VERIFICATION TEST PLAN
FOR
Big Fish Environmental, LLC
Big Fish Environmental Septage Processing System

Prepared for
NSF International
Ann Arbor, Michigan
And
The Environmental Technology Verification Program
Of the
US Environmental Protection Agency
Edison, New Jersey

By

Scherger Associates
Ann Arbor, Michigan

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VERIFICATION TEST PLAN
BIG FISH ENVIRONEMNTAL, LLC
For
EPA/NSF Environmental Technology Verification Program

Water Quality Protection Center

John Campbell
Big Fish Environmental, LLC
12640 Taylor Road
Charlevoix, Michigan 49720
Phone: 231-547-4429

Dale Scherger
Scherger Associates
3017 Rumsey Drive
Ann Arbor, Michigan
Phone: 734-213-8150

Thomas Stevens
NSF International
Project Manager, Source Water Protection
789 N. Dixboro Road
Ann Arbor, Michigan 48105

Phone: 734-769-5347

Raymond Frederick
U.S. Environmental Protection Agency
Project Officer, Source Water Protection
NRMRL
2890 Woodbridge Ave. (MS-104)
Edison, New Jersey 08837
Phone: 732-321-6627

Carolyn Esposito
U.S. Environmental Protection Agency
Quality Assurance Officer, UWMB,WSWRD
National Risk Management Research Laboratory
2890 Woodbridge Ave. (MS-104)
Edison, New Jersey 08837
Phone: (732) 906-6895

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Abbreviations and Acronyms

ASTM	American Society for Testing and Materials
Big Fish	Big Fish Environmental, LLC
BOD_5	5 –day Biochemical Oxygen Demand
°C	Celsius degrees
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DQI	Data Quality Indicators
ETV	Environmental Technology Verification
FOG	Fats, Oil, and Grease
ft^2	Square foot (feet)
gal	Gallons
gpd	Gallons per day
gpm	Gallon(s) per minute
GP	Generic Protocol
Kg	Kilogram(s)
L	Liters
Lbs	Pounds
MDL	Minimum Detection Level
NH_3	Ammonia Nitrogen
NO_2	Nitrite
NO_3	Nitrate
NRMRL	National Risk Management Research Laboratory
µg/L	Microgram(s) per liter (ppb)
mg/L	Milligram(s) per liter
mL	Milliliter(s)
NSF	NSF International
NIST	National Institute of Standards and Technology
O&M	Operations and Maintenance
PM	Project Manager for the Testing Organization (TO)
ppb	Parts per billion (µg/L)
QA	Quality assurance
QC	Quality control
RPD	Relative Percent Difference
SD	Standard Deviation
SOP	Standard Operating Procedure
T	Temperature
TKN	Total Kjeldahl Nitrogen
TO	Testing Organization
TP	Total Phosphorus
TSS	Total Suspended Solids
USEPA	U.S. Environmental Protection Agency
VO	Verification Organization (NSF)
VTP	Verification Test Plan
WWTP	Wastewater treatment plant

Glossary of Terms

Accuracy - a measure of the closeness of an individual measurement or the average of a number of measurements to the true value and includes random error and systematic error.

Bias - the systematic or persistent distortion of a measurement process that causes errors in one direction

Comparability – a qualitative term that expresses confidence that two data sets can contribute to a common analysis and interpolation.

Completeness – a qualitative term that expresses confidence that all necessary data have been included

Precision - a measure of the agreement between replicate measurements of the same property made under similar conditions.

Protocol – a written document that clearly states the objectives, goals, scope and procedures for the study. A protocol shall be used for reference during Vendor participation in the verification testing program

Quality Assurance Project Plan – a written document that describes the implementation of quality assurance and quality control activities during the life cycle of the project.

Residuals – the waste streams, excluding final effluent, which are retained by or discharged from the technology.

Representativeness - a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point, a process condition, or environmental condition

Source Water Protection Stakeholder Advisory Group - a group of individuals consisting of any or all of the following: buyers and users of in drain removal and other technologies, developers and vendors, consulting engineers, the finance and export communities, and permit writers and regulators.

Standard Operating Procedure – a written document containing specific procedures and protocols to ensure that quality assurance requirements are maintained

Technology Panel - a group of individuals with expertise and knowledge of decentralized wastewater treatment technologies

Testing Organization – an independent organization qualified by the Verification Organization to conduct studies and testing of technologies in accordance with protocols and test plans

Vendor – a business that assembles or sells decentralized wastewater treatment equipment.

Verification – to establish evidence on the performance of in drain treatment technologies under specific conditions, following a predetermined study protocol(s) and test plan(s).

Verification Organization – an organization qualified by USEPA to verify environmental technologies and to issue Verification Statements and Verification Reports.

Verification Report – a written document containing all raw and analyzed data, all QA/QC data sheets, descriptions of all collected data, a detailed description of all procedures and methods used in the verification testing, and all QA/QC results. The Test Plan(s) shall be included as part of this document.

Verification Statement – a document that summarizes the Verification Report reviewed and approved by USEPA.

Verification Test Plan – A written document prepared to describe the procedures for conducting a test or study according to the verification protocol requirements for the application of treatment technology. At a minimum, the Test Plan shall include detailed instructions for sample and data collection, sample handling and preservation, precision, accuracy, goals, and quality assurance and quality control requirements relevant to the technology and application.

1.0 INTRODUCTION

This document contains the technology specific Verification Test Plan (VTP) to be used for the verification testing of the Big Fish Environmental Septage Processing System. Big Fish Environmental, LLC (Big Fish) has developed an aerobic biological treatment system to manage/treat septage wastes, which produces an effluent that can be discharged to a municipal sewer system. The processing system includes a bar screen, grit removal, blending tanks, lime treatment tank and screw press to dewater solids, producing a Class A biosolids. The filtrate from the screw press is processed through a series of aeration tanks where aerobic treatment of the organics occurs, followed by a settling tank, and final discharge tanks. The aerobic processing tanks use White Knight Microbial Generators to supply microorganisms and the system includes a "hatchery" to grow and maintain a supply of organisms. The entire processing system including the unloading/receiving area is enclosed in a building with exhaust air treated by a biofilter to control odors. An existing system operating in Charlevoix, Michigan will be evaluated.

This VTP has been prepared in accordance with the *Protocol for the Verification of Wastewater Treatment Technologies* (April 2001) developed under the United States Environmental Protection Agency (USEPA) Environmental Technologies Verification (ETV) Program's Source Water Protection area of the Water Quality Protection Center.

The USEPA ETV Program is intended to:

- Evaluate the performance of innovative and commercially available environmental technologies;
- Provide permit writers, buyers and users, among others, with objective information about technology performance; and
- Facilitate "real world" implementation of promising technologies.

The ETV program has developed verification testing protocols that serve as templates for conducting verification tests for various technologies. The *Protocol for the Verification of Wastewater Treatment Technologies* (April 2001) (GP) was published as the guidance document for test plan development for verification testing of decentralized wastewater treatment systems for all non-residential wastewater (commercial and industrial) and for residential wastewater treatment systems with flow rates greater than 1,500 gallons per day (gpd). This VTP was developed in accordance with the GP. The goal of the verification testing process is to generate high quality data for verification of equipment performance.

The ETV Program is made up of six Centers, one of which is the Water Quality Protection Center. This Center focuses on technologies addressing wet weather flows and source water protection, and includes the verification testing of decentralized wastewater treatment systems that are installed at locations without access to wastewater collection treatment systems and that provide protection for groundwater and surface water sources.

NSF International (NSF) oversees the verification testing center project for decentralized wastewater treatment technologies under the sponsorship of the USEPA Urban Watershed Branch, Water Supply and Resources Division. The role of NSF is to provide technical and administrative leadership in conducting the testing.

It is important to note that verification of the equipment does not mean or imply that the equipment is "certified" or "approved" by NSF or USEPA. Instead, verification testing is a formal mechanism by which the performance of equipment can be determined, resulting in the issuance of a Verification Statement by NSF and USEPA.

2.0 OBJECTIVES AND DESCRIPTION OF VERIFICATION TESTING

2.1 Objectives

Big Fish Septage Processing Systems (system) are designed to treat septage, Porta John waste, wastewater treatment plant biosolids, and fat, oil, and grease wastes to meet the regulatory requirements for discharge of treated effluent to a municipal wastewater treatment system, while producing a Class A biosolids, which can be used for agricultural or home garden use. Actual numerical standards for discharge to municipal treatment systems will vary by location. The Big Fish is designed to meet pretreatment standards for discharge to most secondary wastewater treatment systems (typically 250-300 mg/L BOD_5; 300-350 mg/L TSS; 50-70 mg/L NH_3; and locally determined restrictions on T-P). The lime treatment and heated screw press are designed to meet Class A biosolids requirements. The system that will be tested in this verification is a full scale, commercially available unit installed and operated by Big Fish in Charlevoix, Michigan. The discharge from the system is to the City of Charlevoix Wastewater Treatment Plant (WWTP).

Verification testing of decentralized wastewater treatment systems under the ETV Water Quality Protection Center is designed to verify a technology's contaminant removal performance, and the operation and maintenance performance of the commercial-ready technology, following technically sound protocols and appropriate quality assurance and control. A primary objective of the ETV is to measure the performance of these technologies through a well-defined test plan that includes measurement of contaminants present in residential and non-residential wastewaters, before and after application of the treatment technology.

The objective of this VTP is to determine the performance attained by Big Fish when used to treat a mixture of wastewaters. These wastes contain organic, solids, and nutrient constituents that can impact groundwater and surface water if discharged or disposed of untreated. Reduction in contaminant loads will be evaluated to determine the effectiveness of the system to remove suspended solids, BOD, and nutrients (phosphorus and nitrogen). The production of Class A biosolids will also be evaluated and verified during the test. The objective will be achieved by implementing testing and monitoring procedures presented in this Verification Test Plan.

The treatment system will receive septage from residential and commercial septic tanks, Porta John waste, municipal WWTP secondary sludge, and commercial wastes with fats, oils, and grease (FOG), containing solids, organics, nutrients, and other constituents typically present in residential and commercial septage and related wastes. The treatment system will be challenged under a variety of hydraulic loading conditions and contaminant loads during the one-year test period. Waste generation and demand for treatment varies seasonally, so the one-year test period will cover high and low demand periods. The influent and effluent to/from the system will be sampled and the samples will be analyzed for various contaminants or contaminant indicators, including five-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total suspended solids (TSS), nitrogen compounds (TKN, NH_3, NO_2+NO_3), total phosphorus (TP) and FOG. The results will be used to calculate removal efficiencies and system capacities, and to determine the system treatment effectiveness. These parameters and other operating parameters (flow, pH, alkalinity, temperature, dissolved oxygen, per cent solids, biosolids production) will be monitored to meet the ETV objective of providing an overall assessment of the technology that can be used by permit writers, buyers, and users of the technology.

The treatment system will also be monitored for operation and maintenance characteristics, including the performance and reliability of the equipment, the amount of personnel time required to operate the process, the level of operator skill required, and the maintenance required to maintain process operation. Data will also be collected on the generation of residues.

2.2 Test Site Description

The verification test will be performed at the Big Fish facility in Charlevoix, Michigan, as shown in Figure 2-1.

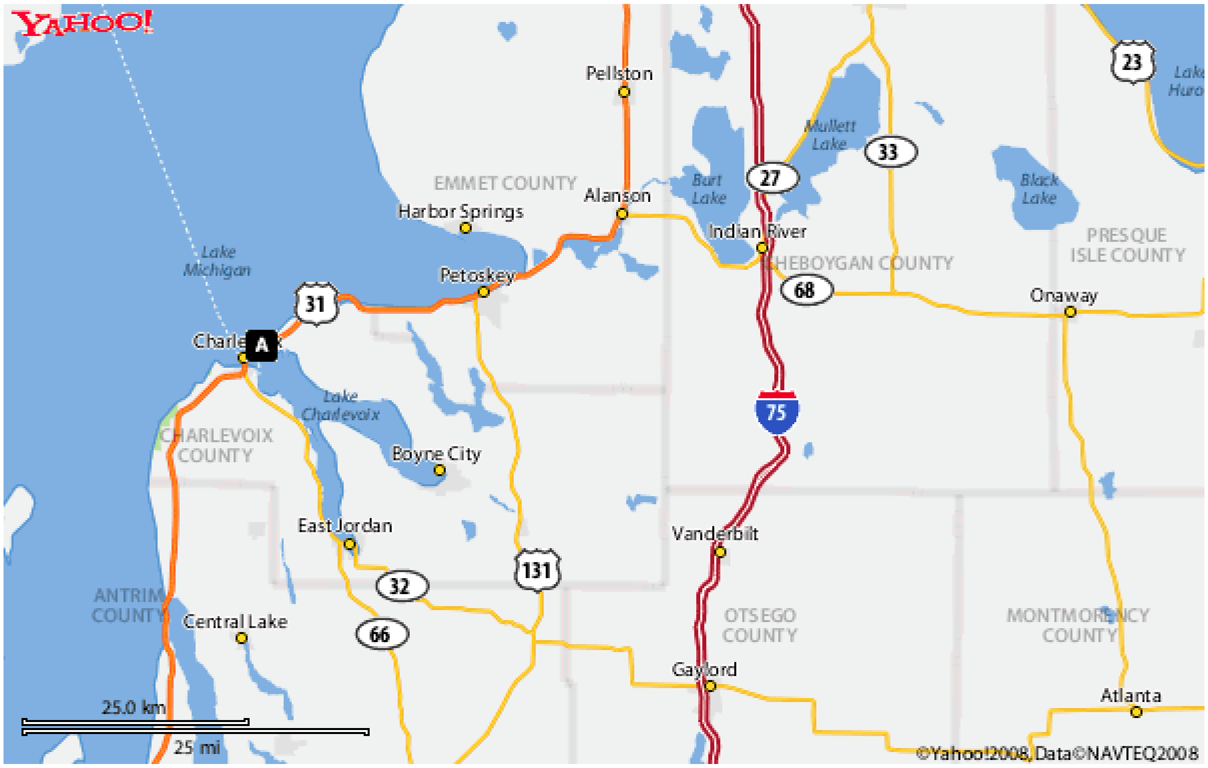


Figure 2-1. Verification test site location map.

Big Fish has built a full-scale treatment system in Charlevoix to serve the surrounding area. The system receives septage waste from several septic tank cleanout companies, secondary sludge from the City of Charlevoix WWTP, commercial grease interceptor waste containing FOG from local businesses, and Porta John waste. The current treatment system has been in operation for over two years. Treated effluent is discharged to the City of Charlevoix municipal WWTP. Operating reports required under the State of Michigan permit system and by the City of Charlevoix show that the effluent has achieved the required standards for the past year. Table 2-1 shows the permit limits set for the Big Fish facility.

Table 2-1. Discharge Permit Limits for the Big Fish Facility

Parameter	Sample Frequency	Sample Type	Permit Limit
Flow	Every discharge period	Meter	Report
BOD	Every discharge period	Composite	300 mg/L maximum.
TSS	Every discharge period	Composite	350 mg/L maximum
Ammonia (NH_3-N)	Every discharge period	Composite	65 mg/L (as N) maximum
Total Phosphorus	Every discharge period	Composite	XX lbs/day

Big Fish owns, operates, and maintains the system as a private business under a permit issued by the Michigan Department of Environmental Quality (MDEQ) and in accordance with the requirements of the City of Charlevoix.

The volume of wastewater received and treated at the facility has been collected as part of normal facility operation and for reporting to the MDEQ. The system operates in a batch/semi continuous mode. Under normal operation, when the aerated equalization/receiving tanks are full, wastewater is transferred to the completely mixed lime reaction/holding tank, where lime is added to the wastewater to bring the tank contents to a pH of 12. The contents are mixed for 24 hours to meet the hold time for Class A biosolids, and are then processed through the screw press in an 8-12 hour period (typical process time). The filtrate from the screw press is discharged to the aerobic treatment tanks; while the dewatered solids are collected in a bin prior for subsequent transport of the Class A biosolids to a storage area. The filtrate displaces treated water in the aerobic system and settling tanks that had been in a recycle mode following the previous treatment period. The number of discharges per month can vary from 2 or 3 up to 10-15 during busy months. A summary of the average monthly flow rates for the period January 2007 through January 2008 is shown in Table 2-2.

Table 2-2. Summary Flow Rate and Water Quality Data For Test Site

Period January 2007 thru January 2008	Average Monthly Flow Data	BOD_5		TSS		NH_3		TP	
	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
	Gallons per month	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Average	74,587	3,300	105	10,900	123	111	23	310	10
Maximum	177,720	4,380	210	14,060	266	407	53	652	25
Minimum	12,985	1,980	27	6,930	15	26	1.0	32	1.3

Influent and effluent water quality data is available from the monthly reports prepared for the MDEQ. The monthly data is presented in Appendix A. Influent and effluent data will be collected throughout the verification test.

2.3 Summary of Installation, Startup and Schedule

The Big Fish system is operational at the test site, so all of the needed electrical, mechanical, and support systems are in place for the verification test. Automatic sampling and flow monitoring equipment are in place to monitor the effluent location. The automatic sampler collects composite samples for effluent over the duration of each discharge. Influent waste samples are collected as grab samples from the receiving equalization tank, which is aerated and mixed. This tank is pumped to the lime treatment/holding tank when a treatment cycle is started. Therefore the sample of the equalization tank represents a composite of the entire influent batch that is processed through the system.

All of the wastewater generated at the site will be treated through the system during the verification test. This is a full-scale verification test, using the standard Big Fish commercial system.

The GP calls for evaluation of the start up of the system, as well as one year of sampling as part of the verification testing. The verification test is expected to begin in July or August 2008, and will begin using the operating system without cleanout. Big Fish has agreed to demonstrate startup of the system during low demand months in either January or February. At this time, typically a low demand period, Big Fish will empty the aerobic treatment tanks, the settling tanks, and the discharge tank. These tanks will be cleaned and then placed back into service. The cleanout is expected to take less than one week. Once the system is clean, the system will be restarted using normal startup procedures. The startup is expected to take approximately 1-2 weeks during which time the organisms will establish themselves in the aerobic treatment tanks and the system will reach a steady state operation. Wastewater from the equalization tanks is processed through the lime treatment and screw press systems with the effluent entering the aerobic treatment tanks. Fresh microorganisms will be placed in the aerobic tanks and the system recycled for several days. The system will be monitored for routine parameters such as temperature, dissolved oxygen, and pH. Big Fish indicates that the startup usually takes about 1-2 weeks and the system will be ready to process additional wastewater.

The overall verification test and report preparation is expected to span a period of fifteen months. The actual verification test will run for twelve months. If the startup extends beyond the expected two weeks, then an additional month may be required to obtain 12 months of verification data. Final data at the end of the operation will be complete within one month and the draft final report is should be completed within two month of receipt of the final data. The fifteen months schedule is as follows:

Verification Test	Month 1 – 12
Cleaning and Startup	Month 7-8 (assumes a July start date)
Final Lab Data	Month 13
Draft Report	Month 15

3.0 VERIFICATION TESTING RESPONSIBILITIES

EPA sponsors the ETV Program, which is implemented through contracted Verification Organizations (VO). NSF International is the VO for the ETV Water Quality Protection Center. The VO is responsible for selection of the Testing Organization (TO) for each technology to be verified, and to provide oversight for the testing program. NSF reviews all test plans and oversees all of the participants in the testing program to ensure there is no bias or conflict of interest that could influence the test results. Scherger Associates will act as the TO.

3.1 NSF International - Verification Organization (VO)

The ETV Water Quality Protection Center (WQPC) is administered through a cooperative agreement between USEPA and NSF, the verification partner organization for the Center. NSF administers the WQPC, which includes development and implementation of the Verification Test Plan (VTP).

NSF's responsibilities as the VO include:

- Review and comment on the site specific VTP;
- Coordinate with peer-reviewers to review and comment on the VTP;
- Coordinate with the EPA Center Manager and the technology vendor to approve the VTP prior to the initiation of verification testing;
- Review the quality systems of all parties involved with the TO and subsequently, qualify the TO;
- Oversee the technology evaluation and associated laboratory testing;
- Carry out an on-site audit of test procedures;
- Oversee the development of a verification report and verification statement;
- Coordinate with USEPA to approve the verification report and verification statement;
- Provide QA/QC review and support for the TO; and
- Prepare and disseminate the Verification Report and Verification Statement.

Key contacts at NSF for the Verification Test Plan and Program are:

Mr. Thomas Stevens, ETV WQPC Manager
(734) 769-5347 email: stevenst@nsf.org

Mr. Craig Morr, NSF Manager of Corporate QA and Safety
(734) 769-5143 email: cmorr@nsf.org

NSF International
789 North Dixboro Road
Ann Arbor, Michigan 48105

3.2 U.S. Environmental Protection Agency (USEPA)

The USEPA Office of Research and Development through the Urban Watershed Management Branch, National Risk Management Research Laboratory (NRMRL), provides administrative, technical, and quality assurance guidance and oversight on all ETV Water Quality Protection

Center activities. The USEPA will review and approve each phase of the verification project. The USEPA's responsibilities will include:

- VTP technical and QA review and approval;
- Verification Report technical and QA review and approval; and
- Verification Statement review and approval.

The key USEPA contact for this program is:

Mr. Ray Frederick, Project Officer, ETV Water Quality Protection Center
(732) 321-6627 email: Frederick.ray@epa.gov

USEPA, NRMRL
Urban Watershed Management Research Laboratory
2890 Woodbridge Ave. (MS-104)
Edison, NJ 08837-3679

3.3 Testing Organization (TO)

The TO for the verification testing is Scherger Associates. Scherger Associates has experience in wastewater treatment operations and will oversee all test site operations. A local experienced wastewater operator, Mr. Randy Holecheck, will collect all samples and send the samples to the laboratory, and will also monitor the test site during the testing. Scherger Associates has experience in test plan development, system audits, and verification report writing. The laboratory performing the analytical work will be RTI Laboratories, Inc. The laboratory has many years of experience in water and wastewater testing.

Mr. Dale A. Scherger will be the Project Manager (PM) for the TO and will be responsible for the successful completion of the field portion of the verification project. Mr. Scherger will be responsible for obtaining all of the information from the field activities during the test, overseeing the sample collection activities, and directing Mr. Holecheck in monitoring the site activities. Scherger Associates prepared this VTP and will prepare the draft Verification Report.

RTI Laboratories Inc. will provide the laboratory services for the testing program. The laboratory will be responsible for laboratory quality assurance for the VTP through its QA group. NSF will audit the laboratory. NSF will provide administrative and technical support for review and production of the VTP and the Final Report.

The responsibilities of the TO include:

- Preparation of the site specific VTP;
- Conducting verification testing, according to the VTP;

- Oversight of the startup, operation, and maintenance of the Big Fish system in accordance with the Vendor's O&M manual(s);
- Maintaining safe conditions at the test site for the health and safety of all personnel involved with verification testing;
- Scheduling and coordinating the activities of all verification testing participants, including establishing a communication network and providing logistical and technical support;
- Resolving any quality concerns that may be encountered and report all findings to the VO;
- Managing, evaluating, interpreting and reporting on data generated by verification testing;
- Evaluation and reporting on the performance of the technology; and
- If necessary, document changes in plans for testing and analysis, and notify the VO of any and all such changes before changes are executed.

The key personnel and contacts for the TO are:

Scherger Associates - Project Manager
Mr. Dale A. Scherger
Environmental Consultant
(734) 213-8150 email: daleres@aol.com

Scherger Associates
3017 Rumsey Drive
Ann Arbor, MI 48105

Analytical Laboratory
Brian Hall
Account Manager email: bhall@rtilab.com
734-422-8000 ext 301

RTI Laboratories, Inc.
31628 Glendale Street
Livonia, MI 48150

3.4 Technology Vendor

The Wastewater Treatment Technology being evaluated is the Big Fish Septage Processing System designed, assembled, and installed by Big Fish Environmental, LLC. The vendor will be responsible for supplying the equipment needed for the VTP and will support the TO in ensuring that the equipment is properly operated during the verification test period. Specific responsibilities of the vendor will include:

- Initiate application for ETV testing;
- Provide input to the verification testing objectives to be incorporated into the VTP;
- Select the test site (Charlevoix site already in place);
- Provide complete ready to operate equipment, and the operations and maintenance (O&M) manual(s) typically provided with the technology (including instructions on installation, start-up, operation and maintenance) for verification testing;
- Provide additional equipment, piping, pumps, valves, flowmeters, tanks, etc. needed to setup the test;
- Provide any existing relevant performance data for the technology if it has been tested/operated at other locations;
- Provide logistical and technical support;
- Provide assistance to the TO on the operation and monitoring of the Technology during the verification testing;
- Review and approve the site-specific VTP;
- Arrange for shipments of septage and other wastewaters or residuals to the facility during the verification test.
- Review and comment on the Verification Report; and
- Provide funding for verification testing.

The key contact for Big Fish Environmental, LLC will be:

Mr. John Campbell
(231) 547-4429 Email: info@bigfishenvironmental.com

Big Fish Environmental, LLC
12640 Taylor Road
Charlevoix, MI 49720

3.5 ETV Test Site

As described in Section 2.2, the verification test will be performed at the Big Fish facility in Charlevoix Michigan. Big Fish owns, operates, and maintains the septage processing system at this location. As the owner Big Fish will:

- Provide space and utilities for the verification test; and
- Provide access to the existing equipment, piping, pumps, valves, flowmeters, tanks, etc. needed to setup the test.

3.6 Technology Panel

Representatives from the Technology Panel will provide technical and professional support if needed by the TO during all phases of the verification test period. The Panel will support the VO as needed during the preparation and review of the Verification Report.

4.0 DESCRIPTION OF THE BIG FISH ENVIRONMENTAL SEPTAGE PROCESSING SYSTEM

4.1 Technology Overview

The treatment of concentrated wastewaters, such as septage, presents a challenge due to the intermittent and highly variable volume of wastewater being delivered to the treatment system. The Big Fish Environmental Septage Processing System has combined processes to treat these high strength wastes, producing Class A biosolids and municipal strength wastewater, which can be discharged for final treatment at a municipal wastewater treatment system. The system combines solids treatment and handling with aerobic wastewater treatment to achieve the objectives of the process. An overview of the process steps is shown in Figure 4-1, Figure 4-2 provides a process flow diagram for the entire process and Figure 4-3 shows the biosolids processing diagram. Each of the processes is discussed in detail in the following sections.

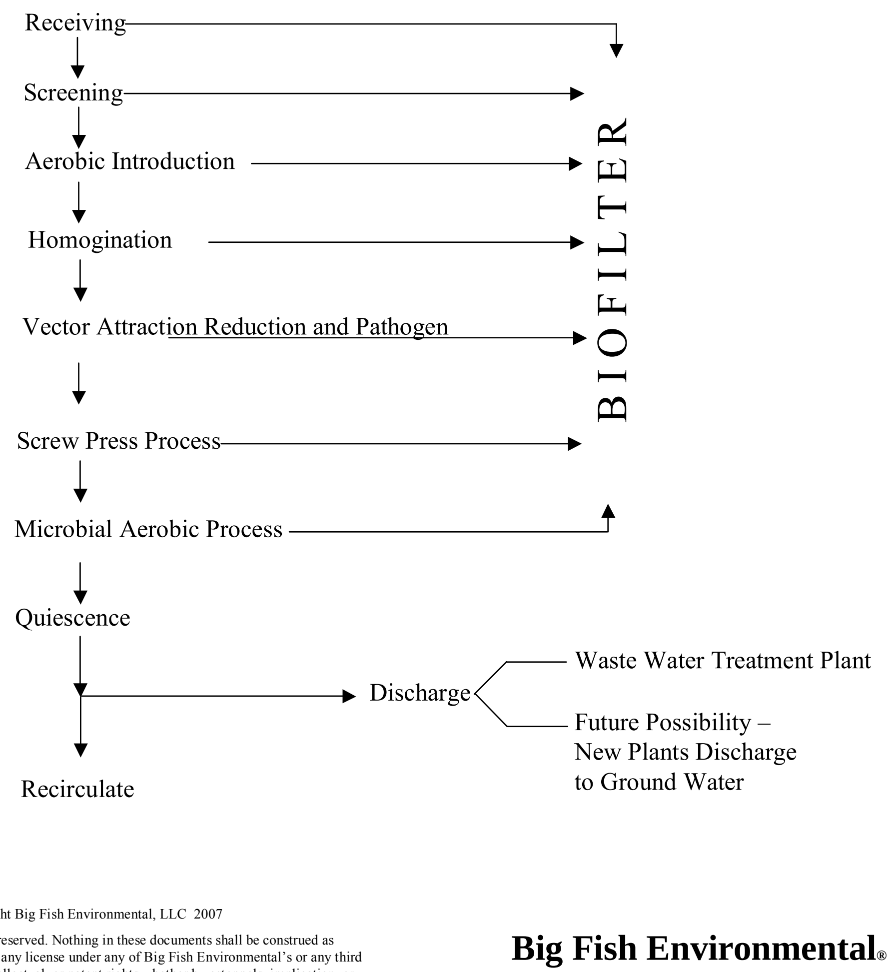


Figure 4-1. Overview of processing steps – Big Fish Septage Processing System.

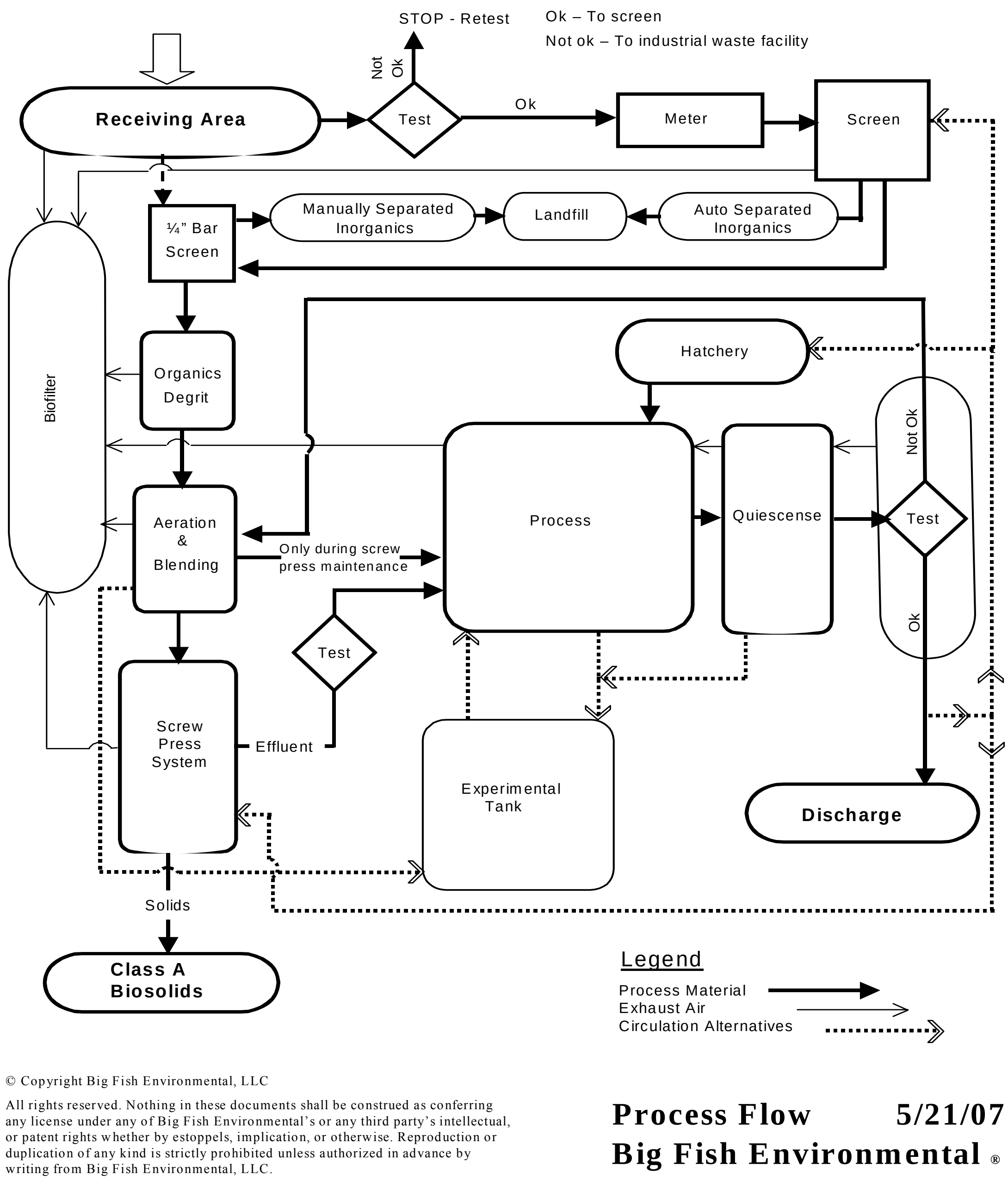
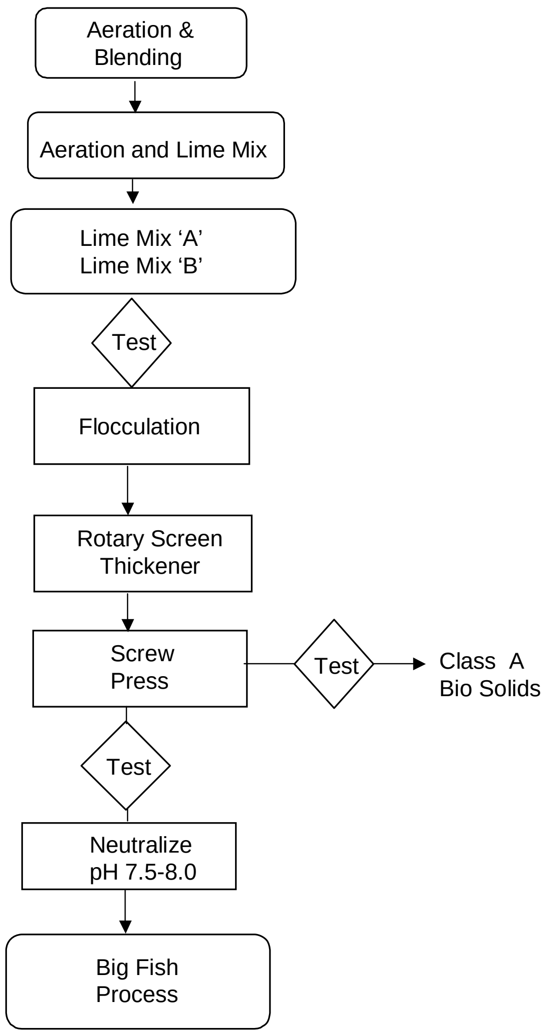


Figure 4-2. Big Fish process flow diagram.



Screw Press Flow 5/21/07

Big Fish Environmental®

Figure 4-3. Big Fish biosolids process description.

4.1.1 Truck Unloading, Screens, and Equalization

The Big Fish truck unloading is inside the main building adjacent to the aerobic treatment tanks and other processing equipment. Trucks enter the unloading area and close the large roll-up door to control odors. Trucks are unloaded by pressurizing the truck tank. A JWC Muffin Monster ¼" screen is in line to remove inorganics. A flow meter records the amount of wastewater unloaded from the truck, and an in-line pH meter monitors the wastewater to confirm the pH is greater than 4. The screened wastewater then passes through a de-grit chamber and flows into the first 11,000 gallon receiving/equalization tank. This tank is aerated, which provides mixing of the various wastewater received and provides oxygen to maintain dissolved oxygen levels so that the stored wastewater remains aerobic. The first receiving/equalization tank is connected to a second aerated 15,000-gallon equalization tank. Large volume equalization is used to mix the variety of wastewater being received and to provide sufficient volume for the batch treatment in the vector attraction and pathogen reduction treatment step (lime treatment and subsequent screw press operation for solids separation).

Once 15,000 gallons or more of wastewater is accumulated in the equalization system, the wastewater is ready for transfer to the lime treatment system. A pump in the second equalization tank is activated to transfer the wastewater to one of the lime treatment tanks.

4.1.2 Lime Treatment and Solids Separation – Biosolids Production

Figure 4-3 shows a process flow description of the biosolids treatment part of the Big Fish system. When a batch of wastewater is ready for treatment, the lime feed system is activated and the equalization tank pump is started. Lime is added directly to the flowing wastewater as it is transferred to a lime treatment tank. The lime feed system uses a standard lime feeder to introduce hydrated lime directly into the flowing wastewater. The lime dosage can be adjusted by changing the lime feed rate and dosing time.

There are two 20,000-gallon lime treatment tanks. Each tank mixes the material to ensure that all of the wastewater and solids are in contact with the elevated pH. Lime is added to the influent waste mixture (septage, FOG, secondary biosolids, etc) to achieve pH 12 for a minimum of 2 hours, and then is held at minimum pH of 11.5 for a minimum of 22 hours. pH is monitored and recorded in the operation log to document that a pH of 12 or greater is maintained for at least two hours. Once these first pH criteria are met, the wastewater continues to be treated in the lime tank for a minimum of 22 additional hours. pH is monitored and recorded to document that a pH >11.5 is maintained for this additional 22 hour period.

After lime treatment is complete, the wastewater is pumped from the lime treatment tank through a flocculation tank and a rotary screen thickener to build solids particle size and thicken the solids prior to entering the screw press. The pH of the wastewater from the lime treatment tank is adjusted to approximately 7.5 – 8.0 with citric acid and polymer is added prior the wastewater entering the flocculation tank. Typically, the solids content after flocculation and thickening is 17-18%. Water extracted in the rotary screen thickener is discharged to a blending tank.

The thickened sludge is processed in a FKC screw press that also heats the solids to a minimum of 72^{o} C for a minimum of 20 minutes. The screw press is a hollow core design that has proven very effective in increasing the solids content to 40-50%. The combination of the lime treatment and the elevated temperature in the screw press meets the Class A biosolids requirements established by the USEPA. A boiler supplies steam that is circulated through the screw press to provide the heat to raise the solids temperature. The temperature of the solids exiting the screw press is measured and recorded to document the operating conditions. Solids are collected in a hopper and the transferred to an outside covered storage area. The filtrate from the screw press is discharged to the first aerobic treatment tank for treatment.

4.1.3 Aerobic Treatment, Settling and Discharge

The aerobic treatment system consists of a series of aerated tanks followed by a quiescent settling tank, a re-aeration tank, and two discharge tanks. The aerobic treatment tanks have a combined volume of 27,000 gallons. There is one 15,000-gallon tank and six (6) 2,000-gallon tanks. Each tank is aerated and has one or more White Knight microbial generators installed in the tank. These White Knight systems are suspended in the aerated and well-mixed treatment tanks to provide a source of microorganisms in addition to the naturally occurring organism in the suspended growth aerobic system. The large capacity of the aeration tanks provides time for biological treatment to reduce the very high organic and solids loadings that are normally present in septage type wastes.

Treated water from the aerobic system enters a 2,000-gallon settling tank. This tank is a standard tank, with no special settling enhancements such as weirs or sludge collecting rakes. The quiescent settling tank provides sufficient time for the solids to separate. The clarified wastewater then enters the 2,000-gallon re-aeration tank where the dissolved oxygen is increased prior to discharge. The aerated water then flows into two 2,000-gallon discharge tanks. Solids that accumulate in the settling tank are periodically removed and placed back into the receiving tank for processing through the lime treatment and screw press processes.

When water is discharged from the screw press and thickener, the balance of water within the system demands that water be discharged from the system. The discharge pump is activated to pump the treated wastewater to the municipal sewer system. The effluent passes through a flow meter to record the volume of the discharge and a sampler on the discharge line collects a composite sample over the period of discharge.

As shown in the summary flow data (Table 2-2), the volume of wastewater delivered/treated can vary from 13,000 to 178,000 gallons per month. This means that the system operation can vary from as few as two batches in a month to as many as 10-15 batches (2- 15 operating days). Big Fish has stabilized the operation of the aerobic system by using a combination of internal recycle, organism augmentation, and food addition during periods of low demand and between actual production/discharge days. When water is not being processed through the screw press, the discharge pump is not used and the water is recycled back to the first aerobic treatment tank. Thus, water is always moving through the aerobic, settling, re-aeration, and discharge tanks in the treatment system. Big Fish monitors the system on a periodic basis to determine if additional organisms or food need to be added to the system. The White Knight microbial generators are the primary approach to maintaining healthy microorganism pollution during extended recycle periods. In addition, an onsite hatchery (aerated tank with organism from the main system) is maintained and fed with molasses or other food sources to grow and maintain an adapted culture of mixed organism. These microorganisms can be added to the treatment system if prolonged recycling periods are encountered or if upset conditions were to occur. This also is the reason that a restart from a clean empty tank condition can usually be accomplished in a few days, rather the weeks that many aerobic systems require. Further, if the organic content of the main aerobic treatment system gets very low due to lack of demand in the market, food can be added to the system to maintain a healthy population of microorganisms. These additions of organism and food generally are only needed in the winter months when incoming wastewater volumes are very low.

4.2 Big Fish Claims and Criteria

Big Fish claims that their Septage Processing System treat septage, Porta John waste, municipal secondary sludge, and FOG wastes to produce Class A biosolids and a wastewater that meets criteria for discharge to municipal wastewater treatment systems. Effluent criteria stated by Big Fish for the system include:

Table 4-1. Big Fish Aerobic Septage Treatment Claims

Parameter	Effluent Characteristics after Treatment
BOD_5	< 300 mg/L
TSS	< 350 mg/L
NH_3-N	< 65 mg/L (as N)
Total Phosphorus	5 – 15 mg/L (as P)

5.0 Experimental Design

5.1 Introduction

The experimental design described in this Test Plan will obtain quantitative and qualitative data on the performance capabilities of the Big Fish Septage Processing System, and will serve as the basis for determining the effectiveness of the treatment unit to reduce constituent loads in the influent wastewater and to produce Class A biosolids. The data, collected in accordance with the experimental design and sampling analysis plan, will be presented in the Verification Report and serve as the basis for the Verification Statement for this technology.

The experimental design follows the methods and procedures defined in the GP *Protocol for the Verification of Wastewater Treatment Technologies*, April 2001. The design incorporates the elements described in the protocol and includes a startup period and a 12-month testing program. The following sections describe the influent wastewater characterization (flow data), the startup procedures, and the actual verification test. Sampling and analysis procedures are presented in Section 6.0 Sampling and Analysis Procedures.

5.2 Influent Wastewater Characterization

As described in Section 2.2, the test site is located in Charlevoix Michigan. The facility receives various wastewaters by trucks, which are unloaded inside the facility to the receiving equalization tanks. Wastewater and sludges received include septage from residential and commercial septic tanks, Porta John cleanout wastes, municipal secondary sludge from the City of Charlevoix, and commercial wastewaters high in fats, oil, and grease. Flow data for the system has been collected as part of the normal operation of the system and for reporting to the State of Michigan. A summary of the average monthly flow rates for the period January 2007 through January 2008 is shown in Table 2-2 of Section 2.2. Individual monthly flow data is presented in Appendix A.

The flow data shows that there is a large variation in the monthly flow (e.g. from 13,000 to 178,000 gallons per month). The highest demand for treatment is in the summer (July – September) and the lowest demand is in the winter (January – March). The system will be tested for a 12-month period, so any changes in performance due to seasonal effects will be monitored.

Instantaneous flow data is not recorded. However, the treatment system has a large equalization capacity and operates in a batch/semi-continuous flow mode. Therefore, instantaneous flow rate is not important or applicable for this treatment system. The aerobic treatment system receives flow from the screw press on operating days at a fairly steady rate and the discharge is also steady as it is pumped to the city sewer city based on incoming flow to the aerobic system The Big Fish is a complete treatment system. There will be no pre treatment or post treatment requirements for the verification test. The existing unit has been achieving the permit limits since shortly after the initial startup.

Influent data will be collected to characterize the mixed equalized wastewater received at the facility and treated during the treatment cycles. In addition records are maintained of each waste received at the facility, including a description of the type of waste, the source, and the volume received. Each load is monitored for pH. These records will be used to describe the type of waste material in each batch treated during the verification test sampling and analysis periods.

5.3 Startup

As stated previously, the Big Fish system has been installed and operating at the test site for two years. The unit has been treating the various wastewaters and meeting the State of Michigan discharge permit limits. The existing system is in use on a regular basis to treatment customer wastes. Big Fish has agreed to demonstrate startup of the system during low demand months in either January or February. The verification test is expected to begin in July – August and will start by using the operating system without cleanout. In the winter, typically a low demand period, Big Fish will empty the aerobic treatment tanks, the settling tanks, and the discharge tank. These tanks will be cleaned and placed back into service. Once the system is clean, the system will be restarted using normal startup procedures.

The tank cleaning procedure will include pumping all of the wastewater out of the aerobic treatment tanks, the settling tank, re-aeration tank, and final discharge tank. This wastewater will be sent to the municipal treatment system. It is expected that this work will take 1-2 days to complete. The tanks will then be rinsed and cleaned as needed to remove any significant solids buildup in the tanks. Once the tanks are clean, they will be filled with a combination of processed wastewater from the screw process and/or equalization tank and clean water. Microorganism will be seeded to the aerated tanks and White Knight microbial generators will be hung in place in accordance with standard operating practice.

There is no requirement in the protocol for sampling and analysis during the startup period, unless the startup period exceeds thirty days. However, there are daily field tests (pH, dissolved oxygen and temperature) that will be made by the operating staff of Big Fish with review by the TO. Settleable solids will monitored three times per week during the startup. All field test data collected during startup will be recorded in the logbook. Visual observations and any changes made to the system will also be recorded in the logbook to track the startup process. In addition to these tests, some sampling and analysis may be performed at the request of Big Fish. If this work is requested, it will be performed using grab samples or the installed composite sampling equipment to be used during the verification test. If for some reason the startup extends beyond four (4) weeks then a monthly sampling program will be started to monitor the critical parameters of biochemical oxygen demand, total suspended solids, TKN, and total coliform. Table 5-2 shows the normal startup parameter list and the monitoring that will occur if startup extends beyond four weeks.

Scherger Associates, in consultation with Big Fish management and onsite operators will determine when the startup is complete and the verification test can resume. This decision will be based on reviewing the operating conditions and the effluent quality to determine that the system is stable and operating in accordance with the Big Fish specifications. When the system is ready for the re-start of the verification test, Scherger Associates will contact NSF and inform them that the Verification Test is ready to restart, and with NSF concurrence, the Verification Test will resume.

Table 5-1. Startup Monitoring

Sample Schedule Parameter	Frequency	Sample Type	Record Keeping
Flow Rate, gpd	Daily	Meter	Recorded by time and date
PH	Daily	Grab	Recorded by time and date
Temperature	Daily	Grab	Recorded by time and date
Settleable Solids	3 / week	Grab	Recorded daily during startup
Dissolved Oxygen	Daily	Grab	Recorded daily during startup
BOD_5 in, mg/L	1 / month	Composite	Chain of custody and lab reports
BOD_5 out, mg/L	1 / month	Composite	Chain of custody and lab reports
TSS in, mg/L	1 / month	Composite	Chain of custody and lab reports
TSS out, mg/L	1 / month	Composite	Chain of custody and lab reports
Ammonia Nitrogen	1 / month	Composite	Chain of custody and lab reports
Total Phosphorus	1 / month	Composite	Chain of custody and lab reports

5.4 Verification Testing

5.4.1 Introduction

The Big Fish Septage Processing System is designed to treat septage and similar wastewater to meet typical discharge standards to municipal treatment systems as established by state and local government. This Verification Test will establish the effluent quality achieved by Big Fish in typical wastewater applications. The system will be tested to determine the effectiveness of the system to reduce TSS, BOD_5, NH_3, and TP to meet municipal pretreatment standards. This will be achieved by collecting and analyzing samples of the treated effluent discharged from the aerobic treatment system. Operating parameters will also be evaluated to show that Class A biosolids criteria are met for all dewatered biosolids produced.

5.4.2 Objectives

The objectives for the Experimental Design for this Verification Test are:

- Determine the treatment performance of the Big Fish System to remove the key target constituents, including TSS, BOD, NH_3, and TP;
- Determine the Operation and Maintenance requirements for the system;
- Determine the biosolids residuals meet the criteria for Class A biosolids; and
- Determine the labor time, chemical use and energy consumption of the system.

5.4.3 Verification Test Period

In accordance with the GP, one verification test period will be performed for the Big Fish system. The test period will continue for twelve (12) consecutive months. No more than 36 days of upset conditions or downtime will be allowed during the verification test period. The test will include a full range of flow conditions and influent characteristics. The test site flow data presented in Section 5.2 and general information available about the test site indicate that with reasonable spacing of sampling through the year, all types of conditions should be monitored over the one-year period.

If, for any reason, the downtime or upset conditions exceed 36 days (about 10% of the operating time), the verification test period will be extended based on consultation and agreement with the Verification Organization. If an extension is needed, the additional time will be designed to insure that all seasons and flow conditions are included in the verification test. Full documentation of the reasons for any down time or upsets will be made by the TO and provided in the final verification report.

5.4.4 Flow Monitoring

The volume of each received truckload of waste is recorded and will be available to describe the type and volume of waste in the receiving tanks when monitoring is scheduled. When the system is ready for treatment of a batch of wastewater, the volume of water placed in the lime treatment tank will be recorded, based on the time the pump is operated and the wastewater level in the lime treatment tank after the transfer is complete.

The water discharged to the municipal collection system from the Big Fish system is monitored by a flow meter on the discharge line to the municipal system. The discharge volume is recorded as required by the permit for the Big Fish facility. This discharge volume will be recorded and will provide the flow record for the verification test.

All flow data will be provided in the final report

5.4.5 Sampling and Analysis

Basis for Sample Schedule Deviation from the General Protocol

The sampling requirements in the GP are designed for a continuous flow system operating 365 days per year. The GP specifies twelve (12) sampling periods (four days of sampling with daily or four-day composites) and four (4) special sampling periods targeted to special flow or loading conditions. The Big Fish system, however, operates only a few days per month, with fewer operational days in the winter and more in the summer. Even in the summer period the unit does not typically operate for four days in a row. During high flow/demand months, typical operation will be for two or three days followed by several days with no discharge (unit in recycle mode). In the winter only two or three operating days may occur an entire month. Therefore, a special revised sampling schedule has been devised for this verification test. The sampling program will cover a 12-month test period and will include a minimum of one sampling period per month.

The GP sampling events each include four days of TSS, BOD_5, and COD sampling and analysis, and four day periods where the individual nutrient samples are composited together into one sample. Overall, the GP specifies 64 samples for BOD_5, TSS, COD, and 16 sample results for nutrients (nitrogen and phosphorus). On a percentage basis, 17.5% of the operating days will have BOD_5, TSS, COD (64/365) sampling and 4.4% of operating days will have nutrient samples (16/365). The nutrients are four-day composites, so the nutrient data actually represent the same 17.5% of operating days as the BOD_5, TSS, and COD sample schedule.

Using a similar approach for the Big Fish system to obtain samples on a cross section of operating days, and based on Big Fish having an average of 108 - 135 operating days per year (averaging 9 - 11/ month), this test plan sampling schedule is designed to have 24 sampling days (two per month), which is 17.5% of operating days based on 135 days/yr, and 22% of operating days based on 108 days/year. During six high flow months (typically June to November), the two days of sampling will be consecutive treatment days, with a minimum batch size of 5-10,000 gallons. For those sampling periods with consecutive days, nutrients will be composite samples for the two-day period. For the other six months, two sampling days will be performed each month, but they will not be consecutive days (i.e., the sampling days could be in different weeks). These composite samples (for the duration of the discharge – typically 8 - 12 hours) will include all the analyses, BOD_5, TSS, COD, FOG, and nutrients (nitrogen and phosphorus).

This revised sampling approach yields a minimum of 24 daily composite samples for BOD_5, TSS, COD and FOG, and a minimum of 18 nutrient samples (one two-day composite per month in the six high flow months, and two samples per month in the low flow months). Overall, this sampling and analysis schedule will yield the equivalent number of representative samples for

BOD_5, TSS, COD, and FOG on a percentage of operating/discharge day basis compared to the to the general protocol, and more nutrient data than required in the protocol.

The sampling program does not include any special extra periods, as there is no need to target special periods for this system. The system uses large equalization tanks and thus any given day or weekend period is averaged out when the incoming truckloads are mixed together in the receiving tanks. The special sampling periods were included in the 64 and 16 sample base numbers used for the percentages of operating/discharge days. All data sets for this system will start with the routine startup of the unit from the recycle mode, so the issue of a resuming discharge after a holding period will be addressed in every data set. The two consecutive day requirements for six months provides six sets of data with resumption of discharge followed by an additional day of operation. The other six months will provide data for one-day resumption of discharge after an extended recycle period, which is the typical operating mode for this system. Normally, sampling the first day of operation after a recycle period for an aerobic system would be considered a worst case, but for the Big Fish system with the recycling and possibly adding food, the first discharge day might be better than the next operating day. While the past operating data of the Big Fish system does not indicate this pattern, the potential concern is addressed by sampling for two consecutive days for at least six months of the test period

Sample Locations, Type, and Analysis

Sampling locations will include the untreated wastewater influent (mixed wastewater in the equalization tank) and the final treated effluent discharged to the municipal treatment system. The untreated wastewater will be collected as grab samples from the equalization tank prior to the transfer of a batch of wastewater to the lime treatment tank. This mixed wastewater will represent the entire mixture of wastewater being treated for that batch, and will be matched with the discharged wastewater that will occur when the lime treated wastewater is processed through the screw press and the resultant liquid processed through the aerobic treatment system. The treated effluent will be collected using the existing composite sampler located on the discharge line just prior to the effluent entering the municipal wastewater collection system. This location is the official sampling location for the facility operating permit. Composite samples will be collected for the duration of the discharge, which is typically 8 - 12 hours, but can extend longer depending on batch size and discharge rate. The composite sampler collects equal aliquots on a time basis. This is equivalent to a flow weighted composite sample for this system as the discharge is pumped to the municipal system at a constant flow rate.

In addition to the influent and effluent sampling locations, the individual truckloads of wastewater are monitored for volume and pH. These data will be collected as part of the normal plant operation and will be available along with a description of the type wastewater being received. Samples are also collected for pH from the lime treatment tank to document the pH and time of treatment of the tank contents to confirm the requirements for Class A biosolids are met. After lime treatment, the wastewater pH is adjusted to 7.5 - 8.0 using citric acid, and the adjusted pH is recorded. Temperature is monitored at the screw press to document that the biosolids have been heated to the required greater than 72 ^{o}C for a minimum of 20 minutes.

Both grab and composite samples will be collected during all sampling events. The type of sample will depend on the requirements and the holding time for each analysis. Grab samples at both the influent and effluent sample locations will be collected each day for pH, temperature, dissolved oxygen, and FOG. Grab samples of the influent mixed wastewater will also be collected for TSS, BOD_5, COD, Alkalinity, TKN, NH_3-N, NO_2+NO_3, and TP. Composite samples of the discharge (minimum of two liter volume) will be collected each sampling day for TSS, BOD_5, COD, Alkalinity, TKN, NH_3-N, NO_2+NO_3, TP, chloride and sodium. For the six monthly sample periods where two consecutive days of discharge and sampling occur, an aliquot of the daily composite sample will be taken each day and a two-day composite sample made for TKN, NH_3-N, NO_2+NO_3, TP, chloride and sodium. Table 5-2 shows a summary of the sample collection and analysis program.

Table 5-2. Summary of Sampling Collection and Analysis

Parameter	Sample Type	Frequency	Number of Sampling Days	Estimated Number of Samples (2)
pH	Grab	Daily- 2 days per month	24	48
Temperature	Grab	Daily- 2 days per month	24	48
TSS	Daily composite for duration of discharge	Daily- 2 days per month	24	48
BOD_5	Daily composite for duration of discharge	Daily- 2 days per month	24	48
COD	Daily composite for duration of discharge	Daily- 2 days per month	24	48
FOG	Grab	Daily- 2 days per month	24	48
Alkalinity	Daily composite for duration of discharge	Daily- 2 days per month	24	48
Total Kjeldahl Nitrogen (TKN)	Composite(1)	One per 2 day event; 1 for all other events	18	36
Ammonia-Nitrogen	Composite(1)	One per 2 day event; 1 for all other events	18	36
Nitrate/nitrite	Composite(1)	One per 2 day event; 1 for all other events	18	36
Total Phosphorus	Composite(1)	One per 2 day event; 1 for all other events	18	36
Chloride	Composite(1)	One per 2 day event; 1 for all other events	18	36
Sodium	Composite(1)	One per 2 day event; 1 for all other events	18	36

(1) For high flow months, a two-day composite is made by taking the daily composite, preserving it, and then combining at the end of the 2-day event the two daily samples into one event composite.
(2) Number of samples is based on two (2) sampling locations, untreated influent, and the final treated effluent discharged to the municipal sewer system after biosolids processing and aerobic treatment.

Dewatered biosolids are produced from the screw press. Treatment conditions are designed to produce Class A biosolids, based on Federal requirements. While routine analyses are not required of the biosolids, the verification test will include analysis for heavy metals and moisture/solids content. Grab samples of the biosolids will be collected twice during the verification, once during the summer high demand period and once in the winter low demand period. Analysis will include percent solids and metals (As, Cd, Cr, Cu, Hg, Pb, Ni, Se, Zn). The volume or weight of biosolids produced by the screw press will be recorded for each sampling event.

5.4.6 Operations and Maintenance

The Big Fish will be operated during the verification test by Big Fish personnel in accordance with the Operating Manual. The TO will monitor the system during the test, including review of operating conditions, maintenance performed and keep records of all site visits and site conditions. The TO will also collect all samples for analysis and send them to the laboratory.

The Operating Manual provides detailed information on each unit operation. These detailed instructions include descriptions of the operating data (pH, times, temperature, flows, etc.) that are recorded in the facility operating log. A field logbook will be maintained by the TO that will provide written notes for each visit to the site. This logbook will also become part of the permanent record on the operation of the unit.

Maintenance performed by Big Fish personnel will be logged in an on-site maintenance log and will be reviewed and initialed by the TO on a monthly basis. If any extraordinary maintenance is required, Big Fish will inform the TO and document the maintenance performed.

Periodically the polymer and citric acid solutions need to be replenished. The Big Fish operators will record the level in each chemical solution tank at the end of each treatment period and will also record when a new tank of solution is prepared or placed in use. These records will be reviewed by the TO on a monthly basis. Chemical use will be reported in the final report based on these records.

Power consumption will be monitored on a monthly basis. A standard electrical power meter is already installed at the site. Meter readings will be taken at least once per month throughout the test. These reading will be recorded in the logbook. The natural gas used to heat the boiler that feeds the screw press will also be monitored from the gas meter at the site, and the readings will be recorded in the logbook.

Any other observations of the operating condition of the unit, or the test system as a whole, will be recorded in the logbook for future reference. Observations of changes in effluent quality based visual observations, such as color change, oil sheen, obvious sediment load, etc., will be recorded for use during the Verification Report preparation.

Odor, if any, will be observed on each visit to the site (minimum of three to four days per month while processing). Also, any citizen complaints will be part of the operating record and will be included in the verification test record.

The plant operating and maintenance logbook(s) and the TO site logbook will be important records for use during the Verification Report preparation. These logs will provide the information to validate the flow and operating conditions during the test periods. Further, they will serve as the basis for making qualitative performance determinations regarding the unit's operability and the level/degree of maintenance required. These plant operating and maintenance logs will be maintained by Big Fish personnel and reviewed by the TO throughout the verification test.

6.0 SAMPLING AND ANALYSIS PLAN - PROCEDURES

6.1 Sampling Locations and Procedures

There are two primary sampling locations in system. The influent sampling location is the equalization tank containing the mixed wastewaters received from the truck unloading station. A minimum if four liters of influent sample will be collected using a sludge judge so that a well-mixed grab sample is collected from each batch of wastewater to be treated. The effluent sampling location for the treated water has an automatic sampler that collects aliquots on a time basis for the duration of discharge. This is the equivalent to a flow weighted composite sample as the discharge is a constant flow pumped discharge. The automatic sampler will take a preset volume of sample (e.g., 250 mL of sample every 15 minutes, which equal 250 gallons of discharged effluent), by pumping at a set rate for a set period. A minimum of three liters of water sample will be collected for each discharge period. The quantity of sample collected for each sampling period will be recorded. The total sample volume collected will checked against the amount anticipated to be collected based on the total flow data for the period as a check that the sampler is working properly and collecting the appropriate amount of sample.

All of the sample containers used for the composite samples will be cooled during the sampling period by placing ice around the sample container.

In addition to the grab and composite samples, there will also be composite samples collected representing a two-day sampling periods. These samples will be collected by taking an aliquot of each of the daily grab or composite sample, and combining the two sub-samples to create a two-day composite. The procedure for TKN, ammonia, nitrite plus nitrate, and TP will be to take a one-liter aliquot of the daily grab or composite sample and preserve the sample with sulfuric acid. For sodium, a 100 mL bottle preserved with nitric acid will be prepared each day. A 100 mL unpreserved bottle will be prepared each day for chloride. The sample bottles will then be refrigerated and held at or below 4 °C until the two-day sampling period is complete. The two daily samples (two for the influent and two for the effluent) will then be combined on a flow proportional basis to make an influent and an effluent two-day composite.

The automatic sampling equipment will be cleaned before each use and after each sampling event. Automatic samplers will be inspected to determine that tubing is in excellent condition and timers will be checked as part the preparation for a sampling event. Clean sample containers will be used each sampling day.

Grab samples will be collected at the influent and effluent locations for pH, temperature, dissolved oxygen, and FOG.

In addition to the influent and effluent samples, samples will also be collected of the biosolids twice during the 12 month verification test. These samples will be manual grab samples collected from the biosolids holding hopper that collects the dewatered solids from the screw press. The biosolids sample will be obtained by collecting individual 500 mL aliquots of biosolids at two locations in the hopper. These aliquots will be combined in a two-L container. The container will be thoroughly mixed, cooled, and sent to the laboratory for analysis. The volume of biosolids will be estimated and recorded by the site operators and confirmed by the TO during sampling events.

6.2 Sampling Frequency and Schedule

Sampling type, frequency and the analytical list discussed in the experimental design section are summarized in Table 5-2. There will be twenty-four (24) sampling days over the 12-month test period. During high flow months (six months during the test), the two days of sampling for the month will occur on consecutive processing days with batch sizes of a minimum of 5,000 gallons treated and discharged per day. During the remaining six months (lower flow demand periods), the two sampling days will occur when the system is treating wastewater and discharge occurs. The estimated testing schedule is shown below, but may require adjustment based on actual incoming waste loads to the faculty.

Estimated Test Schedule:

July 2008 **(2 sampling days on consecutive days)**

August 2008 **(2 sampling days on consecutive days)**

September 2008 **(2 sampling days on consecutive days)**

October 2008 **(2 sampling days on consecutive days)**

November 2008 **(2 sampling days on consecutive days)**

December 2008 **(2 sampling days, when discharging; non consecutive)**

January 2009 **(empty and clean the aerobic system, restart the system)**

January 2009 **(2 sampling days, when discharging; non consecutive)**

February 2009 **(2 sampling days, when discharging; non consecutive)**

March 2009 **(2 sampling days, when discharging; non consecutive)**

April 2009 **(2 sampling days, when discharging; non consecutive)**

May 2009 **(2 sampling days, when discharging; non consecutive)**

June 2009 **(2 sampling days on consecutive days)**

6.3 Sample Preservation and Storage

The grab and composite samples for BOD_5, TSS, COD, FOG, and alkalinity, and the aliquot for TKN, ammonia, nitrite plus nitrate, TP, chloride and sodium will be well mixed and poured into individual sample containers containing appropriate preservatives. Table 6-1 shows the bottle types, sample size, and preservation required for each parameter.

The sample bottles required for the various analyses will be provided by RTI Laboratories, Inc., the outside subcontracted laboratory for this work. The bottles will come with preservative in the bottles and will be labeled by analysis type.

Sample labels will include:

Project Name: Big Fish ETV

Sample location: influent; final effluent; biosolids

Date:

List of analyses:

Notation of preservative type

Lab number: assigned by lab

The samples will be logged in the field notebook (same information as label above plus samplers name), placed in coolers with ice to maintain temperature, and sent to the laboratory the same day.

Table 6-1. Preservation, Bottle Type, and Sample Size By Analysis

Sample Matrix	Analyses	Bottle type, recommended size	Preservation, Holding Time
WASTEWATER	pH	Plastic 250 mL	None, analyze immediately
	Temperature	Plastic 250 mL	None, analyze immediately
	Dissolved oxygen	Glass, special BOD bottle	None, analyze immediately
	Fats, Oil, and Grease (FOG)	Glass, 750 mL	Cool to 4 degrees C, pH < 2 H2SO4, 28 days
	TSS	Plastic, 200 mL	Cool to 4 degrees C, 7 days
	BOD_5	Plastic 500 mL	Cool to 4 degrees C, 24 hours
	Chloride	Plastic 100 mL	Cool to 4 degrees C, 28 days
	COD	Plastic 100 mL	Cool to 4 degrees C, pH < 2 H2SO4, 28 days
	Alkalinity	Plastic 250 mL	Cool to 4 degrees C, 7 days
	TKN	Plastic 500 mL	Cool to 4 degrees C, pH < 2 H2SO4, 28 days

	NH_3-N	Plastic 250 mL	Cool to 4 degrees C, pH < 2 H2SO4, 28 days
	Nitrite plus nitrate	Plastic 100 mL	Cool to 4 degrees C, pH < 2 H2SO4, 28 days
	Total Phosphorus	Plastic 100 mL	Cool to 4 degrees C, pH < 2 H2SO4, 28 days
	Sodium	Plastic 100 mL	Cool to 4 degrees C, pH < 2 HNO3, 180 days
BIOSOLIDS	Metals	Plastic or Glass 250 mL or larger	Cool to 4 degrees C, 6 months
	Total Solids/percent moisture	Plastic or glass, 500 ml	Cool to 4 degrees C, 7 days

6.4 Chain of Custody

Chain of Custody will be maintained for all samples collected during the verification test. The TO operators responsible for sample collection will fill out a chain of custody form for each set of samples. The form will be signed and dated for each set of samples delivered to the laboratory. The receiving technician will acknowledge receipt of the samples by signing the chain of custody form and providing a copy of the form to the sample delivery person. All copies of the chain of custody records will be maintained by the TO and by the chemical laboratory for all samples. Copies of the completed chain of custody forms will be included with all laboratory reports transmitting final analytical results.

6.5 Analytical Methods

All analytical methods used during the verification test will be USEPA approved methods or methods from *Standard Methods for the Examination of Waster and Wastewater*, 20th Edition. Table 6-2 shows the analytical methods that will be for the verification test and the typical detection limits that are achieved by these methods.

Table 6-2. Analytical Methods

Sample Matrix	Analyses	Reference Methods	Reporting Detection Limit for matrix (1)
LIQUID	PH	SM 4500-H B	N/A (range 1-13 S.U.)
	Temperature	SM 2550 B	N/A
	Dissolved oxygen	SM 4500-O G	0.5 mg/L
	FOG	EPA 1664A	3.0 mg/L
	TSS	SM 2540 D	1 mg/L
	BOD_5	SM 5210 B	2.0 mg/L
	Chloride	EPA 300.0	1.0 mg/L
	COD	EPA 410.4	20 mg/L
	Alkalinity	SM 2320 B	10 mg/L

	TKN	EPA 351.2	0.5 mg/L
	NH_3-N	SM 4500-NH3 D	0.05 mg/L
	Nitrite and Nitrate	SM 4500-NO3 H	0.05 mg/L
	TP	SM 4500-P F	0.01 mg/L
	Sodium	EPA 200.8	0.5 mg/L
SOLID	Metal	EPA 200.8/245.1	Varies by metal and solids content
	Total Solids	SM 2540 B	10mg/kg

(1) PQL or normal reporting limit.

(2) Samples will be preserved with acid. Results will be a combined concentration for nitrite plus nitrate

Three parameters will be measured in the field, pH, dissolved oxygen, and temperature. The contract laboratory will conduct all other analyses. Both the field and laboratory will report all results with all associated QC data. The results will include all volume and weight measurements for the samples, field blank results, method blanks, spike and spike duplicate results, results of standard check samples and special QC samples, and appropriate calibration results. All work will be performed within the established QA/QC protocol as described in the Quality Assurance Project Plan (Section 7), and as outlined in the analytical SOPs. The TO will be immediately notified by field and analytical laboratories of any deviations from the standard test procedures or difficulties encountered during the analyses. These deviations and difficulties will be documented and reported with the data.

6.6 Flow Meter Calibration

The flow meter on the discharge line is a standard wastewater flow meter used to record flow for reporting purposes for both State and City operating permits. This meter will be checked for accuracy by using the "fill and draw" technique. The discharge holding tank will be filled with a known volume of water (by measuring the height in the tank) and the water will be pumped through the flow meter to the sewer. At the end of the pumping cycle the level in the discharge tank will be measured again, and the difference in height will be used to calculate the actual water volume discharged. This measured volume will be compared to the actual flow meter reading of the volume discharged to verify accuracy of the meter. This calibration check will be done once at the beginning of the verification test and once at the end.

7.0 QUALITY ASSURANCE AND QUALITY CONTROL – PROJECT PLAN

The purpose of this section is to describe the quality assurance/quality control program that will be used during the verification test to ensure that data and procedures are of measurable quality and support the quality objectives and test plan objectives for this verification test. The quality assurance activities and scope are based the guidance provided in the *Protocol for the Verification of Wastewater Treatment Technologies*. The plan has been developed with guidance from the USEPA's Guidance for Quality Assurance Project Plans and Guidance for the Data

Quality Objectives Process. The QA/QC plan is tailored to this specific test plan and requirements for verification of the Big Fish Septage Processing System in this application. The QA/QC plan is written as part of the VTP and should be read and used with the VTP as a reference. The VTP contains descriptions of various requirements of the QA/QC Plan and they are incorporated by reference at several locations.

7.1 Verification Test Data – Data Quality Indicators (DQI)

Several Data Quality Indicators (DQIs) have been identified as key factors in assessing the quality of the data and in supporting the verification process. These indicators are:

- Precision
- Accuracy
- Representativeness
- Comparability
- Completeness

Each DQI is described below and the goals for each DQI are specified. Performance measurements will be verified using statistical analysis of the data for the quantitative DQI's of precision and accuracy. If any QA objective is not met during the tests, an investigation of the causes will be initiated. Corrective Action will be taken as needed to resolve the difficulties. Data failing to meet any of the QA objectives will be flagged in the Verification Report, and a full discussion of the issues impacting the QA objectives will be presented.

7.1.1 Precision

Precision refers to the degree of mutual agreement among individual measurement and provides an estimate of random error. Analytical precision is a measurement of how far an individual measurement may deviate from a mean of replicate measurements. Precision is evaluated from analysis of field and laboratory duplicates and spiked duplicates. The standard deviation (SD), relative standard deviation (RSD) and/or relative percent difference (RPD) recorded from sample analyses are methods used to quantify precision. Relative percent difference is calculated by the following formula:

$$RPD = [(abs [C_1 – C_2]) / (C_1 + C_2) / 2] \times 100\%$$

Where:

C_1 = Concentration of the compound or element in the sample

C_2 = Concentration of the compound or element in the duplicate

Field duplicates will be collected of both influent and effluent samples. The field duplicates will be collected at a frequency of one duplicate for every ten samples collected of influent and effluent. The laboratory will run duplicate samples as part of the laboratory QA program. Duplicates are analyzed on a frequency of one duplicate for every ten sample analyzed. The data quality objective for precision is based on the type of analysis performed. Table 7-2 shows the laboratory precision that has been established for each analytical method. The data quality objective varies from a relative percent difference of ± 10% to ± 30%.

7.1.2 Accuracy

Accuracy is defined for water quality analyses as the difference between the measured value or calculated sample value and the true value of the sample. Spiking a sample matrix with a known amount of a constituent and measuring the recovery obtained in the analysis is a method of determining accuracy. Using laboratory performance samples with a known concentration in a specific matrix can also monitor the accuracy of an analytical method for measuring a constituent in a given matrix. Accuracy is usually expressed as the percent recovery of a compound from a sample. The following equation will be used to calculate Percent Recovery:

$$\text{Percent Recovery} = [(A_T - A_i) / A_s] \times 100\%$$

Where:

A_T = Total amount measured in the spiked sample

A_i = Amount measured in the un-spiked sample

A_s = Spiked amount added to the sample

During the VTP, the laboratory will run matrix spike samples at frequency of one spiked sample for every 10 samples analyzed. The laboratory will also analyze liquid samples of known concentration as lab control samples. The accuracy objectives by parameter or method are shown in Table 7-2.

7.1.3 Comparability

Comparability will be achieved by using consistent and standardized sampling and analytical methods. All analyses will be performed using USEPA or other published methods as listed in the analytical section (Table 6-2). Any deviations from these methods will be fully described and reported as part of the QA report for the data. Comparability will also be achieved by using National Institute of Standards (NIST) traceable standards including the use of traceable measuring devices for volume and weight. All standards used in the analytical testing will be traceable to verified standards through the purchase of verifiable standards, and maintaining a standards logbook for all dilutions and preparation of working standards.

Comparability will be monitored through QA/QC audits and review of the test procedures used and the traceability of all reference materials used in the laboratory.

7.1.4 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic population, parameter at a sampling point, a process condition, or an environmental condition. The test plan design calls for grab and composite samples of influent and effluent to be collected and then analyzed individually or as composites. The sampling locations for the samples are designed for easy access. The influent samples are taken directly from a well-mixed equalization tank and the effluent samples are being collected directly from the discharge pipe. This design will help ensure that a representative sample of the wastewater is obtained in each grab or composite sample bottle. The sample handling procedure includes a thorough mixing of the composite container prior to pouring the samples into the individual containers. The laboratory will follow set procedures (in accordance with good laboratory practice) for thorough mixing of any samples prior to sub-sampling in order to ensure that samples are homogenous and representative of the whole sample. The Big Fish unit will be operated in a manner consistent with the operating manual, so that the operating conditions will be representative of a normal installation and operation for this equipment.

Representativeness will be monitored through QA/QC audits (both field and laboratory), including review of the laboratory procedures for sample handling and storage, review and observation of the sample collection, and review of the operating logs maintained at the test site. The Verification Organization or their representative will perform field and lab audits as needed.

7.1.5 Completeness

Completeness is a measure of the number of valid samples and measurements that are obtained during a test period. Completeness will be measured by tracking the number of valid data results against the specified requirements in the test plan.

Completeness will be calculated by the following equation:

$$\text{Percent Completeness} = (V / T) \times 100\%$$

Where:

V = number of measurements that are valid
T = total number of measurements planned in the test

The goal for this data quality objective will be to achieve minimum 80% completeness for samples scheduled in the test plan.

7.2 Project Management

7.2.1 Management Team

The Test Organization is responsible for management of the VTP including meeting the VTP objectives and the Data Quality Objectives as measured by the DQI's. Section 3 of the VTP describes the key personnel involved in this ETV program and the persons responsible to implement the test plan, including a Quality Control Officer from NSF who will be responsible for audits, assessment, and review of procedures and quality data. The phone number, email address, and mailing address for each person named are given in Section 3.

7.2.2 Project Description and Objectives

A full description of the Big Fish system being verified and the objectives for the verification test has been presented in Sections 1 through 4 of the VTP. Sections 5 and 6 describe the experimental design and the sampling and analysis plan for the verification test. The reader is referred to the VTP for more details.

The primary objective of the VTP is to measure the performance of this technology through a well-defined test plan that includes measurement of key parameters in the wastewater before and after application of the treatment technology. This objective will be accomplished by implementing the sampling and analysis program described in Sections 5 and 6, and by meeting the data quality objectives described in this Quality Assurance and Quality Control - Project Plan. The test plan includes operating the Big Fish system, and measuring the influent to and effluent from the unit, and removed residual (biosolids). The primary parameters being measured are TSS, BOD_5, FOG, TKN, NH_3-N, TP, chloride and sodium. Other parameters will include COD, alkalinity, nitrite plus nitrate, temperature, and pH. The solids and metals content of the biosolids produced will be measured twice during the verification.

7.2.3 Project Schedule

The verification test will cover a 12-month period with a cleaning and startup of the system performed sometime during the verification test. Sampling and analysis will be performed each month (two days per month). An estimated sampling schedule by month has been set. The schedule will be confirmed or adjusted as necessary during the test.

7.3 Measurements and Data Acquisition

7.3.1 Sample Collection and Chain of Custody

There are two basic types of samples being collected for this verification test, grab samples and composite samples. Samples will be collected only when the unit is actively transferring wastewater from the equalization tank or when discharging wastewater. Sections 5 and 6 describe the sampling approach in detail.

The contract laboratory will provide the sample bottles required for the various analyses. The bottles will come with preservative in the bottles and labeled by analysis type. Samples will be placed in coolers with ice to maintain temperature, and will be sent to the laboratory the day of sample collection. More details on the sample collection procedures are given in Sections 5 and 6

Chain of Custody will be maintained for all samples collected during the verification test. The unit operators who are responsible for sample collection will fill out a chain of custody form. The form will be signed and dated for each set of samples sent to the laboratory. The receiving technician will acknowledge receipt of the samples by signing the chain of custody and providing a copy of the form to the TO. Copies of the completed chain of custody forms will be included with all laboratory reports transmitting final analytical results.

7.3.2 Analytical Methods

All of the analytical methods used during the verification test will be USEPA approved methods or methods from *Standards Methods for the Examination of Waster and Wastewater*, 20th Edition. Table 6-2 shows the analytical methods that will be for the verification test and the typical detection limits that are achieved by these methods.

7.3.3 Analytical Quality Control

The quality control procedures for blanks, spikes, duplicates, calibration of equipment, standards, reference check samples and other quality control measurements will follow the guidance in the USEPA methods, the contract laboratory's SOPs and Quality Assurance and Quality Control Manual. Table 7-1 shows the frequency of analysis of various quality control checks. Table 7-2 shows the quality control limits that will be used by the laboratory for these analyses and to ensure compliance with the DQI's for accuracy and precision. Field and laboratory duplicates will be performed at a frequency of one duplicate per ten samples collected. Samples will be spiked for accuracy determination at a frequency of one sample per ten samples analyzed by the laboratory. Accuracy and precision will be calculated for all data using the equations presented in earlier in this section.

Table 7-1. Summary of Calibration Frequency and Criteria

Analysis	Calibration Frequency	Calibration Points	Acceptance Criteria
pH	Initial Calibration daily Check calibration after every 10 non-calibration analyses	Initial Calibration: Two buffers 4-7 or 7-10 Independent buffer at 7 (ICV) Continuing Calibration Check: pH 4, 7 or 10 (CCV) Depending on initial calibration range	Initial: ICV ± 0.1 s.u. Continuing: CCV ± 0.1 s.u.
Temperature	Once per quarter	NIST traceable	± 0.2 degrees
Dissolved Oxygen	Air calibrate each use; additional calibration once every three months per manufactures recommendation	Oxygen saturated water; zero set point; redline	N.A.
FOG	Calibrate balance daily NIST traceable weights	QC standard each run Blank each set	QC std within ± 20% of true value Blank < MDL
Total Suspended Solids	Calibrate balance daily NIST traceable weights	QC standard each run Blank each set	QC std within supplier specifications Blank < MDL
BOD_5	Calibrate DO Probe with Winkler titration; monthly or when new membrane installed	QC check sample each set Blank each set	QC ± 10%
Chloride	Calibrate at start of each run Check calibration after every 10 non-calibration analyses	Initial Calibration: Five point standard curve, blank, ICV check Continuing Calibration Check: CCV standards every 10 samples	Initial: Correl. Coeff. ≥0.995 Blank <MDL ICV ± 10% Continuing: CCV ±10% of Theo. Value
COD	Calibrate at start of each run Check calibration after every 10 non-calibration analyses	Initial Calibration: Four point standard curve, blank Continuing Calibration Check: mid-range standard (CCV) every ten samples	Initial: Blank <MDL Continuing: CCV ±10% of Theo. Value Blank <MDL
Alkalinity	Calibrate pH meter every run –see above	Calibrate at pH 7, run check at pH 10, ICV check	ICV ± 10%
Total – PO_4-P	Calibrate at start of each run; Check calibration after every 10 non-calibration analyses	Initial Calibration: Five point standard curve, blank, ICV check Continuing Calibration Check: CCV standards every 10 samples	Initial: Correl. Coeff. ≥0.995 Blank <MDL ICV ± 10% Continuing: CCV ±10% of Theo. Value
TKN	Same as PO_4-P	Same as PO_4-P	Same as PO_4-P
NH_3-N	Same as PO_4-P	Same as PO_4-P	Same as PO_4-P
Nitrite plus Nitrate	Same as PO_4-P	Same as PO_4-P	Same as PO_4-P

Sodium	Calibrate at start of each run Check calibration after every 10 non-calibration analyses	Initial Calibration: Three point standard curve, blank, ICV check Continuing Calibration Check: CCV standards every 10 samples	Initial: Correl. Coeff. $\geq$0.995 Blank <MDL ICV $\pm$ 10% Continuing: CCV $\pm$10% of Theo. Value

N.A. - Not applicable

Table 7-2. Summary of Analytical Accuracy and Precision Limits

Sample Matrix	Analyses	Units	Reference Methods	Accuracy Percent Recovery	Precision Relative Percent Diff.
WATER	pH	S.U.	SM 4500-H B	N.A.	0-10%
	Temperature	^{o}C	SM 2550B	N.A.	0-10%
	Dissolved oxygen	mg/L	SM 4500-O G	N.A.	0-10%
	FOG	mg/L	EPA 1664A	79-114%	0-18%
	Total suspended solids	mg/L	SM 2540 D	N.A.	0-10%
	BOD_5	mg/L	SM 5210 B	75-125%	0-25%
	Chloride	Mg/L	EPA 300.0	75-125%	0-25%
	COD	mg/L	EPA 410.4	80-120%	0-25%
	Alkalinity	mg/L as $CaCO_3$	SM 2320 B	80-120%	0-25%
	PO_4-P (Total)	mg/L as P	SM 4500-P F	75-125%	0-20%
	TKN	mg/L as N	EPA 351.2	75-125%	0-25%
	NH_3-N	mg/L as N	SM 4500-NH3 D	75-125%	0-25%
	Nitrite plus Nitrate	mg/L as N	SM 4500-NO3 H	75-125%	0-20%
	Sodium	Mg/L	EPA 200.8	75-125%	0-25%
SOLID	Total solids	%	SM 2540 B	N.A.	0-10%

N.A. - Not applicable

Laboratory blank water of known quality will be used for all laboratory analyses. If contamination is detected in the blank water, the analysis will be stopped and the problem corrected. Laboratory blanks, method blanks and any other blank water data will be reported with all analytical results.

Laboratory control samples, where applicable, will be used to verify the methods are performing properly. The control samples will be blank water spiked with constituents from standards obtained from certified source material.

Balances will be calibrated each day with NIST traceable weights. A calibration logbook is maintained to demonstrate the balances are accurate. Temperature of all refrigerators, ovens, and incubators will be monitored and recorded in logbooks at the laboratory.

Field blanks will be prepared at the test site and sent to the laboratory with the samples for two sampling events.

7.3.4 Data Reduction, Handling, and Reporting

7.3.4.1 Reporting Units Requirements

All analytical results will be reported in standard units of mg/L, ug/L, mg, grams, etc. Flow rates and volumes will be reported as gallons per minute, gallons per day and gallons. Analysis of solids will clearly indicate if the concentration is on a dry weight or wet weight basis. Table 7-2 shows a summary of the reporting units.

7.3.4.2 Documentation

All of the field and laboratory activities will be thoroughly documented by the use of field logbooks, chain of custody sheets, laboratory notebooks and bench sheets, and instrument records.

A field logbook will be maintained at the test site by the TO. Big Fish will maintain the normal operating log for the facility. Daily activity entries will be made in the logbook documenting operating conditions, observations, and maintenance activities, if any are needed. Each sample collected will be noted in the TO logbook and any other pertinent information will be recorded. Completed pages in the logbook will be signed and dated.

Original chain of custody forms will be sent with all sample(s) sent to the chemical laboratory. The laboratory will produce a final data report that includes all chemical test results, physical measurements; QA/QC data for blanks, accuracy (recovery), and precision (percent difference), and lab control or matrix check samples. Any deviations from the standard protocols will be discussed in a narrative, any data that does not meet the QA/QC requirements will be flagged, and a narrative will be prepared discussing the findings of any corrective action.

The laboratory will maintain all logbooks, bench sheets, instrument printouts etc. in accordance with the laboratory QA/QC Manual. The QA/QC or Laboratory Coordinator will make these records available for inspection upon request.

7.3.4.3 Document Handling

During the test period, the original field logbook will be kept at the test site. At the end of the test period, the original logbook will be sent to the NSF VO manager for storage in a secure central project file. Original laboratory data reports with the original chain of custody will be placed in the central project file at NSF. Copies of these reports and any electronic data will be sent to the Project Manager (TO) and QA/QC officer for review. Other copies of the data or logbooks may be distributed to other project team members.

7.3.4.4 Data Reduction and Validation

All measurements and analytical results will be reported in units that are consistent with the methods used, and as shown in Table 7-2. The laboratory analysts will record raw data in laboratory notebooks or bench sheets using standard formats. Each analytical method will contain instructions for recording and calculating the results. The laboratory analyst will have primary responsibility to verify the results recorded are accurate. Data review and QA/QC review will be the responsibility of the laboratory staff following the standard data review and verification procedures for the laboratory. Data transcribed for entry to a computerized database will be checked against the lab bench sheets or instrument printouts. The final data report will be signed by an authorized laboratory manager/supervisor in accordance with laboratory policy.

The final data reports and any electronic data received by the project team from the laboratory will be 100% checked. The Project Manager (TO) or designee will cross check 100% of the data in the final reports from the laboratory with a printout of spreadsheets developed to summarize the data. The QA/QC officer for the VO (NSF ETV Program), or their designee, will review the final data reports and all QA/QC information. The QA/QC officer will issue a QA/QC review report discussing the quality of the data, how it compares to the DQI's, and any data that should be flagged as invalid or questionable. The VO Project Coordinator will back check 100 % of the draft verification report data tables and calculations with the laboratory data and spreadsheets provided by the TO.

7.4 Assessments

At least one field audit will be conducted by the VO (NSF WQPC Manager, NSF QA/QC staff or designee) during the test. The audit(s) will be to review the sample collection procedures being used, to observe operation of the unit, condition of the test site, and to review the field logbook(s). A written report will be prepared by the auditor and submitted to the NSF QA/QC Officer and the WQPC Manager. At least one lab audit will be performed by the VO (NSF WQPC Manager, NSF QA/QC staff or designee) during the test to observe sample receipt, handling, storage, and to confirm proper analytical methods, QA/QC procedures and calibrations are being used. The on site lab audit may be waived if the laboratory has already been audited by the NSF QA/QC department for other ETV or related NSF programs.

The contract lab will have an assessment program that includes internal and external audits, quality reports to management, and other internal checks are part of the system used to ensure that the QA/QC procedures are being implemented and maintained. The assessment procedures will be part of the QA/QC program and will be followed during the time the analytical work is being performed for the verification test.

7.5 Corrective Action

Field related activities that could require corrective action include problems with sample collection, labeling, and improper entries or missed entries in logbooks, or operational problems with the unit. The primary person responsible for monitoring these activities will be Dale Scherger, with external audits by NSF designated staff. If a problem occurs, the problem will be noted in the field logbook and Mr. Scherger will notify the VO and Big Fish, in the case of unit operating issues. The problem, once identified, will be corrected. If a change in field protocol related to sample collection or handling is needed, the change will be approved by the NSF

Manager. All corrective action will be thoroughly documented and discussed in the Verification Report.

Laboratory corrective action will be taken whenever:

- There is a non-conformance with sample receiving or handling procedures
- The QA/QC data indicates any analysis is out of the established control limits
- Audit findings indicate a problem has occurred
- Data reporting or calculations are determined to be incorrect.

The contract laboratory will have a corrective action plan as part of the laboratory QA/QC Manual. These procedures will be followed, including notifying the laboratory QA/QC Manager and the Test Organization. All corrective action will be thoroughly documented and reported to the Test Organization. All data impacted by a correction will be so noted and a discussion of the problem and corrective action will be included with the data report.

All corrective actions, either in the field or in the laboratory, will be reported to the Verification Organization (VO) Project Coordinator. The VO will review the cause of the problem and the corrective action taken by the TO. The review will include consideration of the impact of the problem on the integrity of the test, and a determination will be made if the test can continue or if additional action is needed. Additional action could include adding additional days to the test period, re-starting the test at day one, or other appropriate action as determined by the VO. The VO will respond to any notification of corrective action within twenty-four hours of being notified of the problem. This response can be to continue the testing, cease testing until further notice, or other appropriate communication regarding the problem. The response by the VO will be in writing by email, fax, or letter.

8.0 DATA MANAGEMENT AND ANALYSIS

Several types of data will be collected or generated during the testing periods of this VTP. Quantitative data, including flow data, influent and effluent water quality data, type and amount of residuals generated, etc., will be measured and reported by the TO and/or the laboratory. Qualitative data describing the setup, operation, and maintenance of the Big Fish system will be collected in the field throughout the test period. All of this information will be managed during the verification using methods outlined in this section. The test results will be analyzed and presented in the verification report using a standardized approach, which is described in Section 7.3.

8.1 Data Management

The data being collected during this verification will include both manual and electronic data collection and storage methods. Field and laboratory notebooks will be maintained to document all activities related to the sampling, operation, and maintenance activities at the site, and to document sample handling, equipment calibrations, and other related activities in the laboratory. Laboratory results will be reported in paper reports showing all results and QA findings for each set of data. These results will then be entered into Excel spreadsheets for ease of analysis and storage.

All samples collected in the field or prepared in the laboratory will be assigned a specific identification number that will be used to track and record the data throughout the collection analysis, and data reporting steps. The samples collected in the field will have a clear label supplied by the laboratory. The label will show client name, source of sample or sample name, date and time of collection, and analyses requested. The chain of custody sheet accompanying the sample(s) to the laboratory will also show this information. The laboratory data reports will show the sample identification number assigned by the laboratory, a cross reference to the field sample associated with the lab ID, and will include copies of the chain of custody forms that clearly track the sample names from their assignment in the field through the analysis in the laboratory.

8.1.1 Manual Data Collection

All data collection, observations, and sample records will be written in a field logbook maintained at the site by field personnel. Copies of these records will then be reviewed by the Project Manager (TO) or a designee to ensure the records are being properly maintained. At the end of the verification test, the field log will be sent to the VO to become part of the permanent record for this verification test.

The laboratory will use laboratory notebooks to record all manual data and related information in accordance with good laboratory practice and the laboratory QA/QC and SOP documents. The laboratory logbooks will be available for review by the VO at any time. The laboratory will be responsible for maintaining and archiving the notebooks and manual records that support the data reported by the laboratory. The original chain of custody records and any appropriate supporting documents will be provided to the VO with the data reports. The data reports will include a discussion of any problems that occurred during the analysis, corrective action taken, and any other factors that could impact the data. The laboratory reports will include all QA/QC results, including blanks, spikes, duplicates, check samples, etc., such that the VO can validate the data and make an independent opinion as to the quality and acceptability of the data.

8.1.2 Electronic Data Collection

The laboratory will provide the analytical results in hard copy reports The data will be entered into an Excel spreadsheet by the TO. The TO will verify the data in the spreadsheet by comparing a print out of the spreadsheet with the hard copy results and their supporting documents prior to release of the data.

Upon receipt of the laboratory reports and spreadsheets, the Project Manager (TO), QA Officer or their designee will verify the accuracy of the data. A direct comparison of the hard copy data and the electronic spreadsheet will be made. Any corrections required will be written on the print out of the spreadsheet and the corrections made to the spreadsheet.

8.2 Data Analysis and Presentation

All results, including statistical analysis, will be provided in the Verification Report. Any data that was excluded in statistical analysis will be reported with an explanation as to why it was not included in the analysis. The data obtained during verification testing will be statistically analyzed, reduced, and presented in tables, graphs and charts. All raw data will be included as an appendix to the Verification Report. The statistical methods and any statistical programs used will be described in the Verification Report. A detailed discussion of the results will accompany the tables, graphs and/or charts and will be presented in the Verification Report. Conclusions drawn from the analysis of the test results will be presented in the Verification Report.

8.2.1 Flow Data

Flow data will be collected during the entire verification test period. The total discharge flow for each day will be summarized in a spreadsheet. The results will be presented in the final report as a table showing average, maximum and minimum daily flow. The 95% confidence limits will be calculated. Flow data will also be presented in a graphical format showing total daily flow plotted against time.

8.2.2 Treatment Performance Quality Data

Valid wastewater quality data obtained during the verification test will be analyzed and presented as follows:

- Tables showing the average, maximum and minimum influent concentration for each sampling events for the target contaminate list;
- Tables showing the average, maximum and minimum effluent concentration for each sampling event and the removal efficiency for the target contaminate list;
- Graphical formats will be used to present influent and effluent water quality results as a function of time;
- Table(s) showing the mass of the residual stream and any water quality data (solids content and metals); and
- Confidence limits (95%) will be presented in the Tables.

8.2.3 Operation and Maintenance Parameters

Results of monitoring operation and maintenance parameters during verification testing shall be presented in a discussion format. The Verification Report will include a thorough discussion of any difficulties encountered in operating or maintaining the unit during the verification test. Discussion will include observations regarding the ease/difficulty of installation, and factors, such as operator training, presentation clarity in the O&M manual, etc. The TO staff assigned to monitor the system will prepare a summary report on the operation and maintenance observations made during the 12-month test. This report will be from an "operators" point of view and reflect the degree of complexity and difficulty of operating the Big Fish system.

Specific operating parameter presented in the final report will include, but not be limited to:

- Time required for startup of the treatment system;
- Average monthly personnel time required for maintenance;

- Average monthly lime, polymer, citric acid used; and
- Average monthly power consumption.

8.2.4 Equations

The data analysis will include the calculations of removal efficiency and various statistics. The equations to be used in the data analysis are provided below.

Removal Efficiency (as percent)

$$\frac{(\text{mg/L influent} - \text{mg/L effluent})}{(\text{mg/L in the influent})} \times 100$$

Sample Mean (Average)

$$y_{bar} = \Sigma v / n$$

Where:

y_{bar} is the sample mean

Σv is the sum of the sample values

n is the number of samples

Standard Deviation

$$s = (\Sigma (y - y_{bar})^2 / n)^{1/2}$$

Where:

s is the sample standard deviation

y is an individual sample value

y_{bar} is the sample mean

95% Confidence Interval

$$= y_{bar} \pm t_{\alpha/2} (s / n^{1/2})$$

Where:

y_{bar} is the sample mean

s is the sample standard deviation

n is the number of samples

$t_{\alpha/2}$ is the Student's t-distribution with n-1 degrees of freedom, with $\alpha/2=0.025$

and

$t_{\alpha/2}$ = 2.068 for n=25

8.3 Verification Report

The Verification Report will be a document containing all raw and analyzed data, all QA/QC data sheets, a description of all types of data collected, a detailed description of the testing procedure and methods, results and QA/QC results. The Report will thoroughly present and discuss the findings of the verification test, conclusions regarding the performance of the Big Fish System and make a comparison with the performance goals for the verification test.

It is expected that the Verification Report will contain the following main sections. There may be some deviation from the order given below in order to present the findings in a clear and precise manner. Additional sections will added as needed to properly present all of the findings.

- Verification Statement
- Preface
- Glossary
- Acknowledgements
- Executive Summary
- Introduction and Background
- Description of Technology and Test Site
- Experimental Design
- Procedures and Methods Used In Testing (summarizing essential information from the Test Plan)
- Results and Discussion
    - Influent characteristics
    - Startup
    - Verification Test Period Results
- Limitations
- Conclusions
- Recommendations
- References
- Appendices
    - Raw Data
    - Special Laboratory Procedures – Standard Operating Procedures
    - QA/QC Manual/Procedures
    - Vendor O&M Manual
    - Field logs and supporting documentation as appropriate
    - Test Plan
    - Lab reports with QA/QC and Chain of Custody forms

9.0 HEALTH AND SAFETY PLAN

Big Fish and the TO will follow the site Health and Safety procedures while operating the system. In addition, all operators have been trained in proper health and safety procedures for working at wastewater treatment facilities. The MSDS information for citric acid, lime, and polymer, the major chemicals used at the facility are available at the Big Fish facility.

The contract laboratory will have a health and safety program in place at the laboratory. The laboratory will follow the established procedures during all analyses.

10.0 REFERENCES

(1) NSF International, *Protocol for the Verification of Wastewater Treatment Technologies*, April 2001, Ann Arbor, Michigan.

(2) United States Environmental Protection Agency: *Environmental Technology Verification Program - Quality and Management Plan for the Pilot Period (1995 – 2000)*, USEPA/600/R-98/064, 1998. Office of Research and Development, Cincinnati, Ohio.

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(4) United States Environmental Protection Agency: *Methods and Guidance for Analysis of Water*, EPA 821-C-99-008, 1999. Office of Water, Washington, DC.

(5) United States Environmental Protection Agency*: Methods for Chemical Analysis of Water and Wastes,* Revised March 1983, EPA 600/4-79-020

(6) United States Environmental Protection Agency*: Test Methods for Evaluating Solid Waste: Physical/Chemical Methods 3rd ed - 4 vols.,* November 1986, Final Update IIB and Proposed Update III, January 1995.

(7) APHA, AWWA, and WEF: *Standard Methods for the Examination of Water and Wastewater, 20th Edition,* 1998. Washington, DC.

(8) United States Environmental Protection Agency: *USEPA Guidance for Quality Assurance Project Plans, USEPA QA/G-5*, USEPA/600/R-98-018, 1998. Office of Research and Development, Washington, DC

(9) United States Environmental Protection Agency, *Guidance for the Data Quality Objectives Process, USEPA QA/G-4*, USEPA/600/R-96-055, 1996. Office of Research and Development, Washington

Appendix A – Flow and Effluent Water Quality Data

BIG FISH
OPERATING DATA SUMMARY

February 9, 2008

	pH S.U.	D.O. ppm	Temp Deg F	BOD mg/l	TSS mg/l	P mg/l	NH3 mg/l	NO2 mg/l	NO3 mg/l	Flow Gal/Month
JANUARY 2008										
Influent	7.25	0.4	60	2557	11000	285.0	72.0	32.0	2.0	28,942
Effluent	8.1	8.0	61	26.5	28.0	1.25	1.0	25.0	16.0	
% Removal				98.0	99.75	99.6	86.2			
DECEMBER 2007										
Influent	7.25	0.4	60	2557	11000	285.0	72.0	32.0	2.0	102,257
Effluent	7.5	7.6	67	79	30	2.42	53.2	24.0	1.8	
% Removal				97.7	98.3	99.2	57.1			
NOVEMBER 2007										
Influent	7.73	5.4	67	3600*	11000*	330.0*	124.0*	23.0	2.0	89,936
Effluent	7.83	7.9	67	84	25	2.54	53.2	21.0	1.8	
% Removal				97.6	99.8	99.2	57.1			
OCTOBER 2007										
Influent	7.34	3.2	75.5	3600*	11000*	330.0*	124.0*	29.4	4.6	105,864
Effluent	7.67	5.9	76.6	89	15	2.5	43.0	26.3	7.3	
% Removal				97.5	99.9	99.2	65.3			
*NOTE – used historical BOD, TSS, P & NH3 Influent averages										
SEPTEMBER 2007										
Influent	7.42	0.9	81.1	3598	11021	332	124.0	26.0	4.0	160,029
Effluent	7.61	4.9	81.2	150	37	2.9	38.5	42.6	9.2	
% Removal				95.8	99.7	99.1	70.0			
*NOTE – used historical BOD, TSS, P & NH3 Influent averages										
AUGUST 2007										
Influent	7.71	1.0	81.7	3598	11021	332	124.0	61.0	6.0	153,412
Effluent	7.74	4.9	81.9	108	99	4.5	51.0	50.0	4.0	
% Removal				97.0	99.1	98.6	58.9			
JULY 2007										
Influent	7.69	1.0	81.7	3106	6932	253.0	101.0			177,720
Effluent	7.43	4.7	78.9	210	266	21.1	36.5			
% Removal				93.2	96.2	91.7	63.9			
JUNE 2007										
Influent	7.11	0.0	73.2	3695	9657	285.2	25.6			88,901
Effluent	7.28	5.3	74.5	148	228	23.5	2.7			
% Removal				96.0	97.6	91.8	89.5			
MAY 2007										

Influent	**6.83**	**0.0**	**69.8**	**3682**	**9478**	**260.0**	**29.0**	**36,464**
Effluent	**7.62**	**6.0**	**67.0**	**81**	**228**	**24.7**	**5.3**	
% Removal				**97.8**	**97.6**	**90.5**	**81.7**	
APRIL 2007								
Influent	**7.44**	**1.0**	**67.1**	**3052**	**14063**	**507.00**	**121.0**	**42,410**
Effluent	**7.99**	**7.3**	**71.6**	**111**	**207**	**20.2**	**3.1**	
% Removal				**96.3**	**98.5**	**96.0**	**97.4**	
MARCH 2007								
Influent	**7.36**	**1.7**	**64.3**	**4380**	**13521**	**652.0**	**63.0**	**25,055**
Effluent	**7.79**	**8.1**	**65.2**	**96**	**115**	**11.4**	**6.7**	
% Removal				**97.8**	**99.1**	**98.3**	**89.3**	
FEBRUARY 2007								
Influent	**7.36**	**2.3**	**67.3**	**3675**	**12475**	**32.0**	**407.0**	**12,985**
Effluent	**7.78**	**7.7**	**65.3**	**73**	**132**	**5.8**	**3.3**	
% Removal				**98.0**	**98.9**	**81.9**	**99.2**	
JANUARY 2007								
Influent	**7.32**	**1.9**	**67.9**	**1981**	**9770**	**143**	**58.0**	**33,674**
Effluent	**7.45**	**8.2**	**74.6**	**112**	**195**	**11.6**	**6.6**	
% Removal				**94.3**	**98.0**	**91.9**	**88.6**	

Appendix B – Operating Manual

See separate pdf file

Appendix C – Photo

See separate photo file