City of Schenectady, New York

Wastewater Treatment Plant Sludge Dewatering Centrifuge - Engineering Report

July 1995

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July 10, 1995

Mr. Milton G. Mitchell, P.E.
Commissioner, Department of Public Works
City Hall
105 North Jay Street
Schenectady, New York 12305

Subject: Wastewater Treatment Plant
Sludge Dewatering Centrifuge - Engineering Report

Dear Mr. Mitchell:

Camp Dresser & McKee (CDM) is pleased to present our Engineering Report for the evaluation of a sludge dewatering centrifuge for the City of Schenectady Wastewater Treatment Plant (WWTP). The purpose of this evaluation was to determine the technical feasibility of using a centrifuge to dewater the primary and secondary sludge generated at the WWTP. The City's goal is to install a centrifuge to improve sludge dewatering particularly during periods when the sludge has a high volatile solids content. Presented in this report is a summary of existing conditions, results of the dewatering pilot test, estimated capital and operating costs, and recommendations. The report also presents an initial assessment of the environmental impacts as required by the New York State Environmental Review Process (SERP).

In summary, CDM recommends that the City proceed with the design and installation of the sludge dewatering centrifuge. The design documents to be prepared will include a procurement specification for the centrifuge and controls, and drawings and specifications for installation. The installation design will include equipment support and access, piping (sludge, polymer, plant water, and centrate), dewatered sludge conveyors, electrical and polymer feed pumps. Concurrent with the design, CDM will submit this report, subsequent specifications and drawings to the New York State Department of Environmental Conservation and Environmental Facilities Corporation in support of the City's long-term refinancing of the project through the SRF.

CDM has enjoyed working with the City of Schenectady on this project and look forward to working with the City on the implementation of the centrifuge. If you have any questions, please call me at 459-3961.

Very truly yours,

CAMP DRESSER & McKEE

Richard A. Molongoski, P.E.
Principal Engineer

cc: B. Sisson - Assistant City Engineer, City of Schenectady

File: 5438-1-CG

The City of Schenectady, New York

Wastewater Treatment Plant
Sludge Dewatering Centrifuge
Engineering Report

Table of Contents

Section 1
Existing Conditions and Background

The City of Schenectady owns a wastewater treatment plant (WWTP) which serves the City and the Village of Scotia. The plant has a permitted hydraulic capacity of 18.5-mgd and discharges treated effluent to the Mohawk River. The plant presently provides secondary treatment to an average daily flow of approximately 13-mgd. Sludge handling facilities include waste activated sludge thickening, anaerobic digestion, sludge blending (primary and secondary sludge) tanks and belt filter press dewatering. Based on historical data, the WWTP produces about 2,700 dry tons of sludge per year. The dewatered sludge cake is either composted or incinerated onsite, or hauled offsite for final disposal during composting equipment downtime. The preferred sludge processing option is composting

The WWTP has historically experienced sludge dewatering problems during the cold weather months which impact the composting operation. To adequately operate the compost facility, the dewatered sludge cake needs to be a minimum of 25% solids. The composting operation at the WWTP is an in-vessel aerated pile operation where the dewatered sludge is co-composted with a bulking material. The dewatered sludge is mixed with amendment (primarily wood chips) in the composter and placed in the composting vessels where the organic material undergoes biological degradation to a stable end product. Based on information provided by the City, the cost for composting the dewatered sludge is about $200 per dry ton of solids.

During the cold weather months, the sludge generated has a volatile solids (VS) content of greater than 70%. The high sludge VS content is attributed to high organic wastewater discharges from seasonal manufacturers within the City. During the period of high VS content sludge, the dewatering belt filter presses (BFPs) typically achieve less than 20% sludge cake solids. At this percent solids, the sludge cannot be properly mixed with the amendment and cannot be composted. Therefore, the sludge must be hauled off-site for final disposal. The City's current off-site disposal cost is $62.50 per wet ton. At a sludge solids content of 20%, the resulting cost per dry ton is $312 which is $112 more per ton as compared to composting.

To address the dewatering problem, the City and PSG considered the installation of a centrifuge for dewatering. Historically, centrifuges produce a final sludge cake that is 4% to 8% higher in solids than BFP sludge cake.

In January 1995, the City retained Camp Dresser & McKee (CDM) to evaluate and provide design engineering services for a sludge dewatering centrifuge. The intent of this project is to provide one centrifuge as the primary dewatering system, with the BFPs to be retained as the backup system. The approximate capacity of the centrifuge will be 100 gpm. This will enable the City to maintain the use of the existing variable speed sludge feed pumps which take suction from the blending tanks.
Based on historical WWTP information, the characteristics of the WWTP sludge during the winter months is as follows:

Blend:	20% Primary 80% Secondary
Type:	Anaerobically digested blend, or anaerobically digested secondary with raw primary blend
Total Solids (TS) Concentration:	Average - 2.5%, range 2.0% to 4.5%
Volatile Solids (VS) Concentration:	Average - 70%, range 60% to 75%
Quantity:	1,250 lbs. solids/hr. at 2.5% TS (100 gpm)

The proposed centrifuge will be required to produce a dewatered sludge cake with a minimum solids content of 25% TS and with a minimum suspended solids capture of 95%.

Following a review of the sludge characteristics, CDM in consultation with several centrifuge manufacturers decided that a pilot test was required to determine if a 25% solids sludge cake could be achieved with the high VS content raw sludge.

Section 2
Pilot Testing

The purpose of the pilot test was to determine the dewatering capabilities of a centrifuge on the high VS content sludge from the WWTP. Additionally, the test evaluated polymers required for dewatering and determined how well the dewatered centrifuge sludge cake worked with the WWTP's composting operation, in particular the composter where the sludge is mixed with the ammendment.

Due to the necessity to perform the pilot test during the winter season (March) only one of the centrifuge manufacturers was able to provide the pilot test equipment during this time frame. The pilot testing was performed during the first two weeks of March 1995. A copy of the Pilot Test Report is presented in Attachment A.

In summary, the pilot test determined the following:

1. With 100% anaerobically digested sludge (primary and secondary), the centrifuge was only capable of achieving a dewatered cake at 20% to 22% solids. This percent solids would not be suitable for composting during the winter months. Dewatering to this level also required a polymer dose of 36 pounds per ton which is considerably high and would result in high polymer costs.

2. With blended sludge (raw primary and anaerobically digested secondary), the centrifuge produced a dewatered cake at greater than 27% solids. The polymer dose ranged from 20 to 26 pounds per ton which is reasonable for a centrifuge with a high VS sludge.

3. The testing of different polymer tests showed that an emulsion (liquid) polymer provided the best sludge conditioning.

4. The dewatered blended sludge worked well in the compost mixing operations. The higher solids sludge cake from the centrifuge significantly improved composter operations and amendment volumes required were about 40% less than with the "wetter" BFP sludge.

Based on the results of the pilot test on the blended sludge, the City, PSG and CDM decided to begin the implementation of a full-scale centrifuge design.

Section 3
Recommendations and Costs

3.1 Equipment Recommendations

Based on the results of the pilot test and on the ability to operate the compost facility during the winter, CDM recommends that the City implement the design and installation of the centrifuge. The centrifuge will be designed to achieve the following performance:

Sludge feed rate:	1,250 lbs./hr. dry solids
Sludge feed concentration:	2.5% to 3.0% dry solids
Sludge volatile content:	70% to 80%
Minimum cake solids:	27% total solids
Minimum percent recovery:	95% suspended solids
Maximum polymer dosage:	25 lbs./dry ton feed solids

The centrifuge will be located on the second floor of the existing Sludge Dewatering Building adjacent to the BFP room. This area housed one of the original three vacuum filters which was replaced by the BFPs in the late 1980s. This area also provides direct access to the dewatered sludge conveyor that feeds the Composting Facility. The centrifuge will be installed on concrete piers designed to support the dead and dynamic loads of the centrifuge. Raw sludge will be pumped from the blending tanks by the existing sludge feed pumps through new feed piping to the centrifuge. Flow control between the existing BFPs and the new centrifuge will be by manually operated valves. A flow meter will be installed in the sludge feed line to the centrifuge. Dewatered sludge from the centrifuge will be conveyed, using one or two conveyors, to the existing belt conveyor. The centrate drain from the centrifuge will be piped to an existing drain line that is directed to the primary effluent line feeding the aeration tanks.

The centrifuge will be equipped with a dedicated control panel which will be interlocked with the existing sludge feed pumps and the polymer feed system. The total horsepower required for the centrifuge will be 60 to 90 HP depending upon the manufacturer selected. The Sludge Dewatering Building has spare power sources available for the use with centrifuge.

In addition to the centrifuge, CDM evaluated the existing polymer system for use with the centrifuge. The existing liquid polymer storage, aging and transfer pumping system located in the basement of the Sludge Dewatering Building will be made operable for the centrifuge. This system will provide liquid polymer to the existing polymer feed system located on the first floor. The existing system is currently a dry polymer system that will need to be converted to handle liquid polymers. Control interlocks between the liquid storage system and the feed system will need to be provided. The current polymer feed pumps have a capacity of 8 gpm which will not meet the requirements of the centrifuge. Therefore, these pumps will need to be replaced with two larger positive displacement pumps each capable of delivering polymer at a flow and pressure of 20 gpm, 60 psi, respectively.

3.2 Cost Estimates

Presented below are capital and annual operating cost estimates for the proposed dewatering centrifuge installation. Capital costs were based on manufacturer quotations for major equipment and on CDM's experience with similar installations. Annual costs were based on historical WWTP operating data and unit costs provided by the City.

<u>**Capital Costs**</u> - The total estimated capital cost for the centrifuge is $825,000. A

breakdown of these costs are presented below:

Capital Cost Estimate

Planning and Design	$ 59,000
Centrifuge & Appurtenances	
Piping, Valves and Connections	$ 23,000
Centrifuge and Control Panel	$ 350,000
Sludge Flow Meter	$ 6,000
Dewatered Cake Conveyors	$ 47,000
Access Platform	$ 10,000
Electrical	$ 40,000
Equipment Installation and Contingencies	$ 135,000
Contractor Profit	$ 39,000
Total	$ 650,000
Polymer System Modifications	
Polymer Feed Pumps	$ 26,000
Polymer Flow Meter	$ 3,000
Electrical	$ 9,000
Installation and Contingencies	$ 20,000
Contractor Profit	$ 8,000
Total	$ 66,000
Engineering During Construction, Testing and Start-up	$ 50,000
Total Capital Cost	$825,000

Annual Costs - The operating costs for the centrifuge are based on an annual sludge throughput of 2,700 tons of dry solids with dewatering operations performed 6 days per week. For comparative purposes, the annual operating costs for the BFPs are also presented. The centrifuge costs reflect composting year round. The BFP costs consider off-site hauling and disposal of the sludge for a six month period

(November through April). Composting costs for the centrifuge reflect the reduced volume of sludge due to the higher solids content. Based on the results of the pilot study, operation of the composter (amendment mixing) with the dryer centrifuge sludge will be 7 hours per day versus 12 hours per day with the BFP sludge. Dewatered sludge cake solids for the BFPs were assumed at 19% during the winter and 23% during the summer. For the centrifuge, cake solids were assumed at 27% and 32% for the winter and summer, respectively.

Annual Cost Estimate

	Proposed Centrifuge	Existing BFPs
Dewatering:		
Maintenance	$ 19,500	$ 12,000
Electrical ($0.083/kwh)	46,500	7,500
Polymer	170,000	99,000
Subtotal	$ 236,000	$ 118,500
Composting:		
Maintenance	$ 27,000	$ 22,500
Electrical	$ 97,000	$ 83,500
Amendment	$ 130,000	$ 243,500
Subtotal	$ 254,000	$ 349,500
Off-site Hauling and Disposal:	$ 0	$ 360,000
Debt Service (20 Years):		
Cost of Annual Payment (3%)	$ 57,000	$ 0
Total Annual Costs	$ 547,000	$ 828,000

The above annual costs show that the centrifuge will reduce the operating costs for dewatering and composting of the sludge at the WWTP. Overall costs are also reduced by eliminating the off-site hauling expense during the winter months. The total operating cost reduction for the WWTP with the centrifuge is estimated to be $281,000. Therefore, the potential savings to the City's 20,653 flat rate users is $13.61 per user.

Section 4.0

State Environmental Review Process

CDM understands that the City of Schenectady will be applying for long-term refinancing for the centrifuge costs from the New York State Water Pollution Control Revolving Fund (SRF). The project is currently included on the draft Intended Use Plan (IUP) for Federal Fiscal Year 1996. As part of the New York State SRF requirements, all projects are subject to the State Environmental Review Process (SERP) to assess the potential environmental impacts resulting from the project.

Under SERP, projects can fall into one of the three categories:

Type I Action - Potential for significant environmental impact
Type II Action - Little or no environmental impact
Excluded or
Exempt Actions - Projects that meet specific excluded or exempt definitions

This section of the report presents an assessment of environmental impacts from the proposed centrifuge project.

The centrifuge project will have little environmental impact to the WWTP and the surrounding community. The proposed centrifuge to be installed will serve as the primary sludge dewatering unit for the WWTP with the existing BFPs as the secondary dewatering units. From the existing sludge feed pumps, the piping system will be designed to deliver the sludge to either the centrifuge or to the BFPs. The capacity of the centrifuge will be the same as the capacity of the existing BFPs. Therefore, there will be no increase in the sludge dewatering capacity at the WWTP.

The centrifuge will be installed on the second floor of the existing Sludge Dewatering

Building at the WWTP, next to the BFPs. This area originally housed a sludge vacuum filter which was removed in the late 1980s. There will be no expansion or modification to the existing Sludge Dewatering Building.

The centrifuge will not contribute to any environmental impacts exterior to the building including noise, odors or emissions. Noise levels for the centrifuge will be specified to be below 94 dBA at a point 3-feet from the unit. Because the unit will be located in the existing building, noise impact outside the building will be negligible. With respect to odors and emissions, the centrifuge, unlike the BFPs, is an enclosed unit that will provide better containment sludge odors and emissions during dewatering. Therefore, when compared to the existing BFPs, the centrifuge will not increase odors or emissions from dewatering operations at the WWTP.

During construction, the centrifuge and appurtenances will be delivered to the second floor through an equipment opening in the building. Therefore, temporary removal of the exterior walls of the building will not be required.

Based on the above, CDM believes that the installation of the sludge dewatering centrifuge in the Dewatering Building at the WWTP will have no significant environmental impact and should be considered a Type II Action.

Attachment A
Pilot Test Report

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TEST REPORT

Project Name: The Schenectady Water Pollution Control Facility
Schenectady, New York

Consulting Engineer: CDM Engineers, Inc.
Edison, New Jersey

Application: Dewatering Anaerobically Digested Sludge
and Blended Sludge

Equipment Tested: Humboldt CP1-1.1 Centripress

Test Dates: March 6, 7, 13, 14, 15, 1995

Tested and Reported by: Mr. Robert Trionfetti, HDI

April 1995

Introduction

The Schenectady Water Pollution Control Facility is an 18.5 MGD complete-mix activated sludge treatment plant. The present annual average flow is approximately 14 MGD. Incoming wastewater receives secondary treatment and disinfection before being discharged to the Mohawk River. The Professional Services Group is the contract operator for the facility.

An in-vessel composting unit is employed to convert sludge solids into a marketable product. Since the composting process effects a pathogen-kill, dewatered raw sludge may be fed directly into the composting unit. However, in order to allow the use of a smaller composting vessel and also to prevent odors, the plant's solids handling scheme provides for anaerobic digestion of the sludge before the composting process. The digested sludge is dewatered using belt filter presses then fed to the composter. During most of the year the belt filter presses produce 24%TS cake which is suitable for the composting operation. In winter, however, the cake concentration falls off.

In winter a significant waste load is discharged to the treatment plant by a local cheese producer. In treating that load the plant generates a large mass of biological sludge. The addition of this excess biological sludge to the existing sludge solids renders the digested blend very difficult to dewater. For the duration of the cheese-making season the cake dryness obtained off of the belt filter presses falls below the optimum level for the composting operation.

The Professional Services Group, working with their consultant, CDM Engineers, Inc., is investigating methods to improve the dryness of the dewatered sludge cake.

In March 1995, Humboldt Decanter, Inc., working together with the Professional Services Group and with the CDM Engineers, tested a Humboldt CP1-1.1 Centripress at Schenectady. The goal of the test was to determine the Centripress' ability to produce dewatered cake of minimum 27% dryness, suitable for optimal composting.

We express our thanks to Mr. Paul LaFond, plant manger, and to his staff for the generous cooperation accorded to us throughout this test program.

Conclusion

The Humboldt Centripress readily dewatered the anaerobically digested sludge and the blended sludge at the Schenectady Water Pollution Control Facility. The following results were obtained with the CP1-1.1 Centripress:

Anaerobically Digested Sludge

Feed Rate GPM	Solids Loading lbs/hr	Feed Conc %TS	Cake Conc %TS	Solids Recovery % of TSS	Polymer Dose lbs/ton
15	150	2.0	22	95	36
25	250	2.0	21	95	36
35	350	2.0	20	95	36

Blended Sludge (Raw Primary:Anaerobically Digested = 1:2 w/w)

Feed Rate GPM	Solids Loading lbs/hr	Feed Conc %TS	Cake Conc %TS	Solids Recovery % of TSS	Polymer Dose lbs/ton
27	350	2.6	29	95	26
35	450	2.6	28	95	26
42	550	2.6	27	95	26
27	350	2.6	26	95	20
35	450	2.6	25	95	20
42	550	2.6	24	95	20

Test Procedure

The Humboldt test trailer, equipped with a CP1-1.1 Centripress, a variable-speed feed pump, and a polymer make-up/feed system, was stationed at the Schenectady Water Pollution Control Facility adjacent to the composting building.

The suction line of our feed pump was connected to a header through which the feed sludge was continually recirculated. Dewatering tests were conducted first on the anaerobically digested sludge alone followed by tests on a blend of the anaerobically digested sludge mixed with raw primary sludge. In the blend the ratio of the anaerobically digested sludge to the primary sludge was 6:1 by volume and 2:1 by weight of solids.

For the disposal of the dewatered cake a conveyor belt was provided by the plant. The belt deposited the cake into a bin from which it could be processed through the composting operation. The centrate was drained into a 100-gallon collection bin, adjacent to our trailer, then pumped back to the treatment plant.

Feed rates to the Centripress were varied from 15 to 41 gpm for the anaerobically digested sludge and from 25 to 45 gpm for the blended sludge.

Cytec 2081 emulsion polymer was selected for conditioning, as the best product from among those available on our test trailer. Polymer solutions were made-up to concentrations of 0.13% to 0.32% active solids basis. Dosage rates from 30 to 52 active lbs/ton were tested for the anaerobically digested sludge and 19 to 26 active lbs/ton for the blended sludge.

Each run was conducted for a minimum of 30 minutes before samples were collected. This was to assure that the samples were representative of a stable operating condition. At the conclusion of each run, samples of the feed sludge, the centrate, and the cake were collected. Also at that time both the feed flow rate and the polymer draw-down rate were recorded.

All of the samples collected were analyzed by the Humboldt representative. Selected samples were submitted to the plant laboratory for confirmation of results.

Results

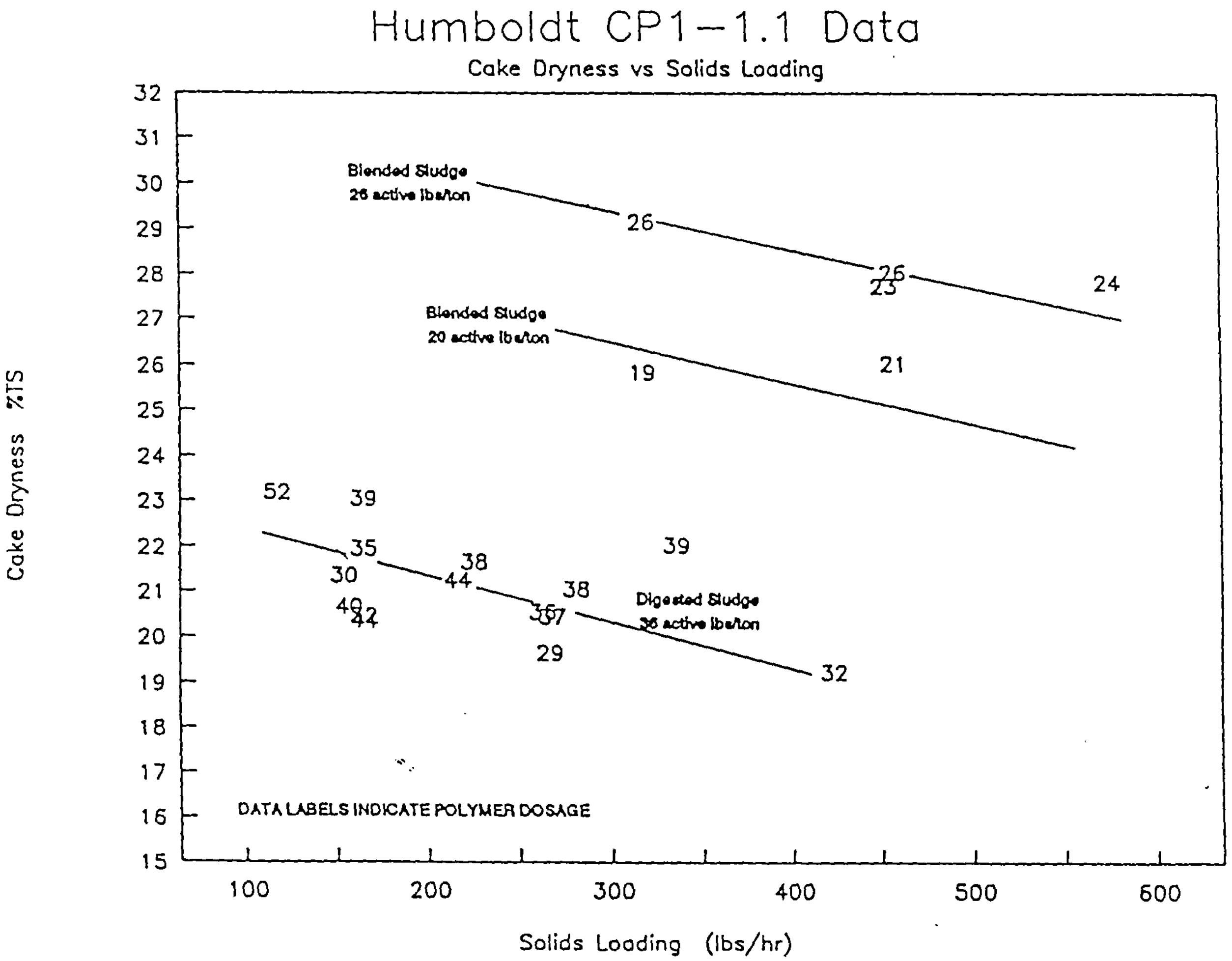
The spreadsheet on page 5 lists all of the data obtained while using the Cytec 2081 emulsion polymer. The data obtained using other polymer products has been deleted from consideration since the dosages were higher and because those scattered results mask the performance trends obtained with the Cytec product.

The graph below Cake Dryness vs Solids Loading shows how the dryness of the cake, produced by the Centripress, is influenced by changes in the rate of the sludge feed to the Centripress. Three lines are scribed on the graph. Each line is labeled showing the type of sludge and the polymer dosage for which the line is representative. Each line exhibits a negative slope reflecting that the cake dryness decreases when the solids loading increases. The relative positions of the three lines together with the data labels, which indicate the polymer dosages, show that dewatering the anaerobically digested sludge alone required much more polymer and rendered wetter cake compared to dewatering the primary/anaerobically digested blend.

The top line relates to the dewatering of the blended sludge dosed with 26 active lbs/ton of polymer. The line shows that a sludge loading of 350 dry lbs/hr results in cake dryness at 29%TS. When the loading is increased to 450 dry lbs/hr the cake dryness falls to 28%TS. Further increasing the loading to 550 dry lbs/hr decreases the cake dryness to 27%TS.

The middle line relates to the dewatering of the blended sludge dosed with 20 active lbs/ton of polymer. At this lower polymer dosage the cake dryness is about 3%TS wetter than at the higher dosage of 26 active pound/ton. Corresponding respectively to solids loading values of 350, 450, and 550 dry lbs/hr are cake concentrations at 26%TS, 25%TS, and 24%TS.

The line near the bottom of the graph relates to the dewatering of the anaerobically digested sludge dosed with 36 active lbs/ton of polymer. The cake drynesses corresponding to solids loading values of 150, 250, and 350 dry lbs/hr are 22%TS, 21%TS, and 20%TS.



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HUMBOLDT CP1-1.1 DATA
Dewatering Digested Sludge and Blended Sludge
Schenectady Water Pollution Control Facility

		[—FEED RATE-]		[STREAM CONCENTRATIONS]			SOLIDS	[——— POLYMER—— ——]					Roto
	RUN NO.	GPM	TSS BS/HR	Feed TSS %w/w	Effluent TSS %w/w	Cake TS %w/w	RCVY %	DOSE Lbs/Ton	RATE GPM	CONC % TS	TYPE	Diff RPM	Pres Bars
1995													
Mar 6	1	15	165	2.20	0.100	20.5	95.92	32	3.80	0.14	SD2081		
Digested	2	15	165	2.20	0.100	20.4	95.92	44	3.66	0.20	CY1596		
Sludge	3	15	165	2.20	0.100	22.0	95.89	35	2.55	0.23	SD2081		
	4	15	165	2.20	0.100	23.1	95.87	39	2.84	0.23	SD2081		
Mar 7	5												
Digested	6												
Sludge	7												
	8	21	226	2.20	0.100	21.7	95.90	38	3.91	0.22	SD2081		45
	9	26	281	2.20	0.100	21.1	95.91	38	4.34	0.25	SD2081	6.9	43
	10	31	336	2.20	0.100	22.1	95.89	39	4.02	0.32	SD2081	7.4	42
	11	11	118	2.20	0.100	23.2	95.87	52	2.50	0.25	SD2081	2.5	57
Mar 13	12	20	216	2.13	0.100	21.3	95.75	44	3.28	0.29	SD2081	5.3	46
Digested	13	25	263	2.10	0.100	20.6	95.70	36	3.28	0.29	SD2081	6.9	48
Sludge	14	25	268	2.14	0.100	20.5	95.79	37	2.55	0.38	SD2081	4.8	48
	15	25	266	2.13	0.100	19.7	95.79	29	2.03	0.38	SD2081	6.1	47
Mar 14	16	15	154	2.08	0.100	21.4	95.64	30	1.52	0.30	SD2081	3.0	47
Digested	17	41	423	2.09	0.100	19.3	95.71	32	4.59	0.30	SD2081	8.8	41
Sludge	18	15	157	2.09	0.100	20.7	95.68	40	4.74	0.13	AC775		
15	19												
nded	20												
Sludge	21												
	22												
	23												
	24												
	25	35	452	2.58	0.100	27.8	96.47	23	3.77	0.28	SD2081		65
	26	35	457	2.61	0.100	26.1	96.54	21	3.42	0.28	SD2081	5.5	50
	27	35	457	2.61	0.100	28.1	96.51	26	4.20	0.28	SD2081		72
	28	25	318	2.54	0.100	29.2	96.39	26	3.04	0.27	SD2081	5.5	90
	29	25	318	2.54	0.100	25.9	96.44	19	2.24	0.27	SD2081		50
	30	45	574	2.55	0.100	27.9	96.42	24	4.50	0.31	SD2081	7.9	60