TEXAS STATE SOIL AND WATER CONSERVATION BOARD

Workplan

FOR THE FY 03 CLEAN WATER ACT, SECTION 319(h) PROJECT

Demonstration and Transfer of Selected New Technologies for Animal Waste Pollution Control

TSSWCB Project FY03-10

Nonpoint Source Summary Page
(Clean Water Act 319(h)

1.Title of Project:	Improving Water Quality by Developing, Implementing, and Field Testing Innovative Methods
2.Project Goals/Objectives	Evaluate up to six technologies for decreasing nonpoint source pollution and improving surface water quality, through on-site demonstrations of reduction of total and soluble P in dairy effluent applied to waste application fields.
3. Project Tasks:	Task 1 Demonstration and evaluation of new technologies to reduce phosphorus pollution in the North Bosque River Subtask 1.1 Identification of potential technology providers. Subtask 1.2 Identification of dairy cooperators in the North Bosque watershed. Subtask 1.3 On-site installation and start-up of the pilot-scale technology Subtask 1.4 QAPP preparation and field data collection and analysis. Subtask 1.5 Develop reports and outreach education materials. Task 2 Demonstrating the cycling of Geotube residue from dairy lagoons through turfgrass sod. Subtask 2.1 Establishment of the demonstration plots and procurement of materials. Subtask 2.2 Analysis of physical and chemical properties of Geotube residuals. Subtask 2.3 Effects of Geotube residues on turfgrass and soil physical, chemical, and biological properties. Subtask 2.4 Evaluate leaching losses of nutrients and dissolved organic C. Subtask 2.5 Statistical analysis and reporting.
4. Measures of Success:	The ability of innovative technologies to lessen phosphorus levels from dairy lagoon effluent will be evaluated. The overall impact of this project will be that it will provide stakeholders with technical information they can utilize to significantly improve water quality in agricultural watersheds.
5. Project Type:	Statewide ( ); Watershed ( ); Demonstration (X)
6. Waterbody Type:	River (X); Groundwater ( ); Other ( )
7. Project Location:	Upper Bosque River, Segments 1226 and 1255.
8. NPS Management Program Reference	*Texas Nonpoint Source Pollution Assessment Report and Management Program* approved February 25, 2000
9. NPS Assessment Report Status:	Impaired (X); Impacted ( ); Threatened ( )
10. Key Project Activities:	Hire Staff (); Monitoring (X); Regulatory Assistance (); Technical Assistance ( ); Education (X); Implementation (X); Demonstration (X); Other ( )
11. NPS Management Program Elements:	
12. Project Costs:	Federal ($229,592); Non-Federal Match ($163,311); Total Project ($392,903)

13.Project Management:	Principal Investigator: C. Allan Jones, Ph.D., Texas Water Resources Institute. Subject Matter Experts, Saqib Mukhtar, Ph.D., P.E., TAMU Biological and Agricultural Engineering Department.
14. Project Period: (Three years from start date.)	September 1, 2003 through August 31, 2006

Demonstration and Transfer of Selected New Technologies for Animal Waste Pollution Control

I. Introduction of this Project and Organization of this Proposal

This proposal provides for testing of new technologies designed for reducing water pollution associated with animal production systems, principally dairies. The focus is restricted to reducing phosphorus in dairy waste streams.

II. Problem Statement

In 1998, segments 1226 and 1255 (corresponding to the North Bosque River and Upper North Bosque River segments) were deemed "impaired segments" on the State of Texas Clean Water Act Section 303(d) under water quality standards related to nutrients and aquatic plant growth. Recent studies conducted or sponsored by the Texas Commission on Environmental Quality (TCEQ), the Texas State Soil and Water Conservation Board (TSSWCB), the Texas Institute for Applied Environmental Research, the Texas Water Resources Institute (TWRI) and others have demonstrated that high levels of phosphorus (P) and other nutrients from point and nonpoint sources degrade water quality in the North Bosque River. Nonpoint sources such as dairy waste application fields (WAF) and point sources such as municipal wastewater treatment plants are the major controllable sources of P in the watershed.

These findings led to the US Environmental Protection Agency (USEPA) approval for the two Total Maximum Daily Loads (TMDLs) for P in the North Bosque River. In December 2002, the TCEQ approved the implementation plan for the two TMDLs, and the TSSWCB approved them in January 2003. The goal of these TMDLs is to achieve a reduction of total annual loading and annual average concentrations of soluble reactive P (SRP) by approximately 50%. The Bosque River Advisory Committee expects that both point and nonpoint sources will have to make significant reductions in their P contributions to achieve this goal. It is anticipated that SRP reductions of this magnitude will reduce the potential for problematic algal growth in the North Bosque River and Lake Waco.

There are roughly 41,000 dairy cows in the Bosque River watershed. Runoff from production areas such as feedlots and feed lanes is regulated as point source. Runoff from waste applications fields (WAFs) is not regulated, and therefore is treated as a nonpoint source. It is anticipated that the measures to control SRP loading from WAFs may include a combination of dairy confined animal feeding operations (CAFOs) regulated for land application of manure and wastewater, as well as voluntary programs. Several permitted dairies in the watershed use some kind of best management practices (BMPs) to reduce nutrients in the effluent being applied to the WAFs. In most cases, these include separation of solids from liquid manure by either gravitational (settling basins) or mechanical (screen separators) methods to remove as much as 40% of solids from liquid dairy manure. While separating solids does reduce total P, as much as 90% of the SRP remains in the effluent to be stored in a basin or lagoon and then land applied to the WAFs. Low-cost, highly efficient and easy-to-adopt technologies in the form of BMPs that will reduce total P and SRP from dairy effluent that is applied on the WAFs will contribute significantly to the overall goal of 50% SRP reduction in annual loading for the two TMDLs in the North Bosque River. In recent years, techniques such as electrocoagulation (a process where electrical current passing between metal electrodes is used to remove dissolved and suspended constituents from wastewater), and chemical precipitation of contaminants with metal coagulants (aluminum sulfate, also known as alum and similar compounds) have been promoted as ways to remove nutrients from dairy wastes. Other methods that have been noted include polymers (such as synthetic long chain polyacrylamides), deep aeration of lagoon using micro-bubblers, geotextile materials, use of special microbial additives as well as technologies currently in the developmental and testing stages.

The North Bosque River Watershed contains areas that have concentrated numbers of dairy operations. Dairy lagoons are designed and built to catch and contain process water and certain amounts of rainwater on most dairies. The lagoons must be dewatered from time to time, which adds phosphorus to the receiving soils. Historical dairy waste application fields that are subject to lagoon dewatering activities have been identified as potentially significant sources of phosphorus entering the waterways.

III. General Project Description

A. Testing innovative technologies

The implementation of this project consists of evaluation of six new technologies that will be demonstrated on cooperators' dairy farms by the providers; electrocoagulation system, polymer enhanced solids separation system, aeration with microbubblers, and a geotextile solids separation system are examples of such technologies which may be demonstrated. These technologies are tested and utilized in municipal waste treatment systems, dredging and sediment recovery from streams, and oil and gas industry but they have not been adequately tested or demonstrated for treating animal waste. This is especially true for testing these technologies for the reduction of phosphorous from land applied liquid dairy manure in the Bosque river watershed. A brief description of each technology is provided.

Electrocoagulation System: This technology is based upon the principle of electrical precipitation using cations from metal (aluminum and/or iron electrodes) as coagulants to remove phosphorus from liquid waste in an electrically energized state. The primary action is combining of orthophosphates with the metal ions but polyphosphates and organic phosphorous compounds are also removed by being absorbed or entrapped in the floc particles. The floc is then removed using a number of removal techniques, including filtration and dissolved air floatation and skimming methods. The provider for this technology indicates that their system can treat liquid waste at a rate of up to 100 gallons per minute and remove significant amounts of P and other heavy metals as well as reduce pathogenic activity in the treated effluent. Preliminary studies by manufacturers will be the basis for demonstration of an optimized process using dairy effluent.

Polymer Enhanced Liquid-Solid Separation: Use of synthetic polymers such as polyacrylamides (PAM) has been known in the municipal waste treatment systems to aid in coagulation of slow settling precipitates or fragile flocs that can be easily fragmented under hydraulic forces in basins and filters. These long-chain, high molecular weight, polymers are commercially available under several trade names. Laboratories have tested how well these polymers help separate solids in animal manure by coagulation and flocculation, but there is no standard method for testing in the field. Some bench scale studies have shown that many more total solids are removed when sedimentation or mechanical separation is followed by chemical treatment of liquid manure. In recent years, less expensive polymers have been introduced into the market. The technology provider will be using these polymers to demonstrate removal of P and other chemicals from the liquid phase and their concentration in sludge..

Deep Aeration with a Micro bubbler System: In a municipal waste treatment process**,** initial solids separation is usually followed by vigorous aeration to remove biochemical oxygen demand (BOD) or organic material. Aerobic bacteria can remove a portion of the nitrogen and phosphorous from liquid waste by biological up-take. Surface aeration is also used in animal waste storage operations to reduce odors. A deep aeration system using micro-bubbles is expected to concentrate lagoon phosphorous in sludge accumulated at the bottom of lagoons, reducing its concentrate in solution and facilitating removal from the watershed. Microbubble technology has been evaluated by its manufacturer at small scale. It must be demonstrated and evaluated for dairy lagoons.

Geotextile Solids Separation System: This system is comprised of a large porous tube made from a heavy duty polypropylene fabric, with a large circumference (up to 45 feet) and variable lengths (up to 400 feet) to remove solids from slurry pumped into the tube. This system has been used in erosion control and sediment removal from streams. Lagoon effluent from the animal feeding operations can be pumped into the tube and as the liquid leaves the tube due to its porous structure, solids larger than the pore size of the tube are trapped. This process can be repeated until the tube is full. The liquid (effluent out of the tube) with reduced amount of phosphorus may be routed back to the lagoon or to a waste application filed. The removed solids, now lower in moisture, can be hauled to a relatively longer distance to fields with low soil phosphorous or composted on site and then land applied to distant fields with low soil phosphorous. The use of geotextile tubes needs to be demonstrated at full scale in the dairy industry.

Struvite (solid magnesium ammonium phosphate): is formed by the reaction of soluble phosphorus with magnesium and ammonium ions under anaerobic conditions at high pH--the conditions present in dairy lagoons. Enhancing the formation of struvite has been identified as a treatment that can be highly effective at removing soluble phosphorus and ammonium from dairy lagoons, wastes from swine and poultry operations, and municipal wastewater. Struvite formation can remove significant amounts of soluble phosphorus from liquid wastes, and this process creates an excellent slow-release fertilizer. In order for struvite to be used to treat dairy wastes, work needs to be done to demonstrate the efficacy of economical sources of magnesium, and to methods to harvest struvite from the waste stream.

Capacitive Deionization Technology (CDT): is a process that utilizes a flow-through capacitor with pairs of electrodes to treat waters and improve water quality. The basic operating principle is that ions and other charged particles are attracted to and held on electrodes of the opposite charge. Materials that are attached to the electrodes can then be released to a waste stream. The application of CDT technologies to dairy waste streams needs to be field tested so that performance and cost issues can be evaluated. The field tests associated with this project will serve to demonstrate the technology’s efficacy to the industry and potential funding agencies.

The above mentioned technologies are only examples of such technologies that may be selected to be demonstrated in this project and should not be viewed as an explicit or exhaustive listing. Any technology designed to remove/reduce P from dairy effluent may be selected to participate in this project upon the suggestion of the advisory committee and with approval from the TSSWCB.

An advisory committee comprised of Texas A&M University System scientists, engineers and extension agents, personnel from the dairy industry, Texas Farm Bureau (TFB), EPA Region 6, the TSSWCB, Texas Cooperative Extension (TCE), the TCEQ, the Brazos River Authority (BRA), the USDA-NRCS, and the Texas Agricultural Experiment Station (TAES), dairy operators and owners, and technology providers will provide:

- Selection of specific pilot systems to be evaluated,
- Selection of dairy facilities on which to conduct the evaluations,
- Protocols and procedures to be used in the evaluation, and
- Publications, field demonstrations, and other documentation to be prepared.

Each technology will be evaluated for its efficacy to reduce total P and SRP, and other nutrients and metals, by sampling and analyzing the raw and treated effluent. Cost effectiveness, treatment efficiency, and ease of adoption of the technology, as a BMP will be evaluated. Each technology will be demonstrated for a period of at least three months. The advisory committee will be consulted to provide input on the priority and order of the evaluation/demonstration. The committee will also provide assistance in identifying and interacting with companies interested in demonstrating and evaluating the efficacy of the technologies.

A TCEQ-recognized independent analytical laboratory will be used for sample analyses.

IV. Work Plans, Deliverables, and Timetables

Task 1 Demonstration and evaluation of new technologies to reduce phosphorus pollution in the North Bosque River

Costs: $223,084 (federal), $163,311 (matching), $386,395 (total)

The overall objective of this demonstration is to reduce nonpoint source pollution of P by removing total and soluble reactive P from dairy lagoon effluent applied to waste application fields. This objective will be accomplished by evaluation and demonstration of at least six new technologies over a period of three years that purport to remove P from the dairy waste stream. The following tasks will be performed for this demonstration/evaluation project.

- **Subtask 1.1** Identification of potential technology providers. TCE, TWRI, TFB, dairy industry representatives, EPA Region 6, TSSWCB, TCEQ, BRA, NRCS, and TAES will identify and select promising technologies represented by willing technology providers. (Month 1-3)

- **Subtask 1.2** Identification of dairy cooperators in the North Bosque watershed area that use a flush system and lagoons to remove, store, treat, and land-apply effluent (manure and process-generated wastewater). TCE, TSSWCB and TFB will identify dairy operations willing to participate in these demonstrations. (Month 1-3)

- **Subtask 1.3** On-site installation and start-up of the six pilot-scale technologies to be demonstrated. Technology providers will carry out the task of equipment transport, on-site installation, set-up, and start-up. With permission from the cooperating dairy owner/operator, the technology provider will prepare the site to install and operate the system for demonstration. First installation by August 2003, last installation 6 months before the end of the 3-year project.
- **Subtask 1.4** QAPP preparation and field data collection and analysis. TCE will prepare the DQO and QAPP, and collect samples from raw and treated effluent and resulting sludge. One of the evaluation tasks will be to analyze the sludge or by-product remaining after raw material treatment for P stability. (August 2003 to May 2006)
- **Subtask 1.5** Develop reports and outreach education materials. TCE in cooperation TWRI will produce educational brochures and publications on effectiveness of this innovative technology. Quarterly and final reports will be prepared and submitted in a timely manner.

Deliverables

- Advisory committee setup and functioning
- Prioritization of technology studies
- Identified cooperators
- Installed pilot-scale demonstrations
- Field data collected for efficiency and financial viability determinations
- Reports and outreach materials
- Final report

Task 2: Demonstrating the cycling of Geotube residue from dairy lagoons through turfgrass sod.

Costs: $6,508 (federal), $0 (matching), $6,508 (total)

The objective of this demonstration is to determine the physical and chemical properties of residue contained inside of the Geotube, evaluate the effects of sod growth under varying Geotube residual application scenarios and evaluate the amount of nutrient leaching on differing soil textures with and without Geotube residual incorporation and removal.

Subtask 2.1 Establishment of the demonstration plots and procurement of materials. Geotube residuals, soil, leachate, sampling, and laboratory supplies will all be purchased in preparation of setting up the demonstration. TCE will oversee these activities and handle the procurement of needed materials and supplies. (Installation will occur within one month of task approval).

Subtask 2.2 Analysis of physical and chemical properties of Geotube residuals. Samples will be taken from two Geotubes and analyzed to determine water content, aggregate size, total organic carbon, total nitrogen, total phosphorus, potassium, calcium, magnesium, sodium, aluminum, iron, manganese, copper, zinc, nitrate, ammonium, and nitrate and phosphorus residuals retained in within the Geotubes. (Month 2 thru 5 after task approval).

Subtask 2.3 Effects of Geotube residues on turfgrass and soil physical, chemical, and biological properties. Four demonstration replications will be tested to demonstrate the effects of different Geotube residual application rates on turfgrass and soil properties. (Month 2 thru5 after task approval).

Subtask 2.4 Evaluate leaching losses of nutrients and dissolved organic C. Filtered and unfiltered leachate will be collected at 45 and 90 days after the start of the demonstration. Dissolved organic carbon, total nitrogen, nitrate, ammonium, total phosphorus, magnesium, calcium, sodium, potassium, iron, copper, zinc, manganese, molybdate-reactive phosphorus and organic phosphorus leaching will all be quantified. (Month 2 thru 5 after task approval).

Subtask 2.5 Statistical analysis and reporting. Variations in soil physical, chemical, and biological properties among main effects and for interactions between soil type and rates of Geotube residue applied will be analyzed. Regression analyses will also be conducted to relate soil pH and concentrations of soil N, P, organic C, and cations to concentrations and mass of N, P, organic C, and cations in turfgrass and leachate. A report will also be drafted showing the results of this demonstration. (Month 5 thru 6 after task approval).

Deliverables

- Installed pilot-scale demonstrations
- Reports and outreach materials
- Final report

V. Coordination of Roles and Responsibilities, Public Participation, and Measures of Success

Coordination of Roles and Responsibilities.

The following entities will coordinate activities, be responsible for the tasks described above, will all serve on a testing protocol advisory committee, and perform in other support roles as indicated, but not limited to those below:

- Texas State Soil and Water Conservation Board (TSSWCB): Responsible for overall project coordination and oversight.
- Texas Water Resources Institute (TWRI): Project administration and work efforts coordination.
- Texas Cooperative Extension (TCE): Conduct demonstrations, educational programs, accountability reports.
- Brazos River Authority (BRA): Serve on advisory committee and otherwise assist with project.
- Texas Farm Bureau (TFB): Assist with stakeholder and private sector involvement.
- Technology providers (to be determined): Supply technology equipment and materials, project setup and data collection.
- EPA Region 6: Assess regulations, revisions, and implications of technologies.
- Texas Commission on Environmental Quality (TCEQ): Assess regulatory implications of technologies.

- USDA-NRCS: Technical assistance.

Public Participation.

TCE will conduct field days and other educational programming during the operating period of each technology. BRA and TFB will participate in these functions, particularly with regard to projects for which they provide leadership. Dairy producers, media representatives, scientists, engineers, regulatory personnel, representatives of commodity groups, and the general public in the North Bosque River and Upper North Bosque basins and surrounding areas will be invited to view the systems in operation. A guidance document for operators will be offered through the TCE online bookstore.

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Budget for Task 1 and Task 2 for the TWRI 319 Project

	Federal	Nonfederal Match	Total
Personnel	109,813	34,594	144,407
Fringe	15,003	7,660	22,663
Travel	10,180	0	10,180
Small Equipment	3,685	0	3,685
Supplies	5,400	0	5,400
Contractual	40,000	0	40,000
Construction	0	30,000	30,000
Miscellaneous	14,000	16,300	30,300
Total direct costs	198,081	88,554	286,635
Indirect costs (allowable @15%)	29,712		29,712
Forgiven indirect costs (30.5%)		44,490	44,490
Indirect Cost (45.5%) (DHHS negotiated Rate)		40,292	40,292
Total Project Cost	**$227,793**	**$173,336**	**$401,129**

Budget Justification

Personnel

(In light of uncertainties in the State of Texas budget, an annual salary increase is not assumed.)

1. Extension Assistant (to be hired) , 33 months, 100% effort, $26,500/year to conduct sampling and analysis, and to help conduct field days
2. Science Writer, $52,000/year, 8% effort, to assist with preparation of reports and project tracking
3. (cost-share) Extension Specialist, $69,500/year, for overall management of the project

Fringe Benefits

1. Fringe benefits at 15.5% of salaries
2. Pro-rated medical insurance at $383 month

Travel

1. Sampling: 84 one-day trips for sampling and meeting attendance by Extension Assistant, approximately 350 miles round-trip each. $4,200
2. Field Days: 6 total two-day trips by Extension Assistant and Extension Specialist for field days, 350 miles round-trip each in common vehicle, $200 ea per trip. $1,200
3. Meetings between Extension Specialist, Extension Assistant, and technology providers. Six meetings total: 3 involving one-day travel, transportation @ $120; three involving 2 days' travel, transportation $250; per diem $110/day. $2,400.
4. Travel by TWRI personnel (Director, Associate Director, Science Writer) to participate in field days, advisory committee meetings, and demonstrations. Each trip with an average of two participants. $1,800

Small Equipment

1. Computer and projector for use in presentations at advisory committee meetings and field day demonstrations. $4,500
2. pH Probe for analysis of wastewater $700
3. Hach analyzer for coloerimetric analysis of waste water stream during demonstration and for preliminary analysis. $2,000
4. “Sludge gun” to quantify the sludge content for treatment facilities. $1,500

Supplies

Laboratory plastic ware for sampling, 100 16-oz. HDPE bottles per technology for 6 technologies at $1.20 each. $ 2,400

Contractual

Sample testing by laboratory, Texas Institute for Applied Environmental Research, 100 samples per technology at $106.98 each for 5 technologies. $53,492

Installation, sample collection, and analysis of samples collected for the demonstration of Geotube residual effects on sod and soil properties and measurement of constituent leaching off of the test plots conducted by Texas Cooperative Extension Researchers. $6,508

Construction

(Cost-share) Site prep for installation of technologies by technology providers. $30,000

Miscellaneous

1. Printing and dissemination of reports, $5,000
2. Field Days, 6 (one per technology) at $1,500 each
3. In-kind time of field day participants, $35/hour for 30 participants, 6 field days. $6,300
4. Technology Provider –in kind for setting up and implementing demonstrations. $10,000