Florida Department of Health
Bureau of Onsite Sewage Programs
Research Review and Advisory Committee Meeting

DATE AND TIME: **November 15, 2011 at 10:00 a.m. ET**

PLACE: Florida Department of Health Southwood Complex
4042 Bald Cypress Way, Room #240P
Tallahassee, FL 32399

Or via conference call / web conference:
Toll free call in number: 1-888-808-6959
Conference code: 1454070
Website: http://connectpro22543231.na5.acrobat.com/rrac/

This meeting is open to the public

AGENDA: FINAL

1. Introductions and Housekeeping
2. Review Minutes of Meeting September 8, 2011
3. Nitrogen Study
    a. Funding update
    b. Discussion on Legislative Progress Report
4. Update on 319 Grant: Performance of Advanced Onsite Sewage Treatment and Disposal Systems
5. Other Business
6. Public Comment
7. Closing Comments, Next Meeting, and Adjournment

Florida Department of Health
Research Review and Advisory Committee for the Bureau of Onsite Sewage Programs

Draft Minutes of the Meeting held at the Southwood Office Complex, Tallahassee, FL
September 8, 2011

In attendance:

- **Committee Members and Alternates:**
  - **In person:**
    - Mike McInarnay (alternate, Septic Tank Industry)
    - Bill Melton (member, Consumer)
    - Patti Sanzone (member, Environmental Interest Group)
    - Clay Tappan (chairman, member, Professional Engineer)
  - **Via teleconference:**
    - Quentin (Bob) Beitel (alternate, Real Estate Profession)
    - Kim Dove (member, Division of Environmental Health)
    - Tom Higginbotham (alternate, Division of Environmental Health)
    - Bob Himschoot (member, Septic Tank Industry)
    - Kriss Kaye (alternate, Home Building Industry)
    - Tom Miller (member, Local Government)
    - Jim Peters (alternate, Professional Engineer)
    - Eanix Poole (alternate, Consumer)
    - David Richardson (alternate, Local Government)
    - John Schert (member, State University System)
  - **Absent members and alternates:**
    - Sam Averett (alternate, Septic Tank Industry)
    - John Dryden (alternate, State University System)
    - Carl Ludecke (vice-chairman, member, Home Building Industry)
    - Restaurant Industry (no appointed member/alternate)
- **Visitors:**
  - **In person:**
    - Damann Anderson (Hazen and Sawyer)
    - Wendy Hedrick (FOWA)
    - Keith Hetrick (FHBA)
    - Richard Hicks (DEP)
    - Maria Pecoraro (Rep. Nelson)
    - Paul Runk (Florida Senate)
    - Lee Smith (ECT)
    - Shanin Speas-Frost (DEP)
  - **Via teleconference:**
    - Josefin Edeback (Hazen and Sawyer)
    - Sara Fowler
    - Gina
    - Kathryn Lowe (CSM)
    - Maria Pecoraro (Rep. Nelson)
    - Andrea Samson
    - Jim Spinnenweber
    - Pam Tucker
- **Department of Health (DOH), Bureau of Onsite Sewage Programs:**
  - **In person:**
    - Eberhard Roeder, Professional Engineer
    - Elke Ursin, Environmental Health Program Consultant
  - **Via teleconference:**
    - Bart Harriss, Environmental Manager

1. **Introductions** – Nine out of ten groups were present, representing a quorum. The group that was not represented was the Restaurant Industry. Chairman Tappan called the meeting to order at 1:01 p.m. Introductions were made and some housekeeping issues were discussed.

2. **Review of previous meeting minutes** – The minutes of the September 8, 2011 meeting were reviewed.

   Motion by Bob Himschoot, seconded by Bill Melton, to approve the minutes as presented. All were in favor with none opposed and the motion passed unanimously.

3. **Nitrogen Study**

   a) **Review of progress to date** – Elke Ursin presented on the progress to date. The status report on the nitrogen study was sent to the Legislature and the Governor by May 16, 2011. Hazen and Sawyer and the Colorado School of Mines presented on this study at the annual meeting for the National Onsite Wastewater Recycling Association (NOWRA), the National Environmental Health Association (NEHA), and the State Onsite Regulators Alliance (SORA) in Columbus, Ohio in June 2011. This was a great opportunity to get news of this project out to a mix of people who work in government, private industry, and academia.

   Damann Anderson presented some preliminary results from the passive biofilters at the test center at the Gulf Coast Research and Education Center (GCREC) in Wimauma, Florida. The focus of the results presented was around the sulphur-based denitrification systems. Results from two-stage passive biofilter are encouraging after 12 months of testing, showing a total nitrogen reduction of over 95% (2.6 mg/L). There were some clarification questions from the RRAC that were discussed.

   Damann Anderson went over the next steps for the project. The pilot scale work will be done by the end of the year. They are starting to install full-scale systems at actual home sites. They are also working on vertically stacked biofilters, which are designed similar to a drainfield. Plans are being designed currently to install some of these systems at the GCREC. They will need to be built large enough to last the lifetime of the system so that they do not need to be dug up to replenish the media.

   b) **Discussion on budget and process forward** – The RRAC were sent an email with a proposed contract amendment and a summary of the changes. Damann Anderson presented on what contract changes are proposed with this amendment. He stated that now that the funding has been appropriated, the contract needs to be amended to reflect what is to be done during Phase 3 of the project. Bob Himschoot asked for a clarification that this is not showing an overall cost savings, and Damann Anderson stated that that was correct; this amendment is just shifting money around between tasks. Bob Himschoot stated that is would be prudent to show a cost savings where possible without loosing the quality of work. Damann Anderson stated that the deliverables were originally split up prior to having done any design work, so this amendment aligns the costs. Task A is mostly complete, so there are not many changes. The major change is to reduce the number of innovative systems applications due to there likely being less proprietary technologies being tested. Task B changes include a reduction in the number of vendor agreements, reduction of the number of field tested systems by one and the corresponding number of sample events were also reduced, finally the deliverable costs for the final report was reduced. One Task C change was an increase in the cost for the monitoring of the soil and ground water test facility due to needing to use a drill rig for much of the work. There were also increases to the sampling and reporting due to the increased time and equipment required to complete this task. The final changes were to reduce the number of sample event reports due to not being able to determine groundwater flow direction for one of the home sites because of the karst topography. Task D revised from 29 tasks to 18 tasks per previous discussions with the RRAC and the project team. Quentin Beitel asked what staff's opinion is on the consolidation of tasks and Eberhard Roeder stated that this way is organized better than is was before while still achieving the same end results. Task E changes include an increase in the number of RRAC or TRAP meeting presentations, and the number of meetings they will attend. Another Task E change included a reduction in the cost for the Project Advisory Committee (PAC) meeting. The PAC is made up of key scientists in the wastewater community, and the intent was to include them for feedback and guidance. As the project went along, funding was sporadic, and the PAC was one of the subtasks that could be postponed until more funding was secured. Now, the project has moved along and the role of the PAC needs to be redefined as it will be difficult for them to provide guidance on where the project goes. It would be good for them to provide peer reviewed input at the end of the project. Paul Runk stated that the Legislature would appreciate having this project peer reviewed. After a discussion it was decided to leave that cost in, as outlined in the amendment, and the details on how that will be worked out will de decided at a later time.

Motion by Quentin Beitel, seconded by Bill Melton, to accept contract Amendment 3 as presented. All were in favor with none opposed and the motion passed unanimously.

Elke Ursin stated that the likely process forward is to do this amendment and then renew the contract for another three years as the contract expires in January. Elke Ursin stated that $1.8 million has been encumbered for this fiscal year. Out of the original cash that was received, most of that amount is covered. $350,000 is not covered under the current cash and the DOH budget office has the ability to cover that amount from the DOH Grants and Donations Trust Fund. In the past, cash was transferred from a DEP trust fund which was transferred over to DOH. This round of funding, although the authority to spend was made, there is not cash in the DOH Grants and Donations Trust Fund to cover the remaining cash needs.

Bob Himschoot stated that he would like to see this project come in under budget without damaging the quality of the final work product. He stated that he would like the minutes to reflect that this committee is conscious of the current state of the Florida economy and that they will do everything they can to promote due diligence and frugality.

Quentin Beitel stated that it is important for everyone to get with their respective organizations to make sure to find the money to fund the rest of the nitrogen study.

Elke Ursin stated that a legislative report on the completion of Phase II and progress on Phase III that is due in February 2012.

4. **Other Business** – Bob Himschoot asked for an update on the 319 project on the performance and management of advanced onsite systems in Florida. Elke Ursin stated that this project is not part of the agenda for this meeting, but that there has been quite a bit of work done on this project since the last meeting. She stated that the sampling will complete at the end of September when the grant is over and another RRAC meeting will be held in the future to discuss the results of that project.

Elke Ursin stated that the research priorities that were ranked at a previous RRAC meeting have not had much progress due to the 319 project taking up the majority of staff's time. There will be a TRAP meeting in October, and Elke Ursin will present the ranked priorities to them for approval per the statute requirements.

5. **Public Comment** – The public were allowed to comment throughout the meeting. There was no additional public comment.
6. **Closing Comments, Next Meeting, and Adjournment** – Potential dates for the next RRAC meeting will be emailed to RRAC members and alternates to determine the next meeting date. An upcoming meeting topic is a discussion on the 319 grant report on the performance of advanced OSTDS in Florida.

Bill Melton made a motion, seconded by Bob Himschoot, to adjourn at 3:55 p.m. All were in favor, none opposed, and the motion passed.

Florida Department of Health
Research Review and Advisory Committee for the Bureau of Onsite Sewage Programs

Approved Minutes of the Meeting held at the Southwood Office Complex, Tallahassee, FL
November 15, 2011

In attendance:

- **Committee Members and Alternates:**
  In person:
  - Carl Ludecke (vice-chairman, member, Home Building Industry)
  - Mike McInarnay (alternate, Septic Tank Industry)
  - Bill Melton (member, Consumer)
  - Clay Tappan (chairman, member, Professional Engineer)

  Via teleconference:
  - Quentin (Bob) Beitel (alternate, Real Estate Profession)
  - Kim Dove (member, Division of Environmental Health)
  - Tom Higginbotham (alternate, Division of Environmental Health)
  - Kriss Kaye (alternate, Home Building Industry)
  - Tom Miller (member, Local Government)
  - Eanix Poole (alternate, Consumer)
  - David Richardson (alternate, Local Government)
  - John Schert (member, State University System)

  Absent members and alternates:
  - Wayne Crotty (alternate, Septic Tank Industry)
  - John Dryden (alternate, State University System)
  - Bob Himschoot (member, Septic Tank Industry)
  - Jim Peters (alternate, Professional Engineer)
  - Environmental Interest Group (no appointed member/alternate)
  - Restaurant Industry (no appointed member/alternate)
- **Visitors:**
  In person:
  - Damann Anderson (Hazen and Sawyer)
  - Roxanne Groover (FOWA)
  - Keith Hetrick (FHBA)
  - Richard Hicks (DEP)
  - Steve Meints (FOWA)
  - Lee Smith (ECT)

  Via teleconference:
  - Sonia Cruz (FEHA)
  - Sara Fowler
  - Woo-Jun Kang
  - Kathryn Lowe (CSM)
  - Maria Pecoraro (Rep. Nelson)
  - Andrea Samson
  - Pam Tucker

- **Department of Health (DOH), Bureau of Onsite Sewage Programs:**
  In person:
  - Gerald Briggs, Bureau Chief
  - Kara Loewe, Distributed computer Systems Consultant
  - Eberhard Roeder, Professional Engineer
  - Elke Ursin, Environmental Health Program Consultant

  Via teleconference:
  - Ed Williams, Environmental Health Program Consultant

1. **Introductions** – Eight out of ten groups were present, representing a quorum. The groups that were not represented were the Environmental Interest Group and the Restaurant Industry which are both vacant groups. Chairman Tappan called the meeting to order just after 10:00 a.m. Introductions were made and some housekeeping issues were discussed.

   Changes to the committee since the last meeting were that Patti Sanzone and Sam Averett, who have both been with the RRAC for a long time, have left the committee. Wayne Crotty is replacing Sam Averett as the alternate for the Septic Tank Industry and a letter has been sent to the Sierra Club requesting that a new member and alternate be recommended for appointment. Quentin Beitel asked that the department contact the Florida Restaurant and Lodging Association again to see if there is any interest in having someone fill the vacant position. The groups that have terms expiring in January 2012 are the Department of Health, the Septic Tank Industry (which have already sent in their nominations), and the Environmental Interest Group.

   Motion by Bill Melton, seconded by Quentin Beitel, to send a letter of thanks to Patti Sanzone and Sam Averett for all the hard work they have done over the years. All were in favor with none opposed and the motion passed unanimously.

2. **Review of previous meeting minutes** – The minutes of the September 8, 2011 meeting were reviewed.

   Motion by Bill Melton, seconded by John Schert, to approve the minutes as presented. All were in favor with none opposed and the motion passed unanimously.

3. **Nitrogen Study**

   a) **Funding Update** – Elke Ursin stated that one of the reasons this meeting was scheduled was to make sure that RRAC understands what the current funding needs are for this project and to get everyone on the same page. Elke Ursin presented an update on what has happened since the September meeting. There was a TRAP meeting on October 11, 2011 where Elke Ursin presented an update on the nitrogen study. TRAP moved to write a letter to the legislature to request the funding needed to finish the project. Gerald Briggs presented an update on the study on November 10, 2011 at the Wekiva Commission meeting and they are going to write a letter in support of the project as well. Gerald Briggs gave an update on the funding to the committee. He mentioned a letter that Damann Anderson mailed to the Department and the committee members, and that in this letter there was a request for the Department to guarantee the funding for the project. He stated that there is no way for the Department to guarantee the funding because the state works on a year to year budget. Even if all of the cash were in the bank today there would be still be the possibility of a sweep of that trust fund. The Department is dependent on Legislative action every year for both cash allocation and budget appropriation. He outlined the funding history of the project with the first funding year in 2008 being $1,000,000 from DEP's trust fund to DOH's Grants and Donations Trust Fund, which was later reduced to $900,000. Then $2,000,000 of cash and budget was transferred to DOH in 2010. The 2011 appropriation gave budget authority but no additional cash. There is sufficient cash and sufficient budget authority for this fiscal year (end June 2012). The remaining funding will need to be addressed in the Legislature, as it has been done in previous years. Elke Ursin explained why the appropriation amount of $2,725,000 is different from the requested funds of $2,200,000. The extra $525,000 was carry-over funds that were estimated to not be spent as of August of

2010 when the legislative budget proposals were drafted. Staff members have worked with Keith Hetrick on a spreadsheet that has been provided to the budget office downtown, and the Department's budget office has sent a spreadsheet showing the breakdown of funds in the Grants and Donations Trust Fund. The spreadsheet showing the breakdown of funds in the Grants and Donations Trust Fund was passed out and posted online during the meeting. Gerald Briggs stated that the Legislative Progress Report that is to be discussed later during the meeting will be the vehicle for the Department to tell the Legislature where they are with the study and what funding is needed so that they can respond during the legislative session. Quentin Beitel asked who determines how the funds from the Grants and Donations trust fund are spent and Gerald Briggs stated that much of it is outlined in the Florida Statutes. Maria Pecoraro said that Chairman Constantine stated that in his conversations with the Appropriations Chair in the Senate that the funds would be allocated in an appropriate manner and that the study will have the money it needs to complete the final tasks. Damann Anderson stated that it is difficult for him to subcontract work for this project not knowing if the funds will be available. Maria Pecoraro stated that Damann's group contracted with the state and the state operates on a year to year budget. She also stated that this is a high priority project for several members of the Legislature and the Governor is interested in the results of this study, so that the funding will likely not be taken away. Gerald Briggs stated that the Legislative Progress Report requests that the remaining $2.2 million cash be put into the trust fund. Maria Pecoraro stated that this specification needs to be made in the report and she also suggested that RRAC writes a letter to the legislature outlining the problems with the current budget authority process and addressing why a cash allocation is needed. Gerald Briggs stated that the trust fund cash issue was sent downtown last week to Brian Clark with the Healthcare Appropriation Subcommittee in the House. Bill Melton asked whether the misunderstanding was that there was money in the trust fund that could be absorbed from other areas and used for this project. Gerald Briggs stated that he did not know for sure but that they may have looked at the balance of the trust fund and felt that there were sufficient dollars in there to cover this project. The table that was sent downtown showing how the money is split out in the trust fund included several accounts that are restricted. This leaves less than $1 million as non-restricted, and these dollars fund programs such as the Safe Drinking Water Act, biomedical waste programs, contractor registration, and other programs.

Carl Ludecke made a motion, seconded by Mike McInarnay, to have RRAC write a letter outlining the following points:

1. **RRAC's continued support for the project.**
2. **That the project is and has been going on now for slightly under three years.**
3. **That it is a three to five year project.**
4. **That the project was initially scoped at $5 million.**
5. **That the project is on schedule (for the most part, but for cash authorization delays) and within budget.**
6. **That the RRAC supports concluding this study as originally scoped.**
7. **That the one-year non-recurring approach to funding this project has caused delays in progress and is inefficient.**
8. **That the Legislature should find a way or use a mechanism to set-aside the remaining amount of money (i.e. $2.2 million) needed to concluded the project overall, over the next two fiscal years.**

There was a discussion on how long it might take to get this letter out, and there is a target date of the week of December 5, 2011. The thought is that these points will be incorporated into the executive summary of the progress report. All were in favor, none opposed, and the motion passed.

b) **Discussion on Legislative Progress Report** – Two versions of the report were sent out to RRAC members in their meeting packets: one with the tracked changes from the last Legislative report, and a version with the changes accepted. The committee discussed several edits to the document. Maria Pecoraro asked that a list be included in the report of the items that will have a cost breakdown. She also asked on whether there are any patents on the materials that are being used and Damann Anderson said that there were patents on some of the proprietary technologies, but he did not know of any on the materials themselves. Eberhard Roeder stated that there are several related patents that overlap with each other, and he does not know where this project fits into this. To fully answer this question will require consultation with a patent attorney.

Bill Melton made a motion, seconded by Carl Ludecke, for staff to make the changes to the Legislative Progress Report on the Nitrogen Reduction Strategies Study as discussed during the meeting, email the revised version of the report to RRAC, and route the document to executive staff for final approval. All were in favor, none opposed,

4. **Update on 319 Grant: Performance of Advanced Onsite Sewage Treatment and Disposal Systems** – Elke Ursin gave an update on the project. This project is to assess water quality protection by advanced (ATU, PBTS, etc.) throughout Florida. An amendment was executed in September 2011 which updated the budget spreadsheet. The grant period is now over, having ended on September 30, 2011. The final invoice and final progress report will be sent to DEP in the next week or so once all of the payments have cleared. Both Elke Ursin and Eberhard Roeder discussed some of the results for Task 1, which was a study to characterize the variability of grab samples over the course of a day, compare grab and time-composite samples, and to assess the variability of results between repeat visits for a selection of systems in Monroe County. Comments on the draft Task 1 report should be sent to Elke Ursin by November 22nd. The report will be finalized by November 30th and will include sections for the executive summary, discussion, results and conclusions, references, and appendices. Elke Ursin presented on the progress that has been made on the remaining tasks associated with this project. The database task is complete with 16,595 identified advanced systems. The database description has been developed, summary statistics will be finalized, and will be submitted by November 30th. The survey of interest groups task has been completed and has been discussed at previous meetings. The sampling task has been completed as well. There was a final sample size of 1,014 systems. Approximately 600 systems have had a final permit review done, with still quite a bit of review remaining to be done. There were samplers from Charlotte, Lee, Monroe, Volusia, and Wakulla counties. Elke Ursin stated that samplers that worked on this project were extremely helpful and she stated that this project would not have been possible without their help and they all did a great job. A total of 554 systems were sampled, with 28 of them sampled twice, and 2 were sampled 3 times. A total of 644 samples were taken from various points along the treatment train and analyzed by the lab for various parameters (alkalinity, cBOD5, TKN, Nitrate-Nitrite, TSS, TN, and TP). A total of 252 fecal samples were taken and analyzed. Detailed field evaluations were performed at each sample site. There is a task looking at management practices that is currently ongoing. A database was created

linking program evaluations over the past ten years with the survey results for regulators and system owners/users. There will also be links made between the county program evaluation, county survey information, and the sample results. Analysis on this has begun, and will be completed and summarized in the final task report and in a case study booklet format. The final project report is anticipated to be written after all the data entry and data analysis has been completed. The draft report will be presented to the RRAC for review prior to finalization and submission to DEP.

5. **Other Business** – During the October 11, 2011 TRAP meeting, the TRAP voted to approve the 2011 RRAC research priorities. Elke Ursin stated that work on these priorities, as well as work on the Alternative Drainfield Products project, will begin once the 319 project has been completed.

6. **Public Comment** – The public were allowed to comment throughout the meeting. There was no additional public comment.

7. **Closing Comments, Next Meeting, and Adjournment** – Potential dates for the next RRAC meeting were discussed. Upcoming meeting topics are and update on the nitrogen study and a discussion on the 319 grant report on the performance of advanced OSTDS in Florida. Quentin Beitel suggested having another RRAC meeting before the legislative session in January. January 4th and 5th were discussed as possible dates. Elke Ursin will send an email out to the RRAC members to determine the date that works for the most people.

   Bill Melton made a motion, seconded by Carl Ludecke, to adjourn at 1:21 p.m. All were in favor, none opposed, and the motion passed.

Task 1: Monroe County detailed study of diurnal and seasonal variability of performance of advanced systems

Interim draft report as update for the Research Review and Advisory Committee

for

DEP Agreement G0239
Department of Health Assessment of Water Quality Protection by Advanced Onsite Sewage Treatment and Disposal Systems: Performance, Management, Monitoring Project

By Eberhard Roeder

November 7, 2011

Executive Summary

To be written after completion of report.

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1 INTRODUCTION

Grab samples are commonly used to assess treatment results of onsite sewage treatment systems in the field. Testing of installed systems in the field is usually done by taking a few individual grab samples over a time period that can extend for years. Compilations of field sampling results (e.g. Groves et al., 2005, Roeder and Brookman, 2006) have indicated that the variability of field data is much larger than variability of standardized test center results. The most common testing standards for aerated onsite sewage treatment systems, NSF-40 for cBOD5 and TSS removal and NSF-245 for nitrogen reduction, utilize frequent 24-hour flow composite samples from treatment systems installed at a test center and loaded for six months under defined conditions (NSF International, 2000, 2007). One question is if the difference between grab samples and composite samples is important relative to other sources of field variability. The Florida Department of Health (FDOH) and Monroe County Health Department (MCHD) initiated a study to measure treatment results of a sample of aerated treatment units. The field work of the study was completed in three phases from early 2007 to mid-2009. The objectives of the part of the study described here were to characterize the variability of grab samples over the course of a day, to compare grab sample results to time-composite sample results and to assess the variability of sampling results between repeat visits at the same treatment unit. A secondary objective was to gather data on the influent and effluent concentrations of treatment systems. Preliminary results of this study have been presented previously (Roeder and Brookman, 2008, 2009 on data from the first phase of the study; Roeder and Brookman, 2010 on aspects of effluent concentrations). This report expands on these previous summaries and discusses the complete results of the study.

2 METHODOLOGY

2.1 Phases of the Study

The study included three phases. In the first phase, from February 2007 through mid-October 2007, samples were analyzed for cBOD5, TSS, nitrate, nitrite, ammonia, total Kjeldahl nitrogen, and total phosphorus; during the second phase from mid-October 2007 through May 2008, total alkalinity and occasional fecal coliform and enterococci analyses were added. The third phase, January through June 2009, dropped the microbiological analyses and added more replicates and blanks.

2.2 System Selection

The study included samples from volunteer owners for two permitting classes of aerated onsite treatment units installed in the Florida Keys: onsite wastewater nutrient reduction systems (OWNRS) and interim systems. Interim systems are aerobic treatment units approved in Florida based on certification by NSF. They are intended to serve as interim wastewater treatment option until central sewer is extended to the property. OWNRS are a type of performance-based treatment system; engineer-designed systems that usually include an aerobic treatment unit and a separate media filter to remove phosphorus, and are intended as a long-term wastewater solution. In the following, all systems that only include an aerated treatment step are categorized as (“I”) for interim systems. All systems that included a phosphorus reduction step are categorized as (“P”) for performance-based. Limitations in the access of sampling points resulted in some OWNRS being sampled before the phosphorus treatment step. During the first two phases of this project, all systems sampled served single family residences (“R”). These systems had to be serving residences inhabited by permanent residents (homestead exemption) and possess a current maintenance contract, which is required by Florida regulations. During the third phase, in 2009, additional single family residences and commercial establishments (“C”) were recruited to increase the number of systems and types of facilities on which data were gathered.

Monthly water billing records were obtained from the water utility for the year 2007 to estimate water use. System characterizations based on permit records and field observations are contained in appendix A.

2.3 Sampling

Sampling occurred from February 2007 to June 2009. Effluent sampling points were in most cases pump compartments or modified P-traps. The Florida Department of Health has suggested these as a suitable location for a sampling port (FDOH, 2000). Influent samples were obtained from the most upstream accessible tank or compartment. This included some compartments that subsequent analysis indicated were influenced by the aeration. 24-hour time-composite samples in one-hour intervals were obtained by an auto-sampler for effluents and, where accessible, influents. Grab samples were obtained at the same location using another auto-sampler with peristaltic pump several times during staff working hours separated by at least one hour to represent possible monitoring grab samples.

The following types of blank samples were taken: field blanks were taken with grocery-bought distilled water and with tap water. The tap water samples, while not strictly blanks, were aimed at measuring the background concentrations of the water supply feeding the sewage treatment systems. Field equipment blanks with distilled water were taken during the second half of the third phase, starting in May 2009.

Over the course of the project replicates were taken. During the initial two phases of study, replicates were taken occasionally, about once a week. During the third phase, replicates were taken both of the composite effluent sample and of the first effluent grab sample. The replicates were taken in the following manner: the peristaltic pump collected sufficient samples in an intermediate container for two sets of samples. The intermediate container was inverted several times. Then the sample containers were filled. The two sets of samples were sent to the lab with the same shipment. Replicates amounted to about 10% of samples.

Samples were stored in ice, and shipped by courier service to a NELAP-accredited laboratory. The laboratory returned a copy of the chain of custody with the sampling results to Monroe County Health Department.

2.4 Analysis

The laboratory analyzed the samples for the following parameters: total alkalinity, (EPA310.1) (only in phase 2 and 3), carbonaceous biochemical oxygen demand after 5 days ($cBOD_5$) (SM5210B), total suspended solids (TSS) (EPA160.2), ammonia nitrogen (EPA350.1), total Kjeldahl nitrogen (TKN) (EPA351.2), nitrate nitrogen and nitrite nitrogen (SM4500 NO3-F, or EPA300.0), total nitrogen (TN) (calculated), and total phosphorus (TP) (EPA365.4). During phase 2, some samples, generally the last grab sample of an event, were analyzed by a local NELAP-accredited lab for fecal coliform and enterococci.

In addition, a field spectrophotometer (Hach DR/890) allowed analyses for nitrate-nitrogen (high range, Test'n'Tube, Chromotrophic Acid Method), ammonia-nitrogen (High Range, Test'n'Tube. Salicylate method) and reactive or ortho-phosphorus (EPA Method 365.2), and a Taylor-kit was used as additional screening test for alkalinity, free chlorine, and pH.

The laboratory provided lab reports, which were entered manually into a project database. Except for consistency checks between analytes, the laboratory data were accepted as provided. A person different from who had entered the data performed quality control of the entered data. For the purposes of analysis, the value of the detection limit was generally used in the following for results that were below the detection limit.

The differences between duplicate and original results and between time-composite and grab samples were characterized by the relative deviation. The variability of grab samples over the course of a day and of multiple samples over the course of the study were characterized by the relative standard deviation.

Results were characterized in two ways: relative difference (2^{nd} sample-1^{st} sample)/(0.5*(2^{nd} sample + 1^{st} sample); and relative standard deviation (standard deviation/average, or for two samples, abs(relative difference/sqrt(2)), . The distribution of relative differences allows an assessment if systematically the first sample results in lower or higher measurements than the second samples. The relative standard deviation provides an indication how close together the two values are.

To assess qualitatively if concentrations of different analytes were related, Pearson correlation coefficients between the ranks of analytical results or deviation measures were determined. Such a correlation indicates if relatively large values (high rankings) of one parameter are associated with relatively large values of another parameter. Additionally, graphing and linear correlations in Excel were employed to screen for relationships between parameters.

Two aspects of the variability of grab samples were assessed: how variable are grab samples over the course of a day, and how different is the average of grab samples from the time-composite sample obtained over the 24-hour time period?

3 VARIABILITY ASSESSMENTS

3.1 Blanks

Table 1 shows the results of blank analyses, grouped by equipment blanks with DI water, field blanks with DI water, and field blanks with tap water. Equipment blanks showed in all cases below detection limit for TSS and nitrite-nitrogen. In most cases, cBOD5 (92%), nitrate-nitrogen (69%) and total phosphorus (69%), and total alkalinity (62%) were below the detection limits as well. In contrast, most samples contained quantifiable amounts of ammonia (54%), TKN (69%), and total nitrogen (85%). While quantifiable, the concentrations were in most cases much below one mg/L. Of note is that the first three equipment blanks showed the highest concentrations for nitrogen and phosphorus species, with total nitrogen up to about four mg/L and total phosphorus up to 0.8 mg/L. Two explanations appear plausible: the initial equipment blanks were obtained using tap or drinking water instead of distilled water; or the samplers improved the cleaning and sampling procedures after the first three equipment blanks. An argument for the first explanation is that results are fairly consistent with the results for tap water (see below). An argument against the second explanation is that sampling results of the first equipment blanks were only received three weeks after sampling, two weeks after subsequent equipment blanks, therefore no information on high concentration results was available when the improvement would have occurred.

While not all five field blanks using distilled water achieved results below detection limit, the nitrate/nitrite species in addition to cBOD5 and TSS were all below detection limit, all total phosphorus results were below the PQL, but TKN was detected three times, in amounts up to 0.66 mg/L.

Tap water field blanks were mostly free of detectable levels of TSS (58%), nitrite (56%) and total phosphorus (56%). Usually samples were close to about 2 mg/L for cBOD5 and TSS. Median nitrate-nitrogen, TKN, total nitrogen concentrations and total alkalinity were 2.7, 0.8, 3.5and 45 mg/L, respectively. One observation that the large number of samples allowed was how frequently unusually large concentration results are returned from the lab. The occurrence of large concentrations of five times the median or more occurred occasionally (>5%) for cBOD5 and nitrite-nitrogen, and rarely (<5%) for TKN, total nitrogen, total phosphorus, and TSS.

The highest rank order Pearson correlation coefficients were 0.66 between nitrate-nitrogen and total nitrogen, 0.52 between TP and TSS, followed by 0.48 between ammonia-nitrogen and TKN and 0.44 between TKN and total nitrogen. The correlations between nitrogen species are plausible, given that total nitrogen is a value calculated from nitrate, nitrite, and TKN, ammonia is part of TKN, and nitrate-nitrogen in the tap water samples is usually present at the highest concentration of the three. The second correlation suggests a joint appearance of some TSS and TP, such as suspended solids containing phosphorus, in tap water. The lack of strong correlations otherwise suggests that occasional or rare spikes in concentration results occur largely independent from each other and represent noise in the obtained data.

Table 1. Statistics of Blanks (Concentrations in mg/L)

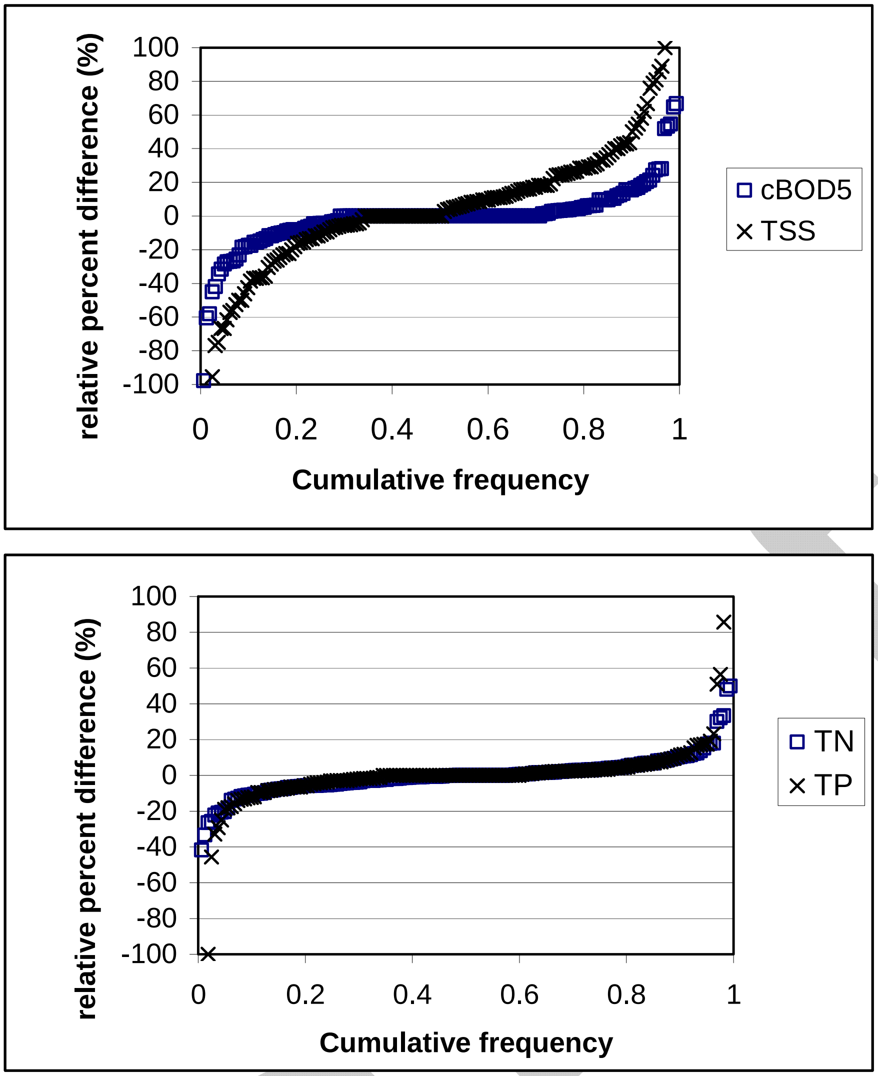
	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TOTAL NITROGEN	TOTAL PHOSPHORUS	Total alkalinity (CaCO3)
Equipment Blanks									
Count	13	13	13	13	13	13	13	13	13
Max	2.61	2	0.59	3	0.026	2.02	4.19	0.79	47
Fraction with "I"	0.00	0.00	0.15	0.15	0.00	0.08	0.00	0.00	0.00
Fraction with "U"	0.92	1.00	0.31	0.69	1.00	0.23	0.15	0.69	0.62
Median	2.00	2.00	0.10	0.05	0.03	0.19	0.19	0.04	5.00
75-percentile	2.00	2.00	0.22	0.10	0.03	0.55	0.55	0.15	10.00
Distilled Water Field Blanks									
Count	4	5	5	5	5	5	5	5	3
Max	4.6	2	0.05	0.05	0.053	0.66	0.66	0.19	62
Fraction with "I"	0.00	0.00	0.40	0.00	0.00	0.20	0.20	0.40	0.00
Fraction with "U"	0.75	1.00	0.60	1.00	1.00	0.40	0.40	0.60	0.00
Median	2.00	1.00	0.04	0.05	0.04	0.26	0.12	0.04	46.00
Tap Water Blanks									
Count	92	93	93	93	93	93	93	91	61
Max	39	10	1.6	12[1]	2.64	8.8	12	5.1	66
Fraction with "I"	0.00	0.00	0.04	0.00	0.17	0.02	0.01	0.18	0.00
Fraction with "U"	0.38	0.58	0.08	0.12	0.56	0.09	0.04	0.56	0.00
Average	4.67	1.70	0.48	2.51	0.14	1.04	3.50	0.19	45.49
25-percentile	2.00	1.00	0.28	2.3	0.03	0.49	3.00	0.035	41.00
Median	2.00	2.00	0.50	2.66	0.05	0.82	3.50	0.08	45.00
75-percentile	2.88	2.00	0.65	2.89	0.09	1.00	3.84	0.14	47.00
95-percentile	20.00	2.80	0.92	3.58	0.57	2.71	4.90	0.33	61.00

[1] this result was associated with a lab report of TN=2.6 mg/L, indicating an inconsistency of reported results

3.2 Replicates

Comparisons of analytical results between samples and their replicates showed that TSS had the highest variability, while nutrient samples had very low variability. Figure 1 shows the cumulative distribution of relative percent differences for cBOD5, TSS, TN and TP. Table 2 shows characteristics of both the relative percent difference and the relative standard deviation for the analytes. For these analyses, it was assumed that the difference between two samples qualified as “U” was zero, even though the numerical value associated with the “U” may have been different, e.g. due to different dilution factors in the analysis. The average relative percent difference is close to zero relative to the standard deviation of these differences and the median difference as a typical value is zero for all analytes. Therefore, no bias in measurements is apparent. The relative standard deviations show that the average for nitrite, nitrate, total nitrogen and total alkalinity is less than five percent. For cBOD5 and TP the average relative standard deviation is less than 10%, while for TSS, ammonia and TKN it is between 13 and about 20%. It is interesting to note that the variability of TN appears to be much less than the variability of ammonia, and TKN, the latter part of the TN-calculation. Differences in the distribution of large deviations become apparent when considering the fraction of samples that had a relative standard deviation of 20% or less. This fraction is for total alkalinity: 100%; TN: 96%; nitrite-N: 95%; nitrate-N: 95%; TP: 94%; cBOD5: 92%; TKN: 82%; ammonia-N: 81%; and TSS: 65%.

A Pearson regression analysis of ranks of relative percent differences deviations of each analyte against the ranks of relative percent differences of other analytes and against the date of sampling was performed to assess if there was a pattern in deviations. The only large correlation was between TKN and total nitrogen (0.72) and the second highest was between nitrate-nitrogen and total nitrogen (0.43) (see table 3). Such a correlation is not unexpected as TKN and nitrate-nitrogen are components of total nitrogen. The lack of strong correlations between any of the other analytes indicates that the relative deviations for analytes are independent of each other. The difference between the observed association between TP and TSS for tap water blanks and the lack of such an association between replicate samples suggests that the fraction of TSS that causes the high variability between replicates does not contain noticeable amounts of TP.



a)

b)

Figure 1. Cumulative distribution of relative percent differences between samples and their replicates for a) cBOD5 and TSS, and b) TN and TP.

Table 2. Statistics of Deviations between Replicate Samples

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Count	160	162	161	162	162	161	161	161	149
Relative % difference									
Average	-0.7	5.2	-7.1	-0.9	-1.8	-1.8	-0.1	0.0	-0.6
standard deviation	18.6	44.1	43.2	20.1	21.0	37.9	11.2	25.9	6.5
5-percentile	-27.2	-61.3	-100.0	-10.5	-12.5	-40.2	-18.4	-18.2	-9.5
25-percentile	-4.5	-10.5	-6.3	-1.1	0.0	-8.2	-5.0	-3.0	-1.7
Median	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75-percentile	3.2	24.3	4.3	0.9	0.0	7.7	3.4	3.2	0.0
95-percentile	24.2	78.6	26.1	8.1	7.4	41.0	15.2	17.4	7.2
Relative standard deviation (%)									
Average	6.9	20.1	14.8	4.5	4.3	13.7	4.9	7.3	2.3
standard deviation	11.1	24.1	27.2	13.5	14.3	23.1	6.2	16.8	3.9
5-percentile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-percentile	0.0	4.1	1.2	0.0	0.0	1.7	1.0	0.0	0.0
Median	2.5	12.1	3.8	0.8	0.0	5.7	3.0	2.2	0.4
75-percentile	9.4	26.2	10.0	2.9	1.7	14.6	6.0	6.0	2.9
95-percentile	32.1	67.2	83.9	14.9	20.1	69.1	18.2	32.3	12.7

Table 3. Pearson Correlation coefficients between ranks of relative percent differences between replicates for analytes, and between the ranks and date.

	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.	Date
CBOD5	1.00	0.03	-0.01	-0.06	0.01	0.10	-0.04	0.09	-0.04	0.09
TSS	0.03	1.00	-0.04	-0.08	0.03	0.13	0.00	-0.11	-0.06	0.15
AMMONIA-N	-0.01	-0.04	1.00	0.09	-0.04	0.03	0.07	0.06	0.01	0.01
NITRATE-N	-0.06	-0.08	0.09	1.00	0.05	0.06	0.43	-0.06	-0.04	0.02
NITRITE-N	0.01	0.03	-0.04	0.05	1.00	0.01	0.09	0.01	-0.07	0.08
TKN	0.10	0.13	0.03	0.06	0.01	1.00	0.72	0.21	0.06	-0.07
TOTAL_NITROGEN	-0.04	0.00	0.07	0.43	0.09	0.72	1.00	0.31	0.10	-0.08
TOTAL_PHOSPHORUS	0.09	-0.11	0.06	-0.06	0.01	0.21	0.31	1.00	-0.03	-0.18
Total_alk.	-0.04	-0.06	0.01	-0.04	-0.07	0.06	0.10	-0.03	1.00	-0.03

3.3 Overall Distribution of Influent and Effluent Concentrations

This section describes the concentration results, but after attributing samples to the categories of either influent; intermediate, as evidenced by system construction or high levels of nitrate in a sample otherwise consistent with sewage; or effluent. The analysis for most samples included cBOD5, TSS, nitrogen species, total phosphorus and total alkalinity. Analysis of bacteriological samples occurred rarely, only twenty times, and a separate subsection will discuss these results.

3.3.1 Influent Composite Samples

Initial review of the obtained influent samples indicated the need for further screening according to the following criteria: For systems where the construction records indicated that there was no pretreatment tank present, “influent” samples were reclassified as an “intermediate” sample, regardless of concentrations; Samples that showed total nitrogen above 10 mg/L and nitrate and nitrite above 3 mg/L indicated some aerobic treatment influence and were also reclassified as “intermediate” samples, for four systems this resulted in some influent samples being included and some reclassified as intermediate samples. The systems for which these occurred were tanks with an aerobic treatment insert, which may or may not have included a baffle wall to separate a pretreatment compartment from the aeration compartment.

Other excursions of note were the following: The laboratory had analyzed the first influent sample with a cBOD5 reporting limit of 300 mg/L and the result was less than this value. For this result an exception was made from the convention to use the reporting limit as measured effluent concentration and it was excluded from the statistics. Two samples showed above 5 mg/L nitrate but low TKN and TP, which indicated that the influent was very close to pure tap water, these samples were included as influent sample.

In the following, only time composite influent samples, without considerations of grab samples or replicates, are summarized.

Summary statistics of influent samples are shown in table 4. Several observations are of note:
TSS and nitrate have a standard deviation much larger than the mean and a mean that is much larger than the median. In both cases this stems from a few samples with very high concentrations. For TSS, an explanation of this could consist of the sample containing scum or sludge, that is, material that is present but that is usually not sampled and retained by the primary treatment compartment. For nitrate, the two samples with the outlying high concentrations were associated with low TKN and TP concentrations and indicative of a high fraction of tap water.

cBOD5, nitrite, and TP show standard deviations on the same order as the mean and means that are about 50-100% higher than the median. For cBOD5, the two highest concentrations are associated with samples that also have very high TSS concentrations. cBOD5 distribution is also influenced by the laboratory’s use of a detection limit of 60 mg/L for most samples, which more than a quarter of the samples did not exceed. Total phosphorus variability is influenced by a few high values that are associated in three of seven cases with high TSS-values, and two low values that a associated with samples similar to tap water. Nitrite variability was caused largely by variations in the detection limit due to differences in dilution of samples

Ammonia, TKN, total nitrogen, and total alkalinity show standard deviations smaller than the mean and a mean that is within 20% of the median. This indicates a limited effect of particularly high concentrations.

The effect of removing a few samples with very high concentrations can be seen in table 4 b): By excluding three samples with very high solids content (TSS>1000 mg/L), which may represent difficulties in sampling from the clear zone, two samples that appeared to be tap water dominated, and six samples from systems that included recirculation, both averages and standard deviations of TSS, nitrate and cBOD5 were markedly lowered. The highest total phosphorus value of 98 mg/L was not associated with high concentrations of any of the other analytes, and continued to skew the average results. Other nutrient concentrations and total alkalinity did not change much, and the interquartiles and medians remained roughly the same. Based on a median test, there were not significant differences between the influent measurements for residential PBTS, ATUs and commercial PBTS for cBOD5, TSS, TKN, TN, TP, and Total Alkalinity.

Looking at the six influent samples from systems with recirculation in isolation (table 4 c), their median values are generally similar to the influent concentrations overall. Even the values for TKN and total nitrogen, which appear to be somewhat lower, and cBOD5 and TSS, which appear to be somewhat higher, were not significantly different as determined by the median test.

Table 4. Summary statistics of composite influent samples: a) all influent samples; b) influent samples without high solids concentrations (>1000 mg/L); tap water, and recirculation; c) influent samples with recirculation

a) all influent samples

		CBOD5*	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	49	50	50	50	50	50	50	49	39
Mean		146.4898	250.2400	53.54460	.51800	.20340	82.66660	83.00000	16.66449	375.538
Std. Deviation		150.09804	610.57202	40.617567	1.293862	.264183	60.487644	60.093293	19.883239	245.6132
Minimum		60.00	14.00	.200	.047	.025	.830	1.800	.960	59.0
Maximum		780.00	3700.00	220.000	7.000	.980	290.000	290.000	98.000	1400.0
Percentiles	5	60.0000	20.4000	.55550	.04700	.02500	1.57500	7.46200	1.64000	77.000
	25	60.0000	40.0000	31.72250	.04925	.03900	46.51500	46.51500	7.55000	270.000
	50	99.0000	64.0000	49.00000	.19000	.09400	73.44500	73.44500	10.00000	300.000
	75	175.0000	135.0000	63.25000	.47000	.20000	94.25000	94.25000	14.50000	460.000
	95	630.0000	1745.0000	138.00000	3.58850	.94000	233.50000	233.50000	68.00000	1000.000

*one cBOD5 result below a reporting limit of 300 mg/L was excluded from analysis.

b) influent samples without high solids concentrations (>1000 mg/L) tap water, and recirculation

		CBOD5*	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	38	39	39	39	39	39	39	38	28
Mean		122.2895	117.4872	55.68385	.25272	.16421	80.80538	80.89410	15.96395	389.286
Std. Deviation		85.96728	156.94650	40.212588	.328943	.235855	54.873544	54.796139	19.669758	246.8913
Minimum		60.00	24.00	.200	.047	.025	1.800	1.800	2.300	120.0
Maximum		520.00	710.00	220.000	1.460	.980	290.000	290.000	98.000	1400.0
Percentiles	5	60.0000	24.0000	7.30000	.04700	.02500	13.00000	14.00000	3.06000	142.500
	25	60.0000	40.0000	34.00000	.04700	.03900	49.20000	49.20000	7.57500	270.000
	50	98.5000	64.0000	50.00000	.09400	.09400	76.00000	76.00000	10.00000	310.000
	75	152.5000	110.0000	69.00000	.25000	.13000	94.00000	94.00000	14.25000	460.000
	95	254.0000	640.0000	120.00000	1.20000	.94000	220.00000	220.00000	77.10000	1116.500

c) influent samples with recirculation

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	6	6	6	6	6	6	6	6	6
Mean		132.6667	116.6667	40.08500	.20067	.21833	62.77667	62.86000	9.83167	291.667
Std. Deviation		51.70171	65.79564	15.220097	.157311	.209473	18.8329	18.959121	2.082791	42.1505
Minimum		60.00	24.00	23.000	.050	.026	40.160	40.160	6.200	240.0
Maximum		180.00	190.00	58.000	.470	.500	86.420	86.920	12.000	360.0
Percentiles	5	60.0000	24.0000	23.00000	.05000	.02600	40.16000	40.16000	6.20000	240.000
	25	81.0000	48.0000	24.50000	.08000	.07400	41.07500	41.07500	8.15000	262.500
	50	144.0000	130.0000	38.75500	.17200	.11200	66.29000	66.29000	10.49500	280.000
	75	180.0000	175.0000	57.25000	.30500	.47750	78.69500	78.82000	11.25000	330.000
	95	180.0000	190.0000	58.00000	.47000	.50000	86.42000	86.92000	12.00000	360.000

3.3.2 Intermediate Composite Samples

The grouping of intermediate samples encompasses samples from a variety of locations before the final treatment step. These samples were taken as far upstream in the treatment process train as the samplers were able to access. This included aeration chambers, clarifiers, or relatively stagnant compartments preceding but in connection with the aeration chamber. One way to assess the importance of sampling influent from a pretreatment tank rather than the upper end of a treatment system is to compare influent results to intermediate samples. Generally, the influent concentrations should be higher than intermediate concentrations. Table 5 a) summarizes the intermediate concentrations overall. Of the 51 samples, 7 had high solids concentrations (>1000 mg/L) associated with them. While these samples may accurately reflect the solids concentration, for example if the sample was obtained from an aeration chamber, they appear not well comparable to other samples. Table 5 b) shows the effect of removing these samples from the statistics. cBOD5, TSS, TKN, TN and TP show a marked reduction in means and standard deviations, but a lesser reduction in the median. In both tables, the summary statistics indicate that these samples show the influence of aerobic treatment. Over three quarters of all samples) or about 90% (samples w/o high solids) of cBOD5 results are at or below a laboratory reporting limit of 60 mg/L. More than 80% of samples show nitrate-N in excess of 3 mg/L and only two had below detectable levels of this analyte. The presence of nitrate as an indicator of aeration points most clearly to the effect of aeration in this sample group. But TKN is still a prominent constituent of total nitrogen, exceeding 10 mg/L in somewhat over half of the samples.

One particular distinction in the data is that a few samples were taken from after the aerobic treatment at the beginning of the phosphorus reduction media tank. These sample locations stemmed from the inaccessibility of the compartments containing the aerobic treatments unit to the samplers at two systems. The differences between samples further up the treatment train and the samples from the two systems where the upper end of the P-media was sampled was only significant for TP using the median test. This is counterintuitive, given that the purpose of the samples was to sample the partially treated prior to total phosphorus reduction. A possible reason for the reduction of total phosphorus measured could consist in the sampling of ponded effluent that was in contact with the phosphorus adsorption media.

Table 5. Statistics of intermediate composite samples, i.e. samples that were taken at the beginning of the treatment train: a) all samples; b) excluding samples with TSS >1000 mg/L; c) samples taken before P-reduction filter tanks; d) sample taken at the beginning of a P-reduction filter tank

a) all samples

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
N	Valid	49	49	50	51	51	50	50	50	32
Mean		91.4490	777.8571	10.81980	19.39557	1.66749	64.98920	85.70400	20.49322	128.531
Std. Deviation		140.47243	2287.92957	25.790763	19.884928	4.636731	125.171022	123.528269	38.209321	211.4002
Minimum		2.00	1.20	.039	.094	.025	.070	3.280	.035	5.0
Maximum		940.00	14000.00	150.000	103.200	27.000	763.450	763.450	240.000	990.0
Percentiles	5	2.0000	2.0000	.04615	1.57800	.02500	.46000	10.08500	.08330	5.000
	25	60.0000	9.8000	.40500	4.70000	.13000	3.98500	23.83000	5.40000	14.000
	50	60.0000	46.0000	1.95000	15.32000	.33000	18.54000	42.01500	8.50000	57.500
	75	60.0000	370.0000	6.45000	29.00000	1.31000	85.44000	106.46000	23.00000	155.000
	95	335.0000	5800.0000	72.25000	65.32200	11.30000	298.83900	306.63650	88.75000	827.500

b) excluding samples with TSS >1000 mg/L

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
N	Valid	42	42	43	44	44	43	43	43	26
Mean		54.5476	128.9286	8.08088	21.02305	1.78618	33.15651	55.80000	10.45723	70.308
Std. Deviation		17.74920	207.28909	17.027974	20.545683	4.974905	44.784861	52.581712	10.154816	80.7449
Minimum		2.00	1.20	.039	.094	.025	.070	3.280	.035	5.0
Maximum		72.00	870.00	75.000	103.200	27.000	190.000	223.180	43.000	330.0
Percentiles	5	2.0000	2.0000	.05520	2.20250	.02500	.39000	7.04000	.08120	5.000
	25	60.0000	7.4500	.41000	6.77000	.12250	2.80000	23.00000	5.00000	10.500
	50	60.0000	30.5000	1.90000	16.50000	.26500	11.74000	39.00000	7.70000	43.000
	75	60.0000	157.5000	3.90000	29.19500	1.21000	46.29000	62.00000	14.00000	94.500
	95	68.2500	652.5000	65.40000	74.99250	16.37500	128.00000	199.44200	37.20000	298.500

c) samples taken before P-reduction filter tanks

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
N	Valid	40	40	41	42	42	41	41	41	30
Mean		102.0750	947.9700	12.89637	19.45652	1.30769	68.02659	88.73659	24.64512	132.133
Std. Deviation		153.35285	2506.16595	28.106202	21.312062	3.171708	134.313092	133.244583	41.098396	217.3971
Minimum		2.00	2.00	.039	.094	.025	.070	3.280	.290	5.0
Maximum		940.00	14000.00	150.000	103.200	20.000	763.450	763.450	240.000	990.0
Percentiles	5	8.7000	2.1000	.05880	.91200	.02500	.74100	6.27000	2.12000	5.000
	25	60.0000	24.0000	.53000	4.34000	.13000	4.56500	23.66000	6.55000	18.000
	50	60.0000	93.0000	2.30000	14.17000	.33000	19.67000	41.03000	11.73000	57.500
	75	63.0000	602.5000	9.40000	29.44500	1.36750	78.40000	92.91500	26.61500	160.000
	95	384.5000	6520.0000	74.50000	77.75550	5.14450	368.32800	370.34300	122.50000	852.500

d) sample taken at the beginning of a P-reduction filter tank

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	9	9	9	9	9	9	9	9	2
Mean		44.2222	21.8000	1.35989	19.11111	3.34656	51.15222	71.88889	1.57900	74.500
Std. Deviation		25.98931	27.07231	1.247920	11.975333	8.886115	74.178640	66.560958	2.450320	92.6310
Minimum		2.00	1.20	.039	2.300	.025	.350	14.000	.035	9.0
Maximum		64.00	76.00	3.900	40.000	27.000	190.000	200.000	6.400	140.0
Percentiles	5	2.0000	1.2000	.03900	2.30000	.02500	.35000	14.00000	.03500	9.000
	25	16.0000	4.5000	.26500	7.85000	.03200	.61000	20.50000	.08300	9.000
	50	60.0000	7.0000	1.10000	22.00000	.20000	4.00000	43.00000	.17000	74.500
	75	60.0000	42.5000	2.05000	26.50000	1.17500	125.00000	132.50000	3.55000	140.000
	95	64.0000	76.0000	3.90000	40.00000	27.00000	190.00000	200.00000	6.40000	140.000

3.3.3 Effluent Composite Samples

Effluent concentrations are present from two sources: grab samples and composite samples. Time composite samples are more comparable to the samples obtained for influents, and so these are discussed here first and table 6 shows their summary statistics. Grab samples will be discussed in the following section.

Among the effluent composite samples there were no samples with TSS-concentrations >1000 mg/L. While cBOD5, nitrite, TN, TP and alkalinity have comparatively narrow distributions (75-percentile is not more than five times the 25-percentile), TSS and the other nitrogen species vary much more. Three quarters of cBOD5 results and about 60% of TSS-concentrations meet a concentration limit of 10 mg/L.

One key distinction in the group of effluent samples is whether or not there was a design P-reduction step present before the location of the effluent sample. This, rather than the design classification, is used here as an initial distinction. Table 6 b) summarizes the results of composite samples following a P-reduction step, and table 6 c) shows the effluent composite results following only the aerobic treatment step. The median test function of SPSS served to assess the significance of differences between the two sets of effluent results (table 7). For cBOD5 and TSS, the additional treatment step resulted in significantly lower concentrations. Because the populations of manufacturers of aerobic treatment systems differ between the two groups, it is not conclusive but likely that the additional residence time and treatment provided by the phosphorus reduction step is at least partly a reason for the better effluent results.

For ammonia, nitrate, TKN and TN, no significant differences between the two groups of effluent samples could be detected. Nitrite-N is somewhat lower (P=0.07) following a P-reduction step. Overall, total nitrogen in the effluent is typically between 20 and 30 mg/L (interquartile 15-43 mg/L), which is considerably lower than the influent concentrations and intermediate sample results. While the lowering of concentrations shows that the treatment is effective, an effluent concentration standard of 10 mg/L that applies to systems with P-reduction is only met slightly more than 10% of the time by those samples. Additional analysis is needed to assess reasons for this deviation.

Total phosphorus showed a significant effect of a P-reduction treatment step. Because the differences in aerobic treatment units are not expected to influent P-treatment, this difference can likely be attributed to the P-treatment. Still, the effluent concentration standard of 1 mg/L is met by less than 10% of samples. Additional analysis is needed to assess reasons for this deviation.

Total alkalinity does show no significant differences as measured by the median test, even though there appears to be a tendency toward a slight increase with the P-reduction step.

Table 6. Statistics of Effluent Composite Sample Concentrations: a) all samples; b) effluent samples following P-reduction treatment step; c) effluent samples not following P-reduction treatment step

a) all samples

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	111	111	110	111	111	110	110	109	76
Mean		8.1612	32.2955	10.73959	14.94288	.85684	20.94282	36.51609	6.42327	125.000
Std. Deviation		11.89332	75.37617	17.030477	17.654600	2.207711	30.023846	34.432948	5.010278	105.2158
Minimum		2.00	1.00	.039	.047	.025	.070	3.790	.036	5.0
Maximum		95.10	510.00	70.960	116.720	19.000	185.380	185.660	34.000	540.0
Percentiles	5	2.0000	1.0000	.03900	.05000	.02500	.37750	6.48250	.38500	5.000
	25	2.0000	2.4000	.36500	2.10000	.12000	2.44750	15.49500	3.45000	49.000
	50	3.1000	9.0000	2.65000	11.00000	.34000	9.71000	23.51500	5.70000	100.000
	75	9.2000	23.0000	11.00000	20.00000	.58000	26.20250	42.75250	7.75000	185.250
	95	30.8000	168.0000	59.00000	41.74200	3.27600	86.28700	117.12450	16.00000	331.500

b) effluent samples following P-reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	82	82	82	82	82	82	82	81	58
Mean		7.5182	30.3902	11.55263	15.11946	.74417	21.46012	36.95878	5.90136	133.586
Std. Deviation		9.06605	83.43561	16.762218	19.088660	2.266753	30.504994	36.846665	4.539155	100.1320
Minimum		2.00	1.00	.039	.047	.025	.070	3.790	.080	5.0
Maximum		34.00	510.00	64.000	116.720	19.000	185.380	185.660	27.000	540.0
Percentiles	5	2.0000	1.0000	.03900	.05000	.02500	.33200	6.31500	.55100	9.750
	25	2.0000	2.0000	.23750	1.70000	.09300	2.06750	15.49500	3.15000	66.500
	50	2.5500	7.0000	3.00000	11.00000	.21500	10.09000	22.25500	5.20000	115.000
	75	9.1250	16.2500	15.50000	20.00000	.55500	29.77750	40.90750	7.60500	190.000
	95	30.0000	178.0000	57.35000	44.09450	2.35800	83.05000	134.13000	15.60000	330.500

c) effluent samples not following P-reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	29	29	28	29	29	28	28	28	18
Mean		9.9793	37.6828	8.35854	14.44359	1.17541	19.42786	35.21964	7.93307	97.333
Std. Deviation		17.70007	46.27225	17.890998	13.039805	2.035076	29.056063	26.665620	6.015130	118.9953
Minimum		2.00	1.00	.039	.050	.025	.350	10.000	.036	5.0
Maximum		95.10	180.00	70.960	42.000	9.590	120.000	130.000	34.000	415.0
Percentiles	5	2.0000	1.5000	.07095	.07200	.02550	.45350	10.90000	.09630	5.000
	25	2.7500	7.4000	.41250	3.25000	.19000	3.67000	16.00000	5.40000	13.750
	50	4.7000	18.0000	1.85000	9.39000	.47000	8.61500	26.34000	7.10000	45.000
	75	10.5000	46.5000	7.00000	23.66500	.87500	17.57000	43.68750	9.19250	155.000
	95	65.0500	170.0000	67.82800	40.17000	7.54000	105.53700	111.03700	25.90000	415.000

Table 7. Median test results for differences between effluent composite samples taken after P-reduction and effluent samples not taken after P-reduction treatment steps.

Test Statistics[a]

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N		111	111	110	111	111	110	110	109	76
Median		3.1000	9.0000	2.65000	11.00000	.34000	9.71000	23.51500	5.70000	100.000
Chi-Square		5.920	8.875	.767	.002	4.004	.192	1.725	6.133	3.171
Df		1	1	1	1	1	1	1	1	1
Asymp. Sig.		.015	.003	.381	.963	.045	.662	.189	.013	.075
Yates' Continuity Correction	Chi-Square	4.915	7.634	.431	.029	3.186	.048	1.198	5.094	2.280
	df	1	1	1	1	1	1	1	1	1
	Asymp. Sig.	.027	.006	.511	.865	.074	.827	.274	.024	.131

a. Grouping Variable: P_reduction_sampled

3.3.4 Effluent Grab Samples

This section discusses effluent grab sample results. As was the case for composite samples, the samples are distinguished by whether or not a phosphorus reduction step was present upstream of the sampling location. Table 8 summarizes the results. A median test shows significant differences between systems with and without phosphorus reduction step not only for total phosphorus but also for cBOD5, TSS, ammonia, nitrite, total nitrogen, and total alkalinity. The assumption of the test that samples are independent of each other is not strictly met if several grab samples over the course of a day are closely related.

The test did not show significant differences for nitrate and TKN. There is an apparent contradiction between the observations that total nitrogen is significantly reduced, but nitrate and TKN, the major components of total nitrogen, are not. The number of analytes for which significant differences occur is much larger for grab samples than composite samples. One reason for this could be that the higher number of samples allows detection of smaller differences as significant. Another reason could be that grab and composite sample are different. A median test for samples after a phosphorus reduction step showed that only cBOD5 was different between grab and composite samples, with the composite samples tending higher. The same test for effluent samples without phosphorus reduction step showed no significant differences between grab and composite samples. This indicates that the detection of more differences in grab effluent sample concentrations between samples after a phosphorus reduction step and before a phosphorus reduction step than in composite effluent samples was due to the larger sample size of grab samples as compared to composite effluent samples.

Table 8. Statistics of Effluent Grab Sample Concentrations: a) all samples; b) effluent samples following P-reduction treatment step; c) effluent samples not following P-reduction treatment step

a) all samples

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	445	448	449	449	449	449	449	445	308
Mean		9.1968	25.9670	11.38101	14.83197	.70231	20.79302	36.09156	6.23426	125.484
Std. Deviation		17.08720	67.56809	17.523687	17.340984	1.486672	30.971103	34.401153	4.306848	108.1260
Minimum		2.00	1.00	.010	.047	.025	.038	2.700	.035	5.0
Maximum		170.00	910.00	90.000	121.030	11.550	198.920	199.050	30.000	590.0
Percentiles	5	2.0000	1.0000	.03900	.05000	.02500	.21500	6.50000	.25900	9.000
	25	2.0000	2.0000	.32500	2.44000	.12000	1.97500	15.00000	3.40000	52.500
	50	2.1000	6.3000	3.46000	11.30000	.24000	8.92000	24.00000	6.00000	98.500
	75	9.0000	22.0000	12.00000	21.00000	.58500	25.38000	44.08000	8.36000	180.000
	95	31.0000	110.0000	55.00000	42.93500	2.95000	78.18500	110.84500	13.00000	325.500

b) effluent samples following P-reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	328	331	332	332	332	332	332	328	236
Mean		7.3490	13.9807	12.36192	14.74019	.52129	21.21756	36.21759	5.65994	135.542
Std. Deviation		9.38602	28.73034	17.293897	18.587893	1.084422	31.877712	36.992441	4.050515	105.2342
Minimum		2.00	1.00	.010	.047	.025	.038	2.700	.080	5.0
Maximum		60.00	300.00	69.000	121.030	9.540	198.920	199.050	30.000	590.0
Percentiles	5	2.0000	1.0000	.03900	.04700	.02500	.07000	5.64300	.31150	11.700
	25	2.0000	2.0000	.21500	1.40000	.09000	1.54000	13.63750	2.70000	66.250
	50	2.0000	4.6000	4.00000	11.41000	.20000	9.05500	23.00000	4.90000	110.000
	75	8.3750	13.0000	17.50000	20.00000	.51000	26.99500	43.96000	7.80000	190.000
	95	28.5500	50.8000	52.05000	43.41900	1.60000	75.14200	122.56100	12.00000	321.500

c) effluent samples not following P-reduction treatment step

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N	Valid	117	117	117	117	117	117	117	117	72
Mean		14.3768	59.8769	8.59757	15.09241	1.21597	19.58832	35.73393	7.84432	92.514
Std. Deviation		28.85286	116.93906	17.944036	13.242922	2.195551	28.335685	25.798742	4.604402	111.6220
Minimum		2.00	1.00	.039	.050	.025	.074	5.800	.035	5.0
Maximum		170.00	910.00	90.000	44.000	11.550	143.260	143.260	27.000	406.0
Percentiles	5	2.0000	1.0000	.06060	.09400	.02600	.80300	7.33000	.03500	5.000
	25	2.0000	6.0000	.60500	3.51500	.18000	3.25000	18.53500	5.40000	11.000
	50	4.2000	20.0000	1.90000	11.23000	.47000	7.69000	27.00000	7.10000	32.000
	75	9.4000	50.0000	7.05000	24.89500	1.20000	17.63000	45.00000	9.60000	140.000
	95	99.5700	269.0000	69.37900	39.22900	5.28700	90.38200	90.38200	16.20000	397.000

Table 9. Median test results of differences between effluent grab samples with and without phosphorus reduction step.

		CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total_alk.
N		445	448	449	449	449	449	449	445	308
Median		2.1000	6.3000	3.46000	11.30000	.24000	8.92000	24.00000	6.00000	98.500
Chi-Square		22.235	37.585	4.725	.087	15.678	.525	5.750	16.101	16.314
Df		1	1	1	1	1	1	1	1	1
Asymp. Sig.		.000	.000	.030	.768	.000	.469	.016	.000	.000
Yates' Continuity Correction	Chi-Square	21.231	36.278	4.269	.035	14.838	.381	5.246	15.249	15.244
	df	1	1	1	1	1	1	1	1	1
	Asymp. Sig.	.000	.000	.039	.852	.000	.537	.022	.000	.000

3.3.5 Bacteriological samples

Late in phase 2 and early in phase 3, samplers obtained some effluent samples that they delivered to a local laboratory for bacteriological analysis. The small number of samples, together with the occurrences of some “too numerous to count” results and varying reporting limits limit the precision of the results. Table 10 provides the summary of numerical values of effluent samples. Five of the twenty fecal coliform samples exceeded both the 200 cfu/100 mL annual average standard and the 400 cfu/100 mL grab sample standard for secondary treatment standards. Two of the 13 enterococci samples resulted in concentrations of 80 cfu/100 mL or larger.

Table 10. Bacteriological sample results

		Fecal_coliform(cfu/100mL)	Enterococcus(cfu/100mL)
N	Valid	20	13
Mean		326.45	104.62
Std. Deviation		636.769	329.821
Minimum		2	2
Maximum		2250	1200
Percentiles	5	2.00	2.00
	25	2.00	2.00
	50	20.00	4.00
	75	394.00	20.00
	95	2221.00	1200.00

3.4 Water use

During most sampling events, samplers obtained an event 24-hour water use based on water meter records. For residences overall, this resulted in 73 daily water uses with a mean of 190 gpd, standard deviation of 170 gpd, a median of 150 gpd, and a interquartile range from 70 to 235 gpd. As mentioned before, for the very first sampling event, samplers added exceptionally much water to the treatment system to trigger a dosing event. After eliminating this data point, mean, standard deviation and median remained approximately the same, and the interquartile range changed from 65 to 230 gpd. Figure 2 shows the distribution of (daily) event water uses. The distribution appears bimodal: one mode (0-67 gpd) is located at very low water uses, which may represent that no users were present on that day. The second mode (133-200 gpd) includes the median and mean water use and in this way represents a “typical water use”. A determination of the spearman correlation between water use and influent concentration (29 data pairs) did not detect any significant correlation.

Averaging water use by system or house resulted in a mean water use of the 32 houses of 190 gpd with a standard deviation of 120 gpd, a median of 170 gpd, and an interquartile range from 110 to 240 gpd. The upward shift of the lower quartile and the reduction in standard deviations suggests that some houses that had no water use on one sampling event day, had high to very high water use on another sampling event day.

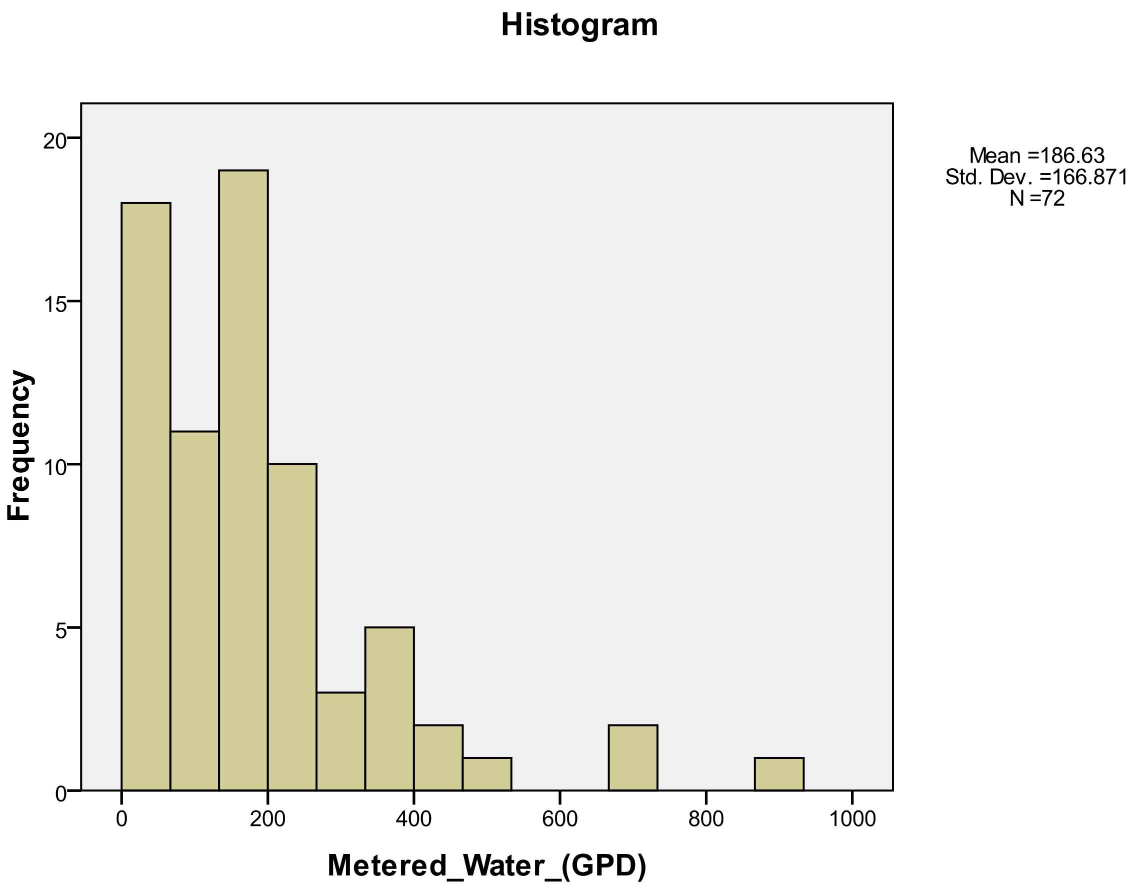


Figure 2. Histogram for residential event water use (except first sampling event)

3.5 Variations between grab samples during a composite sampling period

3.5.1 Variability between pairs of grab samples

One way to assess how representative one grab sample is for a sampling period is to compare it to other grab samples taken during the same sample sampling period. For the sampling periods of this study, this resulted in nearly 700 pairs. For the purposes of this analysis, a difference of zero was assigned to two samples that were below the laboratory detection limit (qualified as "U"), even though the reported detection limit may have varied. Table 11 summarizes the relative standard deviations observed. For cBOD5 and nitrite a substantial fraction of sample pairs did not show a difference, as many samples had concentrations below the detection limit. TSS showed the highest variability with an average RSTD of 35%. The various nitrogen species varied on average more than total nitrogen. TP and total alkalinity tended to vary the least.

Table 11. Relative standard deviations for pairs of grab samples taken during the same event.

relative standard deviation	cBOD5	TSS	Ammonia -N	TKN	Nitrate-N	Nitrite-N	TN	TP	Total Alkalinity
number of pairs	688	692	694	694	694	694	694	688	476
fraction with rstdev=0	0.47	0.18	0.19	0.10	0.23	0.49	0.14	0.17	0.30
5-percentile	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25-percentile	0.000	0.070	0.018	0.036	0.002	0.000	0.013	0.013	0.000
50-percentile	0.034	0.286	0.085	0.109	0.034	0.015	0.046	0.045	0.030
75-percentile	0.227	0.535	0.303	0.262	0.118	0.241	0.103	0.123	0.073
95-percentile	0.794	0.979	0.936	0.850	0.718	1.020	0.383	0.330	0.356
Average	0.166	0.351	0.230	0.206	0.131	0.199	0.100	0.098	0.070
Stdev	0.261	0.322	0.320	0.267	0.267	0.324	0.176	0.167	0.122

3.5.2 Influence of time lag

Several grab samples collected over time allowed an assessment of how quickly concentrations change over the course of a day. This analysis compared the time differences between the times when two grab samples were taken to the relative standard deviations of their concentration results.

Table 12 summarizes the relative differences between a sample and subsequent samples. Initial inspection suggested that the differences between the first grab sample and all subsequent samples might be different from the relationships between all subsequent samples. An explanation for such behavior could be, for example, that the first sample is more influenced by the deployment of the sampling apparatus. Therefore, table 12 distinguishes three groupings: all data, comparisons to the first grab sample of all other grab samples, and comparisons between grab samples other than the first. For cBOD5 and TSS there is a distinct difference between the two latter sub-groupings, that is highly significant as measured by a two-tailed t-test with unequal variances; for total alkalinity the difference is less significant with a significance level of 0.057. For TSS, the first grab sample appears to show noticeably higher concentrations (relative differences median 15%, average 24%) than subsequent samples. For subsequent samples there is still some average decrease in concentrations but to a lesser extent (average 7%, median 0%). For cBOD5, the average relative difference between the first and subsequent samples is about 10%, but the median is 0 %, and for subsequent sample there appears to be no strong downward pattern. For all other analytes, there did not appear to be a significant difference between the differences to the first sample and differences between all subsequent samples.

Table 13 shows the median of the resulting relative standard deviations grouped by time difference between sampling events. Results are based on at least 30 samples in each group. In contrast to the plausible expectation that later samples should generally be more different from an initial sample compared to earlier samples, there is no consistent pattern showing such behavior.

Given the anomaly of the first grab sample results for TSS and cBOD5 discussed before, the same sub-grouping was used in this analysis. TSS, which in all groupings showed the highest variability, showed a median relative standard deviation between 30 and 40% compared to the first grab sample, but only 20-30% for differences between subsequent grab samples. For nitrate and cBOD5 the typical variability is diminished to about half, from levels less than 10% to levels below 5%.

Total alkalinity, ammonia, nitrate-, and nitrite nitrogen do appear to have a tendency towards increased variability with time in both sub-groupings, but the overall effect is small, with increases in relative nitrate and total alkalinity standard deviations of less than 5% in all cases, and increases of ammonia and nitrite relative standard deviations of 11% or less.

Table 12. Median relative difference between two grab samples, the first grab sample and subsequent grab samples, and relative differences between grab samples other than the first grab sample.

Relative differences		cBOD5	TSS	Ammonia -N	TKN	Nitrate-N	Nitrite-N	TN	TP	Total Alk.
overall	Median	0.000	-0.064	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	-0.044	-0.153	-0.022	0.009	-0.006	0.041	0.010	-0.009	-0.021
first sample	Median	0.000	-0.154	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	-0.099	-0.240	-0.028	-0.005	-0.003	0.040	0.011	-0.017	-0.039
all other samples	Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	0.009	-0.070	-0.016	0.023	-0.010	0.042	0.009	-0.002	-0.004
Significance level of two-tailed t-test w/ unequal variance between first and all other samples		0.001	0.001	0.786	0.437	0.832	0.961	0.927	0.473	0.057

Table 13. Median relative standard deviation between different grab samples.

	Time Difference (d)		Parameter								
	between	and	cBOD5	TSS	TKN	Ammonia -N	Nitrate -N	Nitrite -N	TN	TP	Total Alk.
first grab sample	0.04	0.10	0.06	0.30	0.10	0.08	0.04	0.02	0.03	0.03	0.02
	0.10	0.21	0.05	0.40	0.12	0.08	0.03	0.06	0.05	0.05	0.05
	0.22	0.39	0.07	0.37	0.11	0.07	0.04	0.05	0.06	0.09	0.04
	0.71	1.17	0.06	0.34	0.15	0.15	0.06	0.13	0.05	0.05	0.05
all other grab samples	0.04	0.10	0.03	0.22	0.09	0.06	0.02	0.00	0.04	0.04	0.02
	0.10	0.21	0.03	0.30	0.12	0.09	0.02	0.00	0.05	0.03	0.02
	0.22	0.39	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d
	0.71	1.17	0.00	0.22	0.12	0.11	0.04	0.06	0.03	0.05	0.03

3.6 Variability of grab samples during diurnal sampling

Relative standard deviations for the grab samples for each sampling period were determined. Table 14 summarizes the distribution of grab sample relative standard deviations. As could be expected, there is considerable variability in this measure between no changes at all during the course of a day, and relative standard deviations that exceed 100%. Generally, total alkalinity, TN and TP show the lowest variability, with 95% of sampling events resulting in a relative standard deviation of 40% or less. The individual nitrogen species have usually higher variability than the total nitrogen measurements. Nitrate, cBOD5, TKN, ammonia and nitrite show increasing variability. The highest variability by far is shown by TSS, for which only 25% or sampling events show a relative standard deviation of 40% or less.

A Pearson correlation of the ranks of relative standard deviations indicated very limited associations. The highest correlation was 0.56 between nitrate and nitrite nitrogen variability, and 0.53 between TSS and total alkalinity variability. The next highest correlations were between TKN and total nitrogen (0.4), nitrate and total nitrogen (0.39), total nitrogen and total phosphorus (0.38) and ammonia and TKN (0.37). The correlation of variability between nitrogen species is plausible. More interesting is the result that some association exists between analytes that are not as obviously related, such as TSS and total alkalinity, and TN and TP.

Linear correlations between the mean concentration during a day and the relative standard deviations resulted in correlation coefficients of less than 0.1 for all analytes except for TSS, for which the correlation coefficient was only 0.17. This indicates that the normalization of standard deviations to relative standard deviations was successful in removing the influence of the absolute magnitude of concentrations from the variability assessment.

Comparing the distributions of relative standard deviations as measure of differences between individual grab samples (see previous section), the relative standard deviations of grab samples taken during a sampling event tend to be larger, in particular for nitrite, TSS, and cBOD5. The exception is nitrate. While no further analysis of this was attempted, reasons for this could be for example: one grab sample that was markedly different from others in a day would result in one large standard deviation for the day, but only in relatively few large standard deviations for grab sample comparisons; the analysis for this section utilized the numerical value for any sample, while the analysis for inter-grab sample variability assigned a difference of zero to two grab samples that were both below the detection limit, even if the detection limit was different due to different dilutions..

Table 14. Distribution of relative standard deviations for grab samples collected over a day

	CBOD5	TSS	AMMONIA -N	NITRATE -N	NITRITE -N	TKN	TN	TP	Total alk.
number of events	110	111	111	111	111	111	111	110	76
fraction with rstdev=0	0.35	0.07	0.11	0.12	0.39	0.04	0.05	0.05	0.17
5-percentile	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00
25-percentile	0.00	0.24	0.04	0.02	0.00	0.08	0.03	0.03	0.02
50-percentile	0.13	0.40	0.14	0.06	0.14	0.15	0.06	0.08	0.05
75-percentile	0.36	0.66	0.42	0.19	0.44	0.36	0.13	0.14	0.10
95-percentile	0.95	1.03	0.95	0.71	1.22	0.68	0.40	0.36	0.38
Average	0.24	0.47	0.28	0.18	0.29	0.25	0.12	0.13	0.09
Stdev	0.31	0.32	0.35	0.30	0.40	0.24	0.15	0.19	0.12

3.7 Differences between grab and composite samples

Table 15 shows the relative differences between the average of grab samples and the time composite samples taken during the same sampling event. Negative numbers indicate that the composite sample had higher concentrations than the average of the grab samples. The median and average of the relative differences are very close to zero, indicating that there is no systematic bias between the two measures of daily effluent concentrations.

The standard deviation of the relative differences provides a measure of how frequently the differences are large. The most varying analyte is TSS, while total alkalinity, TP, TN and nitrate are the least variable. This order of variability is the same as the one for average relative standard deviations of grab samples over the course of a day (see table 14).

A different approach to comparing grab samples and composite samples consists in performing a median test between all composite effluent samples and all individual grab samples. Table 16 shows the results of this test. This analysis indicates that cBOD5 ($p=0.012$) and to a lesser extent ($p=0.065$), TSS, are somewhat but significantly higher in composite samples than in grab samples. It may require further analysis to discern what causes this result to be different from the results shown in table 15.

Table 15. Distribution of relative differences between average of grab samples and time-composite samples during the same sampling event, generally a 24-hour period.

	CBOD5	TSS	AMMONIA -N	NITRATE -N	NITRITE -N	TKN	TN	TP	Total alk.
Number of events	110	111	110	111	111	110	110	109	76
5-percentile	-0.76	-1.54	-0.89	-0.37	-0.72	-1.05	-0.36	-0.45	-0.37
25-percentile	-0.23	-0.47	-0.10	-0.06	0.00	-0.17	-0.06	-0.06	-0.08
50-percentile	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.01	-0.01
75-percentile	0.10	0.47	0.22	0.07	0.14	0.19	0.10	0.09	0.05
95-percentile	0.80	1.27	1.09	0.42	1.11	0.62	0.34	0.21	0.31
Average	-0.01	-0.01	0.07	0.01	0.05	-0.05	0.02	-0.02	-0.01
Stdev	0.51	0.78	0.55	0.33	0.57	0.53	0.28	0.26	0.22

Table 16. Median test results between all effluent composite and effluent grab samples.

Test Statistics[a]

		CBOD5	TSS	AMMONIA -N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
N		556	559	559	560	560	559	559	554	384
Median		2.4000	6.8000	3.00000	11.11500	.24500	8.98000	24.00000	5.88000	99.500
Chi-Square		6.812	3.802	.621	.101	.551	.199	.004	.560	.066
df		1	1	1	1	1	1	1	1	1
Asymp. Sig.		.009	.051	.431	.750	.458	.655	.947	.454	.798
Yates' Continuity Correction	Chi-Square	6.269	3.400	.465	.045	.405	.116	.002	.411	.016
	df	1	1	1	1	1	1	1	1	1
	Asymp. Sig.	.012	.065	.495	.832	.525	.734	.968	.521	.898

a. Grouping Variable: sample_type

3.8 Observations relating to high variability

Notes taken by the samples on the sampling events suggest a few possible sources for variability between grab samples and differences between grab and time-composite samples.

In the very first sampling event, substantial amounts of water were added to the influent, in order to trigger a dosing event, which in turn would refill the sampling port. This resulted in a total water use for the day of 630 gallons. The series of grab samples from this event show a pronounced step increase in concentrations from the first grab sample to subsequent grab samples for all parameters. Relative to other sampling events, this event had among the highest relative standard deviations for TN, nitrite, and nitrate (top ten), and fairly high for TKN and cBOD5 (top 20). The differences between the average of grab samples and the time-composite samples were among the ten largest positive for cBOD5, nitrite, TKN and TN and negative for nitrate.

For the 53rd and 54th events, notes indicated that the sampler requested the owner to use additional water because not enough was left in the sampling port to sample, resulting in a total water use of 150 and 50 gallons. In both cases, the total suspended solids show a marked elevation during the grab samples preceding the request, and a drop in the samples after the request. The other parameters do not change clearly. The relative standard deviations for event 53 were not particularly high for any parameter, while cBOD5 for the event 54 showed the 5th highest relative standard deviation. In contrast, the relative differences between grab samples and composite samples were among the ten highest positive for cBOD5, TSS, TN and TP in the first case, and the ten highest for cBOD5 and TSS in the second case.

For the 76th event, a sampling note indicated that after the first grab sample, water was added for about 15 minutes to the building sewer cleanout, which increased the total usage to 150 gallons on that day. The influence on effluent concentration is less clear, as suspended solids in the next grab sample increased and then decreased markedly over the next two samples. For this day the TP concentrations show the fifth highest relative standard deviation and cBOD5 concentrations the 17th highest. Among the relative differences between grab and time-composite samples, only ammonia showed a relatively high negative difference

Event 106, included addition of 15 minutes of water after the first grab sample, after having advised the owner to use some water before the sampling event. This resulted in a water use of 340 gallons. While some decrease in the concentrations of several parameters in subsequent grab samples during the same afternoon appears to be present, the composite sample results are consistent with the initial grab samples. Ammonia and total nitrogen relative standard deviations were in the top 20 of sampling events.

A note for event 59 indicated that the owner returned home overnight after being absent while the grab samples were taken. Even though the return occurred after the grab samples were taken, the grab samples show comparatively high relative standard deviations for nitrate and nitrite (in top 10) and TSS (in top 20). The composite effluent sample shows a marked change from the grab effluent samples for all parameters, with ammonia and nitrate showing among the largest negative relative differences, and TKN and TN the highest positive differences. This occurred, even though the water use for the day was only 30 gallons.

A sampling note for event 60 indicated that it rained after the last grab sample was taken, and that surface runoff flowed into to the effluent sampling port. Given that the disturbance occurred after the grab samples were taken, it is not surprising that the relative standard deviations were not very high compared to other events. A comparison of grab and composite effluent samples shows that the composite samples contained about twice as high suspended solids, and about a third lower TKN, Nitrate, nitrite, TN and TP concentrations than the fairly steady grab samples. In terms of relative differences between grab sample average and composite sample for this event, nitrate, TN, TP and total alkalinity are among the ten highest events, but TSS was not.

Overall, these anecdotes suggested that water use patterns over the course of the day can influence grab samples, which in turn can influence the variability of the grab samples obtained and the differences between composite and grab sample averages. Perhaps because timing of water use and grab samples was variable in this study, there was no general pattern in these differences discernable.

3.9 Differences between repeat sampling events

3.9.1 Effluent samples

Over the course of the study, systems were sampled repeatedly, with one exception of a single sample event system. For some systems that were included in all phases of the study, up to 7 sampling events occurred, for systems that were only included in the last phase, only two sampling events occurred. These sampling events provide an opportunity to assess the variability between samples at the same system on different days. The intervals between two sampling events at the same site ranged from the next day to 799 days, with 90% between 49 and 730 days.

The results for relative differences for all possible combinations of sampling event results are shown in table 17. Both TSS and ammonia appear to show a bias that later sampling events are higher in concentration than earlier events, while total alkalinity shows an element of the reverse. Given the large standard deviations, these biases are not significant when assuming a normal distribution.

The differences between results based on grab samples and results based on composite samples could stem from the two groups unexpectedly representing different distributions. Using a two-tailed paired t-test to assess differences between the grab sample and composite sample based differences, total nitrogen had the highest level of significance (0.058), followed by TSS (0.14).

Tables 18 and 19 illustrate the distribution of relative standard deviations between samples of the same system based on averages of grab samples (table 18) and composite samples (table 19). To exclude the effect of some systems having been sampled more frequently than others, table 20 summarizes average relative standard deviations and their variability after first averaging the observations for each system and then averaging across the 38 systems with more than one sampling event. In all cases, TN and TP show the lowest variability, while nitrite and ammonia show the highest variability.

Table 17. Summary of relative differences between event samples at the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Average of relative differences between composite	0.08	0.33	0.38	-0.09	-0.01	-0.03	0.00	-0.09	-0.18
stdev comp	0.84	1.02	1.18	0.87	1.29	1.11	0.65	0.62	0.74
Average of relative differences between average of event grab samples	0.05	0.23	0.35	-0.12	0.01	-0.02	0.08	-0.08	-0.17
stdev grab	0.90	0.92	1.15	0.91	1.23	1.13	0.68	0.63	0.75

Table 18. Distribution of relative standard deviations between event averages of multiple grab samples taken from the same system

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Number	132	138	138	138	138	138	138	136	47
5-percentile	0.00	0.02	0.03	0.03	0.05	0.07	0.01	0.02	0.04
25-percentile	0.02	0.22	0.28	0.11	0.37	0.23	0.10	0.10	0.17
50-percentile	0.36	0.44	0.73	0.40	0.79	0.58	0.31	0.21	0.33
75-percentile	0.80	0.89	1.12	0.80	1.14	1.07	0.58	0.46	0.56
95-percentile	1.21	1.24	1.37	1.30	1.31	1.33	1.03	0.93	1.10
Average	0.46	0.54	0.72	0.49	0.76	0.66	0.37	0.32	0.42
Stdev	0.44	0.40	0.45	0.42	0.41	0.44	0.31	0.31	0.34

Table 19. Distribution of relative standard deviations between composite effluent samples taken from the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Number	138	138	133	138	138	133	133	131	47
5-percentile	0.00	0.00	0.04	0.03	0.07	0.06	0.02	0.01	0.03
25-percentile	0.14	0.35	0.32	0.13	0.55	0.22	0.11	0.11	0.17
50-percentile	0.39	0.62	0.86	0.32	0.85	0.62	0.27	0.23	0.30
75-percentile	0.80	0.97	1.14	0.71	1.18	1.03	0.50	0.46	0.50
95-percentile	1.08	1.28	1.38	1.30	1.34	1.33	0.99	0.97	1.05
Average	0.47	0.64	0.75	0.46	0.81	0.65	0.35	0.32	0.41
Stdev	0.36	0.39	0.45	0.41	0.41	0.44	0.30	0.31	0.35

Table 20. Average relative standard deviations based on averaging relative standard deviations for each system (n=38).

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Average grab system averages	0.45	0.54	0.60	0.57	0.77	0.54	0.34	0.31	0.43
Stdev	0.38	0.34	0.41	0.41	0.33	0.38	0.28	0.28	0.36
Average comp sample systems	0.38	0.61	0.63	0.58	0.80	0.55	0.35	0.31	0.43
Stdev	0.33	0.35	0.39	0.41	0.37	0.39	0.29	0.25	0.37

The pearson correlation coefficient between length of time between sampling events and relative standard deviations was less than 0.2 for all analytes. This indicates that there is no common pattern of samples becoming more different as more time elapses between sampling events. For grab samples, the following pairs showed pearson correlation coefficients between 0.5 and 0.7: TKN and TN, TKN and cBOD5, total alkalinity and cBOD5, and ammonia and total alkalinity. These pairs appear to indicate a common pattern of completeness of biochemical stabilization and nitrification. Composite effluent samples have similar correlations, except lower for ammonia and total alkalinity, and cBOD5 and total alkalinity, and higher between total alkalinity and TKN.

One-way ANOVAs allowed an assessment of the importance of differences between systems relative to the variability of grab samples or composite samples. Differences between systems were significant ($P<0.05$) relative to variability between events (composite samples) and variability between grab samples (grab samples), with the exception of nitrite for composite samples, while nitrate showed the largest F-value of all composite sample parameters. For grab samples, TN and TP were the largest F-values. This indicates that there are differences in the consistency of treatment between systems.

3.9.2 Influent Samples

Table 21 shows the distribution of the resulting relative differences between influent samples from the same system. While the averages suggest some bias, the highest for total phosphorus, ammonia and nitrate, compared to the standard deviation, they are not significantly different from zero (based on a normal distribution). A negative bias would indicate that influent concentrations decrease over time for the same system, for example due to changing patterns of household behavior.

A Pearson correlation between the relative standard deviations of influent samples and the time difference between influent samples showed no correlation coefficient larger than 0.3. Pearson correlations between the relative differences of analytes showed many correlation coefficients larger than

0.5, indicating that for influents, changes occur for several analytes together. The highest correlations were between TKN and TN (0.98) and ammonia and total alkalinity (0.82). TKN and ammonia, TN and ammonia, TKN and total alkalinity, and TN and total alkalinity all showed correlation coefficients between 0.7 and 0.8. With correlation coefficients between 0.5 and 0.7, total phosphorus and total alkalinity, total phosphorus and TKN, total phosphorus and TN, cBOD5 and TSS, TN and cBOD5, TKN and cBOD5, TN and cBOD5, and TN and TSS show much stronger correlations than they did for effluent samples.

Table 22 shows the distribution of relative standard deviations between influent samples from the same system. This table is comparable to table 11 for effluent samples. Table 23 averages the relative standard deviations over the number of systems that were repeatedly sampled. The two tables show similar results, but nitrate appears more variable between systems and total phosphorus less variable between systems. Ammonia and total alkalinity show somewhat lower variability between systems Average relative standard deviations are generally of similar magnitude for influent and effluent samples. An analyte that appears to be more variable in influent samples is nitrate, which in influents is generally a small fraction of the total nitrogen, while ammonia is less variable.

A one-way ANOVA allowed an assessment of the importance of differences between systems relative to the variability of composite samples. Differences between systems were not significant relative to variability between events (composite samples) for cBOD5, TSS, and nitrate, and significant ($p<.05$) for total phosphorus, total alkalinity, ammonia, nitrite, TKN and total nitrogen. This indicates that the influent variability is large enough for each system that differences between systems are not identifiable for cBOD5 and TSS, but that differences by system are identifiable for TN and TP.

Table 21. Distribution of relative differences between influent composite samples taken from the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Number	44	48	48	48	48	48	48	46	21
5-percentile	-1.19	-1.44	-1.36	-1.62	-1.79	-1.05	-0.85	-1.40	-0.45
25-percentile	-0.53	-0.78	-0.16	-0.15	-0.71	-0.53	-0.53	-0.77	-0.19
50-percentile	-0.03	-0.19	0.09	0.00	0.25	-0.10	-0.11	-0.33	-0.04
75-percentile	0.33	0.50	0.62	0.94	0.50	0.47	0.47	0.19	0.12
95-percentile	1.12	1.96	1.33	1.64	1.69	1.35	1.31	1.44	0.50
Average	-0.10	-0.05	0.18	0.12	0.08	0.02	0.05	-0.23	-0.07
Stdev	0.73	1.00	0.83	1.07	1.07	0.83	0.76	0.88	0.38

Table 22. Distribution of relative standard deviations between influent composite samples taken from the same system.

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Number	44	48	48	48	48	48	48	46	21
5-percentile	0.01	0.10	0.00	0.00	0.01	0.01	0.01	0.06	0.03
25-percentile	0.12	0.25	0.10	0.00	0.24	0.09	0.09	0.19	0.05
50-percentile	0.29	0.48	0.26	0.65	0.42	0.38	0.38	0.40	0.14
75-percentile	0.73	0.86	0.74	0.96	1.10	0.65	0.58	0.83	0.27
95-percentile	0.95	1.39	1.17	1.24	1.27	1.27	1.00	1.16	0.40
Average	0.40	0.57	0.43	0.56	0.60	0.43	0.40	0.51	0.19
Stdev	0.32	0.40	0.41	0.50	0.45	0.39	0.35	0.38	0.20

Table 23. Average relative standard deviations based on averaging relative standard deviations for each system (n=18).

Parameter	CBOD5	TSS	AMMONIA-N	NITRATE-N	NITRITE-N	TKN	TN	TP	Total alk.
Average	0.36	0.57	0.46	0.74	0.68	0.42	0.36	0.38	0.22
Stdev	0.32	0.33	0.44	0.40	0.42	0.44	0.35	0.31	0.22

3.10 Summary of Variability

The preceding sections described the variability observed between samples that could be thought of a representing the same observation points. Repeated analyses of the same sample, multiple grab samples during the same sampling events, and multiple sampling events at the same systems provide measures of variability at different time scales. Within the event time-scale, there was some indication that the variability of total alkalinity, ammonia, nitrate-, and nitrite nitrogen increased with longer time intervals between samples, but the effect was small. There was no such effect identified for the between event variability, because the variability was too high.

Figure 3 summarizes the variability as average relative standard deviation and its standard deviation, and as 75th percentile of relative standard deviations. Figure a and b show this for grab sample variability, including the variability of replicate samples as a baseline variability. Figure c and d compare influent and effluent time composite samples. In most cases, the between-event variability is at least twice as large as the within-event variability. The only exception to this is TSS, which has the highest replicate and within-event variability of all analytes and for which the within-event variability is only about a third lower than the between-event variability.

Time composite effluent samples result in very similar variability characteristics as the grab samples. Influent and effluent time composite samples vary similarly with the possible exception that influent TP is more variable than effluent TP and influent total alkalinity is less variable than effluent total alkalinity.

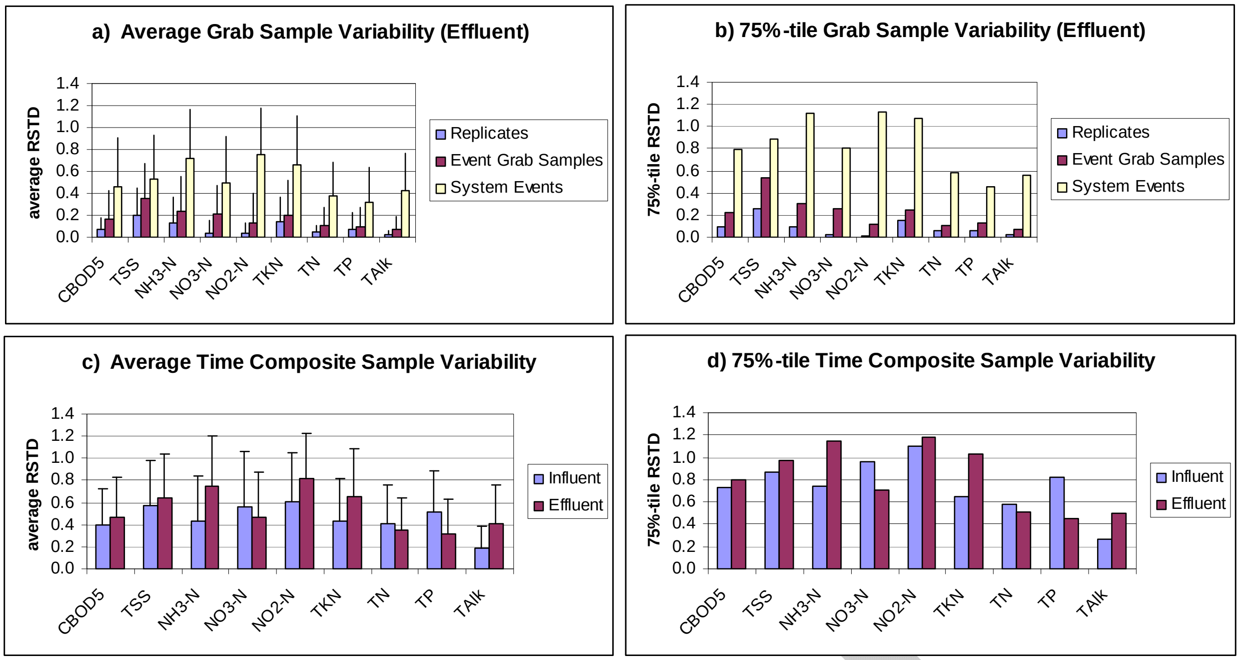


Figure 3. Comparisons of variability between samples. a) average relative standard deviations (+ one standard deviation) of replicates, grab samples during an event, and events for a system; b) 75%-tile of the relative standard deviations of replicates, grab samples during and event, and events for a system; c) average relative standard deviations (+one standard deviation) for influent and effluent time composite samples between events for a system; d) 75%-tile for influent and effluent relative standard deviations between events for a system

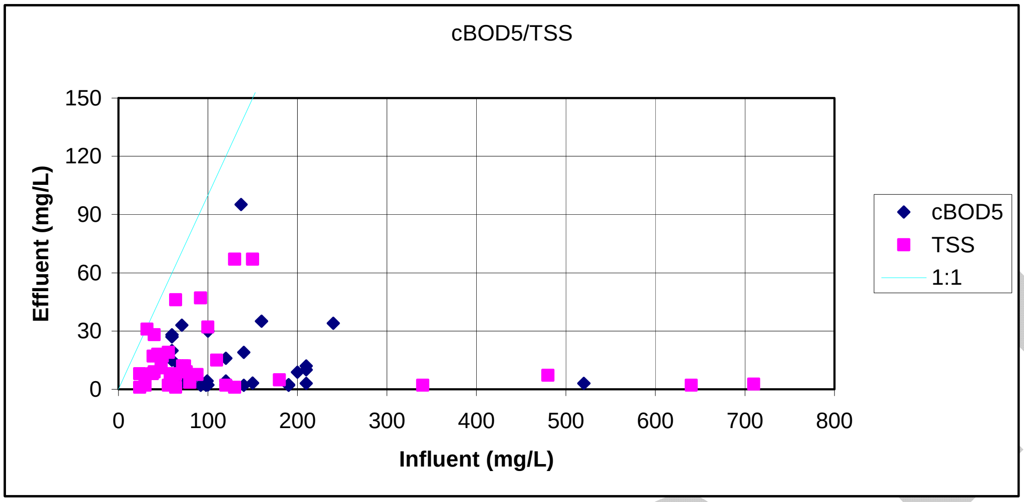
4 ASSESSMENTS OF DIFFERENCES IN EFFLUENT CONCENTRATIONS

This section will discuss treatment effectiveness and will assess if there are differences in treatment effectiveness between some of the employed treatment methods.

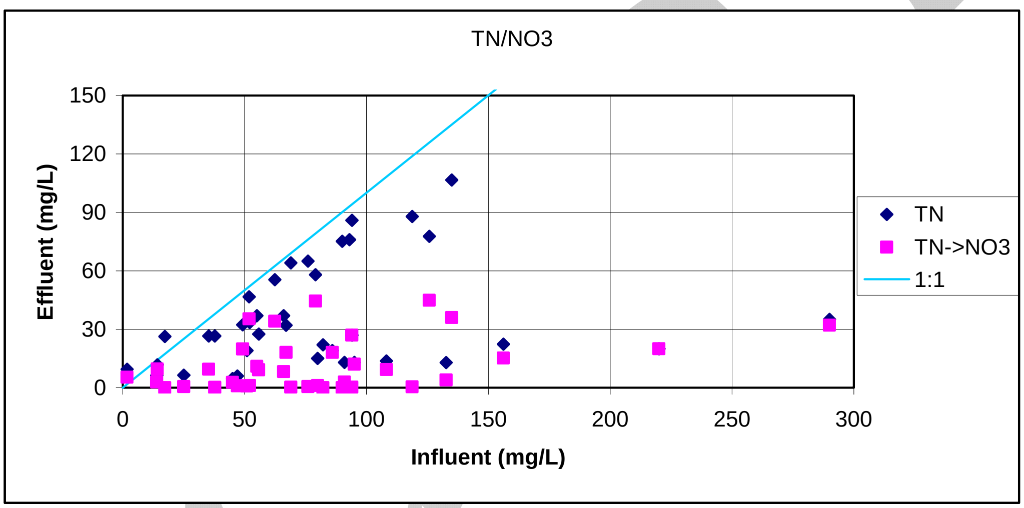
4.1 Influent and effluent comparisons

The first level of analysis consists of a comparison of influent and effluent concentrations, in this case composite samples on the same sampling event. Figure 4 shows the results for up to 38 samples for laboratory analyses (excluding high solids, tap water and recirculation samples). For comparison purposes, a 1:1 line, representing no treatment is also included. A result above the line indicates higher concentrations leaving the treatment system than entering it. One cause for such behavior is variability of the influent, combined with ineffective treatment, as in a situation where the influent concentration is lower for the sampling event period but the effluent concentration reflects prior, higher concentrations for a time influenced by the hydraulic residence time in the treatment system. Few sampling events yielded results that were above this line, and in agreement with the scenario outlined, they occur at relatively low influent concentrations. The most occurrences were for TP. Relative to TN, it appears unlikely that the influent variability is larger, so this is more likely a reflection of treatment effectiveness.

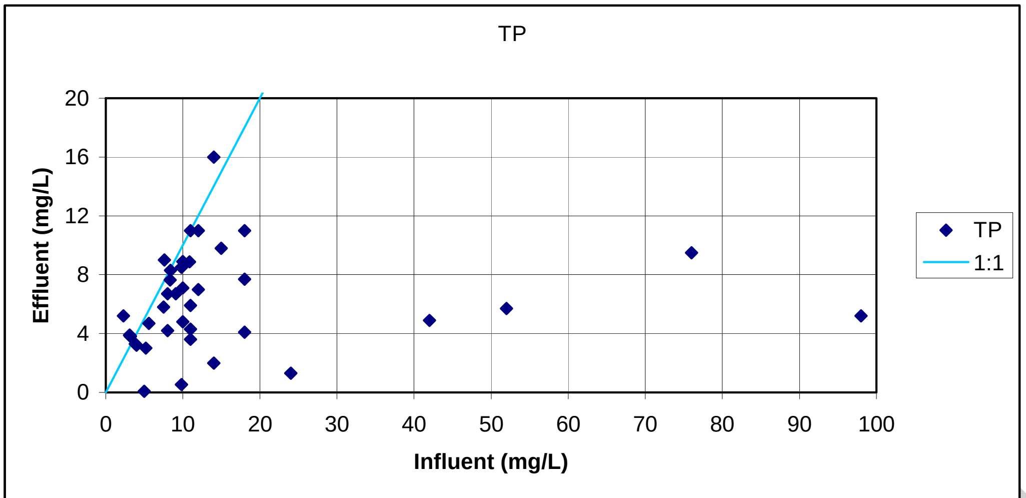
The overall results shows no correlations between influent and effluent concentrations (maximum R^2=0.14 between influent TN and effluent NO3-N). For cBOD5 and TSS, figure a) illustrates that most effluent samples contain less than 10 mg/L of either. While TN effluent concentrations overall did not correlate with influent concentrations, there appears to be one group of results that remains close to the 1:1 line, indicating little treatment effectiveness, and another group with effluent concentrations remain below 40 mg/L regardless of influent concentrations. Only about a quarter of influent samples contain less than 50 mg/L TN. TP shows most points just below the 1:1 line, with a few points indicating higher treatment effectiveness, mainly at high influent concentrations. Total Alkalinity shows a pattern somewhat similar to TN, with a group of results close to the 1:1 line, indicating little removal, and a group that has seen higher alkalinity reductions. This corresponding pattern is consistent with the concept that nitrification, one of the treatment steps in nitrogen reduction, reduces alkalinity.



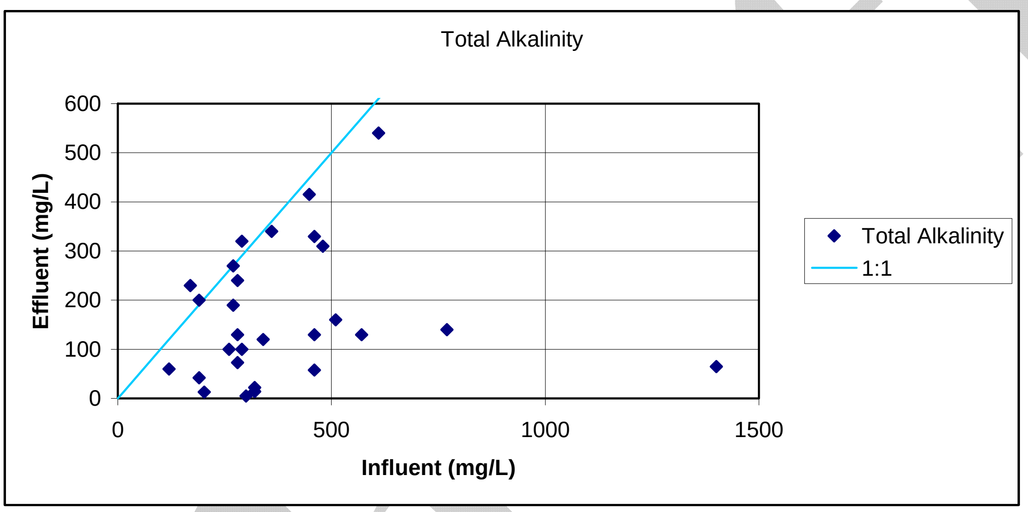
a)



b)



c)



d)

Figure 4. Influent and effluent concentrations for composite samples, where both were sampled during the same sampling event. Influent excludes samples with high solids, tap water and recirculation systems. a) cBOD5 and TSS; b) TN; c) TP; d) Total Alkalinity.

Based on a median test, the influent did not differ significantly among the permitting categories (residential PBTS, ATU, commercial PBTS) for cBOD5, TSS, TKN, TN, TP and total alkalinity. On the other hand, effluent concentrations differed significantly between the different groups (<0.05) for cBOD5, TSS, ammonia-N, and total phosphorus. TKN had a lower level of significance (0.062). A comparison between just single family residences PBTS and ATU had similar results. One difference between many of the PBTSs and the ATUs is the presence of a P-reduction treatment step, which was previously shown to have a significant effect on many of the same analytes.

4.2 Phosphorus reduction treatment approaches

Six phosphorus treatment approaches were included as part of this study. The classification was based on field observations and permit review: AOS, a type of LECA-material, brickchips either unsaturated or undetermined; LECA or filtralite either saturated or unknown, and mid-floc, a chemical additive. Of these, LECA and brickchips had been testing in unsaturated conditions in the OWNRS-study; engineers have specified filtralite in saturated conditions in part based on information by the manufacturer; and engineers have specified mid-floc, likely based on experiences with larger wastewater treatment plants. A median test indicated significant differences in effluent quality for most of the analytes.

Table 24 shows the statistics of total phosphorus concentrations after each of these treatment steps. These statistics indicate, that the mid-floc treatment results in the highest TP-concentrations, while the Leca treatment systems provide the lowest concentrations.

	AOS	mid-floc	brick chip unsaturated	brick chip unknown	LECA saturated	LECA unknown
Mean	6.79	10.39	5.64	6.83	3.99	1.48
Std. Deviation	4.47	6.36	4.63	2.13	2.65	1.03
Median	8.90	8.75	4.60	6.15	3.95	1.20
N	9	8	36	12	10	6

Table 24. Statistics of total phosphorus concentration after P-reduction treatment steps.

5 SCREENING TESTS

The study included several screening tests to assess whether the results agreed with the results of laboratory analytical methods. This agreement could be useful in two ways: a quantitative agreement to allow prediction of laboratory results from field screening tests, or the determination that a sample exceeds a given concentration value.

5.1 Visual classification

The visual classification, after summarizing “slight”, “intermediate”, and “grey” into one category “grey”, consisted of three values: clear, grey, and black. The samplers deemed none of the samples assessed black. A median test between “grey” and “clear” samples indicated significant differences for TSS, TKN, and ammonia. Complicating the diagnostic value is the overlap between concentrations in samples that appeared clear (n=96) and grey (n=19) respectively. Further analysis indicated that the visual analysis can serve as a good indicator if a sample exceeds 10 mg/L TSS. Grey samples had high odds of exceeding 10 mg/L TSS (18:1), while clear samples had comparatively low odds (28:68). The resulting odds ratio of 44 was the highest found for the three analytes for which visual classification appeared to be significant.

5.2 Olfactory classification

The olfactory classification consisted of the categories “no odor”, “earthy”, “musty”, and “septic” or “pungent”. The classification relied on the understanding by the sampler of these terms. The samplers classified most (n=96) of the assessed samples as containing no odor, only three as smelling earthy, eleven as smelling musty, and nine as smelling septic. A median test indicated significant differences between these classes in regards to the visual classification, TSS, ammonia, and TKN. As in the case of visual classifications, the overlap of concentrations for each olfactory class complicates the use of smell as indicator of exceeding certain concentrations. For example, all samples classified as musty or septic contained at least 3 mg/L TSS and TKN, but about two thirds of the non-odorous samples contained also at least 3 mg/L, allowing little distinction. Overall, the presence of smell appeared to be an indicator for TSS, ammonia or TKN exceeding 10 mg/L with odd ratios between 17 and 19.

5.3 Hach-test kits

The study utilized a Hach DR/890 to analyze samples for Nitrate, Ammonia, and reactive-phosphorus. The sample volume analyzed by the Hach kit stemmed from the same intermediate sampling container that the laboratory samples were taken from. Based on this origin, variability similar to the replicate variability is expected. An additional way to assess the ease and reliability of using the screening test consisted in keeping separate the data from phase 1+2 and from phase 3, which coincided with differences in the staff performing the measurements. For the first two phases, half a dozen staff had worked on this project, while in the third phase, only a couple of people performed the sampling. This splitting provides a repetition of the experiment and allows an assessment of the importance of the analyst. Figure 5 compares the laboratory results to the results of the Hach analyses. In each of the three analytes, there are noticeable differences between the phases.

For ammonia (figure 5 a), the slope of the correlation is slightly less than one for both phase categories, indicating a slight underestimate when using the Hach-kit. While the slope is very similar, the correlation coefficient was higher for phase 1 and 2 than in phase 3 (0.9 vs. 0.7). This appears to be due largely to a few outliers during phase 3. For nitrate, the data shown in figure 5 b were truncated at a laboratory concentration of 25 mg/L. This removed the influence of exceeding the upper end of the undiluted measurement range with the screening test, which was 33 mg/L, and resulted in a flattening of the Hach data points. The slope of the correlation between laboratory and screening methods was close to one in both data sets, indicating a good correspondence. The correlation coefficients were higher than for ammonia, and again higher for the first two phases than the third phase (0.97vs 0.68).
For phosphorus, the correlation coefficients were the lowest of this set (0.56 and 0.46, respectively). One possible reason for higher variability is that in contrast to the other two measurements, the screening test does not measure the same chemical species as the laboratory test (reactive vs. total phosphorus) but only a subset. But there are also indications, that the procedure of the screening test gave rise to misunderstandings: During phase 1 and 2, several screening measurements cluster along a 3:1 line; such points are likely the result of analysts forgetting to convert from phosphate (PO4) to phosphorus (PO4-P) by multiplying with 0.326. The upper limit of the measurement range is less than two mg/L phosphorus. This necessitated sample dilutions, usually at a ratio of 1:10 to obtain a result in the measurement range, and this dilution step could lower measurement precision and introduce recording errors.

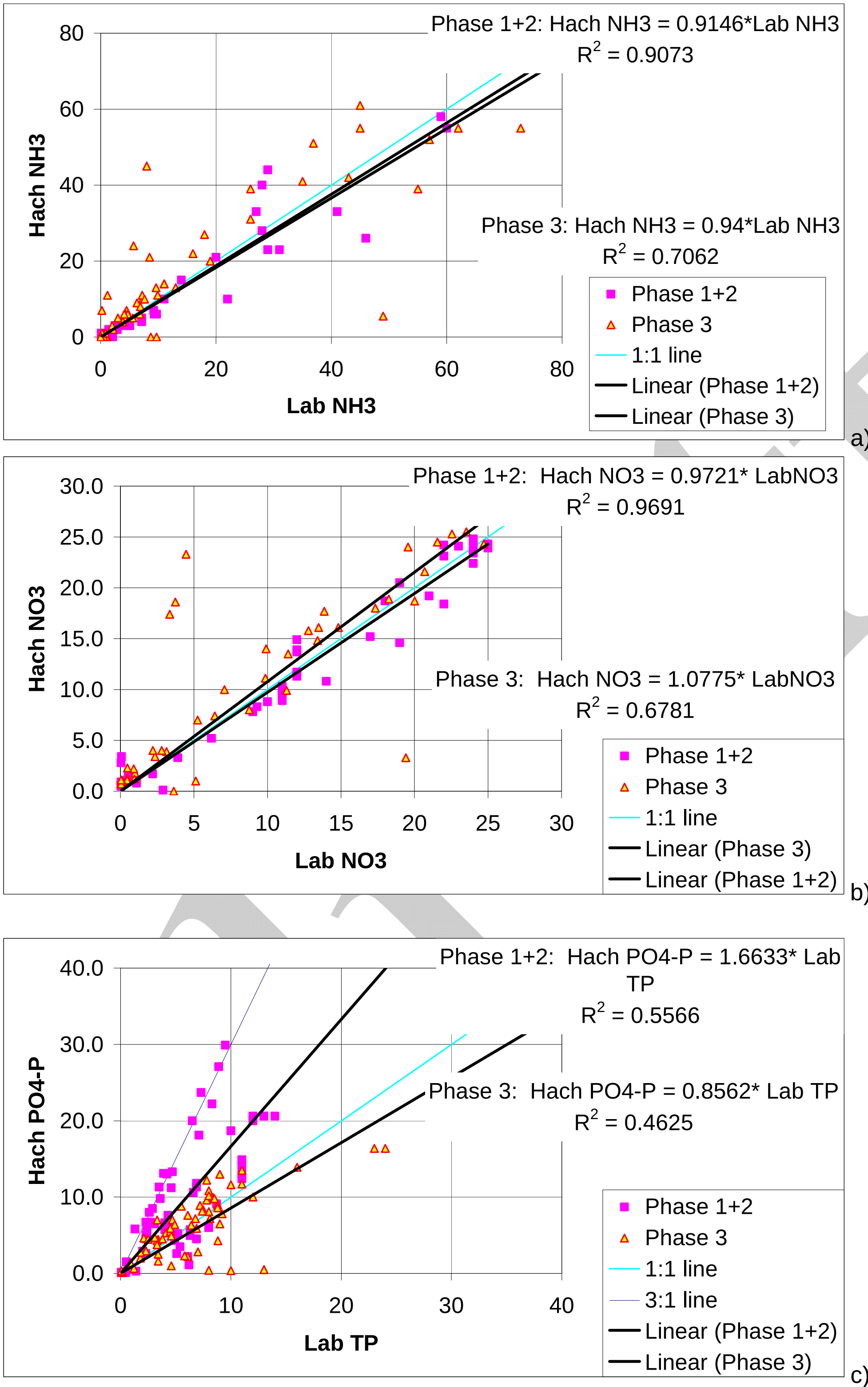


Figure 5. Comparison of Laboratory analysis results and results of analysis by samplers using Hach DR/890 test kits. a) NH3-N; b) NO3-N; c) reactive-P vs. total P

5.4 Taylor Kit

A Taylor swimming pool kit provided an alternative means of assessing pH, total alkalinity and free chlorine. For 37 samples, results from both the laboratory and a Taylor titration of alkalinity were available. Figure 6 illustrates the relationship between laboratory and Taylor measurements of total alkalinity. Except for two visible outliers during phase 1 and 2, the correlations are high in all phases (0.74 and 0.92) and indicate a one-to-one correspondence between the two measurements. One of the outliers was associated with the highest measured total alkalinity sample in the group (540 mg/L), and exceeded 1000 mg/L during Taylor titration. Only one of the three lowest Taylor alkalinity results was associated with below detectable levels of alkalinity in the laboratory analysis. The reasons for the other deviations remain speculative, one possibility, at least for two low Taylor measurements of less than ten, is that the recorder of the measurement omitted the conversion calculation from drops to mg/L, which usually would result in a multiple of ten. Overall, total alkalinity appears a measurement that has potential for reliable determination in the field.

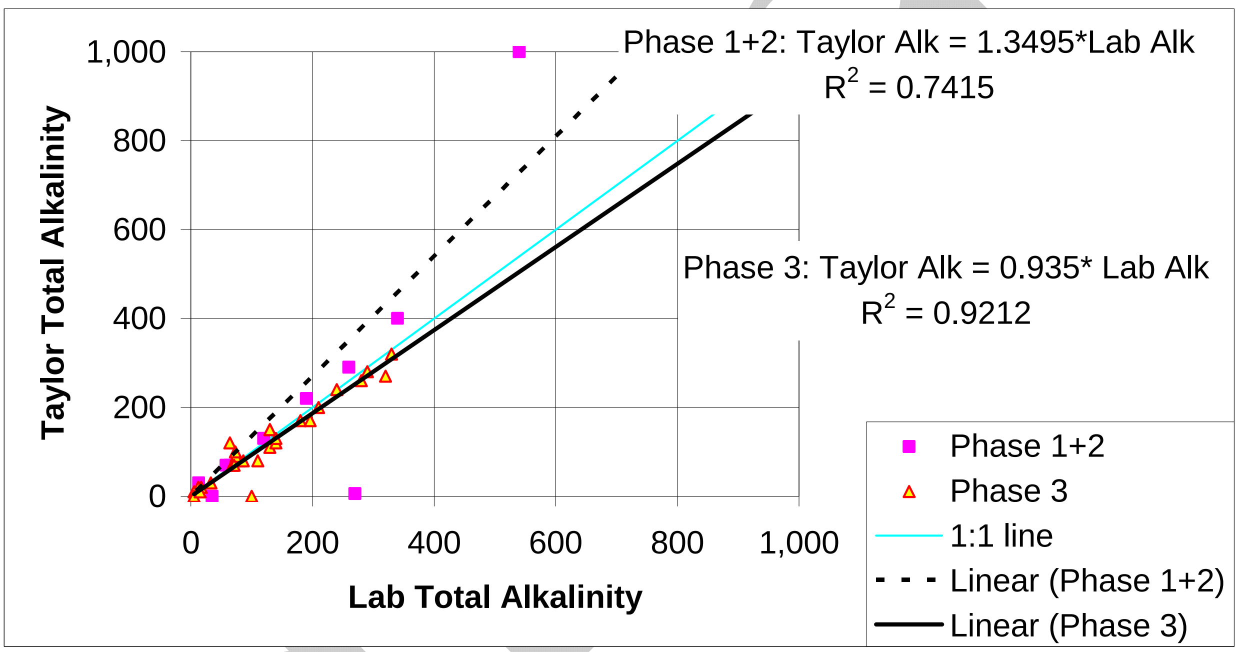
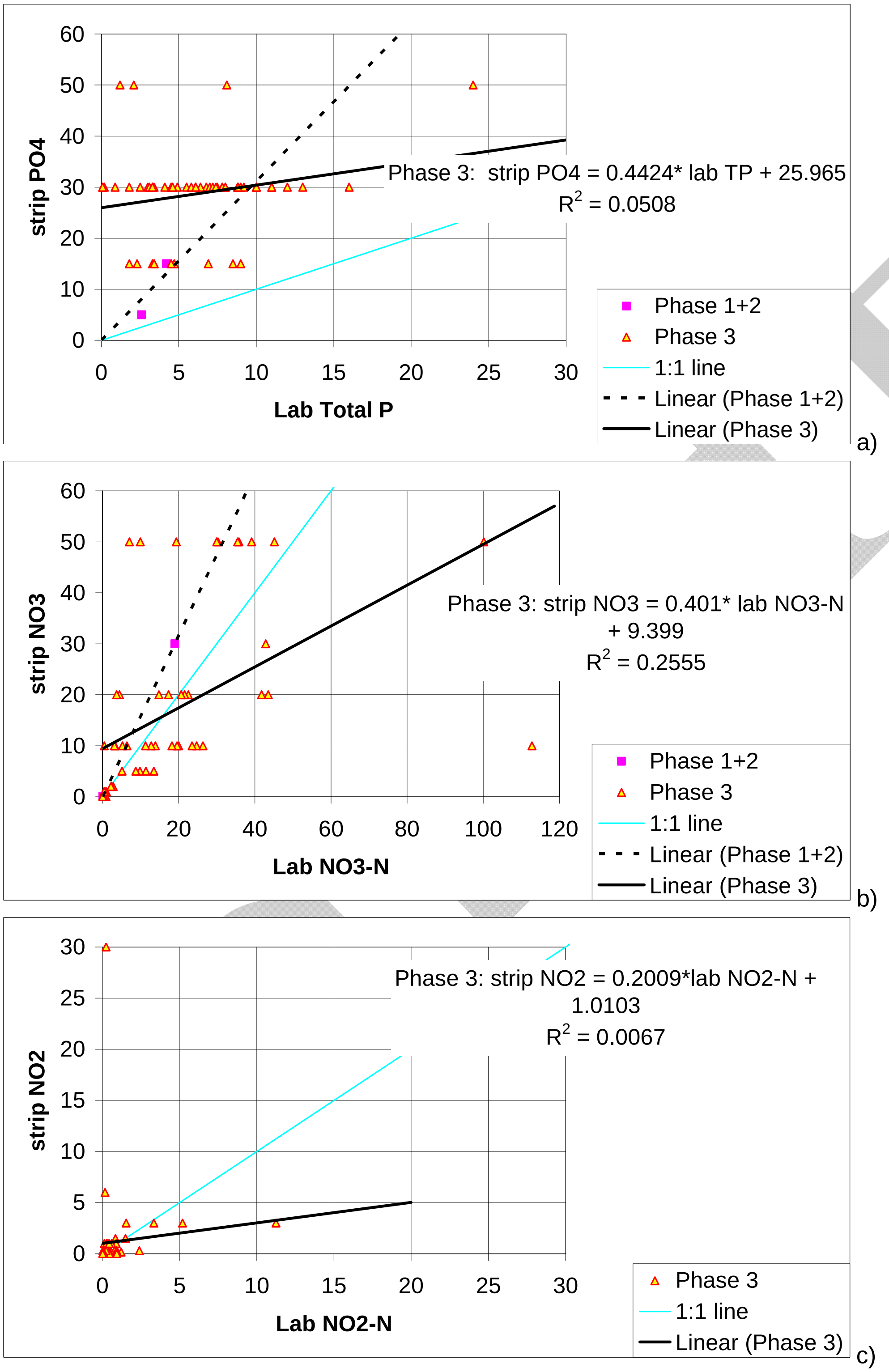


Figure 6. Illustration of the relationship between total alkalinity measurements in the laboratory and measurements using a Taylor kit.

Of the 27 chlorine measurements during phase 3, about half showed no or less than 0.5 mg/L free chlorine, which is below the standard of 64E-6 for free chlorine prior to an injection well. No laboratory measurement of chlorine occurred, so an assessment of the accuracy is not feasible. The chlorine measurements did not coincide with bacteriological samples, so no assessment of the effectiveness of chlorination is feasible.

5.5 Test strip measurements

For up to 58 samples, test strips results are available for reactive phosphorus, nitrate, nitrite, alkalinity and chlorine. Of these, only alkalinity showed any promise as a somewhat quantitative measure of measurements obtained by other methods. Too few data were collected during phase 1 and 2 to perform a meaningful correlation assessment. For reactive phosphorus, the results from phase 3 show no meaningful correlation (0.05) with laboratory concentrations. For nitrate, the results are similar, for phase 3, a very low correlation (0.25) was present. For nitrite, there was no correlation. For total alkalinity, a correlation can be seen, but appears to be leveling off, resulting overall only in a correlation coefficient of 0.5. The correlation coefficient increases to 0.68 if the y-intercept is allowed to vary. For chlorine, the few samples for which both measurements by test strip and by Taylor kit had been obtained showed no apparent correlation between the two.



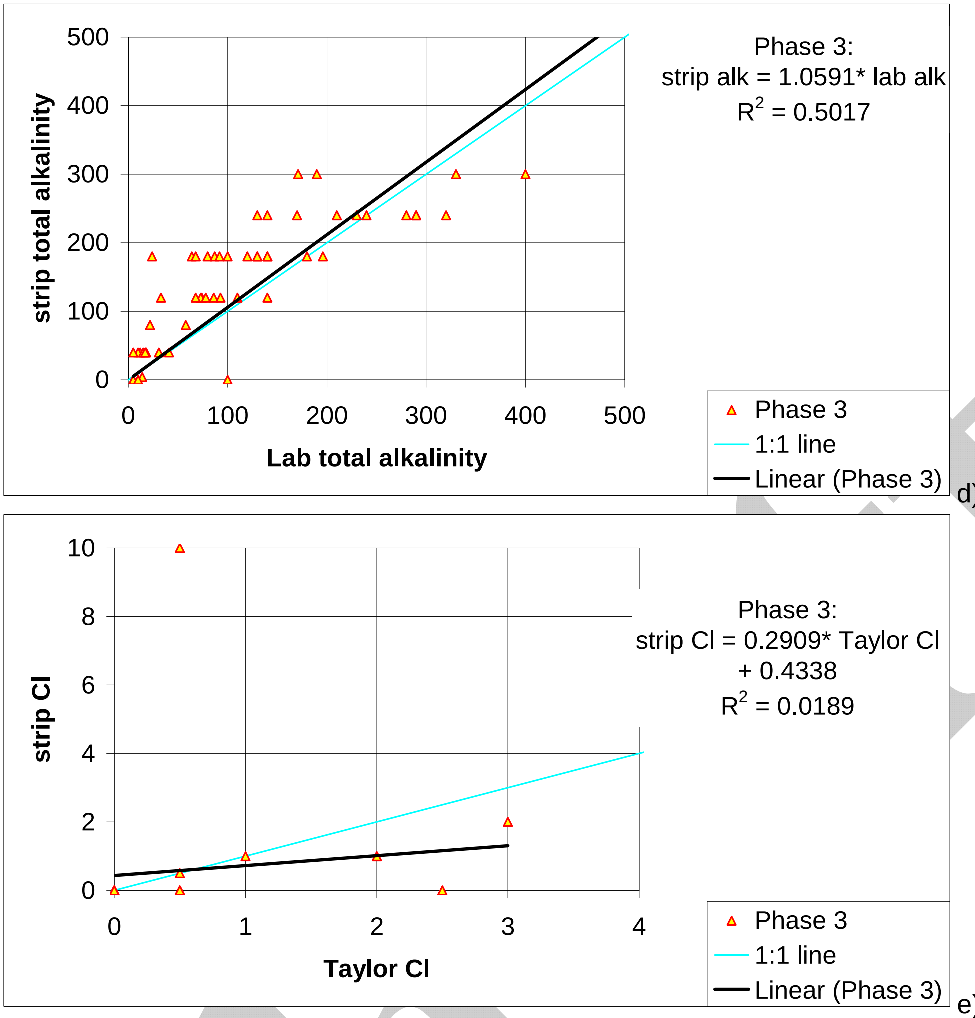


Figure 7. Relationships between other measures of concentrations and results of test strip measurements: a) ortho-phosphorus vs. lab TP b) nitrate vs lab nitrate-N c) nitrite vs lab nitrite d) alkalinity vs. lab total alkalinity e) chlorine vs Taylor chlorine

6 DISCUSSION

To be added

7 CONCLUSIONS AND RECOMMENDATIONS

To be added

8 REFERENCES

To be added

9 APPENDIX A: SCHEMATICS OF SAMPLED SYSTEMS

PROGRESS REPORT FORM

DEP Agreement No.:	G0239		
Grantee Name:	Florida Department of Health		
Grantee Address:	Division of Environmental Health, 4052 Bald Cypress Way, Bin #A-08, Tallahassee, FL 32399-1713		
Grantee's Grant Manager:	Elke Ursin	**Telephone No.:**	850-245-4070 x 2708
Quarterly Reporting Period:	July 1, 2011 – September 30, 2011		
Project Number and Title:	G0239 Department of Health Assessment of Water Quality Protection by Advanced Onsite Sewage Treatment and Disposal Systems: Performance, Management, Monitoring Project		

Provide a summary of project accomplishments to date. (Include a comparison of actual accomplishments to the objectives established for the period. If goals were not met, provide reasons why.)

- Grant was executed on August 6, 2008.
- Task 1: Monroe County Project (in kind match)
  - Monroe County Health Department was selected to perform the sampling.
  - Sampling protocol report has been completed.
  - Presentations made on some of the preliminary results at the Florida Environmental Health Association's Annual Education Conference in August 2008, at the Water Environment Federation's Annual Technical Exhibition and Conference (WEFTEC) in October 2008, in October 2009, and in October 2010. Copies of the presentations have been submitted with previous quarterly reports.
  - All sampling has been completed for this task. Quality control of collected data has been completed. Sampling results have been included in previous progress reports.
  - The employee who did the sampling for this task trained the new employee hired to do the statewide sampling during the week of August 10, 2009.
  - Draft report is mostly completed and will be presented to the Department of Health's Research Review and Advisory Committee for comment at the November 15, 2011 meeting. Anticipated final report will be submitted prior to the end of November.
  - *This task is slightly behind schedule per the grant amendment executed February 3, 2011.*
- Task 2: Database
  - Decision to hire an outside contractor for the data gathering and database development was made initially to obtain the most cost efficient solution to obtaining the end result.
  - Request for Quotes was advertised, responses were received and scored, and negotiations with the highest scored applicant were made. The proposed contractor withdrew their proposal.
  - This task is being completed by bureau staff. During the previous quarters it became apparent that the originally anticipated volunteer effort could not be incorporated into the work-flow.
  - Preliminary surveys and telephone inquiries were made to the County Health Departments to determine the method for recording operating permit data. The responses have been tabulated.
  - Data has been gathered from the state databases, county specific databases, and Carmody.
  - Initial assessments have shown that there is very limited overlap between operating

permits in the state database and in Carmody, complicating efforts to develop a comprehensive database with uniform fields. Much time during previous quarters has been spent identifying duplicate data, cleaning up and combining the records. The approach that was taken focused on the physical address of a system as the identifying characteristic. Duplication of addresses (e.g. for repairs) in the state permitting (EHD) database was remedied by selecting generally the most recent permit and combining construction and operating permits. Carmody records were screened to eliminate operating permits from non-advanced systems such as a conventional system for a restaurant or in an industrial/manufacturing zone. EHD and Carmody records were linked to each other based on address and permit information. Approximately 16,000 distinct records were the results of this work. The addresses have been geocoded, which serves as an additional data quality check.

- Data fields and database structure have been selected and designed by DOH and contract staff. The database of the system records is complete. A description of the data fields and structure has been developed and will be submitted prior to the end of November. Supplemental information is being gathered in the database to capture information outside of the general system information that was gathered from the permitting databases. This supplemental information is anticipated to include tables on the permit review, physical evaluation of the system, sample results, construction information, and the county evaluation of management practices.
- Tools and methods to streamline data entry and ensure data quality have been developed. These tools and forms ensure accuracy and consistency with regards to data entry. A significant amount of time in past quarters was spent designing queries and forms to capture system details to assist with data analysis later on.
- For those records where sufficient information existed, treatment component technologies have been categorized and this information linked to the system record based on the type of technology installed. The treatment technologies have been grouped as either: unsaturated fixed media, combined media, and extended aeration. Additionally, aeration technology for combined media and extended aeration was subcategorized into diffuser and aspirator approaches. Records were selected to represent each of the different technology approaches. Numbers of samples for each manufacturer were proportional to the logarithm of the number of systems in the same category. The record selection used a similar approach as the overall random sample, by selecting the records with the lowest n random numbers that fulfilled the criteria Details on this can be found in Table 1.

Technology Approach	Manufacturer	Product	Aeration_sub_type	Product sample	suptype sample	Approach sample
Combined	Bio-Microbics	FAST	Diffuser	35	35	70
	Jet	Jet	Aspirator	35	35	
Extended aeration	Acquired Wastewater Technologies	Alliance	Diffuser	2	35	70
	Ecological Tanks, Inc.	Aqua Aire	Diffuser	2		
	Ecological Tanks, Inc.	Aqua Safe	Diffuser	2		
	Aqua-Klear	Aqua-Klear	Diffuser	4		
	American Wastewater	B.E.S.T. 1	Diffuser	3		
	Acquired Wastewater Technologies	Cajun Aire	Diffuser	3		
	Clearstream	Clearstream	Diffuser	3		
	Delta	DF or UC	Diffuser	3		
	Hoot	Hoot	Diffuser	4		
	Hydro-Action	Hydro-Action	Diffuser	2		
	H.E. McGrew	Mighty Mac	Diffuser	3		
	Consolidated	Nayadic	Diffuser	4		
	Consolidated	Multi-Flo	Aspirator	15	35	
	Consolidated	Enviro-Guard	Aspirator	3		
	Norweco	Singulair	Aspirator	17		
Fixed media	Orenco	AdvanTex		6		70
	Quanics	Aerocell		4		
	Quanics	Biocoir		4		
	Premier Tech	EcoFlo		9		
	EcoPure	EcoPure		8		
	Earthtek	EnviroFilter		14		
	Klargester	Klargester		2		
	Rotodisk	Rotodisk		3		
	Ruck	Ruck		7		
	NoMound	NoMound		8		
	Sandfilter	Sandfilter		5		

Table 1. Technology of Components Sample Selection

  - Summary statistics on the database will be submitted prior to the end of November.
  - *The task as outlined in the February 3, 2011 grant amendment is slightly behind schedule and is mostly complete.*
- Task 3: Surveys
  - Request for Quotes was sent out to several universities and state contract providers to perform the survey.
  - Two proposals were received and the evaluation was completed with the Florida State University Survey Research Laboratory selected as the successful provider.
  - Development of the six surveys has been completed. There have been several meetings between DOH, DEP, and FSU staff to go over the content of the draft surveys prior to reaching the final version. The surveys ranged from 5 pages long to 10 pages long depending on the user group. The surveys have been submitted in a previous quarterly report.
  - The surveys were sent out to the target interest groups during the beginning of 2010. Some time after the first wave of surveys were mailed out, a second round of follow-up surveys were sent to the non-responders.
  - 100% of the population size will be surveyed for the Onsite Regulators, Installers, Engineers, Manufacturers, and Maintenance Entities. 3,795 of the System Owners have been sampled based on a sampling scheme that was agreed to by all parties. This sampling scheme was designed to send surveys to all identified innovative system owners, oversample commercial systems with approximately 15% of the surveys, and to oversample PBTS' by a factor of 2 relative to ATUs. The oversampling will serve to provide more data on smaller groups to allow comparison to the large group of residential ATUs.
  - FSU reported that a significant fraction of the surveys were returned as undeliverable. 914 of the system user surveys were returned to the department. Surveys were originally sent to the physical property address in order to capture the

user's point of view. The main reasons for the inability to deliver to many of these addresses was because the property was vacant, there was no mail receptacle at the location, that is was not deliverable as addressed, or that the mail was unable to be forwarded. After individually searching each address in the corresponding county property appraiser's database, 825 were resent to the property owner; the remaining 89 addresses could not be located in the property appraiser's database. 103 of these letters with the updated owners address have been returned back as being vacant, undeliverable as addressed, etc.

  - FSU has completed all of the data entry on all of the submitted surveys. Quality assurance on the data has been completed.
  - A DOH intern was utilized to categorize some of the open ended questions on the surveys. DOH sent FSU a list of categories for analysis for the surveys, which have been included in the final report.
  - Data analysis has been completed. The final report from FSU has been submitted to DOH and was included as a deliverable in a previous quarterly report.
  - *This task is complete.*
- Task 4: Assessment of Operational Status and Performance
  - In November 2008 investigations began into the method of procurement for a contract staff position to complete this task, as well as several other tasks associated with this project. DOH has two contractors that provide contract staff: Tallahassee Community College (TCC) and Nitelines USA, Inc. Initially we anticipated utilizing TCC, but in mid February 2009 TCC informed the grant manager that they are no longer taking on new contracts. The process immediately began to utilize Nitelines as the provider with advertising being done in March 2009, interviews being performed in April 2009, and final selection being completed in May 2009.
  - The contract staff position began on June 1, 2009 with much of their time initially being devoted to development of the project database in Task 2. Subsequently that staff's time was spent on developing the QAPP, obtaining permit files and doing data entry associated with permit review. Contract staff became certified in OSTDS in December of 2009 as stipulated in the grant agreement. Staff has also attended GIS mapping training.
  - On March 30, 2011 the employee submitted their resignation.
  - The draft Quality Assurance Project Plan has been written, presented to the DOH Research Review and Advisory Committee (RRAC), revised, and was finalized on April 1, 2011. The original QAPP was submitted to the grant manager at DEP. Delays in getting this QAPP in a final format were to make it as robust and detailed as possible to eliminate any mistakes that could occur later.
  - Criteria regarding site selection were presented and discussed at the RRAC meeting on December 16, 2009. There were many of pros and cons from the system selection strategies list that RRAC discussed. DOH created a flow chart to illustrate the site selection process. This flow chart was finalized and was submitted with a previous quarterly report. The main sample selection was done by taking a random sample of the entire population of advanced systems. This sample will give a snapshot of the operational status and management of all systems. In addition to a pure random sample, the site selection has been modified to ensure treatment comparison samples are included (70 each fixed media, combined media, and extended aeration). Overlap with the initial random sample was maximized, so that a total of 796 sites were targeted for assessment. After performing the initial file review it appeared that approximately 60% of the systems reviewed were not an active advanced system either because the system was abandoned, a conventional system, connected to sewer, etc. After this review, we selected an additional 204

system for a total of 1000 systems: 700 primary sample sites and 300 reserve sites in the event that a primary site is not accessible or no longer exists. Subsequently, several sites were added based on three reasons: to increase the number of sites at which the meeting of fecal coliform standards could be assessed; to designate cases of mistaken identity, that is, the system was not part of the selected sites, but mistaken by the samplers for one; and to include three innovative treatment installations where sites were conveniently located. This resulted in a total of 1014 selected systems as of end of October 2011 (additional cases of mistaken identity may still be discovered during quality control).

- In summary, the counties with the most systems to be assessed were Monroe with 260 systems, Brevard with 133 systems, Charlotte with 126 systems, Lee with 62 systems, and Franklin with 60 systems. A total of 57 out of the 67 counties in Florida have at least one system that will be reviewed as part of this project. An illustration of the distribution of sample sites is shown in Figure 1.

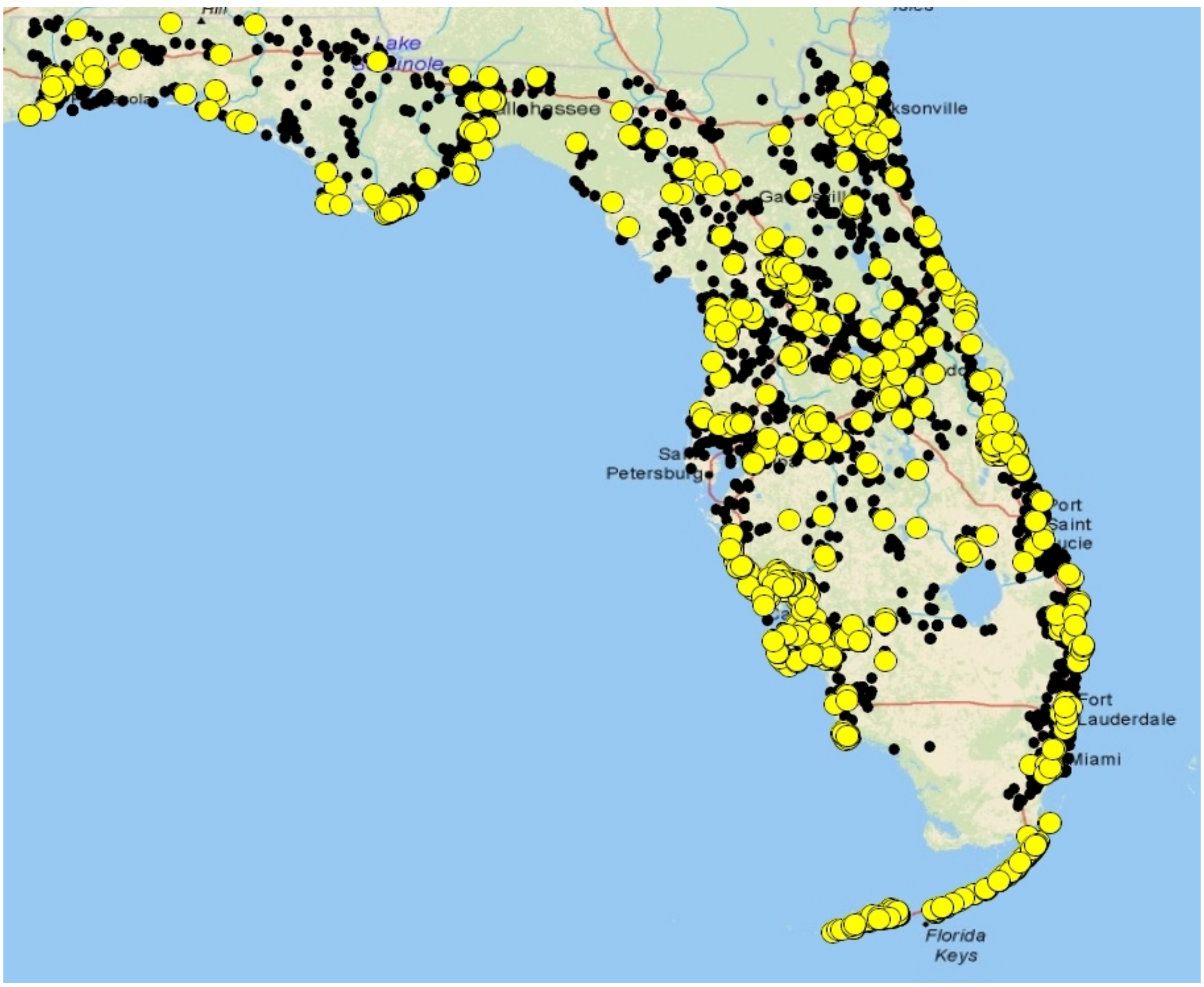


Figure 1. Distribution of Sample Sites

- Nearly all of the permit files have been gathered. Outstanding permit files will be collected as data entry continues. Data entry for approximately 600 permit files has occurred to date. This data entry includes detailed information on the construction permit, the operating permit, and other information. A total of 114 system records were final reviewed during this quarterly reporting period. A spreadsheet listing permits for Task 4 and Task 5 reviewed by month is included with this quarterly report. A separate spreadsheet including all of the quality control lab results is

included with this quarterly report. Data entry will not be done for any non-advanced systems.
    - Due to the contract employee resigning in March 2011, data entry into the database has slowed down significantly. Efforts are being made to utilize bureau staff to perform this work at no cost to the grant.
    - Numerous attempts were made to contact Carmody to set-up user names and passwords to access the system, which contains maintenance and inspection records. There has been no response from Carmody, so any data that is contained in the Carmody system will only be used in as far as it is accessible and County Health Department staff access and print it for the purposes of this project.
    - Quality assurance has been done, and will continue, for the data being entered.
    - Contract staff placed calls to manufacturers to locate a contact and learn about specific suggestions for sampling. In the event a question arises while in the field those individuals would be a point of contact. Contract staff has collected product manuals to assist with sampling.
    - An Invitation to Bid for the analytical laboratory services was advertised in December of 2009 and 15 responses were received. A final decision and purchase order was executed during a previous quarter. The selected lab is Florida Testing Services, LLC DBA Xenco Laboratories. An amendment to the contract was done during this quarter to increase the number of samples to be analyzed to match the anticipated number to be gathered with this project.
    - Lab reports sent to the department will include a spreadsheet of data fields that will be imported into the database. A method has been developed to automate this process and eliminate the potential for data entry mistakes.
    - Included with this quarterly report is a report containing the data fields specified in the Quality Assurance Requirements For Federally Funded NPS BMP Monitoring Agreements. This report combines both the lab data and the field data measurements.
    - Negotiations with Monroe, Charlotte, Lee, Volusia, and Wakulla County Health Departments resulted in their assistance with the sampling effort and a state funding increase memo was submitted and approved. Having multiple samplers operating simultaneously will allow for the sampling portion of this project to be completed in a shorter timeframe.
    - Charlotte, Lee, and Monroe Counties will sample systems in their counties. Volusia County will sample systems in both Volusia and Brevard Counties, and Wakulla County will sample the remainder of the systems throughout Florida. This coordinated effort has proven to be extremely successful.
    - Field training and quality assurance evaluations have been completed for all samplers working on the project. Bureau staff traveled to each of the locations providing hands-on training on how to conduct the sampling.
    - Equipment and supplies have been purchased for the field kits. The equipment and supply purchasing is now complete.
    - A total of 554 systems were sampled once for Task 4.
    - *This task is on schedule per the February 3, 2011 grant amendment and is now complete.*
- Task 5: Assessment of Annual Variability of Performance
    - The Quality Assurance Project Plan has been executed.
    - Finding suitable Task 5 sites proved to be difficult due mostly in part to limited access to influent. Due to the limited sampling time, the priority for samplers was to take as many Task 4 samples as possible, which also affected the number of Task 5 samples that were taken.

- Twenty-eight of the systems sampled in Task 4 were sampled twice, and two were sampled three times.
    - *This task is on schedule per the February 3, 2011 grant amendment and is now complete.*
- Task 6: Management Practices
    - Contract staff compiled data as it became available.
    - Tables, queries, and forms have been created to capture County Health Department management practices and files have been gathered.
    - Contract staff went along with department staff to perform a program evaluation in Gilchrist County. Available files that were selected for sampling for this county were pulled and evaluated.
    - A review will be performed on the last three program evaluation cycles for each of the county health departments. These data have been tabulated and will be evaluated to provide background information on the strengths and weaknesses of each county program.
    - A database was created linking the program evaluations that have been recorded over the past 10 years with the survey results from Task 3 for the regulators and the system owners. Analysis has been done on several potential correlations and the results will be summarized in the final task report.
    - Finalization of this task will not occur until analysis for the final report in Task 7 has been conducted. This will allow for linking between program evaluations, regulator and owner survey responses, and actual system performance from the sampling effort providing a multi-faceted analysis on management practices.
    - *This task is behind schedule per the February 3, 2011 grant amendment.*
- Task 7: Project administration
    - *This task is ongoing and is behind schedule. The only outstanding deliverable for this task is the final project report which is anticipated to be complete in the next few months. Once a draft is available, the Department of Health's Research Review and Advisory Committee will meet to discuss the results in a public meeting and the report will be finalized and submitted to the Department of Environmental Protection.*

Provide an update on the estimated time for completion of the project and an explanation for any anticipated delays.

The grant funding is now complete with deliverables in Task 6 and Task 7 still outstanding. The reason for this is due to delays in getting the QAPP written and approved as well as due to the contract staff resigning which required a complete redesign of how to accomplish the sampling effort. Data analysis and report writing is an in-kind contribution from Bureau of Onsite Sewage Program Staff.

Provide any additional pertinent information including, when appropriate, analysis and explanation of cost overruns or high unit costs.

None to report.

Identify below, and attach copies of, any relevant work products being submitted for the project for this reporting period (e.g., report data sets, links to on-line photographs, etc.)

- Permit review report for the project listing permits for Task 4 reviewed by month
- Examples of all Task 4 and Task 5 forms used for recording and reporting
- Three of each type of form completed with actual Task 4 data
- Table of lab results for samples taken during the project for Task 4
- Three of each type of form completed with actual Task 5 data
- Table of lab results for samples taken during the project for Task 5
- Table of the quality control lab results (both Task 4 & Task 5)

Summarize and provide supporting documentation regarding your efforts in meeting the MBE/WBE requirements contained in paragraph 5.B. of the Agreement

Nitelines USA, Inc. is a MBE. The contract employee that has been hired is a female of minority origin. The contracted lab, Florida Testing Services, LLC dba Xenco Laboratories, is also a MBE/WBE. The contracted lab, Ackuritlabs is a MBE/WBE. The contracted lab Benchmark EnvironAnalytical Inc. is a MBE. No new procurements were made during this quarter. Attachment MBE/WBE Procurement Reporting Form has been included with this quarterly report.

2012 PROGRESS REPORT ON PHASE II AND PHASE III OF THE FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY

Bureau of Onsite Sewage Programs

February 1, 2012

H. Frank Farmer, Jr., MD, PhD, FACP
State Surgeon General

Rick Scott
Governor

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PROGRESS REPORT ON PHASE II AND PHASE III OF THE FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY

EXECUTIVE SUMMARY

The Florida Legislature has provided a total of $2.9 million (cash) for Phases I, II, and III of a three phase project with a total estimated cost of $5.1 million to develop passive strategies for nitrogen reduction for onsite sewage treatment and disposal systems (OSTDS). This report is submitted in compliance with Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012. This project will require cash and budget for the remaining $2.2 million to complete the study.

Funds appropriated and expended to date have established necessary viable protocols and have been appropriately used to test, calibrate, and refine technologies and strategies to be tested in the field. Without further funding for the final Phase 3 of the project, necessary and extensive field testing will not occur. If field testing does not occur, the project will not yield results that can be used to develop viable, cost-effective alternative passive technologies for use by homeowners for nitrogen issues associated with onsite systems.

Regardless of the source, excessive nitrogen has negative effects on public health and the environment. The significance of this innovative project is that it evaluates and develops strategies to reduce nitrogen impacts from OSTDS regulated by the Florida Department of Health (DOH). The goal is to develop systems that are affordable and ecologically protective with reduced engineering and installation costs that assist in sustainable development. This project has been endorsed by Florida TaxWatch as a good use of public funds (Wenner 2008).

The contractor, in coordination with DOH and the Department's Research Review and Advisory Committee (RRAC) per 381.0065(4)(o) F.S., has successfully completed portions of each major task including prioritization of treatment technologies, construction of a test facility, and completion of several sample events of passive systems at the test facility and at field sites, and field sampling of the soil and groundwater under OSTDS at residential homes throughout Florida and at the test facility. Work remaining for the 2011-2012 fiscal year includes: continuing field sampling of passive systems and field sampling of the soil and groundwater under OSTDS at residential homes throughout Florida and at the test facility; and continuing development of a nitrogen fate and transport model.

Further testing is required to verify the results to date and to provide data for development of the specifications for full system designs. The tasks associated with this final phase include: continuation and completion of field monitoring of the performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater; development of nitrogen fate and transport models that will be calibrated with the field sampling results; and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies.

DOH and its Research Review and Advisory Committee recommend that the Legislature:

1. Provide cash in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study.
2. Provide budget authority to DOH in the amount of $1.5 million for the fiscal year 2012-2013 for continuation and completion of the tasks associated with this legislatively mandated study.

Continued support for this project will ultimately benefit Florida's approximately 2.7 million onsite system owners by finding cost-effective nitrogen reduction strategies that will improve environmental and public health protection. If fully funded, the results of this project will assist with producing nitrogen reducing systems that protect groundwater with both reduced life-cycle costs and lower energy demands.

INTRODUCTION

The Florida Legislature has provided a total of $2.9 million (cash) for Phases I, II, and III of a three phase project with a total estimated cost of $5.1 million to develop passive strategies for nitrogen reduction for onsite sewage treatment and disposal systems (OSTDS). This includes an initial appropriation of $900,000 by the 2008 Legislature for the first phase of this study and an appropriation of $2,000,000 by the 2010 Legislatures for the second phase of this study. This project requires cash and budget for the remaining unfunded $2.2 million to complete the study. This report is submitted in compliance with Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012, which appropriated the funding for the study.

This study was based on budget language in 2008 (Line Item 1682, House Bill 5001, General Appropriations Act for Fiscal Year 2008-2009) that instructed:

> …the Department of Health to further develop cost-effective nitrogen reduction strategies. The Department of Health shall contract, by request for proposal, for Phase I of an anticipated 3-year project to develop passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The project shall be controlled by the Department of Health's Research Review and Advisory Committee and shall include the following components: 1) comprehensive review of existing or ongoing studies on passive technologies; 2) field testing of nitrogen reducing technologies at actual home sites for comparison of conventional, passive technologies and performance-based treatment systems to determine nitrogen reduction performance; 3) documentation of all capital, energy and life-cycle costs of various technologies for nitrogen reduction; 4) evaluation of nitrogen reduction provided by soils and the shallow groundwater below and down gradient of various systems; and 5) development of a simple model for predicting nitrogen fate and transport from onsite wastewater systems. A progress report shall be presented to the Executive Office of the Governor, the President of the Senate and the Speaker of the House of Representatives on February 1, 2009, including recommendations for funding additional phases of the study.

The 2010 legislative direction (included in Appendix A) specified that the existing contract for this project will remain in full force; that the Department, the Department's Research Review and Advisory Committee (RRAC), and the Florida Department of Environmental Protection (DEP) shall work together to provide technical oversight and that DEP will have maximum technical input; that the main focus and priority for work in Phase II shall be in developing, testing, and recommending cost-effective passive technologies for nitrogen reduction; that field installations for this project will be subject to significant testing and monitoring; and that no state agency shall implement any rule or policy that requires nitrogen reducing systems or increases their costs until the study is complete.

The 2011 legislative direction (included in Appendix B) specified that the existing contract for this project will remain in full force; that the Department, the Department's Research Review and Advisory Committee (RRAC), and the Florida Department of Environmental Protection (DEP) shall work together to provide technical oversight; that completion of Phase 2 and Phase 3 must be consistent with the terms of the existing contract; that the main focus and priority for Phase 3 be developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction; the installed systems are experimental in nature and shall be installed with significant field testing and monitoring; and that no state agency shall implement any rule or policy that requires nitrogen reducing systems or increases their costs until the study is complete.

Regardless of the source, excessive nitrogen has negative effects on public health and the environment. The primary motivations for this study are the environmental impacts that the increased levels of nitrogen in water bodies can cause. Programs within DEP identify water bodies impaired by excessive nitrogen, establish targets for maximum nutrient loads, and develop management action plans to restore the water bodies. The relative contribution of OSTDS to total nitrogen impacts varies from watershed to watershed with estimates ranging from below five to more than 20 percent. There is widespread interest in the management of OSTDS and their nitrogen impacts. This project has been endorsed by Florida TaxWatch as a study that is a good use of public funds and that provides homeowners with cost-effective options for nitrogen reduction (email communication from Kurt Wenner to Jerry McDaniel June 2, 2008). The significance of this innovative project is that it evaluates and develops strategies to reduce nitrogen impacts from OSTDS regulated by the Florida Department of Health (DOH). The goal is to develop systems that complement the use of conventional OSTDS and are also affordable and ecologically protective with reduced engineering and installation costs that assist in sustainable development.

The study contract was awarded in January 2009 to a Project Team led by Hazen and Sawyer, P.C., and was based upon an anticipated budget of $5 million over a 3 – 5 year project timeframe, with an additional $100,000 budget to DOH for project management. As a result of the time required for contracting, unspent monies in fiscal year 2008-2009 were budgeted in 2009 to complete the initial tasks of the project. The contract identifies the following tasks:

Task A – Technology Evaluation for Field Testing: Review, Prioritization, and Development: This task includes literature review, technology evaluation, prioritization of technologies to be examined during field testing, and further experimentation with approaches tested in a previous DOH passive nitrogen removal study. Objectives of this task are to prioritize technologies for testing at actual home sites and to perform controlled tests at a test facility to develop design criteria for new passive nitrogen reduction systems.

Task B – Field Testing of Technologies and Cost Documentation: This task includes installation of top ranked nitrogen reduction technologies at actual homes, with documentation of their performance and cost.

Task C – Evaluation of Nitrogen Reduction Provided by Soils and Shallow Groundwater: This task includes several field evaluations of nitrogen reduction in Florida soils and shallow groundwater and also will provide data for the development of a simple planning model in Task D.

Task D – Nitrogen Fate and Transport Modeling: The objective of this task is to develop a simple fate and transport model of nitrogen from OSTDS that can be used for assessment, planning and siting of OSTDS.

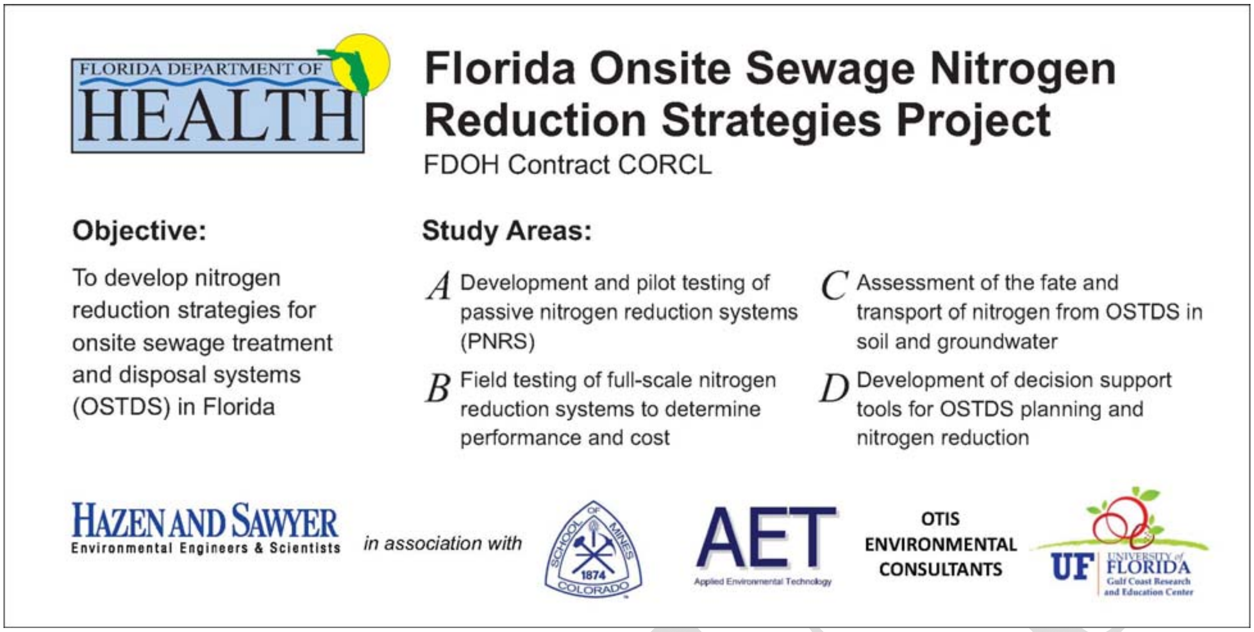

Figure 1. Sign posted at the University of Florida's Gulf Coast Research & Education Center's test facility.

1 PROJECT STATUS

Funding for the first and second phases of this project has been appropriated. A summary of the major project elements and their timing with funding phases is shown in Table 1. The contractor, in coordination with the RRAC and DOH, has successfully completed parts of Tasks A, B, C, and D, including literature reviews; ranking of nitrogen reduction technologies for field testing; design and construction of a test facility for further development of passive technologies; development of quality assurance documents for the test facility work, groundwater monitoring, field testing, and nitrogen fate and transport modeling; completion of several sampling events at the test facility; installation of a nitrogen reducing system at a home site; and instrumentation and sampling of nitrogen fate and transport at existing systems throughout Florida.

Figure 2. Test facility constructed at the University of Florida's Gulf Coast Research & Education Center.

Current efforts and work remaining for the 2011-2012 fiscal year includes: continuing field sampling of passive systems; installation of field sites at residential homes throughout Florida for the testing of passive systems and to test the soil and groundwater under OSTDS; design and construction of a soil and groundwater test facility; sampling at the soil and groundwater test facility; and initiating development of a nitrogen fate and transport model. In particular, the following work by task will proceed with the current funding level:

1. The technology evaluation (Task A) will include a total of 7 sample events at the passive nitrogen test facility, measuring 14 different analytes at 23 sampling points, as well as a final report on the pilot passive nitrogen removal study at the Gulf Coast Research and Education Center (GCREC).
   Current Status as of November 2011: All sample events at the test facility have been completed. Results of most systems are encouraging after 12 months of testing, showing a reduction in total nitrogen of over 95%, with a final effluent concentration of 2.6 mg/L.
2. For field testing of technologies (Task B), the quality assurance project plan has been finalized. Approximately four onsite systems utilizing various nitrogen removal technologies will be installed at home locations throughout the State of Florida. It is anticipated that four field system performance monitoring events will be conducted on these systems with the current funding level, measuring 16 different analytes at 2-8 different sampling points. A life cycle cost assessment template will also be completed.
   Current Status as of November 2011: Eleven homeowners have agreed to participate in the study to date for Task B and a final determination of which sites will be used will be accomplished in the near future. At least one of the home sites will have a gravity-fed system installed. Construction has been completed for one system and sampling has been initiated.
3. To evaluate nitrogen reduction provided by soils and shallow groundwater (Task C), it is anticipated that a soil and groundwater test facility will be constructed to show how groundwater fate and transport of nitrogen occurs in multiple soil treatment unit regimes. Three sampling events will be completed with the current funding level, sampling six different locations at each site, measuring multiple parameters in the effluent, soil, and groundwater.. Instrumentation of the existing OSTDS mound system at the University of Florida's Gulf Coast Research & Education Center (GCREC) in Wimauma, Florida will be done to study how nitrogen behaves in the soil and groundwater. Four sampling events, examining multiple parameters, will be completed at the existing OSTDS mound system at GCREC with the current funding level. At least one soil and groundwater monitoring event will occur at up to two home sites to evaluate nitrogen movement in the soil and groundwater in the field, measuring multiple parameters in the effluent, soil, and groundwater.
   Current Status as of November 2011: Testing of media components has been completed as per 381.0065(4)(m) F.S., one tracer test has been completed, and construction of the soil and groundwater test facility will commence in the near future. Instrumentation of the existing OSTDS mound system at GCREC has been completed and 3 sample events have been conducted. Six homeowners have agreed to participate in the study to date for Task C and a final determination of which sites will be used will be accomplished in the near future. Two home sites have been selected and instrumented and one sample event has occurred at each site. At one site, the groundwater flow direction could not be delineated, and no additional sampling events will occur.

4. To address nitrogen fate and transport modeling for Task D, a final quality assurance project plan has been completed, and the first steps will include the development of a soil model to show how nitrogen is affected by treatment in Florida-specific soils. **Current Status as of November 2011:** Work has focused primarily on soil modeling under the current budget. Development of a soil model is underway and will be utilized to generate a simple tool for prediction of nitrogen removal in the unsaturated zone of Florida soils.

2 ANTICIPATED PROGRESS IN 2012-2013

During the 2011-2012 fiscal year, additional funding will be critical to complete the tasks associated with the final phase. These include: continuation and completion of field monitoring of performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater; development of various nitrogen fate and transport models that will be calibrated with the field sampling results; and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies. In particular, the following work by task will occur with the final phase of funding, which is being requested with this report:

1. For Task A, the final task report will be written, which will include a summary of the accomplishments of the passive nitrogen removal test facility.
2. For Task B, it is anticipated that an additional three onsite systems utilizing various nitrogen removal technologies will be installed at home locations throughout the State of Florida, four field system performance monitoring events will be conducted on these systems. Final reporting on all of the field work associated with this task, including life cycle cost assessments, operation, maintenance, and repairs, will be completed either at the end of this or during the subsequent year.
3. For Task C, instrumentation of two sites and monitoring events at all four home sites will occur to evaluate nitrogen movement in the soil and groundwater in the field, and at six groundwater test areas at the soil and groundwater test facility to show how groundwater fate and transport of nitrogen occurs. Final reporting for this task will be completed either at the end of this or during the subsequent year.
4. For Task D, the soil model will be completed and integrated with groundwater models which will be developed, calibrated, and validated, utilizing the results of the field work collected in previous tasks, and a final task report will be written summarizing the results of this task either at the end of this or during the subsequent year.

3 FUNDING NEEDS

Activities in fiscal years 2008-2011 have prepared the framework for rapid implementation of all remaining project tasks in fiscal year 2012-2013. Cash in the amount of $2.2 million is required to reap the benefits of all previous work and to complete the goals of this project. For the 2012-2013 budget year, $1.5 million are required to fund the completion of scheduled tasks.

Funds appropriated and expended to date have established necessary viable protocols and have been appropriately used to test, calibrate, and refine technologies and strategies to be tested in the field. Without further funding for the final Phase 3 of the project, necessary and extensive field testing, the major portion of Task B, will not occur and, if field testing does not occur, the project will essentially not yield results that can be used to develop viable, cost-effective alternative passive technologies for use by homeowners for nitrogen issues associated with onsite systems.

Project Tasks (described previously) are broken down further into funding phases as follows:

Initial Funding in 2008-2010 (Phase I): $900,000 (cash and budget) appropriated (in 2008 and 2009 state budgets) – status: Complete. The initial funding was targeted to prioritize systems for testing, summarize existing knowledge, develop testing protocols, and establish a test facility for detailed soil and groundwater monitoring and for preliminary testing of pilot scale passive nitrogen reduction systems.

Funding in 2010-2011: $2 million (cash and budget) appropriated (in 2010 state budget) – status: Ongoing. This funding is for field monitoring over at least a one-year monitoring period of performance and cost of technologies at home sites, and of nitrogen fate and transport. This funding will also continue the development and monitoring work at the test facility and continue the modeling work.

Funding in 2011-2012: $2.75 million (budget) appropriated (in 2011 state budget) – status: Ongoing. This funding will continue and complete the development and monitoring work at the test facility and continue the modeling work. The preliminary results of the project are encouraging. This funding is also for field monitoring over at least a one-year monitoring period of performance and cost of technologies at home sites, and of nitrogen fate and transport.

Funding in 2012-2013: To adequately fund the final phase of the project, $2.2 million cash is needed. A budget appropriation of $1.5million will needed for FY 2012-13. Further testing is required to confirm the results to date with field data and to provide data for development of the engineering specifications for full system designs. The funds will be used to complete monitoring and other field activities, additional testing as deemed appropriate by the Legislature, and final reporting with recommendations on onsite sewage nitrogen reduction strategies for Florida’s future.

Further information on this project, including previous legislative reports and detailed project reports, can be found on the Department’s website:

http://www.doh.state.fl.us/environment/ostds/research/Nitrogen.html

Table 1. Summary of Funding Phase Tasks and Associated Number of Deliverables.

Task		Phase I[a] $900,000 (July 2008-November 2010, completed)	Phase II[a] $2,000,000 (Current Funding, in progress)	Phase III[a] $2,200,000 (Future Funding, yet to be funded)
A	**Task A: Technology Selection & Prioritization**	**$352,144**	**$336,514**	**$35,480**
	Literature review	1		
	Ranking of nitrogen reduction technologies for field testing	1		
	Design and construction of test facility	1		
	Quality assurance project plan	1		
	Monitoring and sample events		7	
	Final test facility report		1	
	Final task report			1
B	**Task B: Field Testing of Technologies**	**$50,202**	**$599,610**	**$529,243**
	Quality assurance project plan		1	
	Installation of ranked nitrogen reduction technologies at 8 field sites		4	4
	System performance monitoring events at 8 sites		4	4
	Life cycle cost assessment template development		1	
	Final life cycle cost assessment report (per system)			8
	Final task report			1
C	**Task C: Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater**	**$216,164**	**$1,095,977**	**$598,860**
	Quality assurance project plan	1		
	Design of test facility	1		
	Construction of test facility		1	
	Monitoring and sample events (6 test areas)		3	3
	Instrumentation of existing OSTDS mound at GCREC facility		1	
	GCREC mound sample events		4	
	Field sites sample events (4 sites)		1	3
	Final task report			1
D	**Task D: Nitrogen Fate and Transport Models**	**$74,357**	**$292,021**	**$441,644**
	Quality assurance project plan	0.5 (draft)	0.5 (final)	
	Soil model		1	
	Shallow groundwater models			1
	Calibration of models to existing data sets			1
	Uncertainty analysis for models			1
	Validation and refinement of models			1
	Final task report			1
	Project Management (sum of contractor and DOH)	**$119,953**	**$126,375**	**$231,456**
	Contractor project management	$90,695	$109,003	$178,085
	DOH project management	$29,258	$17,372[b]	$53,371[b]
	Total Budget[c]	**$812,820**	**$2,450,497**	**$1,836,722**
	Total Budget Remaining as of April 15, 2011	**$0**	**$1,670,029**	**$1,836,722**

a. Numbers in each subtask represent the numbers of budgeted deliverables.
b. DOH project management costs for Phases II and III are estimated costs.
c. Budgeted totals differ from the legislative funding amounts due to scheduling.

DOH – Department of Health
GCREC – Gulf Coast Research & Education Center
OSTDS – Onsite Sewage Treatment and Disposal Systems

4 RECOMMENDATIONS

DOH and its Research Review and Advisory Committee recommend that the Legislature:

1. Provide cash in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study.
2. Provide budget authority to DOH in the amount of $1.5 million for the fiscal year 2012-2013 for continuation and completion of the tasks associated with this legislatively mandated study.

This additional funding will be applied to the final phase of the project, primarily continuation and completion of field monitoring of performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater, development of various nitrogen fate and transport models that will be calibrated with the field sampling results, and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies.

Continued support for this project will ultimately benefit Florida's approximately 2.7 million onsite system owners by finding cost-effective nitrogen reduction strategies that will improve environmental and public health protection. If fully funded, the results of this project will assist with producing nitrogen reducing systems that protect groundwater with both reduced life-cycle costs and lower energy demands.

APPENDIX A. 2010 Legislative Language

SECTION 3 – HUMAN SERVICES

486 SPECIAL CATEGORIES
CONTRACTED SERVICES

FROM GENERAL REVENUE FUND	153,772
FROM ADMINISTRATIVE TRUST FUND . . .	337,765
FROM FEDERAL GRANTS TRUST FUND . . .	348,235
FROM GRANTS AND DONATIONS TRUST FUND	2,648,438
FROM RADIATION PROTECTION TRUST FUND	150,000

From the funds in Specific Appropriation 486, $2,000,000 from the Grants and Donations Trust Fund is provided to the department to continue phase II and complete the study authorized in Specific Appropriation 1682 of chapter 2008-152, Laws of Florida. The report shall include recommendations on passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The department shall submit an interim report of phase II on February 1, 2011, a subsequent status report on May 16, 2011, and a final report upon completion of phase II to the Governor, the President of the Senate, and the Speaker of the House of Representatives prior to proceeding with any nitrogen reduction activities.

Section 14. In order to implement Specific Appropriation 486 of the 2010-2011 General Appropriations Act, and for the 2010-2011 fiscal year only, the following requirements shall govern Phase 2 of the Department of Health's Florida Onsite Sewage Nitrogen Reduction Strategies Study:

(1) The underlying contract for which the study was let shall remain in full force and effect with the Department of Health and funding the contract for Phase 2 of the study shall be through the Department of Health.

(2) The Department of Health, the Department of Health's Research Review and Advisory Committee, and the Department of Environmental Protection shall work together to provide the necessary technical oversight of Phase 2 of the project, with the Department of Environmental Protection having maximum technical input.

(3) Management and oversight of Phase 2 shall be consistent with the terms of the existing contract; however, the main focus and priority for work to be completed for Phase 2 shall be in developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction.

(4) The systems installed at actual home sites are experimental in nature and shall be installed with significant field testing and monitoring. The Department of Health is specifically authorized to allow installation of these experimental systems. In addition, before Phase 2 of the study is complete and notwithstanding any law to the contrary, a state agency may not adopt or implement a rule or policy that:

(a) Mandates, establishes, or implements any new nitrogen-reduction standards that apply to existing or new onsite sewage treatment systems or modification of such systems;

(b) Increases the cost of treatment for nitrogen reduction from onsite sewage treatment systems; or

(c) Directly requires or has the indirect effect of requiring, for nitrogen reduction, the use of performance-based treatment systems or any similar technology; provided the Department of Environmental Protection administrative orders recognizing onsite system modifications, developed through a basin management action plan adopted pursuant to section 403.067, Florida Statutes, are not subject to the above restrictions where implementation of onsite system modifications are phased in after completion of Phase 2, except that no onsite system modification developed in a basin management action plan shall directly or indirectly require the installation of performance-based treatment systems.

APPENDIX B. 2011 Legislative Language

SECTION 3 – HUMAN SERVICES

465	SPECIAL CATEGORIES CONTRACTED SERVICES	
	FROM GENERAL REVENUE FUND	97,489
	FROM ADMINISTRATIVE TRUST FUND . . .	335,165
	FROM FEDERAL GRANTS TRUST FUND . . .	643,776
	FROM GRANTS AND DONATIONS TRUST FUND	3,401,038
	FROM RADIATION PROTECTION TRUST FUND	150,000

From the funds in Specific Appropriation 465, $2,725,000 in nonrecurring funds from the Grants and Donations Trust Fund is provided to the department to complete phase II and phase III and complete the study authorized in Specific Appropriation 1682 of chapter 2008-152, Laws of Florida. The report shall include recommendations on passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The department shall submit an interim report of the completion of phase II and progress on phase III on February 1, 2012, a subsequent status report on May 16, 2012, and a final report upon completion of phase III to the Governor, the President of the Senate, and the Speaker of the House of Representatives prior to proceeding with any nitrogen reduction activities.

Section 7. In order to implement Specific Appropriation 465 of the 2011-2012 General Appropriations Act, and for the 2011-2012 fiscal year only, the following requirements govern the completion of Phase 2 and Phase 3 of the Department of Health's Florida Onsite Sewage Nitrogen Reduction Strategies Study:

(1) The Department of Health's underlying contract for the study remains in full force and effect and funding for completion of Phase 2 and Phase 3 is through the Department of Health.

(2) The Department of Health, the Department of Health's Research Review and Advisory Committee, and the Department of Environmental Protection shall work together to provide the necessary technical oversight of the completion of Phase 2 and Phase 3 of the project.

(3) Management and oversight of the completion of Phase 2 and Phase 3 must be consistent with the terms of the existing contract. However, the main focus and priority to be completed during Phase 3 shall be developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction.

(4) The systems installed at homesites are experimental in nature and shall be installed with significant field testing and monitoring. The Department of Health is specifically authorized to allow installation of these experimental systems. Notwithstanding any other law, before Phase 3 of the study is completed, a state agency may not adopt or implement a rule or policy that:

(a) Mandates, establishes, or implements more restrictive nitrogen-reduction standards to existing or new onsite sewage treatment systems or modification of such systems; or

(b) Directly or indirectly requires the use of performance-based treatment systems or similar technology, such as through an administrative order developed by the Department of Environmental Protection as part of a basin management action plan adopted pursuant to s. 403.067, Florida Statutes. However, the implementation of more restrictive nitrogen-reduction standards for onsite systems may be required through a basin management action plan if such plan is phased in after completion of Phase 3.

2012 PROGRESS REPORT ON PHASE II AND PHASE III OF THE FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY

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Bureau of Onsite Sewage Programs

February 1, 2012

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H. Frank Farmer, Jr., MD, PhD, FACP
State Surgeon General

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Rick Scott
Governor

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PROGRESS REPORT ON PHASE II AND PHASE III OF THE FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES STUDY

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EXECUTIVE SUMMARY

The Florida Legislature has provided a total of $2.9 million (cash) for Phases I, II, and III of a three phase project with a total estimated cost of $5.1 million to develop passive strategies for nitrogen reduction for onsite sewage treatment and disposal systems (OSTDS). This report is submitted in compliance with Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012. This project will require cash and budget for the remaining $2.2 million to complete the study.

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Funds appropriated and expended to date have established necessary viable protocols and have been appropriately used to test, calibrate, and refine technologies and strategies to be tested in the field. Without further funding for the final Phase 3 of the project, necessary and extensive field testing will not occur. If field testing does not occur, the project will not yield results that can be used to develop viable, cost-effective alternative passive technologies for use by homeowners for nitrogen issues associated with onsite systems.

Regardless of the source, excessive nitrogen has negative effects on public health and the environment. The significance of this innovative project is that it evaluates and develops strategies to reduce nitrogen impacts from OSTDS regulated by the Florida Department of Health (DOH). The goal is to develop systems that are affordable and ecologically protective with reduced engineering and installation costs that assist in sustainable development. This project has been endorsed by Florida TaxWatch as a good use of public funds (Wenner 2008).

The contractor, in coordination with DOH and the Department's Research Review and Advisory Committee (RRAC) per 381.0065(4)(o) F.S., has successfully completed portions of each major task including prioritization of treatment technologies, construction of a test facility, and completion of several sample events of passive systems at the test facility and at field sites, and field sampling of the soil and groundwater under OSTDS at residential homes throughout Florida and at the test facility. Work remaining for the 2011-2012 fiscal year includes: continuing field sampling of passive systems and field sampling of the soil and groundwater under OSTDS at residential homes throughout Florida and at the test facility; and continuing development of a nitrogen fate and transport model.

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Further testing is required to verify the results to date and to provide data for development of the specifications for full system designs. The tasks associated with this final phase include: continuation and completion of field monitoring of the performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater; development of nitrogen fate and transport models that will be calibrated with the field sampling results; and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies.

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DOH and its Research Review and Advisory Committee recommend that the Legislature:

1. Provide cash in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study.
2. Provide budget authority to DOH in the amount of $1.5 million for the fiscal year 2012-2013 for continuation and completion of the tasks associated with this legislatively mandated study.

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Continued support for this project will ultimately benefit Florida's approximately 2.7 million onsite system owners by finding cost-effective nitrogen reduction strategies that will improve environmental and public health protection. If fully funded, the results of this project will assist with producing nitrogen reducing systems that protect groundwater with both reduced life-cycle costs and lower energy demands.

INTRODUCTION

The Florida Legislature has provided a total of $2.9 million (cash) for Phases I, II, and III of a three phase project with a total estimated cost of $5.1 million to develop passive strategies for nitrogen reduction for onsite sewage treatment and disposal systems (OSTDS). This includes an initial appropriation of $900,000 by the 2008 Legislature for the first phase of this study and an appropriation of $2,000,000 by the 2010 Legislatures for the second phase of this study. This project requires cash and budget for the remaining unfunded $2.2 million to complete the study. This report is submitted in compliance with Line Item 465 Section 3, Conference Report on Senate Bill 2000, General Appropriations Act for Fiscal Year 2011-2012, which appropriated the funding for the study.

This study was based on budget language in 2008 (Line Item 1682, House Bill 5001, General Appropriations Act for Fiscal Year 2008-2009) that instructed:

> …the Department of Health to further develop cost-effective nitrogen reduction strategies. The Department of Health shall contract, by request for proposal, for Phase I of an anticipated 3-year project to develop passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The project shall be controlled by the Department of Health's Research Review and Advisory Committee and shall include the following components: 1) comprehensive review of existing or ongoing studies on passive technologies; 2) field testing of nitrogen reducing technologies at actual home sites for comparison of conventional, passive technologies and performance-based treatment systems to determine nitrogen reduction performance; 3) documentation of all capital, energy and life-cycle costs of various technologies for nitrogen reduction; 4) evaluation of nitrogen reduction provided by soils and the shallow groundwater below and down gradient of various systems; and 5) development of a simple model for predicting nitrogen fate and transport from onsite wastewater systems. A progress report shall be presented to the Executive Office of the Governor, the President of the Senate and the Speaker of the House of Representatives on February 1, 2009, including recommendations for funding additional phases of the study.

The 2010 legislative direction (included in Appendix A) specified that the existing contract for this project will remain in full force; that the Department, the Department's Research Review and Advisory Committee (RRAC), and the Florida Department of Environmental Protection (DEP) shall work together to provide technical oversight and that DEP will have maximum technical input; that the main focus and priority for work in Phase II shall be in developing, testing, and recommending cost-effective passive technologies for nitrogen reduction; that field installations for this project will be subject to significant testing and monitoring; and that no state agency shall implement any rule or policy that requires nitrogen reducing systems or increases their costs until the study is complete.

The 2011 legislative direction (included in Appendix B) specified that the existing contract for this project will remain in full force; that the Department, the Department's Research Review and Advisory Committee (RRAC), and the Florida Department of Environmental Protection (DEP) shall work together to provide technical oversight; that completion of Phase 2 and Phase 3 must be consistent with the terms of the existing contract; that the main focus and priority for Phase 3 be developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction; the installed systems are experimental in nature and shall be installed with significant field testing and monitoring; and that no state agency shall implement

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any rule or policy that requires nitrogen reducing systems or increases their costs until the study is complete.

Regardless of the source, excessive nitrogen has negative effects on public health and the environment. The primary motivations for this study are the environmental impacts that the increased levels of nitrogen in water bodies can cause. Programs within DEP identify water bodies impaired by excessive nitrogen, establish targets for maximum nutrient loads, and develop management action plans to restore the water bodies. The relative contribution of OSTDS to total nitrogen impacts varies from watershed to watershed with estimates ranging from below five to more than 20 percent. There is widespread interest in the management of OSTDS and their nitrogen impacts. This project has been endorsed by Florida TaxWatch as a study that is a good use of public funds and that provides homeowners with cost-effective options for nitrogen reduction (email communication from Kurt Wenner to Jerry McDaniel June 2, 2008). The significance of this innovative project is that it evaluates and develops strategies to reduce nitrogen impacts from OSTDS regulated by the Florida Department of Health (DOH). The goal is to develop systems that complement the use of conventional OSTDS and are also affordable and ecologically protective with reduced engineering and installation costs that assist in sustainable development.

The study contract was awarded in January 2009 to a Project Team led by Hazen and Sawyer, P.C., and was based upon an anticipated budget of $5 million over a 3 – 5 year project timeframe, with an additional $100,000 budget to DOH for project management. As a result of the time required for contracting, unspent monies in fiscal year 2008-2009 were budgeted in 2009 to complete the initial tasks of the project. The contract identifies the following tasks:

Task A – Technology Evaluation for Field Testing: Review, Prioritization, and Development: This task includes literature review, technology evaluation, prioritization of technologies to be examined during field testing, and further experimentation with approaches tested in a previous DOH passive nitrogen removal study. Objectives of this task are to prioritize technologies for testing at actual home sites and to perform controlled tests at a test facility to develop design criteria for new passive nitrogen reduction systems.

Task B – Field Testing of Technologies and Cost Documentation: This task includes installation of top ranked nitrogen reduction technologies at actual homes, with documentation of their performance and cost.

Task C – Evaluation of Nitrogen Reduction Provided by Soils and Shallow Groundwater: This task includes several field evaluations of nitrogen reduction in Florida soils and shallow groundwater and also will provide data for the development of a simple planning model in Task D.

Task D – Nitrogen Fate and Transport Modeling: The objective of this task is to develop a simple fate and transport model of nitrogen from OSTDS that can be used for assessment, planning and siting of OSTDS.

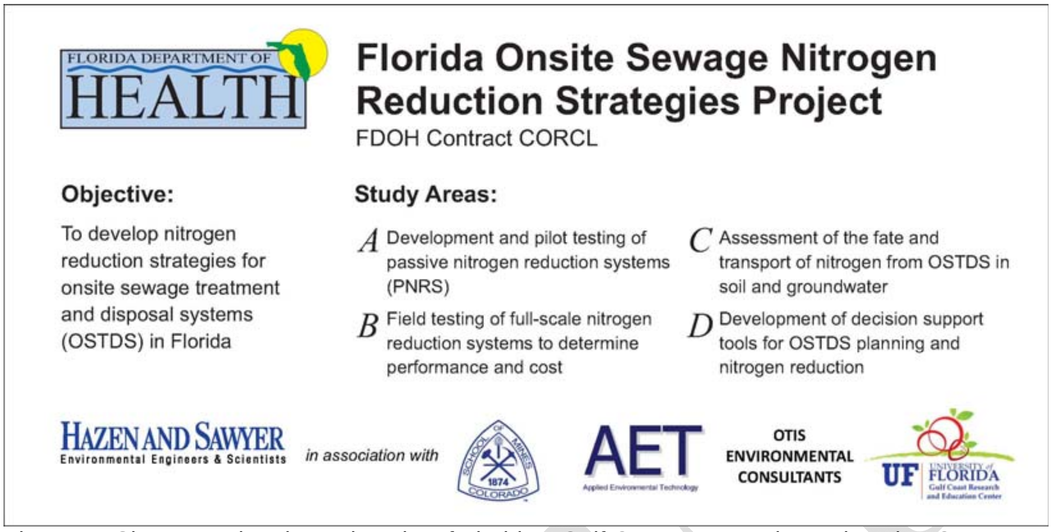

Figure 1. Sign posted at the University of Florida's Gulf Coast Research & Education Center's test facility.

1 PROJECT STATUS

Funding for the first and second phases of this project has been appropriated. A summary of the major project elements and their timing with funding phases is shown in Table 1. The contractor, in coordination with the RRAC and DOH, has successfully completed parts of Tasks A, B, C, and D, including literature reviews; ranking of nitrogen reduction technologies for field testing; design and construction of a test facility for further development of passive technologies; development of quality assurance documents for the test facility work, groundwater monitoring, field testing, and nitrogen fate and transport modeling; completion of several sampling events at the test facility; installation of a nitrogen reducing system at a home site; and instrumentation and sampling of nitrogen fate and transport at existing systems throughout Florida.

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Figure 2. Test facility constructed at the University of Florida's Gulf Coast Research & Education Center.

Current efforts and work remaining for the 2011-2012 fiscal year includes: continuing field sampling of passive systems; installation of field sites at residential homes throughout Florida for the testing of passive systems and to test the soil and groundwater under OSTDS; design and construction of a soil and groundwater test facility; sampling at the soil and groundwater test facility; and initiating development of a nitrogen fate and transport model. In particular, the following work by task will proceed with the current funding level:

1. The technology evaluation (Task A) will include a total of 7 sample events at the passive nitrogen test facility, measuring 14 different analytes at 23 sampling points, as well as a final report on the pilot passive nitrogen removal study at the Gulf Coast Research and Education Center (GCREC).
   Current Status as of November 2011: All sample events at the test facility have been completed. Results of most systems are encouraging after 12 months of testing, showing a reduction in total nitrogen of over 95%, with a final effluent concentration of 2.6 mg/L.
2. For field testing of technologies (Task B), the quality assurance project plan has been finalized. Approximately four onsite systems utilizing various nitrogen removal technologies will be installed at home locations throughout the State of Florida. It is anticipated that four field system performance monitoring events will be conducted on these systems with the current funding level, measuring 16 different analytes at 2-8 different sampling points. A life cycle cost assessment template will also be completed.
   Current Status as of November 2011: Eleven homeowners have agreed to participate in the study to date for Task B and a final determination of which sites will be used will be accomplished in the near future. At least one of the home sites will have a gravity-fed system installed. Construction has been completed for one system and sampling has been initiated.
3. To evaluate nitrogen reduction provided by soils and shallow groundwater (Task C), it is anticipated that a soil and groundwater test facility will be constructed to show how groundwater fate and transport of nitrogen occurs in multiple soil treatment unit regimes. Three sampling events will be completed with the current funding level, sampling six different locations at each site, measuring multiple parameters in the effluent, soil, and groundwater. Instrumentation of the existing OSTDS mound system at the University of Florida's Gulf Coast Research & Education Center (GCREC) in Wimauma, Florida will be done to study how nitrogen behaves in the soil and groundwater. Four sampling events, examining multiple parameters, will be completed at the existing OSTDS mound system at GCREC with the current funding level. At least one soil and groundwater monitoring event will occur at up to two home sites to evaluate nitrogen movement in the soil and groundwater in the field, measuring multiple parameters in the effluent, soil, and groundwater.
   Current Status as of November 2011: Testing of media components has been completed as per 381.0065(4)(m) F.S., one tracer test has been completed, and construction of the soil and groundwater test facility will commence in the near future. Instrumentation of the existing OSTDS mound system at GCREC has been completed and 3 sample events have been conducted. Six homeowners have agreed to participate in the study to date for Task C and a final determination of which sites will be used will be accomplished in the near future. Two home sites have been selected and instrumented and one sample event has occurred at each site. At one site, the groundwater flow direction could not be delineated, and no additional sampling events will occur.

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4. To address nitrogen fate and transport modeling for Task D, a final quality assurance project plan has been completed, and the first steps will include the development of a soil model to show how nitrogen is affected by treatment in Florida-specific soils. **Current Status as of November 2011:** Work has focused primarily on soil modeling under the current budget. Development of a soil model is underway and will be utilized to generate a simple tool for prediction of nitrogen removal in the unsaturated zone of Florida soils.

2 ANTICIPATED PROGRESS IN 2012-2013

During the 2011-2012 fiscal year, additional funding will be critical to complete the tasks associated with the final phase. These include: continuation and completion of field monitoring of performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater; development of various nitrogen fate and transport models that will be calibrated with the field sampling results; and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies. In particular, the following work by task will occur with the final phase of funding, which is being requested with this report:

1. For Task A, the final task report will be written, which will include a summary of the accomplishments of the passive nitrogen removal test facility.
2. For Task B, it is anticipated that an additional three onsite systems utilizing various nitrogen removal technologies will be installed at home locations throughout the State of Florida, four field system performance monitoring events will be conducted on these systems. Final reporting on all of the field work associated with this task, including life cycle cost assessments, operation, maintenance, and repairs, will be completed either at the end of this or during the subsequent year.
3. For Task C, instrumentation of two sites and monitoring events at all four home sites will occur to evaluate nitrogen movement in the soil and groundwater in the field, and at six groundwater test areas at the soil and groundwater test facility to show how groundwater fate and transport of nitrogen occurs. Final reporting for this task will be completed either at the end of this or during the subsequent year.
4. For Task D, the soil model will be completed and integrated with groundwater models which will be developed, calibrated, and validated, utilizing the results of the field work collected in previous tasks, and a final task report will be written summarizing the results of this task either at the end of this or during the subsequent year.

3 FUNDING NEEDS

Activities in fiscal years 2008-2011 have prepared the framework for rapid implementation of all remaining project tasks in fiscal year 2012-2013. Cash in the amount of $2.2 million is required to reap the benefits of all previous work and to complete the goals of this project. For the 2012-2013 budget year, $1.5 million are required to fund the completion of scheduled tasks.

Funds appropriated and expended to date have established necessary viable protocols and have been appropriately used to test, calibrate, and refine technologies and strategies to be tested in the field. Without further funding for the final Phase 3 of the project, necessary and extensive field testing, the major portion of Task B, will not occur and, if field testing does not occur, the project will essentially not yield results that can be used to develop viable, cost-effective alternative passive technologies for use by homeowners for nitrogen issues associated with onsite systems.

Project Tasks (described previously) are broken down further into funding phases as follows:

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Initial Funding in 2008-2010 (Phase I): $900,000 (cash and budget) appropriated (in 2008 and 2009 state budgets) – status: Complete. The initial funding was targeted to prioritize systems for testing, summarize existing knowledge, develop testing protocols, and establish a test facility for detailed soil and groundwater monitoring and for preliminary testing of pilot scale passive nitrogen reduction systems.

Funding in 2010-2011: $2 million (cash and budget) appropriated (in 2010 state budget) – status: Ongoing. This funding is for field monitoring over at least a one-year monitoring period of performance and cost of technologies at home sites, and of nitrogen fate and transport. This funding will also continue the development and monitoring work at the test facility and continue the modeling work.

Funding in 2011-2012: $2.75 million (budget) appropriated (in 2011 state budget) – status: Ongoing. This funding will continue and complete the development and monitoring work at the test facility and continue the modeling work. The preliminary results of the project are encouraging. This funding is also for field monitoring over at least a one-year monitoring period of performance and cost of technologies at home sites, and of nitrogen fate and transport.

Funding in 2012-2013: To adequately fund the final phase of the project, $2.2 million cash is needed. A budget appropriation of $1.5million will needed for FY 2012-13. Further testing is required to confirm the results to date with field data and to provide data for development of the engineering specifications for full system designs. The funds will be used to complete monitoring and other field activities, additional testing as deemed appropriate by the Legislature, and final reporting with recommendations on onsite sewage nitrogen reduction strategies for Florida's future.

Further information on this project, including previous legislative reports and detailed project reports, can be found on the Department's website:

http://www.doh.state.fl.us/environment/ostds/research/Nitrogen.html

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Table 1. Summary of Funding Phase Tasks and Associated Number of Deliverables.

	Task	Phase I[a] $900,000 (July 2008-November 2010, completed)	Phase II[a] $2,000,000 (Current Funding, in progress)	Phase III[a] $2,200,000 (Future Funding, yet to be funded)
A	**Task A: Technology Selection & Prioritization**	**$352,144**	**$336,514**	**$35,480**
	Literature review	1		
	Ranking of nitrogen reduction technologies for field testing	1		
	Design and construction of test facility	1		
	Quality assurance project plan	1		
	Monitoring and sample events		7	
	Final test facility report		1	
	Final task report			1
B	**Task B: Field Testing of Technologies**	**$50,202**	**$599,610**	**$529,243**
	Quality assurance project plan		1	
	Installation of ranked nitrogen reduction technologies at 8 field sites		4	4
	System performance monitoring events at 8 sites		4	4
	Life cycle cost assessment template development		1	
	Final life cycle cost assessment report (per system)			8
	Final task report			1
C	**Task C: Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater**	**$216,164**	**$1,095,977**	**$598,860**
	Quality assurance project plan	1		
	Design of test facility	1		
	Construction of test facility		1	
	Monitoring and sample events (6 test areas)		3	3
	Instrumentation of existing OSTDS mound at GCREC facility		1	
	GCREC mound sample events		4	
	Field sites sample events (4 sites)		1	3
	Final task report			1
D	**Task D: Nitrogen Fate and Transport Models**	**$74,357**	**$292,021**	**$441,644**
	Quality assurance project plan	0.5 (draft)	0.5 (final)	
	Soil model		1	
	Shallow groundwater models			1
	Calibration of models to existing data sets			1
	Uncertainty analysis for models			1
	Validation and refinement of models			1
	Final task report			1
	Project Management (sum of contractor and DOH)	**$119,953**	**$126,375**	**$231,456**
	Contractor project management	$90,695	$109,003	$178,085
	DOH project management	$29,258	$17,372[b]	$53,371[b]
	Total Budget[c]	**$812,820**	**$2,450,497**	**$1,836,722**
	Total Budget Remaining as of April 15, 2011	**$0**	**$1,670,029**	**$1,836,722**

a. Numbers in each subtask represent the numbers of budgeted deliverables.
b. DOH project management costs for Phases II and III are estimated costs.
c. Budgeted totals differ from the legislative funding amounts due to scheduling.

DOH – Department of Health
GCREC – Gulf Coast Research & Education Center
OSTDS – Onsite Sewage Treatment and Disposal Systems

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4 RECOMMENDATIONS

DOH and its Research Review and Advisory Committee recommend that the Legislature:

1. Provide cash in the amount of $2.2 million for continuation and completion of the tasks associated with this legislatively mandated study.
2. Provide budget authority to DOH in the amount of $1.5 million for the fiscal year 2012-2013 for continuation and completion of the tasks associated with this legislatively mandated study.

This additional funding will be applied to the final phase of the project, primarily continuation and completion of field monitoring of performance and cost of technologies at home sites and of nitrogen fate and transport in the shallow groundwater, development of various nitrogen fate and transport models that will be calibrated with the field sampling results, and final reporting on all tasks with recommendations on onsite sewage nitrogen reduction strategies.

Continued support for this project will ultimately benefit Florida's approximately 2.7 million onsite system owners by finding cost-effective nitrogen reduction strategies that will improve environmental and public health protection. If fully funded, the results of this project will assist with producing nitrogen reducing systems that protect groundwater with both reduced life-cycle costs and lower energy demands.

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Provide DOH budget authority for any remaining funds from the 2010 appropriation to carry over to fiscal year 2011-2012

APPENDIX A. 2010 Legislative Language

SECTION 3 – HUMAN SERVICES

486	SPECIAL CATEGORIES CONTRACTED SERVICES	
	FROM GENERAL REVENUE FUND	153,772
	FROM ADMINISTRATIVE TRUST FUND . . .	337,765
	FROM FEDERAL GRANTS TRUST FUND . . .	348,235
	FROM GRANTS AND DONATIONS TRUST FUND	2,648,438
	FROM RADIATION PROTECTION TRUST FUND	150,000

From the funds in Specific Appropriation 486, $2,000,000 from the Grants and Donations Trust Fund is provided to the department to continue phase II and complete the study authorized in Specific Appropriation 1682 of chapter 2008-152, Laws of Florida. The report shall include recommendations on passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The department shall submit an interim report of phase II on February 1, 2011, a subsequent status report on May 16, 2011, and a final report upon completion of phase II to the Governor, the President of the Senate, and the Speaker of the House of Representatives prior to proceeding with any nitrogen reduction activities.

Section 14. In order to implement Specific Appropriation 486 of the 2010-2011 General Appropriations Act, and for the 2010-2011 fiscal year only, the following requirements shall govern Phase 2 of the Department of Health's Florida Onsite Sewage Nitrogen Reduction Strategies Study:

(1) The underlying contract for which the study was let shall remain in full force and effect with the Department of Health and funding the contract for Phase 2 of the study shall be through the Department of Health.

(2) The Department of Health, the Department of Health's Research Review and Advisory Committee, and the Department of Environmental Protection shall work together to provide the necessary technical oversight of Phase 2 of the project, with the Department of Environmental Protection having maximum technical input.

(3) Management and oversight of Phase 2 shall be consistent with the terms of the existing contract; however, the main focus and priority for work to be completed for Phase 2 shall be in developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction.

(4) The systems installed at actual home sites are experimental in nature and shall be installed with significant field testing and monitoring. The Department of Health is specifically authorized to allow installation of these experimental systems. In addition, before Phase 2 of the study is complete and notwithstanding any law to the contrary, a state agency may not adopt or implement a rule or policy that:

(a) Mandates, establishes, or implements any new nitrogen-reduction standards that apply to existing or new onsite sewage treatment systems or modification of such systems;

(b) Increases the cost of treatment for nitrogen reduction from onsite sewage treatment systems; or

(c) Directly requires or has the indirect effect of requiring, for nitrogen reduction, the use of performance-based treatment systems or any similar technology; provided the Department of Environmental Protection administrative orders recognizing onsite system modifications, developed through a basin management action plan adopted pursuant to section 403.067, Florida Statutes, are not subject to the above restrictions where implementation of onsite system modifications are phased in after completion of Phase 2, except that no onsite system modification developed in a basin management action plan shall directly or indirectly require the installation of performance-based treatment systems.

APPENDIX B. 2011 Legislative Language

SECTION 3 – HUMAN SERVICES

465 SPECIAL CATEGORIES
CONTRACTED SERVICES

FROM GENERAL REVENUE FUND	97,489
FROM ADMINISTRATIVE TRUST FUND . . .	335,165
FROM FEDERAL GRANTS TRUST FUND . . .	643,776
FROM GRANTS AND DONATIONS TRUST FUND	3,401,038
FROM RADIATION PROTECTION TRUST FUND	150,000

From the funds in Specific Appropriation 465, $2,725,000 in nonrecurring funds from the Grants and Donations Trust Fund is provided to the department to complete phase II and phase III and complete the study authorized in Specific Appropriation 1682 of chapter 2008-152, Laws of Florida. The report shall include recommendations on passive strategies for nitrogen reduction that complement use of conventional onsite wastewater treatment systems. The department shall submit an interim report of the completion of phase II and progress on phase III on February 1, 2012, a subsequent status report on May 16, 2012, and a final report upon completion of phase III to the Governor, the President of the Senate, and the Speaker of the House of Representatives prior to proceeding with any nitrogen reduction activities.

Section 7. In order to implement Specific Appropriation 465 of the 2011-2012 General Appropriations Act, and for the 2011-2012 fiscal year only, the following requirements govern the completion of Phase 2 and Phase 3 of the Department of Health's Florida Onsite Sewage Nitrogen Reduction Strategies Study:

(1) The Department of Health's underlying contract for the study remains in full force and effect and funding for completion of Phase 2 and Phase 3 is through the Department of Health.

(2) The Department of Health, the Department of Health's Research Review and Advisory Committee, and the Department of Environmental Protection shall work together to provide the necessary technical oversight of the completion of Phase 2 and Phase 3 of the project.

(3) Management and oversight of the completion of Phase 2 and Phase 3 must be consistent with the terms of the existing contract. However, the main focus and priority to be completed during Phase 3 shall be developing, testing, and recommending cost-effective passive technology design criteria for nitrogen reduction.

(4) The systems installed at homesites are experimental in nature and shall be installed with significant field testing and monitoring. The Department of Health is specifically authorized to allow installation of these experimental systems. Notwithstanding any other law, before Phase 3 of the study is completed, a state agency may not adopt or implement a rule or policy that:

(a) Mandates, establishes, or implements more restrictive nitrogen-reduction standards to existing or new onsite sewage treatment systems or modification of such systems; or

(b) Directly or indirectly requires the use of performance-based treatment systems or similar technology, such as through an administrative order developed by the Department of Environmental Protection as part of a basin management action plan adopted pursuant to s. 403.067, Florida Statutes. However, the implementation of more restrictive nitrogen-reduction standards for onsite systems may be required through a basin management action plan if such plan is phased in after completion of Phase 3.

Department of Health
Bureau of Onsite Sewage Programs

Nitrogen Reduction Strategies Study
Progress Update
November 2011

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Purpose:

- Develop passive strategies for nitrogen reduction that complement the use of conventional onsite sewage treatment and disposal systems
- Further develop and test the most cost-effective nitrogen reduction strategies

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Project Tasks:

A. Technology Selection & Prioritization

B. Field Testing of Technologies

C. Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater

D. Nitrogen Fate and Transport Modeling

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task A: Technology Selection & Prioritization

- Selected different technologies for field testing after conducting a literature review, technology evaluation, and technology prioritization process

- Built pilot scale units with various media combinations at a newly constructed test facility at the University of Florida's Gulf Coast Research and Education Center in Wimauma, Florida

- Results from two-stage passive biofilter are encouraging after 12 months of testing, showing a TN reduction of over 95% (2.6 mg/L)

- Also testing reactive media in a more in-situ/in-ground system approach

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Nitrogen Study Test Facility

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task B: Field Testing of Technologies

- Installation of top ranked nitrogen reduction technologies at actual home sites and document performance and cost
- Total of seven sites to be installed and monitored
- One system (Nitrex) installed to date in Wakulla County, sampling is underway
- Other homeowner agreements have been reached for potential sites in Hillsborough, Marion, Lee, Seminole, and Wakulla counties

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task C: Evaluation of Nitrogen Reduction by Soils & Shallow Groundwater

- Field evaluations of nitrogen reduction in Florida soils
- Will provide data for the development of a simple planning model
- Test Facility to be constructed to conduct controlled tests in multiple drainfield configurations
- Up to four home sites will be evaluated
- Two home sites (Wakulla and Seminole counties) and the existing mounded system at the test facility have been instrumented and tested to date
- Other homeowner agreements have been reached in Hillsborough, Marion, Seminole, and Wakulla counties

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Task D: Nitrogen Fate and Transport Modeling

- Development of a simple fate and transport model of nitrogen from onsite sewage treatment and disposal systems that can be used for assessment, planning, and siting
- Quality Assurance Project Plan has been completed
- Development of a soil model is underway and will be utilized to generate a simple tool for prediction of nitrogen removal in Florida soils

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Funding Recommendations

- Project is funded through June 30, 2012. Funding (cash) required in the amount of $2.2 million for continuation and completion of all tasks in the original project scope.
- The results of this project will assist with producing more cost-effective nitrogen reducing systems that protect groundwater with lower life-cycle costs and lower energy demands.

Department of Health
Bureau of Onsite Sewage Programs
Research Review and Advisory Committee

Thursday November 15, 2011

10:00 am – 3:00 pm

Agenda:

- Introductions and Housekeeping
- Review Minutes of Meeting September 8, 2011
- Nitrogen Study
  - Funding update
  - Discussion on Legislative Progress Report
- Update on 319 Grant
- Other Business
- Public Comment
- Closing Comments, Next Meeting, and Adjournment

Introductions & Housekeeping

- Roll call
- Identification of audience
- How to view web conference
- DO NOT PUT YOUR PHONE ON HOLD!!!!
- Download reports:

http://www.myfloridaeh.com/ostds/research/Index.html

Introductions & Housekeeping

Changes to committee since last meeting:

- Environmental Interest Group member and alternate positions are vacant
- New alternate for the Septic Tank Industry: Wayne Crotty (replacing Sam Averett)

Review Minutes of Meeting September 8, 2011

- See draft minutes

Florida Onsite Sewage Nitrogen Reduction Strategies Study

Purpose: Develop passive strategies for nitrogen reduction that complement use of conventional onsite sewage treatment and disposal systems, and further develop cost-effective nitrogen reduction strategies

Florida Onsite Sewage Nitrogen Reduction Strategies Study

- October 11, 2011 TRAP meeting
  - Presented update on nitrogen study
  - TRAP moved to write a letter to the legislature to request the funding needed to finish the project
- November 10, 2011 Wekiva Commission meeting
  - Presented update on nitrogen study
  - Will write a letter in support of the project

Florida Onsite Sewage Nitrogen Reduction Strategies Study

- Funding Update
  - Project is funded through June 30, 2012. Funding (cash) required in the amount of $2.2 million for continuation and completion of all tasks in the original project scope.
  - The results of this project will assist with producing more cost-effective nitrogen reducing systems that protect groundwater with lower life-cycle costs and lower energy demands.

F.Y.	Authorizations	Source	Actual Contract & DOH Costs within FY	Cumulative Expenditures	New Cash	Reapprop.	Purpose: Project Phase
2008/09 7/1 - 6/30	$1,000,000.00 HB 5001 Approp. # 1682	DEP/WPSPTF	$99,881.20 - Actual $19,189.58 - DOH $119, 070.78 - Total	$119,070.78	$900,000.00 [2]		1
2009/10 7/1 - 6/30	$540,000.00 SB 2600 Approp. # 471	DEP/WPSPTF	$506,208.71 - Actual $ 6,826.22 - DOH $513, 034.93 - Total	$632,105.71	$0.00	$540,000.00 [3]	1
2010/11 7/1 - 6/30	$2,000,000.00 HB 5001 Approp. # 486	DEP/WPSPTF	$538,363.23 - Actual $ 4,153.22 - DOH $542,516.45 - Total	$1,174,622.10	$2,000,000.00		1 & 2
2011/12 7/1 - 6/30	$2,725,000.00 SB 2000 Approp. # 465	GDTF	$388,033.00 - Actual $ 3,057.75 - DOH $391,090.75 [4]	$1,565,712.80	$0.00	$525,000.00 [3]	2
2011/12 [5] **ESTIMATED**			$1,041,442.30	$2,607,155.00			2
2012/13 [6] **ESTIMATED**			$1,500,000.00	$4,107,155.00			2 & 3
2013/14 [6] **ESTIMATED**			$892,845.00	$5,000,000,00			3

1 At the inception of this project in 2008/09, it was estimated that the cost would be $5 million and said contract was entered into for $5 million (subject to annual appropriation) for 3 phases expected to take place over the course of 3 to 5 years. FDOH authorizes tasks based on available cash. As of June 2010 FDOH has authorized tasks for the cumulative total of $2.9-million. However, project tasks with expenditures after June 30, 2012, cannot be authorized without appropriation of new cash for 2012/2013.

2 This amount was reduced by 10% during f.y. 2008-2009.

3 This was re-appropriation of monies not spent in previous year due to fact contract wasn't let until 2/09.

4 This is in progress. Amount shown is what DOH has spent as of 10/11/2011.

5 This is an estimate of expenditures that could occur beyond the actual expenditures as of 10/11/11 for the remainder of the fiscal year, assuming all project tasks were authorized at beginning of fiscal year.

6 This is an estimate by the Contractor assuming all project tasks were authorized at beginning of fiscal year 11/12.

Florida Onsite Sewage Nitrogen Reduction Strategies Study

- Discussion on Legislative Progress Report
  - Review document with tracked changes
  - Main changes were to update report to reflect current task status, budget, and funding needs

319 Project on Performance and Management of Advanced Onsite Systems

Purpose: Assess water quality protection by advanced OSTDS throughout Florida

Progress:

- Executed amendment to grant to update budget spreadsheet
- Granting period is now complete
- Final invoice to be sent to DEP in next week

319 Project on Performance and Management of Advanced Onsite Systems

Progress cont. :

- Monroe County Project
  - Objectives:
    - Characterize the variability of grab samples over the course of a day
    - Compare grab sample results to time-composite sample results
    - Assess the variability of sampling results between repeat visits at the same unit
  - System Selection:
    - Volunteer
    - Both OWNRS and interim systems
    - Mean water use was 190 gpd

319 Project on Performance and Management of Advanced Onsite Systems

Progress cont. :

- Monroe County Project
  - Sampling
    - Feb 2007 – June 2009
    - Effluent sampling points: pump compartments & P-traps
    - Influent sampling points: most upstream accessible location
    - 24-hour time-composite samples in 1-hour intervals
    - Grab samples at same location several times(1-hour intervals)
    - Field blanks, tap water, and replicates were taken
  - Assessments
    - How variable are grab samples over the course of a day
    - How different is the average of grab samples from the 24-hour time-composite sample

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Progress cont. :

- Monroe County Project
  - Analysis of blanks showed that the majority of the samples were within acceptable limits, with some exceptions that appear to be possible lab reporting errors or labeling errors
  - Analysis of replicates:
    - TSS had highest variability
    - Nutrient samples had low variability

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Progress cont. :

- Monroe County Project Results
  - Influent composite samples
    - No significant difference between influent measurements for residential PBTS, ATUs, and commercial PBTS
    - Influent from systems with recirculation was not significantly different from those without recirculation
    - No significant correlation between water use and influent concentration
  - Intermediate composite samples
    - One way to assess the importance of where to sample influent
    - Intermediate samples show the influence of aerobic treatment, but nitrogen is still predominantly in the TKN form

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Progress cont. :

- Monroe County Project Results
  - Effluent composite samples
    - Better effluent results for cBOD5 and TSS with addition of phosphorus reduction step
    - Phosphorus requirement of 1 mg/L is met by less than 10% of samples
    - Typical (median) TN in effluent is between 20-30 mg/L (interquartile 15-43 mg/L), with a mean of 36 mg/L that is considerably lower than influent (81 mg/L) and intermediate concentrations (56 mg/L)

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Progress cont. :

- Monroe County Project Results
  - Effluent grab samples
    - Better effluent results for most sampling parameters with addition of phosphorus reduction step
    - TN significantly reduced but no significant differences in nitrate and TKN due to P-reduction step
  - Bacteriological samples
    - 75% of samples met treatment standards

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Progress cont. :

- Monroe County Project Results
  - Variations between grab samples during a composite sampling period
    - Allows for comparison of how representative one grab sample is for a sampling period
    - 700 pairs of samples
    - cBOD5 and nitrite a large fraction were below detection, no differences
    - TP and total alkalinity had least variability, followed by TN
    - TSS showed highest variability
    - First grab sample tended to be higher than all subsequent samples for TSS and cBOD5 only

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Progress cont. :

- Monroe County Project Results
  - Variability of grab samples during diurnal sampling (relative standard deviation)
    - Total alkalinity, TN, and TP show the lowest variability
    - TSS had the highest variability
    - Some association between analytes that are not obviously related (TSS and total alkalinity; TN and TP)
  - Differences between grab average and composite samples
    - No systematic bias found for sampling event differences
    - Total alkalinity, TP, TN, and nitrate are the least variable, and is similar to the differences between grab samples throughout a day

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Progress cont. :

- Monroe County Project
  - Differences between repeat sampling events
    - Some systems had 7 sampling events, most 2 of 3
    - Subsequent events had a tendency to higher effluent concentrations for TSS and ammonia and had lower concentrations for total alkalinity, probably not significant
    - Differences in the consistency of treatment between systems highest for TN and TP
    - Correlations between influent samples were higher than effluent
    - differences between influent consistency for systems appears significant for TN and TP; not significant for cBOD5 and TSS

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Progress cont. :

- Monroe County Project
  - Variability
    - Between-event variability is at least twice as large as the within-event variability for all analytes except TSS
    - Not much difference in variability between time composite effluent samples and grab samples
  - Differences in concentrations
    - No correlations between influent and effluent concentrations
    - Influent did not differ significantly among permitting categories (residential PBTS, ATU, commercial PBTS), for effluent significant differences for cBOD5, TSS, ammonia-N, and TP (P-treatment step)
    - For TP: mid-floc had highest TP concentrations and Leca had lowest

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Progress cont. :

- Monroe County Project
  - Screening tests
    - Could allow for prediction of lab results
    - Visual classifications can be a good indicator
      - Grey color (not clear) generally means a sample exceeds 10 mg/L TSS
    - Presence of smell is an indicator for TSS, ammonia, or TKN exceeding 10 mg/L
    - Correlation between lab results with Hach results (nitrate, ammonia, reactive Phosphorus) and with Taylor kit (total alkalinity) results
    - Half of the chorine measurements were less than 0.5 mg/L prior to injection well
    - Test strips for alkalinity show promise as a field screening test, the rest (reactive phosphorus, nitrate, nitrite, and chlorine) had very low correlations

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Progress cont. :

- Monroe County Project
  - Next steps:
    - Revise and edit report based on discussion during meeting and any other comments sent to Elke Ursin by **November 22nd**
    - Complete executive summary, discussion, results & conclusions, references, and appendices
    - Submit report to DEP by November 30th

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Progress cont. :

- Database
  - Database of system records is complete
  - 16,595 identified advanced systems in the state
  - Description of data fields and structure has been developed and will be submitted prior to end of November
- Surveys of Interest Groups
  - Completed

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Progress cont. :

- Sampling
  - Final sample size of 1014 systems
  - Permit file reviews are ongoing, 600 files have been reviewed
  - Samplers from Charlotte, Lee, Monroe, Volusia, and Wakulla counties
  - Total of 554 systems were sampled, 28 were sampled twice, and 2 were sampled 3 times
  - Total of 644 samples taken from various points along treatment train and analyzed by lab for various parameters (alkalinity, cBOD5, TKN, Nitrate-Nitrite, TSS, TN, and TP)
  - Total of 252 fecal samples taken and analyzed

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Progress cont. :

- Management Practices
  - Database was created linking program evaluations over past 10 years with survey results for regulators and system owners/users
  - Analysis has been done and will be summarized in the final task report
  - Linking between this database and the sample results will also be done and summarized in the final task report

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Progress cont. :

- Final Project Report
  - Anticipated to be written after all data entry and data analysis has been completed
  - Draft report to be presented to RRAC for review prior to finalization and submission to DEP

Other Business

- **TRAP voted to approve the 2011 RRAC research priorities**

Public Comment

Next Meeting

Upcoming meeting topics:

- Discussion on 319 grant report on the performance of advanced OSTDS in Florida
- Discussion on process forward with research priorities

Proposed dates for next meeting:

- Will send email to RRAC at a future date to determine next meeting

Closing Comments and Adjournment