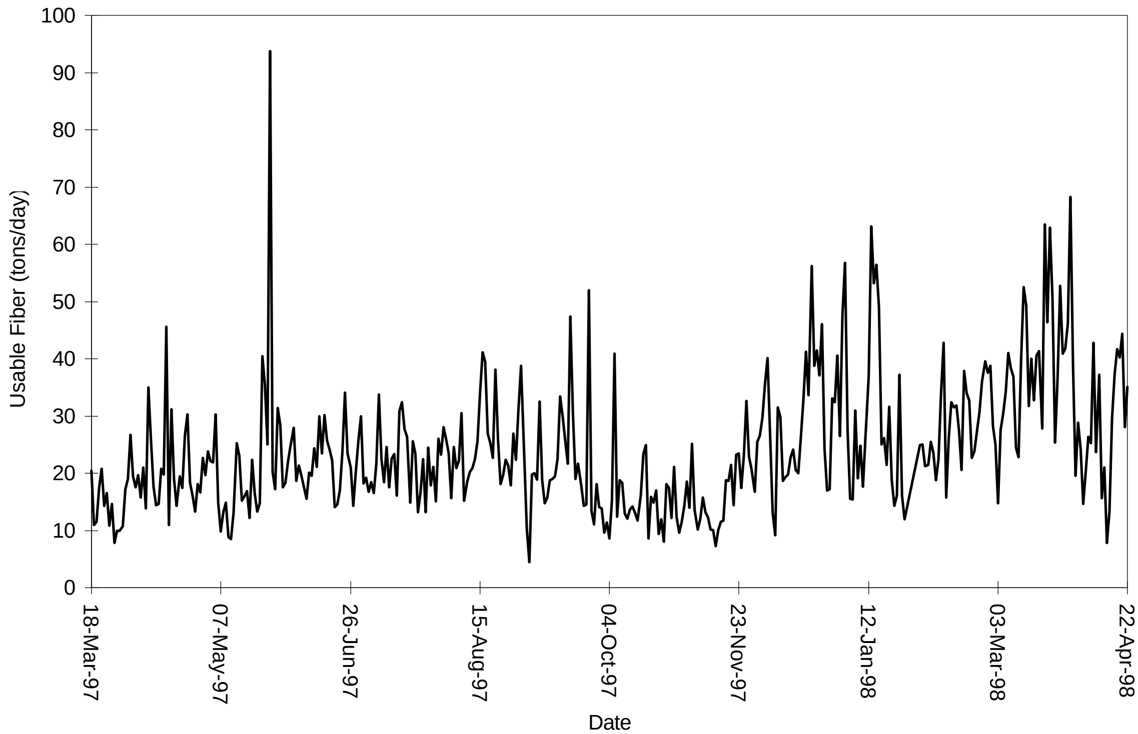


*Figure 3.1:* Total Usable Fiber Loss From Paper Mill

| *Paper Machine Number* | *Range* (tons/day) | *Average* (tons/day) |
|---|---|---|
| 1 & 3 | 0.0 – 18.8 | 2.6 |
| 2 | 0.0 – 75 | 3.5 |
| 4 | 0.2 – 43.5 | 11.0 |
| 5 | 0.0 – 18.5 | 5.1 |
| 6 | 0.0 – 28.4 | 2.4 |
| Total | 4.5 – 93.8 | 24.1 |

*Table 3.1:* Usable Fiber Loss by Paper Machine

As a result of the sewer crossovers mentioned previously, the fiber loss averages for each paper machine are not representative of actual losses. Although the average fiber loss over this period is only 24.1 tons/day, the paper mill would like to focus efforts on reducing the frequency of spikes that approach and often exceed 40 tons/day.

To better explain spikes and trends in Figure 3.1, fiber losses over the same time period were analyzed for each PM. Figures 3.2 through 3.5 illustrate fiber losses for PMs 1&3, 4, 5, and 6 respectively. As discussed earlier, PMs 1 and 3 have a combined floor drain system, so measurements cannot be taken independently. Plots are shown to identical scales and were constructed separately to avoid clutter.

It is important to note that losses from centrifugal cleaner cones on PM number 3 are represented by fiber loss data from PM number 4. This loss, although still significant, was later determined to contribute only 3 to 5 tons per day. This fiber is just a fraction of the often 30 tons per day seen to be lost from PM number 4.

On many occasions as much as 13 tons of fiber per day from PM number 4 floor drain was observed to flow into the PM number 5 floor drain. As a result, fiber loss data from PM number 5 is largely indicative of losses experienced by PM number 4. A true quantification of fiber loss from PM number 5 is not available.

Extreme spikes, above 40 tons per day, are most likely due to emptying of chests or spills, although the researcher was not present to view these occurrences. PM numbers 1 and 3 are noted to have more extreme fiber loss incidences in the latter half of the period.

Fiber loss on PM number 4 fluctuates with regular consistency. Spike events generally occur every two weeks when there is a change of grade from brown kraft to white. The spike is a result of emptying a stock chest in preparation for a grade change.

PM number 5, with the exception of overflows from PM number 4, operates with minimal fiber loss.

PM number 6, with the exception of a few infrequent spikes, operates with very little fiber loss.

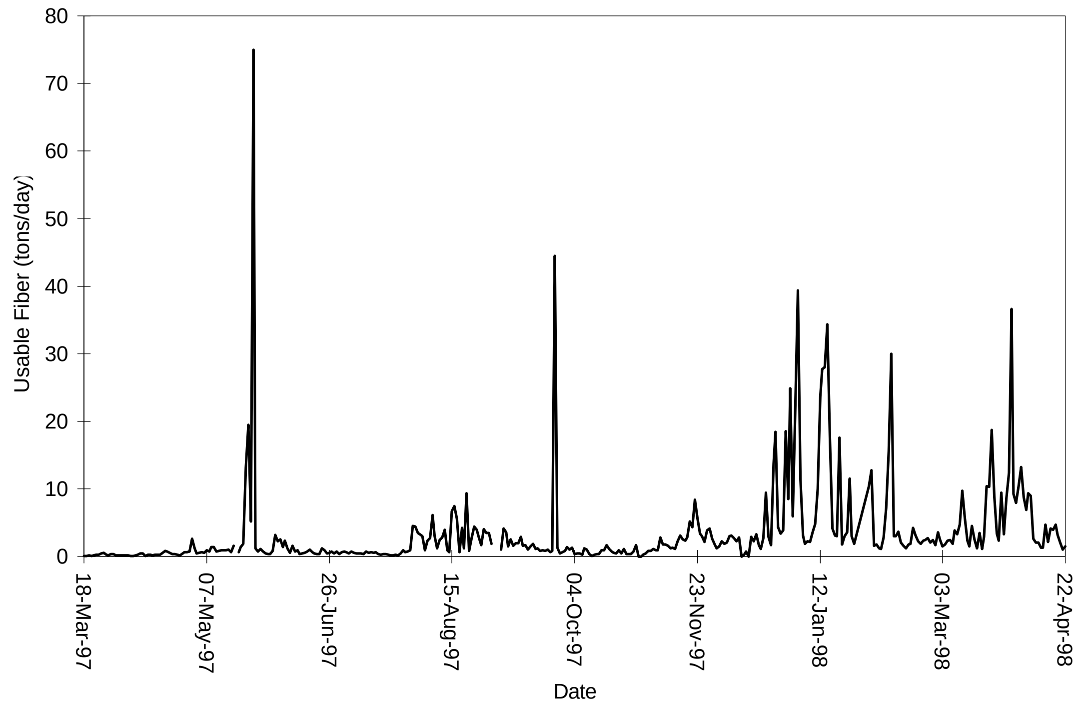


*Figure 3.2:* Fiber Loss from Paper Machine Nos. 1&3

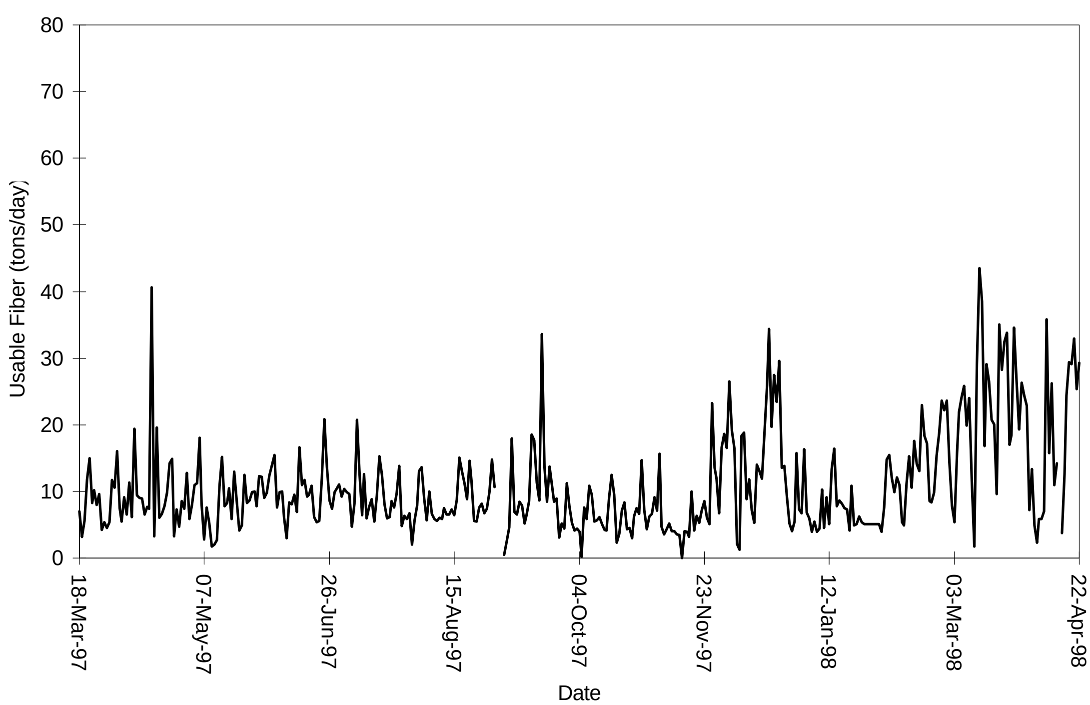


*Figure 3.3:* Fiber Loss from Paper Machine No. 4

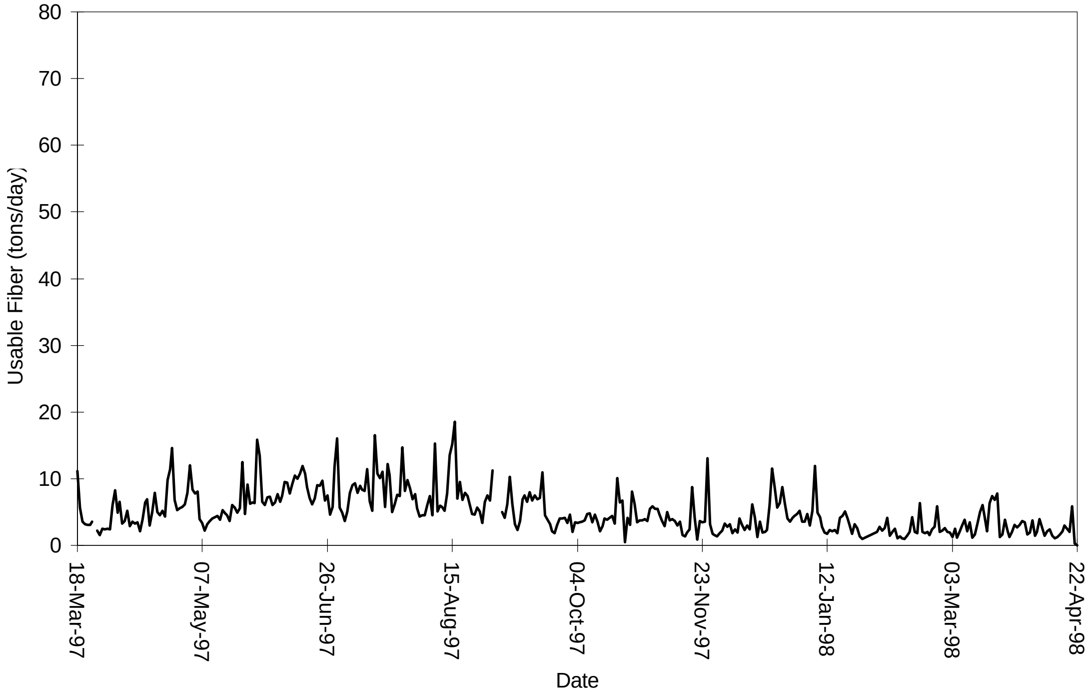


*Figure 3.4:* Fiber Loss from Paper Machine No. 5

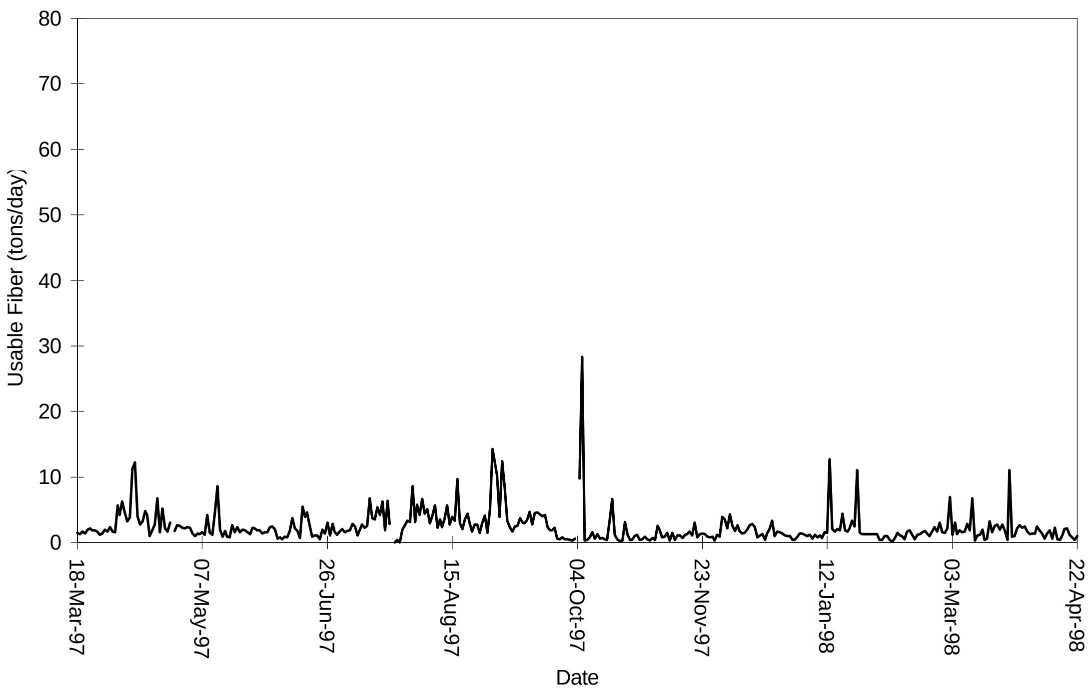


*Figure 3.5*: Fiber Loss from Paper Machine No. 6

## 3.3 Quantity of Fiber Loss

### 3.3.1 Sampling Procedure and UF Measurement

A sampling program was established to locate and quantify sources of fiber loss on each paper machine. After many visual inspections of the grated PM sewers, 15 sampling locations were established. These sampling locations were placed where waste streams both with and without highly visible fiber content was noted. Refer to Figure 2.1 for a floor drain schematic with labeled sampling locations.

Sampling was conducted with a Cerlic Type DWS Automatic Water Sampler mounted on a hand truck for ease of transport within the paper mill. The sampling hose was strapped to a four foot piece of reinforcing steel. The hose and reinforcing steel was inserted through floor grates into the flow such that the reinforcing steel rested on the bottom of the channel, and the sampling hose was at half the depth of flow. All samples taken with the automatic sampler were 2 hour composite samples, consisting of a 750 mL sample gathered every 15 minutes. The composite sample, collected in a 5 gallon bucket at the base of the hand truck, was mixed thoroughly, and a 500 mL representative sample was collected. Each sample was refrigerated until analysis. The usable fiber test described in § 3.1 was conducted on each of the composite samples. Results were recorded in units of mg/L. These data appear in Table 3.2.

### 3.3.2 Flowrate Determination and UF Wastage Calculation

Since the usable fiber test generates a concentration for each sample, it is necessary to measure the flowrate during each sampling period to calculate a mass of fiber wasted per unit time. Several attempts were made using an impeller type flowmeter, however the solids content of most wastestreams proved to be too high for this flowmeter. Fowling of the impeller blade occurred soon after immersion in flow.

After much deliberation, a more primitive method of flow measurement proved to be more functional. The dimensions of the channel were measured (channel width and depth of flow) to determine a cross-sectional area of flow. Using wood chips obtained from the chip yard of the pulp mill, the velocity of flow was recorded by measuring the time of individual chips to traverse a set distance of floor drain. From the velocity and cross-sectional area, a volumetric flowrate, in units of cfs, could be determined and used to calculate mass wastage of fiber. To calculate wastage rates in units of tons/day, the following equation was used.

$$\text{UF Wastage (tons/day)} = \text{UF (mg/L)} * \text{Vol. Flowrate (cfs)} * 2.697*10^{-3}$$

Following composite sampling, conclusions were made as to where major fiber losses were occurring. With the exception of occasional spills or emptying a stock chest (uncommon events) there appeared to be two point source contributors to fiber loss: (1) centrifugal cleaner cones and (2) thick stock screens. The exception to this was PM number 4, which does not have a thick stock screening system.

Flowrate and wastage rate data appears in Table 3.2.

Table 3.2: *Usable Fiber/Wastage Rate Data*

| Sample Location | Date | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|
| 4-1 | 2-Apr | 0.36 | 552 | 0.5 |
| | 3-Apr | 0.36 | 492 | 0.5 |
| | 4-Apr | 0.36 | 1380 | 1.3 |
| 4-3 | 2-Apr | 0.69 | 1790 | 3.4 |
| | 3-Apr | 0.56 | 2080 | 3.1 |
| | 4-Apr | 0.91 | 2050 | 5.0 |
| 4-5 | 19-Mar | 1.07 | 4500 | 12.9 * |
| | 30-Apr | 0.69 | 5500 | 10.3 * |
| | 1-May | 0.84 | 4110 | 9.4 |
| | 1-May | 0.24 | 3050 | 2.0 |
| 4-6 | 3-Apr | 1.19 | 4070 | 13.1 |
| | 4-Apr | 1.02 | 3000 | 8.3 |
| | 6-Apr | 1.07 | 3530 | 10.2 |
| | 7-Apr | 1.38 | 4270 | 15.8 |
| | 19-Mar | 0.25 | 3780 | 2.6 * |
| | 20-Mar | 1.43 | 4880 | 18.8 * |
| | 30-Apr | 1.49 | 4770 | 19.1 * |
| | 1-May | 1.53 | 4100 | 16.9 |
| | 1-May | 1.21 | 3340 | 10.8 |
| 4-7 | 6-Apr | 0.17 | 4510 | 2.0 |
| | 7-Apr | 0.17 | 3950 | 1.8 |
| | 8-Apr | 0.17 | 5000 | 2.2 |
| | 9-Apr | 0.17 | 6330 | 2.8 |
| | 30-Apr | 0.20 | 4910 | 2.7 |

* Brown Kraft

| Sample Location | Date | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|
| 5-1 | 19-Mar | 1.12 | 3800 | 11.5 |
| 5-2 | 20-Mar | 0.76 | 4140 | 8.5 |
| 5-3 | 21-Mar | 0.27 | 4381 | 3.2 |
| 5-4 | 2-Apr | 0.26 | 913 | 0.6 |
| | 3-Apr | 0.44 | 1060 | 1.2 |
| | 4-Apr | 0.24 | 1060 | 0.7 |
| | 19-Mar | 1.20 | 3770 | 12.2 |
| | 30-Apr | 2.43 | 2560 | 16.7 |
| | 1-May | 0.35 | 2070 | 1.9 |
| 5-5 | 2-Apr | 0.82 | 261 | 0.6 |
| | 3-Apr | 1.19 | 205 | 0.7 |
| | 4-Apr | 0.62 | 523 | 0.9 |
| | 5-Apr | 0.73 | 869 | 1.7 |
| | 20-Mar | 0.95 | 3420 | 8.8 |
| | 30-Apr | 1.39 | 4020 | 15.1 |
| | 1-May | 0.59 | 839 | 1.3 |
| 6-2 | 2-Apr | 0.20 | 303 | 0.2 |
| | 5-Apr | 0.19 | 631 | 0.3 |
| | 6-Apr | 0.31 | 320 | 0.3 |
| 6-3 | 1-Apr | 1.22 | 91 | 0.3 |
| | 5-Apr | 0.83 | 45 | 0.1 |
| | 6-Apr | 0.81 | 75 | 0.2 |
| | 9-Apr | 0.83 | 165 | 0.4 |
| 6-5 | 6-Apr | 2.08 | 27 | 0.2 |

### 3.3.3 Centrifugal Cleaner Cone Fiber Loss

The most significant contributor of fiber to the sewer on all PMs was determined to be from centrifugal cleaner cone reject. Reject from cleaner cones is a continuous flow of fiber and foreign material from the last stage of cones being used. As mentioned earlier, PM numbers 3, 4, 5, and 6 were focused on most heavily. The only paper machine observed to bypass stages of cones is PM number 4. When PM number 4 is put on line after a field day or grade change, all four stages of cleaner cones are used. A foreman at the dry end of the paper machine will order the beaterman at the wet end of the paper machine to drop a stage of cleaner cones when excessive dirt appears in the finished roll of paper. One stage is dropped at a time until the dirt is no longer visible in the finished roll. Cleaner cone stages 3 and 4 are most often bypassed, resulting in sewering the reject of stage 2 cleaner cones. This is most often the case when PM number 4 is running brown kraft grade of paper. According to Greg Meese of the company's research and development division, it is inevitable to lose approximately 5 tons per day of fiber from each paper machine. Beyond this is likely unnecessary fiber loss. PM number 3, 5, and 6 were never observed to bypass cleaner cone stages. Fiber loss data from cleaner reject is shown in Table 3.3.

*Table 3.3:* Fiber Loss from Sewered Cleaner Cone Reject

| Sample Location | Date | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|
| PM3 TR | 2-Apr | 0.20 | 5500 | 3.0 |
| | 30-Apr | 0.20 | 4440 | 2.4 |
| | 4-May | 0.20 | 4880 | 2.6 |
| PM4 SR | 2-Apr | 1.89 | 4520 | 23.0 |
| | 1-May | 1.88 | 4020 | 20.4 |
| | 4-May | 1.90 | 5710 | 29.2 * |
| PM5 TR | 2-Apr | 0.05 | 4810 | 0.7 |
| | 30-Apr | 0.05 | 5530 | 0.8 |
| | 4-May | 0.05 | 6640 | 0.9 |
| PM6 TR | 2-Apr | 0.01 | 3450 | 0.1 |
| | 30-Apr | 0.01 | 2200 | 0.1 |
| | 4-May | 0.01 | 2790 | 0.1 |

* Brown Kraft

PM number 3 consistently sewered between 3 and 5 tons of usable fiber daily. PM number 4 sewers 25 to 29 tons per day of usable fiber when running brown kraft and 12 to 23 tons of fiber when running white grade. These losses are representative only when sewering reject from second stage cleaner cones; this occurred for approximately 75% of the time during sampling trips. Multiple sampling points were necessary to measure fiber loss from second stage cleaners as flow from this area splits to multiple sewers. Data in Table 3.2 reflects these measurements when multiple losses are summed. PM number 5 consistently sewered 0.7 to 0.9 tons of usable fiber daily. PM number 6 consistently sewered 0.1 tons of usable fiber daily.

These results suggest focusing fiber reduction efforts on PM numbers 3 and 4.

### 3.3.4 Thick Stock Screen Fiber Loss

A minor amount of sampling was conducted at the purge point of thick stock screens. However, it is essentially impossible to measure quantities of fiber loss at this point. Purges occur at varying intervals for a few seconds at a time at the full flow to the paper machine. Therefore the flowrate cannot be measured. On a strictly subjective basis, these losses are not comparable to those observed from centrifugal cleaner cones.

## 3.4 Quality of Fiber Loss

An excellent measure of the efficiency of any stock preparation equipment is the amount of dirt in sewered fiber. The goal of operation of centrifugal cleaner cones is to sewer the least amount of fiber, but ensure that the fiber being sewered has a very high dirt content. Sewered fiber that is especially clean indicates poor cleaner performance. This can be attributed to a number of problems including blockage in cleaner cones or an undersized system. Excessive dirt can easily be accepted through an underdesigned cleaner system. This will often result in bypassing one or more stages of cleaners.

### 3.4.1 Dirt Content Analysis

Dirt analyses were performed on cleaner cone rejects to judge the performance of cleaning systems on PMs 3, 4, 5, and 6. The standard dirt content analysis was modified to use a smaller volume of sample while achieving similar results. Using the modified method, many more samples could be analyzed in a shorter period of time.

A sample of fiber is mixed thoroughly and 25 mL is filtered on a standard qualitative filter pad. From this a total solids concentration is used to determine a volume of sample necessary to construct a 2 g handsheet of paper. This volume is filtered onto a 12.5 cm filter pad and oven-dried for approximately 10 minutes before removing the filter pad. Using a dirt template from TAPPI (The Association of Pulp and Paper Industries) test methods, the dirt on a single side of a handsheet is sized and tallied. The total black area (dirt) is divided by the total area of one side of the handsheet, resulting in an equivalent black area. This value is express in $mm^2$ of dirt/$m^2$ of paper. This can also be represented in units of ppm.

Handsheets with more dirt than can be counted were labeled simply as “dirty”. Those handsheets that a dirt content value can be assigned to appear relatively clean to the eye. Ideally, the dirt on a handsheet constructed from rejected fiber should be high enough that it cannot be manually counted.

### 3.4.2 Centrifugal Cleaner Cone Reject Dirt Content

Sampling was conducted directly at the reject point of final stage cleaner cones on PM numbers 3, 4, 5, and 6. It was critical to sample reject prior to entering the floor drains, as contamination is an immediate result once this occurs. A great deal of biological growth and other organic contamination was observed microscopically in samples collected from floor drains. Data from dirt count tests appear in Table 3.3 In this table, Pin refers to primary feed, PA refers to primary accept, PR refers to primary reject, etc. Also noted is whether the fiber stream was being sewered during sampling. GS refers to the gross solids, EBA is the equivalent black area, or dirt content.

*Table 3.4:* Centrifugal Cleaner Cone Reject Dirt Content

| Sample Location | Date | Sewered | GS (g/L) | EBA (ppm) |
|---|---|---|---|---|
| PM3 Pin | 7-Apr | | 9.86 | 8 |
| PM3 PA | 7-Apr | | 8.92 | 9 |
| PM3 PR | 7-Apr | | 6.25 | 6 |
| PM3 SA | 7-Apr | | 5.59 | 10 |
| PM3 SR | 7-Apr | | 3.46 | 18 |
| PM3 TA | 7-Apr | | 3.21 | 6 |
| PM3 TR | 7-Apr | X | 6.02 | 91 |
| | 1-May | X | 7.24 | 99 |
| | 2-May | X | 7.54 | 68 |
| | 2-May | X | 7.24 | 114 |
| | 4-May | X | 7.14 | 94 |
| PM4 SR | 2-Apr | | 5.57 | 65 |
| | 3-Apr | X | 6.64 | 23 |
| | 4-Apr | X | 5.89 | 9 |
| | 6-Apr | X | 6.68 | 28 |
| | 30-Apr | X | 7.21 | 18 * |
| | 1-May | X | 6.25 | 22 |
| | 2-May | X | 8.45 | 17 |
| PM4 TR | 1-Apr | X | 3 | 129 |
| | 2-Apr | | 3.76 | 147 |
| | 4-Apr | X | 5.9 | 17 |
| PM4 QR | 2-Apr | X | 1.38 | - |
| | 3-Apr | X | 0.09 | - |
| | 9-Apr | X | 0.91 | 204 |
| PM5 SR | 2-Apr | | 8.48 | 57 |
| PM5 TR | 2-Apr | X | 3.89 | ** |
| | 1-May | X | 11.37 | ** |
| | 4-May | X | 8.55 | ** |
| PM6 SR | 2-Apr | | 8.68 | 33 |
| PM6 TR | 2-Apr | X | 9.07 | ** |
| | 4-May | X | 7.71 | ** |

* Indicates brown kraft
** Indicates dirt content beyond countability

Samples collected from third stage cleaner reject on PM number 3 ranged from 68 to 114 ppm dirt.

Samples from secondary stage sewered reject on PM number 4 ranged from 9 to 24 ppm when running white grade and 25 to 75 ppm when running brown kraft. When tertiary stage cleaner reject was sewered on PM number 4, dirt values ranged from 17 to 129 ppm. Dirt measurements from quaternary stage reject were in excess of 200 ppm.

The dirt content in tertiary reject from PM numbers 5 and 6 was consistently too high to measure.

From these analyses, centrifugal cleaner cone systems on PMs 5 and 6 were considered to operate normally while cleaner systems on PMs 3 and 4 were considered to be inadequate. Handsheet consistency from PMs 5 and 6 was extremely dirty and very gritty.

PM number 3 consistently sewers 3 to 5 tons per day of relatively clean fiber (<100 ppm dirt). This is not a severe problem, but slight adjustments can be made to improve the performance of the cleaning system on PM number 3.

During the majority of operation of PM number 4 during sampling, secondary stage reject was sewered at very high quantities with very low dirt content. At times, there was almost no observable dirt in the reject. Obviously, this is contrary to the design of a cleaning system. A test conducted by sampling secondary stage cleaner reject on PM number 4 throughout the operating day indicates a large fluctuation in dirt content of reject (Figure 3.6). At times dirt content in the reject was as low as 8 ppm.

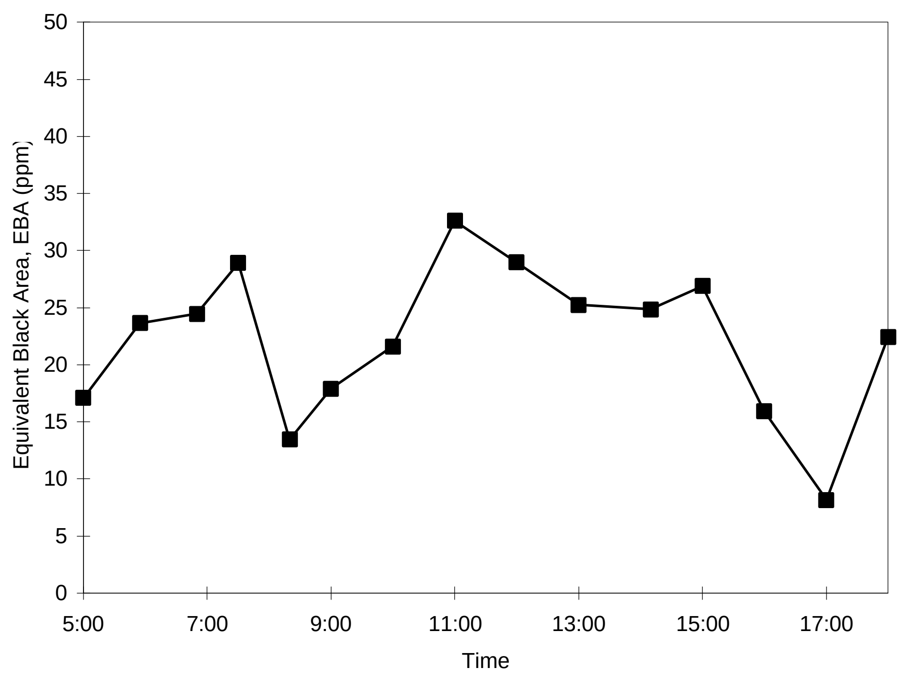


*Figure 3.6:* Dirt Content in Secondary Stage Cleaner Reject on PM No.4

### 3.4.3 Thick Stock Screen Dirt Content

Samples were collected from the purge point of thick stock screens on PMs 5 and 6. The concentration of dirt in these samples consistently exceeded 250 ppm. Since these sources of fiber loss are not significant contributors to total quantity of fiber loss and the dirt content of this fiber is relatively high, the focus of fiber loss prevention should remain on centrifugal cleaner cone systems.

# 4.0 Fiber Loss Prevention Strategies

## 4.1 Cleaner Maintenance

Fiber loss prevention should focus on centrifugal cleaner cone systems for PMs 3 and 4. A number of strategies should be considered to reduce the quantity of sewered cleaner reject while increasing the dirt content in these rejects.

Cleaner cone maintenance is a critical step in ensuring proper operation of these systems. Plugging within individual cones can frequently occur, causing the bottom of the cone to fill with grit. As the plug orbits within the cone, it can easily cut into the body of the cleaner, destroying the hydraulic integrity of the cone (Grimes, 1994). When one cone is blocked, additional stress is placed on other cones in the system, as they are forced to clean a greater volume of fiber than dictated by their design. Blockages can be removed when the entire paper machine is off-line for maintenance. An acrylic portion of most cones can be used to visually inspect for blockages during operation. PMs 3 and 4 were observed to have multiple cone blockages, contributing to poor performance.

All cleaner cone systems have a system of pressure valves and/or taps to measure pressure drops across cone stages. This information, along with consistency measurements, allows paper technicians to perform a balance to calculate a reject rate. These valves and pressure taps can often become clogged with fiber and contamination, preventing accurate balances. Maintenance should also be performed on these pressure taps to removing any blockage. Pressure gauges on PM 3 were often observed to be inoperative or “pinned”.

It is also critical to ensure constant flow to cleaning systems. Stock consistency can easily be effected by allowing feedtank levels to drop too low, or by pulling too little stock from feedtanks. Whitewater is used to makeup additional volume and reduce consistency in the cones allowing for better removal. Ideally, the only time cleaners should be added or taken off-line is when adjustments for stock flow are necessary to maintain consistency.

## 4.2 Additional Cleaners

Much of the existing cleaning equipment was installed in the late 1960s and early 1970s. Since then, production has increased as much as 50% on some machines with little upgrading of cleaning systems. As a result some systems are likely cleaning a greater quantity of fiber than they are designed to treat. Because of this, cleaners cannot operate efficiently, and all stages cannot be used because of the frequent occurrence of dirt in the final product. Additional cones will ease the load being placed on the whole system and operating performance will increase.

PM number 4 has additional space for secondary, tertiary, and quaternary cleaner cones. Since secondary stage reject is most frequently sewered, additional cones for this stage as well as tertiary and quaternary stages will likely reduce the quantity of fiber being sewered and increase the dirt content of this fiber. Additional cones will allow operators to make use of all stages of cleaners.

## 5.0 Economic Benefits

The value of fiber in the paper mill where cleaning take place is approximately $200 per dry ton.  PM number 4 will be used as an example of the potential savings.  If the average daily fiber loss on paper machine number 4 can be reduced from 11 tons to 5 tons, annual savings will exceed $400,000.  This is a conservative figure, as $200 per ton does not take into account landfill costs, and a loss of even 5 tons per day is still high.

Adding two secondary stage cleaner cones on PM number 4 will cost approximately $6,000. Savings will far exceed the initial investment to reduce the quantity of wasted fiber.  Further investigation must be conducted to ensure that additional cleaner cones will not upset any aspect of stock preparation.

## 6.0 Fiber Recovery

There is still a significant quantity of wasted fiber when cleaning systems are performing under optimal conditions. The concept of recovering this fiber for reuse has long been an issue, however there are many hurdles to overcome prior to accepting wasted fiber back into the system. Waste fiber cannot be deemed "usable" on the basis of fiber length and cleanliness alone. Many other factors such as fiber strength and degree of bleaching will also dictate the fate of waste fiber. By far the most difficult problem is dirt removal. After several stages of cleaning, the remaining dirt is often a very similar density to that of the wasted fiber. This makes removal on a weight basis difficult.

A minor amount of work was conducted with R&D from this paper mill to better understand the concept of usable fiber. Results from this work will be more useful with additional testing for multiple parameters.

One solution to fiber recovery that has been tested requires storing final stage reject in large quantities and passing it through additional cleaning stages at a very high rate. Another method of recovery involves removal of fiber from sludge (Bunster, 96; Moss and Kovacs, 94).

Fiber recovery is a much more cost-intensive solution. Efforts should be focused on limiting the amount of wasted fiber from the source before fiber recovery is considered.

## 7.0 Conclusions / Recommendations

From this study, it can be concluded that cleaning systems on PM number 4 are the primary culprit of fiber loss in the paper mill. Cleaning systems on PM number 3 could operate more efficiently if routine maintenance is conducted. Cleaning systems on PM numbers 5 and 6 operate very effectively.

The paper mill should focus fiber loss reduction efforts on PM number 4. Reducing the amount of fiber lost on this paper machine would greatly reduce overall paper mill fiber losses. Maintenance must also be conducted on cleaning systems of PM number 4. There is available space for additional cleaner cones as well. Since existing cleaner systems are operating well above design capacity, additional cones would distribute the flow of stock and allow for all stages of cones to be used. The return would far outweigh a small investment to upgrade cleaning systems on PM number 4.

This study is likely applicable at many older, fine paper mills throughout the world. Fiber loss can sometimes go unnoticed, as it did at this mill until very recently, and strategies to prevent or reduce fiber loss are quite simple and inexpensive.

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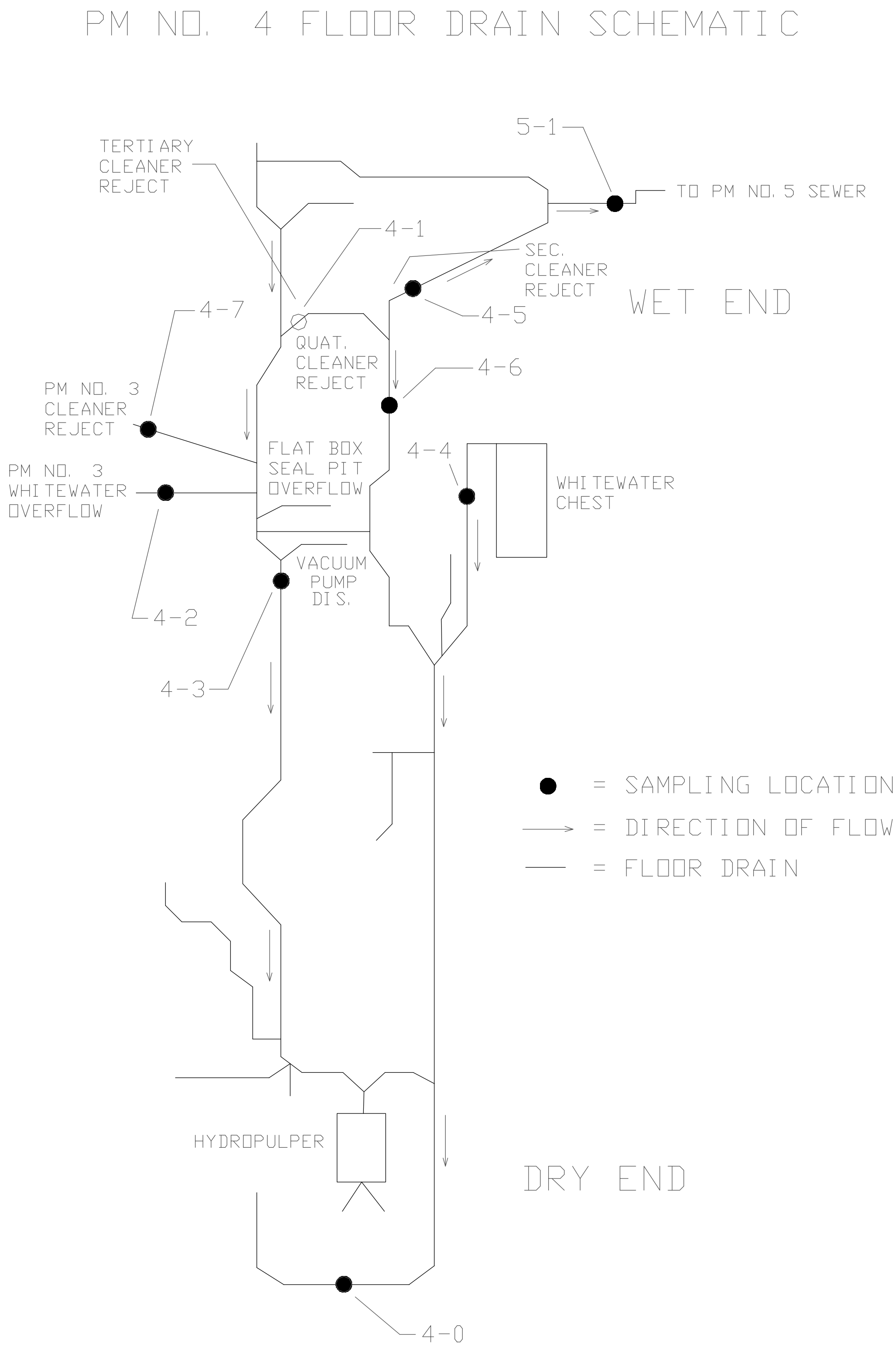
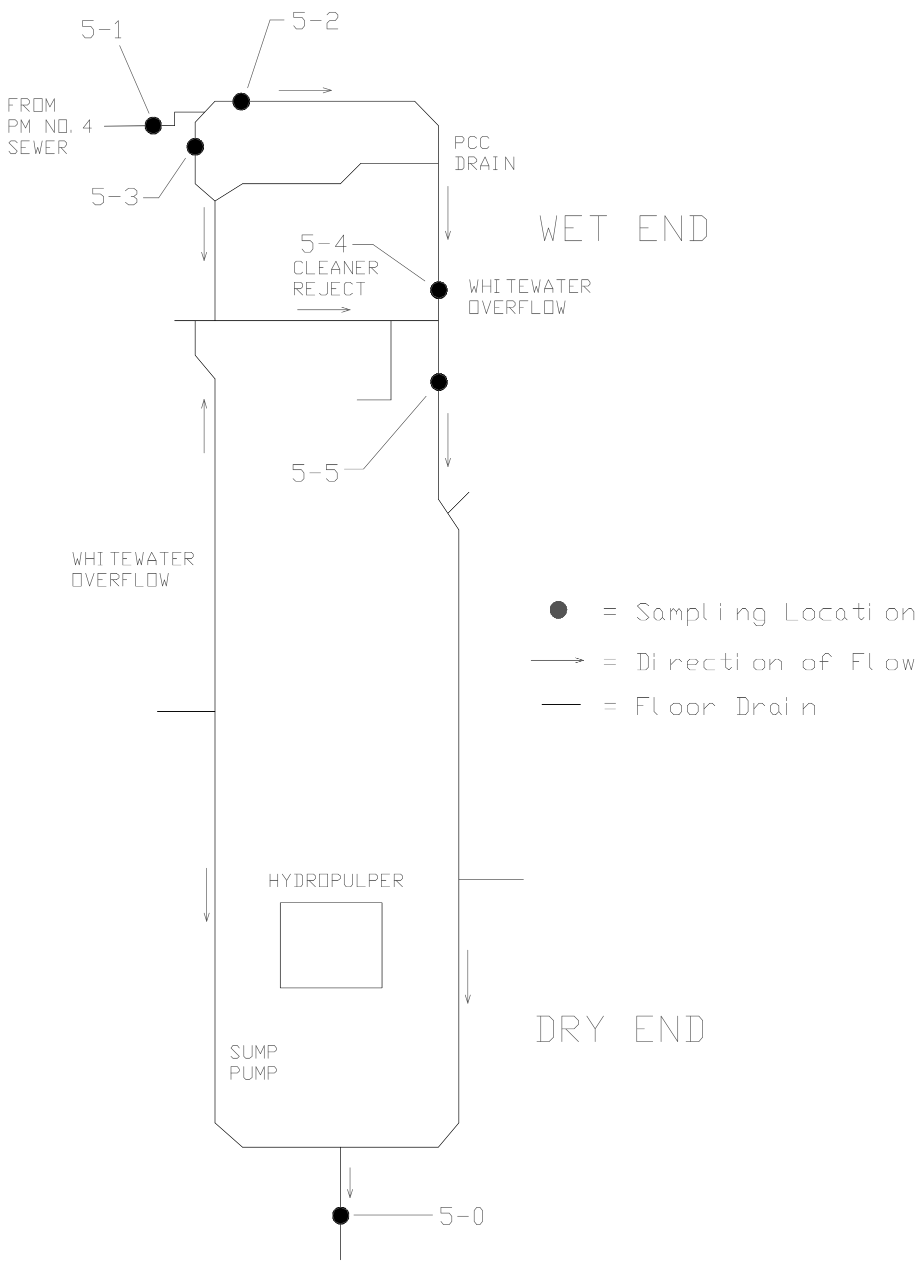
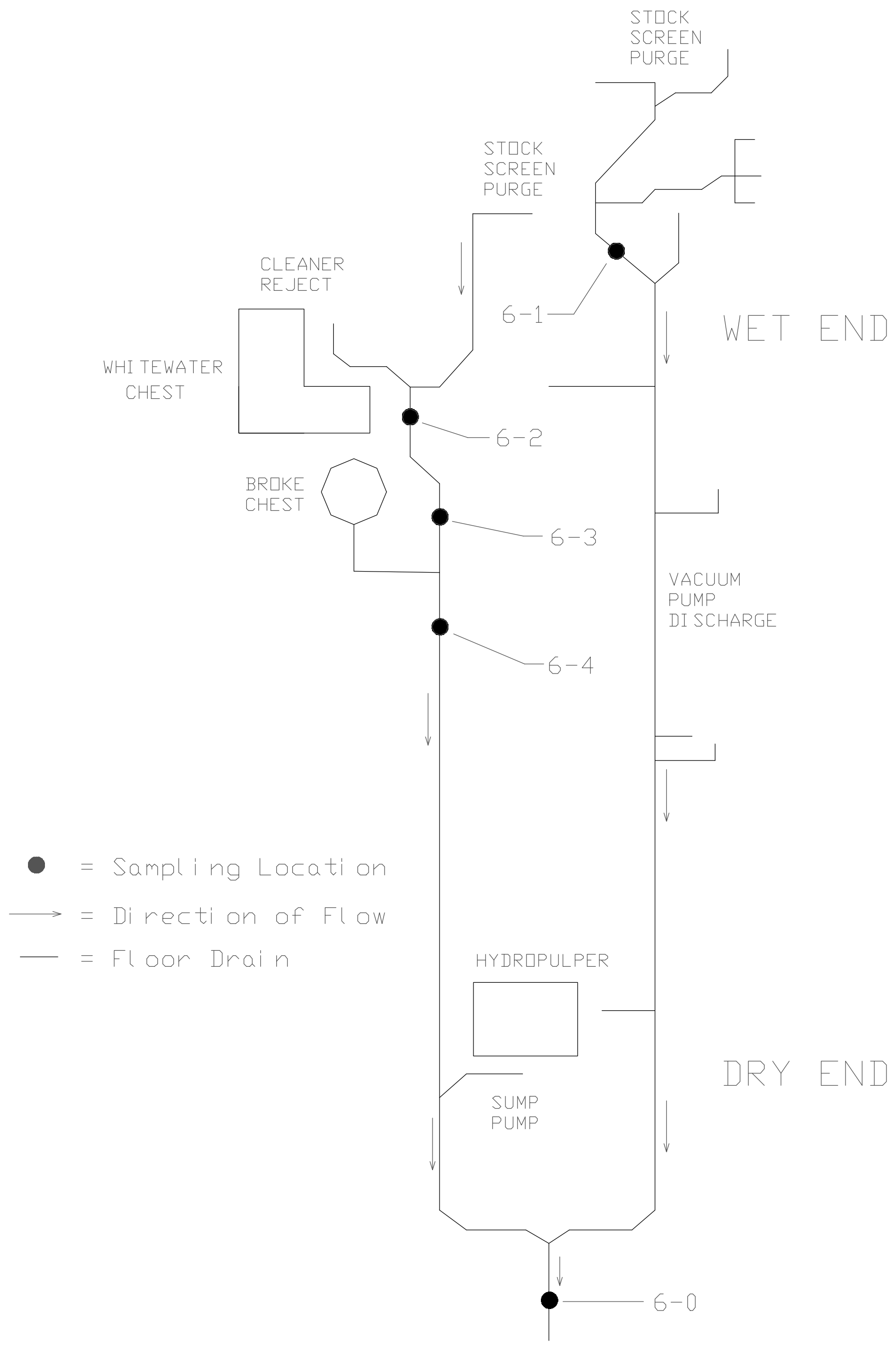
# APPENDIX


PM NO. 4 FLOOR DRAIN SCHEMATIC
5-1
TO PM NO. 5 SEWER
TERTIARY CLEANER REJECT
4-1
SEC. CLEANER REJECT
4-5
WET END
4-7
QUAT. CLEANER REJECT
4-6
PM NO. 3 CLEANER REJECT
FLAT BOX SEAL PIT OVERFLOW
4-4
WHITEWATER CHEST
PM NO. 3 WHITEWATER OVERFLOW
VACUUM PUMP DIS.
4-2
4-3
= SAMPLING LOCATION
= DIRECTION OF FLOW
= FLOOR DRAIN
HYDROPULPER
DRY END
4-0

# PM NO. 5 FLOOR DRAIN SCHEMATIC



# PM NO. 6 FLOOR DRAIN SCHEMATIC



# USABLE FIBER DATABASE

| Date | Paper Machine 1&3 | 2 | 4 | 5 | 6 | TOT |
|---|---|---|---|---|---|---|
| 18-Mar-97 | 0.70 | 0.10 | 7.03 | 11.10 | 1.49 | 20.43 |
| 19-Mar-97 | 0.81 | 0.08 | 3.16 | 5.63 | 1.24 | 10.92 |
| 20-Mar-97 | 0.53 | 0.17 | 5.59 | 3.52 | 1.64 | 11.46 |
| 21-Mar-97 | 1.01 | 0.13 | 11.79 | 3.18 | 1.34 | 17.46 |
| 22-Mar-97 | 0.46 | 0.22 | 15.03 | 3.06 | 1.98 | 20.75 |
| 23-Mar-97 | 0.51 | 0.27 | 8.28 | 3.11 | 2.13 | 14.31 |
| 24-Mar-97 | 0.73 | 0.29 | 10.16 | 3.52 | 1.84 | 16.55 |
| 25-Mar-97 | 0.55 | 0.51 | 7.97 | | 1.83 | 10.85 |
| 26-Mar-97 | 0.70 | 0.56 | 9.58 | 2.19 | 1.62 | 14.65 |
| 27-Mar-97 | 0.59 | 0.25 | 4.25 | 1.55 | 1.21 | 7.85 |
| 28-Mar-97 | 0.62 | 0.19 | 5.38 | 2.46 | 1.34 | 9.99 |
| 29-Mar-97 | 0.76 | 0.36 | 4.48 | 2.37 | 1.96 | 9.93 |
| 30-Mar-97 | 0.82 | 0.40 | 5.38 | 2.50 | 1.68 | 10.78 |
| 31-Mar-97 | 0.63 | 0.16 | 11.73 | 2.36 | 2.37 | 17.25 |
| 01-Apr-97 | 0.59 | 0.16 | 10.53 | 6.03 | 1.69 | 19.00 |
| 02-Apr-97 | 0.76 | 0.18 | 16.08 | 8.21 | 1.52 | 26.75 |
| 03-Apr-97 | 1.09 | 0.20 | 7.51 | 4.94 | 5.65 | 19.40 |
| 04-Apr-97 | 1.14 | 0.15 | 5.46 | 6.58 | 4.23 | 17.55 |
| 05-Apr-97 | 0.79 | 0.22 | 9.09 | 3.26 | 6.28 | 19.64 |
| 06-Apr-97 | 0.83 | 0.10 | 6.53 | 3.69 | 4.56 | 15.71 |
| 07-Apr-97 | 1.06 | 0.13 | 11.35 | 5.16 | 3.27 | 20.97 |
| 08-Apr-97 | 0.93 | 0.20 | 6.13 | 2.88 | 3.76 | 13.91 |
| 09-Apr-97 | 0.50 | 0.29 | 19.41 | 3.51 | 11.23 | 34.94 |
| 10-Apr-97 | 0.50 | 0.45 | 9.38 | 3.30 | 12.17 | 25.81 |
| 11-Apr-97 | 0.62 | 0.45 | 9.07 | 3.49 | 3.98 | 17.60 |
| 12-Apr-97 | 0.58 | 0.13 | 8.92 | 2.08 | 2.69 | 14.41 |
| 13-Apr-97 | 0.68 | 0.25 | 6.48 | 3.96 | 3.22 | 14.58 |
| 14-Apr-97 | 1.59 | 0.27 | 7.70 | 6.43 | 4.75 | 20.74 |
| 15-Apr-97 | 1.10 | 0.20 | 7.43 | 6.89 | 4.20 | 19.82 |
| 16-Apr-97 | 0.63 | 0.32 | 40.63 | 2.98 | 1.00 | 45.55 |
| 17-Apr-97 | 0.67 | 0.31 | 3.23 | 4.96 | 1.84 | 11.00 |
| 18-Apr-97 | 0.58 | 0.28 | 19.61 | 7.90 | 2.77 | 31.14 |
| 19-Apr-97 | 0.56 | 0.60 | 6.07 | 5.03 | 6.71 | 18.98 |
| 20-Apr-97 | 0.71 | 0.83 | 6.60 | 4.56 | 1.60 | 14.30 |
| 21-Apr-97 | 0.50 | 0.80 | 7.82 | 5.15 | 5.13 | 19.41 |
| 22-Apr-97 | 0.68 | 0.57 | 9.77 | 4.31 | 2.14 | 17.47 |
| 23-Apr-97 | 0.55 | 0.35 | 14.22 | 9.81 | 1.70 | 26.63 |
| 24-Apr-97 | 0.49 | 0.41 | 14.84 | 11.47 | 3.04 | 30.25 |
| 25-Apr-97 | 0.18 | 0.25 | 3.27 | 14.58 | | 18.27 |
| 26-Apr-97 | | 0.22 | 7.25 | 6.86 | 1.75 | 16.08 |
| 27-Apr-97 | 0.33 | 0.37 | 4.70 | 5.24 | 2.68 | 13.33 |
| 28-Apr-97 | 0.80 | 0.63 | 8.55 | 5.59 | 2.57 | 18.14 |
| 29-Apr-97 | 0.56 | 0.66 | 7.39 | 5.76 | 2.29 | 16.66 |
| 30-Apr-97 | 0.75 | 0.77 | 12.77 | 6.17 | 2.18 | 22.64 |
| 01-May-97 | 1.08 | 2.68 | 5.82 | 7.83 | 2.30 | 19.70 |
| 02-May-97 | 0.40 | 1.21 | 7.99 | 12.00 | 2.25 | 23.84 |
| 03-May-97 | 1.04 | 0.46 | 10.96 | 8.33 | 1.36 | 22.16 |
| 04-May-97 | 1.27 | 0.55 | 11.27 | 7.80 | 0.98 | 21.86 |
| 05-May-97 | 2.21 | 0.62 | 18.04 | 8.05 | 1.38 | 30.30 |

| Date | Paper Machine 1&3 | 2 | 4 | 5 | 6 | TOT |
|---|---|---|---|---|---|---|
| 06-May-97 | 1.09 | 0.52 | 8.15 | 3.89 | 1.23 | 14.88 |
| 07-May-97 | 1.08 | 0.94 | 2.82 | 3.38 | 1.56 | 9.78 |
| 08-May-97 | 1.39 | 0.74 | 7.58 | 2.23 | 1.20 | 13.13 |
| 09-May-97 | 0.80 | 1.40 | 5.25 | 3.20 | 4.18 | 14.83 |
| 10-May-97 | 0.59 | 1.42 | 1.70 | 3.64 | 1.51 | 8.87 |
| 11-May-97 | 0.46 | 0.77 | 2.05 | 4.02 | 1.16 | 8.44 |
| 12-May-97 | 0.69 | 0.90 | 2.67 | 4.22 | 4.61 | 13.08 |
| 13-May-97 | 0.59 | 0.97 | 10.73 | 4.37 | 8.59 | 25.26 |
| 14-May-97 | 1.12 | 0.97 | 15.17 | 3.83 | 1.91 | 23.00 |
| 15-May-97 | 0.27 | 0.95 | 7.76 | 5.33 | 0.87 | 15.17 |
| 16-May-97 | 0.15 | 1.03 | 8.30 | 4.78 | 1.74 | 16.00 |
| 17-May-97 | 0.30 | 0.64 | 10.48 | 4.51 | 0.92 | 16.84 |
| 18-May-97 | 0.33 | 1.56 | 5.89 | 3.62 | 0.73 | 12.14 |
| 19-May-97 | 0.68 | | 12.98 | 6.07 | 2.64 | 22.37 |
| 20-May-97 | | 0.70 | 8.52 | 5.70 | 1.56 | 16.49 |
| 21-May-97 | 0.50 | 1.39 | 4.12 | 4.91 | 2.36 | 13.28 |
| 22-May-97 | 0.66 | 1.93 | 4.93 | 5.58 | 1.60 | 14.71 |
| 23-May-97 | 0.39 | 13.18 | 12.44 | 12.51 | 1.97 | 40.49 |
| 24-May-97 | 0.99 | 19.49 | 8.28 | 4.75 | 1.90 | 35.42 |
| 25-May-97 | 0.51 | 5.18 | 8.61 | 9.13 | 1.61 | 25.04 |
| 26-May-97 | 1.46 | 74.97 | 9.85 | 6.22 | 1.27 | 93.77 |
| 27-May-97 | 0.38 | 1.24 | 10.02 | 6.40 | 2.22 | 20.26 |
| 28-May-97 | 0.22 | 0.80 | 7.73 | 6.31 | 2.17 | 17.23 |
| 29-May-97 | 0.39 | 1.11 | 12.28 | 15.80 | 1.85 | 31.43 |
| 30-May-97 | 0.24 | 0.73 | 12.24 | 13.41 | 1.81 | 28.43 |
| 31-May-97 | 0.26 | 0.44 | 9.03 | 6.51 | 1.33 | 17.57 |
| 01-Jun-97 | 0.57 | 0.37 | 9.79 | 6.03 | 1.52 | 18.28 |
| 02-Jun-97 | 0.55 | 0.42 | 12.38 | 7.16 | 1.52 | 22.02 |
| 03-Jun-97 | 0.40 | 0.89 | 13.90 | 7.28 | 2.35 | 24.82 |
| 04-Jun-97 | 0.75 | 3.20 | 15.49 | 6.03 | 2.44 | 27.91 |
| 05-Jun-97 | 0.46 | 2.24 | 7.54 | 6.39 | 2.00 | 18.63 |
| 06-Jun-97 | 0.63 | 2.59 | 9.86 | 7.66 | 0.58 | 21.34 |
| 07-Jun-97 | 0.83 | 1.41 | 9.98 | 6.52 | 0.81 | 19.55 |
| 08-Jun-97 | 1.34 | 2.35 | 6.01 | 7.37 | 0.50 | 17.57 |
| 09-Jun-97 | 0.95 | 1.27 | 2.94 | 9.50 | 0.89 | 15.55 |
| 10-Jun-97 | 0.91 | 0.58 | 8.40 | 9.45 | 0.75 | 20.09 |
| 11-Jun-97 | 0.38 | 1.58 | 8.03 | 7.81 | 1.72 | 19.51 |
| 12-Jun-97 | 1.10 | 0.79 | 9.54 | 9.20 | 3.69 | 24.32 |
| 13-Jun-97 | 0.73 | 0.95 | 6.88 | 10.46 | 2.11 | 21.13 |
| 14-Jun-97 | 1.24 | 0.42 | 16.57 | 10.02 | 1.72 | 29.97 |
| 15-Jun-97 | 0.60 | 0.43 | 10.94 | 10.74 | 0.72 | 23.43 |
| 16-Jun-97 | 0.56 | 0.55 | 11.69 | 11.88 | 5.49 | 30.17 |
| 17-Jun-97 | 1.02 | 0.77 | 9.18 | 10.80 | 3.94 | 25.70 |
| 18-Jun-97 | 0.37 | 1.05 | 9.49 | 8.70 | 4.58 | 24.18 |
| 19-Jun-97 | 1.01 | 0.67 | 10.85 | 7.07 | 2.67 | 22.26 |
| 20-Jun-97 | 0.51 | 0.46 | 6.17 | 6.13 | 0.85 | 14.13 |
| 21-Jun-97 | 0.71 | 0.40 | 5.38 | 6.99 | 1.09 | 14.57 |
| 22-Jun-97 | 0.94 | 0.34 | 5.56 | 9.01 | 1.12 | 16.96 |
| 23-Jun-97 | 1.19 | 1.20 | 11.91 | 8.96 | 0.48 | 23.73 |

# USABLE FIBER DATABASE (cont'd)

| Date | Paper Machine | | | | | TOT |
|---|---|---|---|---|---|---|
| | 1&3 | 2 | 4 | 5 | 6 | |
| 24-Jun-97 | 0.69 | 0.98 | 20.80 | 9.72 | 1.93 | 34.12 |
| 25-Jun-97 | 1.25 | 0.48 | 13.65 | 6.75 | 1.34 | 23.47 |
| 26-Jun-97 | 1.31 | 0.57 | 8.65 | 7.50 | 3.01 | 21.05 |
| 27-Jun-97 | 0.46 | 0.74 | 7.43 | 4.56 | 1.10 | 14.29 |
| 28-Jun-97 | 1.38 | 0.50 | 9.85 | 5.76 | 2.80 | 20.28 |
| 29-Jun-97 | 0.98 | 0.78 | 10.42 | 11.78 | 1.69 | 25.65 |
| 30-Jun-97 | 1.30 | 0.39 | 11.06 | 16.04 | 1.14 | 29.92 |
| 01-Jul-97 | 1.05 | 0.63 | 9.21 | 5.64 | 1.68 | 18.20 |
| 02-Jul-97 | 1.11 | 0.75 | 10.39 | 4.93 | 2.01 | 19.20 |
| 03-Jul-97 | 0.98 | 0.63 | 9.93 | 3.63 | 1.58 | 16.75 |
| 04-Jul-97 | 1.49 | 0.49 | 9.59 | 5.13 | 1.78 | 18.47 |
| 05-Jul-97 | 1.27 | 0.76 | 4.74 | 7.88 | 1.89 | 16.54 |
| 06-Jul-97 | 1.21 | 0.52 | 8.12 | 8.99 | 2.84 | 21.68 |
| 07-Jul-97 | 0.70 | 0.46 | 20.76 | 9.36 | 2.48 | 33.76 |
| 08-Jul-97 | 0.54 | 0.45 | 12.55 | 7.86 | 1.03 | 22.43 |
| 09-Jul-97 | 0.47 | 0.49 | 6.45 | 8.91 | 2.08 | 18.40 |
| 10-Jul-97 | 0.51 | 0.40 | 12.59 | 8.37 | 2.74 | 24.61 |
| 11-Jul-97 | 0.41 | 0.78 | 5.92 | 8.15 | 2.26 | 17.52 |
| 12-Jul-97 | 0.37 | 0.55 | 7.68 | 11.45 | 2.56 | 22.61 |
| 13-Jul-97 | 0.46 | 0.69 | 8.84 | 6.63 | 6.74 | 23.36 |
| 14-Jul-97 | 1.05 | 0.60 | 5.52 | 5.15 | 3.75 | 16.08 |
| 15-Jul-97 | 0.71 | 0.67 | 9.30 | 16.56 | 3.56 | 30.80 |
| 16-Jul-97 | 0.60 | 0.42 | 15.25 | 10.74 | 5.37 | 32.38 |
| 17-Jul-97 | 0.65 | 0.25 | 12.49 | 10.12 | 4.17 | 27.68 |
| 18-Jul-97 | 0.70 | 0.34 | 8.02 | 11.06 | 6.22 | 26.34 |
| 19-Jul-97 | 0.94 | 0.33 | 6.00 | 5.76 | 1.87 | 14.89 |
| 20-Jul-97 | 0.51 | 0.28 | 6.17 | 12.24 | 6.39 | 25.59 |
| 21-Jul-97 | 1.22 | 0.23 | 8.51 | 10.58 | 2.86 | 23.39 |
| 22-Jul-97 | 0.38 | 0.20 | 7.62 | 4.97 | | 13.17 |
| 23-Jul-97 | 0.51 | 0.31 | 9.68 | 6.16 | 0.00 | 16.65 |
| 24-Jul-97 | 0.48 | 0.21 | 13.82 | 7.63 | 0.35 | 22.50 |
| 25-Jul-97 | 0.44 | 0.49 | 4.80 | 7.42 | 0.03 | 13.18 |
| 26-Jul-97 | 0.59 | 0.96 | 6.36 | 14.67 | 1.91 | 24.50 |
| 27-Jul-97 | 0.54 | 0.68 | 5.85 | 8.20 | 2.64 | 17.90 |
| 28-Jul-97 | 0.52 | 0.79 | 6.74 | 9.79 | 3.28 | 21.12 |
| 29-Jul-97 | 0.42 | 0.93 | 2.01 | 8.59 | 3.10 | 15.05 |
| 30-Jul-97 | 0.41 | 4.51 | 5.64 | 6.89 | 8.56 | 26.01 |
| 31-Jul-97 | 0.22 | 4.41 | 7.88 | 7.65 | 3.13 | 23.29 |
| 01-Aug-97 | 0.18 | 3.50 | 13.02 | 5.60 | 5.76 | 28.05 |
| 02-Aug-97 | 0.49 | 3.31 | 13.62 | 4.29 | 4.23 | 25.94 |
| 03-Aug-97 | 0.30 | 3.05 | 8.96 | 4.47 | 6.66 | 23.46 |
| 04-Aug-97 | 0.12 | 0.96 | 5.64 | 4.50 | 4.43 | 15.65 |
| 05-Aug-97 | 1.06 | 2.40 | 9.94 | 6.05 | 5.09 | 24.54 |
| 06-Aug-97 | 1.20 | 2.73 | 6.66 | 7.40 | 2.92 | 20.91 |
| 07-Aug-97 | 1.70 | 6.14 | 5.83 | 4.50 | 4.07 | 22.24 |
| 08-Aug-97 | 0.81 | 3.14 | 5.58 | 15.31 | 5.69 | 30.53 |
| 09-Aug-97 | 0.52 | 1.22 | 6.09 | 5.09 | 2.23 | 15.15 |
| 10-Aug-97 | 0.80 | 2.44 | 5.91 | 5.91 | 3.52 | 18.58 |
| 11-Aug-97 | 1.67 | 2.87 | 7.53 | 5.79 | 2.36 | 20.22 |

| Date | Paper Machine | | | | | TOT |
|---|---|---|---|---|---|---|
| | 1&3 | 2 | 4 | 5 | 6 | |
| 12-Aug-97 | 1.69 | 3.94 | 6.56 | 5.14 | 3.58 | 20.91 |
| 13-Aug-97 | 1.50 | 0.94 | 6.50 | 7.80 | 5.68 | 22.42 |
| 14-Aug-97 | 1.28 | 0.62 | 7.34 | 13.57 | 2.76 | 25.56 |
| 15-Aug-97 | 1.89 | 6.67 | 6.45 | 15.20 | 3.90 | 34.12 |
| 16-Aug-97 | 3.04 | 7.45 | 8.78 | 18.54 | 3.32 | 41.13 |
| 17-Aug-97 | 2.19 | 5.54 | 15.04 | 6.97 | 9.66 | 39.40 |
| 18-Aug-97 | 0.80 | 0.67 | 13.02 | 9.52 | 2.95 | 26.95 |
| 19-Aug-97 | 0.82 | 4.26 | 11.28 | 6.82 | 2.07 | 25.25 |
| 20-Aug-97 | 1.19 | 1.22 | 8.86 | 7.83 | 3.57 | 22.67 |
| 21-Aug-97 | 2.26 | 9.37 | 14.64 | 7.44 | 4.35 | 38.05 |
| 22-Aug-97 | 4.17 | 0.86 | 11.56 | 6.27 | 3.02 | 25.88 |
| 23-Aug-97 | 3.27 | 2.79 | 5.61 | 4.75 | 1.70 | 18.12 |
| 24-Aug-97 | 2.36 | 4.49 | 5.46 | 4.61 | 2.77 | 19.68 |
| 25-Aug-97 | 2.47 | 3.94 | 7.58 | 5.63 | 2.69 | 22.31 |
| 26-Aug-97 | 3.61 | 2.96 | 8.21 | 5.10 | 1.47 | 21.36 |
| 27-Aug-97 | 3.00 | 1.75 | 6.73 | 3.34 | 3.07 | 17.90 |
| 28-Aug-97 | 4.87 | 4.05 | 7.35 | 6.57 | 4.13 | 26.97 |
| 29-Aug-97 | | 3.50 | 9.92 | 7.45 | 1.47 | 22.33 |
| 30-Aug-97 | 1.34 | 3.47 | 14.77 | 6.69 | 5.07 | 31.34 |
| 31-Aug-97 | 0.75 | 1.87 | 10.66 | 11.27 | 14.23 | 38.79 |
| 02-Sep-97 | 0.03 | | | | 10.28 | 10.30 |
| 03-Sep-97 | 0.53 | | | | 3.92 | 4.45 |
| 04-Sep-97 | 0.83 | 1.01 | 0.48 | 5.04 | 12.41 | 19.76 |
| 05-Sep-97 | 0.77 | 4.15 | 2.54 | 4.13 | 8.41 | 20.00 |
| 06-Sep-97 | 1.37 | 3.56 | 4.59 | 6.12 | 3.29 | 18.92 |
| 07-Sep-97 | 0.39 | 1.53 | 17.94 | 10.25 | 2.36 | 32.47 |
| 08-Sep-97 | 1.50 | 2.58 | 6.87 | 6.10 | 1.68 | 18.74 |
| 09-Sep-97 | 1.09 | 1.62 | 6.49 | 3.13 | 2.45 | 14.78 |
| 10-Sep-97 | 0.43 | 2.01 | 8.45 | 2.35 | 2.52 | 15.76 |
| 11-Sep-97 | 1.51 | 1.97 | 7.87 | 3.66 | 3.73 | 18.74 |
| 12-Sep-97 | 1.11 | 2.90 | 5.15 | 6.90 | 2.98 | 19.04 |
| 13-Sep-97 | 1.07 | 1.61 | 6.41 | 7.45 | 2.94 | 19.48 |
| 14-Sep-97 | 2.28 | 1.73 | 8.52 | 6.55 | 3.41 | 22.50 |
| 15-Sep-97 | 1.23 | 1.04 | 18.56 | 7.94 | 4.70 | 33.46 |
| 16-Sep-97 | 1.38 | 1.50 | 17.65 | 6.68 | 2.74 | 29.96 |
| 17-Sep-97 | 0.50 | 1.89 | 11.35 | 7.46 | 4.45 | 25.66 |
| 18-Sep-97 | 0.41 | 1.12 | 8.64 | 6.90 | 4.62 | 21.68 |
| 19-Sep-97 | 1.23 | 1.20 | 33.61 | 7.10 | 4.27 | 47.40 |
| 20-Sep-97 | 1.02 | 0.83 | 13.75 | 10.95 | 3.98 | 30.52 |
| 21-Sep-97 | 0.91 | 0.95 | 8.41 | 4.49 | 4.21 | 18.97 |
| 22-Sep-97 | 0.85 | 0.87 | 13.77 | 3.86 | 2.35 | 21.69 |
| 23-Sep-97 | 0.99 | 1.01 | 10.80 | 3.21 | 1.82 | 17.83 |
| 24-Sep-97 | 1.24 | 0.62 | 8.46 | 2.13 | 1.87 | 14.32 |
| 25-Sep-97 | 0.78 | 0.81 | 8.89 | 1.80 | 2.27 | 14.55 |
| 26-Sep-97 | 0.76 | 44.49 | 3.06 | 3.10 | 0.57 | 51.98 |
| 27-Sep-97 | 2.26 | 1.34 | 5.22 | 4.07 | 0.52 | 13.41 |
| 28-Sep-97 | 1.34 | 0.50 | 4.40 | 4.04 | 0.80 | 11.09 |
| 29-Sep-97 | 1.58 | 0.70 | 11.23 | 4.14 | 0.46 | 18.11 |
| 30-Sep-97 | 1.66 | 0.84 | 7.76 | 3.36 | 0.52 | 14.13 |

# USABLE FIBER DATABASE (cont'd)

| Date | Paper Machine 1&3 | 2 | 4 | 5 | 6 | TOT |
|---|---|---|---|---|---|---|
| 01-Oct-97 | 2.25 | 1.41 | 5.24 | 4.60 | 0.36 | 13.86 |
| 02-Oct-97 | 2.11 | 1.07 | 4.12 | 1.99 | 0.34 | 9.63 |
| 03-Oct-97 | 1.56 | 1.32 | 4.42 | 3.47 | 0.62 | 11.39 |
| 04-Oct-97 | 1.01 | 0.39 | 3.92 | 3.33 | | 8.66 |
| 05-Oct-97 | 1.47 | 0.43 | 0.21 | 3.49 | 9.72 | 15.33 |
| 06-Oct-97 | 1.01 | 0.51 | 7.54 | 3.51 | 28.35 | 40.93 |
| 07-Oct-97 | 2.33 | 0.25 | 5.87 | 3.70 | 0.30 | 12.46 |
| 08-Oct-97 | 1.68 | 1.20 | 10.85 | 4.72 | 0.35 | 18.80 |
| 09-Oct-97 | 2.19 | 1.04 | 9.48 | 4.79 | 0.79 | 18.30 |
| 10-Oct-97 | 2.00 | 0.40 | 5.51 | 3.48 | 1.58 | 12.97 |
| 11-Oct-97 | 1.08 | 0.10 | 5.70 | 4.59 | 0.60 | 12.07 |
| 12-Oct-97 | 2.38 | 0.27 | 6.18 | 3.53 | 1.30 | 13.65 |
| 13-Oct-97 | 5.93 | 0.37 | 5.11 | 2.15 | 0.59 | 14.15 |
| 14-Oct-97 | 4.79 | 0.40 | 4.25 | 2.92 | 0.71 | 13.07 |
| 15-Oct-97 | 2.16 | 0.97 | 4.10 | 4.04 | 0.51 | 11.78 |
| 16-Oct-97 | 1.85 | 0.94 | 9.06 | 3.88 | 0.39 | 16.12 |
| 17-Oct-97 | 1.76 | 1.69 | 12.46 | 4.14 | 3.29 | 23.33 |
| 18-Oct-97 | 3.24 | 1.12 | 9.48 | 4.40 | 6.68 | 24.92 |
| 19-Oct-97 | 1.09 | 0.72 | 2.30 | 3.28 | 1.21 | 8.61 |
| 20-Oct-97 | 1.02 | 0.53 | 3.69 | 10.12 | 0.50 | 15.86 |
| 21-Oct-97 | 0.68 | 0.47 | 7.06 | 6.40 | 0.21 | 14.82 |
| 22-Oct-97 | 0.63 | 0.94 | 8.39 | 6.71 | 0.29 | 16.95 |
| 23-Oct-97 | 0.99 | 0.45 | 4.36 | 0.48 | 3.14 | 9.43 |
| 24-Oct-97 | 1.01 | 1.10 | 4.51 | 4.13 | 1.20 | 11.95 |
| 25-Oct-97 | 1.15 | 0.40 | 2.94 | 3.08 | 0.44 | 8.01 |
| 26-Oct-97 | 2.92 | 0.36 | 6.24 | 8.11 | 0.42 | 18.05 |
| 27-Oct-97 | 2.29 | 0.40 | 7.52 | 6.25 | 0.95 | 17.41 |
| 28-Oct-97 | 0.26 | 0.76 | 6.61 | 3.41 | 1.18 | 12.22 |
| 29-Oct-97 | 0.61 | 1.70 | 14.74 | 3.72 | 0.38 | 21.15 |
| 30-Oct-97 | 0.81 | 0.03 | 7.20 | 3.79 | 0.50 | 12.34 |
| 31-Oct-97 | 0.49 | 0.01 | 4.33 | 3.96 | 0.84 | 9.63 |
| 01-Nov-97 | 0.81 | 0.29 | 6.27 | 3.65 | 0.53 | 11.54 |
| 02-Nov-97 | 1.42 | 0.48 | 6.67 | 5.43 | 0.27 | 14.26 |
| 03-Nov-97 | 1.97 | 0.85 | 9.17 | 5.85 | 0.70 | 18.55 |
| 04-Nov-97 | 0.25 | 0.82 | 7.13 | 5.43 | 0.36 | 13.99 |
| 05-Nov-97 | 0.46 | 1.13 | 15.66 | 5.44 | 2.51 | 25.19 |
| 06-Nov-97 | 1.43 | 0.96 | 4.67 | 4.65 | 1.94 | 13.65 |
| 07-Nov-97 | 1.26 | 0.91 | 3.57 | 3.65 | 0.83 | 10.22 |
| 08-Nov-97 | 1.16 | 2.83 | 4.33 | 2.85 | 0.85 | 12.03 |
| 09-Nov-97 | 2.31 | 1.75 | 5.21 | 4.95 | 1.48 | 15.70 |
| 10-Nov-97 | 3.26 | 1.80 | 4.06 | 3.78 | 0.33 | 13.23 |
| 11-Nov-97 | 1.18 | 1.58 | 4.03 | 3.97 | 1.51 | 12.28 |
| 12-Nov-97 | 1.30 | 1.27 | 3.56 | 3.65 | 0.41 | 10.20 |
| 13-Nov-97 | 1.25 | 1.28 | 3.45 | 3.01 | 1.08 | 10.08 |
| 14-Nov-97 | 1.53 | 1.11 | | 3.60 | 1.05 | 7.29 |
| 15-Nov-97 | 1.49 | 2.25 | 4.05 | 1.54 | 0.68 | 10.01 |
| 16-Nov-97 | 1.92 | 3.08 | 3.98 | 1.35 | 1.20 | 11.53 |
| 17-Nov-97 | 2.80 | 2.56 | 3.16 | 1.91 | 1.29 | 11.71 |
| 18-Nov-97 | 2.40 | 2.41 | 9.97 | 2.36 | 1.62 | 18.76 |

| Date | Paper Machine 1&3 | 2 | 4 | 5 | 6 | TOT |
|---|---|---|---|---|---|---|
| 19-Nov-97 | 1.87 | 2.84 | 4.14 | 8.70 | 1.06 | 18.61 |
| 20-Nov-97 | 2.77 | 5.17 | 6.33 | 4.10 | 3.04 | 21.43 |
| 21-Nov-97 | 2.99 | 4.34 | 5.32 | 0.88 | 0.83 | 14.36 |
| 22-Nov-97 | 2.68 | 8.40 | 7.23 | 3.64 | 1.31 | 23.25 |
| 23-Nov-97 | 4.48 | 5.70 | 8.54 | 3.46 | 1.33 | 23.51 |
| 24-Nov-97 | 3.09 | 3.42 | 6.07 | 3.56 | 1.24 | 17.38 |
| 25-Nov-97 | 1.16 | 2.98 | 5.06 | 13.07 | 0.86 | 23.14 |
| 26-Nov-97 | 3.19 | 2.21 | 23.21 | 3.19 | 0.81 | 32.61 |
| 27-Nov-97 | 2.80 | 3.91 | 13.53 | 1.73 | 0.88 | 22.85 |
| 28-Nov-97 | 2.78 | 4.15 | 11.89 | 1.50 | 0.31 | 20.63 |
| 29-Nov-97 | 4.92 | 2.63 | 6.72 | 1.39 | 1.16 | 16.81 |
| 30-Nov-97 | 4.33 | 1.82 | 16.62 | 1.79 | 0.88 | 25.43 |
| 01-Dec-97 | 0.71 | 1.19 | 18.63 | 2.21 | 3.90 | 26.63 |
| 02-Dec-97 | 4.72 | 1.55 | 16.56 | 3.30 | 3.55 | 29.68 |
| 03-Dec-97 | 1.97 | 2.30 | 26.47 | 2.81 | 2.13 | 35.68 |
| 04-Dec-97 | 11.57 | 1.88 | 19.12 | 3.17 | 4.31 | 40.06 |
| 05-Dec-97 | 3.69 | 2.06 | 16.41 | 1.86 | 2.52 | 26.54 |
| 06-Dec-97 | 3.91 | 3.04 | 2.09 | 2.35 | 1.73 | 13.12 |
| 07-Dec-97 | 0.34 | 3.11 | 1.23 | 1.90 | 2.61 | 9.19 |
| 08-Dec-97 | 4.58 | 2.73 | 18.36 | 4.05 | 1.78 | 31.49 |
| 09-Dec-97 | 4.32 | 2.26 | 18.86 | 3.08 | 1.34 | 29.87 |
| 10-Dec-97 | 3.17 | 2.81 | 8.87 | 2.32 | 1.47 | 18.65 |
| 11-Dec-97 | 2.56 | | 11.77 | 3.00 | 2.00 | 19.32 |
| 12-Dec-97 | 7.22 | 0.25 | 7.19 | 2.41 | 2.67 | 19.74 |
| 13-Dec-97 | 7.75 | 0.72 | 5.27 | 6.14 | 2.86 | 22.74 |
| 14-Dec-97 | 3.56 | 0.02 | 14.02 | 4.27 | 2.31 | 24.19 |
| 15-Dec-97 | 2.43 | 2.95 | 13.11 | 1.25 | 0.81 | 20.54 |
| 16-Dec-97 | 1.23 | 2.30 | 11.93 | 3.52 | 1.06 | 20.04 |
| 17-Dec-97 | 0.82 | 3.30 | 18.91 | 1.94 | 1.24 | 26.21 |
| 18-Dec-97 | 2.85 | 1.73 | 25.90 | 2.01 | 0.41 | 32.89 |
| 19-Dec-97 | 2.08 | 1.17 | 34.39 | 2.30 | 1.32 | 41.26 |
| 20-Dec-97 | 3.16 | 2.76 | 19.68 | 5.98 | 2.03 | 33.61 |
| 21-Dec-97 | 4.41 | 9.49 | 27.43 | 11.52 | 3.36 | 56.20 |
| 22-Dec-97 | 2.75 | 2.92 | 23.44 | 8.74 | 0.98 | 38.83 |
| 23-Dec-97 | 2.83 | 1.73 | 29.54 | 5.65 | 1.66 | 41.41 |
| 24-Dec-97 | 1.85 | 13.76 | 13.59 | 6.30 | 1.56 | 37.06 |
| 25-Dec-97 | 3.72 | 18.43 | 13.80 | 8.70 | 1.35 | 45.99 |
| 26-Dec-97 | 3.34 | 4.34 | 9.25 | 6.28 | 1.03 | 24.25 |
| 27-Dec-97 | 3.33 | 3.37 | 5.20 | 4.08 | 1.01 | 16.98 |
| 28-Dec-97 | 4.65 | 3.89 | 4.08 | 3.57 | 1.02 | 17.21 |
| 29-Dec-97 | 4.49 | 18.59 | 5.45 | 4.14 | 0.38 | 33.05 |
| 30-Dec-97 | 3.23 | 8.55 | 15.74 | 4.45 | 0.40 | 32.37 |
| 31-Dec-97 | 2.95 | 24.86 | 7.27 | 4.68 | 0.77 | 40.53 |
| 01-Jan-98 | 7.29 | 5.93 | 6.74 | 5.14 | 1.42 | 26.53 |
| 02-Jan-98 | 4.29 | 22.22 | 16.33 | 3.53 | 1.39 | 47.75 |
| 03-Jan-98 | 5.83 | 39.41 | 6.82 | 3.59 | 1.13 | 56.79 |
| 04-Jan-98 | 4.22 | 11.42 | 6.00 | 4.75 | 0.99 | 27.38 |
| 05-Jan-98 | 4.33 | 3.08 | 3.96 | 2.99 | 1.17 | 15.53 |
| 06-Jan-98 | 2.33 | 1.89 | 5.45 | 5.16 | 0.56 | 15.40 |

# USABLE FIBER DATABASE (cont'd)

| Date | Paper Machine | | | | | TOT |
|---|---|---|---|---|---|---|
| | 1&3 | 2 | 4 | 5 | 6 | |
| 09-Jan-98 | 5.59 | 3.61 | 10.26 | 4.27 | 1.07 | 24.80 |
| 10-Jan-98 | 4.95 | 4.78 | 4.54 | 2.74 | 0.68 | 17.70 |
| 11-Jan-98 | 3.84 | 10.06 | 9.08 | 1.91 | 1.57 | 26.46 |
| 12-Jan-98 | 4.99 | 23.71 | 5.09 | 1.70 | 1.50 | 36.98 |
| 13-Jan-98 | 7.08 | 27.71 | 13.37 | 2.31 | 12.72 | 63.18 |
| 14-Jan-98 | 4.52 | 28.07 | 16.39 | 2.13 | 2.07 | 53.19 |
| 15-Jan-98 | 10.37 | 34.36 | 7.76 | 2.27 | 1.64 | 56.40 |
| 16-Jan-98 | 18.78 | 17.61 | 8.64 | 1.85 | 2.08 | 48.97 |
| 17-Jan-98 | 6.69 | 4.14 | 8.19 | 4.12 | 1.86 | 25.00 |
| 18-Jan-98 | 6.72 | 3.09 | 7.47 | 4.46 | 4.38 | 26.12 |
| 19-Jan-98 | 4.22 | 3.02 | 7.30 | 5.06 | 1.86 | 21.46 |
| 20-Jan-98 | 4.30 | 17.61 | 4.12 | 3.99 | 1.62 | 31.64 |
| 21-Jan-98 | 0.86 | 1.82 | 10.81 | 3.08 | 2.17 | 18.75 |
| 22-Jan-98 | 1.35 | 3.01 | 4.87 | 1.71 | 3.31 | 14.26 |
| 23-Jan-98 | 1.81 | 3.56 | 5.11 | 3.13 | 2.46 | 16.06 |
| 24-Jan-98 | 5.76 | 11.59 | 6.22 | 2.55 | 11.07 | 37.19 |
| 25-Jan-98 | 4.89 | 2.98 | 5.39 | 1.31 | 1.48 | 16.05 |
| 26-Jan-98 | 2.77 | 1.88 | 5.10 | 0.91 | 1.26 | 11.93 |
| 01-Feb-98 | 6.14 | 10.45 | 5.08 | 1.98 | 1.27 | 24.91 |
| 02-Feb-98 | 5.13 | 12.81 | 3.95 | 2.81 | 0.37 | 25.08 |
| 03-Feb-98 | 9.44 | 1.61 | 7.57 | 2.25 | 0.41 | 21.28 |
| 04-Feb-98 | 1.27 | 1.84 | 14.82 | 2.56 | 0.95 | 21.43 |
| 05-Feb-98 | 3.62 | 1.21 | 15.50 | 4.17 | 0.95 | 25.44 |
| 06-Feb-98 | 8.55 | 1.09 | 12.03 | 1.47 | 0.42 | 23.57 |
| 07-Feb-98 | 3.97 | 2.86 | 9.87 | 1.99 | 0.08 | 18.77 |
| 08-Feb-98 | | 7.21 | 12.06 | 2.50 | 0.65 | 22.42 |
| 09-Feb-98 | 5.01 | 15.60 | 10.98 | 1.04 | 1.43 | 34.06 |
| 10-Feb-98 | 5.02 | 30.06 | 5.35 | 1.34 | 1.04 | 42.81 |
| 11-Feb-98 | 5.75 | 2.99 | 4.91 | 1.08 | 1.00 | 15.73 |
| 12-Feb-98 | 10.49 | 3.03 | 11.19 | 0.95 | 0.48 | 26.14 |
| 13-Feb-98 | 10.25 | 3.73 | 15.27 | 1.48 | 1.63 | 32.37 |
| 14-Feb-98 | 14.99 | 2.04 | 10.58 | 2.01 | 1.88 | 31.50 |
| 15-Feb-98 | 7.14 | 1.60 | 17.62 | 4.21 | 1.22 | 31.79 |
| 16-Feb-98 | 9.50 | 1.25 | 14.16 | 2.04 | 0.52 | 27.46 |
| 17-Feb-98 | 2.65 | 1.82 | 13.03 | 1.85 | 1.20 | 20.56 |
| 18-Feb-98 | 5.45 | 1.91 | 22.97 | 6.36 | 1.22 | 37.91 |
| 19-Feb-98 | 7.77 | 4.22 | 18.35 | 2.05 | 1.57 | 33.95 |
| 20-Feb-98 | 8.76 | 3.13 | 17.22 | 1.85 | 1.73 | 32.69 |
| 21-Feb-98 | 8.61 | 2.27 | 8.55 | 2.04 | 1.24 | 22.71 |
| 22-Feb-98 | 11.00 | 1.86 | 8.33 | 1.56 | 1.01 | 23.76 |
| 23-Feb-98 | 11.10 | 2.35 | 9.81 | 2.38 | 1.65 | 27.28 |
| 24-Feb-98 | 7.69 | 2.50 | 15.39 | 2.76 | 2.35 | 30.68 |
| 25-Feb-98 | 7.12 | 2.77 | 18.74 | 5.89 | 1.62 | 36.14 |
| 26-Feb-98 | 8.79 | 2.10 | 23.65 | 2.01 | 3.05 | 39.60 |
| 27-Feb-98 | 9.14 | 2.45 | 22.22 | 2.17 | 1.54 | 37.52 |
| 28-Feb-98 | 9.43 | 1.72 | 23.67 | 2.56 | 1.43 | 38.80 |
| 01-Mar-98 | 6.07 | 3.57 | 14.40 | 2.05 | 2.12 | 28.22 |
| 02-Mar-98 | 5.68 | 2.57 | 7.85 | 1.9 | 6.95 | 24.95 |
| 03-Mar-98 | 5.40 | 1.52 | 5.40 | 1.25 | 1.20 | 14.77 |
| 04-Mar-98 | 4.45 | 1.79 | 15.85 | 2.47 | 3.06 | 27.61 |

| Date | Paper Machine | | | | | TOT |
|---|---|---|---|---|---|---|
| | 1&3 | 2 | 4 | 5 | 6 | |
| 05-Mar-98 | 3.73 | 2.38 | 21.91 | 1.16 | 1.25 | 30.43 |
| 06-Mar-98 | 3.77 | 2.44 | 24.09 | 2.03 | 1.83 | 34.16 |
| 07-Mar-98 | 8.73 | 1.90 | 25.88 | 2.93 | 1.54 | 40.98 |
| 08-Mar-98 | 9.12 | 3.91 | 19.84 | 3.83 | 1.67 | 38.36 |
| 09-Mar-98 | 4.57 | 3.36 | 23.98 | 2.14 | 2.81 | 36.85 |
| 10-Mar-98 | 2.77 | 4.75 | 11.66 | 3.46 | 1.84 | 24.47 |
| 11-Mar-98 | 3.32 | 9.75 | 1.76 | 1.16 | 6.78 | 22.77 |
| 12-Mar-98 | 3.22 | 5.68 | 29.05 | 1.59 | 0.34 | 39.88 |
| 13-Mar-98 | 2.28 | 2.34 | 43.52 | 3.28 | 1.11 | 52.53 |
| 14-Mar-98 | 3.06 | 1.53 | 38.52 | 4.96 | 1.18 | 49.24 |
| 15-Mar-98 | 2.37 | 4.58 | 16.78 | 6.07 | 1.93 | 31.74 |
| 16-Mar-98 | 3.56 | 2.56 | 29.12 | 4.42 | 0.37 | 40.03 |
| 17-Mar-98 | 2.23 | 1.25 | 26.52 | 2.12 | 0.62 | 32.74 |
| 18-Mar-98 | 6.85 | 3.46 | 20.72 | 6.30 | 3.19 | 40.52 |
| 19-Mar-98 | 11.11 | 1.16 | 20.12 | 7.37 | 1.53 | 41.29 |
| 20-Mar-98 | 5.93 | 2.94 | 9.59 | 6.83 | 2.50 | 27.79 |
| 21-Mar-98 | 7.51 | 10.39 | 35.03 | 7.82 | 2.73 | 63.48 |
| 22-Mar-98 | 4.51 | 10.30 | 28.23 | 1.30 | 2.00 | 46.33 |
| 23-Mar-98 | 7.29 | 18.74 | 32.49 | 1.62 | 2.75 | 62.90 |
| 24-Mar-98 | 2.29 | 8.95 | 33.82 | 3.81 | 1.80 | 50.66 |
| 25-Mar-98 | 2.44 | 3.38 | 17.02 | 2.19 | 0.35 | 25.39 |
| 26-Mar-98 | 3.50 | 2.38 | 18.47 | 1.26 | 11.03 | 36.64 |
| 27-Mar-98 | 5.70 | 9.50 | 34.59 | 2.00 | 0.93 | 52.72 |
| 28-Mar-98 | 6.94 | 3.35 | 26.58 | 3.05 | 1.00 | 40.92 |
| 29-Mar-98 | 8.90 | 8.75 | 19.31 | 2.70 | 2.10 | 41.76 |
| 30-Mar-98 | 1.69 | 12.39 | 26.33 | 3.08 | 2.61 | 46.10 |
| 31-Mar-98 | 1.39 | 36.64 | 24.35 | 3.66 | 2.21 | 68.25 |
| 01-Apr-98 | 1.33 | 9.26 | 22.84 | 3.49 | 2.45 | 39.37 |
| 02-Apr-98 | 1.13 | 7.97 | 7.22 | 1.66 | 1.62 | 19.60 |
| 03-Apr-98 | 1.86 | 10.40 | 13.31 | 1.92 | 1.31 | 28.80 |
| 04-Apr-98 | 0.93 | 13.29 | 4.88 | 3.75 | 1.36 | 24.20 |
| 05-Apr-98 | 0.61 | 8.82 | 2.34 | 1.49 | 1.33 | 14.60 |
| 06-Apr-98 | 3.17 | 6.93 | 5.83 | 2.05 | 2.41 | 20.38 |
| 07-Apr-98 | 5.26 | 9.39 | 5.85 | 3.93 | 1.90 | 26.33 |
| 08-Apr-98 | 5.14 | 8.97 | 7.05 | 2.70 | 1.36 | 25.22 |
| 09-Apr-98 | 2.31 | 2.64 | 35.79 | 1.46 | 0.61 | 42.82 |
| 10-Apr-98 | 2.37 | 2.08 | 15.75 | 2.09 | 1.36 | 23.64 |
| 11-Apr-98 | 4.62 | 2.08 | 26.23 | 2.42 | 1.82 | 37.17 |
| 12-Apr-98 | 1.39 | 1.36 | 10.91 | 1.47 | 0.56 | 15.69 |
| 13-Apr-98 | 2.10 | 1.35 | 14.26 | 1.08 | 2.26 | 21.05 |
| 14-Apr-98 | 1.34 | 4.72 | | 1.27 | 0.47 | 7.81 |
| 15-Apr-98 | 5.31 | 2.22 | 3.74 | 1.61 | 0.37 | 13.25 |
| 16-Apr-98 | 9.58 | 4.12 | 12.54 | 2.14 | 1.13 | 29.52 |
| 17-Apr-98 | 3.76 | 3.98 | 24.37 | 3.00 | 2.08 | 37.19 |
| 18-Apr-98 | 2.85 | 4.71 | 29.40 | 2.54 | 2.18 | 41.69 |
| 19-Apr-98 | 4.80 | 3.23 | 29.11 | 1.98 | 1.16 | 40.28 |
| 20-Apr-98 | 2.62 | 2.09 | 32.94 | 5.85 | 0.83 | 44.33 |
| 21-Apr-98 | 0.83 | 1.08 | 25.33 | 0.33 | 0.42 | 28.00 |
| 22-Apr-98 | 3.27 | 1.50 | 29.25 | 0.03 | 1.00 | 35.05 |

## Usable Fiber Data - PM Nos. 1&3

| Sample Location | Sample Number | Date | Time | Flow Data W (in) | D (in) | A ($ft^2$) | L (ft) | T (s) | V (fps) | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-1 | 1 | 7-Apr | 11:05 | 20 | 10 | 1.39 | 9 | 7 | 1.3 | 1.8 | 58 | 0.3 |
| | 2 | 8-Apr | 9:00 | 20 | 15 | 2.08 | 9 | 5 | 1.8 | 3.8 | 115 | 1.2 |
| | 3 | 9-Apr | 8:50 | 20 | 10 | 1.39 | 9 | 7 | 1.3 | 1.8 | 16 | 0.1 |
| 1-2 | 1 | 7-Apr | 13:10 | 20 | 7.5 | 1.04 | 9 | 6 | 1.5 | 1.6 | 4 | 0.0 |
| | 2 | 8-Apr | 14:15 | 20 | 14 | 1.94 | 9 | 6 | 1.5 | 2.9 | 2 | 0.0 |
| | 3 | 9-Apr | 10:55 | 20 | 7.5 | 1.04 | 9 | 6 | 1.5 | 1.6 | 16 | 0.1 |
| TTSSR | 1 | 5-May | 15:50 | | | vol. = | 0.51 | 18 | | 0.03 | 5342 | 0.4 |

# Usable Fiber Data - PM No. 4

| Sample Location | Sample Number | Date | Time | BK | Flow Data W (in) | D (in) | A ($ft^2$) | L (ft) | T (s) | V (fps) | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-1 | 1 | 2-Apr | 1045 | | 15 | 3 | 0.31 | 8 | 7 | 1.1 | 0.4 | 552 | 0.5 |
| | 2 | 3-Apr | 0845 | | 15 | 3 | 0.31 | 8 | 7 | 1.1 | 0.4 | 492 | 0.5 |
| | 3 | 4-Apr | 1130 | | 15 | 3 | 0.31 | 8 | 7 | 1.1 | 0.4 | 1383 | 1.3 |
| 4-3 | 1 | 2-Apr | 1250 | | 15 | 5 | 0.52 | 8 | 6 | 1.3 | 0.7 | 1790 | 3.4 |
| | 2 | 3-Apr | 1050 | | 15 | 4 | 0.42 | 8 | 6 | 1.3 | 0.6 | 2081 | 3.1 |
| | 3 | 4-Apr | 13:35 | | 15 | 6 | 0.63 | 8 | 5.5 | 1.5 | 0.9 | 2048 | 5.0 |
| 4-5 | 1 | 19-Mar | - | X | 16 | 12 | 1.33 | 8 | 10 | 0.8 | 1.1 | 4500 | 12.9 |
| | 2 | 30-Apr | 12:20 | X | 16 | 13 | 1.44 | 12 | 25 | 0.5 | 0.7 | 5502 | 10.3 |
| | 3 | 1-May | 10:22 | | 16 | 9.5 | 1.06 | 12 | 15 | 0.8 | 0.8 | 4108 | 9.4 |
| | 4 | 1-May | 14:30 | | 16 | 10 | 1.11 | 12 | 54.5 | 0.2 | 0.2 | 3046 | 2.0 |
| 4-6 | 1 | 3-Apr | 12:55 | | 15 | 10 | 1.04 | 12 | 10.5 | 1.1 | 1.2 | 4066 | 13.1 |
| | 2 | 4-Apr | 9:25 | | 15 | 9 | 0.94 | 12 | 11 | 1.1 | 1.0 | 3000 | 8.3 |
| | 3 | 6-Apr | 15:00 | | 15 | 9 | 0.94 | 12 | 10.5 | 1.1 | 1.1 | 3528 | 10.2 |
| | 4 | 7-Apr | 15:30 | | 15 | 11 | 1.15 | 12 | 10 | 1.2 | 1.4 | 4266 | 15.8 |
| | 5 | 19-Mar | - | X | 15 | 15 | 1.56 | 8 | 50 | 0.2 | 0.3 | 3783 | 2.6 |
| | 6 | 20-Mar | - | X | 15 | 12 | 1.25 | 8 | 7 | 1.1 | 1.4 | 4883 | 18.8 |
| | 7 | 30-Apr | 11:15 | X | 15 | 12.5 | 1.3 | 8 | 7 | 1.1 | 1.5 | 4771 | 19.1 |
| | 8 | 1-May | 13:15 | | 15 | 11 | 1.15 | 12 | 9 | 1.3 | 1.5 | 4098 | 16.9 |
| | 9 | 1-May | 15:45 | | 15 | 11 | 1.15 | 10 | 9.5 | 1.1 | 1.2 | 3335 | 10.8 |
| 4-7 | 1 | 6-Apr | 17:05 | | 12 | 2 | 0.17 | 7 | 7 | 1.0 | 0.2 | 4510 | 2.0 |
| | 2 | 7-Apr | 8:45 | | 12 | 2 | 0.17 | 7 | 7 | 1.0 | 0.2 | 3950 | 1.8 |
| | 3 | 8-Apr | 16:30 | | 12 | 2 | 0.17 | 7 | 7 | 1.0 | 0.2 | 5004 | 2.2 |
| | 4 | 9-Apr | 13:05 | | 12 | 2 | 0.17 | 7 | 7 | 1.0 | 0.2 | 6327 | 2.8 |
| | 5 | 30-Apr | 13:30 | | 12 | 3 | 0.25 | 12 | 15 | 0.8 | 0.2 | 4914 | 2.7 |

# Usable Fiber Data - PM No. 5

| Sample Location | Sample Number | Date | Time | Flow Data W (in) | D (in) | A ($ft^2$) | L (ft) | T (s) | V (fps) | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-1 | 1 | 19-Mar | - | 16 | 6.5 | 0.72 | 7 | 4.5 | 1.6 | 1.1 | 3802 | 11.5 |
| 5-2 | 1 | 20-Mar | - | 11 | 5 | 0.38 | 8 | 4 | 2.0 | 0.8 | 4142 | 8.5 |
| 5-3 | 1 | 21-Mar | - | 11 | 3.5 | 0.27 | 8 | 8 | 1.0 | 0.3 | 4378 | 3.2 |
| 5-4 | 1 | 2-Apr | 15:00 | 17.5 | 2.5 | 0.3 | 8 | 9.5 | 0.8 | 0.3 | 913 | 0.6 |
| | 2 | 3-Apr | 17:15 | 17.5 | 6 | 0.73 | 12 | 20 | 0.6 | 0.4 | 1058 | 1.2 |
| | 3 | 4-Apr | 17:45 | 17.5 | 4 | 0.49 | 12 | 24 | 0.5 | 0.2 | 1060 | 0.7 |
| | 4 | 19-Mar | - | 17.5 | 7 | 0.85 | 12 | 8.5 | 1.4 | 1.2 | 3771 | 12.2 |
| | 5 | 30-Apr | 15:55 | 17.5 | 10 | 1.22 | 12 | 6 | 2.0 | 2.4 | 2555 | 16.7 |
| | 6 | 1-May | 7:55 | 17.5 | 5.5 | 0.67 | 12 | 23 | 0.5 | 0.3 | 2066 | 1.9 |
| 5-5 | 1 | 2-Apr | 17:05 | 17.5 | 9 | 1.09 | 12 | 16 | 0.8 | 0.8 | 261 | 0.6 |
| | 2 | 3-Apr | 15:10 | 17.5 | 9 | 1.09 | 12 | 11 | 1.1 | 1.2 | 205 | 0.7 |
| | 3 | 4-Apr | 15:40 | 17.5 | 8.5 | 1.03 | 12 | 20 | 0.6 | 0.6 | 523 | 0.9 |
| | 4 | 5-Apr | 14:45 | 17.5 | 9 | 1.09 | 12 | 18 | 0.7 | 0.7 | 869 | 1.7 |
| | 5 | 20-Mar | - | 17.5 | 7.5 | 0.91 | 12 | 11.5 | 1.0 | 1.0 | 3421 | 8.8 |
| | 6 | 30-Apr | 14:50 | 17.5 | 10.5 | 1.28 | 12 | 11 | 1.1 | 1.4 | 4021 | 15.1 |
| | 7 | 1-May | 9:10 | 17.5 | 8.5 | 1.03 | 12 | 21 | 0.6 | 0.6 | 839 | 1.3 |

## Usable Fiber Data - PM No. 6

| Sample Location | Sample Number | Date | Time | Flow Data W (in) | D (in) | A ($ft^2$) | L (ft) | T (s) | V (fps) | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-2 | 1 | 2-Apr | 8:30 | 20 | 2.5 | 0.35 | 10 | 17.5 | 0.6 | 0.2 | 303 | 0.2 |
| | 2 | 5-Apr | 12:35 | 20 | 3 | 0.42 | 10 | 21.5 | 0.5 | 0.2 | 631 | 0.3 |
| | 3 | 6-Apr | 15:00 | 20 | 3.5 | 0.49 | 10 | 15.5 | 0.6 | 0.3 | 320 | 0.3 |
| 6-3 | 1 | 1-Apr | 15:40 | 20 | 3.5 | 0.49 | 7.5 | 3 | 2.5 | 1.2 | 91 | 0.3 |
| | 2 | 5-Apr | 10:30 | 20 | 3 | 0.42 | 10 | 5 | 2.0 | 0.8 | 45 | 0.1 |
| | 3 | 6-Apr | 10:45 | 20 | 3.5 | 0.49 | 10 | 6 | 1.7 | 0.8 | 75 | 0.2 |
| | 4 | 9-Apr | 15:20 | 20 | 3 | 0.42 | 10 | 5 | 2.0 | 0.8 | 165 | 0.4 |
| 6-5 | 1 | 6-Apr | 12:50 | 20 | 9 | 1.25 | 10 | 6 | 1.7 | 2.1 | 27 | 0.2 |

# Usable Fiber Data - Sewered Cleaner Reject

| Sample Location | Sample Number | Date | Time | Flow Data W (in) | D (in) | A ($ft^2$) | L (ft) | T (s) | V (fps) | Bucket Volume ($ft^3$) | Flow (cfs) | Usable Fiber (ppm) | Mass Loading (tons/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PM3 $T_R$ | 98 | 4-May | 9:25 | 12 | 3 | 0.25 | 12 | 15 | 0.8 | | 0.2 | 5500 | 3.0 |
| | 102 | 4-May | 13:25 | 12 | 3 | 0.25 | 12 | 15 | 0.8 | | 0.2 | 4436 | 2.4 |
| | 106 | 4-May | 15:15 | | | | | | | | 0.2 | 4884 | 2.6 |
| PM4 $S_R$ | 99 | 4-May | 9:40 | 16<br>15 | 9.5<br>11.5 | 1.06<br>1.2 | 12<br>10 | 44<br>7.5 | 0.27<br>1.33 | | 1.9 | 4524 | 23.0 |
| | 103 | 4-May | 13:30 | 16<br>15 | 10.5<br>11.5 | 1.17<br>1.2 | 12<br>10 | 50<br>7.5 | 0.24<br>1.33 | | 1.9 | 4021 | 20.4 |
| | 107 | 4-May | 15:15 | | | | | | | | 1.9 | 5707 | 29.2 |
| PM5 $T_R$ | 100 | 4-May | 9:20 | | | | | 21 | | 1.08 | 0.05 | 4814 | 0.7 |
| | 104 | 4-May | 13:20 | | | | | 21 | | 1.08 | 0.05 | 5532 | 0.8 |
| | 108 | 4-May | 15:20 | | | | | | | | 0.05 | 6640 | 0.9 |
| PM6 $T_R$ | 101 | 4-May | 9:15 | | | | | 95 | | 1.17 | 0.01 | 3447 | 0.1 |
| | 105 | 4-May | 13:15 | | | | | 95 | | 1.17 | 0.01 | 2202 | 0.1 |
| | 109 | 4-May | 15:20 | | | | | | | | 0.01 | 2791 | 0.1 |

# Dirt Content Analysis - PM No. 3

| Sample Location | Date | Time | S | GS (g/L) | Volume for 2g (L) | Sample Number | Handsheet Weight (g) | EBA (ppm) | EBA - Ave (ppm) | Dirt Content (Norm to GS) |
|---|---|---|---|---|---|---|---|---|---|---|
| PM3 $P_{IN}$ | 7-Apr | 8:30 | | 9.86 | 0.203 | 40.1 | 2.17 | 18 | 8 | 1 |
| | | | | | | 40.2 | 2.20 | 5 | | |
| | | | | | | 40.3 | 2.15 | 3 | | |
| | | | | | | 40.4 | 2.18 | 7 | | |
| PM3 $P_A$ | 7-Apr | 8:30 | | 8.92 | 0.224 | 41.1 | 2.23 | 2 | 9 | 1 |
| | | | | | | 41.2 | 2.28 | 16 | | |
| PM3 $P_R$ | 7-Apr | 8:30 | | 6.25 | 0.320 | 42.1 | 2.05 | 8 | 6 | 1 |
| | | | | | | 42.2 | 2.03 | 2 | | |
| | | | | | | 42.3 | 2.31 | 7 | | |
| PM3 $S_A$ | 7-Apr | 8:30 | | 5.59 | 0.358 | 43.1 | 2.31 | 7 | 10 | 2 |
| | | | | | | 43.2 | 2.29 | 12 | | |
| PM3 $S_R$ | 7-Apr | 8:30 | | 3.46 | 0.578 | 44.1 | 2.24 | 18 | 18 | 5 |
| PM3 $T_A$ | 7-Apr | 8:30 | | 3.21 | 0.623 | 45.1 | 2.11 | 6 | 6 | 2 |
| PM3 $T_R$ | 7-Apr | 8:30 | X | 6.02 | 0.332 | 46.1 | 2.41 | 112 | 91 | 15 |
| | | | | | | 46.2 | 2.45 | 70 | | |
| | 1-May | 16:45 | X | 7.24 | 0.276 | 62.1 | 2.35 | 99 | 99 | 14 |
| | 2-May | 5:00 | X | 7.78 | 0.257 | 65.1 | 2.22 | 85 | 85 | 11 |
| | 2-May | 5:55 | X | 7.44 | 0.269 | 67.1 | 1.98 | 104 | 104 | 14 |
| | 2-May | 6:50 | X | 6.84 | 0.292 | 69.1 | 2.10 | 77 | 77 | 11 |
| | 2-May | 7:30 | X | 7.54 | 0.265 | 71.1 | 2.05 | 68 | 68 | 9 |
| | 2-May | 8:20 | X | 7.79 | 0.257 | 73.1 | 2.06 | 82 | 82 | 11 |
| | 2-May | 9:00 | X | 7.44 | 0.269 | 75.1 | 2.77 | 84 | 84 | 11 |
| | 2-May | 10:00 | X | 8.1 | 0.247 | 77.1 | 2.21 | 77 | 77 | 10 |
| | 2-May | 11:00 | X | 8.59 | 0.233 | 79.1 | 2.05 | 94 | 94 | 11 |
| | 2-May | 12:00 | X | 8.2 | 0.244 | 81.1 | 1.86 | 81 | 81 | 10 |
| | 2-May | 13:00 | X | 8.61 | 0.232 | 83.1 | 2.11 | 101 | 101 | 12 |
| | 2-May | 14:10 | X | 7.24 | 0.276 | 85.1 | 2.10 | 114 | 114 | 16 |
| | 2-May | 15:00 | X | 7.11 | 0.281 | 87.1 | 2.98 | 79 | 79 | 11 |
| | 2-May | 16:00 | X | 7.61 | 0.263 | 89.1 | 1.99 | 80 | 80 | 11 |
| | 2-May | 17:00 | X | 6.62 | 0.302 | 91.1 | 2.20 | 95 | 95 | 14 |
| | 2-May | 18:00 | X | 7.18 | 0.279 | 93.1 | 2.15 | 94 | 94 | 13 |
| | 4-May | 8:35 | X | 7.14 | 0.280 | 94.1 | 2.18 | 94 | 94 | 13 |

S = Flow Being Sewered

# Dirt Content Analysis - PM No. 4

| Sample Location | Date | Time | BK | S | GS (g/L) | Volume for 2g (L) | Sample Number | Handsheet Weight (g) | EBA (ppm) | EBA - Ave (ppm) | Dirt Content (Norm to GS) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PM4 $S_R$ | 2-Apr | 10:45 | | | 5.57 | 0.359 | 5.1<br>5.2 | -<br>- | 66<br>64 | 65 | 12 |
| | 3-Apr | 14:35 | | X | 6.64 | 0.301 | 19.1<br>19.2<br>19.3 | 2.49<br>2.44<br>2.49 | 36<br>21<br>11 | 23 | 3 |
| | 4-Apr | 8:50 | | X | 5.89 | 0.340 | 24.1<br>24.2 | 2.15<br>2.16 | 7<br>10 | 9 | 1 |
| | 6-Apr | 8:00 | | X | 6.68 | 0.299 | 34.1<br>34.2<br>34.3 | 2.22<br>2.25<br>2.17 | 30<br>33<br>21 | 28 | 4 |
| | 30-Apr | 11:30 | X | X | 7.21 | 0.277 | 60.1 | 2.45 | 18 | 18 | 2 |
| | 1-May | 10:30 | | X | 6.25 | 0.320 | 61.1 | 2.35 | 22 | 22 | 4 |
| | 2-May | 5:00 | | X | 8.45 | 0.237 | 64.1 | 2.20 | 17 | 17 | 2 |
| | 2-May | 5:55 | | X | 7.82 | 0.256 | 66.1 | 2.28 | 24 | 24 | 3 |
| | 2-May | 6:50 | | X | 7.11 | 0.281 | 68.1 | 2.18 | 24 | 24 | 3 |
| | 2-May | 7:30 | | X | 6.99 | 0.286 | 70.1 | 2.44 | 29 | 29 | 4 |
| | 2-May | 8:20 | | X | 7.74 | 0.258 | 72.1 | 2.25 | 13 | 13 | 2 |
| | 2-May | 9:00 | | X | 7.47 | 0.268 | 74.1 | 2.34 | 18 | 18 | 2 |
| | 2-May | 10:00 | | X | 9.4 | 0.213 | 76.1 | 2.18 | 22 | 22 | 2 |
| | 2-May | 11:00 | | X | 9.18 | 0.218 | 78.1 | 2.20 | 33 | 33 | 4 |
| | 2-May | 12:00 | | X | 8.83 | 0.227 | 80.1 | 2.05 | 29 | 29 | 3 |
| | 2-May | 13:00 | | X | 8.4 | 0.238 | 82.1 | 2.40 | 25 | 25 | 3 |
| | 2-May | 14:10 | | X | 8.98 | 0.223 | 84.1 | 2.36 | 25 | 25 | 3 |
| | 2-May | 15:00 | | X | 8.08 | 0.248 | 86.1 | 2.37 | 27 | 27 | 3 |
| | 2-May | 16:00 | | X | 8.36 | 0.239 | 88.1 | 2.48 | 16 | 16 | 2 |
| | 2-May | 17:00 | | X | 6.57 | 0.304 | 90.1 | 2.55 | 8 | 8 | 1 |
| | 2-May | 18:00 | | X | 7.93 | 0.252 | 92.1 | 2.34 | 22 | 22 | 3 |
| | 4-May | 8:35 | | X | 8.61 | 0.232 | 95.1 | 2.28 | 27 | 27 | 3 |
| N. Trough | 5-May | 9:00 | | X | 6.99 | 0.286 | 110 | 2.35 | 26 | 26 | 4 |
| S. Trough | 5-May | 9:00 | | X | 8.07 | 0.248 | 111 | 2.48 | 31 | 31 | 4 |
| PM4 $T_R$ | 1-Apr | 16:00 | X | X | 3.17 | 0.631 | 2.1<br>2.2 | -<br>2.25 | 109<br>148 | 129 | 41 |
| | 2-Apr | 10:45 | | | 3.76 | 0.532 | 6.1 | - | 147 | 147 | 39 |
| | 4-Apr | 8:50 | | X | 5.9 | 0.339 | 25.1<br>25.2 | 2.42<br>2.41 | 18<br>15 | 17 | 3 |
| PM4 $Q_R$ | 2-Apr | 10:45 | | X | 1.38 | 1.449 | 7.1 | * Unable to make 2g handsheet w/ 1 L sample | | | |
| | 3-Apr | 15:30 | | X | 0.09 | 22.222 | 21.1 | * Unable to make 2g handsheet w/ 1 L sample | | | |
| | 9-Apr | 8:20 | | X | 0.91 | 2.198 | 53.1 | 2.37 | 204 | 204 | 224 |

BK = Brwon Kraft Grade
S = Flow Being Sewered

# Dirt Content Analysis - PM No. 5

| Sample Location | Date | Time | S | DF | GS (g/L) | Volume for 2g (L) | Sample Number | Handsheet Weight (g) | EBA (ppm) | EBA - Ave (ppm) | Dirt Content (Norm to GS) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PM5 $S_R$ | 2-Apr | 10:45 | | 1 | 8.48 | 0.236 | 8.1 | 2.39 | 57 | 49 | 6 |
| | | | | | | | 8.2 | 2.21 | 48 | | |
| | | | | | | | 8.3 | 2.24 | 46 | | |
| | | | | | | | 8.4 | 2.31 | 43 | | |
| PM5 $T_R$ | 2-Apr | 10:45 | X | 1 | 3.89 | 0.514 | 9.1 | 1.80 | ** | ** | ** |
| | 1-May | 11:30 | X | 1 | 11.37 | 0.176 | 63.1 | 2.5 | ** | ** | ** |
| | 4-May | 8:40 | X | 1 | 8.55 | 0.234 | 96.1 | 2.75 | ** | ** | ** |
| PTSSP | 5-May | 15:37 | X | 2 | 16.49 | 0.121 | 112 | 1.87 | ** | ** | ** |
| STSSP | 5-May | 15:39 | X | 2 | 15.38 | 0.130 | 114 | 1.65 | ** | ** | ** |

S = Flow Being Sewered
** = Extremely High Dirt Content

# Dirt Content Analysis - PM No. 6

| Sample Location | Date | Time | S | GS (g/L) | Volume for 2g (L) | Sample Number | Handsheet Weight (g) | EBA (ppm) | EBA - Ave (ppm) | Dirt Content (Norm to GS) |
|---|---|---|---|---|---|---|---|---|---|---|
| PM6 SR | 2-Apr | 10:45 | | 8.68 | 0.230 | 10.1 | 2.03 | 39 | 33 | 4 |
| | | | | | | 10.2 | 2.12 | 26 | | |
| | | | | | | 10.3 | 2.16 | 24 | | |
| | | | | | | 10.4 | 2.10 | 42 | | |
| PM6 TR | 2-Apr | 10:45 | X | 9.07 | 0.221 | 11.1 | 1.32 | ** | ** | ** |
| | | | | | | 11.2 | 1.17 | ** | | |
| | | | | | | 11.3 | 1.30 | ** | | |
| | | | | | | 11.4 | 1.70 | ** | | |
| | 4-May | 8:40 | X | 7.71 | 0.259 | 97.1 | 1.50 | ** | ** | ** |

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