WASHINGTON STATE DEPARTMENT OF ECOLOGY

January 2006

(Updated September 2009)

USE DESIGNATIONS FOR EROSION AND SEDIMENT CONTROL

For

Chitosan-Enhanced Sand Filtration using FlocClear™ chitosan acetate

Ecology's Decision:

Based on Ecology's review of Clear Creek Systems Inc. (CCSI) application submissions and the findings by the Chemical Technical Review Committee (CTRC), Ecology is hereby issuing the following use designations for the Chitosan Enhanced Sand Filtration (CESF) technology for adequately controlling small particulate turbidity (clays, silt, etc.) in stormwater discharges at construction sites:

1. **General Use Level Designation for the CESF technology with the discharge of chitosan acetate treated water to retention systems capable of infiltrating all storms to the ground with no discharge to surface water. The design of the infiltration system must be based on the criteria in Volume V of Ecology's most recent Stormwater Manual for Western Washington. The design and operational criteria for the CESF specified in this document shall also be strictly adhered to. Records showing that total retention was achieved must be kept on site.**

2. **General Use Level Designation for the CESF technology with a discharge of chitosan acetate treated water from the sand filters to temporary holding ponds or basins then discharged to surface water (batch treatment). The design and operational criteria specified in this document shall be strictly adhered to.**

3. **Conditional Use Level Designation (CULD) for the CESF technology with the chitosan acetate treated discharges conveyed directly or indirectly to surface water (flow-through system). This CULD expires on March 31, 2012, unless extended by Ecology and takes effect when all the applicable "Conditions" and "Design and Operational Criteria" specified in this designation document are implemented or satisfied.**

Conditions Applicable to CESF under this designation

1. **Formal written approval from Ecology is required for the use of chemical treatment at each site. Written approval must be obtained from the appropriate Ecology regional office.**

2. **This use level designation applies only to FlocClear™ (2% chitosan acetate solution).**

3. **The chitosan dose rate for water entering the filters shall not exceed 1 mg/L FlocClear™ (as chitosan by weight). All calibration results must be recorded simultaneously with the flowrates and kept on site.**

4. **Source control procedures shall be implemented to the maximum extent feasible to minimize the need for the use of additional chitosan acetate for the pretreatment of stormwater. Additional FlocClear™ (amounts greater than 1 mg/L chitosan acetate by weight) may be used to pretreat water that exceeds 600 NTU. A portion of the 1 mg/L FlocClear™ may be used to pretreat water less than or equal to 600 NTU. Pretreatment must occur in a tank or basin dedicated to pretreatment. All pretreated water must enter the sand filters. Pretreated water must have no less than 50 NTU and no more than 600 NTU before final dosing. This will help ensure that free chitosan does not enter the CESF system. Also, 1 mg/L FlocClear™ (chitosan by weight) is sufficient to treat water in this range. Water exiting the pretreatment tanks must be continuously monitored for turbidity. An automatic integrated turbidity sensor shall be located on the output from the pretreatment tanks or basins. This sensor will alert the operator when turbidity values fall outside of the 50 to 600 NTU range. If this occurs, operators can reroute the out of spec water to the untreated stormwater pond, shut the system down, or conduct additional residual chitosan tests. One of these actions must occur each time the alarm goes off. Jar tests must be used to determine proper pretreatment dosing and proper filtration treatment dosing.**

5. **This approval only applies to discharges to streams. Additional aquatic toxicity testing will be necessary for discharges to other waterbodies.**

6. **Jar tests will be conducted at startup to determine the dosage level of chitosan acetate solution. Additional jar tests will be conducted when influent turbidity changes by 20% or greater. Jar test results must be recorded in the daily operating log. If the results of the jar test indicate that the dose needs to be adjusted, the jar testing results and the indicated dose rate change shall be documented in the daily operating log.**

7. **During CESF operation, water quality influent and effluent shall be continuously monitored for pH, turbidity, and flow. For batch treatment systems only water discharged from the batch treatment basins or tanks must be continuously monitored for pH, turbidity, and flow during discharge.**

8. **The discharge flowrate shall be continuously metered and recorded. For batch treatment systems only water discharged from the batch treatment basins or tanks must be continuously monitored for flowrate.**

9. **The effluent shall be monitored for residual chitosan or aquatic toxicity. If effluent will be monitored for aquatic toxicity, the most sensitive test reported in the intended use plan must be used. If the effluent will be monitored for residual chitosan, a discrete grab sample of homogeneous sand filter discharge must be collected and analyzed within 30 minutes of the onset of operation and 2 hours after startup to confirm a discharge concentration below 0.2 ppm. The test is to be repeated whenever there is a change in dosage, or a significant change in influent turbidity or flowrate (20% or greater). For batch treatment systems, only water discharged from the batch treatment basins or tanks must be monitored. For batch treatment system, an additional grab sample of the potential batch treatment discharge must be collected and analyzed for aquatic toxicity or residual chitosan before any discharge from the treatment basins or tanks can occur.**

10. **Discharges from the CESF shall be maintained below 0.2 ppm residual chitosan at all times. Discharges must be monitored for residual chitosan or aquatic toxicity. In the event that the chitosan residual in the discharge is greater than 0.2 ppm, the discharge exhibits aquatic toxicity, or when the CESF system fails to meet discharge quality requirements, a contingency plan must be included in every SWPPP that immediately corrects the situation. The operation and maintenance manual must include contingency plan measures and must be available on-site.**

11. **An Operating Period Information Form shall be completed for each operating period (system startup, operation, and shutdown). At a minimum, the form shall include the following:**

    i. **A record of each recycle event**

    ii. **A record of each backwash event**

    iii. **Actions taken when a recycle event occurs**

    iv. **Actions taken when excessive backwashing is occurring**

    v. **A record of pump calibration**

    vi. **A record of chitosan use for pretreatment**

    vii. **A record of chitosan dosage immediately prior to filters**

    viii. **A record of test results for chitosan residual in the effluent**

Weekly, the supervisor shall examine the forms completed the previous week. The supervisor shall sign each daily form indicating it has been reviewed and document actions taken in response to any abnormal conditions observed by the operator.

12. **At all construction sites, at the end of the operating period, a delegated responsible person shall record their assessment of the operational efficiency of the CESF process, any upsets, the sand filter discharge chitosan concentrations, and any other relevant observations that relate to CESF proper operation. They must also certify the acceptability of the CESF discharge to surface water.**

13. **Discharges from the CESF system shall not cause or contribute to receiving water quality violations and shall comply with the discharge requirements of the State of Washington Construction Stormwater General Permit, AKART, and local government requirements for turbidity and other applicable pollutants. This designation document must be used as the basis for Stormwater Pollution Prevention Plans (SWPPPs) for all construction projects where chitosan treatment is planned.**

14. **Discharges from the CESF system under these designations shall achieve performance goals of a maximum instantaneous discharge of 10 NTU turbidity and a discharge pH within a range of 6.5-8.5. These limits reduce interferences associated with the residual chitosan test.**

15. **The CESF facility contractor shall guarantee that the CESF system, when used as directed, will not produce treated water that exhibits aquatic toxicity caused by chitosan added as a treatment agent.**

16. **The CESF system shall only be operated by a trained technician certified through an Ecology-approved training program that includes classroom and field instruction. The CESF operator must remain on-site during CESF operation. The technician must have the following minimum training requirements:**

Prerequisites:

- **Current certification as a Certified Erosion and Sediment Control Lead (CESCL), through an Ecology-approved CESCL training course.**
- **Fundamental knowledge of, high-pressure sand filter systems.**
- **Fundamental knowledge of water pumping and piping systems.**
- **Fundamental knowledge of stormwater discharge regulations for applicable region/locale.**
- **Fundamental knowledge of stormwater quality testing procedures and methods for parameters applicable to the region/locale.**

Classroom (8 hours)

- **Stormwater regulatory framework and requirements**
- **Stormwater treatment chemistry (chitosan, pH, coagulation, filtration, etc.)**

- **Stormwater treatability (how to do jar testing)**
- **Treatment system components and their operation**
- **Treatment system operation**
- **Troubleshooting**

In the field (32 hours)

- **Operating the treatment system**
- **Entering data in the system operations log**
- **Testing turbidity and pH**
- **Optimizing chitosan dose rate**
- **Water quality sampling and testing (turbidity and pH)**
- **Residual Chitosan Test**

17. **The SWPPP is to include a field procedure, accepted by the Department of Ecology, for detecting residual chitosan in stormwater discharges sensitive to 0.2 ppm.**

18. **During the planning of the project, the adverse potential impacts on chitosan efficiency of the use of other erosion and sediment control practices must be evaluated.**

Conditions Applicable to Flow-Through CESF under this CULD

1. **Ecology hereby approves the Intended Use Plan dated May 3, 2006.**

2. **Ecology hereby approves the Quality Assurance Project Plan (QAPP) dated March 6, 2006. A site specific QAPP must be completed and submitted to Ecology by March 31, 2010.**

3. **All required testing must be completed and a TEER in support of a general use level designation for flow-through treatment must be submitted by September 30, 2011.**

Design Criteria for CESF Systems:

1. **Systems must be designed using the relevant portions of the most current versions of BMP C250 and BMP C251 of the Western and Eastern Stormwater Management Manuals. The most recent versions can be found: http://www.ecy.wa.gov/programs/wq/stormwater/ww_stormwater_manual/final_bmp_c250_12_06.pdf. System design must consider downstream conveyance system integrity.**

2. **The facility shall employ a minimum of three (3) sand filter pods to ensure adequate backwashing capacity. The backwash slurry from the sand filters must be discharged to a holding cell that is separate from the temporary storage cell for the incoming turbid stormwater. The overflow from the backwash**

slurry detention cell can overflow into the detention basin for the incoming turbid stormwater.

3. **The operating flow rate shall not exceed 15 GPM per square foot of sand bed filtration area.**

4. **Only filtration media approved in the Sand Filtration Treatment Facilities section (Volume V, Chapter 8) of the most recent Western Washington Stormwater Manual can be used in the filter pods. Minimum sand bed depth shall be 18 inches underlain with a minimum of 6 inches of 1-inch crushed rock.**

5. **The CESF system shall include a flow-regulating valve on the input to and output of the sand filter. These regulating valves will reduce the maximum output of the pump as required and facilitate proper backwash.**

6. **The CESF system treated water output shall be equipped with an automatic integrated turbidity and pH sensor capable of shutting the system down if the output turbidity or pH exceeds preset values. An audible alarm and warning light shall be installed on the treatment system to alert the operator in the event of a system failure.**

7. **The CESF control system (including metering pump, chitosan storage and instrumentation) shall be completely enclosed in a secure structure with locking door. The chitosan liquid concentrate shall be stored in a non-corrosive storage tank. Chitosan storage tank, metering pump, and tubing shall have secondary containment. The metering pump discharge tubing shall have an anti-siphon valve.**

8. **Chitosan injection shall be performed with an LMI-brand C77 high viscosity pump head, electric metering pump, or equivalent. The metering pump must be calibrated within 15 minutes of the beginning of each operating period. The metering pump shall be recalibrated when a significant change occurs in either the flow or influent turbidity.**

Applicant: Clear Creek Systems. Inc. (CCSI) Chitosan vendor and technical consultant
Joe Gannon, President (661 979-2525)

Applicant Address: 4101 Union Ave
Bakersfield, California 93305

Application Documents:

- Application for Conditional Short Term Use Designation for Chitosan Enhanced Sand Filtration, April 2005, Joe Gannon, Clear Creek Systems, Inc

The following are contained in the April 2005 application documentation:

- Flocculation Comparison Testing of Ven-Vis 204 and Storm Klear™ Liqui-Floc™, January 2005, Julie Morgan of Venture Chemicals, Inc.

- The Examination of Residual Chitosan Testing Procedures for Effectiveness, Reproducibility, and Reliability on Polymer from Various Manufacturers, Jason Martino and David Beard, Clear Creek Systems, Inc.

- Aquatic Toxicity Testing Results for a Product – Floc-Clear 2% A One-Species Chronic Definitive Bioassay, January 2005, Block Environmental Services

The following are contained in the October 2005 Application

- Clear Creek Systems, Inc. FlocClear™ Chitosan Enhanced Sand Filtration Stormwater Treatment Evaluation, October 2005, Water Tectonics

- FlocClear™ Chitosan Enhanced Sand Filtration Operations and Maintenance Manual, 2005, Clear Creek Systems

- Flocculation Comparison Testing of Ven-Vis 204 (FlocClear™) and StormKlear™ LiquiFloc™ Addendum to Original Application for Approval, Jason Martino, July 14, 2005

Applicant's Use Level Request:

Interim Short-Term Use Designation for the operation of flow-through Chitosan-Enhanced Sand Filtration (CESF) technology for the reduction of turbidity in construction site stormwater. General Use Level Designation for the CESF technology with the discharge of chitosan acetate treated water to retention systems capable of infiltrating all storms to the ground with no discharge to surface water. General Use Level Designation for the CESF technology with a discharge of chitosan acetate treated water from a temporary holding pond to surface water only after the treated stormwater is demonstrated to contain less than 0.1 ppm residual chitosan acetate polymer or is non-toxic to aquatic organisms (batch treatment).

Applicant's Performance Claims:

For construction site stormwater runoff with a turbidity of less than 600 NTU (influent), a properly engineered and deployed *Chitosan-Enhanced Sand Filtration System* will remove greater than 95% of the turbidity, producing effluent that will consistently meet the State surface water discharge standards.

Chemical Technical Review Committee (CTRC) Recommendation:

The CTRC finds sufficient evidence to recommend to Ecology to grant Clear Creek Systems Inc. a CUD for a flow through CESF technology that can remove turbidity from stormwater at construction sites within acceptable limits.

Findings of Fact:

1. A CESF system has demonstrated the ability to reduce turbidity caused by the disturbance of sediment on construction sites by 99.1% (overall average) when operated at a flow rate of approximately 200 GPM to 97.2% when operating at a flowrate of 1200 GPM.

2. Influent turbidity levels above 600 NTU demonstrated the potential to cause a slow degradation of the turbidity removal performance by the system resulting in eventual system failure. CESF systems shall be limited to influent turbidity levels of 600 NTU or less**.** Turbidity levels above 600 NTU shall be allowed additional settlement time or be pretreated in another manner not covered in this application for Conditional Use Designation.

3. Water with a pH range outside the CESF treatment window of 6.5 to 8.5 shall be pretreated to achieve this range. This pretreatment process is not covered in this application for Conditional Use Designation.

4. In the CESF treatment systems that have been constructed and operated to date no aquatic toxicity has been observed in the treated filtrate.

5. The chitosan acetate polymer component, used for water treatment, is non-toxic to humans and other mammals, which makes it somewhat unique in the universe of treatment agents. Chitosan acetate does, however, exhibit toxicity to rainbow trout and should therefore be used at a maximum dose rate of 1 mg/L as chitosan acetate as a conservative measure to ensure no possibility of toxicity to rainbow trout in receiving water.

6. CCSI provided a design/operation/maintenance manual, which includes information on selecting, sizing, assembling, operating and maintaining a CESF system.

7. CCSI provided a significant amount of aquatic toxicity data demonstrating that the discharge residual of the chitosan acetate polymer is expected to be within toxicity levels acceptable to Ecology when used as directed.

Description of the Technology:

Chitosan-enhanced sand filtration (CESF) is a stand-alone construction site water treatment technology, which is comprised of four basic components:

- Stormwater transfer pump
- Chitosan addition
- Pressurized multi-pod sand filtration
- Interconnecting treatment system piping

CESF is a flow-through stormwater treatment technology that utilizes chitosan, a natural biopolymer, in conjunction with pressurized sand filtration to remove turbidity (suspended sediment). Each treatment system is designed and installed to operated on an as need basis, pumping water from a retention basin whenever the water level of the retention basin is high enough to warrant processing. When stormwater is transferred from the retention basin to the sand filtration unit, chitosan is introduced to stormwater to coagulate suspended solids producing larger particles, which are retained within a sand filter. The filtration systems are equipped with automatic backwash systems, which will backwash the collected sediment from the individual filter pods as necessary to maintain the hydraulic capacity of the filtration media. This feature allows the treatment system to operate on a continuous flow-through basis. A link to a diagram of the system is included here:

Recommended Research and Development

Ecology encourages CCSI to pursue continuous improvements to the CESF system. To that end, the following actions are recommended:

- Further research should be conducted to create a more reliable residual chitosan test. A test that quantifies chitosan concentrations should be developed.
- Determine how different soil types affect chitosan treatment.
- Determine aquatic threshold for marine species.

Contact Information:

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Applicant Website: www.clearcreeksystems.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

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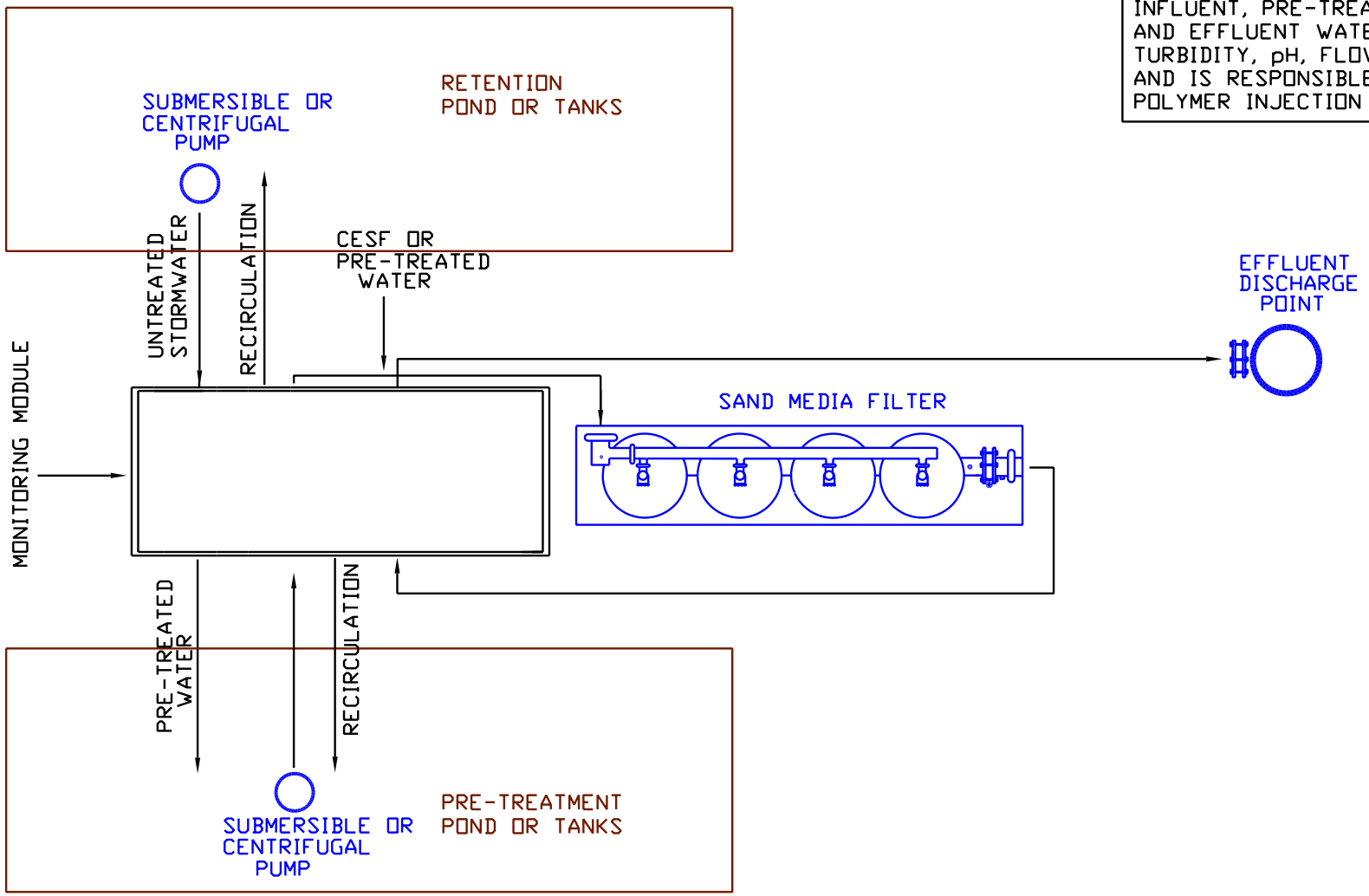
NOTES:
MONITORING MODULE MEASURES: INFLUENT, PRE-TREATMENT AND EFFLUENT WATER FOR TURBIDITY, pH, FLOW AND IS RESPONSIBLE FOR POLYMER INJECTION



FLOCCLEAR™ CHITOSAN ENHANCED SAND FILTRATION SYSTEM

FIGURE 1. TYPICAL CONCEPTUAL LAYOUT.

SHEET NO. 1/1

DWG NO. 1

DATE: JAN 08

DRAWN BY: C. HINDS

REV DATE: 1-21-08