WATER REUSE TECHNOLOGY DEMONSTRATION PROJECT

Demonstration Facility Pilot Study
Ballasted Flocculation (Densadeg®)
Primary Treatment Application
Final Draft Report

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By

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Contents

Tables

Figures

Appendices

Executive Summary

The King County Department of Natural Resources conducted a 9-month pilot testing program to assess the performance of emerging wastewater treatment technologies. The Densadeg® process (ballasted flocculation) was tested to determine its utility for primary treatment. This report presents the findings of that testing.

Demonstration Facility and Testing Goals and Objectives

The Densadeg® demonstration unit was on-site for a total of 16 weeks. It was brought onsite in a 40-foot-long trailer that was parked outside of the testing facility. The unit arrived on site as a complete packaged system, consisting of the following: bar screen tank, coagulation (rapid mix) tank, reactor/clarifier, and a chemical batching system and process control/laboratory building. A testing plan was prepared prior to the pilot study and updated throughout the test.

- The target performance goals were:
  - Total Suspended Solids removal efficiency > 80 %
  - Chemical Oxygen Demand removal efficiency > 60 %
  - Total phosphorus removal efficiency > 80 %
- The operational conditions were selected to:
  - Determine optimum polymer and coagulant types and doses. Polymers Nalco IC34 and Ciba LT225, and coagulants, alum, ferric chloride, and polyaluminum chloride (PACl) were tested.
  - Collect long-term performance data at optimum and sub-optimum chemical doses.
  - Evaluate the impact of wet and dry start-ups and loss of chemical feed.
  - Collect data pertaining to metals removal.

Results and Conclusions

Following is a summary of the results derived from the pilot testing data:

- Target Performance Goals
  - **COD Removal:** COD removal efficiency is between 58% and 71% for the three coagulants tested, generally exceeding the 60% removal target for the Densadeg® unit.
  - **TSS and Turbidity Removal:** The Densadeg® process consistently achieved excellent TSS removal of 85% to 96%, exceeding the goal of 80% TSS removal. Turbidity removal averages 89% for all the coagulants tested.

- **Total Phosphorus Removal:** Ferric chloride and alum achieved 85% and 91% phosphorus removal, exceeding the goal of 80% removal. Alum addition was more effective for phosphorus removal at equal dose.
- **BOD_5 Removal:** BOD removal in the Densadeg® was shown as high as 92 % for one test at alum dosage of 60 mg/L. Coagulant PACl achieved 63% of BOD removal based on analysis of a single sample collected.

- Operational Consideration
  - **Comparison of Coagulants:** With the exception of PACl for COD removal, all three coagulants were found to surpass the target performance goals. Alum provided relatively higher overall removal based on a comparison of COD, TSS, and phosphorus removal efficiencies**.**
  - **Process Start-up:** The Densadeg® pilot plant started up every morning with no sludge or water ('dry' startup) in the unit. It took about 35 minutes to fill the Densadeg® pilot unit (to go into production). The start-up tests conducted demonstrate that the Densadeg® 4D reaches it's optimal, steady state performance within approximately 20 minutes of production.
  - **Soluble Organic Removal:** Removal efficiency of soluble BOD was approximately 28% (data shown in Appendix B). Most likely this "soluble" removal was associated with colloidal particles that were slightly smaller than the pore size of the membrane used for suspended solids analysis. As evident by the high TSS removal efficiencies, the Densadeg® process is highly effective at removing particulates/solids from raw wastewater. However, since it is a physical/chemical process and relies on particle-to-particle interaction for removal, it lacks the ability to remove soluble organic constituents. Some colloidal particles can be coagulated and removed as evidenced by the soluble BOD and metal removal.
  - **Sludge Blanket:** The unit performance on stable sludge blanket. The Densadeg® unit operation shows that establishing and maintaining adequate sludge blanket is essential to sustain process performance.
- Overall Performance – Pilot testing results demonstrated that the Densadeg® process performed better than conventional primary clarification with regard to removal efficiencies and performance stability. However, the Densadeg® process requires continuous chemical feed, which increases the operational cost for the process.

If this technology is implemented full-scale, further pilot testing and/or investigation of existing installations may be considered to determine:

- The effect of dual polymer addition.
- The ability to treat high-strength influent (e.g. influent during dry month).
- How quickly the system can provide treatment during dry and wet startups.
- How to optimize the sludge recirculation system and sludge blanket monitoring.

Introduction

The King County Department of Natural Resources (King County) conducted a nine-month demonstration pilot testing project to assess the performance of emerging wastewater treatment technologies. The focus of this project was to assess technologies that had the potential to minimize the footprint, impacts and costs of producing recycled water (Class A or better) at small satellite facilities. The Densadeg@ process was selected because of its purported small footprint and improved effluent quality when compared to conventional primary treatment. This unit process would be used in conjunction with secondary and tertiary treatment processes to produce reclaimed water.

The Densadeg® process (ballasted flocculation) was pilot tested to determine its utility for primary treatment. This report presents the findings of that testing.

Description of the Technology

The Densadeg® process is an external-recirculation, high-density sludge unit based on the lamella settling principle. Chemical additions (polymer and coagulant) are required to enhance performance and maintain stable operation. It is a compact and high rate clarification process designed to handle variations in raw water composition and flow rate.

The Densadeg® 4D pilot plant was configured the same as a full-scale installation. The pilot plant has a hydraulic capacity of 300 gallons per minute (gpm), or 0.432 million gallons per day (MGD), and a hydraulic loading rate (HLR) of 70 gpm/sf. The lamella settling area used in this pilot study was 4.3 ft square feet. Figure 1 is a schematic of the process.

At the West Point WWTP, the Densadeg® 4D pilot plant was fed by a submersible pump. The Densadeg® 4D has five distinct zones, as shown in Figure 1. Raw water is pumped to the arc screen chamber (not shown) equipped with ¼-inch-spaced bar screen. Coagulant was added on the discharge side of the raw water feed pump. The screened wastewater is pumped to the aerated grit chamber (also the flash mixer). Within the flash mix zone, grit and grease are removed and coagulation takes place. The coagulated water flows by gravity from the grit chamber/rapid mix zone into the bottom of the reactor.

The reactor (slow mixer) is equipped with a bell-bottomed draft tube and mixer. At the top of the draft tube, polymer is added to aid flocculation. The reactor zone provides for flocculation with mixing by an axial flow mixer. The zone of transition from the reactor to the clarifier/ thickener, called the "piston flocculation zone," provides for a gentle mixing condition that enhances flocculation and densification. Since the wastewater is forced hydraulically upwards through the transition zone, oil and grease constituents are trapped at the top of the transition zone. These constituents are skimmed off by means of a drain valve.

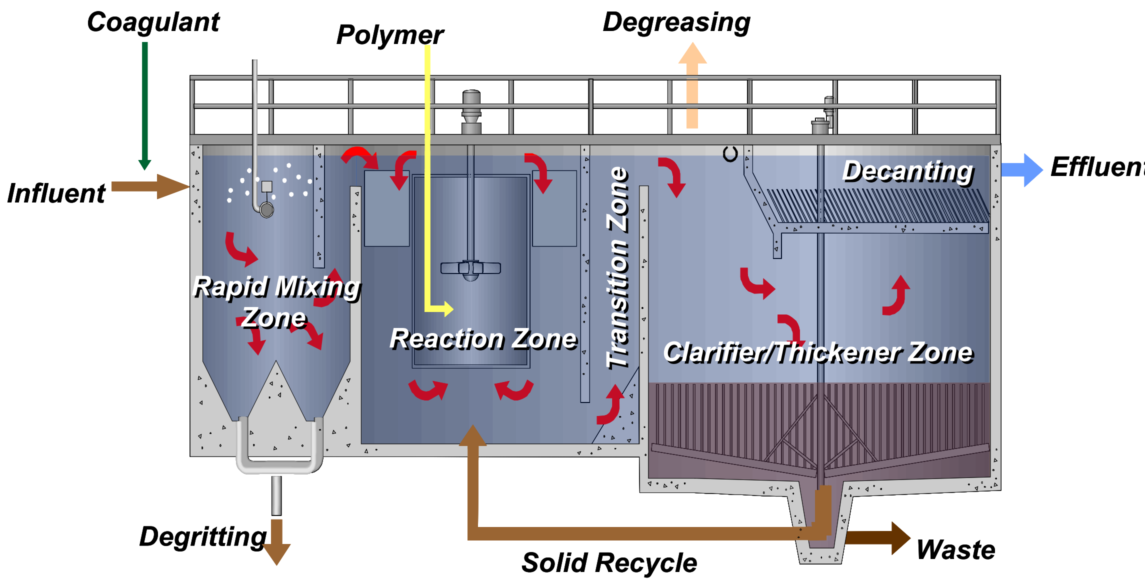

Figure 1.Full-Scale Densadeg® Flow Diagram. (Ondeo Degremont 2002)

The heavy, dense solids formed in the transition zone settle in the clarifier/thickener zone. The clarifier/thickener zone is equipped with a bottom scraper. A part of the sludge produced in the thickener is recycled externally into raw water piping which runs from the grit chamber to bottom of the reactor zone during operation to ensure that optimum sludge concentration is maintained in the reactor at all times. This recycling of solids from the clarifier/thickener to the reactor zone helps to enhance flocculation and provides the ballast for the particles. Thickened sludge is drawn off from the central sludge hopper. Excess sludge is pumped out via the waste line. Supernatant travels up through the lamella settling tubes (hexagonal in shape), where small stray floc is removed. The settled water is recovered by a collection trough and discharged into the effluent line.

Table 1 lists the Densadeg® installations for primary treatment in North America. There are more than 30 other installations for primary treatment and phosphorus removal, mostly in Europe. The complete installations list was provided by Ondeo Degremont and is included in Appendix D of this report.

Table 1. Densadeg® Installation in North America.

Municipality and Plant Location	Country	Unit Startup Date	Maximum Flowrate Mgd
Laval Station De Lapiniere	Québec, Canada	1998	160
Beloeil	Québec, Canada	1997	15
Saint-Jean Sur Richelieu	Québec, Canada	1996	31
Repentigny	Québec, Canada	1996	14
Saint-Eustache	Québec, Canada	1991	14
Sherbrooke	Québec, Canada	1988-1991	38
Puebla Station De Barranca Del Conde	Mexico	2001	11
Puebla Station De San Francisco	Mexico	2001	34
Puebla Station D' Atoyac Sur	Mexico	2001	14
Puebla Station D' Alseseca Sur	Mexico	2001	23
Breckenridge	Colorado, USA	1998	2

Pilot Testing

Goals and Objectives

The goal of the pilot study was to evaluate the Densadeg® process and determine its effectiveness for primary treatment. The following key performance issues were investigated:

- The ability of this process to remove 5-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total suspended solids (TSS), and total phosphorus.
- The optimum combination of polymer and coagulant doses for conventional and advanced (phosphorus removal) primary treatment.
- Process performance parameters during dry start, wet start, and chemical feed failure conditions.
- Operational and maintenance requirements such as labor, chemical and energy requirements, as well as performance during startup.
- Ability to achieve target performance goals of:
  - TSS removal efficiency > 80 %
  - COD removal efficiency > 60 %
  - Total phosphorus (TP) removal efficiency > 80 %

Demonstration Setup

The Ondeo Degremont Densadeg® 4D demonstration unit arrived at the West Point WWTP on October 22, 2001. The unit was on-site for a total of 16 weeks and was shipped back on February 8, 2002. Technology Assessment Program and West Point staff operated the unit, collected laboratory samples, and recorded field data. A majority of the samples was analyzed by West Point Process laboratory. Metal analysis was done by the county's Environmental Laboratory.

The demonstration pilot, which has a maximum capacity of approximately 300 gpm, was brought in a 40-foot long trailer that was parked outside of the testing facility as shown in

Figure 2. The unit arrived as a complete packaged system, consisting of bar screen tank, coagulation (rapid mix) tank, reactor/clarifier, and a chemical batching system and process control/laboratory rooms.

Figure 2. Trailer Mounted Densadeg® Pilot Unit.

Table 2 summarizes the pilot unit's physical attributes.

Table 2. Summary of physical parameter
(from Ondeo Degremont/Denard Technical Data Sheet)

Parameter	Unit	Value
Influent Pump	HP	7.40
Rapid Mix	ft^3	100
Coagulation Zone Mixer	HP	0.75
Reaction Zone	ft^3	122
Reaction Zone Mixer	HP	1.50
Piston Flocculation	ft^3	60
Extraction Pump	HP	0.75
Clarifier Area	ft^2	4.3
Clarifier Volume	ft^3	96
Recycle Pump	HP	0.75
Lamella Tubes	ft^3	31
Thickener Scraper	HP	2.00

The pilot unit has a capability to vary flow, recycle rate, blanket depth, blow down frequency and duration, and other process variables. The feed water to the pilot unit was de-gritted. The hydraulic loading rate is controlled via influent feed pumps and an adjustable curtain insert, which allows the clarifier surface area to be changed. The pilot unit was operated at 30 gpm/sf with the curtain insert at a location to provide a total surface area of 4.3 ft^2. The surface area was constant throughout the testing.

The trailer has a data logger that can be used to record the unit operation and its performance, including chemical dosage, sludge extraction rate, height of sludge blanket, influent and effluent turbidity. The pilot unit PLC controls the chemical dosages. The chemical dose is automatically adjusted based on influent turbidity using a preprogrammed three-point calibration curve.

The general control strategy of the unit operation is described in the Ondeo unit operation manual. Key operation control parameters and set points are summarized as follows:

- **Feed stream alkalinity**: Alkalinity (e.g. 75 mg/L) needs to be maintained in the feed flow to assist flocculation.
- **Coagulant dose:** Coagulant dose is controlled by three-point PID dosing curve according to the influent turbidity.
- **Polymer dose:** The polymer dose must not exceed 2 mg/L. The dose is maintained with a feed pump controlled with a VFD.
- **Sludge blanket:** Sludge blanket is established and held between 1 and 3 feet.
- **Sludge recirculation:** Sludge recirculation flow is controlled at 3 - 5 % of raw water flow.

- **Sludge withdrawal location:** Sludge is withdrawn either from the bottom of clarifier or from cone, which was approximately six inches from the bottom.
- **Sludge wasting:** Sludge wasting occurs for 1 minute every 60 to 120 minutes.

The operation parameters and set points of each trial were recorded in the data logbook, which is attached in Appendix B of this report. In the data logbook, sludge blanket height was shown as having been recorded by both instrument and visual observation. Influent and effluent turbidity data were obtained from both online turbidity metering and grab sampling.

Testing Plan

A testing plan was prepared prior to the pilot study and updated throughout the pilot test to reflect actual test progress. A copy of the final testing plan is contained in Appendix A of this report. Following is a summary of key information presented in the testing plan:

- **Jar Testing.** Jar testing was to precede pilot testing in order to determine the most effective type of polymer and coagulant and their effective dosages. The source wastewater was to be primary influent from the West Point WWTP. Two polymer solutions were to be tested initially. (A single polymer was selected for subsequent testing stages based on a comparison of test performance results.)
- **Pilot Testing.** The plan included three testing trials:
  - **Coagulant and Polymer Optimization Trials.** These trials were to determine optimum polymer and coagulant doses. Each testing condition consisted of different polymer and coagulant dose combinations, and the selection of optimum chemical doses was to be based on a review of measured COD, TSS, and turbidity removal efficiencies. (The pilot unit was operated under one test condition for a period of at least two hydraulic residence times prior to collecting a sample that was considered representative of that particular test condition.)
  - **Hydraulic Loading Trial.** This trial was for the purpose of evaluating the Densadeg® unit under variable flow conditions. The average flow rate was to be 172 gpm (HLR 40 gpm/sf), or 25 percent lower than the peak flow of 215 gpm (HLR 50 gpm/sf). That difference would be great enough to produce measurable impacts on treatment performance.
  - **Chemical Feed Failure Trial.** These trials were designed to evaluate the impact from loss of chemical feed at peak flow. The planned test conditions were as follows: Shut off coagulant and polymer feed for one hour. Keep operating unit at 129 gpm (HLR 30 gpm/sf). In the following hour, collect four grab samples and combine these into a composite for analysis. Restart the chemical feed and operate the unit for one hour at the same flow rate. In the next hour, collect four grab samples and combine these samples for analysis.

Turbidity measurements were to be recorded throughout the test and then used to determine how much time would be required for the process to achieve steady-state performance. Once the process had achieved steady-state performance, hourly samples were to be collected for a minimum of three hours to produce a single composite sample.

BOD (total and soluble) would be measured for the two optimal runs for each of the three coagulants. For each of these coagulants, influent and effluent metals would be measured during a single test condition (i.e., optimal coagulant and polymer doses).

The Densadeg® pilot study was planned for a total of 47 workdays (eight hours per day: 2 days for jar testing, 12 days for optimization trials, 3 days for floating tests, 21 days for three-stage steady-state operation, 4 days for peak hydraulic loading as well as chemical failure runs, and 5 days for phosphorous removal trials. (In reality, the pilot unit took longer than planned to function properly. King County staff worked overtime to meet the timeline. After the jar test was completed in the ONDEO laboratory during the week of October 25, 2001, optimization trials, peak hydraulic loading and chemical failure runs, as well as phosphorous removal trials were completed within three weeks from January 18 to February 6, 2002. Due to time constraints, some tests were not conducted as planned. Those include wet and dry startup and continuous sub-optimum chemical dose runs.)

Results

Test results are summarized below. Test data of the complete pilot study is contained in Appendix B.

Jar Tests

Preliminary jar tests were performed by Ondeo in their Richmond, Virginia laboratory, utilizing the three coagulants (alum, ferric chloride and polyaluminum chloride) and two polymers (Nalco IC34 and Ciba LT22S) to test the treatability of the primary influent. Five liters of feed water were shipped by King County in mid-October. Polymer Ciba Magnafloc LT22S is very high in molecular weight, and in cationic, dry polyacrylamides. Nalco IC34 is a high-molecular-weight, anionic, emulsion polymer. The jar test results were used to determine coagulant dosages and to determine the polymer type for pilot testing. Four jar tests were done.

- **Jar test 1:** Ferric chloride ($FeCl_3$) was evaluated (at dosages from 10 to 60 mg/L) with polymer Nalco IC34 (0.5 mg/L). TSS and COD treatment objectives were met for all jars. The floc was large in size and uniform.
- **Jar test 2:** Alum was evaluated (at dosages from 10 to 60 mg/L) with polymer Nalco IC34 (0.5 mg/L). TSS and COD treatment objectives were met for all jars. The floc was large in size and uniform.
- **Jar test 3:** Polyaluminum chloride (PACl) was evaluated (at dosages from 10 to 60 mg/L) with polymer Nalco IC34 (0.5 mg/L). TSS and COD treatment objectives were met for all jars. The floc was large in size and uniform.

- **Jar test 4:** A comparison of polymer Nalco IC34 and Ciba LT22S was performed with ferric chloride (20 mg/L). Nalco IC34 had lower turbidity levels and larger floc sizes, resulting in slightly lower TSS, total phosphorous, and COD concentrations as shown in Table 3.

Table 3. Jar testing comparison of polymer types.

Polymer Type	Turbidity Removal %	TSS Removal %	COD Removal %	Phosphorous (P) Removal %
Nalco IC34	86.5	93.0	66.9	80.6
Ciba LT22S	84.0	91.7	64.2	76.5

Nalco IC34 was selected as the flocculation aid for all trials. The pilot study was conducted using one polymer and the following three coagulants: alum, ferric chloride ($FeCl_3$), and polyaluminum chloride (PACl).

Coagulant Optimization Trials

Pilot testing trials from January 18 through February 2 were conducted to determine the optimum chemical doses for the three coagulant/polymer combinations. Pilot scale trial tests were performed (as opposed to jar testing) to confirm these doses since the Densadeg® process responds quickly to chemical dose changes (because it has a short hydraulic detention time). Composite samples were taken from both feed and effluent, e.g. one-half-hour grab samples to composite over a three- to four-hour steady state period. Based on previous studies and operating experience, a constant polymer dosage of 1.0 mg/L was selected and used throughout this stage of pilot testing. A summary of operating conditions is shown in Table 4. All optimization trials were conducted at a flow rate of 129 gpm, which corresponds to a reactor overflow rate of 30 gpm/sf.

Table 4. Coagulant optimization operating conditions.

Operating Condition	Units	Value
Flow Rate	gpm	129
Hydraulic Loading Rate	gpm/sf	30.0
Polymer Nalco IC34	mg/L	1.0
Coagulant Dose		
PACL	mg/L	10, 20, 40, 60
Ferric Chloride	mg/L	10, 20, 40, 60
Alum	mg/L	20, 40, 60
Hydraulic Residence Time		
Grit Chamber	minutes	5.8
Reaction Tank	minutes	7.0
Piston Flocculation	minutes	3.5
Clarifier Tank	minutes	12.9
Lamellar Tubes	minutes	1.8
Overall	minutes	31.0

Selection Criteria

- **Optimum Coagulant Doses:** The optimum coagulant doses were selected based on a review and discussion of measured COD, TSS, TP, and turbidity removal efficiencies. Optimum coagulant doses were selected based on the "best" performance obtained from various coagulant doses coupled with a constant polymer dose of 1 mg/L.
- **Low Chemical Doses:** The selection of "low" polymer coagulant doses was based on reviews of TSS- and turbidity-removal efficiency data. The overall goal of the selection process was to determine the minimum coagulant dose (coupled with a constant polymer dose of 1.0 mg/L) that would achieve a minimum 80 % TSS removal efficiency and a relatively high turbidity removal.

Testing and Results

Optimal PACl Dose

Figure 3 shows the turbidity removal efficiencies of PACl dosages ranging from 10 to 60 mg/L at a constant polymer dose of 1 mg/L. Higher PACl dosage yields higher turbidity removal.

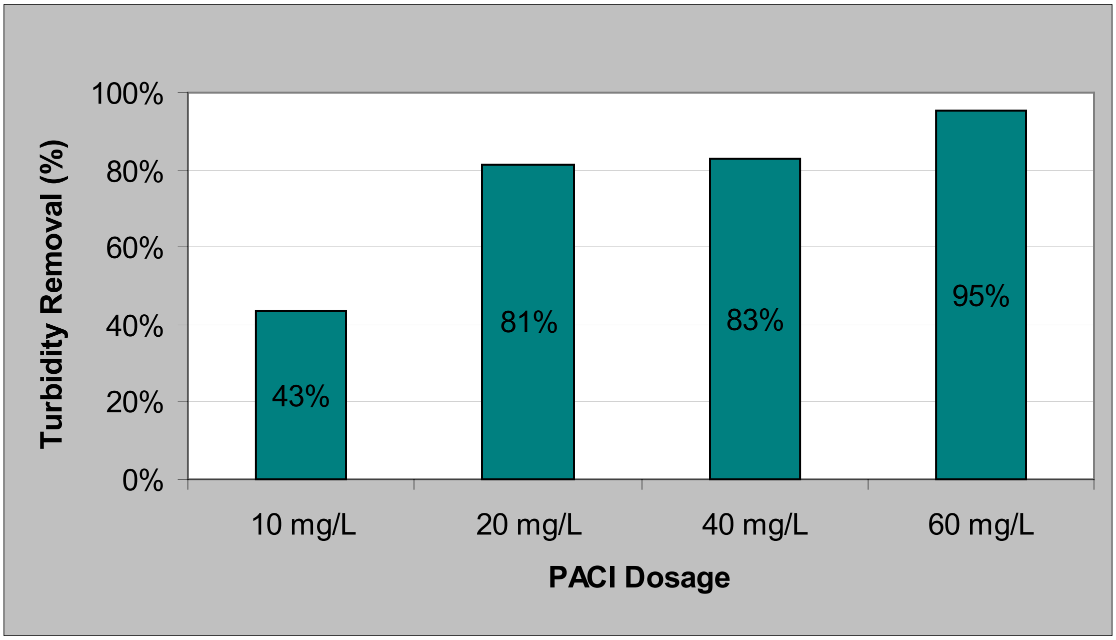

Figure 3. PACl dosage trial.

Table 5 shows the COD and TSS removal for the various PACl dosages. Dosages at 20 mg/L and above achieved the goal of the greater than 80% TSS removal. Dosages at 20 and 40 mg/L approached the COD removal goal of greater than 60%, but failed to achieve the target. TP data were not collected for this trial.

Table 5. PACl dosage trial.

PACl		COD			TSS	
Dosage mg/L	Influent mg/L	Effluent mg/L	Removal %	Influent mg/L	Effluent mg/L	Removal %
10	435	218	50	167	84	50
20	260	110	58	93	14	85
40	484	206	57	219	41	81
60	-	-	-	95	7	93

Note: "-" stands for no data being collected or recorded.

Optimal $FeCl_3$ Dose

Figure 4 shows the turbidity removal efficiencies of differing $FeCl_3$ dosages ranging from 10 to 60 mg/L at a constant polymer dose of 1 mg/L. Higher $FeCl_3$ dosage yields higher turbidity removal up to 40 mg/L $FeCl_3$ dosage. Increasing the coagulant dose above 40 mg/L did not improve turbidity removal.

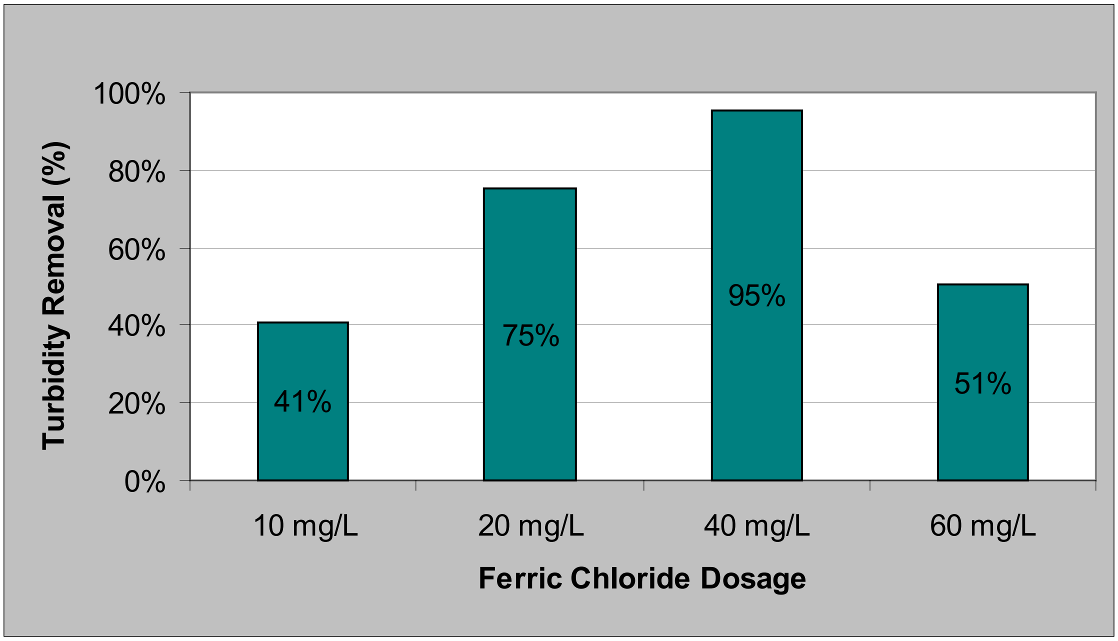

Figure 4. $FeCl_3$ dosage trial.

Table 6 shows the TSS and TP removal for the various $FeCl_3$ dosages. Dosage at 40 mg/L achieved the goal of TSS removal greater than 80% as well as the TP removal goal of 80% or more. It is not clear if a lower ferric dose may also meet the phosphorous removal goal. COD values were not available for this trial.

Table 6. $FeCl_3$ dosage trial.

$FeCl_3$ Dosage mg/L	TSS Influent mg/L	TSS Effluent mg/L	TSS Removal %	TP Influent mg/L	TP Effluent mg/L	TP Removal %
10	216	139	36	-	-	-
20	90	23	74	-	-	-
40	258	11	96	4.25	0.65	85
60	154	149	3	-	-	-

Note: "-" stands for no data being collected or recorded.

Optimal Alum Dose

Figure 5 shows the turbidity removal efficiencies for alum dosages ranging from 20 to 60 mg/L at a constant polymer dose of 1 mg/L. Higher alum dosage yields higher turbidity removal.

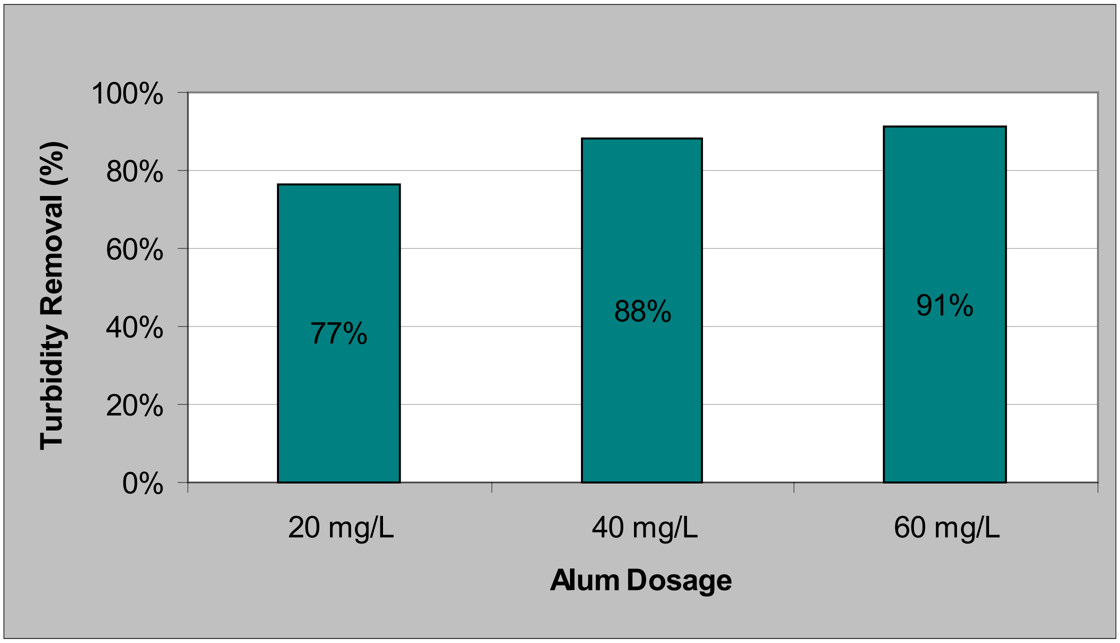

Figure 5. Alum dosage trial.

Table 7 shows the COD, TSS, and TP removal for the various alum dosages. Dosage of 60 mg/L achieved all three treatment goals. All selected alum doses achieved the TSS removal goal of 80% or more. Alum dosages of both 20 and 40 mg/L attained the desired removal percentage for COD and TSS but not for TP. The TP removal goal was reached only at the alum dosage of 60 mg/L. If phosphorus removal is not required, the lower alum dose can be used.

Table 7. Alum dosage trial.

Alum Dosage mg/L	COD Influent mg/L	COD Effluent mg/L	COD Removal %	TSS Influent mg/L	TSS Effluent mg/L	TSS Removal %	TP Influent mg/L	TP Effluent mg/L	TP Removal %
20	989	406	59	436	51	88	3.44	1.99	42
40	-	-	-	-	-	-	2.66	0.76	71
60	876	250	71	417	54	87	2.28	0.2	91

Note: “-“ stands for no data being collected or recorded.

Optimal Coagulant Doses

- **PACl:** The optimum and low PACl doses were determined to be 60 and 20 mg/L, respectively. A dosage of 20 mg/L PACl, coupled with a polymer dose of 1 mg/L, would achieve 80% TSS removal efficiency and 60% COD removal efficiency.
- **$FeCl_3$:** The optimum ferric chloride dose was determined to be 40 mg/L. A dosage of 40 mg/L $FeCl_3$, coupled with a polymer dose of 1 mg/L, would achieve a minimum 80% removal efficiency for both TSS and TP.

- **Alum:** The optimum alum dose was determined to be 60 mg/L. A dosage of 60 mg/L alum, coupled with a polymer dose of 1 mg/L, would achieve all removal efficiencies for TSS, COD and TP.

Hydraulic Loading Trials

The hydraulic loading trials were conducted from January 29, 2002 through February 5, 2002. Table 8 summarizes the operating conditions during this testing. All tests were conducted at flow rates ranging from 86 gpm to 215 gpm, which corresponds to hydraulic loading rates from 20 to 50gpm/sf. Three optimum coagulant and polymer dose combinations were tested. Composite samples (comprised of grab samples taken every half-hour over a three- to four hour steady state period) were taken from both feed and effluent. The trial lasted approximately 16 hours for each coagulant and consisted of the following components:

- The unit was started with a low hydraulic loading rate of 20 gpm/sf.
- Samples were taken after two to three hydraulic retention time periods, when the unit operation had reached steady state.
- The hydraulic loading rate was increased, and samples were taken after two or three hydraulic retention times.

Table 8. Hydraulic loading trial operating condition.

Operating Condition	Units	Value			
Hydraulic Overflow Rate	gpm/sf	20	30	40	50
Flow Rate	gpm	86	129	172	215
Polymer Dose	mg/L	1.0	1.0	1.0	1.0
Coagulant Dose					
PACl	mg/L	30-40-50	30-40-50	30-40-50	30-40-50
Ferric Chloride	mg/L	30-40-50	30-40-50	30-40-50	30-40-50
Alum	mg/L	30-40-50	30-40-50	30-40-50	30-40-50
Hydraulic Residence Time					
Reaction Tank	min	10.6	7.0	5.3	4.2
Clarifier Tank	min	19.5	13.0	9.7	7.8

Note: Coagulant dose was under control and varied per influent turbidity between 30-40-50 mg/L.

For coagulant PACl and $FeCl_3$, HLRs of 20 and 30 gpm/sf were tested intermittently. Higher HLRs were not tested due to the time limitation. The unit was loaded with increasing flow until the recorded data showed complete failure of treatment for the alum coagulant run. The performance for each coagulant under various hydraulic loading conditions is presented below by comparing turbidity removal efficiencies.

PACl Hydraulic Loading Trial

Figure 6 is a plot of turbidity in and out of the unit over time during the PACl hydraulic loading trial. During the test, the baseline HLR was 20 gpm/sf. For the higher HLR, the unit was run at 150% of the baseline HLR. This corresponds to 30 gpm/sf.

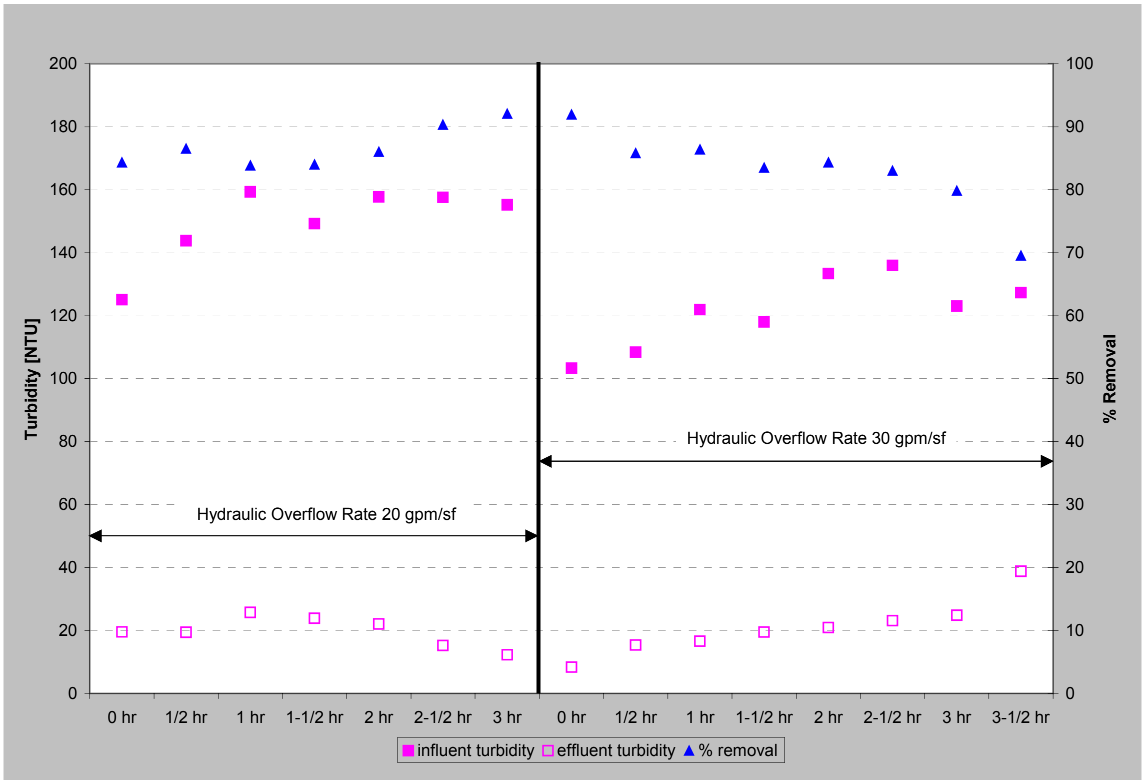

Figure 6. PACl hydraulic loading trial.

During the 20 gpm/sf period, the influent turbidity ranged from 120 to 160 NTU, and the effluent turbidity from 15 to 25 NTU, which resulted in approximately 85% reduction. During the 30 gpm/sf run, the influent turbidity ranged from 100 to 140 NTU, and the effluent turbidity ranged from 10 to 40 NTU, which gave a reduction of approximately 85%.

Table 9 presents the treatment performance during the PACl hydraulic loading trial. During the 20 gpm/sf run, the average influent TSS was 234 mg/L, and the average effluent TSS was of 53 mg/L, which resulted in 77% TSS removal. During the 30 gpm/sf run, 81% TSS removal was achieved. COD removal followed a similar trend. It appears that hydraulic loading changes from 20 to 30 gpm/sf slightly improved the unit treatment performance.

Table 9. PACl hydraulic loading trial.

HLR gpm/sf	COD Influent mg/L	COD Effluent mg/L	COD Removal %	TSS Influent mg/L	TSS Effluent mg/L	TSS Removal %
20	643	364	43	234	53	77
30	484	206	57	219	41	81

Note: TP data were not collected or recorded.

$FeCl_3$ Hydraulic Loading Trial

Figure 7 is a plot of turbidity in and out of the unit over time during the $FeCl_3$ hydraulic loading trial. During the test, the baseline HLR was 20 gpm/sf. For the higher HLR, the unit was operated at 150% of the baseline HLR. This corresponds to 30 gpm/sf.

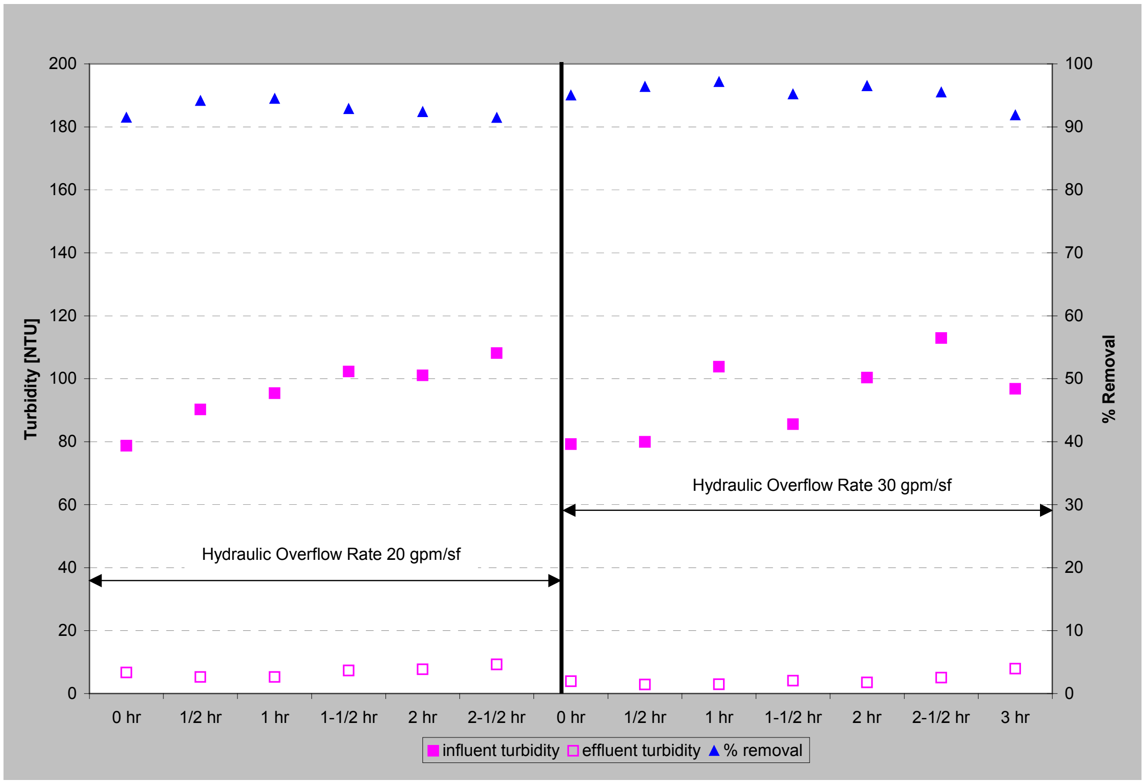

Figure 7. $FeCl_3$ hydraulic loading trial.

During the 20 gpm/sf run, influent turbidity ranged from 80 to 110 NTU and effluent turbidity was consistently around 10 NTU, which achieved approximately 95% reduction. During the 30 gpm/sf run, the influent turbidity ranged from 80 to 120 NTU and the effluent turbidity was consistently around 7 NTU, which gave a reduction of approximately 95%.

Table 10 presents the treatment performance during the $FeCl_3$ hydraulic loading trial. During the 20 gpm/sf run, the average influent TSS was 146 mg/L, and the average effluent TSS was 15 mg/L, which resulted in 90% TSS removal. During the 30 gpm/sf run, 96% TSS removal and 85% TP removal were achieved. It appears that hydraulic loading changes from 20 to 30 gpm/sf did not significantly impact the treatment performance.

Table 10. $FeCl_3$ hydraulic loading trial.

HLR gpm/sf	TSS Influent mg/L	TSS Effluent mg/L	TSS Removal %	TP Influent mg/L	TP Effluent mg/L	TP Removal %
20	146	15	90	-	-	-
30	258	11	96	4.25	0.65	85

Note: COD data collected shows negative removal.

Alum Hydraulic Loading Trial

Figure 8 is a plot of turbidity in and out of the unit over time during the alum hydraulic loading trial. During the test, the baseline HLR was 20 gpm/sf. For the higher HLRs, the unit was run at 150%, 200%, and 250% of the baseline HLR. This corresponds to 30, 40, and 50 gpm/sf.

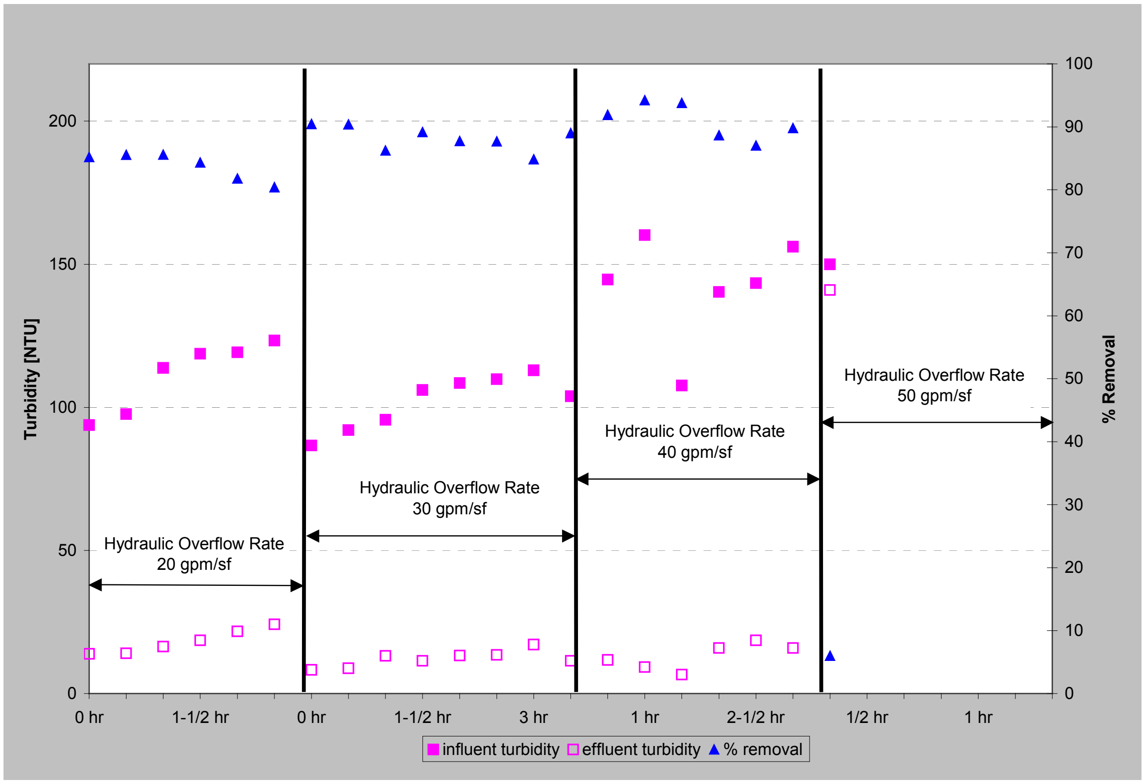

Figure 8. Alum hydraulic loading trial.

During the 20 gpm/sf run, the influent turbidity ranged from 90 to 120 NTU, and the effluent turbidity ranged from 15 to 25 NTU, which yielded approximately 80% reduction. Increasing the HLR to 30 gpm/sf produced an influent turbidity of around 100 NTU and an effluent turbidity that was consistently around 10 NTU, which gave a reduction around 85%. At an HLR of 40 gpm/sf, the influent turbidity fluctuated between 100 and 160 NTU while the effluent turbidity remained under 20 NTU for an even higher turbidity removal efficiency of 90%. However, at a HLR of 50 gpm/sf the unit performance deteriorated rapidly and effluent turbidity increased to close to influent level. The unit performance after deterioration was not monitored.

Table 11 presents the treatment performance during the alum hydraulic loading trial. COD removals were 45% and 53% at HLR 20 gpm/sf and HLR 40 gpm/sf, respectively. During the 20 gpm/sf run, the average influent TSS was 210 mg/L, and the average effluent TSS was 38 mg/L, which resulted in 82% TSS removal. During the 40 gpm/sf run, only 65% TSS removal was achieved. In addition, TP removal decreased as the HLR increased from 30 gpm/sf to 40 gpm/sf. It appears that raising the hydraulic loading rate above 30 gpm/sf impacts the unit treatment performance.

Table 11. Alum hydraulic loading trial.

HLR	COD			TSS			TP		
gpm/sf	Influent mg/L	Effluent mg/L	Removal %	Influent mg/L	Effluent mg/L	Removal %	Influent mg/L	Effluent mg/L	Removal %
20	729	398	45	210	38	82	2.85	1.69	41
30	765	810	-	-	-	-	2.66	0.76	71
40	624	294	53	306	106	65	3.11	1.32	58

Note: "-" stands for no data being collected or recorded.

Loss-of-Chemical-Feed Trials

The loss-of-chemical-feed trial was conducted on February 6, 2002, using polymer and alum. The intent of this trial was to determine the responsiveness of the Densadeg® process to the loss of chemical feed. The trial duration was approximately 5 hours and consisted of the following components:

- Operated unit with polymer and coagulant addition; collected a sample when steady state was reached.
- Loss of polymer feed – polymer addition stopped.
- Polymer feed re-initiated.
- Ran unit until steady state was reached.
- Loss of coagulant feed – alum addition stopped.
- Alum feed reinitiated.
- Ran unit until steady state was reached.
- Loss of chemical feed – both polymer and coagulant addition stopped.
- Process shutdown

Table 12 summarizes the loss-of-chemical-feed trial operating conditions.

Table 12. Loss of chemical trial operating conditions.

Operating Condition	Units	Value
Flow Rate	gpm	129
Hydraulic Loading Rate	gpm/sf	30
Polymer Dose	mg/L	1.0
Alum Dose	mg/L	40
Hydraulic Residence Time		
Grit Chamber	minutes	5.8
Reaction Tank	minutes	7.0
Piston Flocculation	minutes	3.5
Clarifier Tank	minutes	13.0
Lamellar Tubes	minutes	1.8
Overall	minutes	31.1

Figure 9 contains the influent and effluent turbidities along with the various operating modifications made throughout the testing trial.

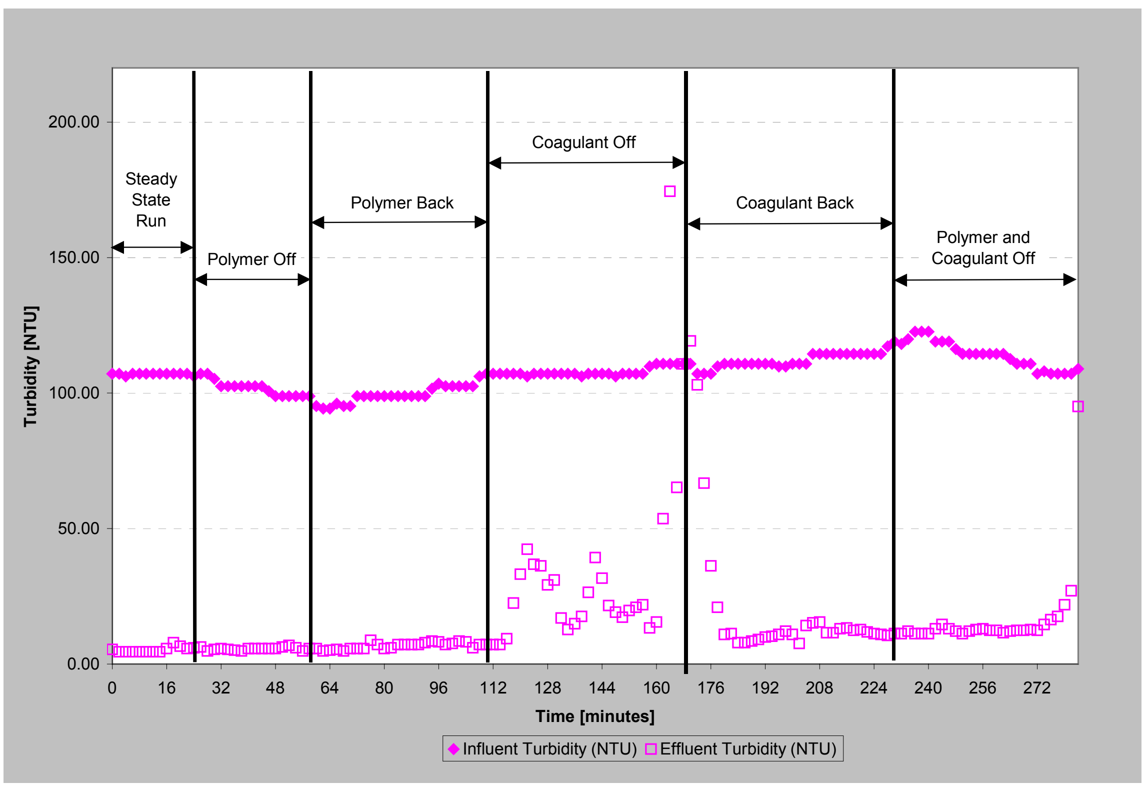

Figure 9. Loss-of-chemical-feed trial.

The unit effluent turbidity was recorded throughout the loss-of-chemical-feed trail.

Loss of Polymer Feed: The polymer feed was turned off for approximately 30 minutes. No dramatic changes in the turbidity removal occurred during this period.

Polymer Feed Re-Initiated: The unit performance remained stable for turbidity removal. The measured removal efficiency was approximately 90%.

Loss of Coagulant Feed: Loss of coagulant feed was determined to have a dramatic impact on performance. Effluent turbidities were fluctuating drastically about six minutes after the coagulant turn-off. The data indicates that the unit performance deteriorates quickly and within a time period of one hydraulic detention time of the Densadeg® process. The performance loss lasted throughout the entire 30-minute turn-off period. Negative removal efficiencies occurred when coagulant turn-off approached 30 minutes.

Coagulant Feed Re-Initiated: The recorded effluent turbidity showed that approximately 16 minutes (approximately twice the hydraulic retention time) after coagulant feed was re-initiated, a dramatic improvement in turbidity removal occurred. The removal efficiency resumed to about 87%, which was slightly lower than the values achieved under steady-state conditions (measured removal efficiencies in the range of 90%). These data indicate that the Densadeg® process responds quickly when coagulant feed is re-initiated.

Loss of Polymer and Coagulant: Both polymer and coagulant were turned off when the unit was running in steady state after coagulant feed was reinitiated. The unit performance did not deteriorate quickly in response to the loss of both polymer and coagulant. However, the obvious increase of effluent turbidity occurred approximately 25 minutes after the turn-off. Grab samples taken 45 minutes after the turn-off showed that turbidity declined to less than 10%.

Metals Removal Assessment

The metals removal assessment was conducted on January 29, 2001. The intent of this trial was to evaluate the potential of the Densadeg®process to remove various metal constituents. The trials were operated at optimum coagulant- and polymer-dose combinations and a constant flow rate of 86 gpm (HLR = 20 gpm/sf). Metal grab samples were collected for all coagulants (PACl, $FeCl_3$ and Alum) under optimum coagulant doses of 30-40-50 mg/L. Table 13 summarizes of the results of the metal testing.

Table 13. Metal Removal Assessment

Coagulant			PACl			$FeCl_3$			Alum		
Operating Condition			HLR	20	gpm/sf	HLR	30	gpm/sf	HLR	30	gpm/sf
			Dose	30-40-50	mg/L	Dose	30-40-50	mg/L	Dose	30-40-50	mg/L
Constituent	**Unit**	**MDL***	**Influent**	**Effluent**	**Removal**	**Influent**	**Effluent**	**Removal**	**Influent**	**Effluent**	**Removal**
Calcium	mg/L	-	-	23.8	-	15.8	14	11%	15.7	14.7	6%
Iron	mg/L	0.05	-	1.56	-	2.19	0.921	58%	2.77	0.271	90%
Magnesium	mg/L	-	-	16.2	-	6.88	6.39	7%	10.5	10.7	-
Aluminum	mg/L	-	-	-	-	1.41	0.405	71%	1.93	0.294	85%
Antimony	mg/L	0.0005	0.00063	0.00065	-	-	0.005	-	0.0012	0.00052	57%
Arsenic	mg/L	0.0005	0.0023	0.0024	-	0.00274	0.00091	67%	0.00314	0.001	68%
Barium	mg/L	0.0002	0.0271	0.027	0%	0.0349	0.0105	70%	0.0438	0.0099	77%
Beryllium	mg/L	0.0002	-	-	-	-	-	-	-	-	-
Cadmium	mg/L	0.0001	0.00017	0.00016	6%	0.00036	<0.0001	72%	0.00135	0.00012	91%
Chromium	mg/L	0.0004	0.00311	0.00356	-	0.00447	0.0016	64%	0.00597	0.001	83%
Cobalt	mg/L	0.0002	0.00068	0.00069	-	0.00091	0.00078	14%	0.00139	0.00032	77%
Copper	mg/L	0.0004	0.039	0.0396	-	0.0361	0.00768	79%	0.0382	0.00474	88%
Lead	mg/L	0.0002	0.00653	0.00645	1%	0.0127	0.00162	87%	0.0242	0.00073	97%
Molybdenum	mg/L	0.0005	0.00558	0.00577	-	0.0139	0.00855	38%	0.0143	0.0138	3%
Nickel	mg/L	0.0003	0.00455	0.00506	-	0.00508	0.00523	-	0.0057	0.00223	61%
Selenium	mg/L	0.0015	-	-	-	-	-	-	-	-	-
Silver	mg/L	0.0002	0.00274	0.00368	-	0.00429	0.00078	82%	0.00319	0.00029	91%
Thallium	mg/L	0.0002	-	-	-	-	-	-	-	-	-
Vanadium	mg/L	0.0003	0.00214	0.00225	-	0.00357	0.00044	88%	0.00487	0.00177	64%
Zinc	mg/L	0.0005	0.0956	0.0966	-	0.0988	0.0345	65%	0.139	0.0417	70%
Mercury	mg/L	0.00005	-	-	-	0.00013	<0.00005	-	-	-	-

Note: "-" stands for the measurement under detection limit, or negative removal.

* MDL = method detection limit

The results presented in Table 13 demonstrate that the performance of the Densadeg® 4D process is very strong with regard to metal-removal efficiencies when coagulant is $FeCl_3$ or alum. These results are impressive considering that the Densadeg® process was functioning as a primary treatment process and does not have the ability for metals removal via biological uptake or adsorption.

Primary, secondary, and tertiary treatment processes have been shown to have the potential for significantly reducing pollutant metal concentrations.[1] During primary treatment, metals removal typically occurs by sedimentation of particle-associated metals. However, when chemicals such as iron salts or alum are added, interactions may occur between the added chemicals and metal complexes that enhance the overall removal of these pollutants. Removal of both particle-associated metals and dissolved metals can occur in the activated sludge

[1] *Assessing Methods of Removing Metals from Wastewater: A Review of Data and Methodologies*. WERF Project 97-CTS-4 Final Report, 2000.

process through the incorporation of particle-associated metals in flocs and dissolved metal uptake or adsorption.

PH and Alkalinity

Influent and effluent pH and alkalinity were recorded during the trials. The pilot unit influent pH was consistent with the plant influent pH varying from 6.9 to 7.4. A slight pH drop was observed in the unit effluent. For all the trials, average decrease of pH was approximately 0.3 standard units.

Alkalinity in the unit influent and effluent was recorded in PACl and $FeCl_3$ optimization trials (See Table 14). Reduction of alkalinity through the unit ranged from 2% to 49%, with average at 17%.

Table 14. Densadeg unit influent and effluent alkalinity.

Coagulant	Dose	HLR	Influent Alkalinity	Effluent Alkalinity	Reduction
	mg/L	gpm/sf	mg/L	mg/L	%
PACl	40	30	146	138	5
PACl	60	30	60	44	27
PACl	20	30	115	106	8
PACl	10	30	132	127	4
PACl	30-40-50	20	129	125	3
$FeCl_3$	40	30	116	74	36
$FeCl_3$	60	30	122	62	49
$FeCl_3$	20	30	122	104	15
$FeCl_3$	10	30	139	136	2

Evaluation of Pilot Results

Overall, the Densadeg® process appears to have performed better than conventional primary clarification, as illustrated by the comparison shown in Table 15. This process appears to have out-performed conventional treatment with regard to both average removal efficiencies and performance variability. These findings are based on a comparison of Densadeg® pilot results and King County primary clarification performance data obtained for February 2002.

The Densadeg® process requires chemical addition (both polymer and coagulant), which increases the operating cost of the unit with respect to chemical usage and chemical sludge production and treatment. A comparison of the total cost of the process (Densadeg® versus conventional primary clarification) must include both the capital and operating costs. The removal efficiencies of the Densadeg® are more stable, in part because the chemical addition is controlled to maintain optimal performance.

Table 15. Comparison of conventional primary clarification and Densadeg® operation and performance.

Operation / Performance Parameter	Units	Conventional Primary Treatment			Ballasted Flocculation (Densadeg®)		
		Average	Peak	Range	Average	Peak	Range
Overflow Rate[a]	gpm/sf	0.7[b]	1.7	--	30	60	--
Hydraulic Retention Time[c]	minutes	120	--	--	23.7	11.9	--
COD Removal[d]	%	36	--	15 – 71	70	--	63 – 74
TSS Removal[d]	%	70	--	39 – 90	93	--	90 – 96
TP Removal[d]	%	42	--	14 – 50	72	--	42 –91

[a] Overflow rate based on primary clarifier surface area and Densadeg® settling tank surface area. Primary clarifier overflow rate is based on typical criteria for process design.

[b] Actual 2001 average overflow rate for King County was 0.80 gpm/sf (1,150 gpd/sf).

[c] Hydraulic retention time based on primary clarifier volume and the total combined volume of all Densadeg® process tanks. Primary clarifier hydraulic retention time is based on typical criteria for process design.

[d] Average performance values and ranges are based on February 2002 King County primary clarifier performance data and optimum chemical dose trials.

The hydraulic loading rate of Densadeg® 4D is approximately 50 times higher than that of conventional primary clarifiers. The higher HLR results in shorter retention times. With higher hydraulic loading rates and shorter retention times, the Densadeg® 4D achieved higher COD, TSS and TP removal rates compared to the conventional primary treatment.

Effectiveness of Technology to Achieve Performance Goals

Table 16 summarizes the target performance goals and continuous-run results at optimum chemical doses. Values shown in Table 16 are based on an average of all continuous trials performed at optimum chemical doses. BOD_5 (both total and soluble), COD, and turbidity performance measurements are included in the table for comparison purposes.

Table 16. Effectiveness of Process to Achieve Performance Goals

Goal Description	Target (%)	Measured Performance		
		PACl (%)	Ferric Chloride (%)	Alum (%)
BOD_5 Removal	NE	62	-	75
Soluble BOD_5 Removal	NE	28	-	-
COD Removal	> 60	58	-	71
TSS Removal	> 80	85	96	87
Turbidity Removal	NE	81	95	91
Total Phosphorus Removal	> 80	-	85	91

NE = Performance goal was not established.

\- = Not measured.

The data presented in Table 16 show the following:

- **COD Removal:** COD removal efficiency is between 58% and 71% for the three coagulants tested, generally exceeding the 60% removal target for the Densadeg® process.
- **TSS and Turbidity Removal:** The Densadeg® process consistently achieved excellent TSS removal of 85% to 96%, exceeding the goal of 80% TSS removal. Turbidity removal averaged 89% for all the coagulants tested.
- **Total Phosphorus Removal:** Ferric chloride and alum achieved 85% and 91% phosphorus removal, exceeding the goal of 80% removal. An equal dose of alum was more effective for phosphorus removal.
- **BOD_5 Removal:** BOD removal in the Densadeg® unit averaged 75% with alum. BOD removal as high as 92% was achieved in one test at an alum dosage of 60 mg/L. Coagulant PACl achieved 63% of BOD removal in the only sample that was collected.
- **Comparison of Coagulants:** With the exception of PACl for COD removal, all three coagulants were found to surpass the target performance goals. Alum provided relatively higher overall removal rates compared to COD, TSS, and phosphorus removal efficiencies**.**
- **Process Start-up:** The Densadeg® pilot plant started up every morning with no sludge or water ('dry' startup) in the unit. It took about 35 minutes to fill the Densadeg® pilot unit (to go into production). The start-up tests conducted demonstrate that the Densadeg® 4D reaches it's optimal, steady state performance within approximately 20 minutes of production.
- **Soluble Organic Removal:** Removal efficiency of soluble BOD was approximately 28%. (This data is shown in Appendix B.) Most likely this "soluble" removal was associated with colloidal particles that were slightly smaller than the pore size of the membrane used for suspended-solids analysis. As evidenced by the high TSS removal efficiencies, the Densadeg® process is highly effective at removing particulates and solids from raw wastewater. However, since it is a physical/chemical process and relies on particle-to-particle interaction for removal, it lacks the ability to remove soluble organic constituents. Some colloidal particles can be coagulated and removed as evidenced by the soluble BOD and metal removal.
- **Sludge blanket:** The operation of the Densadeg® 4D pilot unit reveals the process' reliance on a stable sludge blanket for performance. Because the sludge is the ballasted material in the process, controlling of the sludge-recycling rate is critical for establishing and maintaining an adequate sludge blanket to sustain the process performance.

Reliability Considerations and Comparison of Coagulation Chemicals

Figure 10 and Table 17 show the results of statistical analyses of Densadeg® effluent data for the three chemical coagulants. All of the data collected for the optimum chemical-dose continuous-run trials were utilized for these analyses. Effluent turbidity values were used as a surrogate to measure effluent stability since it had the largest number of available data points.

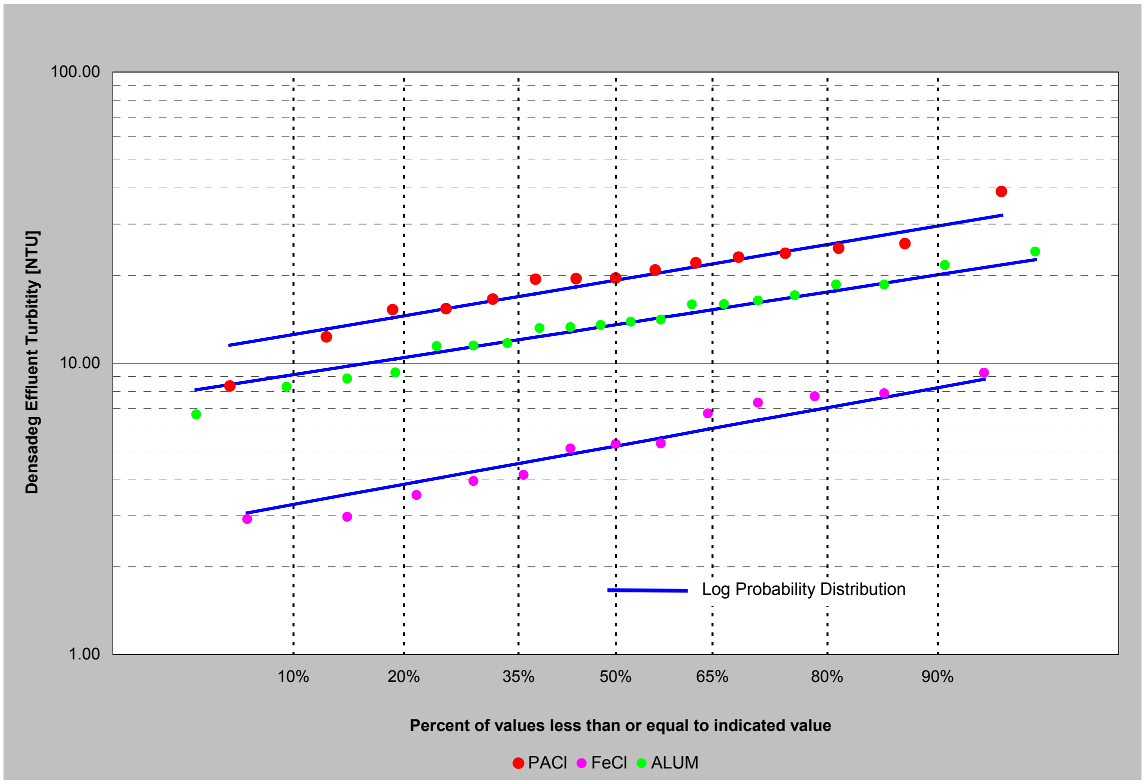

Figure 10.Process Reliability and Coagulant Comparison.

Table 17. Comparison of Chemical Coagulants Effluent Turbidity Statistics.

Value	Units	Densadeg® Effluent Turbidity		
		Alum	PACL	Ferric Chloride
Average (50-percentile value)	NTU	13.6	19.3	5.2
10th percentile value	NTU	9.1	12.6	3.3
90th percentile value	NTU	20.1	29.6	8.2
Standard Deviation	NTU	4.9	7.7	2.3
Coefficient of Variance	%	36.1	39.7	43.4

Although ferric chloride provided the highest effluent quality with regard to effluent turbidities, the three coagulants demonstrated nearly equal efficiencies in terms of turbidity removals. Alum coagulation addition appears to have provided the most consistent effluent, because this chemical had the lowest overall coefficient of variance. In addition, as shown Figure 10 the effluent turbidity data points are very close to the normal trend lines. This means that the removal rate for all three coagulants was stable.

In addition to removal efficiencies, alkalinity consumption and sludge production should also be considered when selecting the best chemical for this application. Table 18 contains a summary of the optimum coagulant doses, estimated sludge production and alkalinity consumption based on stoichiometry and a flow rate of 1 mgd. For reference, the additional sludge production attributed to alum and ferric chloride addition represents an increase of approximately 20 % in the overall primary sludge production on a dry weight basis. This value is based on an assumed influent TSS concentration of 175 mg/L and 95% removal efficiency.

Table 18. Comparison of Alkalinity and Sludge Production

Coagulant	Optimum Coagulant Dose	Estimated Sludge Production[a]	Estimated Alkalinity Consumption	
	(mg/L)	(lb TSS / mgd)	(lb Alkalinity / mgd)	mg/L
Alum	60	130	470	55
PACL	20	270	1,700	205
Ferric Chloride	40	100	845	100

[a] Dry weight basis.

Table 19 contains a summary of chemical-dose requirements and estimated chemical costs obtained from a local vendor. Chemical costs (both unit and daily chemical costs) are expressed in terms of the weight basis previously described. Daily chemical costs are based on a flow rate of 1.0 mgd.

Table 19. Comparison of Coagulant Costs

Coagulant	Optimum Coagulant Dose (mg/L)	Unit Cost ($/pound)[a]	Daily Chemical Costs ($/day)
Alum	60	0.146	75
PACL	20	1.75	295
Ferric Chloride	40	0.15	55

[a] Unit costs are reports based on a dry weight basis for alum and ferric chloride and on a dry weight of Al_2O_3 basis for PACL.

As shown, the costs associated with PACl are significantly higher than those associated with alum and ferric chloride. Overall ferric chloride and alum are approximately equal with regard to cost. Ferric chloride is a considered to be more corrosive than alum due to its low pH and ability to stain surfaces. In addition, ferric produces more sludge and requires more alkalinity addition compared to alum. Based on these findings, the most favorable coagulant for this application appears to be alum.

Implementation

Design Criteria

Based on the pilot testing, the following design criteria are recommended for a full-scale application of the Densadeg® process:

- Reaction Tank Retention Time = 7 minutes
- Settling Time = 10 minutes
- Hydraulic loading rate = 30 gpm/sf.

Table 20 presents the design parameters of a Densadeg® installation for primary treatment along with the recommended design criteria based the results of this pilot study. Full-scale Densadeg® installations throughout the world are listed in Appendix D.

Table 20. Densadeg® full-scale and pilot study comparison.

Design Criteria	Unit	Full-Scale Installation[1]	Pilot Study[2]
Reaction Tank Detention Time	min	13	7
Clarifier Detention Time	min	18	10
Hydraulic Loading Rate	gpm/sf	10	30

Note:

1. The design parameters of full-scale installation were estimated from Densadeg® installation in Quebec, Canada.

2. The design parameters of pilot study were based upon this pilot study with Densadeg®.

Design Features

Control, Monitoring, and Special Requirements

The following features should be included in a full-scale Densadeg® application for primary treatment:

- **Chemical Addition Facilities:** As shown in Figure 9, the Densadeg® process is highly dependant on both polymer and coagulant addition for pollutant removal. Loss of these chemicals can cause process failure. The full-scale facility needs redundant feed pumps, chemical feed and turbidity monitoring equipment, and automatic switchover capability for changing feed pumps.
- **Monitoring and Process Control:** Turbidity is used as the primary measure to monitor and control the Densadeg® process. Turbidimeters should be installed to monitor the Densadeg® influent and effluent streams. Streaming current detectors could be considered for optimizing chemical addition.
- **Coagulant and Polymer Dosing Control:** Dosage of coagulant and polymer can be controlled through a programmable PID based on changes of influent turbidity.

Pretreatment Requirements

- **Fine Screen:** Provide fine screening prior to the Densadeg® process to reduce the potential for damage to the process equipment or clogging caused by material and debris such as rags, paper, plastic, or wood. The manufacturer recommends that a 6-mm fine screen be provided upstream of the Densadeg® process in a 1 mgd primary treatment application. The selected screen opening size is dependant on the capacity of the Densadeg® process.
- **Grit Removal:** Grit removal is recommended for primary treatment applications to minimize the accumulation of inert solids in the process tanks, and the amount of particles being recycled within the process. The removal system should be designed to remove all particles larger than 100 microns.

Dual Injection of Polymer

Other studies by Ondeo Degremont suggests that injection of polymer directly into the sludge recirculation line improves the stability of the Densadeg® unit, especially during start-ups while treating water with low TSS. The quality of recycled sludge improves with dual injection during the early stages of operation when sludge is less dense (less than 1 or 1.5 % solids). The polymer injected to the sludge line not only increases the density of the recycled sludge but also seems to improve flocculation. Dual injection also increases the contact time of the polymer and the sludge being recycled. The effect of dual injection was not tested due to the time constraints.

Residuals

Residuals generated by the Densadeg® process include the following:

- Sludge stream
- Grease and scum.

Note that the Densadeg® unit generates considerably more solids than conventional primary clarification due to the added coagulant. Ferric, alum, and PACl generated hydrated metal hydroxides in addition to the raw TSS captured in the process. At a coagulant sludge generation of 0.5 lb sludge/lb coagulant, this chemical sludge can amount to an additional 10-30 mg/L of TSS removed, which must be processed in the solids handling facilities.

Issues not Resolved by Pilot Test Program

- Performance at lower coagulant (sub optimal) doses to minimize chemical addition.
- Dual polymer addition.
- High strength influent (e.g. influent during dry month).
- Wet and dry startups.

If this technology is selected for full-scale implementation, further investigation in pilot testing and/or existing installations should be considered.

Appendix A - Test Plan Revisions and Test Plan

Appendix B - . Data Workbook and Operator Log

Appendix C - Pilot Unit Photos

Appendix D - Densadeg® Installation Lists

Densadeg Test Plan Revisions Summary

A testing plan was prepared prior to the pilot study. A copy of the original testing plan is contained in this appendix. The original test plan consisted of two major testing stages:

Stage 1 – Optimization/Coagulant & Polymer Trials: Optimization will be used to determine optimal polymer and coagulant doses.

Stage 2 – Continuous Run: This stage will be used to confirm the optimal coagulant and polymer doses for COD, TSS and BOD removal. The impacts from reducing the coagulant and polymer, wet and dry startup, loss of chemical feed, peak flow and peak solids will also be evaluated during this testing stage.

Numerous mechanical and electrical problems were encountered at the beginning of the testing operation. The actual testing started almost two months behind the originally scheduled date. Due to the time constraint, only selected tests were conducted.

The actual pilot test consisted of the following testing trials:

Coagulant and Polymer Optimization Trials: This trial was conducted to determine optimum polymer and coagulant doses. Each testing condition consisted of different polymer and coagulant dose combinations.

Chemical Feed Failure: The objective of this phase is to evaluate the impact of loss of chemical feed. The coagulant and polymer feed were alternately shut off and turned back on. The unit was operated after each switch until a steady state was reached, and a sample was taken at the steady state.

Peak Flow Stress Test: The Peak Flow Stress Test will be used to evaluate the Densadeg unit under maximum flow conditions. The flow rate was regulated in a wide range to allow enough difference in flow rates to evaluate the impacts on the unit treatment performance.

Densadeg Test Plan

DND Test Plan_V1 Draft

The Ondeo Degremont Inc. Densadeg pilot unit arrived at the West Point WWTP on October 22, 2001. It will be on-site for a total of two months and is scheduled to leave the site at the end of December 2001. Key performance issues that will be investigated for this process during the pilot test are:

- Performance for treating raw wastewater
- Ability to remove BOD, phosphorus and solids
- Optimal combination of polymer and/or coagulant for raw wastewater treatment and phosphorus removal

This unit will be operated five days per week, eight hours per day by King County staff. The unit is being tested as one of the eight treatment processes for the Reuse Demonstration Project. The demonstration testing facilities are configured to convey primary influent from the West Point WWTP to the Densadeg unit. The focus of the testing will be to evaluate the ballasted flocculation process as a primary treatment option. If possible, the primary influent feed source will be diluted with West Point secondary effluent to simulate a CSO event. This version of the testing protocol describes the testing plan during the initial weeks of the pilot tests. A revision of this testing protocol will be released in the near future to address the CSO application testing.

Primary Treatment Application Test Goals

Under constant flow conditions evaluate one polymer and three coagulants (alum, ferric chloride, and poly aluminum chloride) with the following performance goals:

- Total Suspended Solids (TSS) removal: >80%
- Total Phosphorus removal: > 80%
- COD removal: >60%

BOD sampling is limited due to West Point Process lab workload considerations. The intent is to use COD and TSS removal as the primary evaluation parameters for evaluating this technology for primary treatment. Under optimal conditions, BOD analysis would be conducted.

Metals analysis will be limited to one test condition to minimize the County lab's workload.

Once a range of coagulant and polymer doses is tested, selected chemical feeds, which reflect optimal chemical doses, will be used to assess the following issues:

- How much time is required for the process to achieve effective treatment during a dry startup.
- How much time is required for the process to achieve effective treatment during a wet startup.
- How loss of chemical feed impacts process performance.

- How peak flow conditions impact process performance.
- How high solids loading impact process performance. This issue can be addressed only if rain occurs during the pilot tests.

With the exception of the peak flow test, all of the testing will be conducted at a constant feed-flow rate. Initially, the flow rate will be 87 gpm, which is equivalent to a hydraulic loading rate of 14.5 gpm/sf.

Test Stages

There will be two stages in the primary treatment evaluation. Both are defined below.

Stage 1 – Optimization/Coagulant & Polymer Trials

Optimization will be used to determine optimal polymer and coagulant doses for the following three combinations:

- Polymer and alum
- Polymer and ferric chloride
- Polymer and poly aluminum chloride

These testing stages are also referred to as the polymer and coagulant trial phase. Each test condition is expected to last 1.5 to 3.0 hours to allow a wide range of coagulant and polymer doses to be evaluated in a brief period of time. This short testing time is possible with this process because the hydraulic residence time is approximately 45 minutes. Typically, the unit is operated at one test condition for a period equivalent to two hydraulic residence times (90 minutes) before taking a sample that is representative of that particular test condition.

The data collected during these optimization/coagulant and polymer trails will be used to develop U-shaped curves for dose-versus-effluent turbidity, COD and TSS. BOD will not be measured during these trails because of the long processing time for the analysis and the impacts to the West Point Process lab workload.

Stage 2 – Continuous Run

This stage will be used to confirm the optimal coagulant and polymer doses for COD, TSS and BOD removal. A sustained (up to 8 hour run) for the optimal test conditions will be conducted. The impacts of reducing the coagulant and polymer will also be evaluated during this testing stage along with wet and dry startup, loss of chemical feed, peak flow and peak solids testing.

Test Conditions and Sampling

The test conditions and number of samples/analyses for the Optimization and Continuous Run stages are listed in Table 1 along with the number of samples. The sample locations and types are listed below. All sample locations are within the Densadeg pilot and will be collected by King County staff.

SAMPLING

Below is a table that described the sample designation and types for the various testing phases. Table 1 contains a description of the anticipated duration for each testing phase and conditions.

Sample Description	Sample Designation	Sampling Make-up / Methodology	
		Optimization Phase	**Continuous Run Phase**
Influent	Sample# S1BF	Single grab sample	Hand composite of hourly grab samples
Densadeg Effluent	Sample# S3	Single grab sample	Hand composite of hourly grab samples
Sludge Recycle	none required	--	Hand grab sample

TEST CONDITIONS

Stage 1 – Optimization: Coagulant and Polymer Trials

Operate unit at constant flow rate of 87 gpm.

Test two polymers at various dose rates with alum at a constant dose.

King County operators will develop U-shaped curves for polymer dose versus turbidity, COD and TSS. Select the polymer and its dose for subsequent coagulant trials.

Test alum, poly aluminum chloride (PACl), and ferric chloride (ferric) at varying doses to achieve a target TSS and COD removal efficiencies of 80% and 60%, respectively. Use selected polymer and a constant alum dose as described above.

King County operators will develop U-shaped curves showing dose versus effluent turbidity, COD, and TSS concentrations. From these curves, the optimal alum, ferric and PACl doses for the Continuous Run stage will be selected.

Stage 2 – Continuous Run

With the exception of the peak flow test, operate the unit at 87 gpm under the following test conditions:

Alum

- 8 hour run: Optimal alum and polymer dose
- 4 hour run: Half the optimal alum dose, optimal polymer dose
- 4 hour run: Optimal alum dose, half the optimal polymer dose
- 8 hour run: 4 hour run of half the optimal alum and polymer doses. Following this 4-hour test, alum and polymer doses will be increased to optimum values. Turbidity measurements to be recorded throughout the test. This data will be used to determine how much time is required for the process to achieve steady-state performance. Once the process has achieved steady-state performance, hourly samples are to be collected for a minimum of 3 hours to produce a single hand composite sample.

Ferric Chloride

- 8 hour run: Optimal ferric and polymer dose
- 4 hour run: Half the optimal ferric dose, optimal polymer dose
- 4 hour run: Optimal ferric dose, half the optimal polymer dose
- 8 hour run: 4 hour run of half the optimal ferric and polymer doses. Following this 4-hour test, ferric and polymer doses will be increased to optimum values. Turbidity measurements to be recorded throughout the test. This data will be used to determine how much time is required for the process to achieve steady-state performance. Once the process has achieved steady-state performance, hourly samples are to be collected for a minimum of 3 hours to produce a single hand composite sample.

Poly Aluminum Chloride

- 8 hour run: Optimal PACl and polymer dose
- 4 hour run: Half the optimal PACl dose, optimal polymer dose
- 4 hour run: Optimal PACl dose, half the optimal polymer dose
- 8 hour run: 4 hour run of half the optimal PACl and polymer doses. Following this 4-hour test, PACl and polymer doses will be increased to optimum values. Turbidity measurements to be recorded throughout the test. This data will be used to determine how much time is required for the process to achieve steady-state performance. Once the process has achieved steady-state performance, hourly samples are to be collected for a minimum of 3 hours to produce a single hand composite sample.

Further Alum, Ferric Chloride, and Poly Aluminum Chloride Testing

- 4 hour run: (If needed) further reduction of alum dose to assess the impact of chemical dose on COD, TSS, and? phosphorus removal efficiencies.
- 4 hour run: (If needed) further reduction of ferric chloride dose to assess the impact of chemical dose on COD, TSS, or phosphorus removal efficiencies.
- 4 hour run: (If needed) further reduction of poly aluminum chloride dose to assess the impact of chemical dose on COD, TSS, or phosphorus removal efficiencies.

Then develop curves for effluent COD, TSS and P versus coagulant and polymer dose. Calculate percent removals for the parameters measured. As indicated in Table 1, BOD (total and soluble) will be measured for the two optimal runs for each of the three coagulants. For one of these coagulants, influent and effluent metals will be measured during a single test condition (i.e., optimal coagulant and polymer doses).

Dry Start

Shut down unit.

Restart with all tanks empty. Operate at 87 gpm. It is estimated that this test will require 4 hours.

Use a single coagulant dose and polymer dose at optimal treatment conditions from previous testing. Selection of the coagulant will be based on a review of the Optimization and Continuous Run data. Based on the on-line effluent turbidity monitoring, collect a minimum of four grab samples once the effluent turbidity is <5 NTU. Combine these grabs into a composite for analysis per Table 1. King County operators will note how long it takes for the effluent turbidity to reach <5NTU.

Wet Start

Shut down unit. Wait for a minimum of one hour. Keep tanks full.

Restart unit with all tanks full. Operate at 87 gpm. It is estimated that this test will require four hours.

Use the same coagulant dose and polymer dose from the Dry Start test. Based on the on-line effluent turbidity monitoring, collect a minimum of four grab samples once the effluent turbidity is <5 NTU. Combine these samples into a composite for analysis per Table 1. King County operators will note how long it takes for the effluent turbidity to reach <5NTU.

Chemical Feed Failure

Shut off coagulant and polymer feed for one hour.

Keep operating unit at 87 gpm. In the following hour, collect four grab samples and combine these into a composite for analysis per Table 1. King County operators will note how long it takes for the effluent turbidity to exceed 5 NTU. It is estimated that this test will require four hours.

Restart chemical feed and operate the unit for one hour at the same flow rate. In the next hour, collect four grab samples and combine these samples together for analysis per Table 1. King County operators will note how long it takes after the chemical feed is restarted , for the clarifier effluent turbidity to drop back down below 5 NTU.

Peak Flow Stress Test

The Peak Flow Stress Test will be used to evaluate the Densadeg unit under maximum flow conditions. The peak flow rate will be 25% higher than the average flow rate to allow enough of a difference in flow rates to evaluate the impacts on the treatment performance.

(Time = 0 to 2 hours) The unit will be operated at the average flow condition for two hours. Four grab samples will be collected and combined into a single composite sample for analysis per Table 1.

(Time = 2 to 4 hours) The unit will then be operated at the peak flow condition for two hours. Four grab samples will be collected and combined into a single composite sample for analysis per Table 1.

(Time = 4 to 6 hours) Finally, the flow rate will be reduced back to the average flow rate for the subsequent two hours. Four grab samples will be collected and combined into a single composite sample for analysis per Table 1.

SCHEDULE

The duration of the testing and associated dates are listed in Table 1. It is assumed optimization will start on October 29, 2001. It is expected that Densadeg testing will be completed at the end of December 22, 2001 and that the unit will be shipped back to the manufacturer on December 22, 2001. No testing will occur on this date since it will be reserved for disassembly and packing up the unit.

CONTACTS

Since there are many test conditions to be evaluated in the Densadeg testing, it is important to maintain frequent, if not daily communications between the IDI staff, King County, and the consultant team (HDR and Black & Veatch). The following is a list of the project team members.

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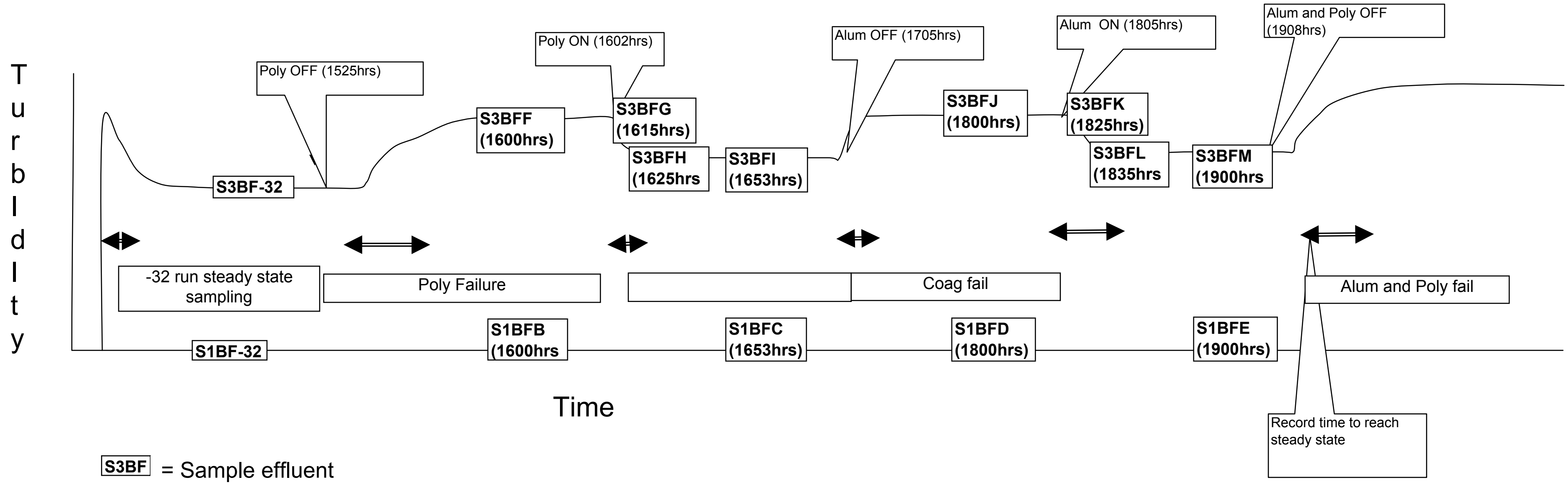
It is essential that the project team hold frequent conference calls as needed. Bob Bucher will coordinate the calls. At a minimum, they will include Bob Bucher from King County, Rohan and Troy from Ondeo, and J. B. Neethling and Kevin Kennedy from HDR Engineering.



S3BF = Sample effluent

S1BF = Sample influent

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
10/8/2001		At 13:300 hrs, densadeg trailer arrived onsite. Trailer located and shipping paper work signed off. Photographs taken for demonstration
10/9/2001		
10/10/2001		
10/11/2001		
10/12/2001		
10/13/2001		
10/14/2001		
10/15/2001		Maintenance provided WP crane and operator to stand clarifier tower and relocate polymer shack.
10/16/2001		
10/17/2001		Shipped 5 gal of primary influent to denard lab for jar testing. Environ lab (Katherine Boubonais) handles logistics.
10/18/2001		
10/19/2001		
10/20/2001		
10/21/2001		
10/22/2001		1). Ondeo representative (Sudhakar) onsite for trailer installation. Working on trailer utilities setup and checkout. 2). Talked with Shinn (Craig) about hoses for trailer. Expected to have within 1 wk. May use WP FS hoses to get trailer started up.
10/23/2001		1) Ondeo continued trailer set up. Additional cleaning required from previous job (industrial application).
10/24/2001		Ondeo continue with trailer setup
10/25/2001		Ondeo continue with trailer setup
10/26/2001		1) Ondeo continue with trailer setup. 2) Repair contractor called in by Ondeo to repair feed pump and sludge recir. Pump. Expect to have pumps back on Saturday morning for install. 3). Stil waiting on hoses from American Hose 4) Two drums of ferric chloride ordered from Easy Treat Chemical (Clearwater).
10/27/2001		Repair contractor onsite to install feed and sludge recirc pumps. Ondeo overseeing work.
10/28/2001		
10/29/2001		1) Ondeo reps onsite (Rohan and sudhakar) for startup. 2) Electrical problems identified on trailer: air compressor tripping in ply shed and grit removal air blower tripping. Plan to have Prime Elect troubleshoot on Tuesday. 3) Ondeo performing mechanical and electrical checkouts throughout the day.

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
10/30/2001		1) Ondeo reps continued with trailer startup. 2) completed troubleshoot of trailer eletrical problems with support from Prime Elec. : air compressor (plugged into wrong circuit, air blower (mechanical, blower locked). Ondeo plans to replace air blower with mechanical mixer which will be shipped from Richmond. 3) Portland Eng working on connection of DH+ communication network. Prolem with setup in trailer- node 2 is assigned to operatore interface panel in the trailer. Facility node 2 is already allocated to the zenon MBR. Resolved problems by electing not to connect trailer to DH+ network. The trailer has a data logger capable of being utilized. Requested Ondeo to configured for weekly King County downloads. 4) Ondeo discovered problem with feed pump VFD unit- troubble shooting initiated. 5) West Point FS (Al Williamson) probided saftely harness, rope grab, etc to use with trailer tower ladder.
10/31/2001		1) Ondeo reps continued with startup. 2) Spent entire day troubleshooting feed pump VFD- solved by late afternoon (new VFD installed). 3) Received results from Ondeo lab jar testing Ferric chloride, alum and poly aluminum chloride were all tested along with two polymers. 4) Sh8inn onsite with noses to finish connections for trailer. 5) New mechanical mixer (to replace grit air blower) arrived from Richmond.
11/1/2001		1) Ondeo reps continued with trailer startup. Performed water checkouts throughout the day. 2) discussed installation of new mechanical mixer. Need to provide means of sealing electrical box- currently not rated for outdoor use (3R). Dennis Olsen okayed install if steps are taken to weather proof. Existing air blower circuit will be used for powering mechanical mixer. 3) Informed by Ondeo that there is problem with another VFD on trailer. Further troubleshooting is required. 4) King county CM folks OKed use of Prime Elect to install new mixer. hope to have onsite on Monday. 5) Around 10:45 hrs, Tony Greville from Easy Treat onsite to discuss coagulant selection and tour through trailer. 6) Tow drums of ferric chlorid3e arrived and located to trailer. Also provided eye wash and secondary contament for drums.
11/2/2001		1) Ondeo reps travel day back to Richmond. No trailer work performed. 2) Expect to have Sudhakar onsite next Monday by noon. Need to arrange for mixer installation. 3) Tentatively arranged for 1300 hrs conference call with HDR to discuss jar test results and test plant for trailer.
11/3/2001		No comments
11/4/2001		No comments
11/5/2001		1) Ondeo (Sudhakar) onsite in afternoon to continue with startup. Completed final preps for mechanical mixer install. 2) Ondeo continues to have problems with mixer VFD. Suspect problem with installed VFD was water in enclosure. VFD is installed inhorizontal positon with touch pad and display on top . Water pools on top and works its way into enclosure. New VFD will be protected against moisture. 3) Called Shinn to arrange for Prime onsite to install new mechanical mixer and troubleshoot VFD. Did not talk to anyone. Let messages with Donnie and Craig. 4) Contacted WP Maint about supporting mixer install. Wrote paperwork to handle work- mait available tomorrow. 5) Conference call with Ondeo, HDR,KC. KC-Bob, Ondeo-Sudhakar, Rohan, HDR- JB, Mike, June Leng. Discussed following topics: Hyddraulic loading rate, curtain installed, testing protocol, jar test results and coagulant optimizing (ferric, alum and PACL_.

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
11/6/2001		1) Both WP maint. And Prime showed to work trailer. Prime completed troubleshoot of reactor mixer VFD and confirmed comments in Note 2 from 11/5. Ondeo ordered new VFD in morning and will have onsite by the end of the day. WP Maint will handle new mechanical mixer installation. Rented JLG will be utilized for work. 2) Problem with "rented" JLG. Maint can not get unit operational - rental company called to fix. On hold until tomorrow.
11/7/2001		1) Ondeo working install of curtain in reactor (4.3 sf setting) Having problems with attaching curtain on upper end. Also have issues with potential "confined space" work. Discussed with Ondeo. 2) WP Maint still not working install of new mechanical mixer. JLG not fixed. 3) Ondeo batched tank of polymer in preparation for startup. 4) Setup safety harness and strap anchor for climbing tower.
11/8/2001		1) Ondeo and KC proceeded with lifting new mechanical mixer into position and bolting- completed. 2) finally have KC Maint. Over to trailer to wire new mechanical mixer- completed. Overloads are too high on starter for new mixer motor. Ondeo will pickup and install new overloads. 3) Ondeo completed installation of curtain partition into reactor (to set surface overflow). 4) Coagulant feed system setup completed- will initiate testing with ferric chloride.
11/9/2001		1) Vendor started up unit at 40 gpm/sf and ferric chloride addition. 2) Discussed next step with Ondeo. Plan to initiate coagulant trials (ferric chloride) on Monday. Two four hours runs planned. 3) Requested o/m procedures for Densadeg. Ondeo will email by early next week.
11/10/2001		No comments
11/11/2001		No comments
11/12/2001		1) Completed 1-4th trial under following conditions: Hydraulic loading = 3- gpm/sf, coagulant dose = 40 mg/L, ply dose = 0.5 mg/L. Sample identification S1BF-1 and S3-1. 2) Ondeo continues to have problem with trailer air compressor. Tripping electrical circuit after period of operation. 3) Unit shutdown for the evening. 4) Received software required to download data from trailer data logger. Will install on laptop.
11/13/2001		1) Ondeo continue operation of unit to assess chemical addition. Using turbidity to monitor performance. No official samples colleted in am. Looking @ 40 gpm/sf. 2) after continued troubleshooting of trailer air compressor. Ondeo purchased and installed new compressor. Discovered old compressor accumulator tank was full of water. Previous client did not drain tank.
11/14/2001		1) Ondeo continued with coag trials 2) having problems with feed water. Feed waer low alkalinity (25 mg/L) is impacting flocculation. Provided 5 gal bucket of 50% NaOH to Ondeo for alkalinity addition. Dosing pump and bucket set up and performed checkout. Dose set to accomplish 75 mg/l of alk. in feed water. 3) Ondeo having problem with control panel circuit tripped. Circuit delivers power to PLC, operator interface. Panel lights etc.. Also, trailer interior lights not functioning.

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
11/15/2001		1) Ondeo conducted prelim. Training on trailer operation (~ 2 hrs). 2) unit operating with NaOH dosing to feed water. 3) Ran 4 hrs trial in the afternoon under following conditions: hydraulic loading rate = gpm/sf, coagulant dose = , poly dose = , NaOH dose = . 4) Ondeo working on checkout of sludge blanket level instrument (milltronics). Not operating properly and will have vendor onsite to checkout. 5) Informed by Ondeo that they will remain onsite until Wed (11/21). ** Need to complete prelim. optimization and 24 hrs run prior to Ondeo leaving.
11/16/2001		1) Ondeo informed KC that sludge blanket level sensor will have to be replaced. New sensor is currently stuck @ canadian border in customs. Expect to have on Mon am. New sensor install requires draning of reactor and entering inside. 2) Reactor drained and flushed in preparation for old blanket level sensor removal. 3) Plan to operate unit on Sun (11/18) using PACL as coag. 4) summarized Training from yesterday: **Startup**: a) Run jar test (proportion mixer times based on influent flowrate). b) turn unit "ON". c) Go to page 2 - depress "ENTER". d) check dosages on Panel Mate. Pretreatment: PID to set feed flow 175~40 gpm/sf, 129 ~ 30 gpm/sf. 3 adjustments: feed flow, poly dose and coag dose. **Poly dose** on poly screen, only change poly conc. (g/L). Need to maintain poly dose in range to run poly feed pum VFD (> 30 gpm/sf, use 1.o g/L poly conc) Do not EXCEED 2.0 g/L. See dosing control graph in log book pg 68. On poly feed skid: no automation on mixing, run mixer in MANUAL. **Coag dose** On coag s[illegible]
11/17/2001		No comments
11/18/2001		1) Ondeo removed sludge blanket level instrument in preparation for new unit delivery tomorrow. 2) working unit operation with PACL as coagulant source. Operating conditions: - feed flow = 129 gpm (30 gpm/sf), poly feed = 0.5 mg/L, coag feed = 40 mg/L. 3) On sludge extraction use, 100 min frequency (if change required, use freq adjust) and 1 min duration. On poly system, using only flow 5 * (poly flow, gpm) = dilution water flow set. Don't run poly pump below 6 Hz.
11/19/2001		1) The new sludge blanket level sensor arrived and installation started with instrument representatives. Sensing head damaged during install and will require replacement. Expect new sensor on Wednesday (potentially Tuesday). 2) vendor continue start up operations. Operating at 40 gpm/sf and PACL coagulant dose of 40 mg/L. Unit to operate overnight unattended as part of startup checkout process.
11/20/2001		1) New sludge blanket level sensor arrived and installed. Instrument representative onsite to calibrate unit. Representatives will return tomorrow morning to fine tune after sludge blanket developed. 2) vendor continued startup operations- started unit in afternoon and will run overnight. Operating @ 20 gpm/sf and PACL coag dose of 40 mg/L. Will operated successfully Monday night unattended.
11/21/2001		Unit secured for Thanksgiving holiday
11/22/2001		Unit secured for Thanksgiving holiday
11/23/2001		Unit secured for Thanksgiving holiday
11/24/2001		Unit secured for Thanksgiving holiday
11/25/2001		Unit secured for Thanksgiving holiday

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
11/26/2001		Unit secured for Thanksgiving holiday
11/27/2001		1) Instrument representative finished calibration of new sludge blanket level sensor by midday. 2) vendor continue to have electrical problems. Control panel power (circuit breaker #1) tripped several times during the day. Until this electrical problem is fixed. KC will not take over operation of the pilot. Plan to continue troubleshooting tomorrow morning- checking current draw on circuit. 3) requested vendor to provide accurate as-built prints for electrical systems.
11/28/2001		1) Vendor troubleshooting control panel electrical power problem with support from KC CM staff. Removal and replaced 15 A GFI circuit breaker (circuit breaker #1). Unit operated for a few hours and tripped again with new breaker. Plan to continue tomorrow with component by component checkout of circuit. 2) Received as built drawing from vendor to support continued electrical troubleshooting.
11/29/2001		1) Vendor continued troubleshooting control panel electrical problem with support from KC CM staff. Component-by-component checkout revealed moisture in all of the trailer VFDs. Vendor dried out the VFDs and temporarily sealed by bagging. Restarted unit and discovered that the influent feed pump was not operating properly (no discharge flow with pump running). Continued operation led to control panel circuit breaker tripping. Vendor is pursuing checkout of the feed pump- arranged for inspection by company that previously had rebuilt the pump. Inspection will occur tomorrow. 2) Vendor plans to be onsite for another week. At the earliest, optimization will continue on Monday.
11/30/2001		1) Feed pump inspected and no problem identified. Reassembled pump an started pilot unit. 2) Continued with component by component troubleshooting of electrical problem. Manually starting one component @ a time until all equipment operational. Was able to get all operational with no breaker trip. Plan to run unit overnight for extended checkout. Will not run poly or coag.
12/1/2001		No comments
12/2/2001		No comments
12/3/2001		1) confirmed unit continues to operate with no electrical breaker "tripping". Unit started on PACL/poly run to commence optimization. 2) completed optimization run (-6) under the following conditions: duration = 10 day (8 hrs), HLR (gpm/sf) = 3-, coag dose (ppm)= 40, Coag = PACL, Poly dose (ppm) = 1.0.
12/4/2001		1) King county staff received vendor training. 2) Vendor completed 2 optimization runs under the following conditions: Opt #1: Duration = 0.5 day (4 hrs), HLR = 30, Coag type/dose= PACL/60, poly dose = 1.0. Opt #2: duration = 0.5 day (4 hrs), HLR = 30, Coag/dose= PACL/20, poly dose = 1.0.
12/5/2001		Vendor completed 1 optimization run under the following conditions: duration = 0.5 d (4 hrs), HLR = 25, coag/dose = PACL/20, poly dose = 1.0.
12/6/2001		1) Vendor completed 1 optimization run under following conditions: duration = 0.5 d (4 hrs), HLR = 30, coag type/dose = alum/40, poly dose= 1.0. 2) KC staff received training on polymer batching. 3) Vendor turned pilot unit over to KC staff. Leaving Seattle. 4) Pilot unit left "powered-up" through the weekend in preparation for continued operation on 12/10.

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
12/7/2001		No comments
12/8/2001		No comments
12/9/2001		No comments
12/10/2001		1) Operation staffs discovered feed hose had started leaking over the weekend. Hose secured by valving feed OFF. Will need to replace hose- using WP Facility services hose sections. 2) Preparing for continued coagulant optimization testing.
12/11/2001		During trailer startup, discovered facility side main breaker to pilot unit tripped and will not react. Troubleshooting revealed that problem is on trailer sid eo circuit. Set up further troubleshooting with KC CM staff for tomorrow.
12/12/2001		1) continued troubleshooting power problem. Discovered vendor transformer is failed. 2) Called vendor in the afternoon to relay message that transformer failed. Provided nameplate information from transformer. 3) Located replacement hosing for leaking feed line.
12/13/2001		1) Vendor arranged for "rental transformer from local dealer. Attempt will be made to deliver transformer tomorrow. Working on arranging for WP Maint to install but may have to wait for work order contractor on Monday. 2) Vendor still working on final arrangements for transformer. Question about transformer capacity and facility side feed source.
12/14/2001		1) Installed replacement hose section on feed to pilot trailer. 2) "rental" transformer failed to arrive by early afternoon. Called local dealer and he will not be able to deliver until Monday morning. Faxed directions to West Point. 3) Photographed failed transformer and emailed to vendor.
12/15/2001		No comments
12/16/2001		No comments
12/17/2001		1) Rental transformer delivered by local dealer. Located transformer and palleted failed unit for shipment back to Ondeo. 2) Installation on hold until work order contractor arrives. Onsite in afternoon and will need to assemble required parts. Expect to wire tomorrow morning.
12/18/2001		1) Work order contractor (Prime Elect) completed wire and checkout of new transformer. 2) Ran through startup procedure in preparation for operating tomorrow. 'Left trailer powered throughout he night as a part of checkout.
12/19/2001		1) Shortly after noon, setup/started trailer under the following operating conditions: Feed flow = 129 gpm, poly dose = 1 mg/L, coag dose = 40 mg/L (Alum). Start up at 1500 hrs. Shutdown at 2050hrs. Operated using "old" polymer batch from 12/5. Even with old polymer achieved 10.1 NTU effluent turbidity (78 NTU influent). confirmed all equipment operational. 2) Secured trailer for Christmas holiday. Plan to restart on 12/27.
12/20/2001		Unit secured for Christmas holiday
12/21/2001		Unit secured for Christmas holiday
12/22/2001		Unit secured for Christmas holiday
12/23/2001		Unit secured for Christmas holiday

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
12/24/2001		Unit secured for Christmas holiday
12/25/2001		Unit secured for Christmas holiday
12/26/2001		Unit secured for Christmas holiday
12/27/2001		Unit secured for Christmas holiday
12/28/2001		1) Cleaned out polymer batch tanks. 2) Updated operational procedure with notes from vendor training. 3) confirmed ability to assess datalogger and extract data
12/29/2001		No comments
12/30/2001		No comments
12/31/2001		No comments
1/1/2002		No comments
1/2/2002		1) Delayed startup until tomorrow due to work on another pilot (Pall-MF). 2) Drained polymer tanks and reactor (want to perform dry start up)
1/3/2002		1) Batched polymer. Poly type (dry)- ciba magna floc 1011 serial (batch)# 000102g03. 757 grams in 200 gallons potable water (= 1 g/L).
1/4/2002		1) Operating trailer under the following condition: startup time - 1145 hrs. Left operating overnight. Feed flow = 129 gpm (30 gpm/sf). Sludge recir flow = 5.4 gpm (4.2% of feed flow). Coag = 40 mg/L (alum). Poly = 1 mg/L (magna floc 1011). Poly flow = 8.5 gph w 0.65 gpm dilution water (see calculation in log book pg 84). 2) Changed extraction time from 30-60 min.
1/5/2002		1) At 8:50 hrs, shutdown the unit with ~ 25 gal of polymer remaining. 2) Noted prior to shutdown: Influent turbidity = 57.42 NTU. Effluent turbidity = 67.41 NTU. Sludge blanket level = 2.0 ft.
1/6/2002		No comments
1/7/2002		1) Batched new poly tank. 662.4 g in 175 gal potable water = 1 g/L. Completed mixing @ 11:00 hrs. 2) From 11:30 to 12:00 hrs, drained reactor in preparation for startup. Switching from alum to PACL. 3) At 13:50 hrs, start up of unit under the following conditions: feed flow = 129 gpm. coag = 40 mg/L (PACL). Poly = 1 mg/L (Magnafloc 1011). 4) At 16:45 hrs, discovered V1 valve on coag dosing pump was closed (from securing on 1/5). Opened valve to initiate coag flow. Note: no coag feed from startup. 5) At 17:30 hrs, check of unit shows treatment working. Influent turbidity = 66.6 NTU, effluent turbidity = 17.5 NTU. Sludge extraction set at 1 min every 60 min with pump running at 75% speed.

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
1/8/2002		1) At 8:30 hrs, discovered effluent turbidity reading 300+ NTU on local display. Troubleshooting revealed that big ball of floc material suck in turbidimeter. Cleaned out and effluent turbidity dropped below 10 NTU. 2) At 10:30 hrs, switched coag dosage from 40 mg/L to PID control (50-40-30 mg/L). High turbidity= 199, low turbidity = 30. in an attempt to improve performance. 3) At 10:40 hrs, increased sludge recirc speed setting from 70% (3.8 gpm) to 80% in an attempt to improve performance. 4) At 10:50 hrs, switched sludge recirc speed back to 65%- will only use coag control @ this point. 5) At 11:30 hrs, high effluent turbidity again caused by flow stuck in turbidimeter. Cleaned and turbidity dropped below 10 NTU. 6) at 11:30 hrs, new polymer batch online. 7) Running unit overnight @ same operating condition.
1/9/2002		1) At 6:15 hrs, high effluent turbidity caused by floc stuck in turbidimeter. Cleaned out and turbidity dropped to <10 NTU. 2) AT 13:20 hrs, batching new poly tank. 240 gal - 25 gal (leftover) equiv. To 814 g dry polymer 3) from 12:00 to 13:30 hrs, unit in IDLE for sludge recirc pump packing fix. 4) Conference call with Vendor and HDR to discuss testing. Plan to repeat PACL coag optimization runs. Also, when running with opt poly- select the following poly doses for H-M-L (1.2-1.0-0.5). Sludge blanket to be maintained between 0.5 and 3.0 ft.
1/10/2002		1) At 3:10 hrs, cleaned effluent turbidity meter (was showing 21 NTU). Collected solids in effluent lind cleared. Turbidity sill sbove 10 NTU. Procedure for cleaning turbidimeter: a) open ball valve completely to drain. Close after approx 30 sec. B) drain and refill turbidimeter. 2) At 3:15 hrs, discovered sludge recirc flow @ 0.5 gpm. Pulled sample from line to find 6+% solids. Tried increasing recirc pump speed from 65-80% with minimal response. Will try to call vendor about new step, left messge @ 3:30 hrs. 3) At 3:45hrs, decided to idle unit until there is a chance to talk to vendor. 4) at 5:05 hrs, talked with vendor about sludge recirc problme. Vendor left message also: How to run sludge recirc pump in MANUAL: password = 0 or 9. Reverese pump rotation to clean pump/line suction. 5) Unit secured for the day. Flush recirc line with water and drained through 1/2 ball valve. Drain unit completely in preparation for dry start.
1/11/2002		1) At 11:00 hrs, setup for dry startup. At 11:45 hrs, initiated stry start. 12:15 hrs, shutdown unit due to no recirc flow (pump running but no flow). 2) From 12:30 to 14:00 hrs, disassembled and cleaned discharge line from sludge recirc pump. Full of grease and sludge. 3) At 14:15 hrs, restarted unit (dry start). 4) At 14:45 hrs, discovered V1 coag dosing valuve closed- opened. 5) at 16:35 hrs, cleaned effluent turbidimeter. 6) At 16:40 hrs, Reduced sludge recirc flow 65-60% speed. 7) At 17:00 hrs, secured system until Sunday startup. Drain valves on reactor and clarifier opened to empty system.
1/12/2002		No comments

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
1/13/2002		1) At 11:50 hrs, started unit (dry) up to run overnight. 2) Around 12:35 hrs, sludge level high alarm. Reset sludge extraction to 30 min. interval. Sludge level still increasing- At 1:50 hrs, reduced sludge recirc from 60 to 55% speed. 60% speed - 5 gpm, 55% speed - 4.6 gpm. At 12:00 hrs, open clarifier drain to remove sludge (approx 1 min 3/4 rpm.). At 12:55 hrs, checked manual grab samples from various levels- no excess sludge (some floc not settling). At 13:45 hrs, changed sludge extraction back to 60 min interval. 3) At 15:25 hrs, cleaned effluent turbidimeter- was reading 74 NTU (after cleaning @ 17.5 NTU). 4) Checked coag dosing 10 mL/min ( )
1/14/2002		1) Preparing for optimization testing at 8:45 hrs- increased sludge recirc flow from 1.5 gpm, 55% to 80%. Cleaned effluent turbidity meter. At 12:00 hrs, cleaned effluent turbiditmeter. 2) At 12:30 hrs, setting up for 40 mg/L PACL run. Forced to repair leaking garden hose supply potable water to trailer. Shutdown of potable wtaer cut poly to unit for approx 10 min. 3) Waiting a detention time prior to initiating run. Will start @ 13:15 hrs. 4) At 13:05 hr, switched coag dosing back to 40 mg/L high- middle-low. 5) At 13:20 hrs, problems with effluent quality- high turbidity floc in suspension. Performed following to improve- increased recirc sludge flow to 80% (4.2 gpm), checking coag/poly dosing. Calculate coag flow for 40 mg/L = 0.238 gph, field check = 0.238 gph. Poly dose = 7.74 gph, field check = 8.2 gph. (see detailed calculation in log book pg 93. 6) At 13:50 hrs, changed sludge extraction to every 30 min. 7) At 14:15 hrs, increased poly dose to 1.2 mg/L to handle floc carryover. 9) at 14:50 hrs, called vendor for input. Sugtgestions included following: check unit from top of reactor to isolate where chemi
1/15/2002		1) At 10:00 hrs, batch polymer is tank 1, 60 gal residual. 240 gal - 60 gal (3.2854 L/gal) = 681. For 1 g/L poly conc. Add 681 g dry poly. 2) At 10:15 hrs, cleaned stored data in datalogger. 3) At 14:25 hrs, restarting unit (dry start). Coag setting 50-40-30. Poly setting 1 mg/L, sludge recirc 80%. Sludge extract 1 ming/30 min. 4) At 15:45 hrs, sludge extraction resut every 10 in for 3 min. Sludge blanket level increasing 4 ft. 5) At 15:50 hrs, total extraction tim = 6 min with sludge balnket about 3 ft. Sludge blanket drop from 4.1 to 3.9 ft (6 min). 6) At 16:55 hrs, changed sludge extraction to run time 1 min every 10 min. Sludge blanket dow to 2.5 fot. &) 17:20 hrs, changed extraction to 15 min interval. 8) At 18:05 hrs, changed extraction to 30 min interval. 9) At 15:45 hrs, confirmed sludge extraction actually operational by running hose from extraction line to drain.
1/16/2002		1) At 5:10 hrs, cleaned effluent turbidimeter. 2) Noted that sludge banket is going. Influent turbidity = 76.66 effluent trubidity = 60.07. 3) At 8:00 hrs, unit sludge blanket @ 2 ft and effluent turbidity down to 6 NTU. Will allow unit to run until west point outage drops out fed pum (expect shortly after 12:00 hrs.) 4) Email responses from vendor attached (see pg. 96). 5) At 19:00 hrs, batched new tank of polymer. 6) Preparing for startup. Operating conditions as follows. HOR= 30 gpm/sf (129 gpm feed) coag = PACL, controlled @ 50-40-30 mg/L. Poly set at 1 mg/L Sludge recirc = 80% speed. Sludge extraction = 1 min/90 min. Dry start. Performed checkout of reactor and clarifier:cleaned stringy material from reactor mixer (1/4 bucket full), noted sludge in bottom of reacor (~6"-12"), noted sluged on lamellar tube settlers. 7) At 19:40 hrs, initaited dry start. Will allow to run overnight.

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
1/17/2002		1) At 6:40 hrs, cleaned efflluent turbidimeter and sampling line. 2) At 10:00 hrs, conference call to discuss progress, Attendees: HDR (Mike, Jung), BV (cindy), Ondeo (Rohan, Suchakar). 3) At 19:45 hs, checked unit prior to batch new poly tank. Lost sludge blanket. Will download data to determine when. At 19:40 hrs, also cleaned effluent trubidimeter. 4) At 19:55 hrs, secured uit and will drain/restart. 5) At 20:10 hrs, batching new poly tank. 240 gal - 50 gal (3.7854L/gal) = 719.2 dry polymer added. 6) Packing leak on sludge recirc pump. WP had already installed additional packing on 1/9/02. Need to call vendor about new seat kit or new pump.
1/18/2002		1) At 8:45 hrs, cleaned 1/3 bucket of debris from reactor mixer. Also cleaned screen catch basket. 2) At 9:15 hrs, dry startup. Follwing conditions: HDR= 30 gpm/sf (129 gpm). Coag= PACL (50-40-30) control, poly = set @ 1 mg/L, sludge recirc = 80%, sludge extraction = 1 min/120 min. Plan to run minimum of 2 HRT and then start opt run @ 40 mg/L PACL. 3) At 13:00 hrs, set coag dosage control to 40-40-40. Will ait until 13:20 hrs to start sampling routine. 4) At 16:55 hrs, unit shutdown and drained. 5) Sample analysis BFSG-10 (tss), S1BF (tBOD, tCOD, tss, vss, alk). S3-10 (tBPD, tCOD, TSS, VSS, alk).
1/19/2002		No comments
1/20/2002		No comments
1/21/2002		No comments
1/22/2002		No comments
1/23/2002		No comments
1/24/2002		1) At 15:30 hrs, cleaned debris fro reactor mixer. 2) At 16:00 hrs, started unit with plan to operate overnight. Dry startup. HDR= 30 gpm/sf, coag= PACL (50-40-30) control. Poly = 1 mg/L, sludge recirc = 80%, sludge extraction = 1 min/120 min.
1/25/2002		1) Unit sucessfully ran all night. Sludge blanket @ 1'-9". Sensor not functioning. 2) Completed opt trial-12 (60 mg/L PACL).
1/26/2002		At 15:25 hrs, lost treatment- adjusted coag dose back to 60-40-30 mg/L in attempt to recover. At 17:30 hrs, efflluent turbidity still @ 32.7 NTU (inf = 87.36 NTU). At 17:35 hrs, coag dose adjusted to 50-40-30 mg/L. Turbidity also increasing again. Plan to experiment at bit if turbidity stays high- secure sludge recirc pump for 15 min. At 17:40 hrs, adjusted coag dose to 60-60-60 mg/L. At 18:00 hrs, Batched new poly tank. 240 gal -50 gal = 719.2 g dry polymer. At 19:00 hrs, adjusted coag dose to 50-40-30. Influent turbidity = 83.9 NTU, effluent turbidity = 5.42 NTU.
1/27/2002		No comments

Densadeg Operator Log

Date	Comments Operator Data Sheet	Comments (Log Book)
1/28/2002		1) At 4:15 hrs, batched new polymer. 240 gal - 25 gal = 814 g. 2) At 4:10 hrs, cleaned debris from reactor mixer. 3) At 2:20 hrs, onsite to find unit operating with only 0.6 gpm recirc (sludge blanket very think > 6%). Influent turbidity = 91.24 NTU. Effluent turbidity = 3.63 NTU. At 2:25 hrs, secured unit. Will batch new poly/clean sludge recirc line/ and restart. 3) At 5:10 hrs, unit started. Dry start (2.8' showing on sludge blanket). HOR = 30 gpm/sf (129 gpm), coag = PACL (50-40-30) control. Poly = set @ 1 mg/L. sludge recirc = 80%. Sludge extraction = 1/120 min. 4) At 5:40 hrs, low sludge recirc flow (0.5 gpm) due to seal leak 5) At 14:45 hrs, completed install of new sludge recirc pump- had to pull new wire due to location of motor wire housing (opposite old). 6) At 14:50 hrs, startup of unit (Dry). DND recirculation high alarm - acknowledged prior to startup. 7) At 17:00 hrs, sludge recirc flow still showing HIGH. Pg 20 - sludge recirc pump PID controller. Flow = 9.23 gpm. Local readout on flowmeter = 6 gpm. 8) At 17:05 hrs, colleted operating conditions: Feed flow (gpm) = 129.8. (40% speed setting)
1/29/2002		1) At 9:20 hrs, switched to 20 gpm/sf overflow (setpoint 3 on feed pump to 86 gpm). Set coag to 30-40-50 and poly to 0.5-1.0-1.2 2) At 10:10 hrs, sludge high level (4.4 ft on meter). Set to extract in 3 min. Extraction for 2 min did not impact reading on meter. 3) From 10:15 to 10:20 hrs, manually extracted blanket using lowest sample tap. No change on meter (think sludge removal). 4) At 10:20 hrs, changed poly to 1-1-1. 5) At 10:30 hrs, discovered sludge recirc still @ 6 gpm (40%). this should have been changed with feed change (129-86 gpm). Recuded recirc flow to 3.8 gpm (20%). 6) At 11:00 hrs, shutdown unit - poor effluent quality. Will drain and restart dry. 7) At 13:15 hrs, Unit start up (dry start) Operating condition: HOR=130 gpm (30 gpm/sf). coage = 50-40-30. Poly = 1-1-1, extract = 1/120 min. 8) At 14:10 hrs, changed coag dosing to 60-50-40. INfluent turbidity = 83.02. Effluent turbidity = 18.31. 9) At 14:30 hrs, reduced HOR to 20 gpm/sf (86 gpm). Sludge recirc (20%) 3.8 gpm. 10) At 15:30 hrs, coad change to 50-40-30. 11) AT 15:50 hrs, discoverd ("remembered) that
1/30/2002		No comments
1/31/2002		No comments
2/1/2002		1) Batching new poly tank 240-25 gal = 814 g dry poly. 2) Running Trials -20, -21.
2/2/2002		
2/3/2002	**REMAINING TEST COMMENTS ARE INCLUDED ON INDIVIDUAL TRIAL SHEETS**	

Densadeg Pilot Unit Photos

Introduction

The following is a series of photos of the Ondeo Densadeg pilot unit trailer taken during the pilot testing. Each photo includes a caption and text boxes to point out key pieces of equipment.

Figure 1. Ondeo Densadeg Pilot Trailer

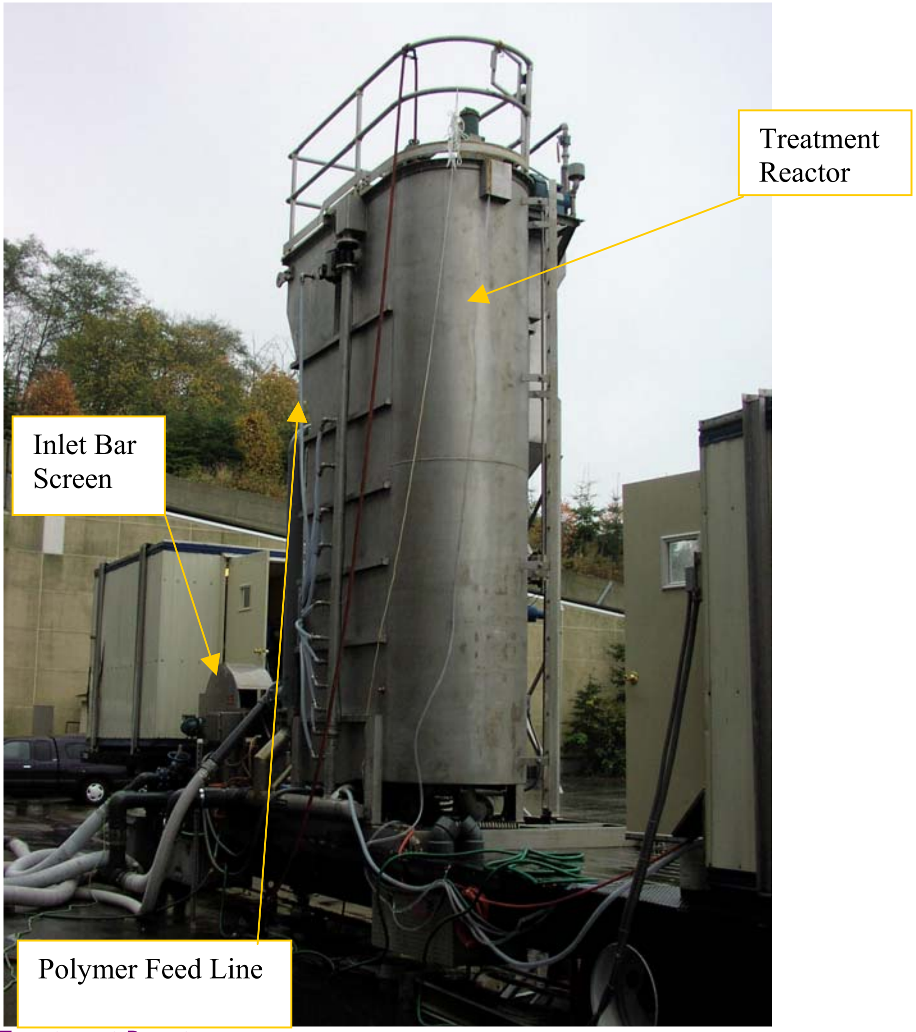


Figure 2. Densadeg Treatment Reactor

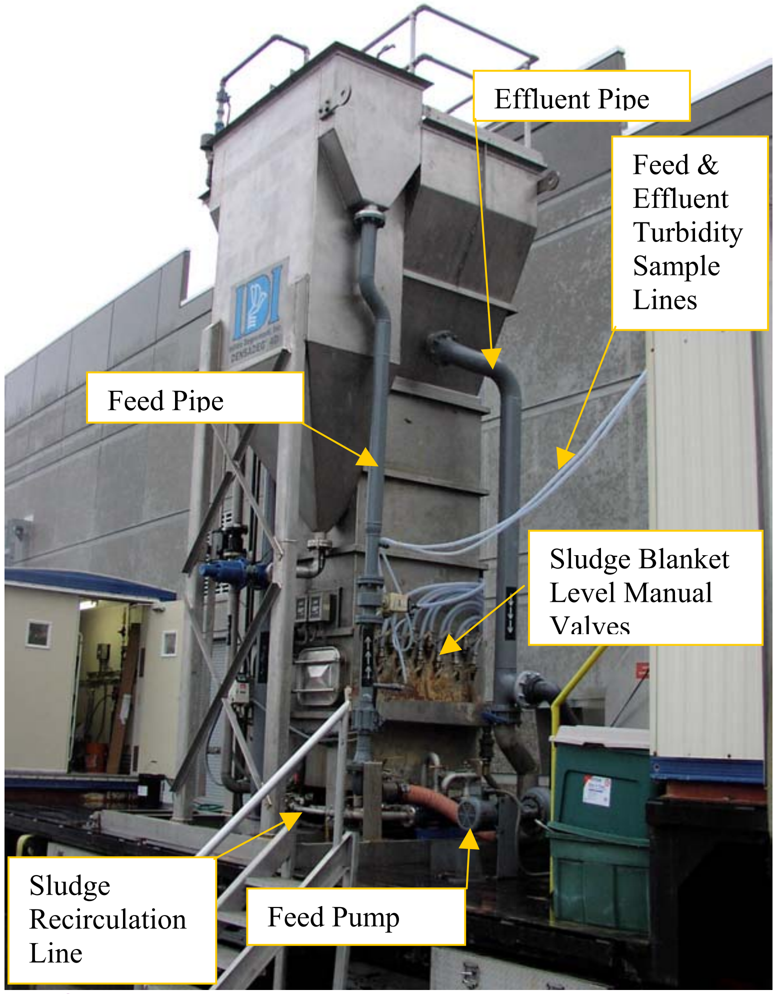


Figure 3. Reactor Tower Components

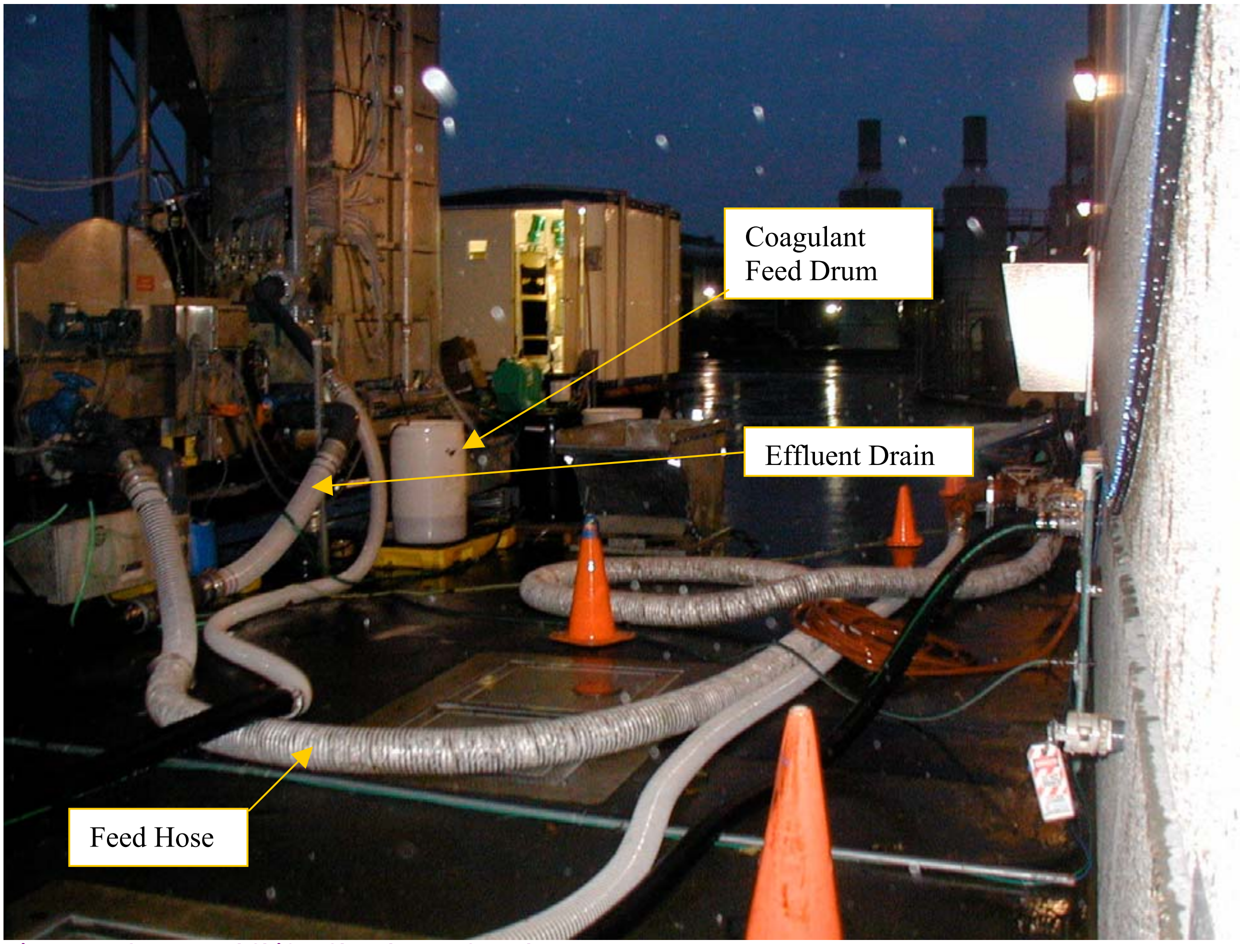


Figure 4. Graveyard Shift – Sleepless In Seattle

DEGREMONT - Listes de Références/*Reference Lists*

Décanteur lamellaire/*Lamellar settling tank*

DENSADEG®

Eaux Résiduaires Urbaines/*Municipal Wastewater*

Hors France/*Abroad*

(Mise à jour/*Updated* : 13/02/02)

Voir également Notices n° 1432 + 1531 + 1569 "DENSADEG" - Français-Anglais + Anglais-Italien + Anglais-Allemand/*See also Brochure n° 1532 + 1531 + 1569 "DENSADEG" - French-English + English-Italian + English-German*
Voir également Notice n° 1581 "DENSADEG 4D" - Français + Anglais/*See also Brochure n° 1581 "DENSADEG 4D" - French + English*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Pays	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*Country*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
PAS DE LA CASA	Andorre/*Andorra*	**8 000**	*1996*	**270**	**1**	DENSADEG RL		***14.00***	*19.29*	INOX *STAINLESS STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
MALMEDY	Belgique/*Belgium*	**70 000**	*1992*	**750**	**1**	DENSADEG RPL	*8.30 x 8.30*	***41.00***	*18.29*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
LAVAL STATION DE LAPINIERE	Québec Canada/*Canada*	**400 000**	*1998*	**25208**	**6**	DENSADEG 4D	*17.00 x 17.00 H: 7.70*	***170.00***	*24.71*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BELOEIL	Québec Canada/*Canada*	**50 000**	*1997*	**2292**	**2**	DENSADEG RL	*12.70 x 12.70*	***100.00***	*11.46*	BETON *CONCRETE*	DEPHOSPHATATION PRIMAIRE *PRIMARY PHOSPHORUS REMOVAL*
SAINT-JEAN SUR RICHELIEU	Québec Canada/*Canada*	**100 000**	*1996*	**4885**	**3**	DENSADEG RL	*15.00 x 15.00*	***140.00***	*11.63*	BETON *CONCRETE*	DEPHOSPHATATION *PHOSPHORUS REMOVAL*
REPENTIGNY	Québec Canada/*Canada*	**70 000**	*1996*	**2190**	**2**	DENSADEG RL	*13.90 x 13.90*	***120.00***	*9.13*	BETON *CONCRETE*	DEPHOSPHATATION PRIMAIRE *PRIMARY PHOSPHORUS REMOVAL*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Pays	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*Country*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
SAINT-EUSTACHE	Québec Canada/*Canada*	**82 000**	*1991*	**2224**	**2**	DENSADEG RL	*10.30 x 10.30*	***66.00***	*16.84*	BETON *CONCRETE*	DEPHOSPHATATION PRIMAIRE *PRIMARY PHOSPHORUS REMOVAL*
SHERBROOKE	Québec/*Canada* Canada	**125 000**	*1991* *1988*	**6000**	**4**	DENSADEG RL	*14.00 x 14.00*	***115.00***	*13.00*	BETON *CONCRETE*	DEPHOSPHATATION PRIMAIRE *PRIMARY PHOSPHORUS REMOVAL*
SARRIO URANGA	Tolosa Espagne/*Spain*		*1997*	**150**	**1**	DENSADEG RL	*D: 4.40*	***8.00***	*18.75*	ACIER *STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
RIVADAVIA STATION DE LA CORUNA	Espagne/*Spain*		*1996*	**160**	**1**	DENSADEG RPL	*D: 4.40*	***8.00***	*20.00*	ACIER AU CARBONE *CARBON STEEL*	DECANTATION PRIMAIRE + EPAISSISSEMENT *PRIMARY SETTLING + SLUDGE THICKENING*
JUNTA SANEAMENTO STATION DE MARENY SUECA	Valencia Espagne/*Spain*		*1996*	**229**	**1**	DENSADEG RL	*5.15 x 5.15*	***14.00***	*16.36*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
PROAGUAS STATION DE BANERES	Alicante Espagne/*Spain*		*1995*	**52**	**1**	DENSADEG RL	*D: 3.80*	***5.50***	*9.09*	INOX *STAINLESS STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
GUIMAR	Ténérife Espagne/*Spain*	**18 000**	*1994*	**185**	**1**	DENSADEG RL	*D: 4.40*	***8.00***	*23.10*	ACIER *STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
EDIMBOURG STATION DE LEVENMOUTH	Scotland Grande-Bretagne/ *Great-Britain*	**440 000**	*2002*		**1**	DENSADEG DENSADEG					DECANTATION EAU PLUVIALES *STORMWATER SETTLING* DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
SOUTH WEST WATER STATION DE PLYMOUTH	Grande-Bretagne/ *Great-Britain*	**100 000**	*1998*	**630**	**4**	DENSADEG RL	*D: 8.60* *H: 5.50*	***33.00***	*19.10*	ACIER *STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
POOLE - WESSEX WATER	Grande-Bretagne/ *Great-Britain*	**100 000**	*1995*	**2667**	**2** **1**	DENSADEG RL DENSADEG RL	*10.40 x 10.40*	***67.00***	*19.90*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
PULSANO	Italie/*Italy*	**120 000** **15 000**	*2000*	**2160**	**3**	DENSADEG RL	*8.30 x 8.30* *H: 5.40*	***41.00***	*17.56*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Pays	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*Country*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
COMODEPUR ***STATION DE COME***	Italie/*Italy*	**16 000**	*1998*	**300**	**1**	**DENSADEG RL**	*D: 5.50* *H: 5.00*	***12.00***	*25.00*	ACIER *STEEL*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
PUEBLA ***STATION DE BARRANCA DEL CONDE***	Mexique/*Mexico*	**29400**	*2001*	**1800**	**2**	**DENSADEG RL**	*8.30 x 8.30*	***41.00***	*43.90*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
PUEBLA ***STATION DE SAN FRANCISCO***	Mexique/*Mexico*	**96000**	*2001*	**5400**		**DENSADEG RL**	*8.30 x 8.30*	***41.00***	*43.90*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
PUEBLA ***STATION D' ATOYAC SUR***	Mexique/*Mexico*	**34560**	*2001*	**2160**		**DENSADEG RL**	*8.30 x 8.30*	***41.00***	*43.90*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
PUEBLA ***STATION D' ALSESECA SUR***	Mexique/*Mexico*	**60480**	*2001*	**3600**		**DENSADEG RL**	*8.30 x 8.30*	***41.00***	*43.90*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BERLIN - BEWAG	RFA/*FRG*			**25**	**1**	**DENSADEG RPL**	*D: 3.80*	***5.50***	*5.60*	ACIER *STEEL*	DECANTATION EAUX D' EGOUT *SEWAGE SETTLING*
HAMBURG	RFA/*FRG*			**500**	**1**	**DENSADEG RL**	*D: 7.30*	***22.50***	*22.22*	ACIER *STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
VEVEY - MONTREUX ***STATION DE ROCHE***	Suisse/*Switzerland*	**30 000 (100 000)**	*1999*	**709**	**2**	**DENSADEG RL**	*6.10 x 6.10*	***19.00***	*18.66*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BAGNES	Suisse/*Switzerland*	**17 000**	*1993*	**850**	**1**	**DENSADEG RL**	*10.00 x 10.00* *H: 5.80*	***65.80***	*13.00*	BETON *CONCRETE*	DEPHOSPHATATION PRIMAIRE *PRIMARY PHOSPHORUS REMOVAL*
NYON ***STATIONS DE NYON-ASSE***	Suisse/*Switzerland*	**40 000**	*1993*	**1200**	**2**	**DENSADEG RL**	*8.50 x 8.50* *H: 6.00*	***50.00***	*12.00*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
PERROY	Suisse/*Switzerland*	**7 500**	*1989*	**95**	**1**	**DENSADEG RL**	*4.00 x 4.00* *H: 4.85*	***7.50***	*12.70*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BRECKENRIDGE	Colorado USA/*USA*		*1998*	**237**	**1**	**DENSADEG RL**	*4.72 x 4.72* *H: 4.72*	***11.15***		BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Pays	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*Country*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
CARLSBAD ***LECUDIA COUNTY WATER DISTRICT***	California USA/*USA*			**316**	**1**	**DENSADEG RL**	*11.73x 11.73 H: 4.57*	***11.33***		ACIER *STEEL*	DECANTATION TERTIAIRE *TERTIARY SETTLING*
SAN RAFAEL ***STATION LAS GALINAS***	California USA/*USA*		*1989*	**318**	**1**	**DENSADEG RL**	*6.00 x 6.00*	***15.00***	*21.20*	ACIER *STEEL*	DECANTATION TERTIAIRE *TERTIARY SETTLING*
VRISHABHAVATHI VALLEY	Bangalore INDE/*INDIA*		*2002*								

D E G R E M O N T - Listes de Références/*Reference Lists*

Décanteur lamellaire/*Lamellar settling tank*

D E N S A D E G ®

Eaux **R**ésiduaires **U**rbaines/***M**unicipal **W**astewater*

France

(Mise à jour/*Updated* : 13/02/02)

Voir également Notices n° 1432 + 1531 + 1569 "DENSADEG" - Français-Anglais + Anglais-Italien + Anglais-Allemand/*See also Brochure n° 1532 + 1531 + 1569 "DENSADEG" - French-English + English-Italian + English-German*
Voir également Notice n° 1581 "DENSADEG 4D" - Français + Anglais/*See also Brochure n° 1581 "DENSADEG 4D" - French + English*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Département	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*French Department*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
AIX-EN-PROVENCE ***STATION DE LA PIOLINE***	Bouches-du-Rhône	**175 000**	*2001*	**4000**	**2**	DENSADEG RL	*10.40 x 10.40* *H: 5.65*	***67.00***	*29.85*	BETON *CONCRETE*	DECANTATION EAUX PLUVIALES *STORMWATER SETTLING* + TRAITEMENT TERTIAIRE *TERTIARY TREATMENT*
FORT DE FRANCE ***STATION DE LA POINTE DES NEGRES***	Martinique	**30 000**	*2000*	**375**	**2**	DENSADEG RL	*4.60 x 4.60*	***10.50***	*17.86*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BOURG-EN-BRESSE ***STATION DE MAJORNAS***	Ain	**100 000**	*2000*	**3500**	**2**	DENSADEG RL	*10.40 x 10.40* *H: 5.70*	***67.00***	*26.12*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING* + DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
LIMOGES	Haute-Vienne	**235 000** *eNGL Pt1*	*2000*	**3750**	**1**	DENSADEG 4D	*8.50 x 8.50* *H: 7.00*	***50.00***	*75.00*	BETON *CONCRETE*	DECANTATION EAUX PLUVIALES *STORMWATER SETTLING*
				5300	**2**	DENSADEG RL	*12.70 x 12.70* *H: 7.00*	***100.00***	*26.50*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
FLERS ***STATION DE L' AUBRIERE à CALIGNY***	Orne	**60 000**	*1999*	**760**	**1**	DENSADEG RL	*7.20 x 7.20* *H: 5.00*	***31.00***	*24.52*	BETON *CONCRETE*	DECANTATION TERTIAIRE *TERTIARY SETTLING*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Département	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*French Department*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
MERU STATION DE L' EAU D' AMONT	Oise	**36 000**	*1999*	**500**	**1**	**DENSADEG RL**	*6.60 x 6.60 H: 4.70*	***25.00***	*20.00*	BETON *CONCRETE*	DECANTATION EAUX PLUVIALES OU DEPHOSPHATATION TERTIAIRE *STORMWATER SETTLING OR TERTIARY PHOSPHORUS REMOVAL*
BOLBEC	Seine-Maritime	**45 000**	*1999*		**2**	**DENSADEG RL**	*6.10 x 6.10 H: 4.65*	***19.00***		BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
SAINT-CHAMOND	Loire	**70 000** *eNGL1.5*	*1999*	**10000**	**2**	**DENSADEG 4D**	*11.20 x 11.20 H: 9.55*	***72.00***	*70.00*	BETON *CONCRETE*	DECANTATION EAUX PLUVIALES *STORMWATER SETTLING*
MEGEVE STATION DE PRAZ-SUR-ARLY	Haute-Savoie	**50 000**	*1999*	**1700**	**2**	**DENSADEG RL**	*8.30 x 8.30 H: 5.30*	***41.00***	*20.73*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING* + DEPHOSPHATATION *PHOSPHORUS REMOVAL*
COLOMBES STATION SEINE CENTRE	Hauts-de-Seine	**900 000** *f NGL2 + Pt2* *eNK2 + Pt1*	*1998*	**43700**	**9**	**DENSADEG RL**	*15.00 x 15.00 H: 8.00*	***140.00***	*34.68*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE + EAUX PLUVIALES *PRIMARY AND STORMWATER SETTLING* + DEPHOSPHATATION *PHOSPHORUS REMOVAL*
MEULAN - HARDRICOURT STATION LES MUREAUX	Yvelines	**100 000**	*1998*	**1600**	**1**	**DENSADEG RL**	*10.40 x 10.40 H: 5.70*	***67.00***	*23.88*	BETON *CONCRETE*	DECANTATION PRIMAIRE EAU DE PLUIE + DEPHOSPHATATION TERTIAIRE *PRIMARY STORMWATER SETTLING + TERTIARY PHOSPHORUS REMOVAL*
BEAUVAIS	Oise	**110 000**	*1997*	**1640**	**2**	**DENSADEG RL**	*7.20 x 7.20*	***31.00***	*22.90*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
SATROD - CET DU VALLON DE BORDE-MATIN A LA ROCHE-LA-MOLIERE	Loire		*1997*	**40**	**1**	**DENSADEG RL**	*D: 3.30*	***4.00***	*10.00*	ACIER *STEEL*	DECARBONATATION TERTIAIRE *TERTIARY LIME SOFTENING*
VERNEUIL - VERNOUILLET	Yvelines	**45 000**	*1997*	**700**	**1**	**DENSADEG RL**	*6.60 x 6.60 H: 4.70*	***25.00***	*28.00*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
SAINT-QUENTIN-EN-YVELINES STATION D' ELANCOURT	Yvelines	**40 000**	*1996*	**650**	**1**	**DENSADEG RL**	*7.20 x 7.20 H: 5.20*	***31.00***	*21.00*	BETON *CONCRETE*	DECANTATION TERTIAIRE *TERTIARY SETTLING*
VALBONNE - SOPHIA-ANTIPOLIS STATION DES BOUILLIDES	Alpes-Maritimes	**26 000**	*199. 1996*	**1100**	**2**	**DENSADEG RL**	*6.60 x 6.60 H: 5.30*	***25.00***	*22.00*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Département	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*French Department*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
BONNEUIL-EN-FRANCE	Val-d' Oise	**300 000**	*1996*	**2860** **3300** **3700**	**2** **2** **2**	**DENSADEG RL** **DENSADEG RL** **DENSADEG RL**	*11.50 x 11.50 H: 5.90* *11.50 x 11.50 H: 5.90* *12.70 x 12.70 H: 6.15*	***82.00*** ***82.00*** ***100.00***	*17.43* *20.12* *18.50*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE EFFLUENTS *PRIMARY EFFLUENTS SETTLING* DECANTATION PRIMAIRE EAU DE PLUIE *PRIMARY STORMWATER SETTLING* DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
GRASSE ***STATION DE LA PAOUTE***	Alpes-Maritimes	**50 000**	*1996*	**375**	**1**	**DENSADEG RL**	*7.20 x 7.20 H: 5.30*	***31.00***	*12.09*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
DREUX	Eure-et-Loir	**80 000**	*1996*	**1850**	**1**	**DENSADEG RL**	*11.50 x 11.50 H: 5.25*	***82.00***	*22.56*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
SYNDICAT DE L' OUDAR ***STATION DE VERSONNEX***	Ain	**6 000**	*1995*	**240**	**1**	**DENSADEG RL**	*4.50 x 4.50 H: 4.45*	***11.00***	*21.80*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
METZ ***STATION NORD***	Moselle	**400 000**	*1995*	**3600** **7200**	**1** **2**	**DENSADEG RL** **DENSADEG RL**	*15.00 x 15.00 H: 5.90* *15.00 x 15.00 H: 5.90*	***140.00*** ***140.00***	*25.71* *25.71*	BETON *CONCRETE* BETON *CONCRETE*	DECANTATION PRIMAIRE EAU PLUVIALES *PRIMARY STORMWATER SETTLING* DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
GOLBEY - EPINAL	Vosges	**80 000**	*1995*	**2200**	**1**	**DENSADEG RL**	*12.70 x 12.70 H: 5.40*	***100.00***	*22.00*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
BORDEAUX ***STATION DE CLOS DE HILDE - BEGLES***	Gironde	**150 000**	*1994*	**2700**	**2**	**DENSADEG RL**	*10.40 x 10.40 H: 5.93*	***67.00***	*20.20*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
GHISONACCIA - PRUNELLI DI FIUM ORBO	Corse	**15 000** *f NK1 Pt1*	*1994*	**240**	**1**	**DENSADEG RL**	*5.15 x 5.15 H: 4.60*	***14.00***	*17.14*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
SETE	Hérault	**150 000**	*1994*	**900**	**2**	**DENSADEG RL**	*6.60 x 6.60 H: 4.70*	***25.00***	*18.00*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BOURG-D' OISANS ***STATION AQUAVALLEES***	Isère	**70 000**	*1994*	**1250**	**2**	**DENSADEG RL**	*7.20 x 7.20 H: 5.00*	***31.00***	*20.20*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
VITTEL - CONTREXEVILLE ***STATION DE CONTREXEVILLE***	Vosges	**35 000**	*1994*	**610**	**1**	**DENSADEG RL**	*8.30 x 8.30 H: 5.20*	***41.00***	*14.87*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Département	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*French Department*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
ETRETAT	Seine-Maritime	**5 000**	*1993*	**140**	**2**	**DENSADEG RL**	*3.50 x 3.50 H: 4.50*	**4.50**	*15.60*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
LA BOURBOULE - LE MONT-DORE STATION DU MONT-DORE	Puy-de-Dôme	**30 000**	*1993*	**750**	**1**	**DENSADEG RL**	*8.30 x 8.30*	**41.00**	*18.30*	BARDAGE + COUVERTURE *CLAD + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
MONTBELIARD STATION SAINTE-SUZANNE	Doubs	**65 000**	*1993*	**1500**	**1**	**DENSADEG RL**	*10.40 x 10.40 H: 4.90*	**67.00**	*22.40*	BETON *CONCRETE*	DEPHOSPHATATION TERTIAIRE *TERTIARY PHOSPHORUS REMOVAL*
PERIGUEUX STATION DE SALGOURDE	Dordogne	**60 000**	*1993*	**1500**	**2**	**DENSADEG RL**	*8.30 x 8.30 H: 4.40*	**41.00**	*18.30*	COUVERTURE *COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
LES MENUIRES - VAL THORENS STATION LES MENUIRES	Savoie	**45 000**	*1992*	**480**	**1**	**DENSADEG RL**	*6.20 X 6.20*	**20.00**	*24.00*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
LES CHAMPSAURS	Hautes-Alpes	**17 000** *eNK1 Pt1*	*1992*	**250**	**1**	**DENSADEG RL**	*5.50 x.5.50*	**15.00**	*16.60*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
FAUVILLE-EN-CAUX	Seine-Maritime	**2 000**	*1991*		**1**	**DENSADEG RL**		**2.20**			
AGDE	Hérault	**160 000**	*1991*	**740**	**1**	**DENSADEG RL**	*8.30 x 8.30 H: 5.20*	**41.00**	*18.00*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
GUILLESTRE	Hautes-Alpes	**25 000**	*1991*	**300**	**1**	**DENSADEG RL**	*5.50 x 5.50*	**15.00**	*20.00*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
TIGNES-LE-LAC STATION DU VAL-CLARET	Savoie	**30 000**	*1991*	**460**	**1**	**DENSADEG RL**	*6.60 x 6.60*	**25.00**	*18.40*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION-EPAISSISSEMENT *SETTLING-THICKENING*
ROYAN STATION DE SAINT-PALAIS	Charente-Maritime	**200 000**	*1990*	**1100**	**2**	**DENSADEG RL**	*7.20 x 7.20*	**31.00**	*17.00*		DECANTATION PRIMAIRE *PRIMARY SETTLING*
ALLOS	Alpes-de-Haute-Provence	**20 000**	*1990*	**300**	**1**	**DENSADEG RL**	*5.50 x 5.50 H: 5.20*	**15.00**	*20.00*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
VALLOUISE	Hautes-Alpes	**20 000**	*1989*	**300**	**1**	**DENSADEG RL**	*5.50 x 5.50*	**15.00**	*20.00*	BETON + COUVERTURE *CONCRETE + COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*

MUNICIPALITE ET LIEU DE L' INSTALLATION	Département	EH	Mise en Route Unités	Débit maxi. m3/h	Nombre Unités	Type Unités	DIMENSIONS m	Surface Lamellaire m2	Vitesse Théorique m/h	CONSTRUCTION	TRAITEMENT CONCERNE
MUNICIPALITY AND PLANT LOCATION	*French Department*	*PE*	*Unit Startup Date*	*Max. Flowrate m3/h*	*Number of Units*	*Unit Type*	*SIZE m*	*Lamella Area m2*	*Theoretical Velocity m/h*	*CONSTRUCTION*	*TREATMENT STAGE*
GREOUX-LES-BAINS	Alpes-de-Haute-Provence	**20 000**	*1988*	**400**	**1**	**DENSADEG RL**	*4.30 x 2.50* *H: 1.50*	***21.50***	*18.60*	BETON *CONCRETE*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BOLQUERE	Pyrénées-Orientales	**20 000**	*1987*	**344**	**1**	**DENSADEG RL**	*4.00 x 4.00*	***8.40***	*41.00*	ACIER *STEEL*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
METABIEF (F. A.)	Doubs	**11 000**	*1985*	**250**	**2**	**DENSADEG RL**		***10.00***	*12.50*	COUVERTURE *COVERED TANK*	DECANTATION PRIMAIRE *PRIMARY SETTLING*
BEAUFORT SUR DORON	Savoie	**5600**	*2002*	**11**	**2**	**DENSADEG 4D**					DECANTATION PRIMAIRE *PRIMARY SETTLING*