# TEXAS COMMISSION ON ENVIRONMENTAL QUALITY LITTLE DUFFAU CREEK AND UN-NAMED TRIBUTARY of LITTLE DUFFAU CREEK ENVIRONMENTAL MONITORING RESPONSE SYSTEM CONTINUOUS WATER QUALITY MONITORING PROJECT PLAN

## A1 APPROVAL PAGE

| | |
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Date

This project plan documents specific details of a new continuous water quality monitoring project not covered in the Continuous Water Quality Monitoring Network (CWQMN) QAPP. Please see the CWQMN QAPP for other network details.

## A2 TABLE OF CONTENTS



**Appendices:**



**Tables:**

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LIST OF ACRONYMS

| | |
|---|---|
| **AFO** | **Animal Feeding Operation** |
| **CAFO** | **Confined Animal Feeding Operation** |
| **CAMS** | **Continuous Ambient Monitoring Station** |
| **CVS** | **Calibration Verification Sample** |
| **CWQMN** | **Continuous Water Quality Monitoring Network** |
| **DM&QA** | **Data Management and Quality Assurance** |
| **DQO** | **Data Quality Objective** |
| **E. coli** | **Escherichia Coli** |
| **EC** | **Electrical Conductance (Reported as Specific Conductance)** |
| **EMRS** | **Environmental Monitoring Response System** |
| **FOD** | **Field Operation Division** |
| **IB** | **Instrument Blank** |
| **LCS** | **Laboratory Control Sample** |
| **MDL** | **Method Detection Limit** |
| **mg/L** | **Milligram per Liter** |
| **$NH_3$-N** | **Ammonia-Nitrogen** |
| **$NO_3$-N** | **Nitrate-Nitrogen** |
| **LEADS** | **Leading Environmental Analysis and Display System** |
| **MOPs** | **Monitoring Operation Division** |
| **NA** | **Not Applicable** |
| **LD** | **Little Duffau** |
| **PL-566** | **Public Law Reservoirs** |
| **POD** | **Point of Discharge** |
| **$PO_4$-P** | **Orthophosphate-Phosphorus** |
| **ppm** | **parts per million** |
| **QA** | **Quality Assurance** |
| **QAPP** | **Quality Assurance Project Plan** |
| **QC** | **Quality Control** |
| **SC** | **Specific Conductance** |
| **SOP** | **Standard Operating Procedure** |
| **SWQM** | **Surface Water Quality Monitoring Team** |
| **SWQMIS** | **Surface Water Quality Monitoring Information System** |
| **T** | **Temperature** |
| **TIAER** | **Texas Institute for Applied Environmental Research** |
| **TBD** | **To Be Determined** |
| **TCEQ** | **Texas Commission on Environmental Quality** |

| | |
|---|---|
| **TRP** | **Total Reactive Phosphorus** |
| **µS/cm** | **micro Siemens/centimeter** |
| **WAF** | **Waste Application Field** |
| **WWTP** | **Waste Water Treatment Plant** |
| **WQM&A** | **Water Quality Monitoring & Assessment Section** |

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## A4 PROJECT/TASK ORGANIZATION

This section is intended to identify individuals and organizations that will be responsible for developing and/or supporting new CWQMN projects. For a list of additional project/task and responsibilities please refer to section A4 of the CWQMN QAPP.

### A4.1 TCEQ Network Coordinator (Charles Dvorsky)

- Provides overall support for coordination, development, and installation of new Continuous Ambient Monitoring Station (CAMS)

### A4.2 TCEQ Project Lead and CWQMN QC Officer (Edward Ragsdale)

- Responsible for writing Project Plan
- Responsible for site development (electricity & phone)
- Participate in station deployment

### A4.3 TCEQ Stephenville (Chris Pearson & Mike Caldwell)

- Responsible for site operation
- Landowner liaison

- Assist project lead in site development (electricity & phone)
- Participate in station development

**A4.5 TCEQ Ambient Monitoring** (Ambient Monitoring staff)

- Configure trailers
- Install sites

**A4.6 TCEQ Ambient Monitoring** (Robert Hernandez)

- Configure level sensor for Aqualab triggering
- Responsible for site communication setup
- Participate in station deployment

**A4.7 TCEQ Data Validation** (Rebecca Ross)

- Aqualab Analyzer data validation

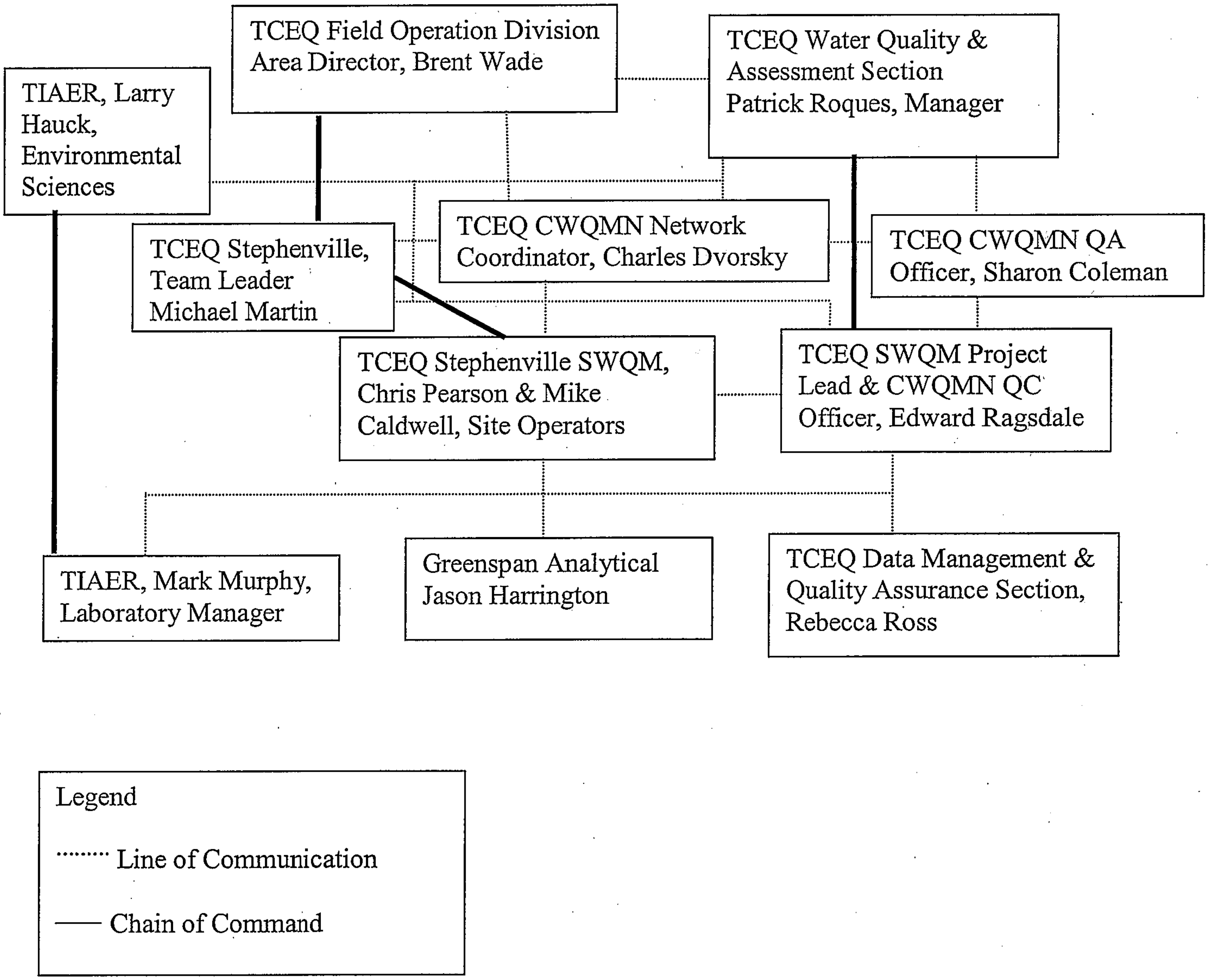
**A4.8 TIAER Laboratory Manager** (Mark Murphy)

- Provides Aqualab analyzer standards and reagents

**A4.9 Greenspan Analytical** (Jason Harrington)

- Responsible for providing/coordinating Aqualab analyzer installation.
- Responsible for providing/coordinating Aqualab analyzer repair visits.

## PROJECT ORGANIZATION CHART
### Figure A4.1 Organization Chart



## A5 PROBLEM DEFINITION/BACKGROUND

### North Bosque River Watershed

The North Bosque River is in the Brazos River basin. The North Bosque River watershed encompasses approximately 1,210 square miles in north central Texas, approximately 160 miles in length, and drains into Lake Waco[1] (please see Appendix A for footnote references). The watershed contains forty (40) Public Law (PL)-566 flood retardation reservoirs built in the 1950s and 1960s[1]. These flood control reservoirs can have a significant impact on the hydrology of the tributaries. These reservoirs are designed to control flooding by reducing peak stream flows[1]. Additionally, upstream run-off from rainfall events in the tributaries may be totally captured by PL-566 reservoirs, depending on the magnitude of the rainfall event and the existing storage capacity of a given PL-566 reservoir[2].

### North Bosque River Nutrients

Nutrient concentrations in excess of screening levels established by the TCEQ have been found in the North Bosque River (segment 1226) and Upper North Bosque Rivers (Segments 1255) since 1996. In 1998, Segments 1255 and 1226 were included in the Clean Water Act Section 303(d) list for Texas as impaired water bodies under narrative water quality criteria related to nutrients and aquatic plant growth. Confined Animal Feeding Operations (CAFOs), Animal Feeding Operations (AFOs) and associated Waste Application Fields (WAFs) were identified as major nonpoint sources of nutrients. Additional sources of nutrients in the watershed include discharges from municipal wastewater treatment plants (WWTP).

### Environmental Monitoring Response System Pilot Project (EMRS)

A viable continuous auto-analyzer capable of measuring nutrients became commercially available in 2004. Nutrient analyzers were deployed as part of the Bosque I Environmental Monitoring Response system (EMRS) Pilot Project at four existing Continuous Ambient Monitoring Stations (CAMS) (sonde physiochemical sites) on the Bosque and Leon Rivers in August and September of 2004 at the request of TCEQ executive management and commissioners. Sites were selected at the following locations:

- Greens Creek (CAMS 701), tributary of the North Bosque River, Segment 1226B.
- Clifton Texas (CAMS 702), main stem of the North Bosque River, Segment 1226
- Resley Creek (CAMS 704), tributary of the Leon River, Segment 1221A
- Gatesville Texas (CAMS 703), main stem of the Leon River, Segment 1221 (in the summer of 2007, the Gatesville site was destroyed by flood waters)

The goal of the EMRS pilot project is to automatically measure and screen in-stream total reactive phosphorus (TRP), nitrate-nitrogen ($NO_3$-N) and ammonia-nitrogen ($NH_3$-N) concentrations and to notify TCEQ regional Stephenville staff via email when automated ambient water analyses exceed established trigger concentrations to assist regional staff in targeting field investigations to identify source(s) of emissions.

In February 2007, TCEQ staff recommended the EMRS sites at Clifton and Gatesville Texas be re-designated as regular Continuous Water Quality Monitoring Network stations (CWQMN). Gatesville CAMS is located at the lower section (main stem) of the Leon River watershed a short distance downstream of a permitted WWTP. The Clifton CAMS site is located at the lower section (main stem) of the North Bosque River watershed. Both these site are significant distances downstream of potential dairy point and nonpoint emission sources. Additionally, numerous PL-566 reservoirs are located throughout the watershed upstream of these CAMS locations.

**EMRS Phase II**

Due to the large geographic size of the Bosque River watershed and distribution of point and nonpoint sources on the tributaries of the watershed, it was decided to add four new EMRS sites to the northern portion of the North Bosque River watershed (EMRS phase II) where the majority of the AFOs, CAFOs, and WAFs are located. In January 2007, a Bosque River EMRS phase II site became operational on the main stem of the North Bosque River at State Highway 6 near the confluence of Greens Creek. In May of 2007, the second EMRS phase II site became operational on Scarborough Creek. Scarborough Creek is a rainfall dependent intermittent stream. The current project (Little Duffau Creek and Un-named tributary of Little Duffau Creek) will be the third and fourth EMRS phase II deployments. Below are the existing EMRS phase II sites.

- Bosque River at State Highway 6 (CAMS 725) near the confluence of Greens Creek, segment 1226
- Scarborough Creek (CAMS 726), tributary of the North Bosque River, Segment 1255C

**Identification of Emission Sources and EMRS Triggers (Fall 2004 to Present)**

TCEQ has received numerous valid trigger level based notifications from the EMRS stations. To date, no dairy related emission sources (nonpoint source or point source) have been identified as a result of the EMRS notifications. Consequently, various nutrient trigger level concentration revisions have been made at the remaining EMRS sites, and, TCEQ has begun focusing on smaller watersheds where the potential to identify sources is believed to be greater.

Between March and August 2007, Stephenville, Texas received over 32 inches of rain[3] (30 year average annual rainfall for Stephenville is 29 inches). During this time period, TRP EMRS trigger level based notifications originating from the Resley Creek station, resulted in the identification of two non-reported point source wastewater emission events from the City of Dublin, Texas WWTP.

During the March to August rainfall events, numerous dairy related emission discharge events occurred in the Bosque and Leon River watersheds. However, no Dairy related emission events have been identified as a result of the EMRS notifications. This may be due to dilution based on the number, duration, and aerial extent of the rainfall run-off.

During a rainfall event in the summer of 2007, staff from TCEQ Stephenville Office observed a Dairy lagoon overflow event upstream of the Scarborough Creek site. During the event, $NO_3$-N and $NH_3$-N site-specific trigger levels were not exceeded (TRP sensor was not operational during the event). TCEQ staff speculate, that rain water runoff (with relatively low $NO_3$-N and $NH_3$-N concentrations) from other parts of micro-watershed diluted the lagoon emissions before the emissions reached the site. $NH_3$-N trigger levels at the site were lowered as result of this observation.

### Specific Conductance (SC) and Dairy Emissions

TCEQ has collected dairy related Point of Discharge (POD) grab water quality samples. These samples were analyzed for a suite of parameters including nutrients and SC. See Appendix B for the analysis of POD samples that were collected between the summer of 1999 and spring of 2005. Several upstream water quality samples were collected and analyzed. The results are also included in this data set. Conductivities measured in the POD samples are magnitudes higher as compared to a reference tributary (Neils Creek[1]). Additionally, POD downstream and upstream SC measurements correlated well with nutrients with an R squared value of 0.710 (Sum of $NH_3$-N, $NO_3$-N, and Total Phosphorus).

It is also interesting to note that there is a relationship (mean TIAER stream grab samples[1]) between Escherichia Coli (E. coli) and SC in the watershed. Generally, elevated E. coli colonies are found in run-off samples collected from dairy intensive micro watersheds as compared to other parts of the watershed.

Elevated SC measurements and the correlation of SC to nutrients and E. coli may be the result of the measurement of the conductive components (via SC) of dairy manure. See Appendix D for an analysis of the composition of various dairy manure types by North Carolina State University[4].

As part of this project, stand-alone combination SC and water level sensors will be installed at both CAMS sites in an effort to determine if near real-time in-stream SC measurements can provide useful EMRS dairy source and nonpoint source emission information.

It should be noted that measuring SC to identify emission sources would also be subject to potential emission dilution limitations. There are two known methods to address this limitation:

- Upstream and downstream monitoring of specific emission sources.
- Standardization of in-stream measurements (nutrients or SC) through volumetric stream flow measurements (i.e. in-stream measurements would be corrected for dilution).

### Little Duffau (CAMS 728) and Un-Named Tributary (CAMS 765) of Little Duffau

CAMS 728 and 765 will be located on the Parker Ranch. The closest intersection to the ranch is Farm to Market (FM) 2841 and 1824. The CAMSs will be located approximately two miles north northwest of FM 1824. Both CAMSs are located approximately one mile upstream (north northwest) of the confluence of Little Duffau Creek and the Un-Named Tributary of Little Duffau Creek (see figure1). Both Creeks are rainfall dependent intermittent streams. Little Duffau Creek is a tributary of Duffau Creek. Duffau Creek enters the North Bosque River near Iredell, Texas.

TIAER operates an ISCO storm water sampler on Little Duffau Creek at FM 1824 (TIAER designates this site as LD040). The total drainage area of Little Duffau Creek at FM 1824 is approximately 7, 314 acres (~11.4 square miles)[1].

Estimated land use for the drainage area at FM 1824 (LD040) is 59.3% wood & range, 5.4% pasture, 5.4% cropland, 29.6% WAFs[1]. No PL-566 reservoirs are located upstream of the sites. It should be noted that during TCEQ site surveys numerous cows (non-dairy) were observed on the Parker Ranch.

The Aqualab analyzers at both sites will be configured to start and stop sample collection and analysis based on in-stream water level. This capability was developed as part of the Scarborough Creek EMRS project and has proved to be a robust configuration.

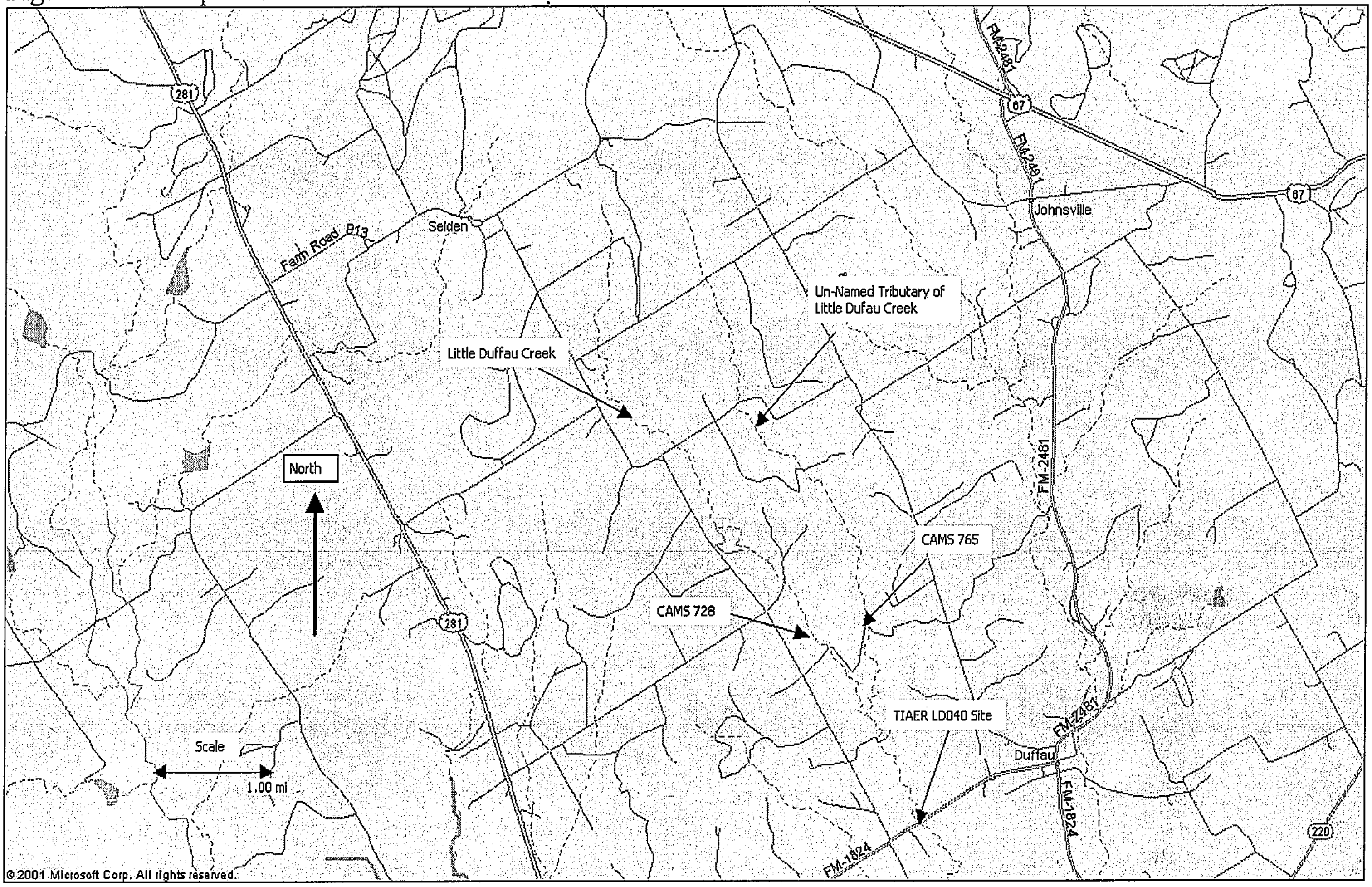
## A6 PROJECT/TASK DESCRIPTION

TCEQ will install two CAMS stations. One station will be located on Little Duffau Creek and the other station will be located on the Un-named tributary of Little Duffau Creek. CAMS measurement equipment will include Aqualab analyzers and In-Situ TROLL water level sensors. The Aqualab analyzers will measure TRP, $NH_3$-N, and $NO_3$-N. A Greenspan CTD-1200 SC and water level sensor will be installed at both CAMS sites.

The Aqualab analyzer (based on water level sensor measurements) water level triggering configuration will need to be installed. See Section B1 for information on Aqualab Analyzer water level triggering.

The purpose of these sites is to generate data to be used for the EMRS pilot project. Work products discussed in this Project Plan are: CAMS site development; CAMS installation; and, sample collection, analysis, and data transmittal.

Figure A6.1: Map of CAMS Locations




## A7 QUALITY OBJECTIVES AND CRITERIA

Methods used for the Aqualab Analyzer are based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998.

### Aqualab Analyzer

The Aqualab analyzers will be configured to automatically collect and analyze nutrient samples when the streams are flowing. However, when the Analyzers are "triggered" to collect and analyze ambient samples, the Analyzers can not automatically analyze Laboratory Control Samples (LCSs) and instruments blanks (IB).

When the analyzers are not "triggered" nutrient LCSs will automatically be analyzed once daily. These LCS results will be used to assess the analytical status of the Analyzer before and after ambient sampling events.

## Nutrient Trigger Level Development

Historical water quality data for the new CAMS locations does not exist. Initial nutrient trigger level concentrations for both sites were established using TIAER's historical (May 2001 - September 2005) ISCO storm water and grab data record at LD040. Projected field responses were calculated using the LD040 data record (see Appendix C). Initial nutrient trigger levels concentrations were based on TCEQ Stephenville staff resources available to conduct field response investigations as a result of in-stream nutrient concentrations exceeding trigger levels. Trigger levels may be revised as data from the sites becomes available.

## EMRS Performance Specifications

When an email notification is received, the EMRS responder will (remotely via telephone modem) evaluate Analyzer performance data (IBs, LCSs, and general operational status) and will decide if the quality of the data is sufficient to warrant a field investigation. See table A7.1 for Aqualab analytical information and projected number of field responses.

**Table A7.1 – Aqualab Analyzer Performance Specifications, EMRS Trigger Levels, and Projected Field Responses**

| Parameter | LEADS Parameter Code | Units | Method | MDL | CAMS 728 and 765 Trigger Levels and Projected Field Responses | | Blanks | Recovery at Trigger Levels (LCS) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Trigger Levels | Responses Per Year | | |
| TRP (0-4.00 ppm Range) | 10105 | ppm | Colorimetric, Standard Method 4500-P·E | 0.015 | 0.600 | 17 | NA | NA |
| $NH_3$-N (0-10.0 ppm Range) | 10100 | ppm | Ion Selective Electrode 4500 - NH3 D | 0.100 | 1.200 | 3 | NA | NA |
| $NO_3$-N (0-15.0 ppm Range) | 10101 | ppm | Ion Selective Electrode, Standard Method 4500-NO3 D | 0.100 | 3.00 | 12 | NA | NA |

LCS = Laboratory Control Sample
ppm = parts per million
TRP = Total Reactive Phosphorus
$NO_3$-N = Nitrate-nitrogen
$NH_3$-N = Ammonia-nitrogen
NA = Not Applicable

## Specific Conductance Trigger Level Development

Historical water quality data for the new CAMS locations does not exist. The mean grab SC measured by TIAER at LD040 is 1160 μS/cm and the median is 1100 μS/cm (27 SC measurements). The median value will be the initial SC trigger level (1100 μS/cm). Trigger levels may be revised as data from the sites becomes available.

## Specific Conductance Performance Specifications

When an email notification is received, the EMRS responder will (remotely via TCEQ web site) assess sensor measurements. Based on Aqualab nutrient concentrations, water level, and SC measurements the responder will decide if a field investigation is warranted.

## Greenspan CTD-1200 SC and Water Level Sensor

The CTD-1200 will be secured to the stream-bed. The creek is dry except during significant rainfall events. The SC sensor outputs near zero µS/cm in ambient air. The water level sensor will be zeroed to atmospheric pressure and will read zero feet when a column of water is not present. See table A7.2 for the CTD-1200 performance specifications.

**Table A7.2 – CTD-1200 Performance Specifications, and EMRS Trigger levels****

| Parameter | LEADS Parameter Code | Units | Method | Un-named Tributary Trigger Level (CAMS 728 and 765) | Range | Accuracy | Resolution |
|---|---|---|---|---|---|---|---|
| SC | 10095 | µS/cm | Torodial* | 1600 | 0 – 60,000 | 0.2% full scale | 0.0015% full scale |
| Water Level | 10079 | Feet | Vented Pressure Transducer | NA | 0 – 33.0 feet | 0.03% full scale | 0.0015% full scale |

*Method not based on *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998
** Specifications from CTD-1200 Operation Manual

## In-Situ TROLL 500 Water Level Sensor

The TROLL 500 will be secured to the stream-bed and will be used to trigger the Aqualab analyzer. The water level sensor will be zeroed to atmospheric pressure. See table A7.3 for In-situ TROLL 500 water level sensor performance specifications.

**Table A7.3 - In-Situ TROLL 500 Performance Specifications***

| Parameter | LEADS Parameter Code | Units | Method | Range | Accuracy | Resolution |
|---|---|---|---|---|---|---|
| Water Level | 10095 | feet | Vented Pressure Transducer | 0 – 33 feet | 0.05 % full scale (-5 to 50 °C) | 0.005 % full scale |

* Specifications from TROLL 500 Operation Manual. This sensor will be used to start and stop Aqualab Analyzer sample collection and analysis.

### Ambient Water Reporting Limits (AWRLs)

AWRLs are not applicable for this project.

### Precision & Bias

Currently, no information exists to determine acceptable measurement error for EMRS trigger level response decisions.

### Representativeness

As described in Section B2 of the CWQMN QAPP.

### Comparability

As described in Section B2 of the CWQMN QAPP.

### Completeness

As described in Section B2 of the CWQMN QAPP.

## A8 SPECIAL TRAINING/CERTIFICATION

TCEQ Stephenville Office will be responsible for site operation. TCEQ Stephenville staff have years of experience operating and maintaining Aqualab analyzer sites. Training for the CTD-1200 will be provided by the project lead. The CTD-1200 is easy to calibrate and operate and it is anticipated that this instrument will require minimal attention.

## A9 DOCUMENTS AND RECORDS

As described in section A9 of the CWQMN QAPP.

## B1 SAMPLING PROCESS DESIGN

### Site Selection Criteria

Little Duffau and Un-Named Tributary of Little Duffau sites were chosen because they are upstream of PL-566 reservoirs and are in close proximity to potential sources of emissions. However, in order to meet these site criteria the sites will be deployed on rainfall dependent creeks that will be dry the majority of the year. A landowner was identified that has allowed access to his land.

## Site Access

As mentioned previously, the CAMS sites will be located on a ranch. The Little Duffau CAMS site will be located on relatively high cut-bank of the creek. The site is adjacent to an existing home that is not on ranch property. Access to the site from the adjacent property (the property has an improved driveway to the county road) has been denied by the landowner. Access to the site will have to be accomplished through a pasture with no roads. The site is located approximately 400 yards from a dirt/caliche road. This site may not be accessible by vehicle during wet conditions. Operation, maintenance, and vendor service during wet conditions could be problematic. The Un-named tributary site is accessible via dirt/caliche ranch roads. However, to access the site either Little Duffau Creek or the Un-named tributary creek will need to be crossed. These are low water crossings that are usually dry. Therefore, access to these sites immediately following significant rainfall events may not be possible.

## Monitoring Station Design

Monitoring and Support Equipment

Both CAMS (728 and 765) sites will include the following monitoring and support equipment:

- Configured twelve-foot portable TCEQ water trailer.
- Aqualab Analyzer, PVC sample line, submersible pump, submersible pump relay box, and sampling system for Scarborough creek.
- In-Situ TROLL 500 Level Sensor, communications cables and support structure.
- Personal computer.
- Zeno data logger
- Two US Robotics modems.

Both CAMSs will also have a CTD-1200 SC and water level sensor installed in the stream bed. Instrument power and communication will be available from the TCEQ water trailer.

## Monitoring Equipment Configurations and Measurement Frequencies

Aqualab Analyzers

The Aqualab analyzers will be configured to start collecting and analyzing ambient samples based on water level sensor measurements made in the creek beds. When the water level in the creek reaches a specified level the Aqualab analyzer will automatically begin collecting and analyzing ambient samples. Conversely, once the creek's water level recedes to a specified level the Analyzer will stop sample collection and analysis. When water level in the creek is below the specified trigger level the Analyzer will automatically analyze IBs and a three component nutrient LCSs on a daily basis.

Initial Analyzer sample initiation and sampling termination water level sensor set-points will be determined during the deployment of the station. A submersible pump will be used for sample collection. The pumps will be suspended by cables that are attached to trees.

Once the Aqualab analyzer is triggered, the Analyzer will measure (TRP, $NO_3$-N, and $NH_3$-N) a repeating nutrient measurement sequence until the water level in the creek recedes below the water level sensor set-point for sampling to stop.

CTD-1200

The SC and water level sensors will be secured to the stream bed in a PVC tube. The Zeno data logger will poll the SC and water level sensors once every fifteen minutes. When no water is present the SC sensor will read zero (or near zero) in ambient air. When the SC sensor becomes covered with water the conductivity of the water will be measured. The water level sensor will be calibrated (zeroed) periodically to ambient barometric pressure. Once the sensor is covered by water the sensor will measure the pressure exerted by the water.

Site Development

These sites will have electric (200 amp meter loop) and phone service installed. The Little Duffau site is located in close proximity to existing electric and phone service infrastructure. The Un-named tributary site is located near the middle of the ranch (see figure 1). The landowner has requested that power pole installation be "contoured" to his land. Additional site development needs are:

- Water level sensor will need to be installed and configured for use with the Aqualab analyzer.
- A chain-link fence will need to be installed around the sites to keep cattle away from site equipment. The fenced areas need to be large enough to include trailer and support equipment.
- The CTD-1200 will need to be installed at both CAMS sites.

## B2 SAMPLING METHODS

As described in sections B2 of the CWQMN QAPP.

### Sampling/Measurement System Corrective Action

As described in sections B2.2 of the CWQMN QAPP.

## B3 SAMPLE HANDLING AND CUSTODY

As described in Section B3 of the CWQMN QAPP.

## B4 ANALYTICAL METHODS

Analytical methods are listed in Section A.7.

## B5 QUALITY CONTROL

Data generated at these sites will be used for the EMRS pilot program.

Aqualab Analyzer

Nutrient LCS concentrations will be 0.600 $PO_4$-P, 3.00 $NO_3$-N, and 1.20 $NH_3$-N ppmv. The LCS concentrations are established at the trigger notification levels. Additionally, Aqualab Analyzer data files (downloadable via telephone modem) and IBs can be evaluated for general operational status of the Analyzer. TCEQ Stephenville staff will determine if the data quality is sufficient to warrant a field investigation.

CTD-1200 SC and Water level Sensor

The CTD-1200 will be calibrated periodically using the Greenspan "Calibration Loop" resister. As mentioned previously, the water level sensor will periodically be calibrated in ambient air. When water is not present the SC and water level sensor should read close to zero for both water level and SC. The sensors can be monitored remotely to assess operational status of the sensors.

In-Situ TROLL 500 Water level Sensor

The water level sensor will periodically be calibrated in ambient air. The sensors can be monitored remotely to assess operational status of the sensor.

### Corrective Action Related to Quality Control

As described in Section B5 of the CWQMN QAPP.

## B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Aqualab Analyzer

As described in Section B6 of the CWQMN QAPP. Also see Section B1 of this Project Plan.

CTD-1200 SC and Water level Sensor

See Greenspan CTD-1200 Operation Manual.

In-Situ TROLL 500 Level Sensor

See In-Situ TROLL 500 Level Sensor Operation Manual.

## B7 INSTRUMENT CALIBRATION AND FREQUENCY

Aqualab Analyzer

Three-point TRP calibrations are performed daily while the Analyzer is in non ambient sampling mode. Once the Analyzer is triggered to begin sample collection, the Analyzer quantitates sample concentration based on the Analyzer's calibration curve generated during the last daily calibration while the Analyzer was not in ambient sampling mode. $NH_3$-N and $NO_3$-N calibration curves are generated for each sample analysis whether the sample is a QC or ambient sample.

CTD-1200 SC and Water level Sensor

CTD-1200 water level sensor calibration frequency has not been determined. Sensor readings in ambient air should be checked periodically. If sensor readings have drifted more than ± 0.30 feet while in ambient air the sensor should be recalibrated using procedures in Greenspan CTD-1200 Operations Manual.

SC sensor Calibration Verification Samples (CVSs) should be analyzed once every two weeks using the Calibration Loop resister. If the Relative Percent Error of the CVS is greater than or equal to 5 percent, the SC sensor should be recalibrated according to instructions in the Greenspan CTD-1200 Operations Manual.

In-Situ TROLL 500 Level Sensor

Water level sensor calibration frequency has not been determined. Sensor readings in ambient air should be checked frequently. If sensor readings have drifted more than ± 0.3 feet while in ambient air the sensor should be recalibrated. See SOP AMPM-0008 for sensor calibration procedures.

## B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

MOPs ambient monitoring section keeps an inventory of common spare parts. The Project lead will be responsible for the coordination of parts replacement.

Aqualab Analyzer

TIAER will provide standard and reagents (including LCS standards) under TCEQ contract. Since only the Aqualab nutrient parameters are going to be used, only nutrient standards and reagents will be needed for Analyzer operation.

In-Situ TROLL 500 and CTD-1200 Sensors

Sensors and communication cable are stocked by MOPs.

## B9 NON-DIRECT MEASUREMENTS

There are no non-direct measurements used in this project.

## B10 DATA MANAGEMENT

As described in CWQMN QAPP. Nutrient and SC data from the CAMSs will be loaded into Surface Water Quality Monitoring Information System (SWQMIS). SC data collected during non stream flow events will not be loaded in SWQMIS. The data collected during stream flow events will be qualified as EMRS data.

## C1 ASSESSMENTS AND RESPONSE ACTIONS

As described in CWQMN QAPP.

### Corrective Action

As described in Section C1 of the CWQMN QAPP.

## C2 REPORTS TO MANAGEMENT

As described in Section C2 of the CWQMN QAPP.

### Reports to TCEQ Project Management

As described in Section C2 of the CWQMN QAPP.

## D1 DATA REVIEW, VERIFICATION, AND VALIDATION

### Aqualab Analyzer

EMRS Data Verification

Aqualab analyzer and CTD-1200 data quality will be assessed by TCEQ Stephenville staff for usability immediately following notifications to determine if field investigations are warranted.

Aqualab Analyzer Data Record Validation

The station's data record will be validated based on nutrient LCS and IB results that were analyzed directly before and after ambient sampling events. Nutrient recovery (TRP, $NO_3$-N, and $NH_3$-N) limits are 75 – 125%. IB limits are ≤0.160 ppm for $NH_3$-N and $NO_3$-N and ≤0.006 ppm for TRP. If either the pre or post event sampling nutrient LCS or IB does not pass criteria then the data collected during a sampling event is considered invalid.

Since this station is designed and located for EMRS purposes, DQOs do not exist for the station's data record. However, LCS and IB limits will provide data quality information for other potential data users.

CTD-1200

Measurements made by the CTD-1200 will not be validated.

## D2 VERIFICATION AND VALIDATION METHODS

As described in Section D2 of the CWQMN QAPP.

## D3 RECONCILIATION WITH USER REQUIREMNTS

As described in Section D3 of the CWQMN QAPP.

## Appendix A

1. *TIAER, Semiannual Water Quality Report for the North Bosque River Watershed. July 2007.* TR0705.

2. *Report on the Water Quality of Eight PL-566 Reservoirs in the upper North Bosque River Watershed. February* 1997. PR97-02.

3. Weather Underground Historical Data, Web Site: (http://www.wunderground.com/)

4. University of North Carolina, Publications, *Soil Fact, Dairy Manure as a Fertilizer*, Web Site: (http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-28/#NutrientContentofDairyManures)

# Appendix B, TCEQ Point of Discharge Data

| TCEQ Sample Number | Date | Source | NH3-N | NO3-N | pH | PO4-P | Total P | SC | TKN | TSS | VSS | ECOLI | Watershed | Microwatershed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 001679-01 | 6/25/1999 | Leaving Property | 133 | | | | 18.6 | 2510 | 190 | 103 | 68 | | Leon | Unnamed Trib |
| 001679-02 | 6/25/1999 | POD | 89.9 | | | | 35.5 | 2370 | 247 | 535 | 395 | | Leon | Unnamed Trib |
| 006865-01 | 2/8/2001 | UPSTRM | | 37.5 | | <0.06 | 0.08 | 1560 | 1.2 | 27 | 7 | | Bosque | Honey Creek |
| 006865-02 | 2/8/2001 | DNSTRM | | 10.4 | | 3.76 | 14.7 | 3780 | 243 | 526 | 280 | | Bosque | Honey Creek |
| 006865-03 | 2/8/2001 | POD | | <0.25 | | 16 | 125 | 5830 | 641 | 14100 | 6500 | | Bosque | Honey Creek |
| 013596-01 | 3/4/2002 | POD | 226 | <0.10 | 7.63 | 14.7 | 65.9 | 4980 | 503 | 1500 | 1180 | | Bosque | Gilmore Creek |
| 013596-02 | 3/4/2002 | MIXED W/Gilmore Creek | 9.33 | <0.05 | 7.76 | 4.93 | 6.25 | 1950 | 19.5 | 84 | 64 | | Bosque | Gilmore Creek |
| 013597-01 | 3/4/2002 | PREMIX W/Gilmore Creek | 224 | <0.10 | 7.77 | 12.4 | 48.2 | 4210 | 413 | 720 | 580 | | Bosque | Gilmore Creek |
| 013597-02 | 3/4/2002 | UPSTRM | <0.05 | <0.05 | 8.4 | <0.06 | 0.09 | 1920 | 0.56 | 2 | <1 | | Bosque | Gilmore Creek |
| 010371-01 | 12/18/2002 | POD | 540 | 0.48 | 8.2 | 9.2 | 22 | 4800 | 1.8 | 480 | 440 | | Leon | Unnamed Trib |
| 010371-02 | 12/18/2002 | Horn @ 1476 | 360 | 0.2 | 8.1 | 9 | 22 | 4600 | 1 | 420 | 340 | | Leon | Unnamed Trib |
| 010374-01 | 9/23/2003 | POD | 330 | <1 | 8.11 | 11.4 | 245 | 5990 | 1160 | 24300 | 19200 | | Leon | Resley Creek |
| 0102931-01 | 2/24/2004 | Berm @ 30' | 152 | <2.50 | 8.13 | 20 | 137 | 6170 | 736 | 10100 | 4980 | | Leon | Resley Creek |
| 0102931-02 | 2/24/2004 | Leaving Property | 11.1 | 9.52 | 7.78 | 12 | 15.7 | 1870 | 79.9 | 328 | 182 | | Leon | Resley Creek |
| 0102931-03 | 2/24/2004 | Leaving Property | 11.7 | 9.96 | 7.8 | 11.2 | 18.2 | 1880 | 77.5 | 402 | 192 | | Leon | Resley Creek |
| 012940-01 | 8/23/2004 | POD | 73.82 | <1 | 8.14 | 16.7 | 23.4 | 4080 | 143 | 1040 | 455 | | Leon | Duncan Creek |
| 010396-01 | 11/11/2004 | County Road | 10.4 | 10.9 | 7.87 | 0.95 | 4.47 | 2310 | 25.7 | 32 | 20 | | Bosque | Duffau Creek |
| 010396-02 | 11/11/2004 | WSP | 10.3 | 11.7 | 7.97 | 0.93 | 4.62 | 2350 | 26.6 | 61 | 37 | | Bosque | Duffau Creek |
| 010397-01 | 11/22/2004 | UPSTRM | 0.17 | 0.14 | 8.3 | | 0.3 | 70 | 1.4 | 77 | 13 | | Bosque | Unnamed Trib |
| 010397-02 | 11/22/2004 | POD | 3.2 | 0.64 | 7.6 | | 3.2 | 400 | 14 | 750 | 160 | | Bosque | Unnamed Trib |
| 010398-01 | 11/22/2004 | POD | 130 | 0.14 | 8 | 23 | 28 | 4000 | 150 | 610 | 340 | | Leon | Flat Creek |
| 010399-01 | 11/22/2004 | POD | 130 | 0.16 | 8.1 | 16 | 20 | 3500 | 160 | 340 | 250 | | Bosque | Duffau Creek |
| 010399-02 | 11/22/2004 | Silage | 13 | 2.5 | 8 | 9 | 10 | 1800 | 5.4 | 1100 | 470 | | Bosque | Duffau Creek |
| 012975-01 | 12/8/2004 | Edge of field | 12.7 | 78.1 | 8.25 | 3.59 | 6.28 | 2210 | 25.8 | 272 | 92 | yes | Leon | Resley Creek |
| 012975-02 | 12/8/2004 | Point of Discharge into Pond | 17.9 | 57.7 | 8.13 | 3.72 | 9.48 | 1950 | 32.8 | 292 | 96 | yes | Leon | Resley Creek |
| 016545-01 | 3/7/2005 | POD | 30.2 | 0.07 | 7.9 | | 26.5 | 1420 | 66 | 226 | 120 | | Leon | Resley Creek |

## Appendix C, Projected Responses

TIAER LD040 Data Record: May 2001 - September 2005

| NH3-N (mg/L) | NO23-N (mg/L) | PO4-P (mg/L) | Projected Responses/Per Year one Parameter | Projected Responses/Per Year All Parameters |
|---|---|---|---|---|
| 38 | 14.4 | 2.94 | 0.2 | 0.7 |
| 18.8 | 13.1 | 2.47 | 0.5 | 1.4 |
| 13.3 | 12 | 1.71 | 0.7 | 2.1 |
| 12.1 | 11.8 | 1.53 | 0.9 | 2.8 |
| 11.3 | 11.7 | 1.35 | 1.2 | 3.5 |
| 9.74 | 10.9 | 1.32 | 1.4 | 4.2 |
| 5.32 | 10.5 | 1.09 | 1.6 | 4.9 |
| 3.44 | 9.49 | 1.07 | 1.9 | 5.6 |
| 3.12 | 9.2 | 1.06 | 2.1 | 6.4 |
| 2.63 | 8.28 | 1.05 | 2.4 | 7.1 |
| 1.67 | 8.25 | 1.02 | 2.6 | 7.8 |
| 1.48 | 7.95 | 0.99 | 2.8 | 8.5 |
| 1.41 | 7.29 | 0.953 | 3.1 | 9.2 |
| **1.2** | 6.99 | 0.945 | 3.3 | 9.9 |
| 1.13 | 6.89 | 0.938 | 3.5 | 10.6 |
| 0.851 | 6.89 | 0.925 | 3.8 | 11.3 |
| 0.79 | 6.66 | 0.919 | 4.0 | 12.0 |
| 0.76 | 6.18 | 0.907 | 4.2 | 12.7 |
| 0.727 | 6.01 | 0.883 | 4.5 | 13.4 |
| 0.724 | 5.82 | 0.877 | 4.7 | 14.1 |
| 0.599 | 5.76 | 0.869 | 4.9 | 14.8 |
| 0.565 | 5.46 | 0.862 | 5.2 | 15.5 |
| 0.539 | 5.39 | 0.857 | 5.4 | 16.2 |
| 0.539 | 5.15 | 0.848 | 5.6 | 16.9 |
| 0.53 | 4.87 | 0.846 | 5.9 | 17.6 |
| 0.515 | 4.85 | 0.843 | 6.1 | 18.4 |
| 0.482 | 4.81 | 0.838 | 6.4 | 19.1 |
| 0.477 | 4.71 | 0.832 | 6.6 | 19.8 |
| 0.399 | 4.62 | 0.831 | 6.8 | 20.5 |
| 0.398 | 4.57 | 0.829 | 7.1 | 21.2 |
| 0.396 | 4.32 | 0.827 | 7.3 | 21.9 |
| 0.393 | 4.23 | 0.827 | 7.5 | 22.6 |
| 0.364 | 4.23 | 0.824 | 7.8 | 23.3 |
| 0.36 | 4.12 | 0.799 | 8.0 | 24.0 |
| 0.345 | 4.1 | 0.793 | 8.2 | 24.7 |

**Appendix C (continued)**

| NH3-N (mg/L) | NO23-N (mg/L) | PO4-P (mg/L) | Projected Responses/Per Year one Parameter | Projected Responses/Per Year All Parameters |
|---|---|---|---|---|
| 0.342 | 4.08 | 0.79 | 8.5 | 25.4 |
| 0.339 | 4.05 | 0.785 | 8.7 | 26.1 |
| 0.335 | 4.05 | 0.774 | 8.9 | 26.8 |
| 0.333 | 4 | 0.764 | 9.2 | 27.5 |
| 0.331 | 3.95 | 0.763 | 9.4 | 28.2 |
| 0.321 | 3.73 | 0.748 | 9.6 | 28.9 |
| 0.316 | 3.56 | 0.742 | 9.9 | 29.6 |
| 0.315 | 3.39 | 0.741 | 10.1 | 30.4 |
| 0.309 | 3.26 | 0.74 | 10.4 | 31.1 |
| 0.291 | 3.2 | 0.738 | 10.6 | 31.8 |
| 0.288 | 3.14 | 0.725 | 10.8 | 32.5 |
| 0.265 | 3.13 | 0.723 | 11.1 | 33.2 |
| 0.265 | 3.06 | 0.722 | 11.3 | 33.9 |
| 0.262 | 3.06 | 0.716 | 11.5 | 34.6 |
| 0.256 | 3.05 | 0.711 | 11.8 | 35.3 |
| 0.254 | 3.05 | 0.7 | 12.0 | 36.0 |
| 0.242 | **3.02** | 0.692 | 12.2 | 36.7 |
| 0.239 | 2.98 | 0.672 | 12.5 | 37.4 |
| 0.239 | 2.97 | 0.654 | 12.7 | 38.1 |
| 0.235 | 2.97 | 0.654 | 12.9 | 38.8 |
| 0.229 | 2.97 | 0.651 | 13.2 | 39.5 |
| 0.22 | 2.95 | 0.651 | 13.4 | 40.2 |
| 0.22 | 2.87 | 0.65 | 13.6 | 40.9 |
| 0.216 | 2.84 | 0.65 | 13.9 | 41.6 |
| 0.213 | 2.8 | 0.647 | 14.1 | 42.4 |
| 0.213 | 2.72 | 0.645 | 14.4 | 43.1 |
| 0.203 | 2.7 | 0.641 | 14.6 | 43.8 |
| 0.2 | 2.7 | 0.638 | 14.8 | 44.5 |
| 0.2 | 2.7 | 0.637 | 15.1 | 45.2 |
| 0.197 | 2.62 | 0.634 | 15.3 | 45.9 |
| 0.197 | 2.55 | 0.631 | 15.5 | 46.6 |
| 0.197 | 2.41 | 0.631 | 15.8 | 47.3 |
| 0.195 | 2.33 | 0.628 | 16.0 | 48.0 |
| 0.19 | 2.27 | 0.618 | 16.2 | 48.7 |
| 0.187 | 2.23 | 0.605 | 16.5 | 49.4 |
| 0.185 | 2.16 | **0.592** | 16.7 | 50.1 |

# Appendix D, Composition of Dairy Manure

**Nutrient Composition of Dairy Manure**

| Manure Type | Total Nitrogen N | Ammonium $NH_4$-N | Phosphorus $P_20_5$ | Potassium $K_2O$ |
|---|---|---|---|---|
| Lot-scraped manure (lb/ton) | 10 | 3 | 6 | 9 |
| range | (3 to 20) | (2 to 15) | (0.6 to 13) | (2 to 20) |
| Liquid manure slurry (lb/1,000 gal) | 22 | 9 | 14 | 21 |
| range | (8 to 50) | (4 to 13) | (0.2 to 38) | (0.7 to 50) |
| Anaerobic lagoon sludge* (lb/1,000 gal) | 15 | 6 | 22 | 8 |
| range | (3 to 42) | (1 to 12) | (2 to 64) | (2 to 20) |
| Anaerobic lagoon liquid (lb/acre-inch) | 137 | 88 | 77 | 195 |
| range | (17 to 268) | (22 to 130) | (10 to 233) | (13 to 571) |

Source: Biological & Agricultural Engineering Department, North Caroiina State University, 1980 to 1990.

*No manure solids removed before lagoon input.

Table 2. Average Secondary and Micronutrient Content of Dairy Manure

| Manure | Ca | Mg | Se | Na | Fe | Mn | B | Zn | Cu | Cl |
|---|---|---|---|---|---|---|---|---|---|---|
| Lot-scraped manure (lb/ton) | 5 | 2.2 | 1.7 | 1.3 | 0.9 | 0.1 | 0.01 | 0.1 | 0.02 | 3.3 |
| Liquid manure (lb/1,000 gal) | 10 | 4.8 | 3.1 | 3.2 | 1.8 | 0.2 | 0.02 | 0.2 | 0.05 | 6.1 |
| Lagoon sludge* (lb/1,000 gal) | 12 | 5 | 3.6 | 1.4 | 1.5 | 0.3 | NR | 0.4 | 0.4 | 2.3 |
| Lagoon liquid (lb/acre-inch) | 69 | 35 | 25 | 48 | 12 | 1.3 | 0.15 | 2 | 0.3 | 67 |

Note: Ca = Calcium, Mg = Magnesium, Se = Selenium, Na = Sodium, Fe = Iron, Mn = Manganese, B = Boron, Zn = Zinc, Cu = Copper, Cl = Chloride

NR = Not reported.

Source: Biological & Agricultural Engineering Department, North Carolina State University.

*No manure solids removed before lagoon input.