ENERGY EFFICIENT PAPER MILL PROCESS WATER AND WASTED PROCESS WATER FILTRATION FOR HIGH CLARITY WATER FOR REUSE AND FIBER RECOVERY

FINAL REPORT 06-09
OCTOBER 2006

NEW YORK STATE
ENERGY RESEARCH AND
DEVELOPMENT AUTHORITY

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Disclaimer:

Jannanco, LLC has prepared this report based upon the extensive mill trials conducted at the SCA North America Tissue Division Mill in South Glens Falls, New York. This program could not have been completed without the overwhelming willingness on the part of the management and staff of SCA Tissue Company to assist in its success. However, the data provided in this report is based upon the performance of the Jannanco, LLC process and equipment performance. The calculations regarding system capacities, mill product and grade mixes, capital costs and cost recovery are based upon legitimate but theoretical equipment configurations that were developed from the evaluation of the data. The calculations and results are in no way intended to represent any aspects of the business or plant operations of the SCA Tissue Company.

Keywords

Filtration, papermaking, energy recovery, process water, white water recovery, fiber recovery, high clarity

Abstract

Jannanco, LLC, in conjunction with the NYSERDA and the Pulp and Paper Dept. of SUNY ESF at Syracuse University, completed exhaustive pilot trial work on "filterdynamic™" technology for the ultra clarification of process whitewater for reuse in place of fresh water. The pilot confirmed the technology's ability to cost-effectively and consistently remove particulate down to 3 to 7 microns in size. Technology modularity lends itself to flows from 10 to 500 GPM. The pilot work demonstrated that the technology may be easily applied to the full range of paper and board-making industries prevalent throughout the United States and internationally. Most equipment configurations evaluated yielded a simple Return on Investment of approximately 33 percent based solely upon potential recovered thermal energy. Scalable energy savings are in the range of $250,000 per year for each 100 gallons per minute of water recovered. Additional potential benefits include the value of the recovered fiber for reuse as raw material, the reduction in operations and maintenance costs at a mill's wastewater treatment plant due to lower wastewater flows, the potential productivity improvement available from running mill processes at desired elevated temperatures, and the avoided power and maintenance costs associated with a mill's existing water recovery technologies. These values are typically site specific but may provide additional savings toward the overall Return on Investment well in excess of $100,000 per year for each 100 gallons per minute of water recovered.

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- The New York State Energy Research and Development Authority (NYSERDA)
- The management, staff, and operating personnel of the SCA North America Tissue Division Mill in South Glens Falls, New York
- The faculty, staff, and student body of the Paper Science and Engineering Department at the State University of New York College of Environmental Science and Forestry
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Summary

Jannanco, LLC, in conjunction with the Paper Science and Engineering College at Syracuse University; the Empire State Paper Research Institute and the New York State Energy Research and Development Authority (NYSERDA) has successfully completed demonstration trials for the ultra-filtration of paper making process and wastewater using "active filtration"[1] filtration technology. The host for these trials was SCA North America Tissue Division mill located in South Glens Falls, N Y. The overall objective of the trials was to demonstrate the technology's ability to reliably and cost-effectively filter thermally rich process water to replace the use of cooler or cold, fresh water in critical and non-critical mill applications.

Various mill process streams were investigated to prove the technology's ability to satisfy the trial objectives. The pilot work demonstrated that the technology may be easily applied to the full range of paper and board-making industries prevalent throughout the United States and internationally. Most equipment configurations evaluated yielded a simple return on investment of approximately 33 percent, based solely upon potential recovered thermal energy. Scalable energy savings are in the range of $250,000 per year for each 100 gallons per minute of water recovered. Additional potential benefits include the value of the recovered fiber for reuse as raw material, the reduction in operations and maintenance costs at a mill's wastewater treatment plant due to lower wastewater flows, the potential productivity improvement available from running mill processes at desired elevated temperatures, and the avoided power and maintenance costs associated with a mill's existing water recovery technologies. These values are typically site specific but may provide additional savings toward the overall Return on Investment well in excess of $100,000 per year for each 100 gallons per minute of water recovered.

In parallel with the in-mill pilot trial, The State University of New York, College of Environmental Science and Forestry (SUNY ESF), Department of Pulp and Paper Science and Engineering conducted extensive laboratory analyses. Through this work, a direct correlation was demonstrated between the characteristics of the feed slurry to the filter, and the actual flow rate capacity of the active filtration technology under plant conditions. This direct correlation has the potential to be a significant aid to mills considering implementation of this technology as it provides scalable data on likely mill performance based upon testing of laboratory scale samples.

To summarize, the demonstration trials confirmed the active filtration technology's ability to consistently, cost-effectively recycle large volumes of thermally rich papermaking process water. The cost savings associated with recovery of this thermal energy allows for a normalized return of investment of approximately 33 percent per year allowing for complete recovery of the capital investment in three years.

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[1] The "active filtration" technology is marketed throughout Europe by Idee e Prodotti of Milan, It. under the trade name of "Squeeze Box". Jannanco, LLC is the US distributor for this technology.

The hardware associated with the technology can be readily engineered to specific applications from the process data generated by this demonstration trial. The technology itself, because of its modularity and compact footprint, can be easily retrofitted into nearly any existing manufacturing setting. Its deployment results in immediate monetary savings and increased competitiveness in nearly any aspect of the paper and board-making industries.

The most basic environmental benefits from the application of the technology are that of avoiding combustion of fossil fuels and from reduced wastewater generation. The avoided fossil fuel combustion mitigates the creation of significant quantities of criteria air pollutants and thousands of tons per year of the greenhouse gas, carbon dioxide.

From the initial market research, it is anticipated that at least 10 to 15 pulp and paper mills in New York State have readily cost justified needs for this technology. In particular, with the onset of increased energy pricing, the benefits of this technology to the New York State mills will accelerate.

Glossary Of Terms

AFU acronym for (Active Filtration Unit): One Standard Unit of Filtration equivalent to one vertical meter of filtration tower height.

Ash: The inorganic portion of paper making process water

Btu: British Thermal Unit – the amount of energy required to raise one pound of water one degree Fahrenheit

Consistency: The concentration of dry matter in a pulp slurry reported as a percentage

Decatherm: Ten therms

NO_X: Oxides of Nitrogen (As used in this report, from industrial boilers)

Product Grade: This is an industry term that refers to a particular product type.

RACT: Reasonably Achievable Control Technology – as used in this report – standards set by the United States Environmental Protection Agency and State of New York limiting emissions of oxides of nitrogen from combustion installations

Therm: 100,000 Btu's

Stock: This is a colloquial term used throughout the paper industry to refer to a slurry of pulp

Sweetener: Medium consistency stock slurry from the process that is used as a filtration aid for conventional white water recovery equipment.

Whitewater: Within a paper mill process water that contains small percentages of pulp fibers and other raw materials is referred to as "whitewater". Typically, if the percentage is in the range of 0.75% or greater it is referred to as "rich" whitewater. If the percentage is below that range it is typically referred to as "lean" whitewater.

Furnish: This is a colloquial term used throughout the paper industry to refer to the blend of pulp fibers and other dry materials added to water to make up the "Stock".

[2]

List Of Abbreviations

10^3: 1,000
10^6: 1,000,000
AP-42: A compilation of air emission factors maintained and periodically updated by USEPA
CF: Cubic Foot
COD: Chemical Oxygen Demand
DOE: (United States) Department of Energy
BOD: Biochemical Oxygen Demand
BTU: British Thermal Unit
DT: Decatherm
GPD: Gallons Per Day
GPM: Gallons per Minute
HAPs: Hazardous Air Pollutants
HHV: Higher Heating Value
EIA: (USDOE) Energy Information Administration
MGD: millions of gallons per day
MMBtu: Millions of British Thermal Units
NYSERDA: New York State Energy Research and Development Authority
USGS: United States Geodetic Survey
WWTP: Wastewater Treatment Plant
TPY: Tons Per Year

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[2] The Nutrient Trap Process is Patent Pending as of the writing of this report.

Section 1
PROJECT OVERVIEW

PROJECT BACKGROUND

The most significant raw materials used in a paper mill are pulp fiber, water, and thermal and electrical energy. Reduction in the use of any or all of these raw materials can have a significant, positive impact on the economics of paper production and a mill's bottom line profitability. Numerous commercially available technologies are currently used throughout the paper industry for the recovery of fiber and clarified water from mill whitewater. Heat recovery systems are also available for minimizing thermal and electrical energy use. However, all of these technologies are subject to a number of performance, energy, efficiency, and reliability shortcomings. None can economically produce high clarity, thermally rich water that may be substituted for fresh make-up water that typically requires heating to process-operating temperature. As a result, with these existing technologies, paper mills waste large quantities of thermal and electrical energy, often sacrifice productivity due to lower than desired process operating temperatures, and are unable to recover significant portions of their process water, wastewater, and pulp fiber.

This Report describes the results of a pilot trial of the active filtration technology that overcomes other traditional technologies' shortcomings by demonstrating how this technology can reliably produce an ultra-high clarity water from excess process water and wastewater streams while minimizing thermal energy losses and/or improving process productivity.

Jannanco, LLC, a Rochester, NY based company specializing in design, technology and efficiency in process industries, has recently completed this extensive paper mill pilot trial of the "filterdymanic" filtration technology on sources of process water (rich and lean whitewater) and wastewater. This pilot trial was conducted at the SCA Tissue Division mill in South Glens Falls, N Y. Funding for this pilot trial was provided in part by The New York State Energy Research and Development Authority (NYSERDA).

Because whitewater and wastewater is often in excess of 105°F in a typical mill, this recovery and re-use of hot water significantly reduces the additional energy required to heat the cool or cold make-up water for various mill processes. In addition, fiber can be recovered from mill process water by the "active filtration" process not normally recovered by many conventional technologies. Many mills may reuse the recovered fiber as a raw material in their processes.

Often, some of this fiber is lost to the wastewater treatment plant (WWTP) due to imbalances in a mill's internal process water systems. Recovery of these fibers with the Active Filtration system results in a reduction of the solids loading at the wastewater treatment plant. There is a decrease in the hydraulic loading to the wastewater treatment plant from recovery of process water as well. These, in turn lower the burden on the wastewater treatment plant. This allows for additional savings including: reduction in pumping energy costs, chemical treatment costs and operations and maintenance costs. Furthermore, many paper mills utilize the benefit of elevated temperatures in the forming sections of their paper manufacturing equipment to improve product quality and equipment productivity. The suppression of the process temperatures resultant from the cooler fresh water required for certain critical applications, coupled with site specific limitations on a process's ability to elevate the temperature, directly impacts on the product quality and mill productivity.

One of the objectives of the Pilot Trial was to conduct an economic evaluation on the concept of using the "active filtration" technology to further filter warm reclaimed water[3] that had already been filtered in a typical mill's existing whitewater clarification system.

In parallel with the pilot trial and the in-mill laboratory analyses, The State University of New York, College of Environmental Science and Forestry (SUNY ESF), Department of Pulp and Paper Science and Engineering conducted rigorous laboratory analyses on samples from the test. Fiber characteristics such as length and coarseness were evaluated along with consistency, ash content, fines content and specific filtration resistance[4]. The analyses were conducted to independently validate results obtained in the field. In addition, a correlation between the performance of the pilot testing data and specific laboratory results was documented. The details of these tests as well as the correlation charts are provided in detail in the Appendix B of this report.

In the interest of creating a uniform basis for evaluation, this report discusses energy savings and environmental benefits associated with two scenarios. These are the reclamation of 50 gallons per minute (GPM) of process water and 350 GPM of process water. A typical small process flow rate of 50 GPM is adequate for a mill to consider initial implementation of this technology, while 350 GPM equates to approximately 500,000 gallons per day.

Nearly all conventional water and fiber recovery technologies require supplemental systems to enhance the separation of the fiber from the water. Many applications require a filtration aid consisting of recirculated pulp slurries (sweetener) that necessitate considerable slurry and shower pumping systems, vacuum pumps and thick stock handling equipment. Other applications require high chemical treatment loading and high-pressure air compressors to coagulate the fibers in the whitewater and force them to agglomerate and float out of the water to clarify it. All of these systems require considerable energy and maintenance. The

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[3] Reclaimed water was chosen as the source for this evaluation as it is the most commonly in excess, and thereby overflowed to the sewer, compared to the other sources. This stream is typically in the range of 105 ° F.

[4] SUNY ESF

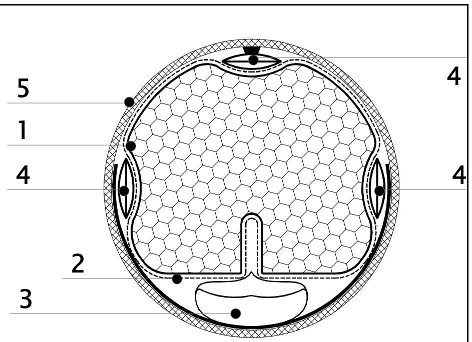
"active filtration" technology typically operates with less than 30% of the energy consumption[5] utilized by the conventional technologies, requiring only a small volume of compressed air during short periods of the filtration cycle. In addition, the active filtration technology operates well below the chemical treatment loading to enhance filtration compared to conventional systems[6].

ACTIVE FILTRATION TECHNOLOGY DESCRIPTION

The basic building block of the process is the active filtration filter press[7]. This operation has three stages: filling, pressurization and detachment/discharge. The system operates in fully automated, semi-continuous/batch mode. The filter press construction consists of a large tubular filter membrane "hose" suspended within a longitudinal arrangement of bladders installed within a metal cylinder.

Figure 1

General Active Filtration Internal Arrangement

1	TUBULAR FILTER MEMBRANE	
2	DRAINAGE NET	
3	PRESSURIZATION BLADDER	
4	DETACHMENT BLADDER	
5	CASING	

During filling, the bladders are partially inflated. The dilute fiber and water slurry is pumped into the filter hose with gravity and pressure separation of the liquid from the slurry occurring through the membrane. The flow rate gradually declines as fiber and filler accumulate on the internal face of the filter membrane. From the mill scale pilot testing, the optimum flow degradation pattern has been determined for each water source to establish the desired filling cycles.

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[5] Energy comparison is based upon estimated typical requirements for conventional systems and compared to field measurements of energy during pilot tests.

[6] A comparison of the complexity and energy requirements of active filtration technology to conventional technologies is provided in Section 4 of this report.

[7] Technical information of the active filtration system is provided in graphical format in appendix A.

The filtered water passes through the membrane and descends within the cylinder in the annular space created by the bladders between the membrane and the cylinder wall. The filtrate collects in a pan at the base of each filter and then drains off through a drain pipe.

Once the filling cycle is completed, the six bladders inflate in a programmed sequence to further compress the fiber and force out additional liquid. Following this pressing stage, a bottom discharge port is opened and additional bladder inflation and deflation is initiated to break up the compacted fiber cake created during the pressurization stage. This detaches any filter cake from the face of the membrane. This cake and the thickened slurry are discharged from the bottom of the filter press. Then the discharge door closes and the filter resets and restarts the filling cycle.

The filtration membrane medium is a highly durable, woven, calendered, polypropylene fabric. This medium is manufactured to provide high clarity filtrate independent of supplemental filter filtration aids (other than common flocculants). The calendered surface promotes the detachment of materials during discharge. The filtration performance is not dependent upon ancillary process systems such as sweetener addition. The primary potential failure mode in this technology is blinding of the membrane and an associated reduction of flow. This failure, although uncommon, is easily corrected with clear water flushing sequences. This is unlike conventional systems in which the failure mode is typically solids breakthrough or carryover and the resultant poor clarity.

The active filtration technology utilizes a patented[8], membrane separation technology that has extensive historical success in municipal and industrial wastewater sludge dewatering applications throughout Europe.

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[2] US Patent # 5614092

Section 2

TESTING METHOD AND ANALYSIS OF RESULTS

TEST MATRIX AND PROTOCOL

The testing program was conducted in a tissue mill using recycled paper as the raw material. A testing matrix was developed and followed. The testing matrix included the following:

1. **Membrane pore size evaluation.** Three membrane pore sizes were tested in the program. There is an economic balance between the pore size, the throughput rate and the treatment chemical regimen. The program tested the 5 micron, 10 micron and 30 micron pore size filtration membranes. Optimum flow rates were determined by adjustments to press parameters and chemical treatment.
2. **Chemical Treatment Regimen.** Chemical additives to enhance filtration by promoting coagulation and flocculation of the fiber and other particles within the press were required in order to achieve optimum flow rates. The program assessed three chemical formulation configurations that included varying ratios of flocculants and coagulants. The testing determined the optimum level of chemical treatment compared to the filter throughput rate.
3. **Chemical Insertion Point.** The testing program assessed numerous locations and methods of chemical injection into the process. The efficiency and performance of the chemical treatment was determined to be a function of the chemical treatment and the method and location of injection into the process as well as the process delivery pumping means. Insertion locations included: the collection tank, the pump inlet and the pump outlet. A peristaltic pump was compared to air diaphragm technology to determine the impact of pump shear on the fiber flocs and the associated performance of the "active filtration" technology.
4. **Process Water Sources.** The testing program assessed the technology's performance on four water sources within the mill. These included two different grades of white water being supplied to the mill's existing fiber recovery process, water from the outlet of the mill's existing fiber recovery process and mill wastewater. The solids concentration, ratio of fiber to fillers and the nature of the fibers were distinctly different in these four sources. These sources also represented the most likely source of water for recovery in a typical board or paper mill.
5. **Correlation of Specific Filtration Resistance to Pilot Results.** The State University of New York College of Environmental Science and Forestry (SUNY ESF) conducted parallel laboratory analyses on the process water being used for the pilot testing. SUNY ESF evaluated process water characteristics including specific filtration resistance (SFR), fines fraction, consistency and other critical parameters in order to determine if there is a correlation between the SFR and the performance of the process waters in the active filtration system.

OVERVIEW OF RESULTS

Raw data from the pilot trial are provided in Appendix B and also in Appendix D. Pilot Testing performance results are provided in summary form in Table 1.

From a review of these data it has been determined that the pilot testing:

1. Demonstrated the technology's ability to achieve high clarity without "sweetener" and determined the energy requirements to operate the system.
2. Demonstrated the technology's ability to provide a filtrate that is superior to currently available technology.
3. Identified the optimum filtration media required for the technology to achieve the optimum clarity and economic operation for the tissue mill operation and similar operations.
4. Identified the optimum coagulant and flocculent chemical regimen required for the selected media for the tissue mill operation and similar operations.
5. Demonstrated the technology's ability to provide high-clarity water that is suitable for forming section wire cleaning showers, felt cleaning showers and for coating or chemical make-down, all typically requiring use of fresh make-up water.
6. Determined the degree to which fresh water costs may be reduced based on scalable sample conceptual systems.
7. Determined the considerable degree to which process heating energy costs may be reduced based on scalable sample conceptual systems.
8. Determined a rough order of magnitude or baseline equipment requirement per unit of mill production based on a scalable sample conceptual system.
9. Demonstrated the technology's ability to have a failure mode that is not detrimental to the supplied processes.
10. Demonstrated the technology's ability to operate on a continuous, automated basis.
11. Provided comparison of the energy consumption per unit of mill clarified water production for the active filtration technology compared to the conventional technologies.
12. Demonstrated the correlation between the SUNY ESF SFR testing and the performance of the process waters in the pilot testing. This is a significant result in that laboratory testing for SFR and other critical parameters may reasonably predict the performance of the active filtration technology in advance of extensive field testing.

Table 1

Summary of Pilot Test Data Analyses

	5 Micron					10 Micron					30 Micron				
	Averaged Flow Rate (GPM)			Chemical Dosage (PPM)		Averaged Flow Rate (GPM)			Chemical Dosage (PPM)		Averaged Flow Rate (GPM)			Chemical Dosage (PPM)	
	Min	Max	Avg	Combined Floc's	Coag	Min	Max	Avg	Combined Floc's	Coag	Min	Max	Avg	Combined Floc's	Coag
Reclaimed water Napkins	3.5	4.1	3.8	48.0	53.0										
Reclaimed water Towels	3.3	4.1	3.8	34.0	0.0	6	7.8	6.8	25.0	27.5	6.7	7	6.9	36.0	20.0
Krofta Feed (Napkins)	3.7	5.4	4.4	36.0	17.0	3.3	4.8	4.1	42.0	0.0					
Krofta Feed (Towels)	5.6	5.6	5.6	26.0	0.0	4.3	5.3	4.9	36.0	0.0	4.5	5.2	4.9	48.0	0.0
Waste Water	1.5	3	2.0	60.0	112.0	2.4	3.5	3.2	40.0	55.0	2.6	3.2	2.9	65.0	76.0

The pilot data were used to develop the following table that may be employed to estimate the equipment requirements to accommodate a particular flow rate and water source.

Table 2
Active Filtration Unit (AFU) Sizing

	Flow Rate (GPM/meter of AFU filtration height "L")	"AFU" Filtration Height - "L" in Meters Required for Process Flow Rate (GPM)				
Water Source		10	50	100	350	<=GPM
Napkin Whitewater	4.50	2	11	22	78	L
Towel Whitewater	4.50	2	11	22	78	
Reclaimed Water	6.75	1	7	15	52	
Sewer Water	3.85	3	13	26	91	
Approximate Installation Size for Referenced Water Recovery Rate *						
5 Meter AFU's Required for Indicated Flow Rate	Napkin Whitewater	0.4	2.2	4.4	16	# 5m Towers
	Towel Whitewater	0.4	2.2	4.4	16	
	Reclaimed Water	0.3	1.5	3.0	10	
	Sewer Water	0.5	2.6	5.2	18	

* Note that Active Filtration Unit Heights are available in fractional heights (i.e. 0.2 (1 meter), 0.4 (2 meter), 0.6 (3 meter) and 0.8 (4 meter)) as a standard from the manufacturer in addition to the basic 5 meter unit.

COMMENTARY REGARDING RESULTS

Pilot System Performance as it Relates to Mill Scale Implementation

The pilot testing has demonstrated that for a typical recycled fiber tissue mill a strong economic case can be made for implementation of the active filtration technology. The ash and fines loading in the source water for the site of the pilot test are considered above levels normally found in many paper and board manufacturing operations due to the furnish in the host mill being typical to recycled fiber tissue mills. As is explained elsewhere in this report, the recovered material was not readily returnable to the mill's process due to this high ash and fines content. Therefore, it is anticipated that mills with lower levels of fines and higher levels of reusable fiber in their wasted clarified water will have stronger economic basis for implementation of this technology as more material will be returnable to the manufacturing process.

The testing has demonstrated that 10 micron filter media will provide for flow rates in the range of 4 GPM to 10 GPM per active filtration unit[9] (AFU) increment of capacity. This flow rate is dependent upon the source of the supplied water as the characteristics vary considerably. Filter media with a more open mesh would be subject to potential breakthrough of oversized particulates in the event of a process upset up-

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[9] An active filtration unit – AFU – is equivalent to one meter of filter column.

stream of the AFU. This was demonstrated during the 30 micron filter media testing. The problem was mitigated by utilization of the 5 and 10 micron filter media. Filter media with a tighter mesh demonstrated a greater resistance to flow and more rapid decay in filtration rate. This was demonstrated during the 5 micron filter media testing.

These data have been used to extrapolate the equipment requirements of systems based upon source water and flow rate. From nearly two decades of experience the active filtration technology has consistently demonstrated that pilot data are very scalable to production scale.

Chemical treatment rates for the whitewater and reclaimed water used in this pilot work ran in the ranges of 30 to 100 ppm, dependent again upon the source of the supplied water. The chemical treatment rates were found to be independent of the filter media porosity.

Optimum operation of the AFU for this application was achieved by alternating long and short semi-continuous batch-cycle times. This provided for additional clearing of the membrane on a consistent basis to prevent fines buildup and accumulation and the potential for associated plugging. The test methodology was conducted to determine the optimum cycle times for long and short cycle times. The acceptance requirement was established as three consecutive entire cycles (defined as one long and one short cycle) that demonstrated the same flow rate and flow decay rate. Extensive testing demonstrated that the three consecutive-cycle acceptance criteria are reasonable as no significant change in flow rate or flow rate decay was observed after repeated subsequent entire cycles. Testing demonstrated that in consideration of the flow-decay rate during long cycles in excess of 45 to 60 minutes, cycles longer than 45 to 50 minutes are achievable but not warranted in the recycled tissue mill furnish application.

In consideration of the fact that fiber may be recovered at consistency ranges of 2% to 5% only one test was run to raise the filter cake to a high percentage of solids (18%). This demonstrated the active filtration technology's ability to serve as a cost effective dewatering process for wastewater high in ash and fines. The dewatered material can be readily disposed of while producing ultra clarified water.

Energy Savings

From the results of pilot testing an estimate of capital and operating costs and the overall economic benefits to a typical paper mill was determined. Preliminary estimates indicate a capital cost in a typical mill for an installed process would have a simple Return on Investment (ROI) in excess of 33%. This estimated return is solely based upon the thermal energy savings associated with the ability to reuse hot process water in place of cold make-up water. The savings do not include the potential additional benefits discussed above, including: the reduction in operations and maintenance costs at a mill's wastewater treatment plant due to lower wastewater flows; the avoided power and maintenance costs associated with a mill's water recovery technologies; the potential impact on mill quality and productivity resultant from operating below desired temperatures; and the value of the recovered fiber for reuse as raw material. These values are typically site specific but may add significantly to the overall Return on Investment.

An operating flow rate of 350 GPM and an annual operating year of 360 days equate to a thermal savings in the range of approximately 94,400 to 144,285 decatherms of energy per year. The associated, gross economic benefit from these thermal savings would be in the range of $777,150 to $988,100 per year based on 2004 energy costs.

Details of the energy savings and cost savings are provided in detail in Section 5 of this report.

Reliability of Product Water Clarity

One phenomenon was observed following testing of failure modes imposed on the process discussed above. During the failure-mode testing, small quantities of particulate matter in the size range of 3 to 7 microns (fines) penetrated the membrane prior to the membrane blinding over. Some of these fines agglomerated on the downstream side of the membrane. Shear imparted by pumping and minor mechanical mixing disrupted these agglomerates.

This was only shown to occur with failures in the chemical feed system during the pilot testing.
The intent of this demonstration project has been to provide documentation of the technology's performance in paper mill process water and waste water recovery applications for clarity and reliability and to determine the relative capital requirements. The product water from the pilot system consistently contained no detectable particles[10]. These results were obtained without sweetener and at chemical loading rates equal to or below conventional technologies. Failure modes were forced on the pilot process that produced some minor turbidity, however the particle size in the product water was consistently in the range of 3 to 7 microns and below. This particle size is well below the typical tolerance level of most mill applications currently requiring fresh water.

Emission Reduction

Avoided emissions of these air pollutants associated with avoided combustion to produce the above indicated energy is as follows:

- NO_X: 9 to 19 tons per year
- CO: 2 to 5 tons per year
- PM: 0.2 to 0.9 tons per year
- SO_2: 0.1 to 0.4 tons per year

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[10] According to the testing by State University of New York College of Environmental Science and Forestry at Syracuse University (ESF). ESF was a sponsor and significant contributor to the protocols for this pilot program.

- VOCs: 0.1 to 0.3 tons per year
- CO_2: 3,600 to 10,000 tons per year

Details of the environmental benefits are provided in detail in Section 5 of this report.

Comparison to Conventional Technologies

The active filtration technology's associated energy for its operation was demonstrated as substantially less than conventional systems. Pumping energy requirements for slurry delivery to the pilot filter was found to be less than one horse power, and air consumption was less than 4 CFM; and then only for a few minutes per hour. A significant energy savings with the active filtration technology is the absence of the electric power requirements associated with the sweetener pump, the larger thick stock pump required to accommodate the sweetener, the vacuum pump, the air compressor for the flotation system, system mechanical drive motors and the knock off shower pumps. The conceptual process defined in later sections of this report has included the extrapolated energy requirements based upon these field results. As these elements are site specific, the savings calculations provided throughout this report do not include the offset in the energy consumption required by conventional systems.

Detailed comparisons to conventional technologies are provided in detail in Section 4 of this report.

Section 3

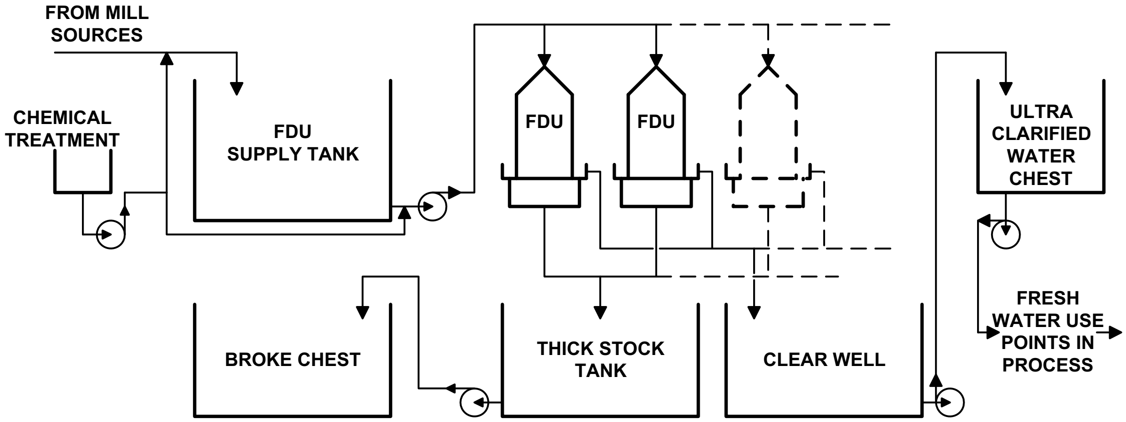
BASELINE PROCESS DESCRIPTIONS AND ASSOCIATED REQUIREMENTS

GENERAL PROCESS CONCEPT

Two conceptual processes have been developed to provide ultra-clarified water from the reclaimed water stream at a typical recycled paper mill. The first of these would apply to a process specific application for a flow in the range of 10 to 150 GPM. The second would apply to a mill-wide water recovery system for a flow in the range of 350 gallons per minute (approximately equivalent to 500,000 gallons per day). Both of these models may be readily applied to alternate, richer, whitewater streams and may be scaled to the flow rate under consideration. Flow rate and the operating temperature of the process are, in most instances, the key factors in affecting savings. Processes generically consist of modular sets of components. In this configuration the systems may be constructed in stages and capacity readily added for future requirements. Following is a schematic of the basic building blocks of an active filtration system.

Figure 2

Typical Active Filtration System Configuration



PROCESS-SPECIFIC APPLICATION FOR 50 GPM INSTALLATIONS

Provided that suitable space is available within a proposed mill, a process may be delivered, assembled, and put into operation in approximately five to six months from project initiation.

The proposed process for the 50 GPM capacity would consist of two or three active filtration units.
Each unit would have the capacity to process an averaged flow rate of 12 to 35 GPM. The production scale

active filtration unit has a footprint of approximately three (3) feet by three (3) feet and is approximately 17 to 23 feet tall. The installed configuration is explained below.

Warm water segregated from the mill process would be delivered to a 100 to 200 gallon, agitated, receiving tank. This influent water would pass through a flow meter and a consistency transmitter. The flow meter and consistency transmitter would be integrated through the master system programmable logic controller (PLC) to adjust the influent solids concentration and control the addition of a charge neutralization coagulant polymer to match the flow and consistency. This coagulant would be injected into the influent water prior to its discharging into the receiving tank. In the receiver tank sufficient dwell time is available to allow for the coagulant polymer to develop preliminary small (pin) flocs. Any required consistency dilution water would be supplied from the ultra clarified water storage (product water).

The supply pipe to the receiver tank would have an on / off control valve. The receiver tank would stop flow from the mill if a high, predetermined level is reached.

From the receiver tank the water and flocculated solids would be drawn out by a filter-delivery pump. The pump would be a low-shear pump such as a progressive cavity or a peristaltic pump. Appropriate pulsation dampening hardware would be provided where required. At the inlet of the delivery pump, a flocculent polymer would be injected. This flocculent would be an anionic or cationic polymer dependent upon the source of the reclaimed water. The selection of the polymer would be done by process staff through the master process PLC.

The filter-delivery pump would feed the slurry to three, identical active filtration units. Prior to the inlet to the filters, additional flocculent polymer would be injected. The polymer injected at this location would be the opposite charge of the polymer injected at the pump inlet. The pilot testing has demonstrated the importance of the proper sequence of chemical injection dependent upon reclaim water source. Note that the secondary polymer addition was required for the pilot test. This may not be a requirement for other mill systems with different furnishes.

A flow meter is proposed in the line to the filter delivery pump to the filters. This flow meter would be integrated through the PLC to control the delivery rate of the polymers as a percentage of the fiber slurry flow. As a single-filling cycle progresses, the fiber slurry flow rate will degrade. It is therefore important to match the flows to control consumption and to prevent problems associated with over feeding of polymers. The flow meter would also signal the active filtration bank PLC control system when the desired volume of slurry has been pumped to the filter, at which point the press and discharge cycles would begin.

The filters may be erected on an elevated platform to allow for discharge and handling of the thickened slurry or on the floor over a trench. The placement of the filters must allow for adequate access around each unit for maintenance and adjustments. An elevated maintenance platform would be provided as well to accommodate work on the upper portion of the units. Maintenance at the top of the active-filtration unit is expected to be on an annual or semi-annual basis. This is based upon operational history in Europe.

The delivery piping would be manifolded to the bank of filters to reasonably accommodate uniform splitting of flow. At the inlet to each filter unit an automatic stop valve or a check valve would be installed. On the manifold to each bank of filter units a pressure transducer would be installed. This pressure transducer would signal the delivery pump, through the active filtration PLC, to turn off as the backpressure in all of the units rises to a predetermined set point. The pump would restart after a timed-hold period if the required volume of slurry has not been delivered.

The ultra-clarified water from the filter units would be collected in a common header and collected in a small clear well. From the clear well the water may pass through a small canister “trap” filter. The filtrate would then discharge into an ultra clarified water storage tank. From the ultra clarified water storage tank the water would then be pumped to mill use points.

The purpose of the small-trap filter is to trap any tramp flocs or other materials that may find their way into the flow stream from cleaning or other activities. These would primarily be agglomerated fines in the 3 to 7-micron size range as discussed in Section 2.

The thickened stock from each filter unit would drop into a sluicing trough that runs beneath the active filtration units. The troughs would converge at and discharge into a small, thick stock pit. The thick stock pit would have an agitator to break up any lumps of dewatered stock. Lumps of dewatered stock have been noted in the discharged thickened stock throughout the pilot tests. The thickened stock slurry may be sent to the WWTP or be pumped back to the mill broke system. The thickened stock slurry is expected to be in the range of 3% to 6% consistency. Based on the pilot data at the recycled tissue mill, this slurry is expected to be very high in ash and fines. Sluicing water would be supplied to the trough directly from the influent water line from the mill, upstream of the automated supply valve to the receiver tank.

The control system for the process would consist of a factory programmed PLC based control system that operates the individual on-board functions of each unit. There would be minimal field wiring to the filter units from the control panels. There would be a pneumatic tubing umbilical to each unit.

Preliminary estimates indicate a capital cost in a typical mill for an installed process to filter 50 gallons per minute would be in the range of approximately $300,000 with a simple return on investment in excess of 33%[11]. It is important to note that applications as small as 15 gallons per minute have demonstrated comparable rates of return in the economic models.

Process Specific Application Operating Requirements And Costs

The proposed process for 50 GPM of reclaimed water would require approximately 100 to 200 square feet of common production space. Utility requirements would include compressed air with peak capacity in the range of 15 CFM and nominal flow rates in the range of 7 CFM. The estimate for total connected horsepower for the entire process is in the range of 15 to 20 HP. Solids from the process may be further dewatered for disposal or returned to the process or the waste stream as slurry.

The operating and maintenance costs for the proposed process would consist of electric power costs, chemical purchases and maintenance costs.

The proposed process would have a connected electrical load in the range of 15 to 20 horsepower. Based upon the expected cycle times and associated power requirements an annual cost of $7,500 would be required for electric power.

The chemical consumption rates determined from the pilot trial were found to be very repeatable. The annual cost for chemicals is based upon the pilot trial rates extrapolated to an annual consumption rate. The costs are based upon the specific coagulant and flocculants utilized for the pilot work. This annual cost is estimated at $16,000. If the fiber is recovered or dewatered further for disposal, the chemical treatment costs may be discounted, as they are approximately equivalent to the chemical requirements for the treatment of the fiber and fillers at the waste treatment plant or the recovery of fiber in alternative technologies.

The maintenance costs for the equipment are very difficult to estimate. Historical results at the numerous installations in Europe indicate that the bladders and membranes have a two- to three-year life. A complete bladder and membrane set for the entire proposed plant would be in the range of $7,000. Other miscellaneous repairs would be required for pumps, valves, instruments, etc. For purposes of this report, an assumed annual maintenance cost of 2.5% of the capital equipment cost has been utilized as a rule of thumb estimate. This cost would be in the range of $5,000.

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[11] Note that this process is based upon data from a recycled fiber tissue mill. The fines and ash loadings at this site may provide for higher filtration resistances and subsequently greater equipment requirements than other applications. A detailed cost and savings analysis is provided in Section 8.

The process is designed to be fully automated, much like most conventional process water and fiber recovery systems. Daily testing by the mill's lab staff, similar to that required for the typical current clarified water systems, would be required to ensure proper operation.

The process-specific baseline process described above may be used for the production of ultra-clarified water from cloudy whitewater. The average expected flow rate from a recycled tissue mill would be in the range of approximately 60% lower for this same three-bank configuration based upon the pilot test data. The annual thermal savings would therefore be lower. The chemical and operating cost would be lower as well. Should there be a benefit in recovering the thickened stock from this stream for reuse in the mill, its value would clearly offset the reduced thermal savings.

Approximate capital and operating costs for the above described system are present in Table 3, below. A detailed return on investment calculation for a mill-wide system is provided in Section 8. The cost savings were found to be scalable for various sized systems.

Table 3

Approximate Capital and Operating Costs for 50 GPM System**

Cost Item	**Annual Costs**	**Capital Cost**
Installed System		$300,000
Energy	$7,500	
Treatment Chemicals	$16,000*	
Routine Maintenance	$5,000	
Total Approximate Annual Costs:	**$28,500**	

* Note that this cost may be offset by chemical savings elsewhere in the mill as discussed above.

** Annual Savings for 50 GPM => Approximately $125,000.

TYPICAL MILL WIDE APPLICATION FOR 350 GPM

This 350 GPM volume was selected, as it represents a likely fresh water flow rate that a typical mill may use on an average paper machine in New York State. It may be substituted with ultra-clarified, reclaimed water.

Provided that suitable space is available within a proposed mill, a process may be assembled and put into operation in approximately six to eight months from project initiation.

The configuration of banks of active filtration units lends itself to a phased approach. The modular configuration of the system provides for cost effective incremental capacity additions. The system's base components of the tanks, power distribution, space allocation, tank manifolds and master control system, etc. would be required by the initial installation. The process infrastructure of the "typical" 350 GPM system discussed herein would support up to at least 500 GPM of capacity. Due to the modular nature of this technology, particular streams with flows as low as 7 to 15 GPM may be economical as well as the flows up to 500 GPM.

The proposed process for the 350 GPM capacity would consist of three banks of active filtration units. Each bank would contain four to five units. Each bank would have the capacity to process an averaged flow rate of 115 to 120 GPM. The production scale active filtration unit has a footprint of approximately three (3) feet by three (3) feet and is approximately 23 feet tall. The installed configuration is explained below. The process diagram for this process is provided in Appendix C of this report.

Warm reclaimed water from the mill would be delivered to a 1000 to 2000 gallon, agitated, receiving tank. This influent water would pass through a flow meter and a consistency transmitter. The flow meter and consistency transmitter would be integrated through the master system programmable logic controller (PLC). It would adjust the influent solids concentration and control the addition of a charge neutralization coagulant polymer to match the flow and consistency. This coagulant would be injected into the influent water prior to its discharging into the receiving tank. In the receiver tank, sufficient dwell time is available to allow for the coagulant polymer to develop preliminary small (pin) flocs. Any required consistency dilution water would be supplied from the ultra-clarified water storage (product water).

The supply pipe to the receiver tank would have an on / off control valve. The receiver tank would stop flow from the mill if a high, predetermined level is reached.

From the receiver tank the reclaimed water would be drawn out to one of three primary filter delivery pumps. Each of these pumps would be an identical low-shear pump such as a progressive cavity or a peristaltic pump. Appropriate pulsation dampening hardware would be provided where required. At the inlet of the delivery pumps a flocculent polymer would be injected. This flocculent would be an anionic or cationic polymer, dependent upon the source of the reclaimed water. The selection of the polymer would be done by process staff through the master process PLC.

The filter delivery pumps would feed the slurry to three identical banks of active filtration units. Prior to the inlet to the filters, additional flocculent polymer would be injected. The polymer injected at this location would be the opposite charge of the polymer injected at the pump inlet. The pilot testing has demonstrated the importance of the proper sequence of chemical injection dependent upon the reclaim water source.

A flow meter is proposed in the delivery line from each filter delivery pump to the filters. This flow meter would be integrated through the PLC to control the delivery rate of the polymers as a percentage of the fiber slurry flow. As a single filling cycle progresses, the fiber slurry flow rate will degrade. It is therefore important to match the flows to control consumption and to prevent problems associated with over feeding of polymers. The flow meter would also signal the active filtration bank PLC control system when the desired volume of slurry has been pumped to the filter, at which point the press and discharge cycles would begin.

Each bank of filters would be erected on an elevated platform to allow for discharge and handling of the thickened slurry. The placement of the filters on the platform would allow for adequate access around each unit for maintenance and adjustments. An elevated maintenance platform would be provided as well to accommodate work on the upper portion of the units.

The delivery piping would be manifolded to the bank of filters to reasonably accommodate uniform splitting of flow. At the inlet to each filter unit an automatic stop valve or a check valve would be installed. On the manifold to each bank of filter units a pressure transducer would be installed. This pressure transducer would signal the delivery pump, through the active filtration bank PLC, to turn off as the backpressure in all of the units in that bank rises to a predetermined set point. The pump would restart after a timed hold period if the required volume of slurry has not been delivered.

The ultra-clarified water from a bank of filter units would be collected in a common header and collected in a small clear well. From the clear well the water would pass through small "trap" filters. The filtrate would then discharge in to the 1000 gallon ultra-clarified water storage tank. From the ultra-clarified water storage tank the water would then be pumped to a mill storage tank for distribution. The pilot testing has demonstrated that there is essentially no measurable temperature loss through the "active filtration" unit. Savings calculations discussed in this report are based upon the outlet temperature for the filter during the pilot testing.

The purpose of the small trap filters is to trap any tramp flocs or other materials that may find their way into the flow stream from cleaning or other activities. These would primarily be agglomerated fines in the 3 to 7 micron size range as discussed in Section 2. Each bank would have its own "trap" filters so that a serious problem may be isolated and initiate a bank shutdown. The trap filters are proposed to be a simple swept surface filter followed by a canister filter. The intent of this configuration is not to perform any process filtration, since their solids-handling capacities are limited, but to block a catastrophic down stream failure that may be created from tramp flocs, etc. The piping around each of the canister trap filters would include a differential pressure transmitter. An increase in differential pressure would provide immediate indication of accumulation of particulate in the filter. This would alarm to annunciate a problem in the associated active filtration bank.

The thickened stock from each filter unit would drop into a sluicing trough that runs beneath each bank of filterdynamica™ units. The troughs would converge at and discharge into a small, thick-stock pit. The thick-stock pit would have an agitator to break up any lumps of dewatered stock. Lumps of dewatered stock have been noted in the discharged thickened stock throughout the pilot tests. From the thick-stock pit, the thickened stock slurry would be pumped to a small screw press. This screw press would discharge approximately into a small disposal dumpster at approximately 25% to 35% solids. Alternately the thickened stock slurry may be sent to the WWTP or be pumped back to the broke system. The thickened stock slurry is expected to be in the range of 3% to 6% consistency. Based upon the pilot data at the recycled tissue mill, this slurry is expected to be very high in ash and fines. Sluicing water would be supplied to the trough directly from the influent water line from the mill, upstream of the automated supply valve to the receiver tank. Effluent water from the screw press would be pumped back to the process influent line, downstream of the automated supply valve to the receiver tank but upstream of the flow meter and the consistency monitor.

The “active filtration” unit has demonstrated during this pilot trial that it may be used to provide high consistency filter cake for disposal from the wastewater slurry stream. However, it is not as efficient as a small screw press at producing pressed waste from the fines found in the recycled tissue mill reclaimed water at the higher solids concentrations desired for disposal.

The control system for the process would consist of four control modules. There would be a master PLC that controls all interactions and process functions external from the workings of the active filtration units. Each of the banks of filter units will have a separate control system. The three active filtration banks would have a factory programmed PLC based control system that operates the individual, on board functions of each unit. The communication from the factory PLC to the units in each bank would be through a pneumatic logic system. There would be minimal field wiring to the filter units from the control panels. There would be a pneumatic tubing umbilical to each unit.

Preliminary estimates indicate a capital cost in a typical mill for an installed process to filter 350 gallons per minute would be in the range of approximately $2,100,000 with a simple return on investment in excess of 33%[12].

Typical Mill-Wide Application Operating Requirements And Costs

An installation to process 350 GPM would require approximately 1500 to 1800 square feet of high-bay production space. Utility requirements would include nominal heat to keep the area above freezing, compressed air with peak capacity in the range of 75 CFM and nominal flow rates in the range of 20 CFM. The estimate for total connected horsepower for the entire process is in the range of 160 HP. Solid waste from the process would be further dewatered for disposal or may be returned to the process or the waste stream as slurry. Smaller systems would require less area and lower head space as well as lower utility requirements.

The operating and maintenance costs for the proposed process would consist of electric power costs, chemical purchases and maintenance costs.

The proposed process would have a connected electrical load in the range of 150 to 160 horsepower. Based upon the expected cycle times and associated power requirements an annual cost of approximately $54,000 would be required for electric power.

The chemical consumption rates determined from the pilot trial were found to be very repeatable. The annual cost for chemicals is based on the pilot trial rates extrapolated to an annual consumption rate. The costs are based on the specific coagulant and flocculants utilized for the pilot work. This annual cost is estimated at $114,000. As discussed above this cost may be discounted if the fiber is recovered or disposed of directly from this process.

The maintenance costs for the equipment is very difficult to estimate. Historical results at the numerous installations in Europe indicate that the bladders and membranes have a two to three year life. A complete bladder and membrane set for the entire proposed plant would be in the range of $50,000. Other miscellaneous repairs would be required for pumps, valves, instruments, etc. For purposes of this report an assumed annual maintenance cost of 2.5% of the capital equipment cost has been used as a rule of thumb estimate. This cost would be in the range of $36,000.

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[12] Note that this process is based upon data from a recycled fiber tissue mill. The fines and ash loadings at this site may provide for higher filtration resistances and subsequently greater equipment requirements than other applications. A detailed cost and savings analysis is provided in Section 8.

The process is designed to be fully automated, much like most conventional process water and fiber recovery systems. Daily testing by the mill's lab staff, similar to that required for the typical current clarified water systems, would be required to ensure proper operation.

The process-specific baseline process described above may be used for the production of Ultra Clarified Water from cloudy whitewater. As discussed above, the average expected flow rate from a recycled tissue mill would be in the range of approximately 60% lower for this same three-bank configuration based upon the pilot test data. The annual thermal savings would therefore be lower. The chemical and operating cost would be lower as well. Should there be a benefit in recovering the thickened stock from this stream for reuse in the mill, its value would clearly similarly offset the reduced thermal savings.

Approximate capital and operating costs for the above described system are present in Table 4, below. A detailed return on investment calculation for this system is presented in Section 5.

Table 4

Approximate Capital and Operating Costs for 350 GPM System**

Cost Item	**Annual Costs**	**Capital Cost**
Installed System		$2,100,000
Energy	$54,000	
Treatment Chemicals	$114,000*	
Routine Maintenance	$36,000	
Total Approximate Annual Costs:	**$204,000**	

* Note that this cost may be offset by chemical savings elsewhere in the mill as discussed above.

** Annual Savings for 350 GPM => Approximately $875,000.

Section 4

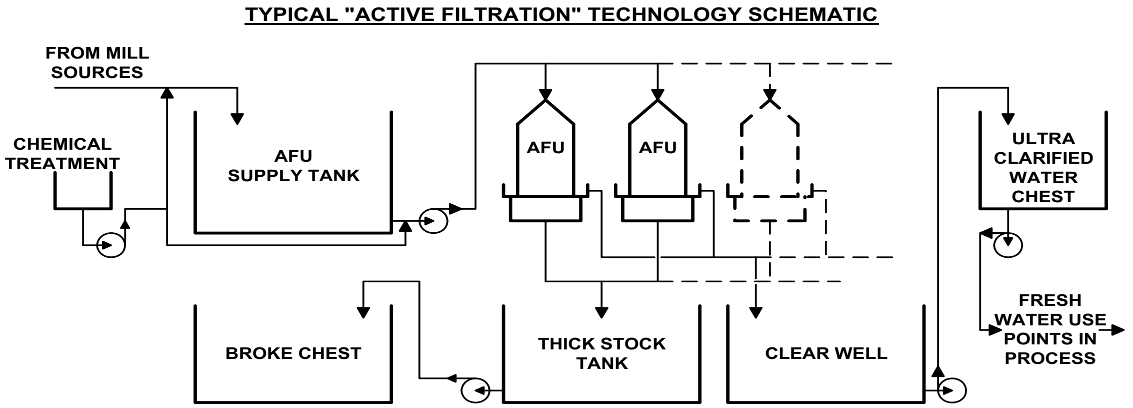
COMPARISON OF ACTIVE FILTRATION SYSTEM TO CONVENTIONAL TECHNOLOGIES

The conceptual processes discussed in the preceding section have significant operational benefits over conventional technologies. A schematic of a baseline active filtration process is provided below along with the associated horsepower requirements.

Schematics of the two most common fiber recovery and water clarification technologies used in the paper industry today, with their power requirements as well, are also provided. These are rotary drum or disk style filter systems (savealls) and dissolved air flotation systems (DAFs).The active filtration process has fewer equipment components compared to conventional processes, and consumes 30% to 40% less horsepower than the conventional systems. The conventional technology schematics indicate numerous process points at which the active filtration technology may be implemented in conjunction with the technology.

Figure 3

Concept Active Filtration Equipment Arrangement

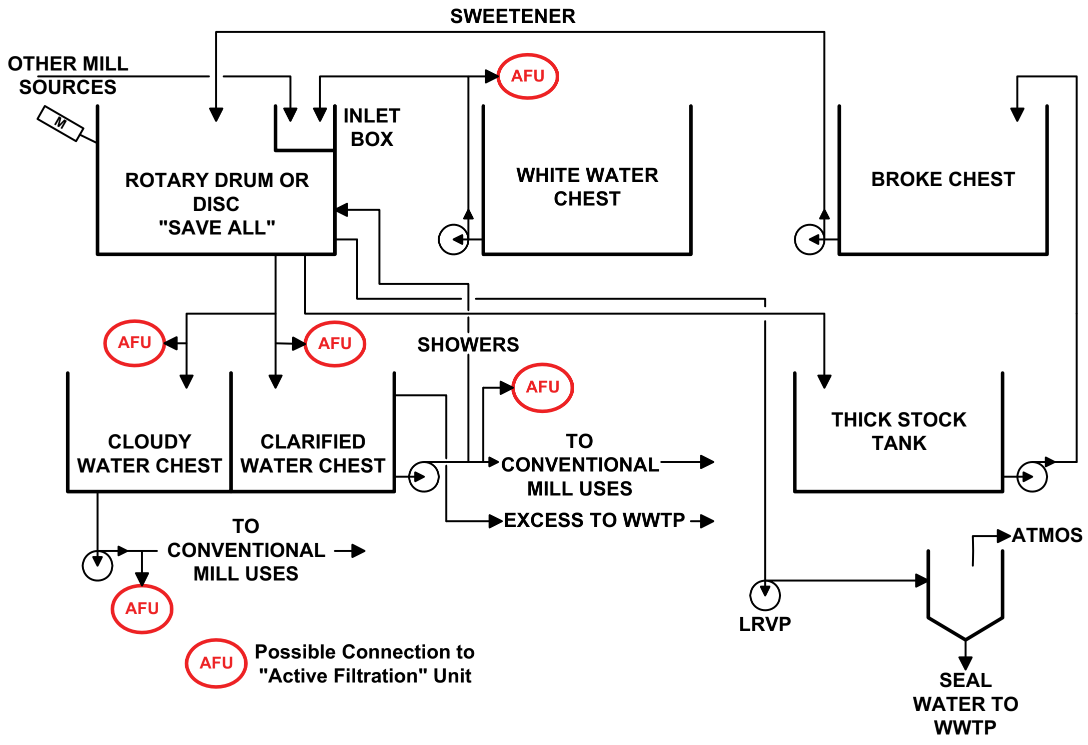


The typical motor list and rough order of magnitude (ROM) horsepower requirements for a 500,000 gallon per day baseline active filtration process are as follows:

Service	Total Horsepower
Filter Feed Pumps (3)	45
Chemical Feed Pump	.25
Clear Well Pump to Storage	25
Thick Stock Pump for recovered stock	10
Air Compressor	10
(ROM) Total	90

Figure 4

TYPICAL "SAVE ALL" TECHNOLOGY SCHEMATIC SHOWING POSSIBLE CONNECTION POINTS FOR ACTIVE FILTRATION TECHNOLOGY



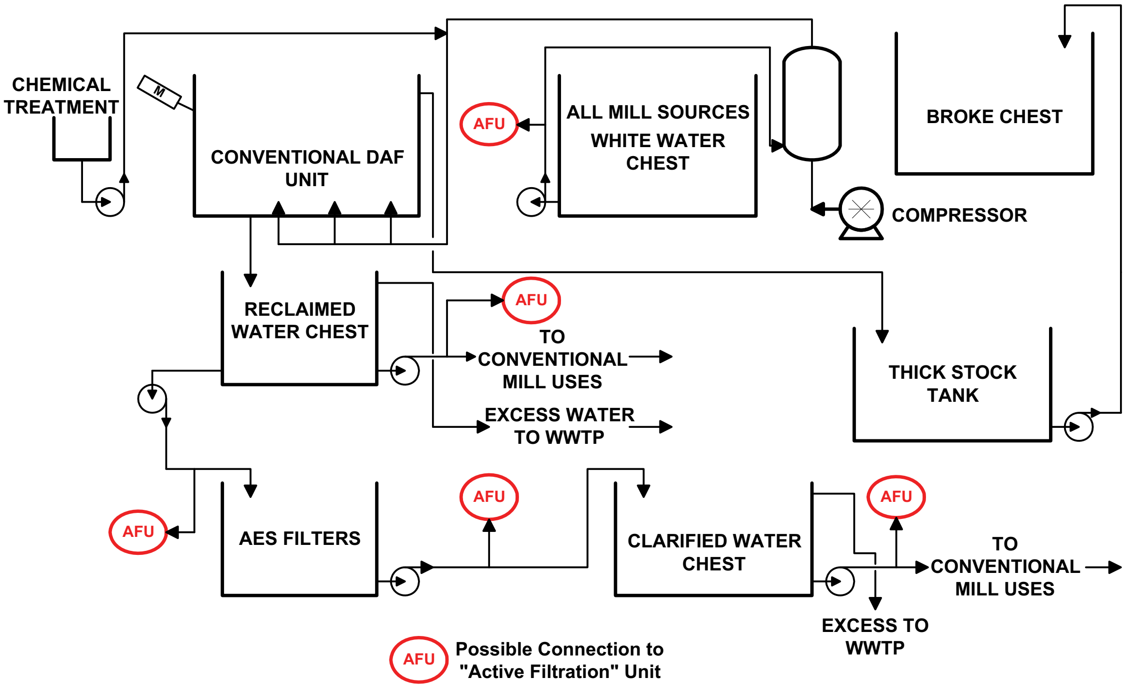
The typical motor list and rough order of magnitude (ROM) horsepower requirements of the conventional “save all” technologies include the following:

Rotary drum or disk style filter system “Save all”

Service	Total Horsepower
Filter Feed Pump	50
Sweetener Pump	15
Filter disk (drum) drive motor	10
Knock off shower pump	10
Thick stock pump for sweetener & recovered stock	25
Liquid Ring Vacuum Pump	20
Cloudy Well Pump	20
Clarified Well Pump	15
(ROM) Total	165

Figure 5

TYPICAL DISSOLVED AIR FLOTATION TECHNOLOGY SCHEMATIC SHOWING POSSIBLE CONNECTION POINTS FOR ACTIVE FILTRATION TECHNOLOGY



The typical motor list and rough order of magnitude (ROM) horsepower requirements of the conventional DAF technologies include the following:

Dissolved air flotation system

Service	Total Horsepower
System Feed Pump	45
Air Compressor	25
Chemical Feed Pump(s)	.25
Fiber Scoop Drive Motor	5
Thick Stock Pump for recovered stock	10
Cloudy Water Pump to Storage Chest & AES Filter	25
AES Filter	5
AES Pump to Storage Chest	10
(ROM) Total	130

Section 5

ENERGY, ECONOMIC AND ENVIRONMENTAL BENEFITS

ENERGY SAVINGS

Overview

Analysis of the study data disclosed that one of the greatest potentials for cost savings is directly related to recovered energy. Recovering this energy avoids having to combust fuel that would otherwise be required to raise raw water to process temperature. Because these two factors are so closely linked, they are presented in the following discussion together. The actual energy savings achievable are very site specific. Some mills have very efficient heat-recovery systems on their process that impact directly on the energy efficiency of the overall process. For purposes of this section, it is assumed that the heating efficiency of an existing system is 100%. That is, there are no losses associated with the method by which the thermal energy is currently supplied to the process in which the hot reclaimed ultra-clarified water is to be supplied. This is the most conservative assumption available for this analysis. In practice this is not typically achievable in production applications.

Savings For Process Specific Application

A process specific application as discussed in Section 3 may be used for sections of a single paper machine's felt showers or wire showers or for chemical and coating solution preparation. Such systems typically operate within the range of 25 GPM to 75 GPM. Table 5 depicts the energy savings associated with a typical mill's fresh water shower water or process water system that operates approximately 60 to 70 degrees above the incoming fresh water temperature. It also provides an array of potential equipment configurations and rough order of magnitude (ROM) installed project costs for a small system as defined in Section 3. The detailed cost savings analysis provided for the Typical Mill Wide Application below may be scaled directly to determine the value of the energy savings for a process specific application.

Table 5
Energy Savings by Water Source - Process Specific Systems

Reclaimed Water Flow Rate (GPM) =>	25	50	75
"L" = "AFU" Filtration Height - in Meters	AFU's's Req'd by Flow Rate		
L2 - 2 Meter AFU's – For Low Overhead (≥ 13 ft.)	2	4	5.5
ROM Installed Cost	$ 185,849	$ 371,698	$ 511,085
Recoverable Btu's/Hr in Recovered Water	688,050	1,376,100	2,064,150
L3 - 3 Meter AFU's – For Medium Overhead (≥ 16 ft.)	1.5	2.5	4
ROM Installed Cost	$ 162,618	$ 255,542	$ 371,698
Recoverable Btu's/Hr in Recovered Water	688,050	1,376,100	2,064,150
L4 - 4 Meter High AFU's – For High Overhead (≥ 20 ft.)	1	2.0	3
ROM Installed Cost	$ 123,590	$ 247,179	$ 370,769
Recoverable Btu's/Hr in Recovered Water	688,050	1,376,100	2,064,150

Savings For Typical Mill-Wide Application

Analysis of the study data disclosed that one of the greatest potentials for cost savings is directly related to recovered energy. Recovering this energy avoids having to combust fuel that would otherwise be required to raise raw water to process temperature. Because these two factors are so closely linked, they are presented in the ensuing discussion together. Both energy and water savings are significant and are summarized for a 350 GPM system in the Table 5.

The energy market experienced considerable volatility in the twelve months prior to and during this report's preparation. By way of example, one decatherm of natural gas delivered to an industrial customer in New York State in January 2004 cost $8.00. One year later in January, 2005 the same customer paid $9.65. This represents an increase of 21 percent. Similarly, a barrel of light sweet crude settled at $43.64 on the NYMEX on December 29, 2004. As of April 6, 2005, May, 2005 NYMEX futures settled at $55.60. This represents an increase of 27 percent in approximately four months. The analysis below uses 2004 energy pricing and indicates that the technology presents significant opportunities for savings. However, the analysis only partially reflects the upward volatility of the energy market. The savings portrayed herein are, therefore, likely conservative of those that may result from application of the technology going forward.

Table 6

Energy and Water Savings by Water Source Typical Mill-Wide Application

		Water Source				
Annual Savings[13]	**Units**	**Towels**	**Napkins**	**Towels + Napkins**	**Reclaim**	**Sewered**
Water Recovered	10^6 Gallons	89.21	92.23	181.44	181.44	181.44
Energy Recovered	DT's	51,331.3	42,054.2	93,385.5	100,998.0	94,390.4
Natural Gas Saved	10^6 CF	48.89	40.05	88.94	96.19	89.90
No. 2 Fuel Oil Saved	10^3 Gallons	366.65	300.39	667.04	721.41	674.22

Notes:

1. The Towels & Napkin (T&N) percentages are assumed to be approximately 50 % for each family of grades. This is not intended to be specific to the host mill or to any other mill. Total T&N – represents total savings based upon the combination of both grades for a year.

Aside from the energy savings, a mill employing the technology may generally expect to recover material for reuse. Reclamation of the material also results in avoiding its loss from the process and the subsequent necessity of its disposal. As a result the mill can expect savings in addition to the above in the form of

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[13] For the purposes of the analyses presented herein, a flow of 350 gallons per minute has been selected. This equates to approximately 500,000 gallons per day. From Table 2 (page 5-4) it should be noted that the equipment requirements vary considerably with the water source.

mitigated material purchase and disposal costs. Table 7 below summarizes energy, material, and disposal savings as well as operating costs to determine net potential savings. The details associated with these costs and savings are presented later in this report. The relative equipment requirements for the various sources may differ considerably dependent upon conditions within a particular mill. The pilot trial demonstrated that for the sources tested in the host mill the whitewater and sewered water required 60% to 80% more capacity compared to the reclaimed water. Mills with alternative furnishes may not encounter such large disparities in capacity requirements.

Table 7

Cost Savings by Water Source

		Total T&N	**Reclaim**	**Sewered**
Case	**Flow Rate (GPM)**	**350**	**350**	**350**
Natural Gas Costs	Fuel	$777,151	$839,328	$785,303
	Material	$185,368	$185,368	$185,368
	Disposal	$37,074	$37,074	$37,074
	Annual Gross Savings	$999,593	$1,061,770	$1,007,745
	Expenses & Operating Costs	$269,960	$195,813	$269,960
	Net Annual Savings	$729,633	$865,957	$737,785
No. 2 Fuel Oil Costs	Fuel	$912,766	$988,079	$922,698
	Material	$185,368	$185,368	$185,368
	Disposal	$37,074	$37,074	$37,074
	Annual Gross Savings	$1,135,241	$1,210,521	$1,145,140
	Expenses & Operating Costs	$269,960	$195,813	$269,960
	Net Annual Savings	$865,281	$1,014,708	$875,180

Every gallon of water that is recovered results in one gallon of water that does not have to be treated prior to discharge. Wastewater treatment costs vary considerably based on a number of criteria including, but not limited to: strength of the wastewater; time volume of discharge; suspended and dissolved solid content. Due to the variability, this cost saving has not been integrated into the overall economic benefits analysis. However, based on 360 days per year of operation for the recovery flow of 350 GPM presented above and a per gallon treatment cost of 0.1 ¢/gallon, a mill might expect to save an additional $181,368 per year. This savings calculation further assumes the water stream being recovered contains a solids concentration of 0.1 percent.

The energy and economic discussion includes a brief sensitivity analysis of the results presented to externalities of the analysis variables. The sensitivity analysis also examines variability in the application of the study results to other mills in the industry. This is followed by a separate discussion that presents energy and economic benefits that are not readily quantifiable without extensive investigation beyond the scope of this study.

In general, the results presented in this section have been extracted and condensed from numerous spreadsheets used to refine the study data and model other economic and operating scenarios. These spreadsheets have been included in Appendix F.

ADDITIONAL POTENTIAL COSTS SAVINGS

Benefits that can be expected from application of the technology with respect to mitigating solid waste generation are directly impacted by the recovered material's characteristics discussed above in the wastewater section. The material recovered in the study mill was considered unsuitable for return to the process by the mill, therefore, in the case of the study mill, no benefit can be expected as regards solid waste generation. The "Gross Annual Material Savings for Selected Flows and Process Water Solids Concentrations" table in Appendix F summarizes amounts of material that could feasibly be recovered based on data generated by the study.

However, transfer of this technology to other paper mills at a similar point of application in the manufacturing process may result in recovery of usable material that would otherwise find its way to the mill's WWTP and ultimately to a solid waste landfill. The "Gross Annual Waste Disposal Savings for Selected Flows and Process-Water Solids Concentrations" table in Appendix F summarizes amounts of material that could feasibly be recovered based on data generated by the study. These tabulations have been prepared for different solids concentrations (i.e. – in the process water) and process-water recovery rates. The tabulated data have been prepared assuming the technology removes 98% of the suspended solids in the process water in order to be conservative with respect to solid waste mitigation. The test data actually support removals in excess of 99.5%. Other variables such as production time have been incorporated in the tabulations, also based on assumptions for a typical mill.

Table 8 provides estimates on potential value of recovered material and avoided disposal costs. The following parameters have been selected in order to present conservative results yet results that closely represent present conditions in the industry:

- Solids removal rate of 99 – 100% as demonstrated by the pilot test
- Solids concentration in the process water of one tenth of one percent (0.10%)
- A value of the recovered fiber of $250 per ton
- Disposal cost of $50 per ton of waste sludge

Table 8

Summary of Potential Additional Material Related Savings

Flow Rate (GPM)	**Material Recovered (TPY)**	**Recovered Material Value**	**Annual Avoided Disposal Cost**	**Total Annual Economic Benefit**
350	741.5	$185,368	$37,074	$222,442

SIMPLE RETURN ON INVESTMENT ANALYSIS

This generic return of investment (ROI) analysis is based on a 350 GPM system processing the reclaim water previously described. Note that the economics associated with each system for a given application are unique. However, the infrastructure and operating costs as well as the ROI described below are scalable to a fair degree of accuracy. That is, for a 175 GPM system, divide the numbers by two, for a 700 GPM system, multiply the numbers below by two, and so on.

Estimated Capital and Operating Costs

As discussed in Section 3, it is estimated that the capital cost for a system of this size would be approximately $2,100,000. The operating and maintenance costs for the proposed mill scale process would include electric power costs, chemical purchases, and maintenance costs. The process is designed to be fully automated, much like most competitive water recovery systems. Daily testing by the mill's lab staff, similar to that required for the typical current clarified water systems, would be required to ensure proper operation. Therefore, labor has been excluded from this analysis.

Table 9

Summary Annual Operating Costs for 350 GPM System

Cost Item	**Annual Costs**	**Notes**
Energy	$54,000	From Table 4, Section 3, Page 10
Treatment Chemicals	$114,000*	From Table 4, Section 3, Page 10
Routine Maintenance	$36,000	From Table 4, Section 3, Page 10
Total Approximate Annual Costs:	$204,000	From Table 4, Section 3, Page 10

* Note that chemical savings elsewhere in the mill, as discussed in Section 3, will typically offset this cost.

Estimated Cost Savings

Gross annual savings are summarized in Table 10, below.

Table 10

Gross Annual Savings for 350 GPM Reclaim Water System

Savings Item	Annual Savings	Notes
Energy	$839,328	See Table 6 for Natural Gas
Material Savings	$185,368	See Table 8
Avoided Disposal Costs	$37,074	See Table 8
Total Approximate Annual Savings:	**$1,061,770**	

Simple Payback Calculation

Capital Cost	$2,100,000
Annual Operating Cost	$ 204,000
Gross Annual Savings	$1,061,770
Net Savings	$ 857,770
$2,100,000 / $ 857,770 =	29 Months

Simple Return On Investment (ROI) Calculation

$857,770/$2,100,000 ~ 41% ROI

The above does not take into account the time value of money or the impact of the new accelerated depreciation allowed under IRS accounting rules, both of which may have a significant impact on the payback period and the ROI. The savings used in the calculation above do not include the potential value of recovered fiber or the potential offset of chemical treatment costs achieved from this process.

UNQUANTIFIED BENEFITS

Energy and Economic

The application of the technology has the potential to reduce the impact on a mill of fluctuations in energy pricing. By decreasing total energy use, the total cost associated with pricing fluctuations is reduced.

Although not the case with the study mill, the technology has the potential to reduce solid waste disposal costs[14] through recovery of usable fiber and filler materials. Aside from this direct economic benefit to the mill, there are also energy savings in the form of avoided wastewater treatment (i.e. – electricity associated with pumping, aeration, sludge pressing, etc.) as well as transportation of wastewater sludge from the mill to its disposal point. Chemical use is an integral part of wastewater treatment. By decreasing hydraulic loading to the wastewater treatment plant, some savings in chemical usage will most likely be realized.

Infrastructure

Benefits with respect to decreased infrastructure usage will be realized at both the mill and energy transportation systems proximate to the mill. As discussed above, it has been demonstrated that significant hydraulic loading may be removed from the wastewater treatment plant. This reclaimed capacity can be reserved for future production increases or to enhance treatment plant performance. Additionally, expansions to wastewater treatment plants typically require considerable physical space that, in many instances, mills do not have. Reducing hydraulic loading to the treatment plant has the same effect as physically expanding it without the space consideration.

For mills with stand-alone power houses, reducing energy usage has the direct effect of decreasing demand on this part of the mill’s infrastructure. Similar to wastewater treatment, this reclaimed capacity may be reserved to accommodate future production capacity increases without the otherwise associated capital expenditure requirements.

Alterations to a mill’s wastewater or power generation infrastructure often require a protracted, expensive permitting process. This is discussed further in the Environmental Benefits Section. Reclamation of capacity through conservation completely mitigates this requirement.

Reductions in natural gas usage result in decreased capacity demand on transportation infrastructure. This may be critical, as in remote areas where mills are frequently located at the “end of the line,” transportation capacity is sometimes limited. Further, the overall demand for natural gas is expected to continue to increase for the foreseeable future, placing an even greater demand on infrastructure whose total transportation capacity is hard to expand.

Societal

Paper mills, and companies in general that pursue conservation and environment stewardship, tend to enhance their images in their communities as well as the marketplace. While this benefit is intangible, it should not be overlooked.

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[14] Please see **ENVIRONMENTAL BENEFITS SECTION** of this report.

Further, mills that decrease their consumption of fossil fuels will reduce their emissions of criteria and hazardous air pollutants[15]. This results in improved ambient air quality proximate to the mill, benefiting the mill's neighbors.

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[15] Please see **ENVIRONMENTAL BENEFITS SECTION** of this report.

ENVIRONMENTAL BENEFITS

Overview

The study has served to verify that the application of the technology to recover thermally rich water for reuse, displacing an equal volume of fresh water, is both feasible and practical. From an environmental benefits perspective, the study confirmed that a significant reduction in impacts to air and water media proximate to the host mill can be expected. Additionally, the study confirmed a significant potential for reduction in solid waste may also be expected.

Environmental benefits will generally fall into two (2) major categories:

- "Direct Benefits": These are benefits that may be readily quantified through the application of: study data; industry available data; emission factors; and best engineering judgment
- "Indirect Benefits": These are benefits that are an intuitive result of the application of the technology but are not readily quantifiable without exhaustive research or analyses (i.e. – a lifecycle type analysis)

Both of these "benefits categories" are discussed further, below.

Direct Environmental Benefits

Air

The host mill purchases steam from a cogeneration (cogen) facility located on an adjacent property. The mill also has its own boilers that can be used in the event of an outage at the cogen. The mill does not, therefore, normally combust its own fuel to produce thermal energy required for the manufacturing process. For the purposes of estimating "avoided" emissions, it was therefore assumed that the cogen's fossil fuel energy to steam efficiency is eighty percent (80%). For other detailed assumptions used to produce the tabulated avoided emissions presented in the table below, please refer to the Avoided Emissions spreadsheets contained in Appendix F of this report.

Benefits to the air medium are nearly all derived from avoided combustion of fossil fuels. For the purposes of this study, two separate fuels were evaluated: natural gas and No. 2 fuel oil. Emissions were estimated using two (2) sources for factors:

- The United States Environmental Protection Agency’s AP-42 emission factor database: Factors used from this database were selected for boilers greater than 100 MMBtu[16]/Hr heat input size. The latest published editions of the individual sections were used.
- With respect to estimating emissions of oxides of nitrogen (NO_X), the emission rate established regulation under Title 6 of the New York Code of Rules and Regulations (6NYCRR), Part 227 was used. This regulation establishes the maximum emission rate for NO_X for various size combustion installations in New York State. The rate associated with combustion installations with a heat input greater than 100 MMBtu/Hr but less than 250 MMBtu/Hr was deemed to be most representative of boilers typically found at most paper mills.

The table below gives estimated, avoided emissions of air pollutants associated with avoided combustion of natural gas in mills’ steam boilers. The combustion of the natural gas would be avoided as a result of the recovery of the thermal energy in the recovered water from the “Active Filtration” technology.

Table 11

Estimated Avoided Emissions Associated with

Avoided Combustion of Natural Gas

			Thermal Energy Recovered Annually Reported in Decatherms (DT's)				
Air Contaminant	**Emission Factor (lbs/10^6 SCF)**	**Notes**	**Process Waters (3) Towels**	**Napkins**	**Reclaimed Water**	**Sewered**	
			51,331	**42,054**	**100,998**	**94,390**	
NO_2 (LNB)	**140.0**	1,2	5.13	4.21	10.10	9.44	**Avoided Emissions Reported in Tons per Year**
CO	**84.0**	2	2.57	2.10	5.05	4.72	
PM (Total)	**7.60**	2	0.23	0.19	0.46	0.43	
SO_2	**0.60**	2	0.02	0.02	0.04	0.03	
VOC	**5.50**	2	0.17	0.14	0.33	0.31	
Formaldehyde	**0.075**	2	0.002	0.002	0.005	0.004	
CO_2	**120,000**	2	3,666	3,003	7,214	6,742	

Notes:

1. NYS RACT requirement for large boilers (6NYCRR Part 227.2): 0.2 lbs_{NOx}/MMBtu
2. Emission factors represent the potential pounds of emissions of each pollutant from the combustion of one million cubic feet of natural gas. The factors are taken from USEPA AP-42 Section 1.4 (7/98 ed.).

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[16] MMBtu/Hr – millions of British thermal units per hour. A British thermal unit is the amount of energy required to raise one pound of water one degree Fahrenheit.

3. The process water columns refer to the potential recovered heat in the wasted process water from the production of napkins or towels. The difference in the values is based upon the difference in the performance of the two streams in the “Active Filtration” technology.

The table below gives estimated, avoided emissions of air pollutants associated with avoided combustion of No. 2 fuel oil in mills’ steam boilers. The combustion of the oil would be avoided as a result of the recovery of the thermal energy in the recovered water from the “Active Filtration” technology.

Table 12

Estimated Avoided Emissions Associated with Avoided Combustion of No. 2 Fuel Oil

			Thermal Energy Recovered Annually Reported in Decatherms (DT's)				
Air Contaminant	**Emission Factor (lbs/10^3 Gals)**	**Notes**	**Process Waters** (4) **Towels**	**Napkins**	**Reclaimed Water**	**Sewered**	
			51,331	**42,054**	**100,998**	**94,390**	
NO_2 (LNB)	**24.0**	1,2	9.62	7.89	18.94	17.70	**Avoided Emissions Reported in Tons per Year**
CO	**5.0**	2	1.15	0.94	2.25	2.11	
PM (Total)	**2.0**	2	0.46	0.38	0.90	0.84	
SO_2	**0.81**	2,3	0.19	0.15	0.37	0.34	
VOC	**0.34**	2	0.08	0.06	0.15	0.14	
Formaldehyde	**0.05**	2	0.01	0.01	0.02	0.02	
CO_2	**22,300**	2	5,110	4,186	10,054	9,396	

Notes:

1. NYS RACT requirement for large boilers (6NYCRR Part 227.2): 0.3 lbs$_{NOx}$/MMBtu
2. Emission factors are taken from USEPA AP-42 Section 1.3 (7/98 ed/).
3. Fuel sulfur content assumed at 0.5 percent by weight per 6NYCRR Part 225
4. The process water columns refer to the potential recovered heat in the wasted process water from the production of napkins or towels. The difference in the values is based upon the difference in the performance of the two streams in the “Active Filtration” technology.

As can be seen from the tabulated data, the potential for reduction of criteria air pollutants and ozone precursors is significant. The potential for reduction of greenhouse gases is also significant.

Water

One of the primary objectives of the study was to recover process water for reuse in the papermaking process. Every gallon of water recovered avoids the use of one (1) gallon of fresh water and the discharge of one (1) gallon of treated wastewater.

In the host mill, raw water is not treated prior to injection directly into the process. Therefore, with respect to the host mill, the technology results in no benefit with respect to raw water use aside from the avoidance of withdrawing it from the water source[17]. The 'intangible benefits" of this are discussed in greater detail below.

The study disclosed several potentially different cases with respect to wastewater impacts:

- Reclamation of the process water and return of the separated solids to the wastewater stream;
- Reclamation of the process water and return of the separated solids to the papermaking process;
- Reclamation of the process water and use of the separated solids in another paper or board making process not in the same mill;
- Reclamation of the process water and use of the separated solids in an ancillary beneficial use not in a paper or board manufacturing process.

The particular case applicable to a specific mill will be determined by the characteristics of separated solids. These characteristics include: fiber content, fiber characteristics, and ash[18] content.

The solids separated from process water in the host mill were deemed unsuitable for returning them to the mill process for reuse, for other papermaking applications, or other beneficial use. The solids were, therefore, sent to the mill's wastewater treatment plant. Consequently, environmental benefits that may be expected with respect to receiving water body quality[19] for a typical mill are:

- A decrease in thermal impacts due to a decrease in the total discharge into the receiving water body equal to the amount of water returned to process;

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[17] Mills derive their water from a number of sources, chiefly from surface water bodies (e.g. – the host mill extracts its water from the Hudson River) but also from groundwater wells and municipal systems.

[18] In the papermaking industry the term "ash" refers to that portion of the process water that is inorganic to include: clays, calcium carbonate, titanium dioxide, etc.

[19] Some mills discharge to a publicly owned treatment works (POTW).

- A slight decrease in BOD[20], COD[8], and dissolved solids that may be entrained in the water returned to process; and
- A potential increase in the overall quality of the effluent from the mill's wastewater treatment plant (WWTP).

With respect to this latter, a key factor in a WWTP's performance is the ratio of the actual hydraulic loading to the original, maximum design hydraulic capacity. Generally speaking, the lower the influent flow is with respect to the design capacity, the better the WWTP performs. Ergo, by removing 500,000 gallons per day[21] (GPD) of hydraulic loading from the host mill's WWTP, it would be reasonable to expect enhanced WWTP effluent quality discharged to the receiving water body[22].

Further, "reclaiming" hydraulic capacity through decreasing the influent flow to a WWTP is almost always more cost effective than constructing additional capacity. Quantifying the environmental benefits associated with reduction of hydraulic loading in the host mill's WWTP is well beyond the scope of this study. However, this benefit should not be overlooked when assessing application of the technology and its overall environmental benefit.

Solid Waste

Benefits that can be expected from application of the technology with respect to mitigating solid waste generation are directly impacted by the recovered material's characteristics discussed above in the wastewater section. The material recovered in the host mill was unsuitable for return to the mill process or another type of alternative use. Therefore, in the case of the host mill, no benefit can be expected as regards solid waste generation.

However, transfer of this technology to other paper mills at a similar point of application in the manufacturing process may result in recovery of usable material that would otherwise find its way to the mill's WWTP and ultimately to a solid waste landfill. Selected spreadsheets included in Appendix F summarize the amounts of material that could feasibly be recovered based on data generated by the study. These tabulations have been prepared for different solids concentrations (i.e. – in the process water) and process water recovery rates. The tabulated data has been prepared assuming the technology removes 98% of the suspended solids in the process water in order to be conservative with respect to solid waste mitigation. The test data actually support removals as high as 99.5%. Other variables such as total in production time have been incorporated in the tabulations, also based on data made available by the host mill.

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[20] Please see glossary for this term.
[21] 500,000 GPD equates to returning 350 GPM to the mill process.
[22] In the case of the host mill, the Hudson River.

The following brief tabulation summarizes avoided solid waste generation and associated disposal costs utilizing the selected analysis flow rate of 350 GPM. The solids removal rate of 98%, a conservative influent solids concentration in the process water of one-tenth of one percent (0.10%) and disposal cost of $50 per ton have also been assumed.

Table 13
Estimated Avoided Solid Waste
Generation for Analysis Flow

Flow Rate (GPM)	Material Recovered (TPY)	Annual Avoided Disposal Cost ($/Yr)
350	432.2	$37,074

Indirect Environmental Benefits

There are a number of indirect environmental benefits that may be realized from application of the technology within the papermaking industry. It may be possible, using analysis techniques beyond the scope of this study, (i.e. – a “lifecycle” type approach) to actually quantify these. As this will not be attempted in this report, these potential benefits are presented below for the reader’s consideration:

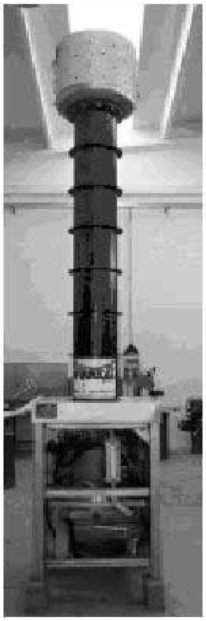
- Avoided marine life mortality from pumping raw water from a river or similar water body;
- Avoided energy use and associated emissions from not having to make pulp, chemicals, and fillers reclaimed and returned to process;
- Avoided media emissions and solid and hazardous waste generation from not having to make pulp, chemicals, and fillers reclaimed and returned to process;
- Avoided energy use and emission from not having to transport these materials to the point of use;
- Reduced demand on energy transportation infrastructure (i.e. – natural gas transportation pipelines and electrical energy transmission lines, etc.); and
- Health benefits due to improvement of local ambient air quality.

APPENDICES

Appendix A

ACTIVE FILTRATION TECHNOLOGY TECHNICAL INFORMATION

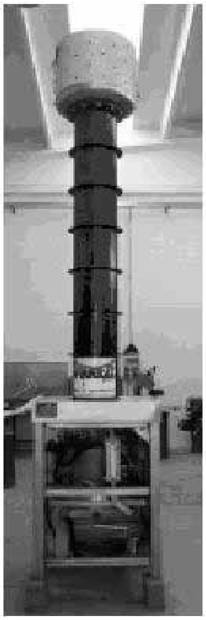
“Active Filtration"
Separation
Technology



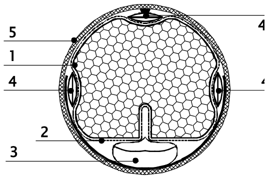
Active Filtration Principals of Operation

- Dynamic Filtration
- Continuous Operation
- Fiber & Fines Containment
- Micro Processor Automation

“Active Filtration" Working Elements

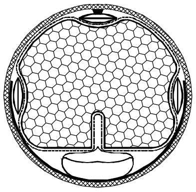


TUBULAR FILTER MEMBRANE	1
DRAINAGE NET	2
PRESSURIZATION MEMBRANE	3
DETACHMENT MEMBRANE	4
CASING	5



Process Stages
Filling

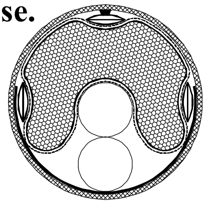
- **During filling, the slurry is pumped into the filter with some gravity drainage of the liquid from the sludge occurring. Solid sludge accumulates on the filter membrane by gravity.**
- **During this filling stage significant liquid drains off through the filter membrane.**



Filling

Process Stages
Pressurization

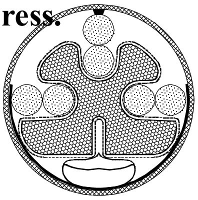
- **During pressurization the three bladders positioned behind the filter membrane are periodically inflated. This action flexes the filter membrane which compresses the sludge and squeezes out liquid.**
- **This action also disrupts the sludge cake and forms new drainage channels in the cake which allow the flow of the liquid to increase.**



Pressurization

Process Stages Detachment & Discharge

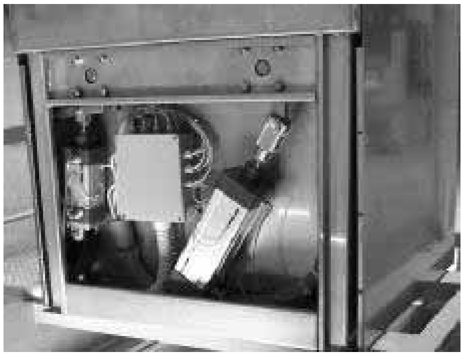
- **During detachment, additional bladders inflate to break up the compacted cake created during the pressurization stage. The three stages are repeated until the "Filterdynamic" Press is full. At that time the detachment stage becomes the discharge stage and the cake is discharged from the bottom of the "Filterdynamic" Press.**



Detachment

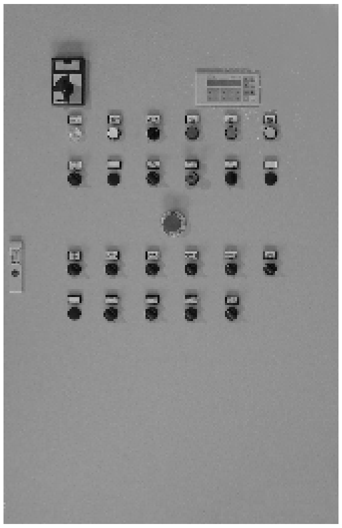
"Active Filtration" Solids Discharge

- **The bottom outlet of the "Filterdynamic" Press is a pneumatically operated door with very unique sealing mechanisms. The door is hollow and the wetted surface is a porous membrane. This allow for filtration at the base of the filter.**
- **The door opens during the detachment cycle to allow the cake or slurry to drop directly into a container, trough or tank.**



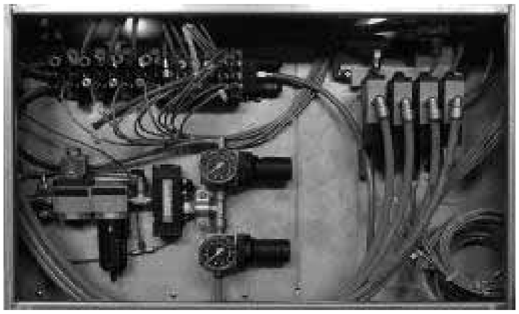
Micro Processor Operation

- The “Active Filtration” control system is Siemens PLC based. The control package is quite flexible to allow for multiple configurations in cycle times and cycle sequences.



Field Control Devices

- The “Active Filtration” is controlled with a pneumatic umbilical which operates from Festo Smart Solenoids in the Control Panel.



Appendix B

PILOT TRIAL METHODOLOGY AND ANALYSIS OF DATA

Pilot Protocol & Testing Matrix
Jannanco, LLC - NYSERDA CONTRACT #8224
Paper Mill Process Water Reuse Investigation

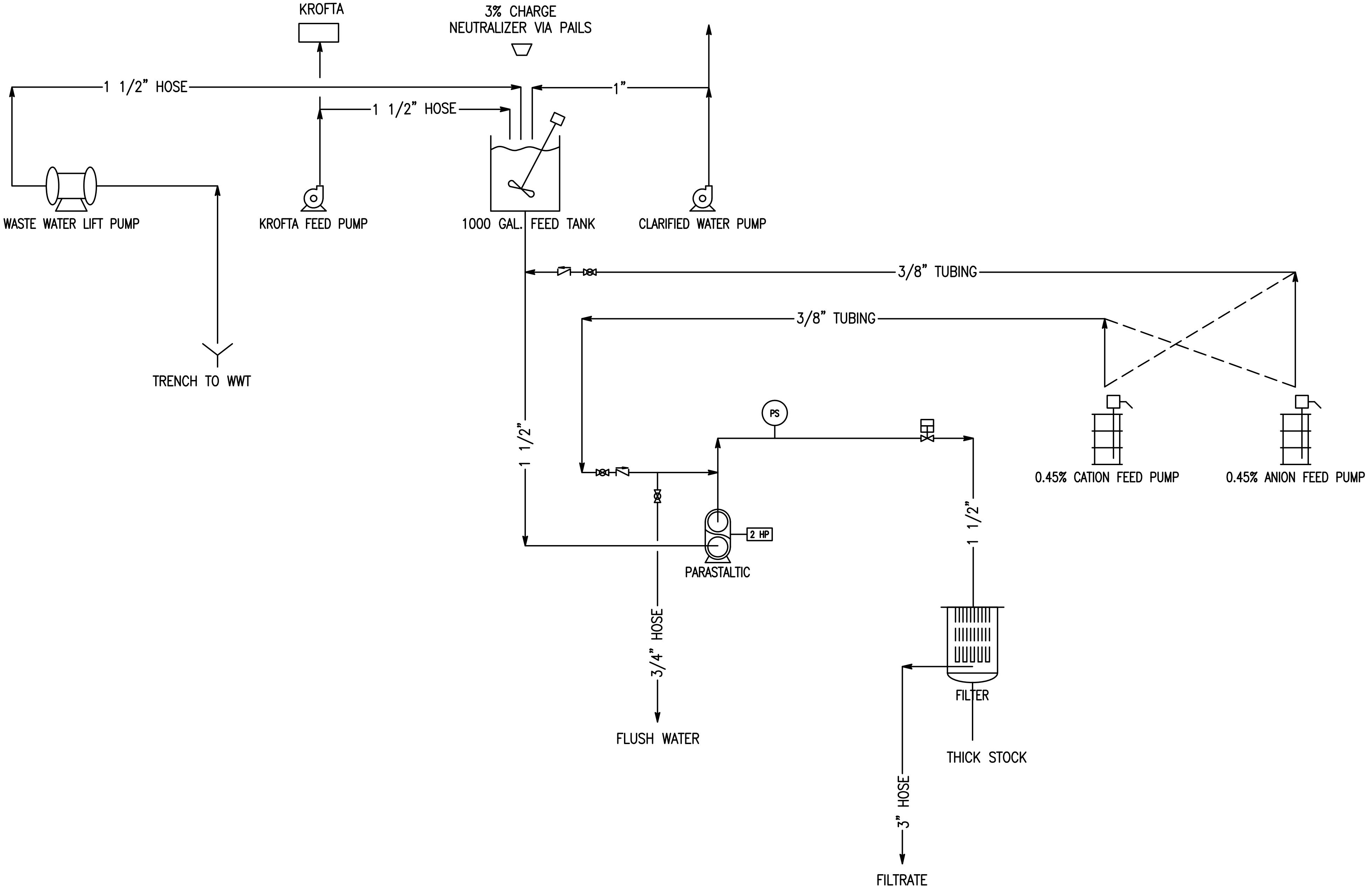
					Filtration Product Testing					Process Parameters			Planned	Comments
Membrane	Whitewater	Pump Type	Chemical	Flocculent	Filtrate Samples			Filter Cake Samples		Flow	Temp	Pump	Schedule	
Pore Size	Source		Insertion Pt.	Formulation	Clarity	TSS	TDS	Moisture	Ash	Rate	deg F	Power*	Week #	
Pilot System Assembly, Set Up and Startup													1-2	
30 Micron	**Whitewater**	**Air Pos. Displ**	Collection Tank	1	Cloudy					1/day		1/day	3	Air Pos. Disp. Pump disintegrated floccs. Abandonded
			Pump Inlet	1	Cloudy					1/day		1/day		
			Pump Outlet	1	Cloudy					1/day		1/day		
	Whitewater	**Peristaltic**	Collection Tank	1	Cloudy					1/day		1/day		Single Flocculant did not form flocs in slurry Abandonded
			Pump Inlet	1	Cloudy					1/day		1/day		
			Pump Outlet	1	Cloudy	1/day	1/day	1/day	1/day	1/day	1/day	1/day		
	Whitewater	**Optimized from above**	**Optimized from above**	2	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 6/18**	
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			Coagulant NR
	Clarified Water			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 6/25**	
	Wasted Water			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
12 Micron	**Whitewater**			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 7/2**	
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
	Clarified Water			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 7/9**	
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
	Wasted Water			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 7/16**	
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
5-8 Micron	**Whitewater**			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 7/23**	
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			Coagulant NR
	Clarified Water			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day		**wk of 7/29**	
	Wasted Water			1	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				2	1/day	1/day	1/day	1/day	1/day	1/day	1/day			
				3	1/day	1/day	1/day	1/day	1/day	1/day	1/day			

Notes:

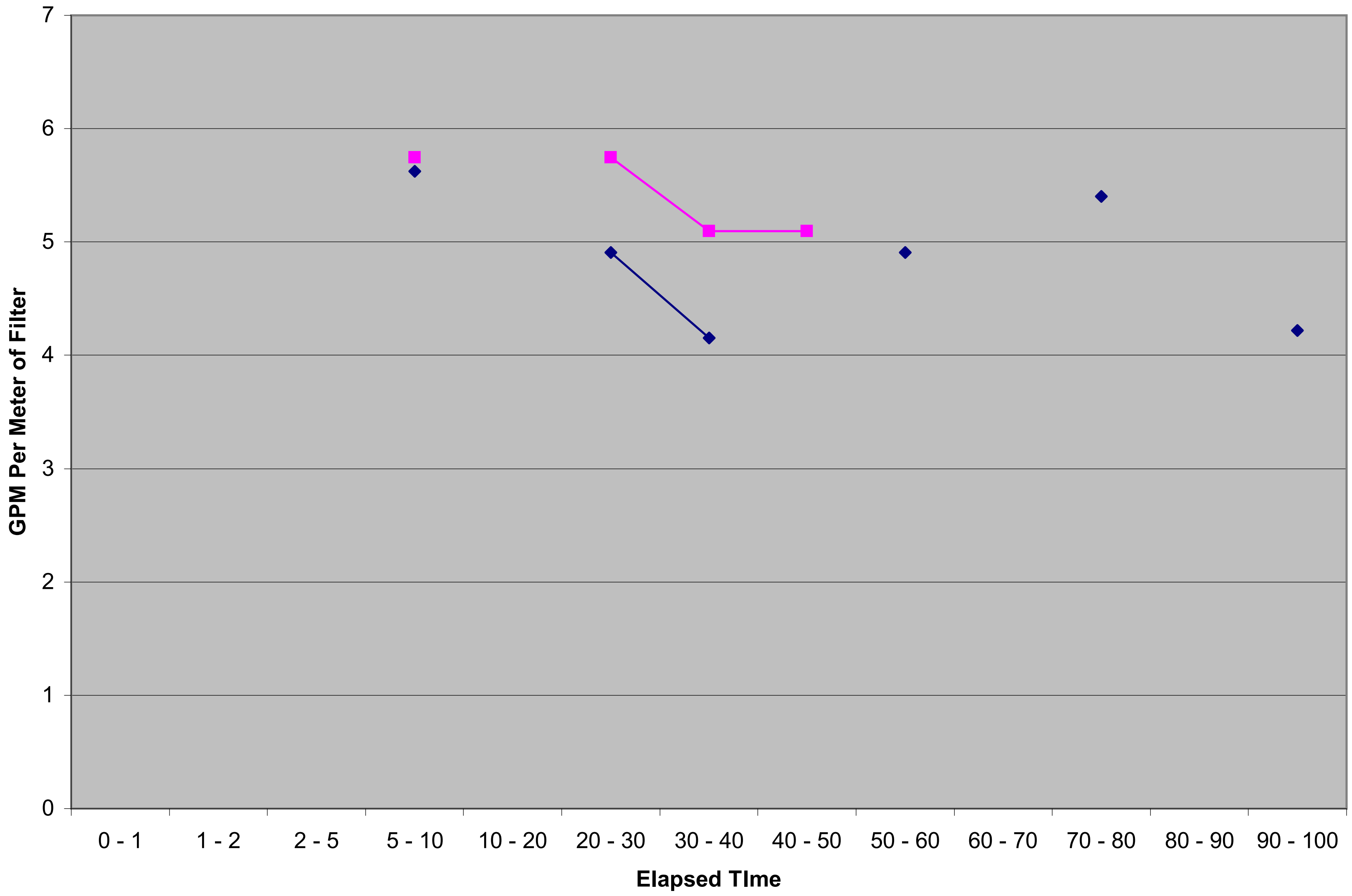
1.) Flocculation Formulations:	**1**	Anion or Cation Flocculant
	2	Two Flocculants w/o Coagulant
	3	Two Flocculants w/ Coagulant
	* Pump Power	Measured in Air Pressure or CFM

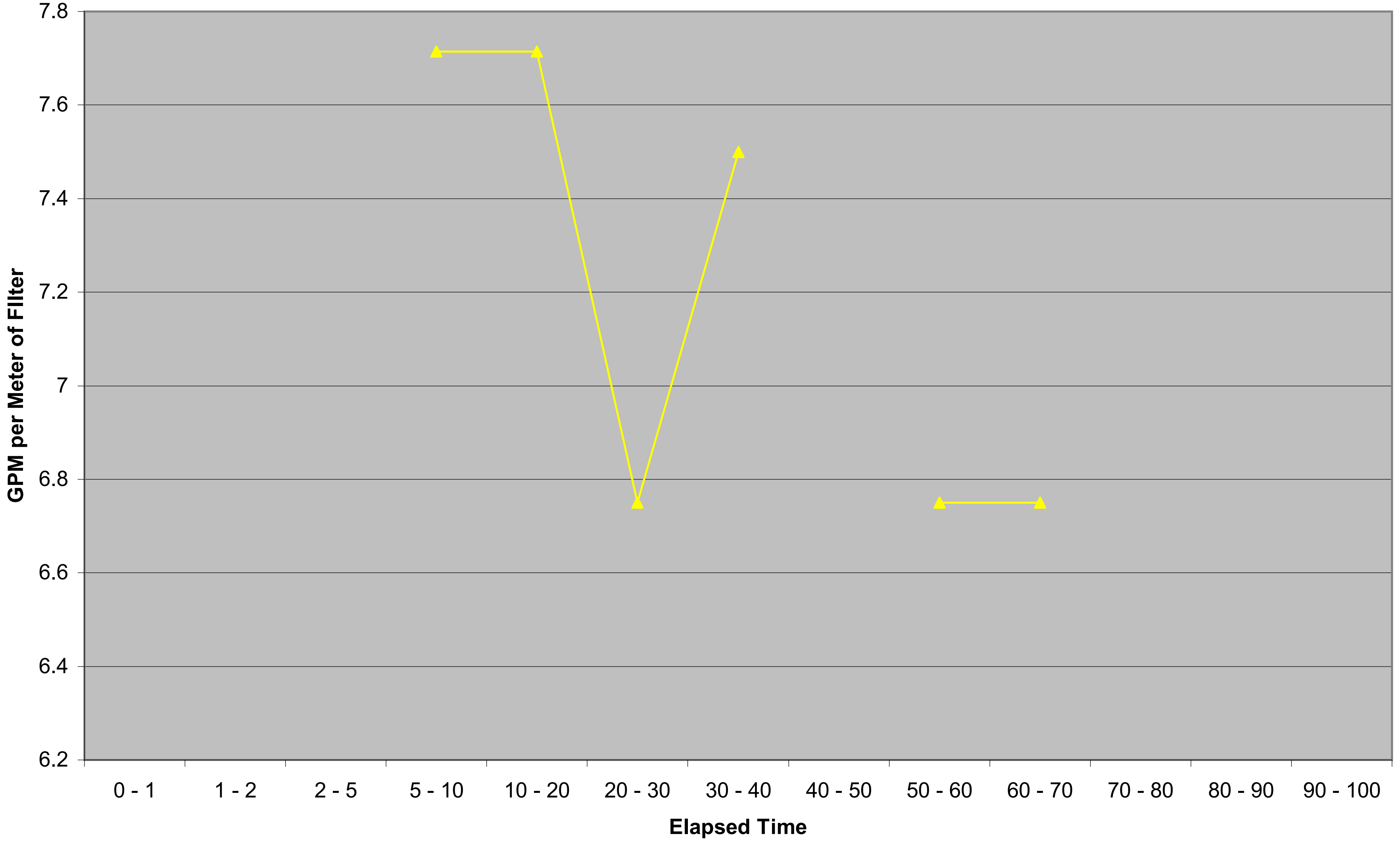
Each protocol was conducted until the performance results repeated at least three times, sequentially or until the protocol proved unsuitable.
Historical work has shown that the filtration performance and flow decay rate are significantly repeatable in production applications once repeatable results are observed in at pilot scale.

JANNANCO WHITE WATER ULTRA FILTRATION PLANT SCALE PILOT ASSEMBLY



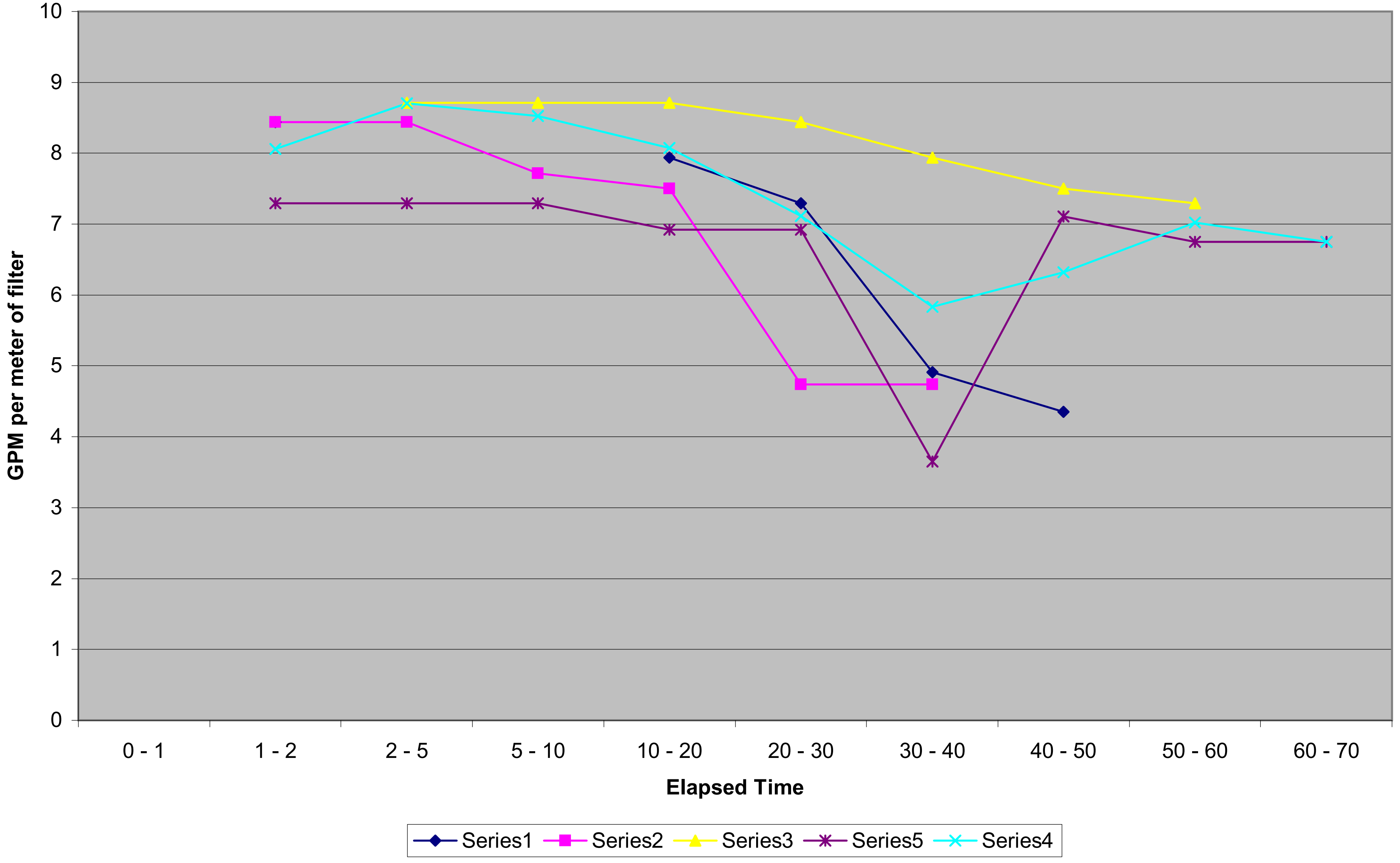
Flow Rate Decay 30 Micron Media w/ Krofta Feed on Towels



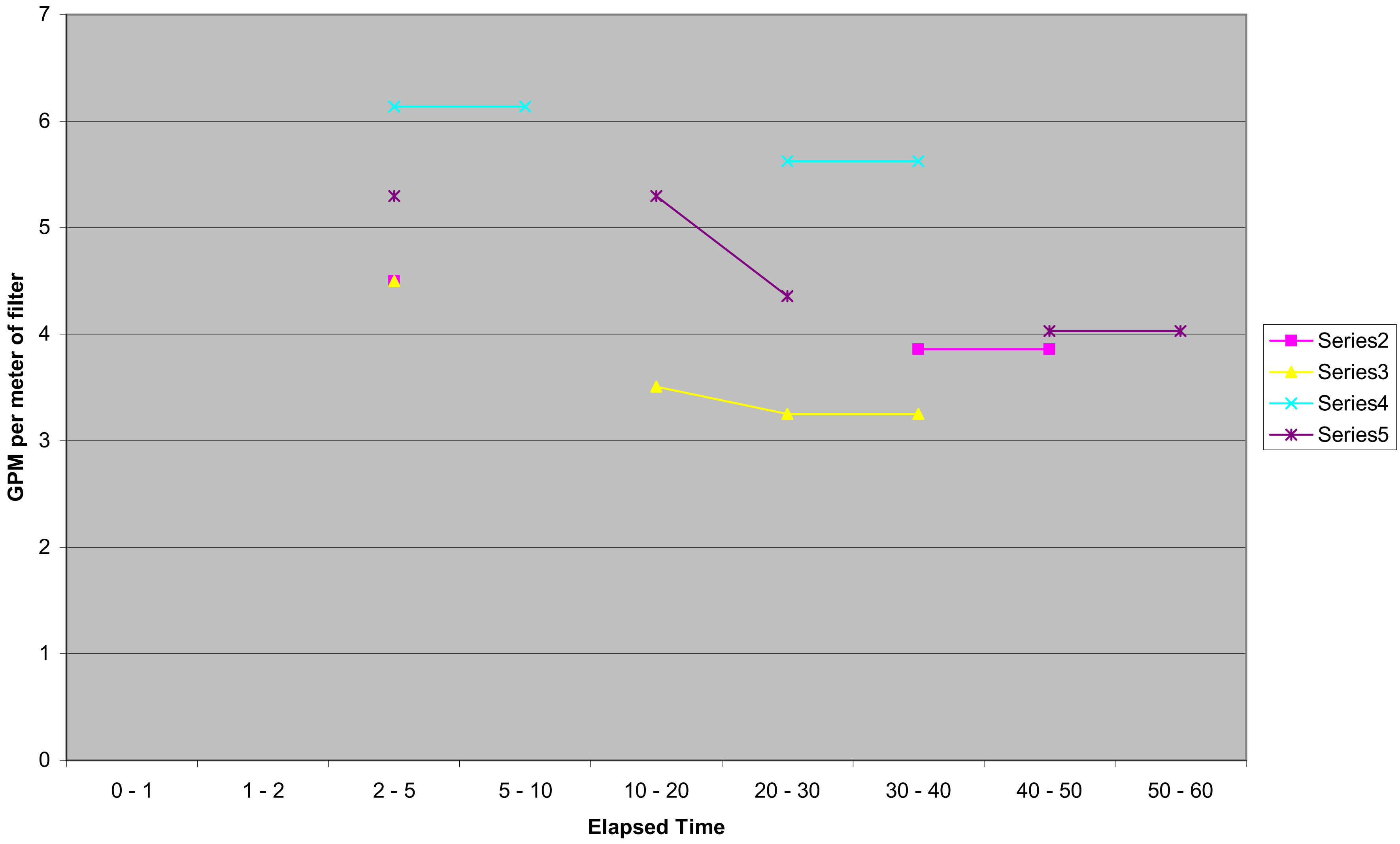


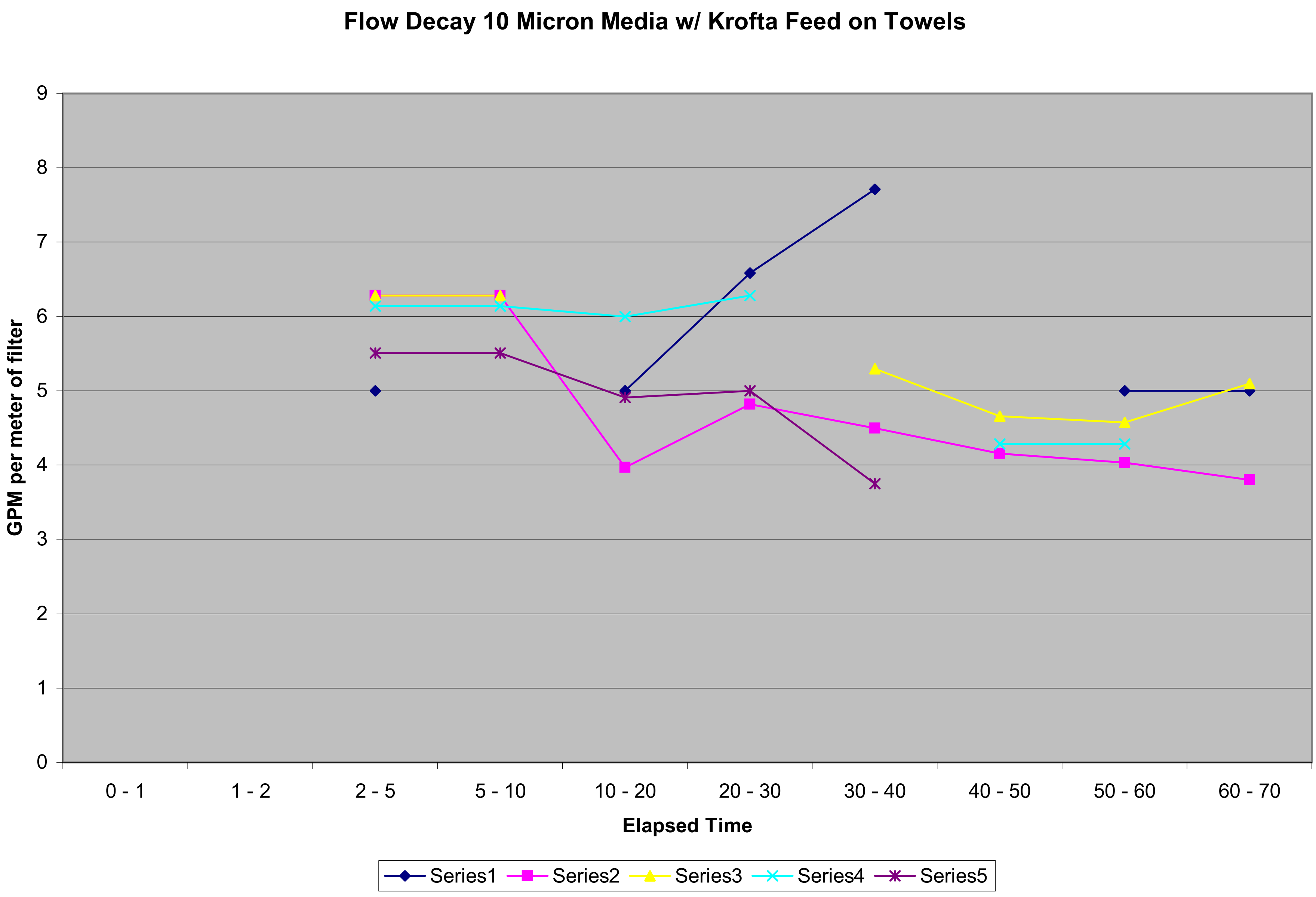
Flow Rate Decay 30 Micron Media w/ Krofta Feed on Reclaim Water

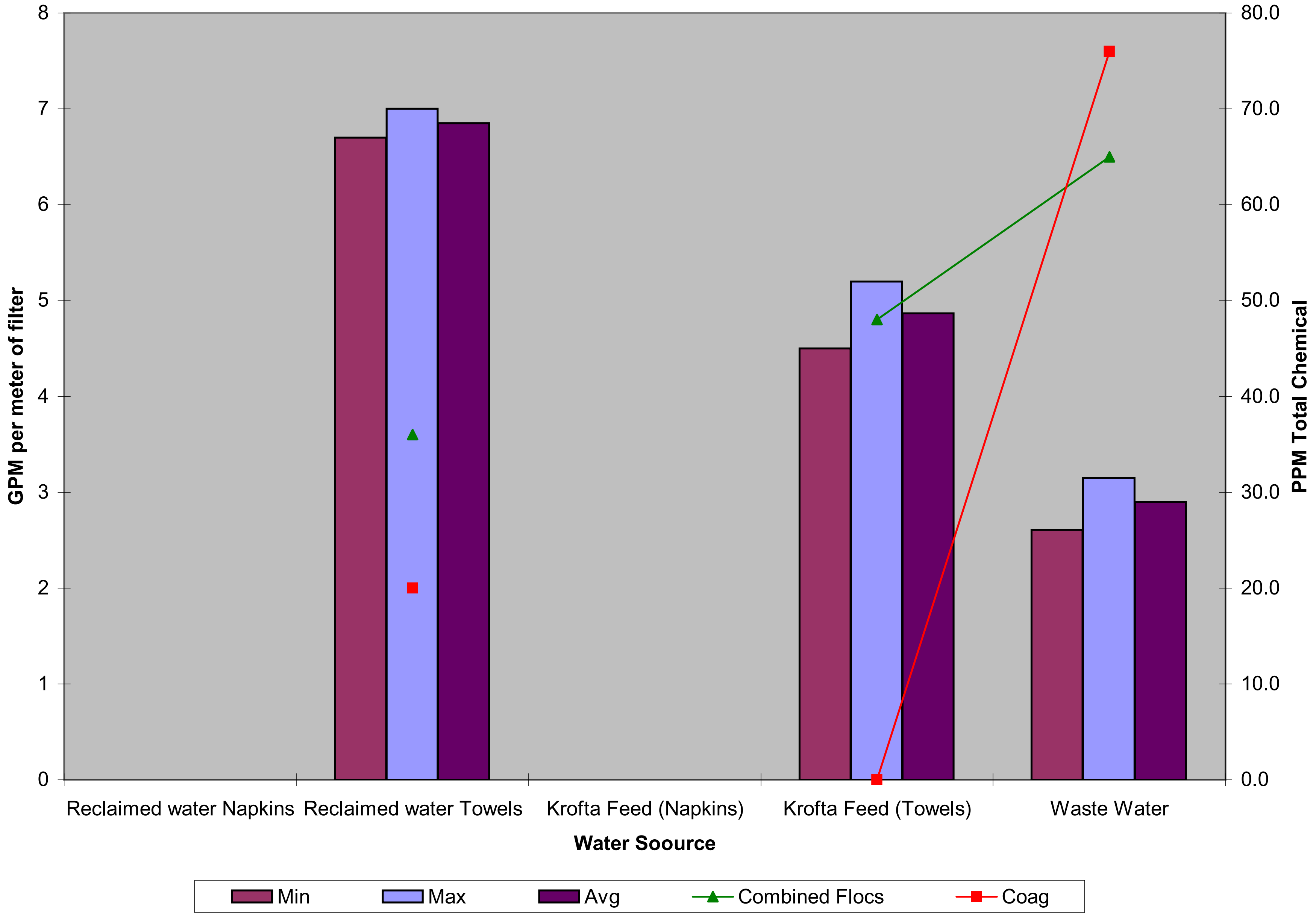
Flow Decay 10 Micron Media w/ Reclaim Water on Towels

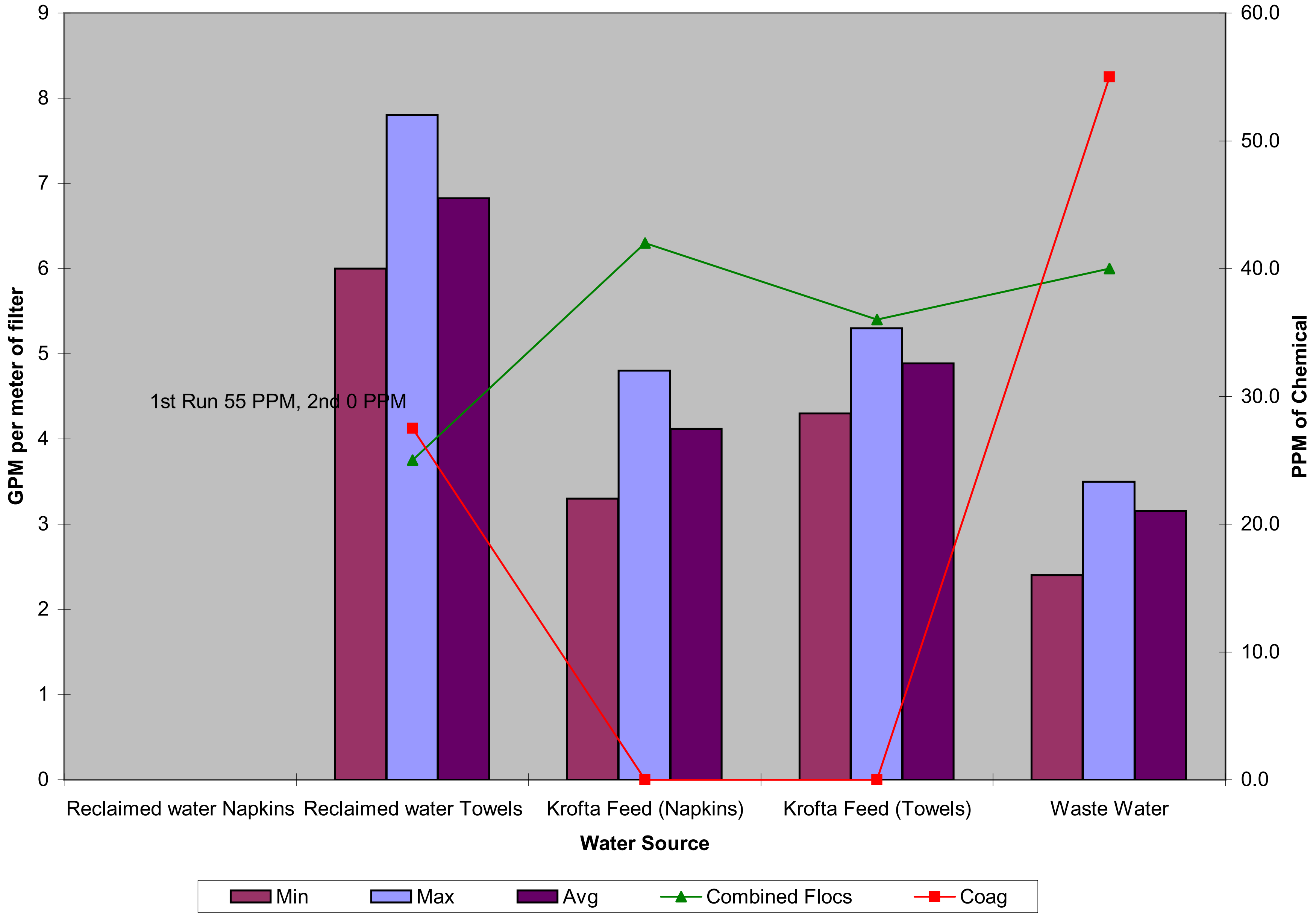


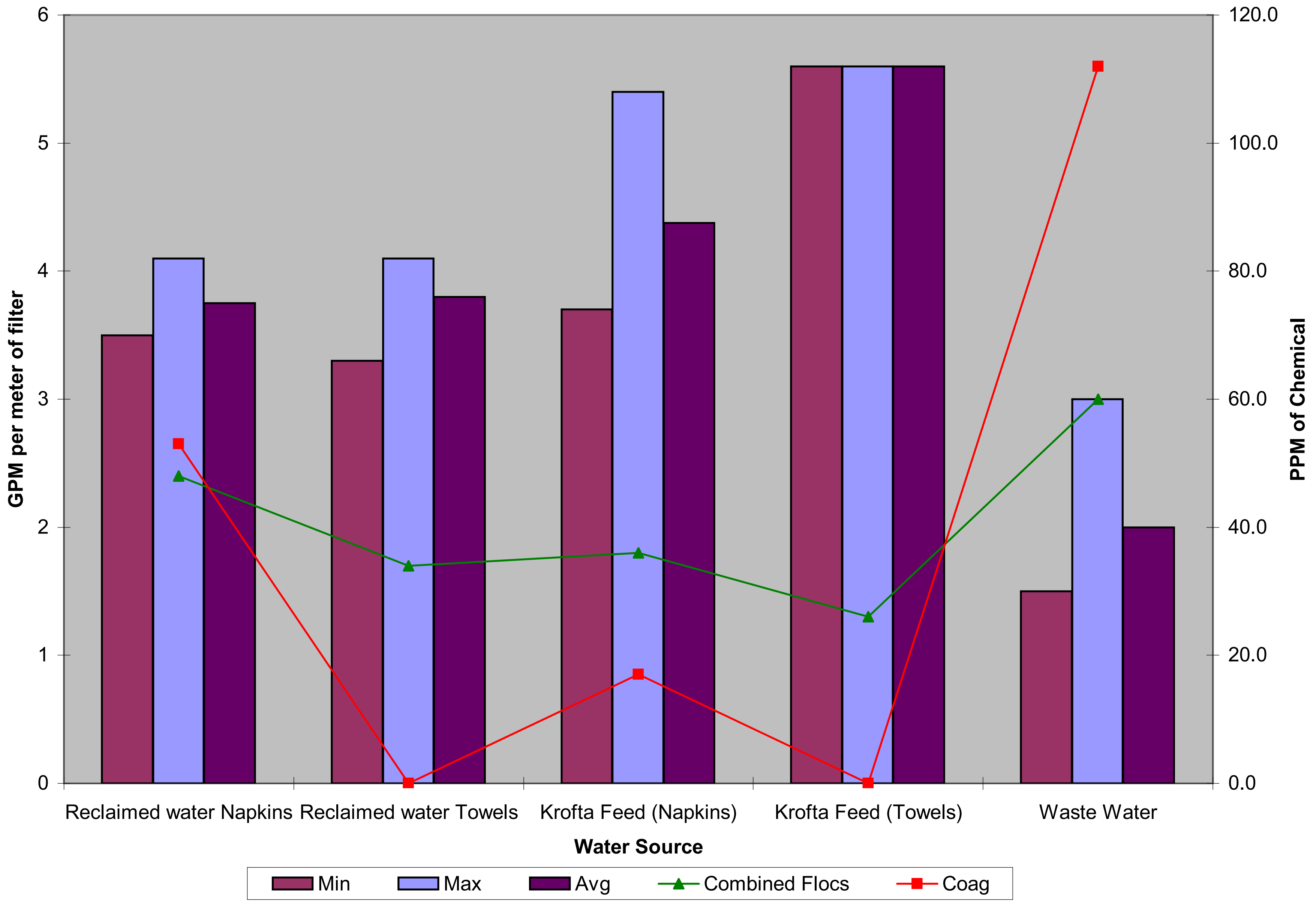
Flow Decay 10 Micron Media w/ Krofta Feed on Napkins

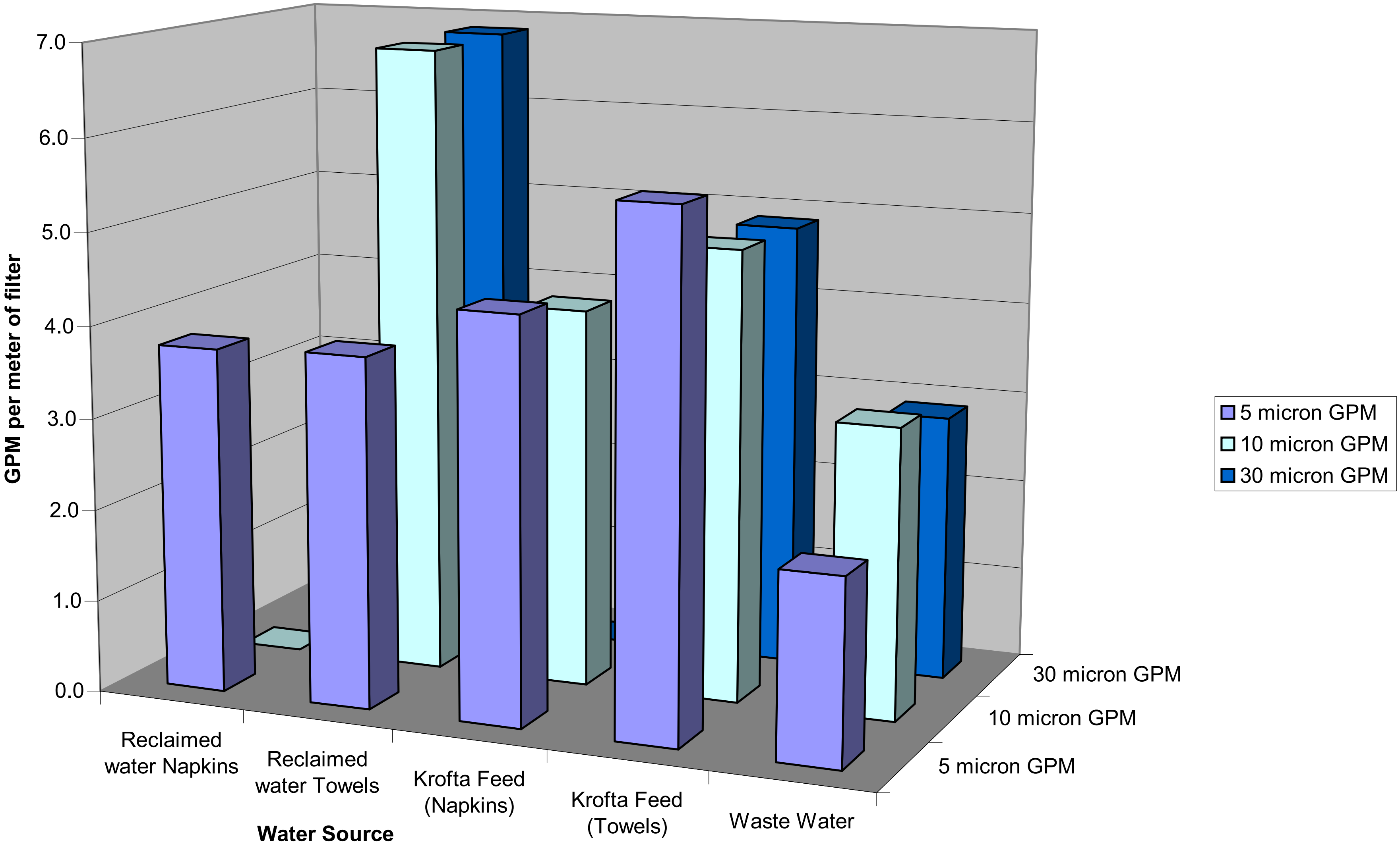


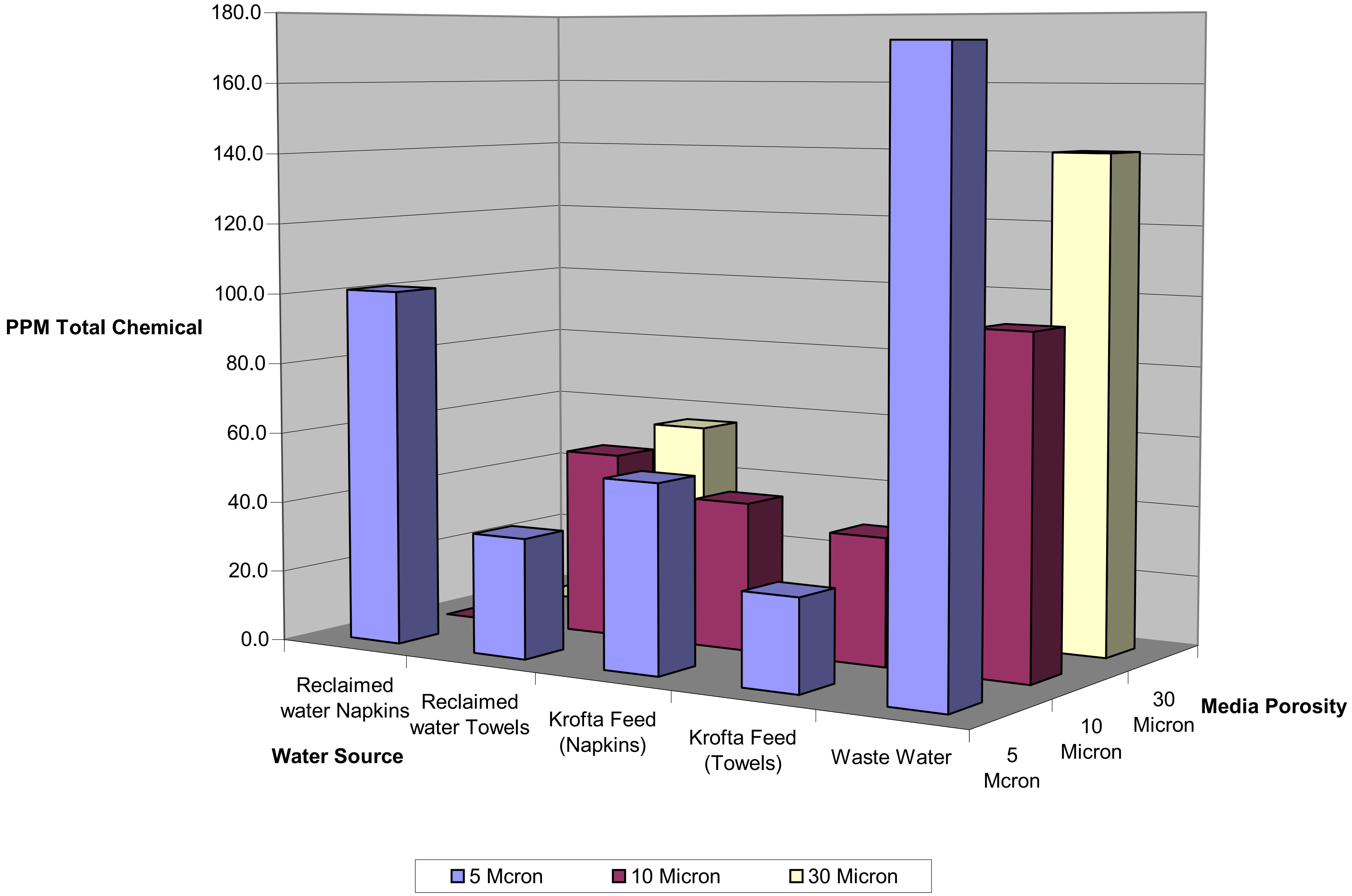

Flow Decay 10 Micron Media w/ Krofta Feed on Towels
GPM per meter of filter
9
8
7
6
5
4
3
2
1
0
0 - 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
Elapsed Time
Series1
Series2
Series3
Series4
Series5

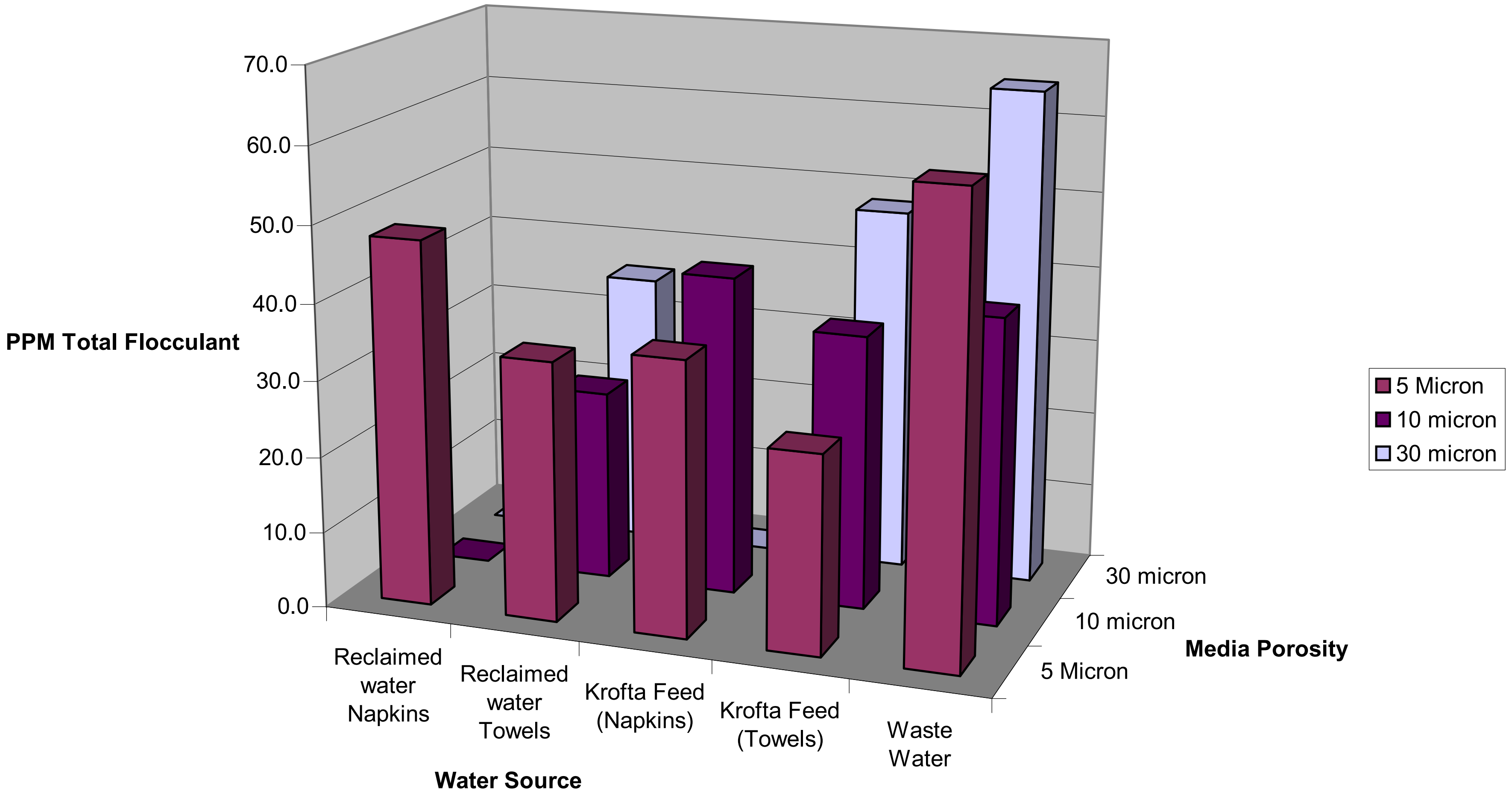

8
7
6
5
4
3
2
1
0
GPM per meter of filter
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
PPM Total Chemical
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Soource
Min
Max
Avg
Combined Flocs
Coag

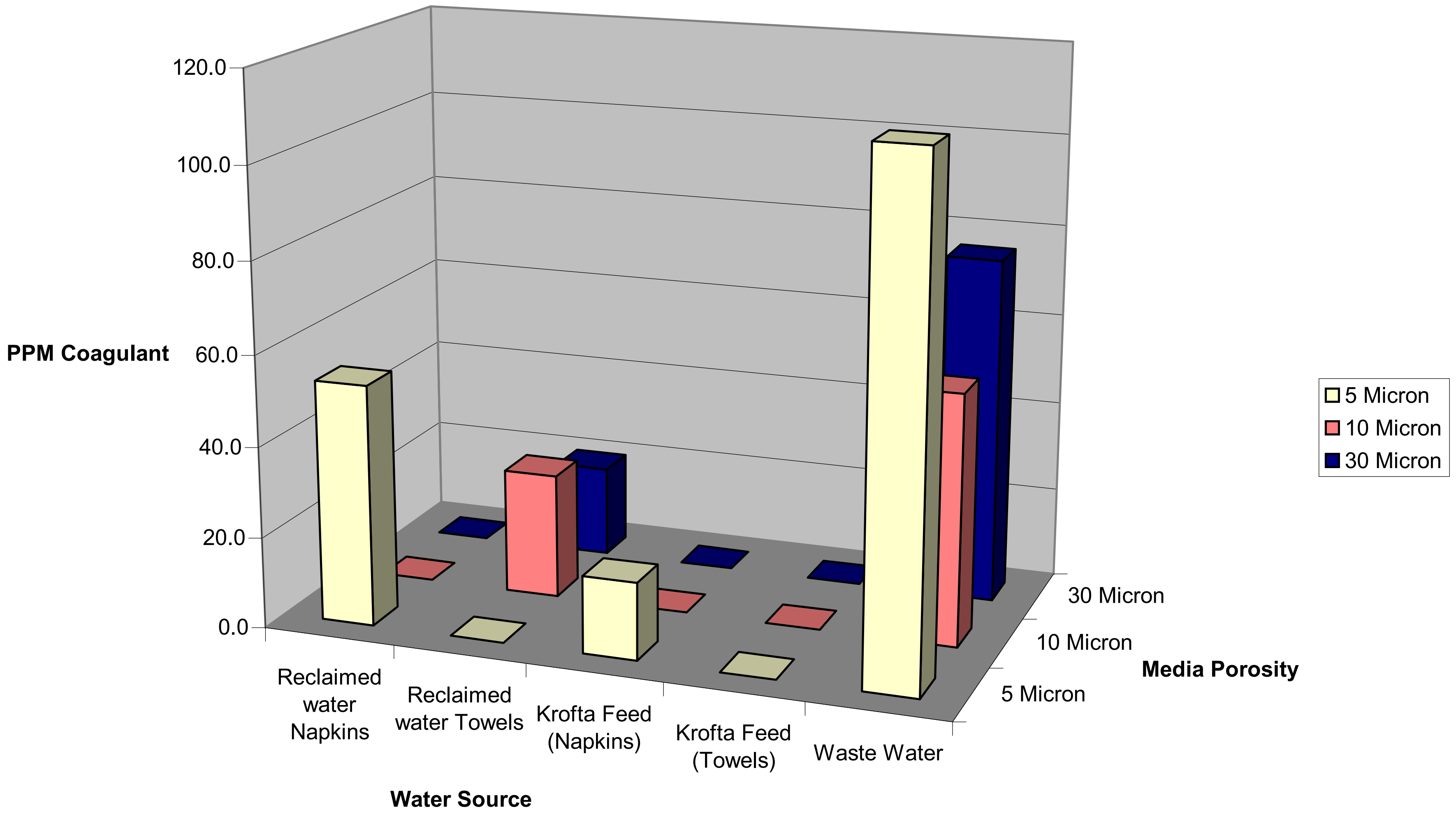

9
8
7
6
5
4
3
2
1
0
GPM per meter of filter
60.0
50.0
40.0
30.0
20.0
10.0
0.0
PPM of Chemical
1st Run 55 PPM, 2nd 0 PPM
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
Min
Max
Avg
Combined Flocs
Coag


GPM per meter of filter
0
1
2
3
4
5
6
PPM of Chemical
0.0
20.0
40.0
60.0
80.0
100.0
120.0
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
Min
Max
Avg
Combined Flocs
Coag

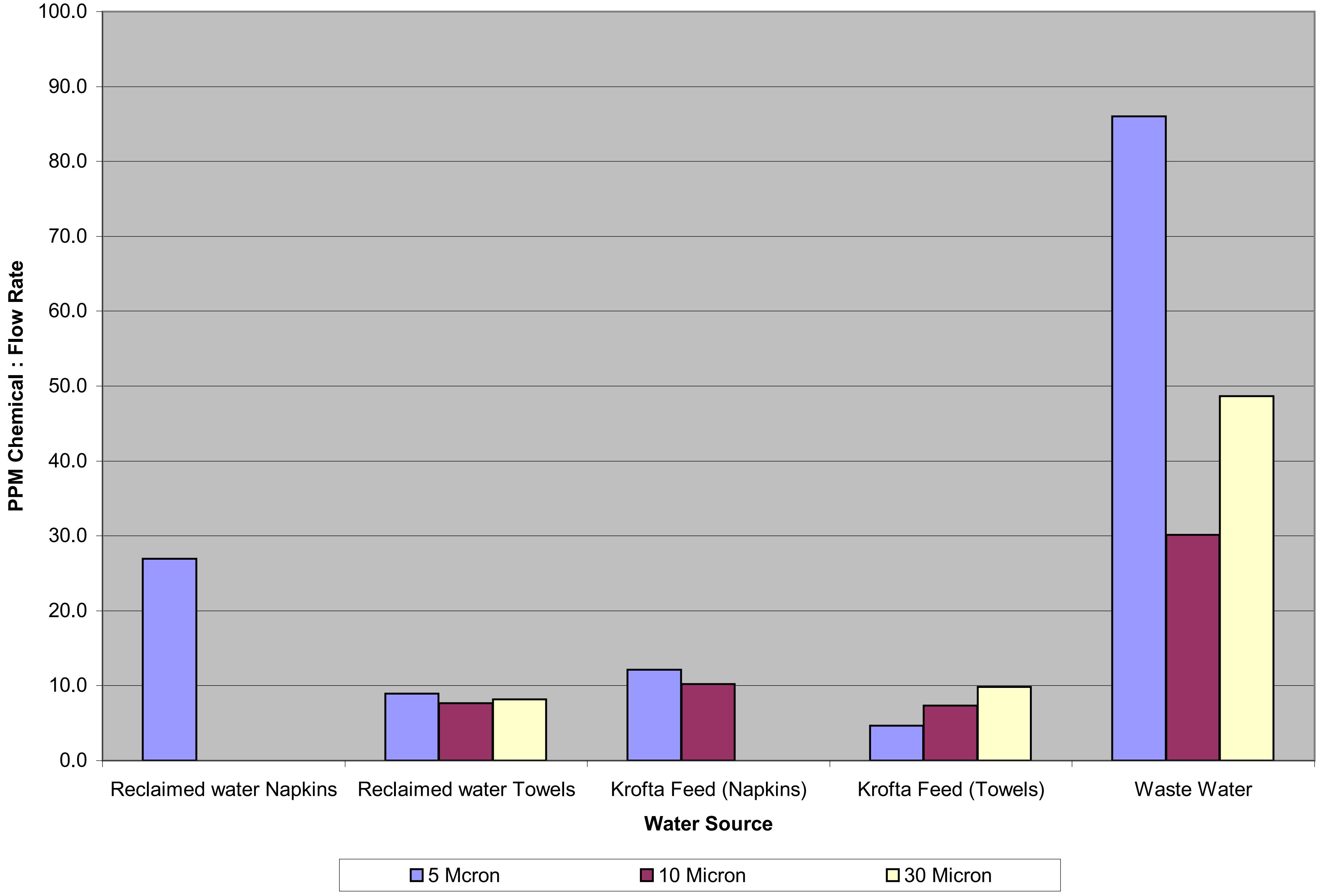

7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
GPM per meter of filter
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
30 micron GPM
10 micron GPM
5 micron GPM
5 micron GPM
10 micron GPM
30 micron GPM


PPM Total Chemical
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
5 Mcron
10 Micron
30 Micron
Media Porosity
5 Mcron
10 Micron
30 Micron


PPM Total Flocculant
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
30 micron
10 micron
5 Micron
Media Porosity
5 Micron
10 micron
30 micron



PPM Coagulant
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
30 Micron
10 Micron
5 Micron
Media Porosity
5 Micron
10 Micron
30 Micron

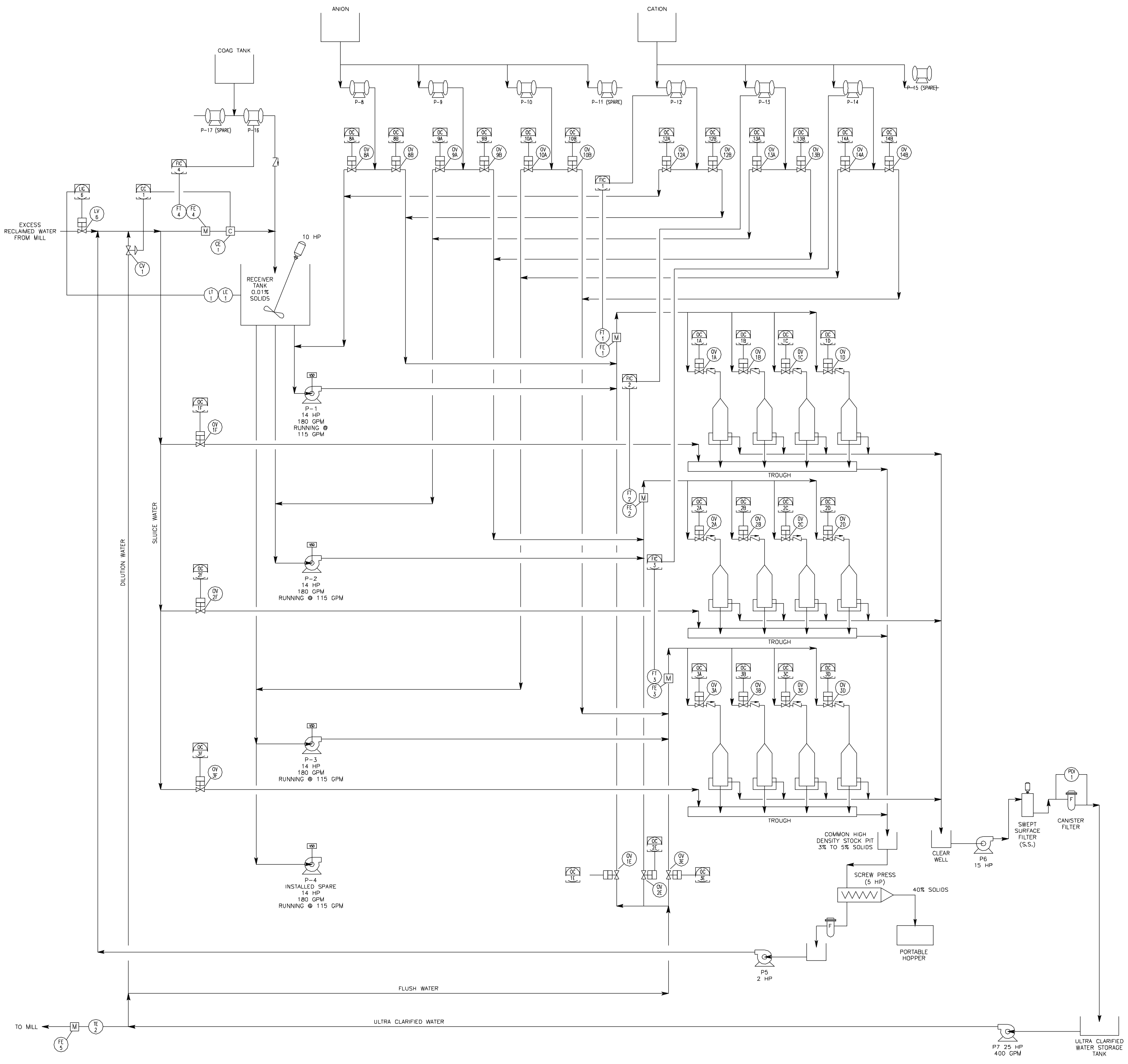

100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
PPM Chemical : Flow Rate
Reclaimed water Napkins
Reclaimed water Towels
Krofta Feed (Napkins)
Krofta Feed (Towels)
Waste Water
Water Source
5 Mcron
10 Micron
30 Micron

Appendix C

BASELINE PROCESS SCHEMATICS AND EQUIPMENT LIST

Mill Scale Schematic Provided Here in Appendix C

Process Specific Schematic Provided in Section 3
(Figure 2)


ANION
CATION
COAG TANK
P-17 (SPARE)
P-16
P-8
P-9
P-10
P-11 (SPARE)
P-12
P-13
P-14
P-15 (SPARE)
LIC 6
LV 6
CC 1
FIC 4
FT 4
FE 4
CE 1
CV 1
EXCESS RECLAIMED WATER FROM MILL
10 HP
RECEIVER TANK 0.01% SOLIDS
LT 1
LE 1
OC 8A
OV 8A
OC 8B
OV 8B
OC 9A
OV 9A
OC 9B
OV 9B
OC 10A
OV 10A
OC 10B
OV 10B
OC 12A
OV 12A
OC 12B
OV 12B
OC 13A
OV 13A
OC 13B
OV 13B
OC 14A
OV 14A
OC 14B
OV 14B
FIC 1
FT 1
FE 1
FIC 2
FT 2
FE 2
FIC 3
FT 3
FE 3
VSD
P-1 14 HP 180 GPM RUNNING @ 115 GPM
P-2 14 HP 180 GPM RUNNING @ 115 GPM
P-3 14 HP 180 GPM RUNNING @ 115 GPM
P-4 INSTALLED SPARE 14 HP 180 GPM RUNNING @ 115 GPM
OC 1F
OV 1F
OC 2F
OV 2F
OC 3F
OV 3F
SLUICE WATER
DILUTION WATER
OC 1A
OV 1A
OC 1B
OV 1B
OC 1C
OV 1C
OC 1D
OV 1D
OC 2A
OV 2A
OC 2B
OV 2B
OC 2C
OV 2C
OC 2D
OV 2D
OC 3A
OV 3A
OC 3B
OV 3B
OC 3C
OV 3C
OC 3D
OV 3D
TROUGH
TROUGH
TROUGH
OC 1E
OV 1E
OC 2E
OV 2E
OC 3E
OV 3E
COMMON HIGH DENSITY STOCK PIT 3% TO 5% SOLIDS
SCREW PRESS (5 HP)
40% SOLIDS
PORTABLE HOPPER
F
P5 2 HP
CLEAR WELL
P6 15 HP
SWEPT SURFACE FILTER (S.S.)
PDI 1
CANISTER FILTER
FLUSH WATER
ULTRA CLARIFIED WATER
TO MILL
FE 5
M
TE 2
P7 25 HP 400 GPM
ULTRA CLARIFIED WATER STORAGE TANK

Process Specific Equipment List

Item	Description	Detail	Quantity
1	Separator Sqz BX (Line Master)	10 Micron Units with control panel	1
2	Separator Sqz BX (Slaves)	10 Micron In sets of four on one control panel	2
3	Trap Cnstr Fltr	10 Micron @ 50 GPM Cap	1
4	Feed Pumps	Progressive Cavity	1
5	Chem Mix Systems	100 gall semi Auto Makedown Systems plus duplex pumps	3
6	Tank Mixer	200 gal tank mixer	1
7	Flow Meters	Flow Tubes w/ Xmttrs	1
8	Differential Pressure Instruments	Pressure Drop Across Trap Filters	1
9	Consistency Inst		1
10	UCW Pump	40 GPM Cap	1
11	Support Structure		1
12	Waste Water Tank	200 Gal	1
13	UCW Stg Tank	100 Gal	1
14	Sluice Troughs		1
15	Consistency Control Valve		1
16	Process Automatic BF Valves	2" AO/SR	3
17	Supply Automatic BF Valve	2" AO/SR	1
18	Level Indicating Transmitters		2
19	PLC		1
20	Misc Valves	Hand Valves & Check Valves for Services, etc.	10

Preliminary Equipment List Based Solely Upon Site Specific Conditions at Pilot Test Site

Mill Scale Equipment List

Item	Description	Detail	Quantity
1	Separator Sqz BX (Line Master)	10 Micron Units with control panel	3
2	Separator Sqz BX (Slaves)	10 Micron In sets of four on one control panel	9
3	Swept Surface Filter	?? Micron @ 200 GPM Cap	3
4	Trap Cnstr Fltr	7 Micron @ 150 GPM Cap	3
5	Feed Pumps	Parastaltic w/ Pulsation Control of Progressive Cavity	4
6	Chem Mix Systems	100 gall semi Auto Makedown Systems plus duplex pumps	3
7	Tank Mixer	2000 gal tank mixer	1
8	Flow Meters	Flow Tubes w/ Xmttrs	4
9	Differential Pressure Instruments	Pressure Drop Across Trap Filters	3
10	Kainni Consistency Inst		1
11	Clear Well Pumps	200 GPM Cap	3
12	UCW Pump	400 GPM Cap	1
13	Support Structure		3
14	Air Compressor		1
15	Waste Water Tank	2000 Gal	1
16	UCW Stg Tank	1000 Gal	1
17	Sluice Troughs		3
18	Discharged Sludge Screw Press	500 PPD Capacity	1
19	Screw Press Liquor Pump	15 GPM	1
20	Consistency Control Valve		1
21	Process Automatic BF Valves	2" AO/SR	24
22	Supply Automatic BF Valve	4" AO/SR	1
23	Level Indicating Transmitters		5
24	PLC		1
25	Misc Valves	Hand Valves & Check Valves for Services, etc.	40

Preliminary Equipment List Based Solely Upon Site Specific Conditions at Pilot Test Site

Appendix D

ESF TESTING METHODS AND RESULTS AND DATA COMPILATION

APPENDIX D
SUNY ESF TESTING RESULTS

The Pulp and Paper Science and Engineering Department at the SUNY College of Environmental Science and Forestry (ESF) has performed extensive laboratory experimentation and analysis in support of this project in concert with the field testing performed by Jannanco, LLC

EXPERIMENTAL METHODS IN LABORATORY TESTING

Samples were drawn from the filter feed and the filtrate streams periodically. These were labeled and shipped to the laboratory in ½ liter plastic containers. The samples were analyzed for particle size distribution and drainage characteristics. Table 1 presented below shows the listing of the samples received and their labeling.

DRAINAGE CHARACTERISTICS

The pulp suspension was passed through a screen under atmospheric and vacuum conditions in the ESPRI drainage analyzer. Drainage curves were modeled so that the specific filtration resistance of the filter cakes could be evaluated. The variation of the specific filtration resistance with pressure was determined by varying the vacuum level within the analyzer. The results were then extrapolated to the pilot scale filtration conditions to provide estimates of filterability.

DRAINAGE TESTING METHODOLOGY

Figure 6 shows a schematic of the drainage analyzer. An ultrasonic ranging device determines the liquid level height at different times during drainage. A vacuum pump is provided to apply vacuum to the suspension as shown.

Figure 6

ESPRI Drainage Analyzer

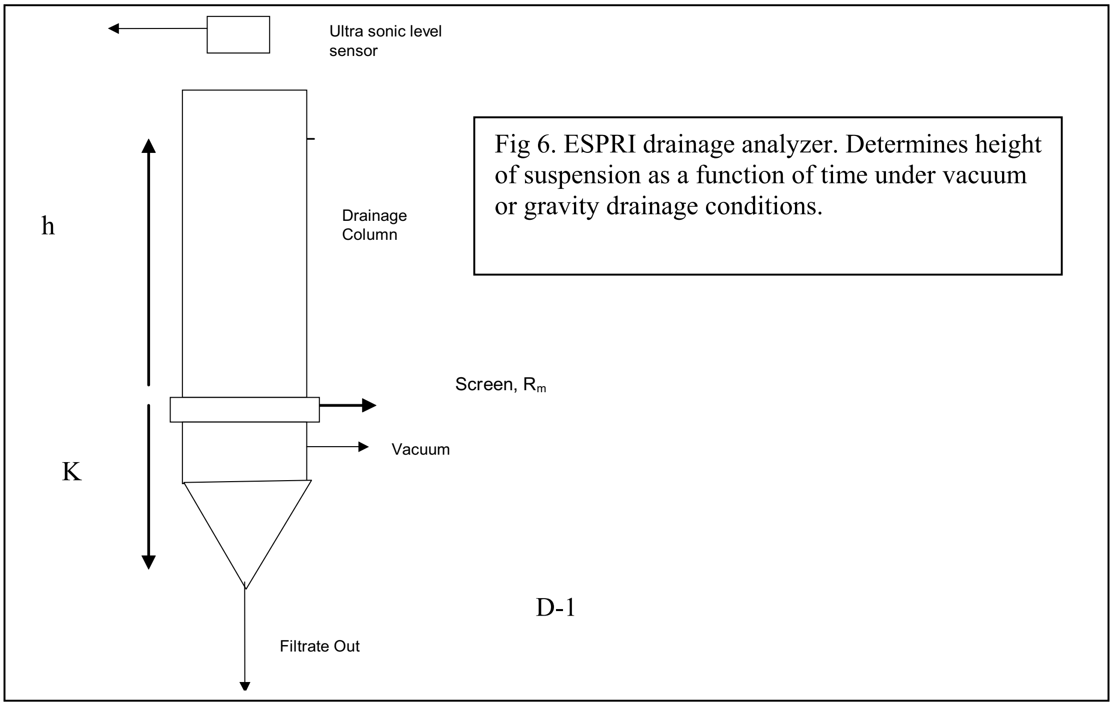


Fig 6. ESPRI drainage analyzer. Determines height of suspension as a function of time under vacuum or gravity drainage conditions.

Applying Darcy’s law and accounting for the pressure head on the filter cake as shown here, we obtain:

$$-\frac{dh}{dt} = \frac{(h-L)\rho_s g + K\rho g}{\mu[\bar{\alpha}L + R_m]} \qquad \textbf{Eq. 1}$$

A mass balance over the solid phase gives:

$$L\bar{c} + (h-L)c_0 = h_0 c_0 \qquad \textbf{Eq. 2}$$

That, when substituted and simplified, yields the following first order differential equation for the variation of the height of the suspension with time:

$$\frac{dh}{dt}[\mu R_m + \mu\frac{\bar{\alpha} h_0 c_0}{\bar{c}-c_0} - \mu\frac{\bar{\alpha} c_0}{\bar{c}-c_0} h] + h[\frac{\bar{c}}{\bar{c}-c_0}]\rho_s g = \frac{h_0 c_0}{\bar{c}-c_0}\rho_s g - K\rho g \qquad \textbf{Eq. 3}$$

The exact solution of the above equation, subject to the condition that $h = h_0$ at time $t = 0$ is:

$$h(t) = h_0 + \frac{A}{C} + \frac{DB}{C^2}\ln D + \frac{B}{C}t - \frac{A}{C}\ln(D-Ct) + \frac{DB}{C^2}\ln(D-Ct) \qquad \textbf{Eq. 4}$$

Where the symbols are defined in the nomenclature. When water is drained through the membranes, the height variation is exponential and can be used to determine the membrane resistance R_m directly.

FIBER LENGTH ANALYSIS

The suspensions were analyzed using a Kajaani FS-100 fiber length analyzer. Figure 2 shows the analysis results for three replicates of the same sample of suspension. The average fiber length and other data from this analysis are presented in Table 14 below.

Table 14
Samples analyzed for drainage and particle size distributions

Sample No.	Name	Date & Time
1	Feed to Filter W/ Chemicals	(6/23), 2:40
1	Replicate	
1	Replicate	
2	Feed Tank	(6/23), 2:30
3	Feed to Filter w/ Chemicals	(6/23), 4:40
4	Feed Tank	(6/23), 4:40
5	Feed Tank Waste Water	(6/29), 8:30
6	Feed Tank Waste Water	(6/29), 8:30
7	Feed Tank	(6/28), 9:15
8	Feed Tank MCPK	7/7, 11:20 PM
9	Feed Tank SMPL	7/14, 11:00 AM
10	Feed Tank	7/14, 12:30 PM
11	Feed Tank	7/20, 4:15 PM
12	Feed Tank Waste Water	7/21, 9:15
13	Feed to Supply Tank (Reclaim)	7/7, 6:30
14	Feed Tank	7/8, 12:40 PM
15	Product Water	7/14, 1:50
16	Product Water (got hazy)	7/14, 5:00 PM
17	Feed Tank	7/27, 5:00 PM
18	Feed Tank, W ppm, CHGPK	7/28, 8:45 AM
20	Product Water, No polymer	8/10, 7:15 PM
21	Feed Tank	8/11, 1:00 PM
22	Feed Tank	8/17, 10:45
23	Feed Tank	8/17, 7:30 PM
25	Feed Tank	8/17, 9:50 PM
28	Feed Tank	8/18, (:30 PM

Figure 7
Particle size distributions for three replicates of samples

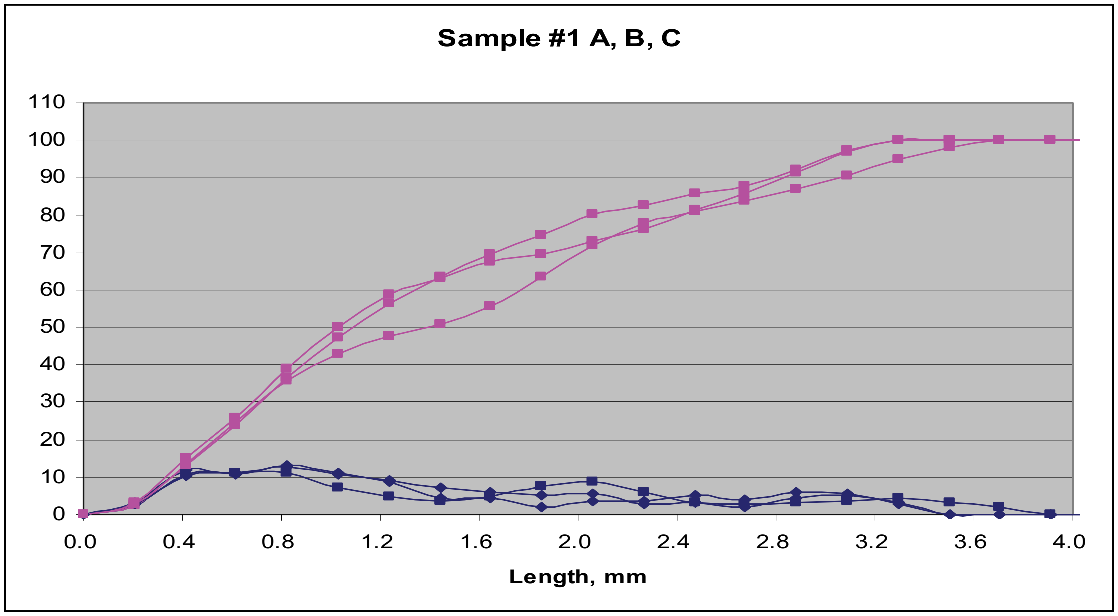


Figure 8
Cumulative Length Distribution of Fibers in Suspension for Samples 1-7

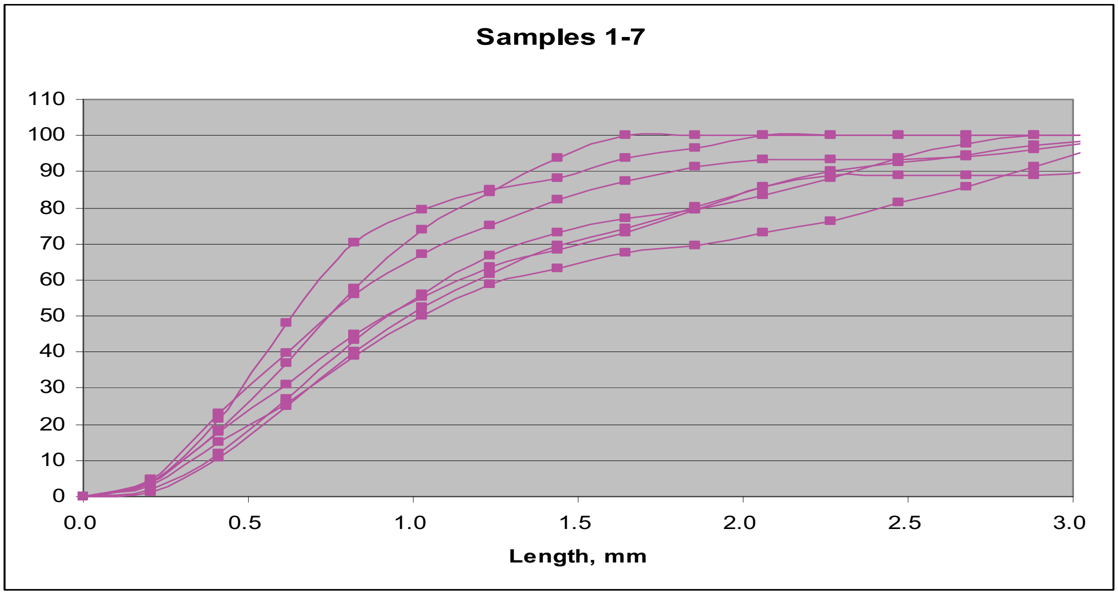


Figure 9
Length Distribution of Fibers in Suspension for Samples 1-7

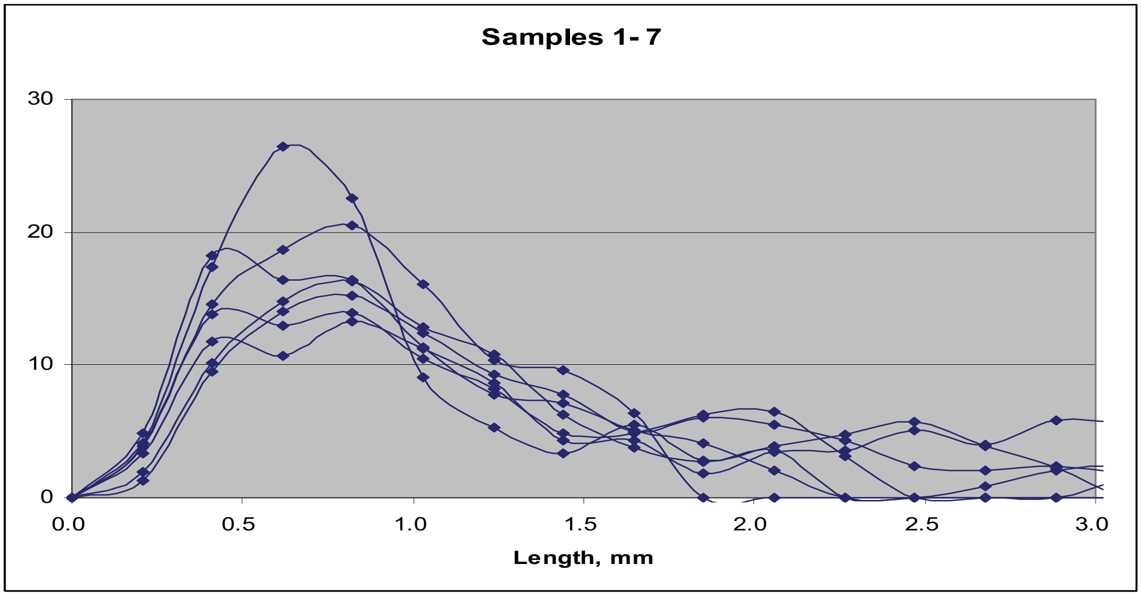


Figure 10
Length Distributions of Samples 8-16

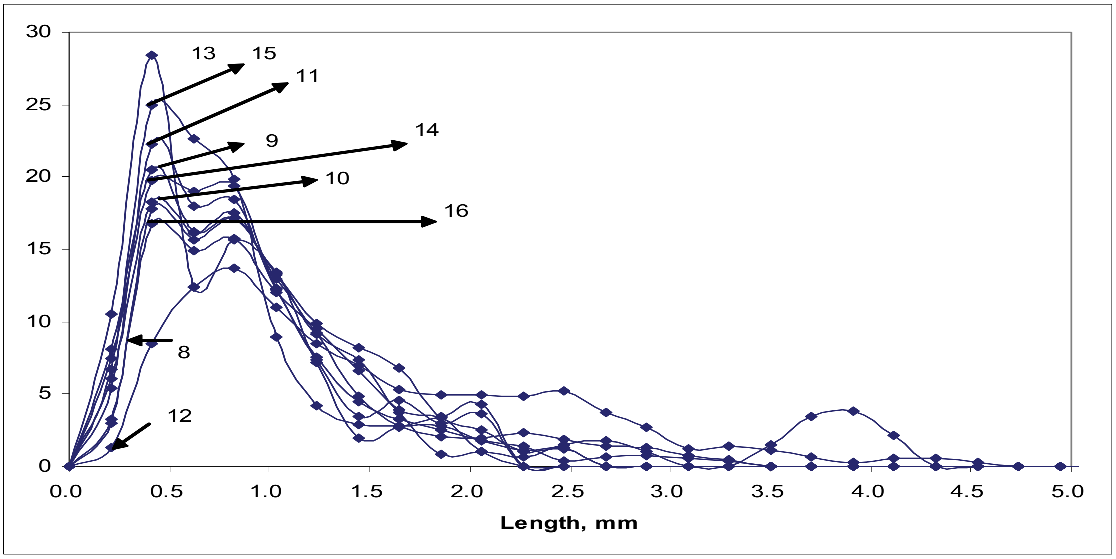
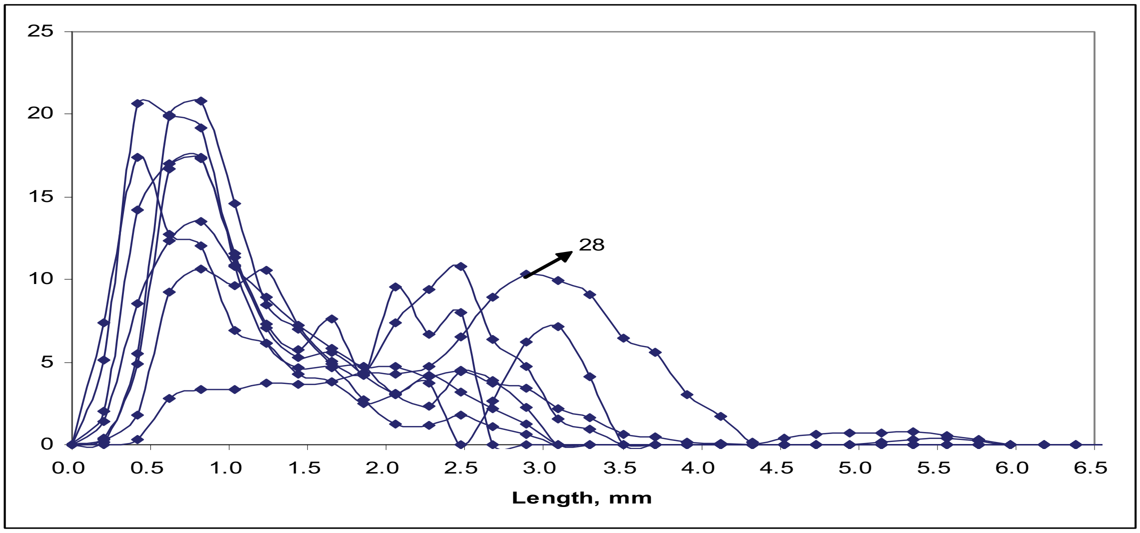


Figure 11
Length Distributions of Third Set of Samples 17-28

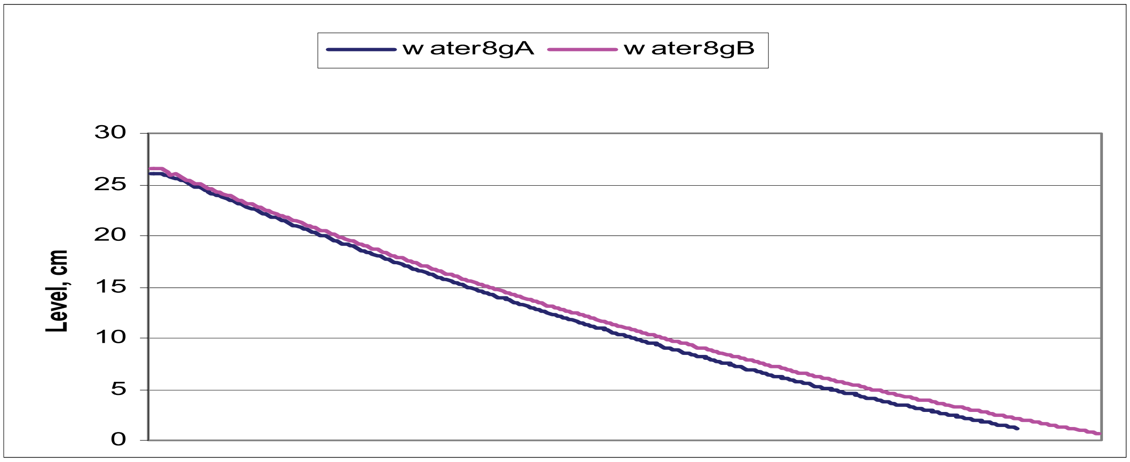


DRAINAGE TESTING RESULTS

Results of testing drainage rates through the 8 um screen are shown below. The two replicates of drainage show good reproducibility for the drainage rates through the open screens. The data for the medium resistance were determined by fitting this curve to the form of eq. 1 with alpha values set to zero.

Figure 12

Drainage of Water Through 8 um Screen



The following table summarizes the results of our drainage testing. Although drainage curves were obtained for all the samples, values of drainage resistance were not obtained for all of them since the program was not able to complete the curve fitting.

Table 15

Summary of Drainage Testing

Sample No.	Name	Date & Time	L Avg (Arith)	L Av (Weight)	Coarseness Wt/L	Fines, %	ALFA	CSF	Cy
1	Feed to Filter W/ Chemicals	(6/23), 2:40	0.28	0.67	2.36	55.56		743.00	0.160
1	Replicate		0.30	0.75	2.41	53.75		737.00	
1	Replicate		0.31	0.72	2.33	53.71			
2	Feed Tank	(6/23), 2:30	0.26	0.60	1.15	60.54		873.00	0.093
3	Feed to Filter w/ Chemicals	(6/23), 4:40	0.28	0.53	2.08	50.29			0.070
4	Feed Tank	(6/23), 4:40	0.25	0.51	1.54	59.19			0.060
5	Feed Tank Waste Water	(6/29), 8:30	0.35	0.70	1.18	46.53			0.062
6	Feed Tank Waste Water	(6/29), 8:30	0.40	0.75	0.91	39.43			0.048
7	Feed Tank	(6/28), 9:15	0.28	0.49	2.59	56.24			0.087
8	Feed Tank MCPK	7/7, 11:20 PM	0.30	0.56	0.71	51.64			
9	Feed Tank SMPL	7/14, 11:00 AM	0.21	0.43	0.65	64.50			
10	Feed Tank	7/14, 12:30 PM	0.23	0.48	0.23	56.35	1.00E+12		
11	Feed Tank	7/20, 4:15 PM	0.25	0.47	0.18	52.89	1.30E+13		0.340
12	Feed Tank Waste Water	7/21, 9:15	0.39	0.80	0.08	38.58	1.91E+12		
13	Feed to Supply Tank (Reclaim)	7/7, 6:30	0.19	0.37	2.26	66.99	2.20e+12		
14	Feed Tank	7/8, 12:40 PM	0.22	0.44	2.32	64.00			
15	Product Water	7/14, 1:50	0.23	0.42	0.55	57.02			
16	Product Water (got hazy)	7/14, 5:00 PM	0.29	0.58	0.91	40.58			
17	Feed Tank	7/27, 5:00 PM	0.25	0.48	0.22	52.93	2.74E+12		
18	Feed Tank, W ppm, CHGPK	7/28, 8:45 AM	0.39	0.79	0.06	38.54	3.80E+11		
19	Product Water, No polymer	8/10, 7:15 PM	0.21	0.50	2.20	66.53	1.75e+12		
20	Feed Tank	8/11, 1:00 PM	0.34	0.63	0.74	33.93	4.10E+11		0.023
21	Feed Tank	8/17, 10:45	0.57	0.78	0.38	38.26	7.25e+11		
22	Feed Tank	8/17, 7:30 PM	0.55	0.85	1.76	49.65	6.50e+12		
23	Feed Tank	8/17, 9:50 PM	0.65	1.11	1.14	45.93			
24	Feed Tank	8/18, (:30 PM	1.18	1.93	0.22	17.29	9.31E+11		
25	Dumped Stock for Particle Size Test.	8/19, 6:00 PM	1.39	2.20	0.20	12.84			

EFFECT OF FINE PARTICLE CONTENT ON SPECIFIC FILTRATION RESISTANCE

The table below shows the variation of drainage resistance with fines fraction and coarseness of fibers. We observe that the fines fraction broadly relates to the Specific Filtration Resistance (SFR). Note that the correlation is confounded by two factors. The first is that residual flocculation of the suspension will result in lower filtration resistance than is indicated by the fines fraction for different suspensions. This can happen since the measurement of fines fraction is done after dilution in the Kajaani analyzer, which can de-flocculate or disperse the fibers flocs better. A second factor is incomplete retention of fines on the screen of the drainage analyzer. This effect was generally found to be minor since the filtrates in most of the cases were quite clear. However, some filtrates did show cloudiness. Investigation of field data indicated that the cloudy samples were likely taken during forced process upset conditions during the pilot trial.

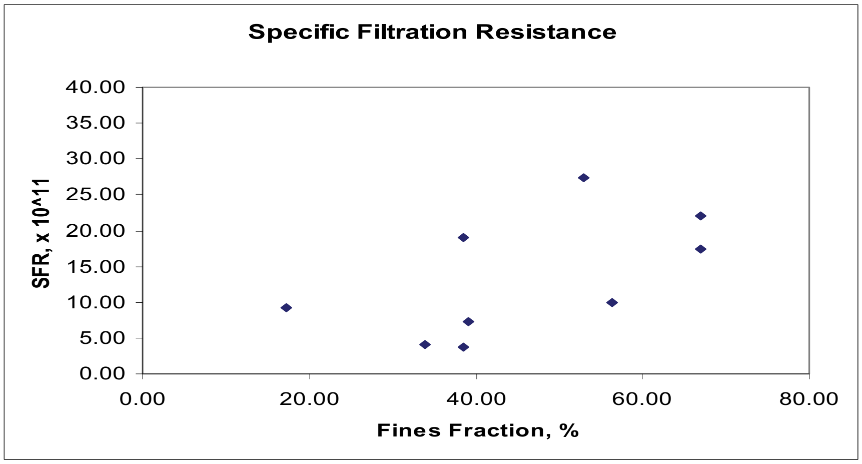
Table 16

SFR vs Fines Concentration and Fiber Coarseness

Coarseness	Fines	SFR
2.26	67.00	17.50
2.26	67.00	22.00
1.76	60.00	65.00
0.38	39.00	7.50
0.23	56.35	10.00
0.18	52.89	130.00
0.08	38.58	19.10
0.22	52.93	27.40
0.06	38.54	3.80
0.74	33.93	4.10
0.22	17.29	9.31

Figure 13

SFR vs Fines Concentration and Fiber Coarseness

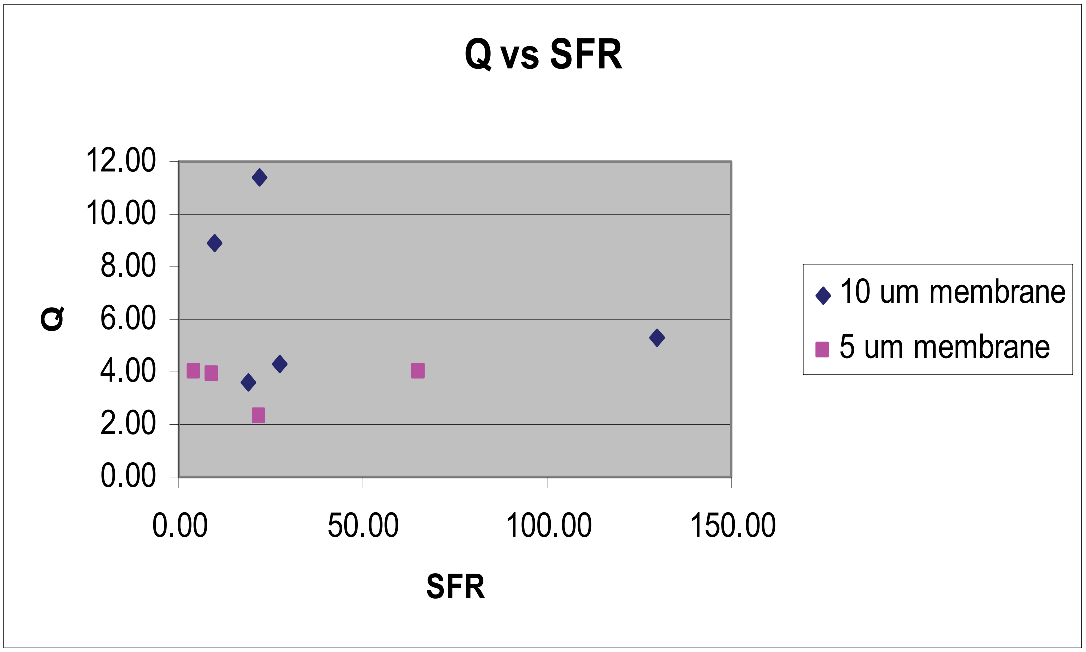


ANALYSIS OF FILTRATE FLOW RATE, Q

The filtrate flow rate Q observed in the mill was correlated against the specific filtration resistance. We note that the membranes offer the most significant flow resistance to the filtrate flow. As shown below, the membrane with the larger hole size (10 um) gave higher flow rates as compared to the membrane with the smaller hole size (5 um). For the smaller membrane, the SFR of the pulp did not affect the flow rate Q clearly indicating that the membrane was the most important resistance across the flow. For the 10 um membrane, a clear decrease in flow rate Q was found with the highest SFR value, showing that the filter cake did have a significant resistance to flow. Our conclusion is that the filterability of the suspensions is not a strong factor in determining filtration flow rates for the 5 um membrane. This means that production rates for the 5 um membrane are determined mostly by the membrane resistance and its choice rather than the inlet suspension consistency or resistance. This provides considerable scope for membrane resistance reduction and optimization while still maintaining filtration efficiency.

Figure 14

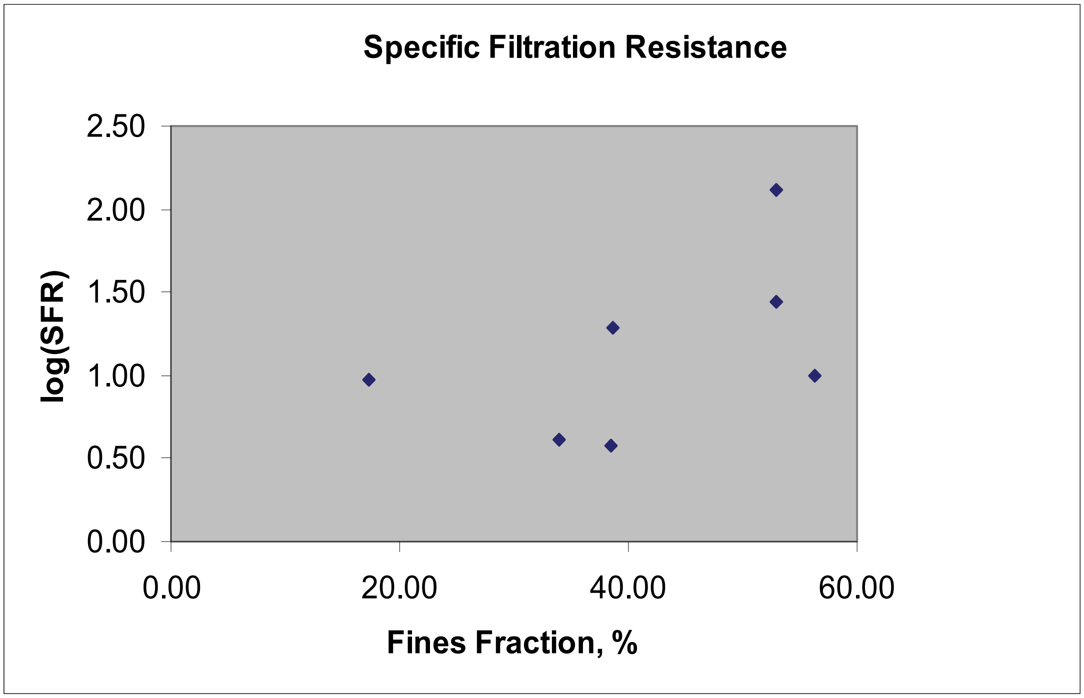
Flow (Q) vs SFR



The figure below shows a correlation of the filtrate flow rates against fines fraction of the suspensions. The flow rates seem to be correlated with the fines fraction, showing that higher fines contents lead to increased flow resistance. The origin of this increased resistance could be in plugging up of the membrane or the filter cake itself. Filter cake plugging by fine particles has been recently investigated and a comprehensive theory has been developed for this purpose [see Ramarao and Tien, 2005].

Figure 15

Fines Concentration vs SFR



CONCLUSIONS

1. The membranes are quite effective at filtration as evidenced by the removal of all fiber particles from the suspensions. The Kajaani analyzer could not detect any particulates in the filtrates.
2. The specific filtration resistance of the cakes could be determined by drainage testing.
3. The fines fraction of the suspensions gives an indication of the SFR.
4. The SFR and the fines fractions can be used to project filtrate flow rates through membranes. However, the membrane resistances seem to be the most significant factor in pressure drop through the filters for the 5 um membrane.

Appendix E

ENERGY, ECONOMIC AND ENVIRONMENTAL BENEFITS ANALYSIS METHODS

APPENDIX E
ENERGY, ECONOMIC AND ENVIRONMENTAL BENEFITS ANALYSIS METHODS AND SPREADSHEETS

ENERGY AND ECONOMIC ANALYSIS METHODOLOGY

The analysis utilizes 2003 climatologic data for Hudson River water temperatures. Energy costs were based on 2004 data from the sources indicated. Energy costs have escalated significantly during the first quarter of 2005 during the preparation of this report. Because of this and continued volatility in the energy market, savings presented herein are most likely somewhat conservative.

The study mill purchases much of its thermal energy in the form of steam from a third party owned cogeneration facility located on an adjacent property. While this is not unusual, by and large most mills produce their own steam (and sometimes electricity) in their own powerhouses. These “standalone” powerhouses use a variety of fuels including: natural gas, No. 2 fuel oil, No. 6 fuel oil, pulping byproducts, coal and wood waste. Rather then trying to address the variability of different fuels and the complexities of cogeneration and its numerous equipment configurations, the analysis in this study was focused to two cases felt to be reasonably representative of the industry in New York State:

- The cost savings that may be realized by a mill employing the technology that uses natural gas to produce required thermal energy.
- The cost savings that may be realized by a mill employing the technology that uses No. 2 Fuel Oil to produce required thermal energy.

From an energy savings point of view, these two cases address a mill using steam purchased from a third party, as is the case of the study mill[23]. However, the savings to a mill operating in this scenario may vary depending on the structure and pricing of the third party energy sales agreement.

This analysis evaluates the energy required to raise raw water to process temperature. In actual practice, the raw water is added directly to the process without preheating. Many mills use supplemental steam to subsequently elevate the process to the desired temperature.

In the case of the study mill, raw water is withdrawn from the Hudson River. The United States Geological Survey (USGS) was contacted for Hudson River water temperature data. USGS maintains a temperature monitoring station near Albany, New York and furnished daily temperature readings for the year 2003, the

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[23] The study mill’s actual cost to purchase steam for operations was proprietary.

analysis base year. Daily temperature data were averaged to obtain monthly averages. This is presented in Table 17, below.

The study examined a total of three water sources in the mill. The process temperatures are typical temperatures taken during the pilot trial period. They do not necessarily represent actual target process temperatures of the host mill:

- ***Process white water*** for both towel and napkin grades. This distinction was drawn to further refine the analysis as whitewater temperatures were an average of 35.5 °C (97.7 °F) for napkin grades and 43.0 °C (109.4 °F) for towel grades
- ***Reclaimed water*** whose average temperature was 42.0 °C (107.6 °F)
- ***Sewered water*** whose average temperature was 40.0 °C (104.0 °F)

As previously discussed, variability in process whitewater impacts the drainage rates required to achieve "runability" for a particular product grade. Table 17 also presents the temperature difference between the raw and the measured water temperature taken during the various product grades the mill was running during the study.

Table 17

Monthly Water Temperature Differentials by Water Source

Month	**Raw Water[24] Temperature (Degrees F)**	**Temperature Differential in Degrees F**			
		White Water from Towels	**White Water from Napkins**	**Reclaimed Water**	**Sewered**
January	32.1	77.3	65.6	75.5	71.9
February	32.1	77.3	65.6	75.5	71.9
March	34.8	74.6	62.9	72.8	69.2
April	43.6	65.8	54.1	64.0	60.4
May	57.6	51.8	40.1	50.0	46.4
June	67.3	42.1	30.4	40.3	36.7
July	77.8	31.6	19.9	29.8	26.2
August	77.4	32.0	20.3	30.2	26.6
September	71.1	38.3	26.6	36.5	32.9
October	55.2	54.2	42.5	52.4	48.8
November	44.0	65.4	53.7	63.6	60.0
December	33.3	76.1	64.4	74.3	70.7

In order to more precisely evaluate potential savings, seasonal fluctuations in fuel pricing were analyzed against seasonal variations in river water temperature. Table 18, below presents historic, monthly pricing

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[24] Source: USGS temperature data for 2003.

for natural gas and No. 2 fuel oil as well as raw river water temperatures. Pricing information was taken directly from NYSERDA's website for "Monthly Average Price of Natural Gas Delivered to Industrial Consumers" and for No. 2 fuel oil "DOE/EIA[25] Weekly Petroleum Status Report". Both reflect analysis base year pricing conditions.

Table 18

Fuel Pricing and River Temperatures (Monthly)

Month	**Natural Gas[26] Price ($/DT)**	**No. 2 Fuel[27] Oil Price ($/DT)**	**Raw Water Temperature (Degrees F)**
January	$8.00	$8.83	32.1
February	$8.76	$8.57	32.1
March	$8.47	$8.58	34.8
April	$8.00	$8.66	43.6
May	$7.36	$9.32	57.6
June	$7.62	$9.06	67.3
July	$7.57	$9.78	77.8
August	$8.07	$10.41	77.4
September	$8.10	$11.25	71.1
October	$7.93	$12.74	55.2
November	$9.40	$11.83	44.0
December	$10.26	$11.06	33.3
Averages:	**$8.30**	**$10.01**	52.2

It is very important to note that the pricing delineated above for No. 2 fuel oil obtained from DOE reflects "New York Harbor" pricing. Accordingly, the tabulated, per gallon costs include $0.25 per gallon for transportation to the point of end use[28] and no sales tax.

All cases useddd the following assumptions:

- An overall fuel to water energy transfer efficiency of 80%. That is, for every 100 Btus of energy released during the fuel combustion process, 80 Btus made their way into the

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[25] US Department of Energy, Energy Information Administration.

[26] Pricing taken from NYSERDA website: "Monthly Average Price of Natural Gas Delivered to Industrial Customers" – last updated 01/04/05

[27] Pricing from DOE/EIA Weekly Petroleum Status Report – Table 15. Spot Prices of Low Sulfur Diesel, Kerosene-Type Jet, Residual Fuels, and Propane. Pricing for low sulfur No. 2 diesel fuel indicated in tabulation.

[28] Adding $0.25 per gallon for transportation represents 17.8% of the average cost per gallon of No. 2 increasing the savings for this fuel through the application of the technology by approximately the same percentage.

raw process water (i.e. – 20 Btus were lost to combustion inefficiencies, radiant cooling, blowdown, etc.).

- A higher heating value (HHV) of 1,050 Btus per cubic foot of natural gas
- An HHV of 140,000 Btus per gallon of No. 2 fuel oil
- 360 days per year of mill operation, 24 hours per day (8,640 hours per year of operation)
- 177 days per year of towel production
- 183 days per year of napkin production

For all cases, the Btus saved per gallon of water recovered were calculated. Once again, this was done by month for the estimated number of days a typical tissue mill would be running each product. Table 19, below depicts the Btus recovered based upon the assumed temperatures for a typical tissue mill.

Table 19

Btu Savings per Gallon of Recovered Water

	Btu's Saved Per Gallon of Water Recovered			
Month	**White Water from Towels**	**White Water from Napkins**	**Reclaimed Water**	**Sewered**
January	782	664	764	727
February	782	664	764	727
March	755	636	736	700
April	666	547	647	611
May	524	406	506	469
June	426	308	408	371
July	320	201	301	265
August	324	205	306	269
September	387	269	369	333
October	548	430	530	494
November	662	543	643	607
December	770	651	752	715
Averages:	**579**	**460**	**561**	**524**

ENERGY RECOVERED:

Table 20 presented below summarizes the amount of water saved at the above indicated recovery rates and the heat recovered associated with that volume of water. This table is the primary data source for all of the case analyses developed in this section.

Table 20

Water and Heat Recovered per Month

	Gallons of Water Recovered Per Month Gals (10^6)/Month				Heat Recovered Per Month (DT's)			
Month	**Towels**	**Napkins**	**Reclaim**	**Sewered**	**Towels**	**Napkins**	**Reclaim**	**Sewered**
January	7.56	8.06	22.32	15.62	5,911.7	5,351.3	17,047.1	11,364.0
February	7.06	7.06	20.16	14.11	5,517.6	4,682.4	15,397.4	10,264.2
March	7.56	8.06	22.32	15.62	5,705.2	5,131.1	16,437.4	10,937.2
April	7.56	7.56	21.60	15.12	5,032.2	4,137.4	13,984.4	9,238.4
May	7.56	8.06	22.32	15.62	3,961.5	3,271.2	11,289.5	7,333.6
June	7.56	7.56	21.60	15.12	3,219.7	2,324.9	8,805.8	5,613.4
July	7.56	8.06	22.32	15.62	2,416.7	1,623.4	6,728.5	4,141.0
August	7.56	8.06	22.32	15.62	2,447.3	1,656.0	6,818.8	4,204.2
September	7.56	7.56	21.60	15.12	2,929.1	2,034.3	7,975.5	5,032.2
October	7.56	8.06	22.32	15.62	4,145.1	3,467.0	11,831.3	7,713.0
November	7.56	7.56	21.60	15.12	5,001.6	4,106.8	13,897.0	9,177.2
December	6.55	6.55	18.72	13.10	5,043.9	4,268.4	14,070.3	9,372.0
Annual Totals:	**89.21**	**92.23**	**259.20**	**181.44**	**51,331**	**42,054**	**144,282**	**94,390**

ENERGY COST SAVINGS

Case I – Natural Gas Use

Using the above data, the cost savings associated with "avoided" natural gas use can readily be computed. Once again, this computation was done on a monthly basis to account for the seasonal variability of the cost of natural gas. Estimated gross savings are presented in Table 21, below.

Table 21

Natural Gas Gross Savings

	Natural Gas			
	Gross Annual Savings			
Month	**White Water from Towels**	**White Water from Napkins**	**Reclaimed Water**	**Sewered**
January	$46,788	$42,354	$94,444	$89,941
February	$47,828	$40,589	$93,429	$88,974
March	$47,788	$42,979	$96,379	$91,613
April	$39,828	$32,746	$77,476	$73,118
May	$28,853	$23,825	$57,557	$53,413
June	$24,269	$17,524	$46,463	$42,312
July	$18,102	$12,160	$35,280	$31,018
August	$19,530	$13,216	$38,093	$33,552
September	$23,486	$16,311	$44,764	$40,349
October	$32,533	$27,211	$65,002	$60,536
November	$46,513	$38,192	$90,466	$85,345
December	$51,198	$43,327	$99,974	$95,130
Totals:	**$426,717**	**$350,434**	**$839,328**	**$785,303**
Total T&N:	**$777,151**			

Case II – No. 2 Fuel Oil Use

Using the above data, the cost savings associated with “avoided” No. 2 fuel oil use can readily be computed. Once again, this computation was done on a monthly basis to account for the seasonal variability of the cost of natural gas. Estimated gross savings are presented in Table 22, below. Once again, savings tabulated below were calculated using DOE/EIA pricing for low sulfur No. 2 diesel fuel at New York Harbor including $0.25 per gallon for delivery to the point of use but no sales taxes. The savings stated below are, more than likely, understated.

Table 22
No. 2 Fuel Oil Gross Savings

	No. 2 Fuel Oil			
	Gross Annual Savings			
Month	**White Water from Towels**	**White Water from Napkins**	**Reclaimed Water**	**Sewered**
January	$51,651	$46,755	$104,260	$99,289
February	$46,804	$39,720	$91,428	$87,069
March	$48,432	$43,558	$97,677	$92,847
April	$43,113	$35,447	$83,868	$79,151
May	$36,521	$30,157	$72,855	$67,609
June	$28,852	$20,834	$55,237	$50,303
July	$23,371	$15,699	$45,548	$40,046
August	$25,195	$17,049	$49,141	$43,284
September	$32,600	$22,641	$62,136	$56,008
October	$52,235	$43,690	$104,368	$97,198
November	$58,516	$48,047	$113,811	$107,369
December	$55,179	$46,696	$107,748	$102,528
Totals:	**$502,471**	**$410,295**	**$988,079**	**$922,698**
Total T&N:	**$912,766**			

SENSITIVITY ANALYSIS

Study Variables

With respect to analysis of the study data, the following sensitivities were identified:

- Time on each grade
- Total production time
- 2003 was an unusually cold winter
- Assumed thermal transfer efficiency (Assumed at 80%)

For the purpose of completing the analysis, the total number of days a typical mill might be manufacturing towel and napkin grades was used. Towel grades are assumed to be manufactured at a temperature that is approximately 21% higher than napkin grades. Therefore, a change in the manufacturing product mix will impact energy and cost savings. A total of 8,640 hours of production time was assumed. However, this may vary depending on actual operating time and market conditions for a typical mill's products[29].

In the absence of actual data, fuel-to-energy conversion efficiency was assumed at 80%. This value was selected to conservatively estimate fuel consumption. The results presented herein are viewed as conservatively low.

TRANSFERABILITY

The following sensitivities were identified in terms of application of the study results to other mills in the industry:

- Process temperature and flow rate
- Raw water: source and temperature (Geographically dependent)
- Raw water costs
- Wastewater treatment
- Recoverability/usability of fiber

As explained in the technical results section of this report, process temperature and volumetric flow rates for process waters are very grade specific. Additionally, paper machine speed also impacts these variables. However, the study results have been derived so as to address these operational variables with a minimum of effort.

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[29] It is not unusual for a mill to take a paper machine out of production during periods when market demand for a product is soft. This is opposed to stockpiling production.

Paper mills acquire their raw process water from a variety of sources to include surface waters, ground water (i.e. – supply wells), and in some instances municipal systems. The latter two of these are typically fairly constant in annual average temperature. Surface water temperatures, however, will vary depending on the ambient climatologic conditions. That is to say, a mill in New York State using surface water will encounter lower average annual temperatures than a comparable mill located in Alabama.

Although infrequent, some mills do purchase raw water from municipal systems. Application of the technology in these mills will result in additional savings associated with the avoidance of purchasing the equivalent volumes of fresh water that will be directly proportional to the water recovered.

Wastewater treatment benefits are discussed in greater detail below but are chiefly focused on mills that are "direct dischargers". That is, mills that treat their waste process waters and discharge the resulting effluent to a receiving surface water body. Some mills, although fairly infrequent, do pretreat their waste process waters and discharge to a municipal system. These mills are referred to as "indirect dischargers". These mills are in turn charged by the municipalities for treating the wastewater. Charges are assessed on flow (i.e. – the amount of waste water sent to the municipality) as well as, in some instances, the constituents remaining in the pretreated wastewater. Economic impacts of the technology to indirect discharger mills will be very location dependent. However, the additional benefits of the technology to these mills should not be overlooked.

Fiber that can be recovered for reuse will have a twofold economic impact. Fiber value varies depending on the type of grade being manufactured. "Finer" grades such as writing and printing grades use fiber that is more costly and will likely derive significant benefits from application of the technology. Conversely, mills manufacturing recycled grades may derive very little benefit as most of the useable fiber is retained in the paper sheet. This is discussed in greater detail below. The second benefit of recovering fiber for reuse is removal of solids loading to the mill's wastewater treatment plant. As discussed elsewhere in this report, decreased wastewater treatment plant loading usually results in enhanced performance at a lower cost.

ENVIRONMENTAL ANALYSIS METHODOLOGY

The discussion that follows assesses the potential benefits to each environmental medium with respect to data obtained from investigations at the host mill. The assessment uses the following general criteria:

1. The "displaced" energy use comes from direct combustion of either natural gas or No. 2 fuel oil[30] (i.e. – the assessment presents a separate examination of combustion of each fuel to furnish process energy);

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[30] Fuel oil was assumed to be 0.5 % by weight sulfur.

2. A thermal transfer efficiency of eighty percent (80%) (i.e. – twenty percent (20%) of the fuel's energy is lost between initial combustion and achieving the final required process water temperature);
3. 8,640 hours per year of production;
4. The technology recovers in excess of 99.5% of the solids in the process water stream under consideration;
5. Fuel is combusted in a manner consistent with Reasonably Achievable Control Technology (RACT) as currently embodied in Title 6 of the New York Code of Rules and Regulations Part 227[31];
6. Emission factors used to estimate generation of criteria air pollutants and hazardous air pollutants (HAPs) were either extracted from NYS RACT requirements or the United States Environmental Protection Agency's (USEPA's) AP-42 emission factor database[32] in the absence of actual emission factor information.

As mentioned above, the analysis examines the benefits associated with recovery of 350 GPM of process water. However, the data contained in this section may be readily scaled to larger or smaller flows. That is, the expected benefits associated with 700 GPM will be two (2) times as much; 1,050 GPM three (3) times, and so on.

As discussed elsewhere in this report, the data disclosed by the study indicates the technology's direct transferability to major unit operations in other papermaking processes. The technology is also directly transferable to other types of paper manufacturing, including, but not limited to: liner board, box board, and fine paper. A benefits assessment of application of the technology to these other types of manufacturing and unit operations is beyond the scope of this report. However, given the significant potential for energy, environmental, and economic benefits, additional pilot trial work with respect to these other unit operations should proceed as soon as possible. The generic economic and environmental benefit models developed in this study may be readily adapted to an assessment of data generated in future studies.

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[31] RACT is a requirement of the Clean Air Act of 1990. The requirement is, therefore, more or less universally applied throughout the United States.

[32] Natural gas emission factors where taken from Section 1.4, 11/98 edition of AP-42; No. 2 fuel oil emission factors where taken from Section 1.3, 10/98 edition of AP-42.

Appendix F.

MATERIAL RECOVERY CALCULATION SPREADSHEETS

Table F-1

Gross Annual Material Recovery (Tons) for Selected Flows and Process Water Solids Concentrations

Percent Mill "Up Time": 98.6%
Material Recovery Efficiency: 98.0% Actual Efficiency exceeds 99%

Flow Rate (GPM)	**Process Water Solids Concentration - Percent by Weight**									
	0.10	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**
200	432.3	635.5	847.4	1,059.2	1,271.1	1,482.9	1,694.8	1,906.6	2,118.5	2,330.3
350	741.5	1,112.2	1,482.9	1,853.7	2,224.4	2,595.2	2,965.9	3,336.6	3,707.4	4,078.1
500	1,059.2	1,588.9	2,118.5	2,648.1	3,177.7	3,707.4	4,237.0	4,766.6	5,296.2	5,825.9
700	1,482.9	2,224.4	2,965.9	3,707.4	4,448.8	5,190.3	5,931.8	6,673.3	7,414.7	8,156.2

Table F-2

Gross Annual Material Savings for Selected Flows and Process Water Solids Concentrations

Recovered Material Value: $250 ($'s/Ton)

Flow Rate (GPM)	**Process Water Solids Concentration - Percent by Weight**									
	0.10	**0.15**	**0.20**	**0.25**	**0.30**	**0.35**	**0.40**	**0.45**	**0.50**	**0.55**
200	$108,086	$158,887	$211,849	$264,812	$317,774	$370,736	$423,699	$476,661	$529,623	$582,586
350	$185,368	$278,052	$370,736	$463,420	$556,105	$648,789	$741,473	$834,157	$926,841	$1,019,525
500	$264,812	$397,218	$529,623	$662,029	$794,435	$926,841	$1,059,247	$1,191,653	$1,324,058	$1,456,464
700	$370,736	$556,105	$741,473	$926,841	$1,112,209	$1,297,577	$1,482,945	$1,668,314	$1,853,682	$2,039,050

Table F-3

Gross Annual Waste Disposal Savings for Selected Flows and Process Water Solids Concentrations

Avoided Waste Disposal Value: $50 ($'s/Ton)

Flow Rate	Process Water Solids Concentration - Percent by Weight									
(GPM)	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55
200	$21,617	$31,777	$42,370	$52,962	$63,555	$74,147	$84,740	$95,332	$105,925	$116,517
350	$37,074	$55,610	$74,147	$92,684	$111,221	$129,758	$148,295	$166,831	$185,368	$203,905
500	$52,962	$79,444	$105,925	$132,406	$158,887	$185,368	$211,849	$238,331	$264,812	$291,293
700	$74,147	$111,221	$148,295	$185,368	$222,442	$259,515	$296,589	$333,663	$370,736	$407,810

Table F-4

Gross Annual Savings for Selected Flows and Per Gallon Wastewater Costs

Annual Operating Days: 360

Flow Rate	Pre Gallon Waste Water Treatment Costs ($'s)									
(GPM)	$0.001	$0.002	$0.003	$0.004	$0.005	$0.006	$0.007	$0.008	$0.009	$0.010
200	$103,680	$207,360	$311,040	$414,720	$518,400	$622,080	$725,760	$829,440	$933,120	$1,036,800
350	$181,440	$362,880	$544,320	$725,760	$907,200	$1,088,640	$1,270,080	$1,451,520	$1,632,960	$1,814,400
500	$259,200	$518,400	$777,600	$1,036,800	$1,296,000	$1,555,200	$1,814,400	$2,073,600	$2,332,800	$2,592,000
700	$362,880	$725,760	$1,088,640	$1,451,520	$1,814,400	$2,177,280	$2,540,160	$2,903,040	$3,265,920	$3,628,800

Appendix G

RAW FIELD DATA FROM PILOT TESTING

Jannanco, LLC
NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
Field Data
April 2004 thur August 2004

Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	Avg Flow GPM
5/4/04	Krofta Feed	Brn Twls		15:10	0					-15	936										Added 5 Gallons of 0.3% 2449 to feed tank	
				15:20	0					-15	936										Added 5 Gallons of 0.3% 2278 to feed tank	
					0					-15	936										Large Flocs Visible in Feed Tank	
					16					-17	898										Flocks Shearing In Tank	
					30	3.7				-19	860										Pressure Switch Trip	
					37					-20	841										Flock Breaking Down to Fines	
					40		25															
					42		15															
					70																Started Introducing 2278 to pump suction @ tank outlet. Great Flocs then gone (2449 was in chemical line folc was due to 2449)	
					90																Started Introducing 2449 to pump suction @ tank outlet.	
					117	4.5	25	32	8.4												Turned 2449 down. Increased Pressure Swithch set Point to 5.25 Bar to accommodate bounce in system from Pump	
					123		25			-38	497										Floc OK & Clarity Good in Product Water	
					134		27														Floc OK & Clarity Good in Product Water but floc smaller. Not sufficient contact time	
					160																Hose Blue Off of Pump due to Pulsations	
5/10/04																					Installed Temporary PVC Pulse Dampener - Failed	
5/11/04																					Installed Temporary HP Hose Pulse Dampener - Failed	
																					Installed Factory Pulse Dampener; Installed Auto Fill and Chem Add for Mix Tank; Installed Mixing Chamber In Line	
6/2/04																					Adjusting Chem Feed and Pump settings. No Data taken	
6/9/04																					No Source Water Avail	
6/15/04																					Adjusting Chem Feed Piping and Injection Points. No Data Taken	
6/22/04																					Adjusting Chem Feed Piping and Injection Points. No Data Taken	
6/23/04	Krofta Feed	White Towels		12:50	0		19			-17	898	0.11%	Tank Outlet	90%		Pump Outlet	80%				No Charge Pak Added to Feed Tank	
				13:30	0:40		19														Cloudy Product water & Slowing Flow Rate - Stopped	

Jannanco, LLC
NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
Field Data
April 2004 thur August 2004

Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level '"s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	Avg Flow GPM
				14:04	0:00		19			-14.5	946		Pump Outlet	100%		Tank Ooutlet	100%				No Charge Pak Added to Feed Tank; PS Set Point 5.6 Bar => 4.8 Bar Trip	
					:6		19	48	5.6					100%	24		100%	24				
					:9.5		21							100%			100%					
					:22		21	55	4.9					100%	28		100%	28				
					:30	4	23							100%			100%					
					:38	4	23	65	4.2					100%	33		100%	33				
					:40	4	25							100%			100%					
					:51	4	25	55	4.9					100%	28		100%	28				
					:53	4	27							100%			100%					
					:73	4.3	27	50	5.4					100%	25		100%	25				4.52
					:89		27							50%			50%					
					:95		27	64	4.2	-40.5	449			50%	16		50%	16			Stop & Press & Discharge	497
																						5.2
				16:00	0		27			-14	956	0.10%		50%			50%					
				16:10	0:10		27							75%			75%				Cloudy - Increase Polymers	
				16:13	0:13		27							90%			90%				Cloudy - Increase Polymers	
				16:20	0:20		27	47	5.7					90%			90%					
				16:30	0:30	4.3	27	53	5.1	-29.5	659											
				16:45	0:45		27														PS trip Press & Discharge	4.9
6/24/04	Reclaim Water	White Towels		15:58	0		27			-17.5	889			100%			100%		2400	20	Added 2400 cc 0f 3% ChargePak to Feed Tank	
				16:15	0:17		27	35	7.7					100%	18		100%	18				
				16:25	0:27	3.95	27	40	6.8					100%	20		100%	20				
				16:28	0:30	4.25	30							100%			100%					
				16:35	0:37		30	36	7.5					100%	18		100%	18				6.7
				16:55	0:57	4.35	30	40	6.8					100%	20		100%	20				
				16:56	0:58					-41.5	430			100%			100%				Press & Discharge	459
				17:14	0		30			-17	898			100%			100%				No Charge Pak In Feed Tank	
				17:25	0:11	3.7	30							100%			100%				Some Fines in Product Water	
				17:30	0:16									100%			100%				Add Charge Pak to 20 PPM in Feed Tank	
				17:40	0:26	4.25	30	39	6.9					100%	20		100%	20				7.1
				18:05	0:51	4.35	30							100%			100%				Press	
	Krofta Feed	White Towels		18:13	0:59									100%			100%				Discharge	
				19:06	0		27														Ancillary System Problems - Halted	
6/28/04	Krofta Feed	Napkins		9:30																	Ancillary System Problems - Halted	
				11:00	0		25							100%			65%				Discovered Problem with 2449 Pump - No Keeping Up with 2278 About 30%	
				11:10	0:10		25			-28	688			100%			65%					
				11:19	0:19		0														Stopped - Low on 2278	
				11:20	0:20		27														Recharged 2278 Drum @ 0.45%; Restarted @ 30 Hz but hit PS Trip	
				11:28	0:28		25														Product Water had Fines so Reset Pump to lower speed	
				11:46	0:46																Recharged 2278 Drum @ 0.9%; Immediately Clear but debris (flocs from breakthrough coming with product water)	

Jannanco, LLC
NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
Field Data
April 2004 thur August 2004

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6/29/04	Krofta Feed	Napkins		20:40	0		15			-18	879		Tank Outlet	75%		Pump Outlet	70%					
				20:44	0:04									75%			70%				1st water showing up in Discharge Pipe	
				20:45	0:05		20							75%			70%					
				20:49	0:09		23							75%			70%					
				20:52	0:12									75%			70%				Membrane Blinded Over	
																					Stop & Flush Out Press	
				21:40	0																Added 6000 ml of 3% Charge Pak to Feed tank	
				21:50	0:10		15			-30.5	640		Tank Outlet	100%		Pump Outlet	100%					
				21:55	0:15		22							100%			100%					
				21:58	0:18	3.8	22							100%			100%					
				21:59	0:19		25							100%			100%					
				22:05	0:25	4.3	25	62	4.4					100%			100%					
				22:11	0:31		24							100%			100%				PS Trip - Reduced Pump Speed	
				22:12	0:32		22							100%			100%				PS Trip - Reduced Pump Speed	
				22:20	0:40		0							100%			100%				Press	
				22:25	0:45		22			-35	554			100%			100%				Restart	
				22:30	0:50		19							100%			100%					
				22:35	0:55		20							50%			50%					
				22:41	1:01																Press	
				22:47	1:07					-36	535										Discharge	
6/30/04	Waste Water @ Sump			9:00	0																9000 Ml of 3% Charge Pak Added to Feed Tank	
				9:50	0					-17.5	889		Pump Outlet	80%		Tank Outlet	100%		9000	76		
				9:53	0:03		10	60	4.5					80%	24		100%	30			Started with Water in Press	
				10:00	0:07	2.3	10	128	2.1					80%	52		100%	64				
				10:02	0:09		20							80%			100%					
				10:05	0:12	3.95	20	73	3.7					80%	29		100%	37				
				10:14	0:21		22							80%			100%					210
				10:16	0:23	4.3	22	89	3.0					80%	36		100%	45				3.0
				11:00	1:07	4.4		123	2.2	-28.5	678			80%	50		100%	62				
				11:03	1:10									80%			100%				Press & Discharge	148
				11:19	0		22							80%			100%				Restart	3.2
				11:27	0:08	4.3	22	88	3.1					80%	35		100%	44				2.7
				11:47	0:28		22	99	2.7					80%	40		100%	50				358
				12:02	0:43		22	95	2.8	-36.25	530			80%	38		100%	48				3.1
				12:06	0:47																Stop - Cleaned -	2.6

Jannanco, LLC
NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
Field Data
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Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	
7/7/04	Reclaimed Water	White Towels	45		0								Tank Outlet	75%		Pump Outlet	70%				Clean New Membrane: Added 7000 ml of 3% Charge Pak to Feed Tank	
Clean New Membrane Initial data				19:06	0		15			-12	994			75%			70%		7000	53		
Clean New Membrane Initial data				19:12	0:06	0.2	15	44	6.1					75%	14		70%	13				
Clean New Membrane Initial data				19:13	0:07		22							95%			90%					
Clean New Membrane Initial data				19:21	0:15	0.6	22	26	10.4					95%	10		90%	10				
Clean New Membrane Initial data				19:25	0:19		27							95%			90%					
Clean New Membrane Initial data				19:33	0:27	0.9	27	22	12.3					95%	9		90%	8				
Clean New Membrane Initial data				19:37	0:31	1.2	27							95%			90%					
Clean New Membrane Initial data				19:38	0:32		32							95%			90%					
Clean New Membrane Initial data				19:43	0:37	1.9	32							95%			90%					
Clean New Membrane Initial data				19:50	0:44	2.5	32	19	14.2					95%	8		90%	7				
Clean New Membrane Initial data				19:55	0:49	3.4	32							95%			90%					
Clean New Membrane Initial data				19:56	0:50		32							95%			90%				Vented Pulse Dampener to 3.2 Bar	
Clean New Membrane Initial data				19:57	0:51	2.4	32							95%			90%					
Clean New Membrane Initial data				19:59	0:53		32	19	14.2					95%	8		90%	7				
Clean New Membrane Initial data				20:03	0:57	2.7	32							95%			90%					
Clean New Membrane Initial data				20:06	1:00	3.6	32			-52	229			95%			90%				Stop - Tank Level Below Agitator	764
Clean New Membrane Initial data				20:08	1:02									95%			90%				Press	12.3
Clean New Membrane Initial data																						
				20:23						-10	1032			95%			90%		6000	56	Added 6000 ml of 3% Charge Pak	
				20:32	0		32							95%			90%					
				20:42	0:10	3.4	32	23	11.7					95%	9		90%	9				
				20:50	0:18	4	32	27	10.0					65%	7		60%	7				377
				21:02	0:30	4.3	32	31	8.7					65%	8		60%	8				11.4
				21:05	0:33					-29.75	655			65%			60%				Stop Flow & Press	
				21:16	0:44		32							65%			60%					
				21:21	0:49	4	32	27	10.0					65%	7		60%	7				
				21:32	1:00	4.3	32	30	9.0					55%	7		50%	6				186
				21:36	1:04	4.5	32	33	8.2					55%	8		50%	7				6.0
				21:36	1:04					-39.5	468										PS Trip Stop & Press & Discharge	564
																						8.8
				21:50						-9	1051								4500	58	Added 4500 ml of 3% Charge Pak	
				21:54	0		32							55%			50%				Restart	
				22:00	0:06	4.2	32	30	9.0					55%	7		50%	6				
				22:04	0:10		29							55%			50%				PS Trip Reduce Pump Speed	
				22:07	0:13	4.4								55%			50%					
				22:09	0:15									55%			50%				PS Trip Stop & Press & Discharge	129
				22:24						-15.75	922			55%			50%					8.6
				22:45			32							85%			60%				Restarted with Sample Valve Open ??	
				22:47	0		32							85%			60%				Closed Sample Valve	
				22:52	0:05	3.8	32	27	10.0					85%	10		60%	7				
				22:55	0:08		32							65%			60%					
				23:02	0:15	4.2	32	34	7.9					55%	8		60%	9				
				23:06	0:19		32							55%			60%					
				23:07	0:20	4.4	32	37	7.3					55%	9		60%	9				
				23:11	0:24		32	41	6.6					55%	9		60%	10				224
				23:12	0:25					-28.5	678			55%			60%				PS Trip Stop & Press & Discharge	8.9
				23:30						-8.5	1061								3000	59	Added 3000 ml of 3% Charge Pak	
				23:40	0		32							65%			60%					
				23:44	0:04		25							65%			60%				PS Trip Reduce Pump Speed	
				23:50	0:10	4.1	27	64	4.2					35%	9		30%	8				
				23:55	0:15	4.5	27	65	4.2					35%	10		30%	8				
				23:56	0:16		25							35%			30%				PS Trip Reduce Pump Speed	
				0:01	0:21	4.5	25	92	2.9					35%	14		30%	12				
				0:03	0:23									35%			30%				PS Trip Stop & Press & Discharge	
				0:05	0:25																Wet Discharge Then Clean	

Jannanco, LLC
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7/8/04	Reclaim Water	White Towels		0:33	0		32							95%			90%					
				0:35	0:02	4.2	32	32	8.4					95%	13		90%	12				
				0:44	0:11									95%			90%					
				0:48	0:15	4.4	32	34	7.9					95%	14		90%	13				
				0:53	0:20	4.5	32	37	7.3					95%	15		90%	14				
				0:59	0:26	4.5	32	37	7.3					95%	15		90%	14				
				1:00	0:27									95%			90%				PS Trip Reduce Pump Speed	
				1:01	0:28		27							95%			90%					
				1:06	0:33	4.2	27	55	4.9					95%	22		90%	21				
				1:08	0:35		29.5							95%			90%					
				1:09	0:36		28							95%			90%				PS Trip Reduce Pump Speed	
				1:14	0:41	4.7	28	62	4.4					95%	25		90%	23				
				1:15	0:42																PS Trip Stop & Press	
				1:21	0:48																Discharge	
																						6.0
				1:27	0		32							95%			90%				Restart	
				1:30	0:03		32			-30.5	640			95%			90%					
				1:33	0:06	4.25	32	32	8.4					95%	13		90%	12				
				1:37	0:10	4.35	32	35	7.7					95%	14		90%	13				
				1:41	0:14		32							65%			60%					
				1:42	0:15	4.45	32	36	7.5					65%	10		60%	9				
				1:44	0:17		31							65%			60%				PS Trip Reduce Pump Speed	
				1:45	0:18		31							65%			60%				PS Trip Increase Polymer	
				1:46	0:19		31							95%			90%					
				1:48	0:21		29							95%			90%				PS Trip Reduce Pump Speed	
				1:49	0:22		27							95%			90%				PS Trip Reduce Pump Speed	
				1:52	0:25		27							95%			90%				PS Trip	
				1:55	0:28		27							95%			90%					
				1:57	0:30		28	57	4.7					95%	23		90%	22				
				1:59	0:32		28														Press	
				2:12	0:45					-39.5	468										Discharge	172
																						5.4
				2:27			32			-8.5	1061										Restart	6.7
				2:29																	PS Trip - Blinded - Stop Press Discharge & Clean	
				11:21	0		15			-18	879			110%			100%				Restart	
				11:24	0:03	1	15							110%			100%					
				11:26	0:05	2.5	32							110%			100%					
				11:31	0:10	4.2	32	31	8.7					110%	14		100%	13				
				11:36	0:15	4.2	32	31	8.7					110%	14		100%	13				
				11:41	0:20	4.2	32	32	8.4					110%	15		100%	13				
				11:46	0:25	4.2	32	32	8.4					110%	15		100%	13				
				11:52	0:31	4.3	32	34	7.9					110%	16		100%	14				
				11:56	0:35	4.35	32	35	7.7					110%	16		100%	15				
				12:02	0:41	4.35	32	36	7.5					110%	17		100%	15				
				12:06	0:45	4.35	32	36	7.5					110%	17		100%	15				
				12:11	0:50	4.35	32	36	7.5					110%	17		100%	15				
				12:16	0:55	4.5	32	37	7.3					110%	17		100%	16				
				12:18	0:57		0			-41.5	430										Pause to refill Feed Tank & Replenish 2278 (5 Gal @ .045%)	449
																						7.0

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		Blue Towels	42	12:50	0		16			-10	1032			110%			100%				Restart	
				12:52	0:02	3.4	32							110%			100%					
				12:53	0:03									110%			100%				PS Trip	
				12:54	0:04																PS Trip Stop & Press	
				13:00	0:10																Dischage	
				13:11			16							110%			100%				Restart	
				13:15		3.5				-15	936			110%			100%				Mixer Shut Down Stop & Discharge	
				13:35																		
				13:41			16			-15	936			110%			100%				Restart w/ Air Lance as only Mixer	
				13:45		3.4								110%			100%					
				13:46			32														Membrane Blinded Over - Stop to Clean	
				15:50	0		15			-21	822			110%			100%				Restart	
				15:53	0:03		15							110%			100%					
				15:56	0:06	2.3	15							110%			100%					
				15:57	0:07		32							110%			100%					
				16:00	0:10	37	32	26	10.4					110%	12		100%	11				
				16:05	0:15	4	32	29	9.3					110%	13		100%	12				
				16:10	0:20	4.05	32	30	9.0					110%	14		100%	13				
				16:15	0:25	4.25	32	33	8.2					110%	15		100%	14				
				16:20	0:30	4.35	32	34	7.9					110%	16		100%	14			Press	
				16:25																	Discharge	8.8
	???	???		16:40						-8	1070								5250	55	Refilled Feed Tank Added 5250 ml of 3% Charge Pak	
				17:11			15							110%			100%				Restart - Floc Sinking & not floating in	
				17:14		2	15							110%			100%					
				17:16			32							110%			100%					
				17:17						-25	745			110%			100%				PS Trip Membrane Blinded Stop to Discharge & Clean	
				19:00						-8	1070								3000	55	Refilled Feed Tank & Replenished 2449 & 2278 @ 0.45% Added 3000 ml of 3% Charge Pak to Feed Tank	
	???	???		19:58	0					-16.5	908			110%			100%				Restart	
				20:01	0:03	1.45	13							110%			100%					
				20:03	0:05		20							110%			100%					
				20:05	0:07	3.15		49	5.5					110%	23		100%	21				
				20:08	0:10	3.2		51	5.3					110%	24		100%	21				
				20:16	0:18	3.3		52	5.2					110%	24		100%	22				
				20:21	0:23	3.4		55	4.9					110%	25		100%	23				
				20:26	0:28	3.35		57	4.7					110%	26		100%	24				
				20:31	0:33	3.35		60	4.5					110%	28		100%	25			Press	
				20:35																	Wet Discharge	4.5
				20:36			13															
				20:40		1.5															Chem Pumps Off Dump Wet	

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Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	
	???	???		20:41	0		13							110%			100%				Restart	
				20:44	0:03	1.9								110%			100%					
				20:45	0:04		20							110%			100%					
				20:48	0:07	3.5	20	62	4.4					110%	29		100%	26			Stop ?	
				21:00	0		32	37	7.3					110%	17		100%	16			Restart	
				21:25	0:25	4.4	32							110%			100%				Press	
				21:32	0:32																Discharge	
																					Refill Feed Tank Added Charge Pak @	
				21:40			32							110%			100%				Restart w/ Immediate PS Trip - Press 3	
	???	???		21:44	0		32							110%			100%				Restart	
				21:50	0:06		32	37	7.3					110%	17		100%	16				
				21:52	0:08		32							110%			100%					
				22:03	0:19		32							110%			100%					
				22:04	0:20	4.55	32	39	6.9					110%	18		100%	16				
				22:09	0:25	4.6	32							110%			100%				Press	
				22:12	0:28																Discharge	
				22:13			32							110%			100%				Restart	
				22:16			32							110%			100%				PS Trip	
				22:17																	Press & Discharge	
				22:22	0		32							110%			100%				Restart	
				22:32	0:10	4.3	32	38	7.1					110%	18		100%	16				
				22:37	0:15	4.5	32							110%			100%					
				22:42	0:20	4.45	32	40	6.8					110%	18		100%	17				
				22:47	0:25	4.6	32							110%			100%				Press & Discharge	5.6
7/14/04	Krofta Feed	Napkins (From 7/13)		10:36	0		14			-8.75	1056			100%			85%				Restart - 0.45% Cons. in Tank	
				10:39	0:03		14							100%			85%				Closed Sample Valve	
				10:40	0:04	0	14							100%			85%				Ist Flow	
				10:42	0:06	1	27							100%			85%				Increase Pump Spd	
				10:47	0:11	4.1	27	57	4.7					100%	24		100%	24				
				10:52	0:16	4.2	27	100	2.7					100%	42		100%	42				
				10:56	0:20									100%			85%				PS Trip	
				10:58	0:22									100%			85%				Press & Discharge	
				11:02	0		15							100%			100%				Restart	
				11:05	0:03	1	15							100%			100%					
				11:06	0:04									100%							Press & Discharge	
				11:07	0:05		15							100%			100%				Restart	
				11:10	0:08	1	27							100%							Increase Pump Spd	
				11:17	0:15	4.3	27	85	3.2					100%	36		100%	36				
				11:21	0:19																PS Trip	
				11:22	0:20																Press	
				11:29	0:27																Discharge	
																					Dumped Feed Tank - Chemical Pumps Can't match up with this high cons.	

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Chemical Feed Adjustment Pro			36	13:30			15										95%				0.14% Cons. In feed Tank	
Chemical Feed Adjustment Problems				13:32	0		15							100%			95%				Restart	
Chemical Feed Adjustment Problems				13:36	0:04	2	15							100%			95%					
Chemical Feed Adjustment Problems				13:37	0:05		25							100%			95%					
Chemical Feed Adjustment Problems				13:42	0:10	4.2	25	87	3.1					100%	36		95%	35				
Chemical Feed Adjustment Problems				13:43	0:11		27														PS Trip	
Chemical Feed Adjustment Problems				13:44	0:12		26							100%			95%					
Chemical Feed Adjustment Problems				13:49	0:17	4.55	26	114	2.4					100%	48		95%	45				
Chemical Feed Adjustment Problems				13:54	0:22		26														PS Trip	2.0
Chemical Feed Adjustment Problems				13:55	0:23		24														PS Trip Reduced Pump Speed	
Chemical Feed Adjustment Problems				14:00	0:28																PS Trip Stop & Press 10 Min	
Chemical Feed Adjustment Problems				14:10																	Discharge	
Chemical Feed Adjustment Problems																						
Chemical Feed Adjustment Problems				14:17	0		24							100%			95%				Restart	
Chemical Feed Adjustment Problems				14:23	0:06	4.2	24	87	3.1					100%	36		95%	35				
Chemical Feed Adjustment Problems				14:35	0:18		24														PS Trip	
Chemical Feed Adjustment Problems				14:37	0:20	4.3	24	129	2.1					100%	54		95%	51				
Chemical Feed Adjustment Problems				14:42	0:25	4.35	24	123	2.2					100%	52		95%	49				
Chemical Feed Adjustment Problems				14:45	0:28																Press 5 Min	
Chemical Feed Adjustment Problems				14:50																	Discharge	2.1
Chemical Feed Adjustment Problems																						
Chemical Feed Adjustment Problems				14:54	0		17							100%			95%				Restart	
Chemical Feed Adjustment Problems				14:57	0:03		27							100%			95%					
Chemical Feed Adjustment Problems				15:00	0:06	4.3		71	3.8					100%	30		95%	28				
Chemical Feed Adjustment Problems				15:07	0:13		26							100%			95%				PS Trip Reduce Pump	
Chemical Feed Adjustment Problems				15:11	0:17		25							100%			95%				PS Trip Reduce Pump	
Chemical Feed Adjustment Problems				15:13	0:19	4.55	25	145	1.9					100%	61		95%	58				
Chemical Feed Adjustment Problems				15:21	0:27	4.65	25	161	1.7					100%	68		95%	64			Press < 1 Min	2.6
Chemical Feed Adjustment Problems														100%			95%					
Chemical Feed Adjustment Problems				15:22			25							100%			95%				Discharge Wet & Restart	
Chemical Feed Adjustment Problems				15:24		1	15							100%			95%				Cloudy Slowed Pump	
Chemical Feed Adjustment Problems																						
Chemical Feed Adjustment Problems				15:32	0		15							100%			95%				Restart	
Chemical Feed Adjustment Problems				15:36	0:04		25							100%			95%				Increase Pump Speed	
Chemical Feed Adjustment Problems				15:40	0:08	4.3								100%			95%					
Chemical Feed Adjustment Problems				15:45	0:13									100%			95%				Particles ?? I Product Water. Breakthrough or residue from cleaning	
Chemical Feed Adjustment Problems				15:58	0:26	4.55		160	1.7					100%	67		95%	64			Clearing	
Chemical Feed Adjustment Problems				15:59	0:27									100%			95%				Press	
Chemical Feed Adjustment Problems																					Clean Membrane	
Chemical Feed Adjustment Problems																						
Chemical Feed Adjustment Pro			35	16:40	0		12							100%			100%				Restart	
Chemical Feed Adjustment Problems				16:45	0:05	2.2	15							100%			100%				Increase Pump Speed	
Chemical Feed Adjustment Problems				16:48	0:08	2.65	15	100	2.7					100%	42		100%	42				
Chemical Feed Adjustment Problems				16:49	0:09		18							100%			100%				Increase Pump Speed	
Chemical Feed Adjustment Problems				16:52	0:12	3.2		88	3.1					100%	37		100%	37				
Chemical Feed Adjustment Problems				16:54	0:14		21							100%			100%				Increase Pump Speed Noted "Haze" in Product Water	
Chemical Feed Adjustment Problems				17:00	0:20			92	2.9					100%	39		100%	39				
Chemical Feed Adjustment Problems				17:01	0:21		24							100%			100%				Increase Pump Speed	
Chemical Feed Adjustment Problems				17:06	0:26	4.2		102	2.6					100%	43		100%	43			Noted 2449 Pump Can't keep up with 2270 by ~ 20%	1.8
Chemical Feed Adjustment Problems				17:17	0:37									100%			100%			55	Added Charge Pak to Feed Tank	
Chemical Feed Adjustment Problems				17:19	0:39									100%			100%				Press & Discharge (10 Min Total)	
Chemical Feed Adjustment Problems																						

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				17:30	0		12							100%			100%				Restart	
				17:38	0:08		15							100%			100%				Increase Pump Speed	
				17:43	0:13	3	15							100%			100%				Crystal Clear	
				17:44	0:14		19							100%			100%				Increase Pump Speed	
				17:49	0:19	3.3	19	99	2.7					100%	42		100%	42				
				17:50	0:20		21							100%			100%				Increase Pump Speed	
				17:53	0:23	3.6	21	89	3.0					100%	37		100%	37				
				17:54	0:24		24							100%			100%				Increase Pump Speed	
				17:59	0:29	3.85	24	77	3.5					100%	32		100%	32				
				18:00	0:30		27							100%			100%				Increase Pump Speed	
				18:03	0:33	4.2	27	70	3.9					100%	29		100%	29				
				18:04	0:34		30							100%			100%				Increase Pump Speed	
				18:06	0:36	4.45	30	66	4.1					100%	28		100%	28				
				18:11	0:41	4.55	30	70	3.9					100%	29		100%	29			Press	3.6
				18:23	0		12							100%			100%				Restart	
				18:26	0:03	1	20							100%			100%				Increase Pump Speed	
				18:30	0:07	3.7	30							100%			100%				Increase Pump Speed	
				18:35	0:12	4.55	30	77	3.5					100%	32		100%	32				
				18:51	0:28	4.65	30	83	3.3					100%	35		100%	35				
				18:56	0:33	4.7	30							100%			100%				Press	3.3
7/20/04	Krofta Feed	White Towels		15:40	0		12						Tank Outlet	100%		Pump Outlet	100%				Start	
				15:44	0:04	1.5	19							100%			100%				Increase Pump Speed	
Cleaned Membrane Data ???				15:56	0:16	3.5	19	54	5.0					100%	23		100%	23				
Cleaned Membrane Data ???				15:57	0:17		27							100%			100%				Increase Pump Speed	
Cleaned Membrane Data ???				16:02	0:22	3.8	27	41	6.6					100%	17		100%	17				
Cleaned Membrane Data ???				16:03	0:23		32							100%			100%				Increase Pump Speed	
Cleaned Membrane Data ???				16:06	0:26	4.3	32	35	7.7					100%	15		100%	15				
Cleaned Membrane Data ???				16:10	0:30		29							100%			100%				PS Trip Reduce Pump Speed	
Cleaned Membrane Data ???				16:35	0:55	4.4	29	54	5.0					100%	23		100%	23				
Cleaned Membrane Data ???				16:36	0:56		30							100%			100%				Increase Pump Speed	
Cleaned Membrane Data ???				16:41	1:01	4.65	30							100%			100%					5.3
Cleaned Membrane Data ???				16:42	1:02									100%			100%				Press	
Cleaned Membrane Data ???				16:48	1:08									100%			100%				Discharge	
		Napkins		16:58			12			-8.75	1056			100%			100%				Restart	
				17:01		2	30							100%			100%				Increase Pump Speed	
				17:02			30							100%			100%				PS Trip	
				17:04			30							100%			100%				Wet Dump	
				17:05	0		12							100%			100%				Restart	
				17:08	0:03	1.5	12							100%			100%					
				17:09	0:04		29.5							100%			100%					
				17:11	0:06		29.5			-12.75	979			100%			100%					
				17:12	0:07	4.2	29.5	44	6.1					100%	18		100%	18				
				17:26	0:21	4.3	29.5	48	5.6					100%	20		100%	20				
				17:40	0:35		27.5			-21.75	807			100%			100%				PS Trip Reduce Pump Speed	
				17:45	0:40		27.5							100%			100%				PS Trip - Press	4.8
														100%			100%					

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				17:48	0		12							100%			100%				Discharge & Restart	
				17:52	0:04	1.4	30							100%			100%					
				17:54	0:06		29.5							100%			100%					
				17:59	0:11	4.3	29.5	51	5.3					100%	21		100%	21				
				18:09	0:21		29.5							100%			100%				PS Trip	
				18:10	0:22		28							100%			100%				Reduce Pump Speed	
				18:14	0:26	4.35	28	62	4.4					100%	26		100%	26				
				18:15	0:27		29							100%			100%				Increase Pump Speed	
				18:20	0:32		28							100%			100%				PS Trip Reduce Pump Speed	4.3
				18:35	0:47	4.4	28	67	4.0					100%	28		100%	28				
				18:38	0:50		28			-34	573			100%			100%					483
				18:42	0:54	4.4	28	67	4.0					100%			100%				Press	4.7
7/21/04	Waste Water Trench	Napkins	41	9:26	0		10						Pump Outlet	95%		Tank Outlet	65%				Start 0.34% Concs. In Feed Tank	
				9:29	0:03	1.3	15							95%			65%					
				9:34	0:08	3.2	20							95%			65%					
				9:39	0:13	4.4	24							95%			65%					
				9:45	0:19		24	210	1.3					95%			65%					
				9:46	0:20																Press & Discharge & Clean Membrane	
				10:00																55	Added 220 ml Charge Pak (diluted in water) to Feed Tank)	
				10:13	0		10							95%			65%				Restart	
				10:18	0:05	2	22							95%			65%					
				10:20	0:07	3		77	3.5					95%	31		65%	21				
				10:21	0:08		24							95%			65%					
				10:29	0:16	4.1		97	2.8					95%	39		65%	26				
				10:31	0:18		26							95%			65%					
				10:36	0:23	4.4		129	2.1					95%	51		65%	35				
				10:39	0:26	4.55															Press	2.4
				10:45	0:32																Discharge	
				10:49	0		10							95%			65%				Restart	
				10:55	0:06	2	10							95%			65%					
				10:56	0:07		26							95%			65%					
				10:58	0:09	3.8	26	53	5.1					95%	21		65%	14				
				11:03	0:14	4.1	26	71	3.8					95%	28		65%	19				
				11:11	0:22	4.15	26	95	2.8					95%	38		65%	26				
				11:18	0:29	4.25	26	98	2.8					95%	39		65%	27				
				11:24	0:35	4.4	26	103	2.6					95%	41		65%	28				
				11:32	0:43	4.4	26	114	2.4					95%	45		65%	31				
				11:36	0:47																Press	
				11:45																	Discharge	3.6
				11:51	0		10							95%			65%				Restart	
				11:54			10			-27.75	693			95%			65%					
				11:56	5	2	26							95%			65%					
				12:00	9	4	26	84	3.2					95%	33		65%	23			Press I Min	
				12:01	0		10							95%			65%				Discharge & Restart	
				12:04	0:03		10			-29.75	655			95%			65%					
				12:07	0:06	2	26							95%			65%					
				12:10	0:09	3.9	26	61	4.4					95%	24		65%	17				
				12:27	0:26	4.15		88	3.1					95%	35		65%	24				
				12:43	0:42	4.3		109	2.5					95%	43		65%	30				
				12:47	0:46	4.4								95%			65%				Press	
				12:50	0:49																Discharge	3.5

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				12:54	0		10							95%			65%				Restart	
				12:58	0:04		10			-37.75	502			95%			65%					
				13:05	0:11	4.1	10							95%			65%					
				13:06	0:12																Press & Discharge	
				13:07	0		10			-39.5	468			95%			65%				Restart	
				13:12	0:05	2	26							95%			65%					
				13:17	0:10	4.05	26	77	3.5					95%	31		65%	21				
				13:22	0:15	4.1	26	85	3.2					95%	34		65%	23			Tank Level too low	225
																						3.2
7/27/04	Krofta Feed ??	White Towels	43	17:45	0		12			-17.5	889		Tanl Outlet	100%		Pump Outlet	85%					
				17:49	0:04	1.3								100%			85%					
				17:54	0:09		29	43	6.3					100%	18		85%	15			Increase Pump Speed	
				17:59	0:14	3.95		68	4.0					100%	29		85%	24				
				18:01	0:16									100%			100%				Increased 2270	
				18:04	0:19	4.45		61	4.4					100%	26		100%	26				
				18:10	0:25	4.45		56	4.8					100%	23		100%	23				
				18:19	0:34	4.45		60	4.5					100%	25		100%	25				239
				18:30	0:45	4.45		65	4.2					100%	27		100%	27				3.4
				18:40	0:55	4.45		67	4.0					100%	28		100%	28				
				18:50	1:05	4.45		71	3.8					100%	30		100%	30			Stop & Press	4.3
				18:53	1:08																Wet Dump	
				18:55			12			-30	650			100%			100%				Restart	
				18:58	0:03	1.35								100%			100%					
				18:59	0:04		29							100%			100%				Increase Pump Speed	
				19:01	0:06	3.8		43	6.3					100%	18		100%	18				
				19:04	0:09	3.85		43	6.3					100%	18		100%	18				
				19:33	0:38	4.15		51	5.3					100%	21		100%	21				
				19:38	0:43									100%			100%				Pause to fill Feed Tank	
				19:59	1:04		12			-10	1032			100%			100%				Restart	
				20:00	1:05	2								100%			100%					
				20:05	1:10	4.45	29	58	4.7					100%	24		100%	24			Increase Pump Speed	
				20:10	1:15	4.2		59	4.6					100%	25		100%	25				
				20:11	1:16		31							100%			100%					
				20:15	1:20	4.45		53	5.1					100%	22		100%	22			Increase Pump Speed	
				20:20	1:25									100%			100%				Stop & Press	
				20:23	1:28									100%			100%				Wet Dump	5.2
														100%			100%					
				20:25			12							100%			100%				Restart	
				20:28	0:03	1.2								100%			100%					
				20:29	0:04		29							100%			100%				Increase Pump Speed	
				20:32	0:07					-19	860			100%			100%					172
				20:34	0:09	4.1		44	6.1					100%	18		100%	18				5.2
				20:44	0:19	4.15		45	6.0					100%	19		100%	19				
				20:45	0:20		32							100%			100%					
				20:51	0:26	4.3		43	6.3					100%	18		100%	18				
				21:08	0:43	4.7		63	4.3					100%	26		100%	26				
				21:11	0:46		30							100%			100%					
				21:16	0:51									100%			100%				Pump Hi Temp Fault	
				21:29	1:04									100%			100%				Press	
				21:32	1:07									100%			100%				Wet Dump	
														100%			100%					

Jannanco, LLC
NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
Field Data
April 2004 thru August 2004

Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	
				21:34			12			-34	573			100%			100%				Restart	287
				21:37	0:03	1.2	30							100%			100%				Increased Pump Speed	4.8
				21:43	0:09	4.3	58							100%			100%					
				21:47	0:13	4.3	59							100%			100%					5.1
				21:57	0:23	4.3	58							100%			100%					
				21:58	0:24									100%			100%				Stop & Press	
				22:02	0:28									100%			100%				Wet Dump	
														100%			100%					
				22:03	0		12							100%			100%				Restart	
				22:07	0:04	1.2	30							100%			100%				Increased Pump Speed	
				22:09	0:06	4.0		49	5.5					100%	21		100%	21				
				22:10	0:07		29							100%			100%				Reduced Pump Speed	
				22:13	0:10	4.0		55	4.9					100%	23		100%	23				
				22:17	0:14	4.0		55	4.9					100%	23		100%	23				
				22:18	0:15		31							100%			100%				Increased Pump Speed	
				22:23	0:20	4.55		54	5.0					100%	23		100%	23				
				22:24	0:21		30							100%			100%				Reduced Pump Speed	
				22:27	0:24	4.45		72	3.8					100%	30		100%	30				
				22:29	0:26		29							100%			100%				Reduced Pump Speed	
				22:30	0:27									100%			100%				Stopped. Membrane Blinded. Tank Well Below Agitator	4.3
7/28/04	Waste Water	White Towels		12:05																	Filled Tank	
				8:05																	Added Charge pak to Feed Tank	
				8:39			12						Pump Outlet	100%		Tank Outlet	100%				Started in Auto Cycle	
				8:43		1.2	27														Increased Pump Speed	
				8:58		4.45	27															
				9:20						-22												
				9:22		4.55	26.5														Reduced Pump Speed	
				11:00						-31												
				11:50						-2											Refilled	
				14:30						-14												
				15:15																	Stopped at end of 5th Base Fill & Press. Error in Consistency estimate.	
				15:30																	Start Detatchment Discharge	
																					Had to force out packed solids with water. One shot for 5 seconds. Would not detatch with bladders	

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8/9/04																					New 5 Micron Membrane FWFR 8 Sec/ 5 GP w/ PS @ 2 Bar	
8/10/04	Krofta Feed	Brown Towels		18:47			12			-11.5				0%			0%				Start up Without Polymer	
				18:57		0	15														Product water Clear	
Clean New Membrane Initial data ???				19:00		1	32															
Clean New Membrane Initial data ???				19:03			29														PS Trip w/ Breakthrough of minute fines. Reduced Pump Speed	
Clean New Membrane Initial data ???				19:04			27														PS Trip w/ Breakthrough of minute fines. Reduced Pump Speed	
Clean New Membrane Initial data ???				19:06			25														PS Trip w/ Breakthrough of minute fines. Reduced Pump Speed	
Clean New Membrane Initial data ???				19:09			23														PS Trip w/ Breakthrough of minute fines. Reduced Pump Speed	
Clean New Membrane Initial data ???				19:12		4.3	23															
Clean New Membrane Initial data ???				19:15		4.3	23	108	2.5													
Clean New Membrane Initial data ???				19:25		4.5	23	149	1.8													
Clean New Membrane Initial data ???				19:27																	Stop & Press	
Clean New Membrane Initial data ???				19:32																	Restart	
Clean New Membrane Initial data ???				19:35		4.5															Stop & Clean	
Clean New Membrane Initial data ???																						
Clean New Membrane Initial data ???				20:18			12						Tank Outlet	50%		Pump Outlet	50%				Restart	
Clean New Membrane Initial data ???				20:23		1.1	28															
Clean New Membrane Initial data ???				20:28		4.05		45	6.0					75%	14		75%	14			Flocks in Sample from "debris' in press from last test	
Clean New Membrane Initial data ???				20:36		4.4		55	4.9					75%	17		75%	17			Flocks in Sample from "debris' in press from last test	
Clean New Membrane Initial data ???																					Clean Press Again	
Clean New Membrane Initial data ???																						
Clean New Membrane Initial data ???				21:45	0:00		12			-26				90%			90%				Restart	
Clean New Membrane Initial data ???				21:49	0:04	1.2	28							90%			90%				Increased Pump Speed	
Clean New Membrane Initial data ???				21:51	0:06	3.55		35	7.7					90%	13		90%	13				
Clean New Membrane Initial data ???				21:56	0:11	3.8		39	6.9					90%	15		90%	15				
Clean New Membrane Initial data ???				22:01	0:16	4.1		46	5.9					90%	17		90%	17				
Clean New Membrane Initial data ???				22:11	0:26	4.1		52	5.2					90%	20		90%	20				
Clean New Membrane Initial data ???				22:21	0:36	4.3		59	4.6					90%	22		90%	22				
Clean New Membrane Initial data ???				22:31	0:46									90%			90%				PS Trip. Noted some flocks in Product Water then immediately cleared. Still from "debris"	
Clean New Membrane Initial data ???				22:32	0:47		26							90%			90%					
Clean New Membrane Initial data ???				22:34	0:49		27							90%			90%					
Clean New Membrane Initial data ???				22:36	0:51	4.35								90%			90%					5.6
Clean New Membrane Initial data ???				22:37	0:52		26.5							90%			90%					
Clean New Membrane Initial data ???				22:40	0:55																PS Trip. Feed Tank Below Agitator. Stop & Press	
Clean New Membrane Initial data ???				22:43	0:58																D/D	
8/10/04	Reclaimed Water	Brown towels		23:30																	Filled Feed Tank	

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8/11/04	Reclaimed	Brown towels		8:52	0:00		12			-10	1032			85%			85%				Restart	
				8:56	0:04	1.5	28							85%			85%					
				9:02	0:10	4.1		52	5.2					85%	19		85%	19				
				9:16	0:24	4.15		58	4.7					85%	21		85%	21				
				9:26	0:34	4.3		64	4.2					85%	23		85%	23				
				9:36	0:44	4.3		67	4.0					85%	24		85%	24				
				9:46	0:54	4.4		77	3.5					85%	27		85%	27				
				9:52	1:00	4.4		79	3.4					85%	28		85%	28				
				9:53	1:01									85%			85%				Stop/Press/DD (4 min 30-30-30-30)	
														85%			85%					4.1
				11:30	0:00		12							85%			85%				Restart	
				11:34	0:04	1.5	28							85%			85%					
				11:38	0:08	3.85		49	5.5					85%	17		85%	17				
				11:41	0:11	3.95		51	5.3					85%	18		85%	18				
				11:55	0:25	4.15		65	4.2					85%	23		85%	23				
				12:05	0:35	4.3		70	3.9					85%	25		85%	25				
				12:25	0:55	4.4		91	3.0					85%	32		85%	32				
				12:26	0:56									85%			85%				Stop/Press/DD (4 min 30-30-30-30)	
														85%			85%					3.9
										-32	612			85%			85%				Added to Feed Tank	
				12:32	0:00		12							85%			85%					420
				12:35	0:03		28							85%			85%					3.3
				12:41	0:09	4.2		68	4.0					85%	24		85%	24			Stop/Press/ Wet Dump	
														85%			85%					
				12:48	0:00		12							85%			85%					
				12:51	0:03	1								85%			85%					
				12:52	0:04		28							85%			85%					
				12:57	0:09	4.1		58	4.7					85%	21		85%	21				
				13:01	0:13	4.15		60	4.5					85%	21		85%	21				
				13:12	0:24	4.15		65	4.2					85%	23		85%	23				
				13:23	0:35	4.15		68	4.0					85%	24		85%	24				
				13:32	0:44	4.2		70	3.9					85%	25		85%	25				
				13:37	0:49	4.2		73	3.7					85%	26		85%	26			Stop/Press/DD (4 min 30-30-30-30)	3.9
				15:50									Pump Outlet			Tank Outlet					Restart with change to feed points. Blinded after repeated attempts. Including adding Charge Pak	
				18:10																	Shut Down & Cleaned	
8/17/04	Krofta Feed	Napkins		8:04			12						Pump Outlet	95%		Tank Outlet	95%		4500	55		
				8:08	0:04	1	28							95%			95%					
				8:10	0:06	2.3		31	8.7					95%	12		95%	12				
				8:14	0:10	3.4		43	6.3					95%	17		95%	17				
				8:16	0:12									95%			95%				Cloudy??	
				8:20	0:16									95%			95%		3000			
				8:23	0:19									95%			95%					
				8:30	0:26	3.95		53	5.1					95%	21		95%	21				
				8:40	0:36	4.15		58	4.7					95%	23		95%	23			Clear	
				8:53	0:49	4.2		60	4.5					95%	24		95%	24				
				9:02	0:58	4.2		64	4.2					95%	25		95%	25				5.4
				9:03	0:59									95%			95%				Stop/Press/DD (4 min 30-30-30-30)	
														95%			95%				Product Water "looked" mikly?	
														95%			95%					
				9:08	9:08		12							95%			95%				Restart	
				9:09	9:09									95%			95%				Pin flocs in Pail??	
				9:10	9:10									95%			95%				No Flow	
				9:11	9:11									95%			95%				Wet Dump	
														95%			95%				Refilled Tank	

Jannanco, LLC
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Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	
				9:24			12			-11	1013			95%			95%		2250	17		
				9:27		1.4	28							95%			95%					
				9:30		3.853.85								95%			95%					
				9:37		3.9								95%			95%					
				9:42		3.9								95%			95%					
				9:50		3.9								95%			95%					
				9:58		3.9								95%			95%					
				10:07		3.9								95%			95%					
				10:13		4								95%			95%					
				10:14			29							95%			95%					
				10:16			30							95%			95%					
				10:17		4.2								95%			95%					
				10:20		4.2								95%			95%					
				10:22		4.2								95%			95%					
				10:23										95%			95%				Stop/Press/DD (4 min 30-30-30-30)	
				10:25						-27	707			95%			95%				Restart while filling Feed tank	
				10:30										95%			95%				No Flow	
				10:34										95%			95%				Wet Dump	
				10:40			12			-11	1013			95%			95%					
				10:43	0:03	1	29							95%			95%					
				10:45	0:05	3.8		56	4.8					95%	22		95%	22				
				10:51	0:11	4		58	4.7					95%	23		95%	23				
				10:53	0:13	4		62	4.4					95%	25		95%	25				
				10:54	0:14									95%			95%				Stop & Dump Wet	3.9
														95%			95%					
				10:57	0:00		29							95%			95%				Restart	
				11:00	0:03	3.7								95%			95%					
				11:02	0:05		31							95%			95%					
				11:03	0:06	4.1		48	5.6					95%	19		95%	19				
				11:08	0:11	4.15		51	5.3					95%	20		95%	20				
				11:18	0:21	4.3		58	4.7					95%	23		95%	23				
				11:20	0:23	43		58	4.7					95%	23		95%	23				
				11:22	0:25		30.5							95%			95%					
				11:27	0:30	4.3		61	4.4					95%	24		95%	24				
				11:37	0:40	4.3		64	4.2					95%	25		95%	25				
				11:38	0:41		30							95%			95%					
				11:48	0:51	4.3		71	3.8					95%	28		95%	28				
				11:49	0:52		30.5	70	3.9					95%	28		95%	28				
				11:56	0:59									95%			95%				Stop/Press/DD (4 min 30-30-30-30)	3.7
				12:03	1:06									95%			95%				D/D	
														95%			95%					
				12:11	0:00		12			-29.5	659			95%			95%				Restart	
				12:15	0:04	1	29							95%			95%					
				12:18	0:07	3.75		57	4.7					95%	23		95%	23				
				12:19	0:08		31							95%			95%					
				12:25	0:14	4.3		56	4.8					95%	22		95%	22				
				12:28	0:17									95%			95%				Stop & Dump Wet	
														95%			95%					4.5
				12:29	0:00		12							95%			95%				Restart	
				12:31	0:02	1	28							95%			95%					
				12:35	0:06	3.6		64	4.2					95%	25		95%	25				
				12:37	0:08	3.75	30	55	4.9					95%	22		95%	22				
				12:41	0:12	4.3		54	5.0					95%	22		95%	22				
				12:42	0:13		31							95%			95%					
				12:45	0:16	4.4		58	4.7					95%	23		95%	23				
				12:46	0:17		30.5							95%			95%					
				12:51	0:22	4.4		63	4.3					95%	25		95%	25				

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NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
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				13:10	0:41	4.4		71	3.8					95%	28		95%	28			Tank Level Below Agitator	3.9
8/17/04																					Found 2449 Pump only operates @ 70% Stroke	
8/18/04	Reclaimed Water	Napkins		12:30	0:00		12			-8	1070		Pump Outlet	110%		Tank Outlet	100%		7500	53	Start	
				12:33	0:03	1.1	30							100%			100%					
				12:37	0:07	3.8	32	59	4.6					100%	25		100%	25				
				12:40	0:10	4.25		54	5.0					100%	23		100%	23				
				12:50	0:20	4.3		60	4.5					100%	25		100%	25				
				13:00	0:30	4.3		59	4.6					100%	25		100%	25				
				13:10	0:40	4.3		59	4.6					100%	25		100%	25				
				13:20	0:50	4.3		61	4.4					100%	26		100%	26				
				13:26	0:56	4.4		64	4.2					100%	27		100%	27			Stop & Dump Wet	
														100%			100%					
				13:28	0:00		12							100%			100%				Restart	4.1
				13:30	0:02	1.05	32							100%			100%					
				13:34	0:06	4.7	32							100%			100%				Stop & Press	
				13:37	0:09									100%			100%				Dump	
														100%			100%					
				13:39	0:00		12							100%			100%				Restart	
				13:43	0:04	1	12							100%			100%				Stop & Press	
				13:46	0:07									100%			100%				Wet Dump	
														100%			100%					
				13:47	0:00		12							100%			100%					
				13:50	0:03	1	32							100%			100%					
				13:53	0:06	4.4	31	57	4.7					100%	24		100%	24				
				13:55	0:08		29							100%			100%					
				13:57	0:10	4.3		67	4.0					100%	28		100%	28				
				14:03	0:16	4.3		67	4.0					100%	28		100%	28				
				14:12	0:25	4.2	30	69	3.9					100%	29		100%	29				
				14:15	0:28	4.3		67	4.0					100%	28		100%	28				
				14:21	0:34	4.3		67	4.0					100%	28		100%	28				3.8
				14:30	0:43	4.2		68	4.0					100%	29		100%	29				
				14:35	0:48					-39	478			100%			100%				Stop & Press 30-30-30-30---	592
																						4.7
				15:00						-9	1051			100%			100%		4500	59	Repaired 2449 Pump ??	
														100%			100%					
				15:55			12							100%			100%					
				15:57	0:02	1	22							100%			100%					
				15:59	0:04	3	27							100%			100%					
				16:01	0:06	3.5	29							100%			100%					
				16:02	0:07	3.9	30							100%			100%					
				16:04	0:09	4.3	30	76	3.6					100%	32		100%	32			Stop & Wet Dump	
														100%			100%		3750		Replenish 2270 w/ 5 gal @ 0.45%	
														100%			100%					
				16:21			12							100%			100%					
				16:23	0:02	1.2								100%			100%					
				16:24	0:03		27							100%			100%					
				16:25	0:04		29							100%			100%					
				16:26	0:05		30	85	3.2					100%	36		100%	36			Stop to Clean Press	

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Field Data
April 2004 thur August 2004

Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	
				17:41	0:00		10							100%			100%				Restart	
				17:44	0:03	1	20							100%			100%					
				17:46	0:05	2.4	27							100%			100%					
				17:48	0:07	3.6	30							100%			100%					
				17:50	0:09	4.3		61	4.4					100%	26		100%	26				
				17:59	0:18	4.3		73	3.7					100%	31		100%	31				
				18:06	0:25	4.3		74	3.6					100%	31		100%	31				
				18:17	0:36	4.2		74	3.6					100%	31		100%	31				
				18:21	0:40	4.3		73	3.7					100%	31		100%	31				
				18:26	0:45	4.3		74	3.6					100%	31		100%	31			Stop Press 30-30-30----	
														100%			100%				Dump	
														100%			100%					3.6
				18:34	0:00		10							100%			100%					
				18:36	0:02	1	20							100%			100%					
				18:38	0:04	2.5	27							100%			100%					
				18:40	0:06	3.5	30							100%			100%					
				18:45	0:11	4.3		85	3.2					100%	36		100%	36				
				18:46	0:12									100%			100%				Wet Dump	
														100%			100%					
				18:47	0:00		10							100%			100%				Restart	
				18:50	0:03	1	20							100%			100%					
				18:52	0:05	2.5	27							100%			100%					
				18:54	0:07	3.5	30							100%			100%					
				18:57	0:10	4.25		72	3.8					100%	30		100%	30				
				19:02	0:15	4.2		72	3.8					100%	30		100%	30				
				19:03	0:16		30.5							100%			100%					
				19:12	0:25	4.25		70	3.9					100%	29		100%	29				
				19:27	0:40	4.25		72	3.8					100%	30		100%	30				
				19:32	0:45	4.25		74	3.6					100%	31		100%	31			Stop & Press	
														100%			100%				Dump	3.5
8/19/04	Waste Water	Napkins	42	10:30						-11	1013								15000	112	Filled Previous night - 0.15% Cons. Replenished Polymers @ 0.45%	
				10:45			10			-14	956			100%			100%					
				10:49	0:04	1	20							100%			100%					
				10:51	0:06	2.5	27							100%			100%					
				10:53	0:08	3.4	30							100%			100%					
				10:57	0:12	4.4		69	3.9					100%	29		100%	29				
				11:05	0:20	4.5		89	3.0					100%	37		100%	37				
				11:06	0:21		29							100%			100%					
				11:11	0:26									100%			100%				PS tripped Press & Dump 30-30-30---	
														100%			100%					
				11:18			28							100%			100%				Restart	
				11:24	0:06	4.2	28.5	102	2.6					100%	43		100%	43				
				11:29	0:11		28							100%			100%				PS Trip	
				11:31	0:13		27							60%			60%				Cut Chem Pumps to 60%	
				11:38	0:20	4.5		222	1.2					60%	56		60%	56			Stop & Press 30-30-30	
														60%			60%				Dump	
														60%			60%					
				11:44										60%			60%				Restart	
				11:50										60%			60%				Stopped Clean Press - Blinded	

Jannanco, LLC
NYSERDA Pilot Trail For Ultra Clarification of Paper Mill White Water Waste Water
Field Data
April 2004 thur August 2004

Date	Source	Grade on #9 PM	Feed Tank Temp Degrees C	Time	Time From Start in Min	Feed Pressure in Bar	Feed Pump Speed in Hz	Pail Time	Flow Rate GPM	Feed Tank Level "'s from Lip	Feed Tank Volume	Feed Tank Cons. In %	2449 Addition Point	2449 Pump Rate	2449 PPM	2278 Addition Point	2278 Pump Rate	2278 PPM	Charge Pak Addition To Tank @ 3%	Charge Pak PPM	Comments	
				12:10						-27	707								18000	304		
				12:30	0:20		10							52%			60%				Restart	
				12:35	0:25	2.1	15							52%			60%					
				12:40	0:30		18	80	3.4					52%	17		60%	20				
				12:43	0:33	2.5								52%			60%					
				12:44	0:34		15	80	3.4					52%	17		60%	20				
				12:48	0:38									52%			60%					
				12:52	0:42		18							52%			60%				Stop Press Dump	3.0
														52%			60%					
				16:56			10							52%			60%				Restart	
				16:59	0:03		29							52%			60%					
				17:03	0:07	4.3		117	2.3					52%	25		60%	29				
				17:09	0:13	4.6		185	1.5					52%	40		60%	47			Stop Press Dump	
														52%			60%					
				17:17			10							52%			60%					1.5
				17:20	0:03	1	29							52%			60%					
				17:24	0:07	4.3		99	2.7					52%	22		60%	25				
				17:27	0:10	4.5		144	1.9					52%	31		60%	36				
				17:32	0:15	4.5		168	1.6					52%	36		60%	42				
				17:37	0:20	4.6		188	1.4					52%	41		60%	47				
				17:38	0:21									52%			60%				Wet Dump	
														52%			60%					
														52%			60%					1.8
				17:40			10							52%			60%					
				17:43	0:03	1	29							52%			60%					
				17:48	0:08	4.5		141	1.9					52%	31		60%	35			Tank Level Below Agitator	

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ENERGY EFFICIENT PAPER MILL PROCESS WATER AND WASTED PROCESS WATER FILTRATION FOR HIGH CLARITY WATER FOR REUSE AND FIBER RECOVERY

FINAL REPORT 06-09

STATE OF NEW YORK
GEORGE E. PATAKI, GOVERNOR

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY
VINCENT A. DEIORIO, ESQ., CHAIRMAN
PETER R. SMITH, PRESIDENT, AND CHIEF EXECUTIVE OFFICER

Energy Efficient Paper Mill Process Water and Wasted Process Water Filtration for High Clarity Water for Reuse and Fiber Recovery NYSERDA Final Report 06-09