AgriLIFE RESEARCH & EXTENSION
Texas A&M System

Annual Update to the Upper Trinity Watershed Green Building Infrastructure for Storm Water Management Quality Assurance Project Plan

Texas AgriLife Research
Dallas, TX, 75252

Funding Source:

Nonpoint Source Program CWA §319(h)
Prepared in cooperation with the Texas Commission on Environmental Quality
and the U.S. Environmental Protection Agency
Federal ID # 99614614

Effective Period: One year from date of final approval

Questions concerning this quality assurance project plan should be directed to:

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Summary of Proposed changes

Justification: We have made minor modifications to the monitoring design of the permeable pavement and green roof BMP. The permeable pavement and detention pond BMP are to be contracted out for construction, and due to the lack of appropriate bids from contractors, the project had to be put up for bid again. We made the changes to facilitate more favorable bids from contractors.

Detail of Changes:

1. SECTION A6 – PROJECT/TASK DESCRIPTION

Revisions to the QAPP: This section has been updated to use the most current shell language.

Exact language (Page 27):
Until the work described is completed, this QAPP shall be reissued annually on the anniversary date, or revised and reissued prior to any significant changes being made in activities, whichever is sooner. Reissuances and annual updates must be submitted to the TCEQ for approval at least 90 days before the last approved version has expired. If the QAPP expires, the QAPP is no longer in effect and the work covered by the QAPP must be halted. If the entire QAPP is current, valid, and accurately reflects the project goals and the organization's policy, the annual re-issuance may be done by a certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP. If the QAPP needs to be updated to incorporate amendments made earlier in the year or to incorporate new changes, a full annual update is required. This is accomplished by submitting a cover letter, a document detailing changes made, and a full copy of the updated QAPP (including signature pages).

2. SECTION B1 - SAMPLING PROCESS DESIGN (EXPERIMENTAL DESIGN)

a) Design of permeable pavement monitoring set up was changed to include 5 stalls of each type sampled by one ISCO automatic sampler, instead of 3 per replicate. In the current set up, there are no replicates. The total numbers of stalls have also been reduced to 56 from 95.

Exact language (Pages 39):
Five parking stalls of each type will be connected to an automatic sampler that will collect runoff from all five stalls. The five pavements are grass pavers, permeable interlocking concrete pavers, pervious concrete, pervious asphalt and impervious concrete (control).

b) The geo-coordinates for automatic sampling in the permeable pavement BMP have been altered.

Exact language (page 50-57):
Table B1.3 Field Sampling Collection Details

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
1	RG Inlet	21199	Upper Trinity White Rock Creek Watershed Rain Garden Inlet, 80.46 meters heading N82E from Intersection of Coit Road and McCallum Boulevard	32.987954° -96.767331°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	25	Sampling tied to rainfall
2	RG Outlet/DP Inlet 1	21200	Upper Trinity White Rock Creek Watershed Rain Garden Outlet/ Detention Pond Inlet 1, 84.04 meters heading N70E from intersection of Coit Road and McCallum Boulevard	32.988107° -96.767339°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall
3.	DP Inlet 2	21201	Upper Trinity White Rock Creek Watershed Detention Pond Inlet 2, 170.93 meters heading N74E from intersection of Coit Road and McCallum Boulevard.	32.988282° -96.766415°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	25	Sampling tied to rainfall
4.	P. Asphalt	21202	Upper Trinity White Rock Creek Watershed Porous Asphalt Outflow, 241.46 meters heading S54E from intersection of Coit Road and McCallum Boulevard.	32.986575° -96.766092°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
5.	P. Control	21203	Upper Trinity White Rock Creek Watershed Impervious Pavement Control Outflow, 249.17 meters heading S51E from intersection of Coit Road and McCallum Boulevard.	32.986446° -96.766096°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall
6.	Grass Pave	21204	Upper Trinity White Rock Creek Watershed Grass Pavers Outflow, 259.17 meters heading S48E from intersection of Coit Road and McCallum Boulevard.	32.986305° -96.766108°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall
7.	Block Pave	21205	Upper Trinity White Rock Creek Watershed Interlocking Block Pavers Outflow, 265.45 meters heading S54E from intersection of Coit Road and McCallum Boulevard.	32.986434° -96.765894°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall
8.	Perv. Conc	21206	Upper Trinity White Rock Creek Watershed Pervious Concrete Outflow, 257.49 meters heading S56E from intersection of Coit Road and McCallum	32.986568° -96.765888°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
			Boulevard.							
9.	DP Outflow	21207	Upper Trinity White Rock Creek Watershed Detention Pond Outflow, 205 meters heading N45E from intersection of Coit Road and McCallum Boulevard.	32.989156° -96.766607°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall
10.	RWH_SM	21208	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Soil Moisture Outflow, 93.09 meters heading N8E from NW Corner of Turf Building.	32.986694° -96.762457°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
11.	RWH_ET	21209	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Evapotranspiration Outflow, 100.34 meters heading N8E from NW Corner of Turf Building.	32.986756° -96.762443°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
12.	RWH_HOS	21210	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Home Owner Schedule_Rainwater Outflow, 107.82 meters heading N8E from NW Corner of Turf Building	32.986824° -96.762431°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
13.	RWH_CON	21211	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Control Plot Outflow, 115.17 meters heading N8E from NW Corner of Turf Building.	32.986889° -96.762421°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
14.	GR_PSD_1	21212	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil and Drainage Layer_1 Outflow, 56.66 meters heading N1E from NW Corner of Turf Building.	32.986370° -96.762597°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
15.	GR_PS_1	21213	Upper Trinity White Rock Creek Watershed Green Roof_ Plant s, Soil _1 Outflow, 56.4 meters heading N3E from NW Corner of Turf Building.	32.986369° -96.762572°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID[a]	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
16.	GR_HYD_1	21214	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_1 Outflow, 59.22 meters heading N1E from NW Corner of Turf Building.	32.986395° -96.762595°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
17.	GR_CON_1	21215	Upper Trinity White Rock Creek Watershed Green Roof_ Control_1 Outflow, 59.32 meters heading N3E from NW Corner of Turf Building.	32.986393° -96.762568°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
18.	GR_PSD_2	21216	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil and Drainage Layer_2 Outflow, 64.15 meters heading N1E from NW Corner of Turf Building	32.986439° -96.762590°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
19.	GR_PS_2	21217	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil _2 Outflow, 64.02 meters heading N3E from NW Corner of Turf Building.	32.986438° -96.762565°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
20.	GR_HYD_2	21218	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_2 Outflow, 66.87 meters heading N1E from NW Corner of Turf Building.	32.986463° -96.762587°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
21.	GR_CON_2	21219	Upper Trinity White Rock Creek Watershed Green Roof_ Control_2 Outflow, 66.98 meters heading N3E from NW Corner of Turf Building.	32.986461° -96.762563°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
22.	GR_PSD_3	21220	Upper Trinity White Rock Creek Watershed Green Roof_ Plant s, Soil and Drainage Layer_3 Outflow, 71.5 meters heading N1E from NW Corner of Turf Building.	32.986506° -96.762583°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
23.	GR_PS_3	21221	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil_3 Outflow, 71.6 meters heading N3E from NW Corner of Turf Building.	32.986506° -96.762557°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
24.	GR_HYD_3	21222	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_3 Outflow, 74.37 meters heading N1E from NW Corner of Turf Building.	32.986531° -96.762582°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
25.	GR_CON_3	21223	Upper Trinity White Rock Creek Watershed Green Roof_ Control_3 Outflow, 74.62 meters heading N3E from NW Corner of Turf Building.	32.986531° -96.762554°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
26.	GR_PSD_4	21224	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil and Drainage Layer_4 Outflow, 79.17 meters heading N2E from NW Corner of Turf Building.	32.986575° -96.762577°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
27.	GR_PS_4	21225	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil _4 Outflow, 79.18 meters heading N3E from NW Corner of Turf Building.	32.986574° -96.762551°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments
28.	GR_HYD_4	21226	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_4 Outflow, 82.08 meters heading N2E from NW Corner of Turf Building.	32.986600° -96.762574°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall
29.	GR_CON_4	21227	Upper Trinity White Rock Creek Watershed Green Roof_ Control_4 Outflow, 82.1 meters heading N3E from NW Corner of Turf Building.	32.986599° -96.762548°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall

c) Monitoring set up for the green roof BMP has been changed to capture the entire runoff from an event, instead of a representative portion of the runoff.

Exact Language (page 42):
The monitoring setup will consist of a downspout that drains to a barrel that is sized to collect all the runoff from a 10 year storm. The runoff will be collected in the container from which grab samples will be taken at the end of each storm greater than 0.23 inches (Figure 6, 7).

d) The placement of the bioretention area has been changed. Previously, it was planned on the Northeast corner of the permeable pavement parking lots, and was supposed to treat runoff generated by the impervious parts of the proposed parking lot. However, it was found that due to the reduction in the number of parking lots as well as area, a bioretention area large enough for the purposes of the study will no longer be possible. Hence, the location of the bioretention area BMP was moved to the South side of the detention pond BMP. In this case, runoff generated from surrounding impervious area will be routed to the bioretention area and any overflow will be piped to the detention pond. As it is envisioned, in the new location, the bioretention area will serve as a pretreatment for the detention pond BMP.

Exact Language (Page 40):
A bioretention area (rain garden) will be constructed South of the detention pond (Figure

2, 4, 10). Curb cuts will allow for runoff to drain to a flume at the inflow of the bioretention area. The flume will be equipped with an ISCO 6712 automatic sampler with an ISCO 730 Recording Bubbler Flow Meter for automatic sampling and automatic flow measurement. Runoff will be directed into the bioretention area (100ft x 20 ft). Table B1.1 indicates the initial trigger for automatic sampler measurement of inflow and outflow for the rain garden, which can be adjusted as needed. All runoff in the rain garden watershed will be routed through the inlet flume. A surface overflow box will drain water to an underground pipe to the first inlet of the detention pond. Additionally, the drainage layer of the rain garden will house a perforated pipe that will assist in soil infiltration. An ISCO flow meter will measure the combined outflow through the perforated pipe and overflow and samples will be collected with an ISCO 3700 automatic sampler. The overflow and underground pipe flow will be combined, since the goal of the project is to is to evaluate the overall performance of the bioretention area. In addition, continuous monitoring of the water level in the BMP as well as the design parameters allows calculation and separation of the volume and pollutant load of any overflow that occurs especially for storms under 1.5". Estimation of the total effluent volume and pollutant load is the real goal of the BMP experiments and we believe this will be achieved by composite sampling. The outlet for the rain garden acts as one of the inlets of the detention pond, making the rain garden, in effect, a pre- treatment for the detention pond BMP (figure 10).

e) In Section B2, Field Sampling Procedures, the Urban Stormwater BMP Performance Monitoring Handbook has been inserted as the primary storm event sampling method reference.

Exact Language (Page 57):

Field Sampling Procedures

All field monitoring and sample collection will be conducted in accordance with the *TCEQ Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods, RG-415, August 2012, Austin, TX or most recent version*, except for automated sampling, for which the SOP for the automatic sampler (attached as appendix D) will be used, as automated sampling is not covered in SWQM procedures.

f) Section D3 has been expanded to address more fully how the data will be used to calculate load reductions and other performance features of the BMPs.

Exact Language (Pages 77-78):

D3 Reconciliation with User Requirements

Extension education programs are designed to target specific audiences and to deliver current, unbiased, science-based information and technology. The objective of the evaluation conducted under this QAPP is to provide the Extension education program with unbiased,

science-based, quality assured data on the effectiveness of low impact development best management practices for reducing nutrient and sediment contamination of storm water. No other decisions will be made by the project team based on the data collected.

TCEQ seeks quality assured data that establish the difference in pollutant loads entering and leaving each of the experimental BMPs, in order to estimate load reductions that will result from further installation of similar BMPs. For this purpose, the load reduction will be calculated for each pollutant in each BMP by using the following equation for all storm events for the monitoring period:

$$Load\ Reduction = \sum_{i=1}^{n} (V_{inflow\ i} \times C_{inflow\ i} - V_{outflow\ i} \times C_{outflow\ i})$$

n = total number of storms; V = Volume; C= pollutant concentration

For the BMPs with automatic samplers, continuous flow measurement will be acquired, which then is used to calculate the total storm volume for a particular event. Based on the monitoring methods previously described, flow rates and water quality sample measurements will be representative for each storm event.

For BMPs that do not use automatic samplers, a representative portion of the entire storm (Rainwater Harvesting) or the entire storm (green roof) volume will be captured. Grab samples from these would be analyzed for pollutant concentrations. Statistical analysis will be used only for the green roof BMP, as it is the only BMP with a fully replicated experimental design (randomized complete block design), the data from which will be analyzed using a two- way anova.

These data, and data collected by other organizations, may however be subsequently analyzed and used for model development. Thus, data which do not meet project data quality objectives will not be submitted to the TCEQ nor will be considered appropriate for any of the uses noted above.

A1 Approval Page

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Monitoring Division

Sharon Coleman 11/07/2012
Sharon Coleman, Acting QA Manager, Date

11/7/12
Kyle Girten, Lead NPS QA Specialist, Date
Quality Assurance Team

Water Quality Planning Division

11/7/12
Kerry Neimann, Team Leader Date
Nonpoint Source Program

11/7/12
Nancy Ragland, Team Leader Date
Data Management and Analysis

11/7/2012
Anju Chalise, NPS QA Specialist Date
Nonpoint Source Program

Bill Carter 11/6/12
Bill Carter, TCEQ NPS Project Manager Date
Project Manager, Nonpoint Source Program

Texas AgriLife Research

Fouad Jaber, Project Manager	Date	Clint Wolfe, QA Officer	Date

TTI Environmental Labs, Arlington, TX

Meera Neb, Lab. Director	Date	Jonna Reagan, Lab. QA Officer	Date

Texas AgriLife Research will secure written documentation from additional project participants (e.g., subcontractors, laboratories) stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan and any amendments or revisions of this plan. The Texas AgriLife Research will maintain this documentation as part of the project's quality assurance records. This documentation will be available for review. Copies of this documentation will also be submitted as deliverables to the TCEQ NPS Project Manager within 30 days of final TCEQ approval of the QAPP. (See sample letter in Appendix N of this document).

Texas AgriLife Research

11-05-12 11/05/12

Fouad Jaber, Project Manager Date Sandhya Mohan, QA Officer Date

TTI Environmental Labs, Arlington, TX

11-5-12 11-5-12

Melanie Ball, Project Manager Date Ashleigh Roberts, Lab. QA Officer Date

Texas AgriLife Research will secure written documentation from additional project participants (e.g., subcontractors, laboratories) stating the organization's awareness of and commitment to requirements contained in this quality assurance project plan and any amendments or revisions of this plan. The Texas AgriLife Research will maintain this documentation as part of the project's quality assurance records. This documentation will be available for review. Copies of this documentation will also be submitted as deliverables to the TCEQ NPS Project Manager within 30 days of final TCEQ approval of the QAPP. (See sample letter in Appendix N of this document).

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A3 Distribution List

The Lead NPS QA Specialist will provide original versions of this project plan and any amendments or revisions of this plan to the TCEQ NPS Project Manager and the Texas AgriLife Research Project Manager. The TCEQ NPS Project Manager will provide copies to the TCEQ Data Management and Analysis Team Leader and EPA Project Officer within two weeks of approval. The TCEQ NPS Project Manager will document receipt of the plan and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review.

Nancy Ragland, Team Leader
Data Management and Analysis
MC-234
(512) 239-6546

U.S. Environmental Protection Agency Region 6
State/Tribal Section
1445 Ross Avenue, Suite # 1200
Dallas, TX 75202-2733

Leslie Rauscher, Project Officer
(214) 665-2773

AgriLife will provide copies of this project plan and any amendments or revisions of this plan to each project participant defined in the list below. AgriLife will document receipt of the plan by each participant and maintain this documentation as part of the project's quality assurance records. This documentation will be available for review.

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Meera Neb, Lab. Director
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Jonna Reagan, Lab. QA Officer
(817) 861-5322

List of Acronyms

AWRL	Ambient Water Reporting Limit
BMP	Best Management Practice
CAP	Corrective Action Plan
CAR	Corrective Action Report
COC	Chain of Custody
CWA	Clean Water Act
DOC	Demonstration of Capability
DMP	Data Management Plan
DMRG	Data Management Reference Guide
DM&A	Data Management and Analysis
DQO	Data Quality Objective
EPA	Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
IT	Information Technology
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LID	Low Impact Development
LOD	Limit of Detection
LOQ	Limit of Quantitation
MS	Matrix Spike
NELAC	National Environmental Laboratory Accreditation Conference
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
OPP	Operating Policy and Procedure
PO	Project Officer
QA/QC	Quality Assurance/Quality Control
QAM	Quality Assurance Manual

QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QAS	Quality Assurance Specialist
QM	Quality Manual
QMP	Quality Management Plan
RPD	Relative Percent Difference
SLOC	Station Location
SOP	Standard Operating Procedure
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TBD	To Be Determined
TCEQ	Texas Commission on Environmental Quality
TKN	Total Kjeldahl Nitrogen
TSWQS	Texas Surface Water Quality Standards
WQI	Water Quality Inventory

A4 Project/Task Organization

TCEQ

Monitoring Division

Kyle Girten
Lead NPS QA Specialist
Assists the TCEQ Project Manager in QA related issues. Serves on planning team for NPS projects. Participates in the planning, development, approval, implementation, and maintenance of the QAPP. Determines conformance with program quality system requirements. Coordinates or performs audits, as deemed necessary and using a wide variety of assessment guidelines and tools. Concurs with proposed corrective actions and verifications. Monitors corrective action. Provides technical expertise and/or consultation on quality services. Provides a point of contact at the TCEQ to resolve QA issues. Recommends to TCEQ management that work be stopped in order to safe guard project and programmatic objectives, worker safety, public health, or environmental protection.

Water Quality Planning Division

Kerry Niemann, Team Leader
NPS Program
Responsible for management and oversight of the TCEQ NPS Program. Oversees the development of QA guidance for the NPS program to be sure it is within pertinent frameworks of the TCEQ. Monitors the effectiveness of the program quality system. Reviews and approves all NPS projects, internal QA audits, corrective actions, reports, work plans, and contracts. Enforces corrective action, as required. Ensures NPS personnel are fully trained and adequately staffed.

Bill Carter
TCEQ NPS Project Manager
Maintains a thorough knowledge of work activities, commitments, deliverables, and time frames associated with projects. Develops lines of communication and working relationships between the contractor, the TCEQ, and the EPA. Tracks deliverables to ensure that tasks are completed as specified in the contract. Responsible for ensuring that the project deliverables are submitted on time and are of acceptable quality and quantity to achieve project objectives. Serves on planning team for NPS projects. Participates in the development, approval, implementation, and maintenance of the QAPP. Assists the TCEQ QAS in technical review of the QAPP. Responsible for verifying that the QAPP is followed by the contractor. Notifies the TCEQ QAS of particular circumstances which may adversely affect the quality of data derived from the collection and analysis of samples. Enforces corrective action.

Anju Chalise
NPS Quality Assurance Specialist
Assists Lead QAS with NPS QA management. Serves as liaison between NPS management and Agency QA management. Responsible for NPS guidance development related to program quality assurance. Serves on planning team for NPS projects. Participates in the development, approval, implementation, and maintenance of the QAPP.

Rebecca Ross
NPS Data Manager
Responsible for coordination and tracking of NPS data sets from initial submittal through NPS Project Manager review and approval. Ensures that data is reported following instructions in the Surface Water Quality Monitoring Data Management Reference Guide (January 2012, or most current version). Runs automated data validation checks in SWQMIS and coordinates data verification and error correction with NPS Project Managers' data review. Generates SWQMIS summary reports to assist NPS Project Managers' data reviews. Provides training and guidance to NPS and Planning Agencies on technical data issues. Reviews QAPPs for valid stream monitoring stations. Checks validity of parameter codes, submitting entity code(s), collecting entity code(s), and monitoring type code(s). Develops and maintains data management-related standard operating procedures for NPS data management. Serves on planning team for NPS projects.

Texas AgriLife Research (AgriLife)

Fouad Jaber
AgriLife Project Manager

Responsible for ensuring tasks and other requirements in the contract are executed on time and are of acceptable quality. Monitors and assesses the quality of work. Coordinates attendance at conference calls, training, meetings, and related project activities with the TCEQ. Responsible for verifying the QAPP is followed and the project is producing data of known and acceptable quality. Ensures adequate training and supervision of all monitoring and data collection activities. Complies with corrective action requirements.

Clint Wolfe
AgriLife QAO

Responsible for coordinating development and implementation of the QA program. Responsible for writing and maintaining the QAPP. Responsible for maintaining records of QAPP distribution, including appendices and amendments. Responsible for maintaining written records of sub-tier commitment to requirements specified in this QAPP. Responsible for identifying, receiving, and maintaining project quality assurance records. Responsible for coordinating with the TCEQ QAS to resolve QA- related issues. Notifies the contractor Project Manager and TCEQ Project Manager of particular circumstances which may adversely affect the quality of

data. Responsible for validation and verification of all data collected according with Table 4 procedures and acquired data procedures after each task is performed. Coordinates the research and review of technical QA material and data related to water quality monitoring system design and analytical techniques. Conducts laboratory inspections. Develops, facilitates, and conducts monitoring systems audits.

Meera Neb
Laboratory Director, TTI Labs, Arlington, TX

Responsible for supervision of laboratory personnel involved in generating analytical data for this project. Responsible for ensuring that laboratory personnel involved in generating analytical data have adequate training and a thorough knowledge of the QAPP and all SOPs specific to the analyses or task performed and/or supervised. Responsible for oversight of all operations, ensuring that all QA/QC requirements are met, and documentation related to the analysis is completely and accurately reported. Enforces corrective action, as required. Develops and facilitates monitoring systems audits.

Jonna Reagan
Laboratory QAO, TTI Labs, Arlington, TX
Monitors the implementation of the QAM and the QAPP within the laboratory to ensure complete compliance with QA objectives as defined by the contract and in the QAPP. Conducts internal audits to identify potential problems and ensure compliance with written SOPs. Responsible for supervising and verifying all aspects of the QA/QC in the laboratory. Performs validation and verification of data before the report is sent to the contractor. Insures that all QA reviews are conducted in a timely manner from real-time review at the bench during analysis to final pass-off of data to the QA officer.

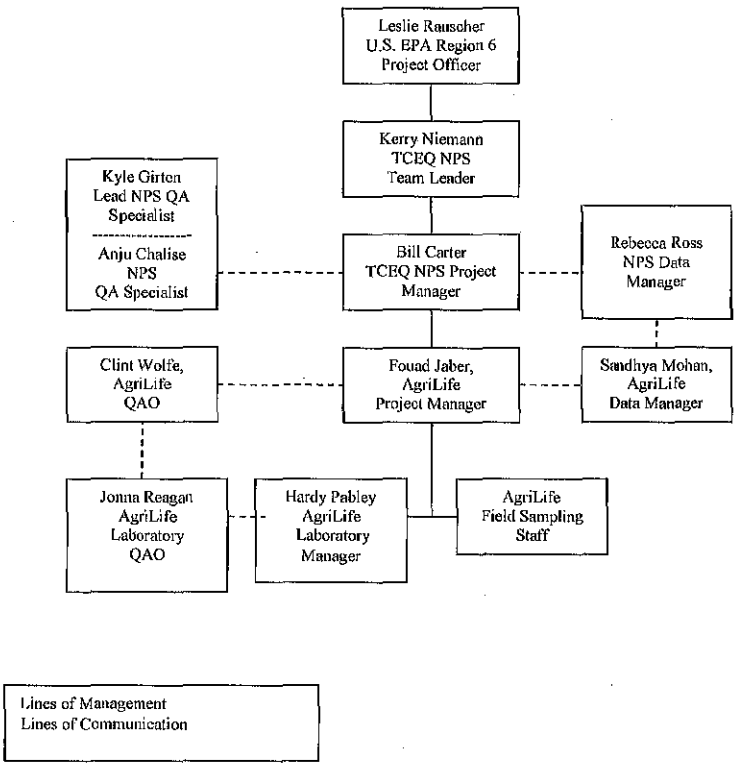
Sandhya Mohan
AgriLife Data Manager
Responsible for the acquisition, verification, and transfer of data to the TCEQ. Oversees data management for the study. Performs data quality assurances prior to transfer of data to TCEQ. Responsible for transferring data to the TCEQ in the Event/ Result format as specified in the DMRG (January 2012, or most current version). Ensures data are submitted according to workplan specifications. Provides the point of contact for the TCEQ Data Manager to resolve issues related to the data.

Sandhya Mohan
AgriLife Field Supervisor
Responsible for supervising all aspects of the sampling and measurement of surface waters and other parameters in the field. Responsible for the acquisition of water samples and field data measurements in a timely manner that meet the quality objectives specified in Section A7 (Table A.1), as well as the requirements of Sections B1 through B8. Responsible for field scheduling, staffing, and ensuring that staff is appropriately trained as specified in Sections A6 and A8.

U.S. EPA Region 6

Leslie Rauscher
EPA Project Officer
Responsible for managing the CWA Section 319 funded grant on the behalf on EPA. Assists the TCEQ in approving projects that are consistent with the management goals designated under the State's NPS management plan and meet federal guidance. Coordinates the review of project workplans, draft deliverables, and works with the State in making these items approvable. Meets with the State at least semi-annually to evaluate the progress of each project and when conditions permit, participate in a site visit on the project. Fosters communication within EPA by updating management and others, both verbally and in writing, on the progress of the State's program and on other issues as they arise. Assists the regional NPS coordinator in tracking a State's annual progress in its management of the NPS program. Assists in grant close-out procedures ensuring all deliverables have been satisfied prior to closing a grant.

Figure A4.1. Organization Chart - Lines of Communication



Field Code Changed

A5 Problem Definition/Background

Nonpoint Source (NPS) stormwater runoff is the leading cause of water quality impairment in the United States (USEPA, 1996). Recent rapid urbanization and population growth have exacerbated this problem. Traditional urban development increases the imperviousness of land. This in turn results in increased total runoff volume, increased peak runoff flow, decreased time to concentration, and deteriorated water quality (Dietz, 2007). Urban runoff contaminants typically include sediments, oil, grease, pesticides and nutrients from yards, roads, and parking lots. Water quality and quantity problems from existing stormwater control measures have resulted in re-evaluation of traditional urban water management and put a new emphasis on sustainable design practices (Standards and Sustainable Sites Initiative, 2007).

Low impact development (LID) is being increasingly adopted as an alternative to traditional water management systems. LID includes practices such as bio-retention, green roofs, rainwater harvesting, and permeable pavements, which can all be integrated in new development as green building infrastructure. While recent studies have evaluated the effectiveness of LID practices in various regions in the United States, there is still a great need to evaluate these practices in the field and to collect quantitative data on LID practices performance, especially in the Southern part of the United States. There is also very little data on the potential impact of the adoption of LID practices at a watershed level.

The goal of this project is to improve the quality and reduce the total and peak flows of stormwater from a site typical of commercial development in the White Rock Lake watershed. The Upper Trinity river (segment #0805) has been considered impaired due to legacy pollutants including chlordane in fish tissue (TCEQ, 2008a). Chlordane is usually found as a sediment bound pollutant. Additionally, nitrogen and phosphorous are considered pollutants of concern for water quality based on screening levels (TCEQ, 2008b). The project will therefore design, construct and evaluate green building infrastructure at the Texas AgriLife Research Urban Solutions Center in Dallas. These Best Management Practices (BMPs) will provide examples of how LID can be integrated in new buildings and developments or retrofitted to existing developments that aim at reducing sediments (and sediment bound pesticides), and nutrients loadings into urban runoff. The five LID BMPs targeted in this study are permeable pavements, bio-retention area, rainwater harvesting, green roofs, and detention ponds.

Funding for the project is provided by the CWA 319 (h) NPS grant programs with match provided by AgriLife Research. Data collected as a result of the project will be used to demonstrate the effectiveness of construction of the LID BMPs, in terms of reduction of pollutant loads mentioned above. This demonstration will be further used to promote knowledge, awareness and implementation of the demonstrated BMPs among individuals, businesses and government entities.

This QAPP is reviewed by the TCEQ to help ensure that data generated for the purposes described above are scientifically valid and legally defensible. This process will ensure that all

data submitted to SWQMIS have been collected and analyzed in a way that helps to guarantee their reliability and therefore can be used in programs deemed appropriate by the TCEQ.

A6 Project/Task Description

In this project, several green building infrastructure BMPs will be constructed and used to:

- Reduce stormwater runoff volume and peak flow and improve the water quality of the water discharged.
- Analyze water quality based on nitrogen, phosphorous, chlordane and total suspended solids.
- Collect engineering performance data for a site typical of the Southern U.S., for subsequent use in design of these BMPs.
- Demonstrate the effectiveness of BMPs in the Trinity River Watershed and the DFW Metroplex.
- Educate city, state, and local officials, stormwater professionals, scientists, students and business owners in the use of green building infrastructure to reduce stormwater runoff volume and peak flow and improve the water quality.

Five low impact development (LID) Best Management Practices (BMPs) will be incorporated into the Texas AgriLife Research Urban Solutions Center in Dallas (figure 1). The potential reduction in pollutant load as a result of implementation of these BMPs is as follows (Table A6.1):

Table A6.1 Estimated Load Reductions Expected

BMP	Volume reduction	TSS reduction	Nitrate reduction	Ortho-P reduction	Chlordane reduction
Bio-retention	-71%	-567 lbs/yr (-96%)	-5 lbs/yr (-30%)	-1 lb	-3 lbs (-96%)
Permeable pavement	-93%	-719 lbs (-93%)	-6.25 lbs (-90%)	-0.1 lb (-10%)	-3.72 (-93%)
Rainwater harvesting	-25%	-208 lbs	-2 lbs	-0.1 lb	-1 lb
Green roof	-63%	-330 lbs	-5 lbs	-1 lb	-2.52 lbs
Detention pond	-50%	-378 lbs	-1.2 lbs	-0.1 lb	-2.00 lbs

Source: Deitz, 2007

The design of bioretention, permeable pavement, rainwater harvesting, green roof, and detention pond BMPs will be evaluated for their effectiveness to reduce stormwater runoff and improve outflow water quality. These technologies aim to identify and treat nitrogen, phosphorus, chlordane and total suspended solids that affect the White Rock Watershed and part of the Upper Trinity River. In the case of the green roofs, rainwater harvesting and permeable pavement, a controlled experimental setup will be constructed to collect data. These three BMPs will also be installed on a larger area on the campus by which data from the controlled setup will be used to calculate the total load of pollutants removed from the area. In order to produce results in a

timely manner, the BMP demonstration/evaluation will follow the timeline described in Table A6.2.

Table A6.2 Project Milestones

Task	Project Milestones	Agency	Start	End
1.2	Prepare & submit quarterly reports(QPR) to TECQ	AgriLife	06/10	03/13
1.3	Conduct and submit reports of quarterly contract conference calls	AgriLife, TCEQ	10/10	01/13
1.6	Submit project fact sheet-original, updates, final	Agrilife	07/10	03/13
9.2.1	Develop QAPP	AgriLife	06/10	10/10
9.3.1	Obtain QAPP approval	TCEQ	11/10	03/11
9.4.1	Final QAPP updates	AgriLife	TBD	TBD
2.1.1, 3.1.1, 4.1.1, 5.1.1, 6.1.1	BMPs draft and final engineering plans and reports	AgriLife	1/11	3/11
9.6.1	Data Submittal	AgriLife	12/10	3/13
10.1	Draft and final reports	AgriLife	2/13	3/13

See Appendix B for the project-related work plan tasks related to data collection and schedule of deliverables for a description of work defined in this QAPP. See Section B1 for monitoring to be conducted under this QAPP.

Revisions to the QAPP

Until the work described is completed, this QAPP shall be reissued annually on the anniversary date, or revised and reissued prior to any significant changes being made in activities, whichever is sooner. Reissuances and annual updates must be submitted to the TCEQ for approval at least 90 days before the last approved version has expired. If the QAPP expires, the QAPP is no longer in effect and the work covered by the QAPP must be halted. If the entire QAPP is current, valid, and accurately reflects the project goals and the organization's policy, the annual re-issuance may be done by a certification that the plan is current. This can be accomplished by submitting a cover letter stating the status of the QAPP and a copy of new, signed approval pages for the QAPP. If the QAPP needs to be updated to incorporate amendments made earlier in the year or to incorporate new changes, a full annual update is required. This is accomplished by submitting a cover letter, a document detailing changes made, and a full copy of the updated QAPP (including signature pages).

Amendments

Amendments to the QAPP may be necessary to reflect changes in project organization, tasks, schedules, objectives, and methods; address deficiencies and non-conformances; improve operational efficiency; and/or accommodate unique or unanticipated circumstances. Requests for amendments are directed from the contractor Project Manager to the TCEQ Project Manager in writing using the QAPP Amendment shell. The changes are effective immediately upon approval by the TCEQ NPS Project Manager and Quality Assurance Specialist, or their designees, and the EPA Project Officer (if necessary).

Amendments to the QAPP and the reasons for the changes will be documented, and revised pages will be forwarded-to all persons on the QAPP distribution list by the Contractor QAO. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

A7 Quality Objectives and Criteria

The project objective is to evaluate, demonstrate and quantify the effectiveness of low impact development on storm water quality. The quantitative and qualitative information needed to monitor the effectiveness of the BMPs are given in table A7.1.

Table A7.1 Measurement Performance Specifications for BMP effectiveness monitoring

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ (%)	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	Completeness (%)
Rainfall (Inches, Gauge data)	IN	Other	Campbell weather station	46530	NA	NA	NA	NA	NA	90
Flow Volume for Duration of Storm Event	GAL	water	ISCO flow meter, Flume, Weir	50052	NA	NA	NA	NA	NA	NA
Flow Stream, Instantaneous	CFS	Water	ISCO flow meter, Flume, Weir	00061	NA	NA	NA	NA	NA	90
pH	Ph/Units	Water	EPA 150.1	00400	NA	NA	NA	NA	NA	90
Specific Conductance	µS/cm	Water	EPA120.1	00094	NA	NA	NA	NA	NA	90
Residue, Total Nonfilterable (TSS)	mg/L	Water	SM 2540 D	00530	4	2	NA	20	80-120	90
NO_2 plus NO_3-N, total, Calculated value (mg/l)	mg/L	Water	EPA 300.0	00593	.05	.05	70-130	20	80-120	90
Nitrogen, Ammonia, total	mg/L	Water	SM 4500 NH3 D	00610	0.1	0.1	70-130	20	80-120	90
Total Kjeldahl N	mg/L	Water	SM 4500 NH3 E	00625	0.2	0.2	70-130	20	80-120	90
Orthophosphate Phosphorus, Dissolved	mg/L	Water	SM 4500 PE	00671	0.04	0.02	70-130	20	80-120	90
Total Phosphorus	mg/L	Water	SM 4500 PE	00665	.06	.05	70-130	20	80-120	90

PARAMETER	UNITS	MATRIX	METHOD	PARAMETER CODE	AWRL	Limit of Quantitation (LOQ)	Recovery at LOQ (%)	PRECISION (RPD of LCS/LCSD)	BIAS %Rec. of LCS	Completeness (%)
*Chlordane (Tech mix & metabs) Whole Water	µg/L	Water	EPA 8081A	39350	0.002	1	65-135	30	65-135	90
*Chlordane (Tech mix& metabs) Sed. Dry Weight	µg/Kg	Sediment	EPA 8081A	39351	2.4	50	40-160	30	40-160	90

References: US EPA Methods for Chemical Analysis of Water and Wastewater, Manual #EPA-600/4-79-020. American Public Health Association, American Water Works Association and Water Environment Federation, *Standard Methods for the Examination of Water and Waste Water*, 20th Ed., Texas Commission on Environmental Quality *Surface Water Quality Monitoring Procedures*, Volume 1,: Physical and Chemical Monitoring Methods, RG-415, August 2012, Austin, TX..

* The LOQ for these parameters are greater than the AWRL, and as a result, data entered into SWQMIS for these parameters will be flagged with the "AA" data qualifier code.
[1]A new parameter code has been requested for rainfall for the period of time runoff flow is measured and sampled during a storm event. Duration will be measured as the difference between the beginning of the first time interval in which rainfall is detected until the end of the last time interval in which rainfall is detected before the end of flow measurement and sampling.

Only data collected that have valid TCEQ parameter codes assigned in Table A7.1 are stored in SWQMIS. Any parameters listed in Table A7.1 that do not have a valid TCEQ parameter code assigned will not be stored in SWQMIS.

Precision
Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. It is a measure of agreement among replicate measurements of the same property, under prescribed similar conditions, and is an indication of random error.

Field splits are used to assess the variability of sample handling, preservation, and storage, as well as the analytical process, and are prepared by splitting samples in the field. Control limits for field splits are defined in Section B5.

Laboratory precision is assessed by comparing replicate analyses of laboratory control samples in the sample matrix (e.g. deioinized water, sand, commercially available tissue). Precision results are compared against measurement performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for precision are defined in Table A7.1.

Bias
Bias is a statistical measurement of correctness and includes multiple components of systematic error. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is determined through the analysis of laboratory control samples and LOQ Check Standards prepared with verified and known amounts of all target analytes in the sample

matrix (e.g. deioinized water, sand, commercially available tissue) and by calculating percent recovery. Results are compared against measurement performance specifications and used during evaluation of analytical performance. Program-defined measurement performance specifications for bias are specified in Table A7.1.

Representativeness
Site selection, an appropriate storm event sampling regime, analysis according to TCEQ SOPs, and use of only approved analytical methods will assure that the measurement data represent the conditions at the site. We anticipate 25 significant storms will be sampled per year, contingent on weather patterns, based on analysis of 19 years (1992 to 2010) of hourly rain data from a City of Dallas monitoring station (http://www.ci.dallas.tx.us/sts/html/fc.html), about 1 mile northwest of the Texas AgriLife campus. The range of storms to be sampled was found to be 25 to 50, depending on the number of rain events that make up 90% of the volume of the rainfall in a dry or a wet year. A significant storm is any storm that yields more than 0.23 inches based on the analysis cited above.

Each sampling event where automatic samplers are used (Permeable pavement, Rain Garden, Detention Pond) will consist of water quality samples collected at each sampling station (BMP inlet- except for permeable pavement- and BMP outlet) at equal time intervals. For automatic samplers, once the sampler is triggered, 450 ml runoff is collected in 30 minutes intervals. A timed collection is used for sampling all parts of the hydrograph. This process continues till runoff drops below the triggering flow or 24 sampling bottles are filled. If the flow rate drops below the triggering flow rate the sampler will stop collecting samples. It will start again as soon as the flow rate rises above the triggering flow rate but in all cases will end 24 hours after the initiation of flow measurement.

At the BMPs where automatic samplers are not used (rainwater harvesting, green roof), grab samples (450 ml) will be collected at the end of each event. In order to collect water samples from the beginning to the end of a storm, a volume splitter will be used, that captures 1/10 and discards 9/10th of the runoff volume. In this manner, a representative sample will be collected, which will retain the characteristics of the first flush as well as the runoff from all parts of the hydrograph, without needing to store large volumes. See section B1 for details. In order to assess effectiveness of the BMPs, data will be collected for storms of varying size and intensity throughout the year.

Completeness
The completeness of the data is basically a relationship of how much of the data is available for use compared to the total potential data. Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project(s) that 90% data completion is achieved.

Comparability
Confidence in the comparability of data sets for this project is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP and in TCEQ SOPs. Comparability is also guaranteed by reporting data in standard units, by using accepted rules for rounding figures, and by reporting data in a standard format as specified in Section B10.

AWRLs (Table A7.1) are used in this project as the *limit of quantitation specification*, so data collected under this QAPP can be compared against the TSWQS. Laboratory *limits of quantitation* (Table A7.1) must be at or below the AWRL for each applicable parameter.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria are provided in Section B5.

Analytical Quantitation
To demonstrate the ability to recover at the limit of quantitation, the laboratory will analyze an LOQ check standard for each batch of samples run.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria are provided in Section B5.

A8 SPECIAL TRAINING/CERTIFICATION

No special certifications are required. However, field personnel will receive training in proper sampling. Before actual sampling occurs, field personnel will demonstrate to the AgriLife Lead and AgriLife QAO their ability to properly perform field sampling procedures. Laboratory analysis will be performed by TTI Environmental Lab, Arlington, TX (NELAC certified) as per TCEQ requirements.

Global Positioning System (GPS) equipment may be used as a component of the information required by the Station Location (SLOC) request process for creating the certified positional data that will ultimately be entered into the TCEQ's SWQMIS database. Any Positional data obtained by the Nonpoint Source Program grantees using a Global Positioning System will follow the TCEQ's OPP 8.11 and 8.12 policy regarding the collection and management of positional data.

Positional data entered into SWQMIS will be collected with a GPS and verified with photo interpolation using a certified source, such as Google Earth or Google Map. The verified coordinates and map interface can then be used to develop a new Station location.

Contractors and subcontractors must ensure that laboratories analyzing samples under this QAPP meet the requirements contained in section 5.4.4 of the NELAC standards (concerning Review of Requests, Tenders and Contracts).

A9 Documents and Records

Laboratory Test Reports

Test/data reports from the laboratory must document the test results clearly and accurately. Routine data reports should be consistent with the NELAC standards (Section 5.5.10) and include the information necessary for the interpretation and validation of data. The requirements for reporting data and the procedures are provided. The data reports will include

- Sample results.
- Units of measurement.
- Sample matrix.
- Dry weight or wet weight (as applicable).
- Station information.
- Date and time of collection
- LOQ and LOD (formerly referred to as the reporting limit and the method detection limit, respectively), and qualification of results outside the working range (if applicable).
- Certification of NELAC compliance on a result by result basis.
- Title of report and unique identifiers on each page.
- Name/address of the laboratory.
- Name/address of the client.
- A clear indication of the sample(s) analyzed.
- Date and time of sample receipt.
- Identification of method used.
- Identification of samples that did not meet QA requirements and why (e.g. holding times exceeded).
- Cleary identified subcontract laboratory results (as applicable).
- Name/title of person accepting responsibility for the report.
- Project-specific quality control results to include field split results (as applicable); equipment, trip, and field blank results (as applicable); and precision, bias, and LOQ check standard results.
- Narrative information on QC failures or derivations from requirements that may affect the quality of results or is necessary for verification and validation of data.

The information in test reports will be consistent with the information that is needed to prepare data submittals to TCEQ.

Otherwise, reports will be consistent with the NELAC standards and should include any additional information critical to the review, verification, validation, and interpretation of data. This should be based on the process that has been worked out with the Contractor and is documented in Section D1 and D2 of this document.

The NELAC certified laboratory's process for reporting data or relevant portions of the laboratory's SOP or quality manual will be submitted as a separate file with the QAPP.

Electronic Data

Data will be submitted to the TCEQ in the event/result format specified in the TCEQ Data Management Reference Guide (DMRG; January 2012 or most recent version) for upload to the Surface Water Quality Monitoring Information System (SWQMIS). The Data Review Checklist and Summary as contained in Appendix C of this document will be submitted with the data.

The submitting entity will submit a station location request (SLOC) directly to the TCEQ Data Manager through SWQMIS for each sampling site to obtain a station identification number. If submitting entity does not have access to the SWQMIS, TCEQ Project Manager will assist the submitting entity to get the access. TCEQ Project Manager should be copied on all the correspondence throughout the process. The TCEQ Project Manager will ensure that submitting entity actually requests SLOCS before submitting any data to the TCEQ. Project personnel should seek guidance from the TCEQ Data Manager regarding proper use of EPA station types when preparing SLOCs. No data can be submitted to the TCEQ until station identification numbers have been assigned to the sites.

The AgriLife Urban Solutions Center will review, verify, and validate water quality monitoring data before it is submitted to the TCEQ. Data will be submitted to TCEQ quarterly (Table A9.1) and at least 1 month prior to use, or prior to presenting to stakeholders. Water quality data consistent with TCEQ formatting requirements will be submitted for upload into the Surface Water Quality Monitoring Information System (SWQMIS). Data submittal will follow the deliverable schedule and continue till 3/15/2013. The deliverable schedule has been attached as an addendum in Appendix B.

Table A9.1 Schedule of data submittal for upcoming quarters

Task Number	Task	Date for Submission to TCEQ
09.6.6	Data Submittal	3/15/2012
09.6.7	Data Submittal	6/15/2012
09.6.8	Data Submittal	9/15/2012
09.6.9	Data Submittal	12/15/2012
09.6.10	Data Submittal	3/15/2013

All reported Events will have a unique TagID (see DMRG). A Tag Prefix must be requested from the TCEQ in accordance with the DMRG where the Submitting Entity does not already have one. TagIDs used in this project will be seven-character alphanumerics with the structure of the two-letter Tag prefix followed by a four digit number and ending with the character "N": for example - KI1234N, KI1235N, etc.

Submitting Entity, Collecting Entity, and Monitoring Type codes will reflect the project organization and monitoring type in accordance with the DMRG. The proper coding of Monitoring Type is essential to accurately capture any bias toward certain environmental condition (for example, high flow events). The Project Manager should be consulted to assure proper use of the Monitoring Type code.

The following table describes the duration and form in which data will be recorded:

Table A9.2 Records and Documents Retention Requirements

Document/Record	Location	Retention	Form
QAPP, amendments, and appendices	AgriLife, TCEQ	5 years	Paper/Electronic
QAPP distribution documentation	AgriLife	5 years	Paper
Chain of custody records	AgriLife	5 years	Paper
Corrective action documentation	AgriLife	5 years	Paper
Laboratory data reports/results	AgriLife, TCEQ	5 years	Paper/Electronic
Progress reports/final report/data	AgriLife, TCEQ	5 years	Paper/Electronic

B1 Sampling Process Design (Experimental Design)

The experimental design of the project aims to demonstrate the effectiveness of Low Impact Development BMPs constructed in the premises of Texas AgriLife Research and Extension Center (Figure 1) in reducing total and peak flows of stormwater as well as improving its quality. The five LID BMPs that will be assessed in this study are permeable pavements, bio-retention area, rainwater harvesting, green roofs, and detention ponds. Each of these BMPs will have its own sampling criteria and the data collected will involve measurement of sediments (and sediment bound pesticides) and nutrients loadings into urban runoff as well as engineering performance data for a site typical of the Southern U.S., for subsequent use in designing these BMPs elsewhere.

Permeable pavements will be designed as functional parking lots with a permeable top layer and underground storage. The bio retention area will be a vegetated BMP that collects runoff from nearby impervious areas and treat it by filtering it through the soil media and underground storage. Rainwater harvesting and green roof BMPs will have two parts to them, a demonstration component and an experimental component that evaluates their use as a stormwater BMP. The detention pond will be designed to collect runoff from the whole center.

The runoff will be collected for water quality data using automatic samplers for the permeable pavement, the rain garden and the detention pond. Automatic samplers will be used to collect both inflow and outflow from the rain garden and the detention pond, while in the permeable pavement, only the outflow will be measured using automatic samplers. It is not possible to collect runoff before it reaches the permeable pavement, since it will be infiltrating rain that will fall on the pavement itself, as well as the runoff from the rest of the watershed. However, sampling the inflow is not necessary in this case, due to the presence of a control.

Grab samples will be used to collect runoff from the green roof BMP and rainwater harvesting BMP. In the rainwater harvesting BMP, runoff will be collected in a water storage container at the end of each storm event. The water collection apparatus is designed in such a way that water flows into one end of the rectangular storage container into a Tipping Bucket Rain Gauge with Data Logger (Spectrum Technologies, Inc.), that measures the volume in five minute increments. As the water exits the rain gauge, it goes into a volume splitter (Figure 1a, 1b) that is designed to keep $1/10^{th}$ of the volume measured by the rain gauge and discard the rest. The volume splitter consists of a metal plate positioned directly below the rain gauge that has 10 equal sized holes drilled in it which are sized to accommodate a 10 year 15 minute flow rate (4.5 in/hr). One of the holes is connected to a tube that diverts the water into the storage container. The rest of the holes are connected to another pipe that diverts the water out of the storage container, ensuring that only $1/10^{th}$ of the volume is stored.

This apparatus will make sure that the runoff is representative of the entire storm event, including the first flush, without needing to store large volumes of water that would have been necessary for storing the entire runoff. The container is around three feet long and will circulate all the runoff from the storm, thus resulting in a well- mixed sample.

The Green Roof BMP is made up of four shelters, each of which is divided into four sections (see below for details. The four sections each drain into a 55 gallon barrel, which is large enough to capture runoff from a 10 year storm from that section, thus ensuring the entire runoff from particular events will be collected. Grab samples will be taken from each barrel after mixing.

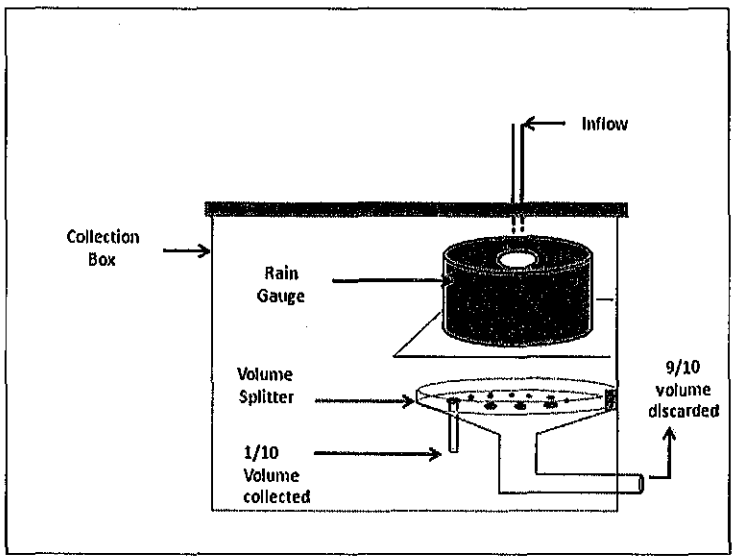


Figure 1a: Diagram of the volume splitting apparatus in the storage containers used for grab samples (Rainwater Harvesting, Green Roof).

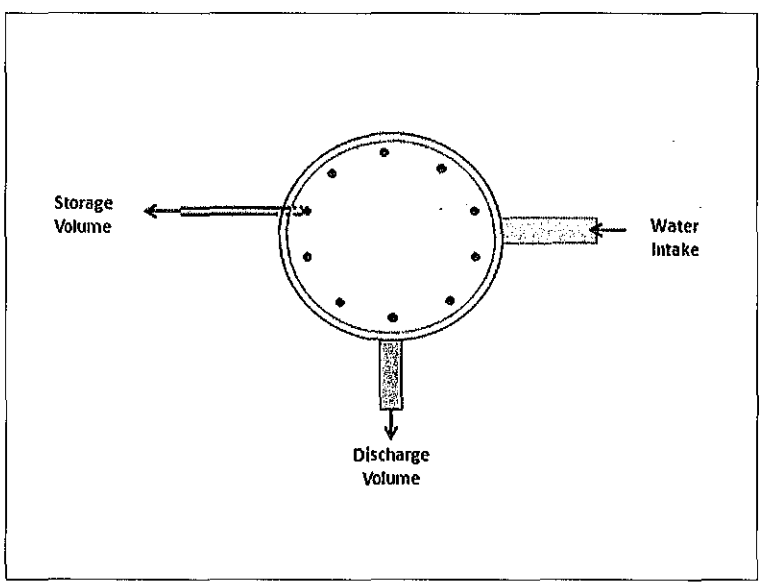


Figure 1b: Top view of the volume splitting apparatus.

Triggers (initiation points) for automatic water quality sampling will be adjusted after collecting flow and volume data from a few initial storm events. Flow measurements will be obtained using loggers, every 5 minutes. This interval was determined to be adequate based on hydrographs collected during previous studies done at the center (Ampim et al 2011). Data from these events will be used to adjust the triggers for the rest of the experimental period. The following table (B1.1) illustrates the initial trigger flow for the three BMPs equipped with automatic sampling, as well as initial sampling intervals.

Table B1.1 Summation of the sampling triggers and sampling interval for the BMPs equipped with automatic samplers

BMP	Area of watershed per sampler (Ha)	Inflow			Outflow		
		Automatic Sampling	Initial Trigger	Initial sampling intervals	Automatic Sampling	Initial Trigger	Initial sampling intervals
Permeable Pavement	0.0056	No	NA	NA	Yes	$2x10^{-6}$ m^3/s	30 min
Rain Garden	0.2201	Yes	$1.118x10^{-4}$ m^3/s	30 min	Yes	$2x10^{-6}$ m^3/s	30 min
Detention Pond	9.016	Yes	$5.41x10^{-6}$ m^3/s	30min	Yes	$2x10^{-6}$ m^3/s	30 min

The BMPs are designed to retain runoff from up to a 1.5 inch design storm. The initial flow triggers to collect inflow in the rain garden and detention pond were calculated from historical rainfall data for the area spanning the last 19 years, available from a weather station located a mile away from the AgriLife Center campus.

Initial triggers were determined such that the automatic samplers would start sampling at flow rates (see table B1.1) determined using the curve number method (Curve Number = 90, Natural Resources Conservation Service, http://www.nrcs.usda.gov), for a storm of 0.23 inches and duration of 3 hours, for the drainage area for each BMP (see table B1.1). The 0.23 inches, 3 hour storm was obtained as the average size storm over 19 years that contributed 10% or less of the total yearly runoff volume. Hence, such a storm was designated as "trivial" for the purposes of this study.

The sampling event protocol will be adjusted as needed after the first sample storm event or subsequently, with written concurrence of the TCEQ project manager. Such adjustments will be done to avoid sampling trivial storms of 0.23 inch/3hours or smaller, as mentioned above. The adjustments would also be done to ensure that an adequate number of sampling across a defined

portion of the hydrograph centered around the peak are taken with each significant storm event. If an event triggers sampling but ultimately proves to be trivial, based on daily rainfall data or flow data, the sample(s) will be discarded and the equipment will be re-set. All storm data collected will be recorded regarding if samples are analyzed or not.

Outflow is measured using the automatic sampler in the permeable pavement BMP, as well as the rain garden and detention pond BMPs. Here the sampling threshold needs to be set very low in order to capture any outflow generated from the storm. Therefore, initial trigger flow for the outflow is constrained by the accuracy of the flow meter (ISCO Teledyne), and therefore has been set to the minimum flow rate that can be detected by the flow meter (see Table B1.1).

The automatic samplers, wherever installed, will be programmed to take 450 ml samples every 30 minutes, and sampling starts at the initial phase of that time interval, ensuring collection of any first flush flow. Sampling will continue till the flow drops below the initial trigger level. New discrete samples will be initiated every 24 hours.

The runoff from the rainwater harvesting and green roof BMPs will be collected manually, after each rain event that is greater than 0.23 inches. As mentioned above, a representative sample from all parts of the hydrograph will be retained in the storage container, using a volume splitter that retains 1/10 and discards $9/10^{th}$ of the volume of the runoff. Since it is a one-time grab sample at the end of each event, the water sample that is collected in the water containers (see below for monitoring details) will be adequately mixed at the time of collection.

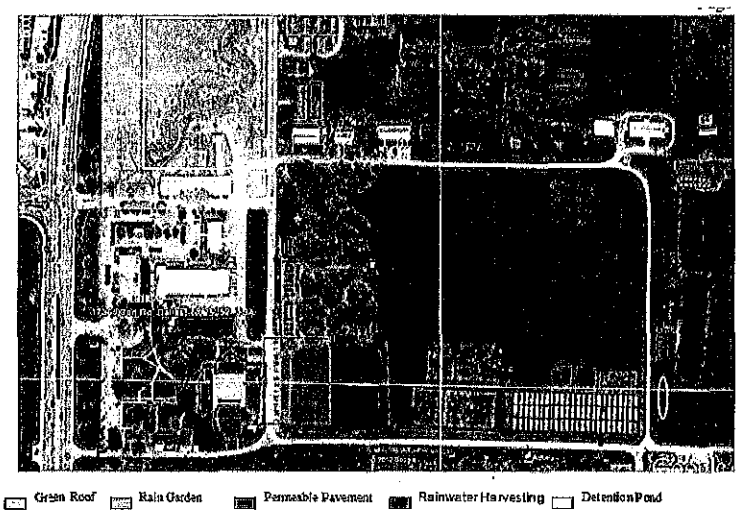


Figure 2. Sampling locations of the five BMPs on the Texas AgriLife campus.

Monitoring will encompass evaluating the following water quantity and quality parameters for each of the BMPs:

- Total runoff volume/event
- Peak flow rate
- pH
- Electrolytic Conductivity
- Total Kjeldahl N (TKN)
- NO_3/NO_2
- Ammonia
- Total Phosphorus
- Orthophosphate
- Sediments; TSS
- Chlordane

Design and sampling parameters for the five different BMPs are as follows:

1. Permeable pavement

A newly constructed parking lot (Figure 2), intended to serve the Center will incorporate five different types of pavements, four of which will be permeable. Five parking stalls of each type will be connected to an automatic sampler that will collect runoff from all five stalls. The five pavements are grass pavers, permeable interlocking concrete pavers, pervious concrete, pervious asphalt and impervious concrete (control).

Runoff quantity and quality will be measured, and storage will be estimated. Inflow quantities will be estimated from rainfall measured from a weather station (Campbell Scientific) on the property. Inflow will not be measured using an automatic sampler, as the experimental setup allows for a control parking lot, which can then be compared to the runoff from the different permeable pavement treatments to study differences in the efficacy of the different kinds of permeable pavements that are being studied. Surface runoff (outflow) will be measured via a perforated drain running the length of the stalls in the parking median and an overflow box and pipe (Figure 3).

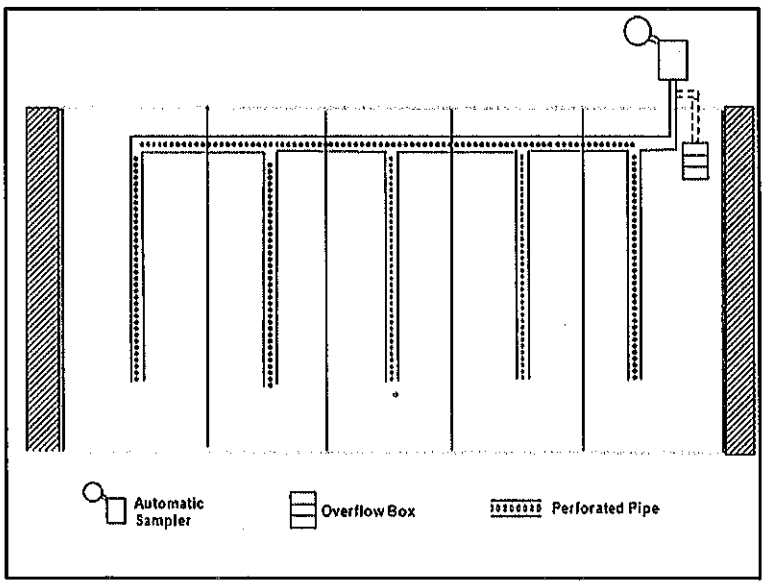


Figure 3. Design of monitoring system (5 parking spots).

A flow meter (ISCO Flow Meter) will be used to measure the overflow and the perforated pipe flow in the sub-grade. Flow from the two pipes will be combined and water quality samples will be collected with an automatic sampler (ISCO 6712 Portable Sampler) located in the median. The structure and placement of the flow meter that measures the combined outflow creates turbulence and ensures adequate mixing before the runoff is collected by the automatic samplers. Table B1.1 indicates the initial trigger for automatic sampler measurement of outflow for permeable pavements, which can be adjusted as needed.

The experimental parking stalls will be part of a larger parking lot intended to hold approximately 56 stalls. The remaining stalls will be constructed of pervious concrete. With the data collected from the experimental stalls, a representation of runoff and pollutant reduction will be estimated for the total parking lot.

2. Bioretention area (Rain Garden)

A bioretention area (rain garden) will be constructed South of the detention pond (Figure 2, 4, 10). Curb cuts will allow for runoff to drain to a flume at the inflow of the bioretention area. The flume will be equipped with an ISCO 6712 automatic sampler with an ISCO 730 Recording Bubbler Flow Meter for automatic sampling and automatic flow measurement. Runoff will be directed into the bioretention area (100ft x 20 ft). Table B1.1 indicates the initial trigger for automatic sampler measurement of inflow and outflow for the rain garden, which can be adjusted as needed. All runoff in the rain garden watershed will be routed through the inlet flume. A

surface overflow box will drain water to an underground pipe to the first inlet of the detention pond. Additionally, the drainage layer of the rain garden will house a perforated pipe that will assist in soil infiltration. An ISCO flow meter will measure the combined outflow through the perforated pipe and overflow and samples will be collected with an ISCO 6712 automatic sampler. The overflow and underground pipe flow will be combined, since the goal of the project is to is to evaluate the overall performance of the bioretention area. In addition, continuous monitoring of the water level in the BMP as well as the design parameters allows calculation and separation of the volume and pollutant load of any overflow that occurs especially for storms under 1.5". Estimation of the total effluent volume and pollutant load is the real goal of the BMP experiments and we believe this will be achieved by composite sampling.The outlet for the rain garden acts as one of the inlets of the detention pond, making the rain garden, in effect, a pre-treatment for the detention pond BMP (figure 10).

The structure and placement of the flow meter that measures the combined outflow creates turbulence and ensures adequate mixing before the runoff is collected by the automatic samplers. A pressure transducer (Levelogger Junior, Model# 3001, Solinst) will also be installed within a well point to measure soil water storage. Overall, the monitoring data will be used to quantify total water inflow (runoff), outflow (runoff and infiltration), soil water storage, and pollutant balances.

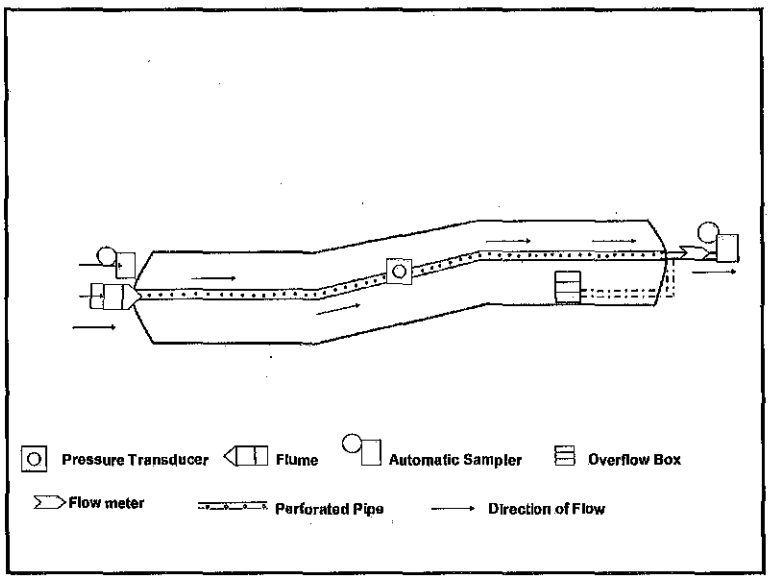


Figure 4. Schematic diagram of rain garden.

3. Green roof

The green roof BMP will include a controlled experiment and a larger roof for pollution reduction as well as a demonstration for the public (Figure 2, 5). The controlled experiment will feature four roof shelters representative of a residential roof with varying green roof designs. Each roof will be divided into four sections to compare four types of growing media that will include different layers of soil, drainage, insulation and roofing membranes.

The four sections (Figure 6) will consist of four different treatments: A conventional green roof, as made by Hydrotech, Inc.; a green roof design that consists of the plant layer, soil mix, drainage layer, and roofing material; a green roof design consisting of plant layer, soil mix and roofing material; a control 'green roof' with no vegetation. Plants will be selected to withstand minimal maintenance.

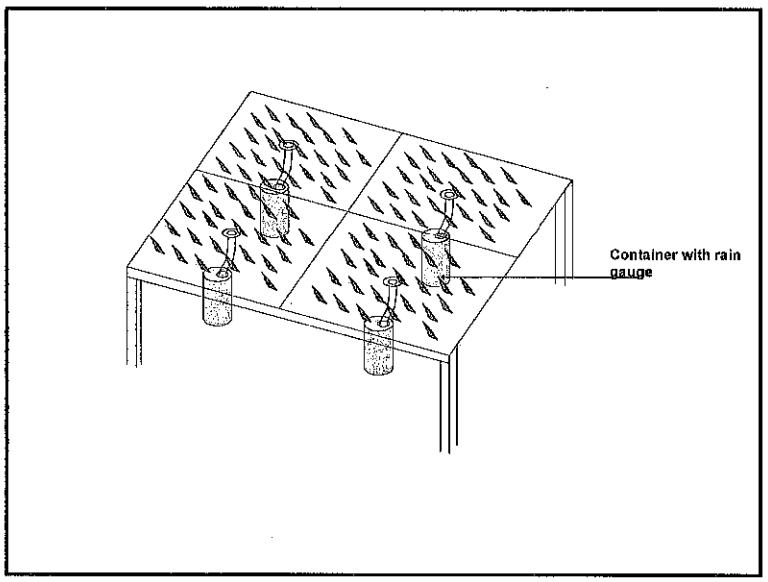


Figure 5. General design of the green roof experimental plot with 4 treatment sections.

All green roofs will be monitored for rainfall, soil storage, and runoff on a continuous basis. Water samples will be collected from the runoff to demonstrate the effectiveness of green roofs in removing pollutants. The monitoring setup will consist of a downspout that drains to a barrel that is sized to collect all the runoff from a 10 year storm. The runoff will be collected in the container from which grab samples will be taken at the end of each storm greater than 0.23 inches (Figure 6, 7). A grab sample will be taken from the container at the end of each event

after stirring to assure the sample will be representative. 450 ml water samples will be collected in water collection bottles as recommended by the NELAC certified lab.

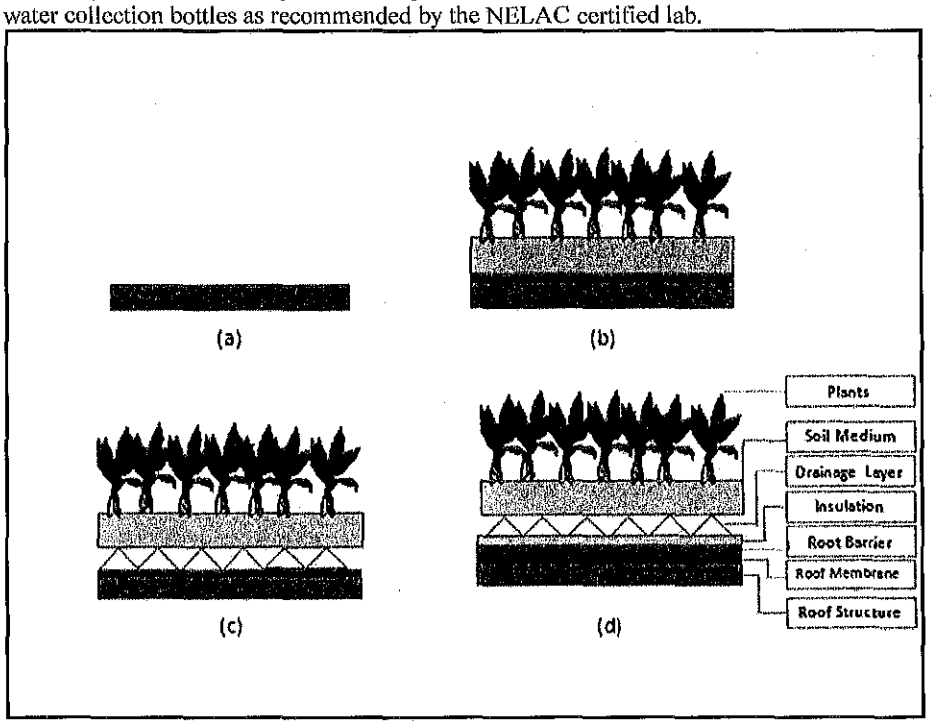


Figure 6. The four treatments in the Green Roof design- a) Control (roof structure only), b)Vegetation, soil medium and roof shelter, c) Vegetation, soil medium, drainage layer, roof structure, d) Commercial green roof (vegetation, soil medium, drainage layer, insulation, root barrier, roofing membrane, and roof structure).

A demonstration green roof will also be constructed on the front veranda of the Pavilion Building at the Center (Figure 2). This will be a conventional green roof made by Hydrotech Inc. that consists of the following layers:

1. Plants selected for their ability to withstand drought and self –regenerate.
2. Engineered lightweight growing medium that has suitable pH range, nutrients, and porosity for plant growth.
3. Drainage layer that retains water in profiled troughs, and drains away excess water through channels between troughs.
4. Insulation layer that resists moisture and situated above roof membrane and root barrier
5. Root barrier that prevents roots from affecting the roof membrane.
6. Roofing membrane that is made of Hydrotech's Monolithic Membrane®.
7. Structural support that is designed to support the weight of the green roof.

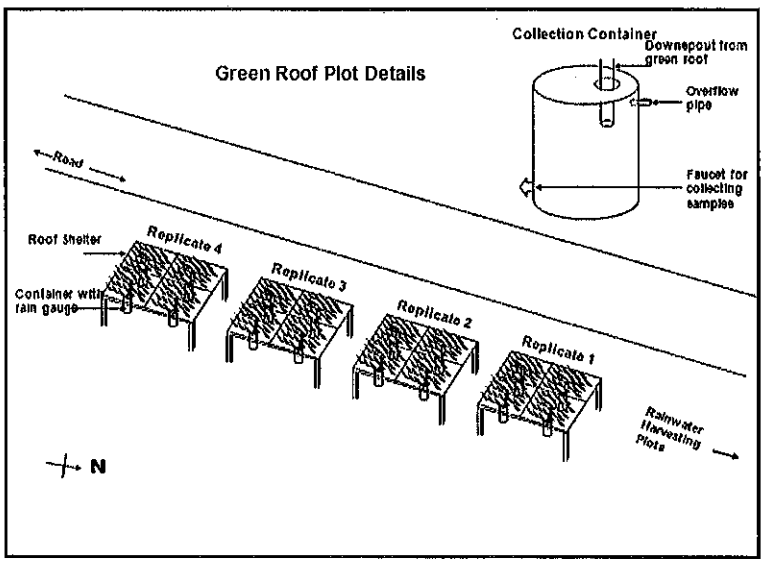


Figure 7. Details of green roof monitoring set up.

4. Rainwater Harvesting

Similar to the green roof, the rainwater harvesting BMP will involve both a controlled experiment and a demonstration component. The controlled experiment will consist of four roof shelters constructed with a turf lawn beside each, planted with *Zoysia japonica* (Figure 2, 8). Three shelters each have a gutter with leaf guard and a downspout draining to three connected 55 rainwater harvesting barrels. The lawns connected to these three shelters will be irrigated with the harvested rainwater, which will be measured using a DLJ Hose Bibb water meter (Daniel L. Jerman Co.). One control plot has a downspout draining directly to the lawn. The barrels are equipped with overflow pipes that drain into the lawn.

A roof to lawn area ratio of 1:3 will be used, to reflect a typical residential area in the Dallas-Fort Worth Metroplex. The roof and plot area considered in this study are 100 square feet (9.3 m^2) and 150 square feet (13.9 m^2), assuming rainfall collection from half the roof. The total runoff volume can be calculated by multiplying area of roof, roof runoff coefficient and rainfall depth. Under the current set up, a 2.64 inch (6.71 cm) rainfall would fill the rain barrels to capacity (165 Gallons), with a roof coefficient of 1.The barrels are equipped with pressure transducers that monitor the depth of water continuously. Since we will know the volume of water that goes in, and the volume of water in the barrels, any overflow that occurs can be

calculated. The barrels are equipped with overflow pipes at the top that discharge directly to the lawn. The amount of overflow will not be measured directly.

Varying irrigation methods will be installed on the plots including soil moisture based, evapotranspiration (ET) based, and timed irrigation (typical homeowner). See Appendix A for location on campus.
The control plot will follow typical homeowner irrigation and will have three barrels manually filled with city water every time the barrels become empty. To ensure all water can be accounted for, drip irrigation is used on all plots. Each plot will have a gutter spanning the length of one of the ends downstream from the plot, which will feed into a pipe system with a rain gauge (Rain Gauge with Data Logger, Spectrum Technologies Inc.) and a water storage container. The rain gauge will measure depth of runoff and a grab sample will be obtained for water quality from the container. The gutters that transport the runoff from the lawn to the water collection container will be sized and sloped to adequately convey a 1.5" design storm without any overflow. Pressure transducers (Levelogger Junior, Model# 3001, Solinst) will also be placed in the rainwater harvesting barrels to measure water levels.

The soil moisture treatment plot will be equipped with a soil moisture probe (VH 400, Vegetronix Inc.) that is connected to a pump via a controller. Each time the soil moisture reaches a critical threshold (50% depletion), the pump will be activated to supply water from the rainwater harvesting barrels to the turf lawn. The pump will shut off when the soil moisture reaches field capacity.

The ET based method will utilize controllers programmed to irrigate based on published ET monthly data (Texas ET Network) and the crop coefficient for warm season turf grass used in the plots.

The time based irrigation treatment will follow a typical homeowner pattern of irrigating the plot various times per week according to season. A goal of this is to show that the typical homeowner patterns contribute to over-irrigation.

The control plot will have a downspout that drains all rainwater directly on the lawn with no storage, as well as timed irrigation using city water. City water will be manually filled in three rainwater harvesting barrels so as to provide uniformity in irrigation, compared with the other plots.

The runoff volume will be monitored and samples taken for water quality measurements from the storage container. The monitoring setup will consist of a Rain Gauge with Data Logger (Spectrum technologies Inc.) for measuring the runoff volume set up in a water storage container. The runoff will be collected in the container from which grab samples will be taken at the end of each storm greater than 0.23 inches (Figure 8). A representative portion of the entire storm will be collected in the container. A grab sample will be taken from the container at the

end of each event after stirring to assure the sample will be representative. Water samples (450 ml) will be collected in water collection bottles as recommended by the NELAC certified lab.

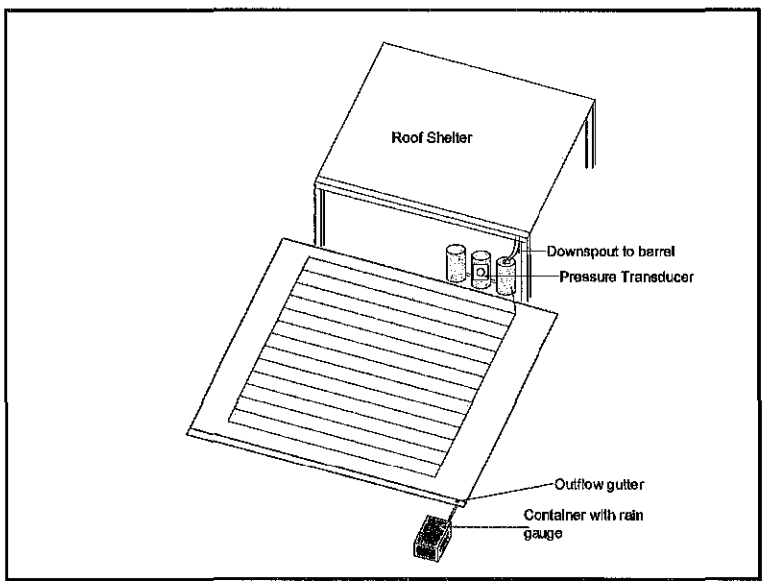


Figure 8. General design of rainwater harvesting experimental plot

The demonstration component will monitor several rainwater tanks installed on Center buildings. Four systems (300, 500, 1500, and 2500 gallon tanks) will house a pressure transducer (Levelogger Junior, Model# 3001, Solinst) to record water levels. This will also aid in calculating the overflow volume, when it happens.

As the tanks in the demonstration are of various sizes, and installed on different roofs, they will retain different storm events. However, the results from the controlled experiment can be normalized to that of the demonstration component by reporting results in gallons stored/sq ft of roof to extrapolate the amount of pollutant reduction and runoff captured from the demonstration tanks.

5. Detention Pond

A detention pond will be designed to retain 1.5 inches of runoff and measured for inflow/outflow and its respective water quality. The pond will be designed to resemble a meandering river with two forks, planted with associated vegetation to reduce erosion as well as act as filter strips, to

serve as a demonstration tool for stream restoration. The width to length ratio will also be taken into consideration to maximize sediment retention and nutrient intake. The detention pond will have two inlet points, one at each fork, and all of the Texas AgriLife campus (6 acres) runoff will be routed to the pond via the two inlet flumes (Figure 9). One of the inlets of the detention pond, also doubles as the outlet of the rain garden BMP (see figure 10).

Water samples and flow will be measured via automatic sampling with an ISCO 3700 and surface flow measuring device. Table B1.1 indicates the initial trigger for automatic sampler measurement of inflow and outflow for the detention pond, which can be adjusted as needed. Also, a pressure transducer (Levelogger Junior, Model# 3001, Solinst) will be placed within the pond to gauge water level periodically.

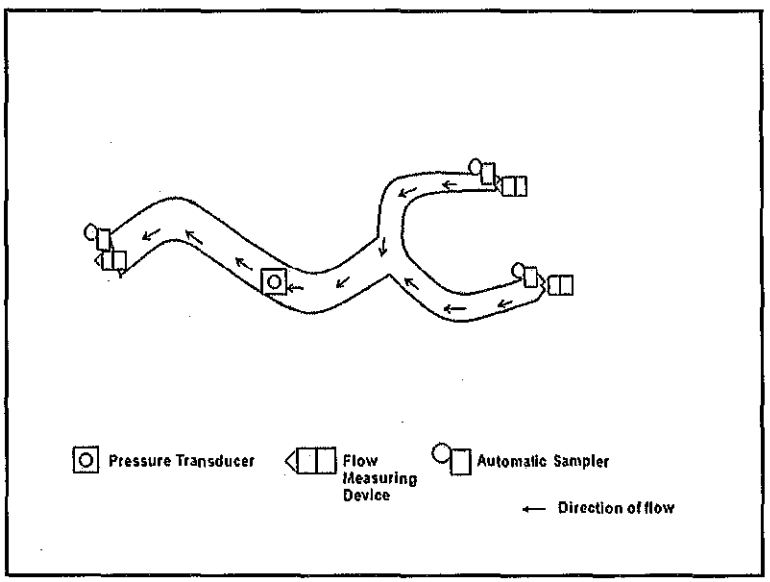


Figure 9. Detention pond monitoring setup, with measurements at the two inlet points and outflow

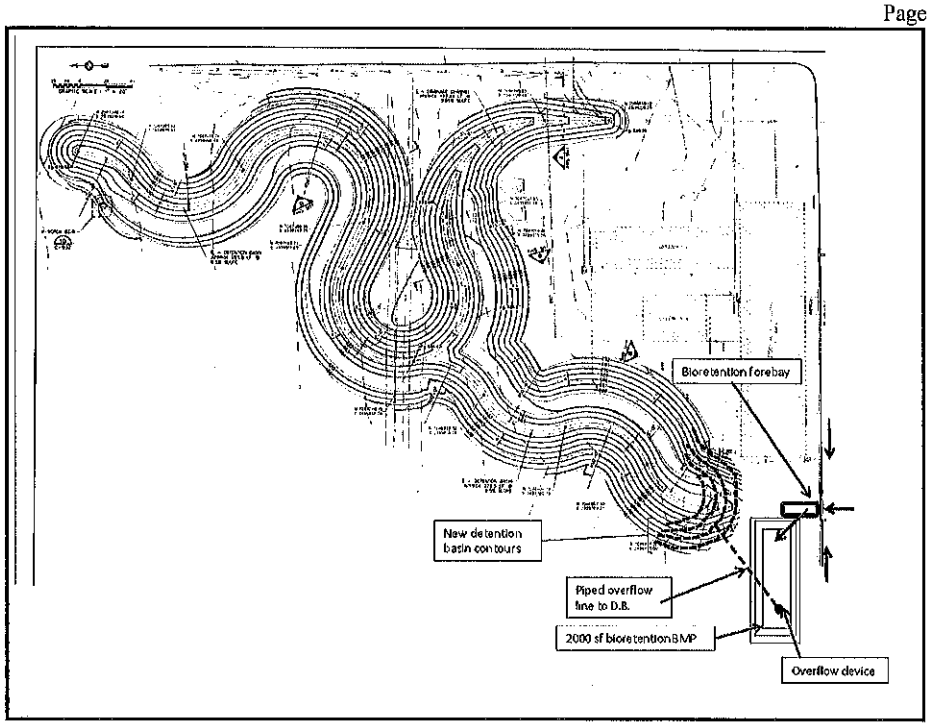


Figure 10. Site Diagram of Detention pond and Bioretention area

Each monitoring station has its own set of equipment for sampling, an overview of which is given in table B1.2. The permeable pavement, detention pond, and rain garden BMPs will be sampled with an automatic sampler for water quality. The water quality of inflow and outflow of the detention pond and rain garden BMPs will be sampled via automatic sampler, but in the permeable pavement BMP, only the outflow will be sampled for water quality via automatic sampler.

The green roof and rainwater harvesting BMPs are not equipped with automatic samplers. The outflow in each of these BMPs will be collected in a container, and samples will be collected manually (grab samples).

Table B1.2 Monitoring Plan Overview

BMP	Location Monitored	Flow/ Volume Measurement	Water Quality	
			Equipment	Nutrients/ Pollutants Measured
Permeable pavement	Inflow	Campbell Scientific Weather station[1]	None	None
	Combined outflow from Perforated pipe and overflow	Flow meter (ISCO Teledyne)	ISCO 3700 Automatic sampler	N, P, TSS, Chlordane
Bioretention	Inflow	Flume	ISCO 3700 Automatic sampler	N, P, TSS, Chlordane
		Pressure transducer (Levelogger, Jr., Solinst)		
	Water storage	Pressure transducer (Levelogger Jr, Solinst)	None	None
	Combined outflow from Perforated pipe and overflow	Flume	ISCO 3700 Automatic sampler	N, P, TSS, Chlordane
Green roof	Inflow	Campbell Scientific Weather station[1]	None	None
	Outflow	Rain Gauge with Data Logger (Spectrum Tech. Inc.)	Water storage container & manual sampling	N, P, TSS
Rainwater Harvesting	Inflow	Campbell Scientific Weather station[1]	None	None
			Rain Barrels	N, P, TSS
	Outflow	Rain gauge & water storage container	Water storage container & manual sampling	N, P, TSS, Chlordane
Detention Pond	Inflow #1	Flow measuring device	ISCO 3700 Automatic sampler	N, P, TSS, Chlordane
	Inflow #2	Flow measuring device	ISCO 3700 Automatic sampler	N, P, TSS, Chlordane
	Water storage	Pressure transducer(Levelloger Jr, Solinst)	None	None
	Outflow	Flow measuring device	ISCO 3700 Automatic sampler	N, P, TSS, Chlordane

[1]Data used from the Campbell Scientific Weather station will represent the rainfall recorded from the initiation of the storm event to the time at which the water quality sampling ends for the permeable pavement, green roof, and rainwater harvesting. The end time may vary for each BMP.

Table B1.3 gives a description of each of the monitoring sites and approximate frequencies of sampling for each parameter. Sampling frequencies depend on the frequency of rainfall. The BMPs are designed to retain storms up to 1.5 inches, and to generate outflow only for events greater than 0.75 inches. We anticipate a minimum of 25 storms per year that would be sampled (see the section on representativeness), and a minimum of 9 storms per year that are greater than 0.75 inches, based on local (1 mile NW of sampling area) rainfall data of the past 19 years (Flood Control District, Dallas, http://www.ci.dallas.tx.us/sts/html/fc.html). This would vary according to the rainfall patterns of the sampling years.

Therefore, we anticipate that outflow will be generated only in about 9 storms per year (storms greater than 0.75 inches) in the permeable pavement, rain garden and detention pond, where

outflow will be sampled by an automatic sampler. This outflow sampling will be triggered at a flow rate of $2x10^{-6}$ m^3/s, which is the minimum flow rate that can be measured by the flow meter.

Table B1.3 Field Sampling Collection Details

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
1	RG Inlet	21199	Upper Trinity White Rock Creek Watershed Rain Garden Inlet, 80.46 meters heading N82E from Intersection of Coit Road and McCallum Boulevard	32.987954° -96.767331°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	25	Sampling tied to rainfall	BF
2	RG Outlet/DP Inlet 1	21200	Upper Trinity White Rock Creek Watershed Rain Garden Outlet/ Detention Pond Inlet 1, 84.04 meters heading N70E from intersection of Coit Road and McCallum Boulevard	32.988107° -96.767339°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF
3.	DP Inlet 2	21201	Upper Trinity White Rock Creek Watershed Detention Pond Inlet 2, 170.93 meters heading N74E from intersection of Coit Road and McCallum Boulevard.	32.988282° -96.766415°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	25	Sampling tied to rainfall	BF
4.	P. Asphalt	21202	Upper Trinity White Rock Creek Watershed Porous Asphalt Outflow, 241.46 meters heading S54E from intersection of	32.986575° -96.766092°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
			Coit Road and McCallum Boulevard.								
5.	P. Control	21203	Upper Trinity White Rock Creek Watershed Impervious Pavement Control Outflow, 249.17 meters heading S51E from intersection of Coit Road and McCallum Boulevard.	32.986446° -96.766096°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF
6.	Grass Pave	21204	Upper Trinity White Rock Creek Watershed Grass Pavers Outflow, 259.17 meters heading S48E from intersection of Coit Road and McCallum Boulevard.	32.986305° -96.766108°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF
7.	Block Pave	21205	Upper Trinity White Rock Creek Watershed Interlocking Block Pavers Outflow, 265.45 meters heading S54E from intersection of Coit Road and McCallum Boulevard.	32.986434° -96.765894°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
8.	Perv. Conc	21206	Upper Trinity White Rock Creek Watershed Pervious Concrete Outflow, 257.49 meters heading S56E from intersection of Coit Road and McCallum Boulevard.	32.986568° -96.765888°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF
9.	DP Outflow	21207	Upper Trinity White Rock Creek Watershed Detention Pond Outflow, 205 meters heading N45E from intersection of Coit Road and McCallum Boulevard.	32.989156° -96.766607°	8/31/12	8/31/13	Automatic, Discrete[1]	Water	9	Sampling tied to rainfall	BF
10.	RWH_SM	21208	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Soil Moisture Outflow, 93.09 meters heading N8E from NW Corner of Turf Building.	32.986694° -96.762457°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
11.	RWH_ET	21209	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Evapotranspiration Outflow, 100.34 meters heading N8E from NW Corner of Turf	32.986756° -96.762443°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
			Building.								
12.	RWH_HOS	21210	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Home Owner Schedule_Rain water Outflow, 107.82 meters heading N8E from NW Corner of Turf Building	32.986824° -96.762431°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
13.	RWH_CON	21211	Upper Trinity White Rock Creek Watershed Rainwater Harvesting Control Plot Outflow, 115.17 meters heading N8E from NW Corner of Turf Building.	32.986889° -96.762421°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
14.	GR_PSD_1	21212	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil and Drainage Layer_1 Outflow, 56.66 meters heading N1E from NW Corner of Turf Building.	32.986370° -96.762597°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
15.	GR_PS_1	21213	Upper Trinity White Rock Creek Watershed Green Roof_ Plant s, Soil _1 Outflow, 56.4 meters heading N3E from NW Corner of Turf Building.	32.986369° -96.762572°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
16.	GR_HYD_1	21214	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_1 Outflow, 59.22 meters heading N1E from NW Corner of Turf Building.	32.986395° -96.762595°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
17.	GR_CON_1	21215	Upper Trinity White Rock Creek Watershed Green Roof_ Control_1 Outflow, 59.32 meters heading N3E from NW Corner of Turf Building.	32.986393° -96.762568°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
18.	GR_PSD_2	21216	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil and Drainage Layer_2 Outflow, 64.15 meters heading N1E from NW Corner of Turf Building	32.986439° -96.762590°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
19.	GR_PS_2	21217	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil _2 Outflow, 64.02 meters heading N3E from NW Corner of Turf Building.	32.986438° -96.762565°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
20.	GR_HYD_2	21218	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_2 Outflow, 66.87 meters heading N1E from NW Corner of Turf Building.	32.986463° -96.762587°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
21.	GR_CON_2	21219	Upper Trinity White Rock Creek Watershed Green Roof_ Control_2 Outflow, 66.98 meters heading N3E from NW Corner of Turf Building.	32.986461° -96.762563°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
22.	GR_PSD_3	21220	Upper Trinity White Rock Creek Watershed Green Roof_ Plant s, Soil and Drainage Layer_3 Outflow, 71.5 meters heading N1E from NW Corner of Turf Building.	32.986506° -96.762583°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
23.	GR_PS_3	21221	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil _3 Outflow, 71.6 meters heading N3E from NW Corner of Turf Building.	32.986506° -96.762557°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
24.	GR_HYD_3	21222	Upper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_3 Outflow, 74.37 meters heading N1E from NW Corner of Turf Building.	32.986531° -96.762582°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
25.	GR_CON_3	21223	Upper Trinity White Rock Creek Watershed Green Roof_ Control_3 Outflow, 74.62 meters heading N3E from NW Corner of Turf Building.	32.986531° -96.762554°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
26.	GR_PSD_4	21224	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil and Drainage Layer_4 Outflow, 79.17 meters heading N2E from NW Corner of Turf Building.	32.986575° -96.762577°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF

Site Number	Temporary Station ID	TCEQ Station ID*	Site Description	Latitude, Longitude (Approximate)	Start Date (Upon QAPP approval)	End Date	Mode of Sampling	Sample Matrix	Approx. Annual Monitoring Freq. (TSS, Nutrients, Chlordane)[2]	Comments	Monitoring Type Code
27.	GR_PS_4	21225	Upper Trinity White Rock Creek Watershed Green Roof_ Plants, Soil _4 Outflow, 79.18 meters heading N3E from NW Corner of Turf Building.	32.986574° -96.762551°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
28.	GR_HYD_4	21226	pper Trinity White Rock Creek Watershed Green Roof_ Hydrotech_4 Outflow, 82.08 meters heading N2E from NW Corner of Turf Building.	32.986600° -96.762574°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF
29.	GR_CON_4	21227	Upper Trinity White Rock Creek Watershed Green Roof_ Control_4 Outflow, 82.1 meters heading N3E from NW Corner of Turf Building.	32.986599° -96.762548°	8/31/12	8/31/13	Grab	Water	25	Sampling tied to rainfall	BF

*SLOC requests for these stations have been submitted to SWQMIS.
[1] For each site, there will be multiple samples in each sampling event, one each 30 minutes of the recorded storm event.
[2] We anticipate, depending on weather pattern, a minimum of 25 significant storm events per year that generate runoff for inflow samples, and a minimum of 9 storm events per year that generate outflow, based on historical rainfall data for the area

B2 Sampling Methods

Field Sampling Procedures

All field monitoring and sample collection will be conducted in accordance with the *TCEQ Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods, RG-415, August 2012, Austin, TX or most recent version,* except for automated sampling, for which the SOP for the automatic sampler (attached as appendix D) will be used, as automated sampling is not covered in SWQM procedures.

The ISCO auto sampler model 6712 with a twenty-four bottle configuration and bubbler flow meter will be used. Continuous flow measurement enables sampling to be triggered by a specified flow rate (See table B1.1) calculated according to historical rainfall data, watershed area and curve number of the watershed. The sampler will be programmed to collect 450 ml of runoff in 30 minutes, with sampling starting at the beginning of that time interval enabling collection of any first flush flow that may be present.

Samples will be picked up within 12 hours after the first sample was collected (sooner if the storm flow has fallen below the trigger level without likelihood of resuming). Samples will be acidified to < 2 pH for nutrient analysis, and transported to the lab for analysis within 3 hours of pick-up, except in the event the lab is closed, in which case the sample(s) will be delivered within 2 hours of the lab re-opening. A SOP for the automated sampler data collection is attached as Appendix D of this document. Sample volume, container types, minimum sample volume, preservation requirements, and holding time requirements for each analytical test collected are given in table B2.1. Preservation of all samples is performed in the field immediately upon collection, within 15 minutes.

Table B2.1 Storage, Preservation and Handling Requirements

Parameter	Container	Minimum Sample Volume (ml)	Preservation	Maximum Storage
Ammonia- N	Plastic or Glass	100	p H< 2 (ADD H_2SO_4), 4° C	28 d
Nitrate/nitrite- N	Plastic or Glass	100	p H< 2 (ADD H_2SO_4), 4° C	28 d
Total Kjeldahl N	Plastic or Glass	500	p H< 2 (ADD H_2SO_4), 4° C	28 d
Orthophosphate P	Plastic	100	Filter, 4° C	48h
Total Phosphorous	Plastic	100	p H< 2 (ADD H_2SO_4), 4° C	28 d
TSS	Plastic or Glass	1000 (Based on turbidity)	4° C	7d

Parameter	Container	Minimum Sample Volume (ml)	Preservation	Maximum Storage
Chlordane	Glass	1000	p H< 2 (ADD HCL), 4° C	30 d

Processes to Prevent Cross Contamination
Procedures outlined in the TCEQ Surface Water Quality Procedures outline the necessary steps to prevent cross-contamination of samples. These include such things as direct collection into sample containers and the use of commercially pre-cleaned sample containers.

Documentation of Field Sampling Activities
Field sampling activities are documented on the Field Data Reporting Form as presented in Appendix F. For all visits, station ID, location, sampling time, sampling date, sampling depth, preservatives added to samples, and sample collector's name/signature are recorded. Values for all measured field parameters are recorded. Detailed observational data are recorded including water appearance, weather, biological activity, stream uses, unusual odors, specific sample information, missing parameters, days since last significant rainfall, and flow severity.

Recording Data
For the purposes of this section and subsequent sections, all personnel follow the basic rules for recording information as documented below:

1. Legible writing in indelible, waterproof ink with no modifications, write-overs or cross-outs;
2. Changes should be made by crossing out original entries with a single line, entering the changes, and initialing and dating the corrections.
3. Close-outs on incomplete pages with an initialed and dated diagonal line.

Sampling Method Requirement or Sampling Process Design Deficiencies and Corrective Action
Examples of sampling method requirement or sample design deficiencies include but are not limited to such things as inadequate sample volume due to spillage or container leaks, failure to preserve samples appropriately, contamination of a sample bottle during collection, storage temperature and holding time exceedance, sampling at the wrong site, etc. Any deviations from the QAPP and appropriate sampling procedures may invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. It is the responsibility of the AgriLife Project Manager, in consultation with the AgriLife QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the NPS Project Manager both verbally and in writing in the project progress reports and by completion of a corrective action plan (CAP).

The definition of and process for handling deficiencies and corrective actions are defined in Section C1.

B3 Sample Handling and Custody

Sample Labeling
Samples from the field are labeled on the container with an indelible marker.
Label information includes:
1. Site identification
2. Date and time of collection
3. Preservative added, if applicable
4. Designation of "field-filtered" *(for metals)* as applicable
5. Sample type (i.e., analysis (es)) to be performed

Sample Handling
Samples are collected at the field site after each rain event, labeled and appropriately preserved for laboratory analysis. Once preserved, the samples will be packaged according to the specifications of the subcontracted NELAC certified laboratory and mailed out to the contracted laboratory by courier.

The details concerning how the samples are logged in at the laboratory, how they are examined for documentation and preservation, how holding times are insured etc, will be provided once a decision is made on selection of the NELAC certified laboratory.

Sample Tracking
Proper sample handling and custody procedures ensure the custody and integrity of samples beginning at the time of sampling and continuing through transport, sample receipt, preparation, and analysis.

A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. The COC form is used to document sample handling during transfer from the field to the laboratory and among contractors. The following information concerning the sample is recorded on the COC form (See Appendix G).

1. Date and time of collection
2. Site identification
3. Sample matrix
4. Number of containers
5. Preservative used
6. Was the sample filtered
7. Analyses required
8. Name of collector
9. Custody transfer signatures and dates and time of transfer
10. Bill of lading (*if applicable*)

Sample Tracking Procedure Deficiencies and Corrective Action
All deficiencies associated with chain-of-custody procedures as described in this QAPP are immediately reported to the Contractor Project Manager. These include such items as delays in transfer, resulting in holding time violations; violations of sample preservation requirements; incomplete documentation, including signatures; possible tampering of samples; broken or spilled samples, etc. The AgriLife Project Manager in consultation with the AgriLife QAO will determine if the procedural violation may have compromised the validity of the resulting data. Any failures that have reasonable potential to compromise data validity will invalidate data, and the sampling event should be repeated. The resolution of the situation will be reported to the TCEQ NPS Project Manager in the project progress report. Corrective Action Plans will be prepared by the Contractor QAO and submitted to TCEQ NPS Project Manager along with project progress report.

The definition of and process for handling deficiencies, nonconformance, and corrective action are defined in Section C1.

B4 Analytical Methods

The analytical methods are listed in Table A.1 of Section A7. Laboratories collecting data under this QAPP are compliant with the NELAC Standards. Procedures for laboratory analysis will be in accordance with the most recently published or online edition of *Standard Methods for the Examination of Water and Wastewater*, the latest version of the TCEQ *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods, RG-415, August 2012, Austin, TX or most recent version*, or other reliable procedures acceptable to TCEQ.

Copies of laboratory SOPs are retained by the contractor and are available for review by the TCEQ. Laboratory SOPs are consistent with EPA requirements as specified in the method.

Standards Traceability
All standards used in the field and laboratory are traceable to certified reference materials. Standards and reagent preparation is fully documented and maintained in a standards log book. Each documentation includes information concerning the standard or reagent identification, starting materials, including concentration, amount used and lot number; date prepared, expiration date and preparer's initials/signature. The bottle is labeled in a way that will trace the standard or reagent back to preparation. Standards or reagents used are documented each day samples are prepared or analyzed.

Analytical Method Deficiencies and Corrective Actions
Deficiencies in field and laboratory measurement systems involve, but are not limited to such things as instrument malfunctions, failures in calibration, blank contamination, quality control samples outside QAPP defined limits, etc. In many cases, the field technician or lab analyst will be able to correct the problem. If the problem is resolvable by the field technician or lab analyst,

then they will document the problem on the field data sheet or laboratory record and complete the analysis. If the problem is not resolvable, then it is conveyed to the AgriLife Laboratory Supervisor, who will make the determination and notify the AgriLife QAO. If the analytical system failure may compromise the sample results, the resulting data will not be reported to the TCEQ. The nature and disposition of the problem is reported on the data report which is sent to the AgriLife Manager. The AgriLife Project Manager will include this information in the CAP and submit with the Progress Report which is sent to the TCEQ NPS Project Manager.

The definition of and process for handling deficiencies, nonconformance, and corrective action are defined in Section C1.

The TCEQ has determined that analyses associated with the qualifier codes "holding time exceedance" "sample received unpreserved", "estimated value," etc. may have unacceptable measurement uncertainty associated with them. This will immediately disqualify analyses from submittal to SWQMIS. Therefore, data with these types of problems should not be reported to the TCEQ. Additionally, any data collected or analyzed by means other than those stated in the QAPP, or they must have an appropriate data qualifier found in the SWQM DMRG (2012, or most recent version).

B5 Quality Control

Sampling Quality Control Requirements and Acceptability Criteria

Field Split - A field split is a single sample subdivided by field staff immediately following collection and submitted to the laboratory as two separately identified samples according to procedures specified in the *SWQM Procedures*. Split samples are preserved, handled, shipped, and analyzed identically and are used to assess variability in all of these processes. Field splits apply to conventional samples only.

The precision of field split results is calculated by relative percent difference (RPD) using the following equation:

$$RPD = [(X_1-X_2)/\{(X_1+X_2)/2\} * 100]$$

A 30% RPD criteria will be used to screen field split results as a possible indicator of excessive variability in the sample handling and analytical system. If it is determined that elevated quantities of analyte (i.e., > 5 times the LOQ) were measured and analytical variability can be eliminated as a factor, than variability in field split results will primarily be used as a trigger for discussion with field staff to ensure samples are being handled in the field correctly. Some individual sample results may be invalidated based on the examination of all extenuating information. The information derived from field splits is generally considered to be event specific and would not normally be used to determine the validity of an entire batch; however, some batches of samples may be invalidated depending on the situation. Professional judgment during data validation will be relied upon to interpret the results and take appropriate action. The

qualification (i.e., invalidation) of data will be documented on the Data Review Checklist and Summary. Deficiencies will be addressed as specified in this section under Quality Control or Acceptability Requirement Deficiencies and Corrective Actions.

Laboratory Measurement Quality Control Requirements and Acceptability Criteria
Batch – A batch is defined as environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 25 hours. An **analytical batch** is composed of prepared environmental samples (extract, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.
Method Specific QC requirements – QC samples, other than those specified later this section, are run (e.g., sample duplicates, surrogates, internal standards, continuing calibration samples, interference check samples, positive control, negative control, and media blank) as specified in the methods. The requirements for these samples, their acceptance criteria or instructions for establishing criteria, and corrective actions are method-specific.

Detailed laboratory QC requirements and corrective action procedures are contained within the individual laboratory quality manuals (QMs). The minimum requirements that all participants abide by are stated below.

Limit of Quantitation (LOQ) – The laboratory will analyze a calibration standard (if applicable) at the LOQ on each day calibrations are performed. In addition, an LOQ check standard will be analyzed with each analytical batch. Calibrations including the standard at the LOQ will meet the calibration requirements of the analytical method or corrective action will be implemented.

> LOQ Sediment and Tissue Samples – When considering LOQs for solid samples and how they apply to results, two aspects of the analysis are considered: (1) the LOQ of the sample, based on the Areal-world@ in which moisture content and interferences affect the result and (2) the LOQ in the QAPP which is a value less than or equal to the AWRL based on an idealized sample with zero % moisture.
>
> The LOQ for a solid sample is based on the lowest non-zero calibration standard (as are those for water samples), the moisture content of the solid sample, and any sample concentration or dilution factors resulting from sample preparation or clean-up.
>
> To establish solid-phase LOQs to be listed in Table A7.1 of the QAPP, the laboratory will adjust the concentration of the lowest non-zero calibration standard for the amount of sample extracted, the final extract volume, and moisture content (assumed to be zero % moisture). Each calculated LOQ will be less than or equal to the AWRL on the dry-weight basis to satisfy the AWRL requirement for sediment and tissue analyses. When

data are reviewed for consistency with the QAPP, they are evaluated based on this requirement. Results may not appear to meet the AWRL requirement due to high moisture content, high concentrations of non-target analytes necessitating sample dilution, etc. These sample results will be submitted to the TCEQ with an explanation on the Data Review Checklist and Summary as to why results do not appear to meet the AWRL requirement.

LOQ Check Standard – An LOQ check standard consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system at the lower limits of analysis. The LOQ check standard is spiked into the sample matrix at a level less than or near the LOQ for each analyte for each analytical batch of samples run.

The LOQ check standard is carried through the complete preparation and analytical process. LOQ Check Standards are run at a rate of one per analytical batch.

The percent recovery of the LOQ check standard is calculated using the following equation in which %R is percent recovery, SR is the sample result, and SA is the reference concentration for the check standard:

$$\%R = SR/SA * 100$$

Measurement performance specifications are used to determine the acceptability of LOQ Check Standard analyses as specified in Table A7.1.

Laboratory Control Sample (LCS) – An LCS consists of a sample matrix (e.g., deionized water, sand, commercially available tissue) free from the analytes of interest spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is used to establish intra-laboratory bias to assess the performance of the measurement system. The LCS is spiked into the sample matrix at a level less than or near the midpoint of the calibration for each analyte. In cases of test methods with very long lists of analytes, LCSs are prepared with all the target analytes and not just a representative number, except in cases of organic analytes with multipeak responses.

The LCS is carried through the complete preparation and analytical process. LCSs are run at a rate of one per preparation batch.

Results of LCSs are calculated by percent recovery (%R), which is defined as 100 times the measured concentration, divided by the true concentration of the spiked sample.

The following formula is used to calculate percent recovery, where %R is percent recovery; SR is the measured result; and SA is the true result:

$$\%R = SR/SA * 100$$

Measurement performance specifications are used to determine the acceptability of LCS analyses as specified in Table A7.1.

Laboratory Duplicates – A laboratory duplicate is prepared by taking aliquots of a sample from the same container under laboratory conditions and processed and analyzed independently. A laboratory control sample duplicate (LCSD) is prepared in the laboratory by splitting aliquots of an LCS. Both samples are carried through the entire preparation and analytical process. LCSDs are used to assess precision and are performed at a rate of one per preparation batch.

For most parameters, precision is calculated by the relative percent difference (RPD) of LCS duplicate results as defined by 100 times the difference (range) of each duplicate set, divided by the average value (mean) of the set. For duplicate results, X_1 and X_2, the RPD is calculated from the following equation: *(If other formulas apply, adjust appropriately.)*

$$RPD = [(X_1 - X_2)/\{(X_1+X_2)/2\} * 100]$$

Laboratory equipment blank – Laboratory equipment blanks are prepared at the laboratory where collection materials for metals sampling equipment are cleaned between uses. These blanks document that the materials provided by the laboratory are free of contamination. The QC check is performed before the metals sampling equipment is sent to the field. The analysis of laboratory equipment blanks should yield values less than the LOQ. Otherwise, the equipment should not be used.

Matrix spike (MS) – Matrix spikes are prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Percent recovery of the known concentration of added analyte is used to assess accuracy of the analytical process. The spiking occurs prior to sample preparation and analysis. Spiked samples are routinely prepared and analyzed at a rate of 10% of samples processed, or one per preparation batch whichever is greater. The information from these controls is sample/matrix specific and is not used to determine the validity of the entire batch. The MS is spiked at a level less than or equal to the midpoint of the calibration or analysis range for each analyte. Percent recovery (%R) is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike.

The results from matrix spikes are primarily designed to assess the validity of analytical results in a given matrix and are expressed as percent recovery (%R). The laboratory shall document the calculation for %R. The percent recovery of the matrix spike is calculated using the

following equation in which %R is percent recovery, SSR is the observed spiked sample concentration, SR is the sample result, and SA is the reference concentration of the spike added:

$$\%R = (SSR - SR)/SA * 100$$

Measurement performance specifications for matrix spikes are not specified in this document.

The results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine the internal criteria and document the method used to establish the limits. For matrix spike results outside established criteria, corrective action shall be documented or the data reported with appropriate data qualifying codes.

Method blank – A method blank is a sample of matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as the samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. The method blanks are performed at a rate of once per preparation batch. The method blank is used to document contamination from the analytical process. The analysis of method blanks should yield values less than the LOQ. For very high-level analyses, the blank value should be less than 5% of the lowest value of the batch, or corrective action will be implemented. Samples associated with a contaminated blank shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action must be documented.

The method blank shall be analyzed at a minimum of once per preparation batch. In those instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

Quality Control or Acceptability Requirement Deficiencies and Corrective Actions
Sampling QC excursions are evaluated by the AgriLife Project Manager, in consultation with the AgriLife QAO. In that differences in sample results are used to assess the entire sampling process, including environmental variability, the arbitrary rejection of results based on pre-determined limits is not practical. Therefore, the professional judgment of the AgriLife Project Manager and QAO will be relied upon in evaluating results. Rejecting sample results based on wide variability is a possibility. Field blanks for trace elements and trace organics are scrutinized very closely. Field blank values exceeding the acceptability criteria may automatically invalidate the sample, especially in cases where high blank values may be indicative of contamination which may be causal in putting a value above the standard. Notations of field split excursions and blank contamination are noted in the quarterly report and the final QC Report. Equipment blanks for metals analysis are also scrutinized very closely.

Laboratory measurement quality control failures are evaluated by the laboratory staff. The disposition of such failures and the nature and disposition of the problem is reported to the AgriLife Laboratory QAO. The Laboratory QAO will discuss with the AgriLife Project Manager. If applicable, the AgriLife Project Manager will include this information in the CAP and submit with the Progress Report which is sent to the TCEQ NPS Project Manager.

B6 Instrument/Equipment Testing, Inspection and Maintenance

Automated sampler testing and maintenance requirements are obtained from the manufacturer's website (http://www.isco.com/products/manuals1.asp?PL=201&GP=20110).

Equipment records are kept on all field equipment and a supply of critical spare parts is maintained by the Contractor Field Supervisor.

All laboratory tools, gauges, instrument, and equipment testing and maintenance requirements are contained within laboratory QAM(s). Testing and maintenance records are maintained and are available for inspection by the TCEQ. Instruments requiring daily or in-use testing may include, but are not limited to, water baths, ovens, autoclaves, incubators, refrigerators, and laboratory pure water. Critical spare parts for essential equipment are maintained to prevent downtime. Maintenance records are available for inspection by the TCEQ.

B7 Instrument/Equipment Calibration and Frequency

All instruments or devices used in obtaining environmental data will be calibrated prior to use as needed. Detailed laboratory calibration methods are contained in the manufacturer's instruction manual.

Each instrument has a specialized procedure for calibration and a specific type of standard used to verify calibration. The instruments that might require calibration are listed below in Table B7.1.

All calibration procedures will meet the requirements specified in the EPA approved methods of analysis. The frequency of calibration as well as specific instructions applicable to the analytical methods recommended by the equipment manufacturer will be followed. All information concerning calibration will be recorded in a calibration logbook by the person performing the calibration and will be accessible for verification during either a laboratory or field audit.

All instruments or devices used in obtaining environmental data will be used according to appropriate laboratory or field practices. Written copies of SOPs are available for review upon request.

Failures in any testing, inspections, or calibration of equipment will result in a CAR and resolution of the situation will be reported to the TCEQ in the quarterly report. The CARs will be maintained by the Project Leader and the TCEQ PM.

Table B7.1. Instrument Calibration Requirements

Equipment	Relevant Calibration Requirement
ISCO 6712Sampler	Product Owner's Manual
ISCO 730 Flow Meter	Product Owner's Manual

Data not meeting post-error limit requirements invalidates associated data collected subsequent to the pre-calibration and are not submitted to the TCEQ.

B8 Inspection/Acceptance of Supplies and Consumables

New batches of supplies are tested before use to verify that they function properly and are not contaminated. The laboratory QAM provides additional details on acceptance requirements for laboratory supplies and consumables.

B9 Non-direct Measurements

This QAPP does not include the use of routine data obtained from non-direct measurement sources. Only data collected directly under this QAPP is submitted to the SWQMIS database. All data collected under this QAPP and any acquired data will comply with all requirements/guidance of the project and QAPP.
However, rainfall data will be collected using a Campbell Scientific weather station. This data will be used for calculating input volumes for the Permeable pavement, Green roof, and Rainwater harvesting BMPs.

B10 Data Management

Field Collection and Management of Routine Samples
Field staff will visit sites immediately following rainfall events to collect samples and download flow data. In addition, these sites will be visited daily to maintain equipment. Site identification, date, time, personnel, water depth, measurements of field parameters, and any comment concerning weather or conditions at the site are noted in the field notebook. A field notebook is filled out in the field for each site visit. If no flow is observed at a site, samples will not be collected but information about the site visit will be recorded in the field notebook.

Samples collected at the site will be labeled for transportation to the laboratory. Site name, time of collection, comments, and other pertinent data are copied from the field notebook to the COC. The COC and accompanying sample bags/bottles are submitted to laboratory analyst, with

relinquishing and receiving AgriLife SWL will be accompanied by COC sheets filled out by the field technician.

All COC, field observations, and data will be manually entered into an electronic spreadsheet. The electronic spreadsheet will be created in Microsoft Excel software on an IBM-compatible microcomputer with a Windows XP/Vista/7 Operating System. The project spreadsheet will be maintained on the computer's hard drive, which is also simultaneously saved in a network folder. All pertinent data files will be backed up weekly on an external hard drive.

Original data recorded on paper files will be stored for at least five years. Electronic data files will be archived to CD after approximately one year, and then stored with the paper files for the remaining 4 years.

Laboratory Data
All field samples will be logged upon receipt, COC's (if applicable) will be checked for number of samples, proper and exact I.D. number, signatures, dates, and type of analysis specified. The field technician will be notified if any discrepancy is found and proper corrections made. All samples will be stored at 4°C until analysis.

Current data files will be backed up on r/w CD's weekly and stored in separate area away from the computer. At least 10% of all data manually entered in the database will be reviewed for accuracy by the AgriLife PM/QAO to ensure that there are no transcription errors. Hard copies of data will be printed and housed in the laboratory for a period of five years.

Personnel
Section A4 lists responsibilities and lines of communication for data management personnel.

Data Management Process
Samples are collected by field staff and transferred to the laboratory for analyses as described in Sections B1 and B2. Sampling information (e.g. site location, date, time, sampling depth, etc.) is used to generate a unique sampling event in an interim database built on an autogenerated alphanumeric key field. Measurement results from both the field data sheets and laboratory data sheets are manually entered (by field and laboratory staff, respectively) into the interim database for their corresponding event. Customized data entry forms facilitate accurate data entry. Following data verification and validation, the data are exported from the interim database into the Event/Result format required for submission to TCEQ's SWQMIS (as described in the SWQM DMRG January 2012 or later version). Once TCEQ approval of the data is obtained, the interim data are loaded into SWQMIS by TCEQ data managers. See Appendix J for the Data Management Process Flow Chart.

Record-keeping and Data Storage
AgriLife record keeping and document control procedures are contained in the water quality sampling and laboratory standard operating procedures (SOPs) and this QAPP. Original field

and laboratory data sheets are stored in the AgriLife offices in a fireproof file in accordance with the record-retention schedule in Section A9. Two copies of the database are backed up each Friday on magnetic tape. One copy is stored in a fireproof safe in the AgriLife office, and one copy is stored off-site. If necessary, disaster recovery will be accomplished by information resources staff using the backup database.

Archives/Data Retention
Complete original data sets are archived on permanent *(hardcopy/external and internal hard drive)* media and retained on-site by the Contractor for a retention period specified in section A9.

Data Verification/Validation
The control mechanisms for detecting and correcting errors and for preventing loss of data during data reduction, data reporting, and data entry are contained in Sections D1, D2, and D3.

Forms and Checklists
See Appendix E for the Field and Laboratory Data Sheets.
See Appendix C for the Data Review Checklist and Summary.

Data Dictionary
Terminology and field descriptions are included in the SWQM DMRG (January 2012 or most recent version). Note that a new Monitoring Type Code for automatic samplers is under development by TCEQ and will be incorporated when available. For the purposes of verifying which entity codes are included in this QAPP, a table outlining the entities that will be used when submitting data under this QAPP is included in table B10.1.

Table B10.1 Example usage of codes

Name of Monitoring Entity	Sample description	Tag Prefix	Submitting Entity	Collecting Entity	Monitoring Type Code
Texas Agrilife Research, Dallas, TX	*Monitoring during rainfall runoff*	***AD***	***AD***	***AD***	***BF***
Texas Agrilife Research, Dallas, TX	*Grab samples of rainfall runoff*	***AD***	***AD***	***AD***	***BF***

Data Handling
Data are processed using the Microsoft Excel 2003/2007 suite of tools and applications. Data integrity is maintained by the implementation of password protections which control access to the database and by limiting update rights to a select user group. No data from external sources are maintained in the database. The database administrator is responsible for assigning user rights and assuring database integrity.

Hardware and Software Requirements
Hardware configurations are sufficient to run Microsoft Excel 2003/2007 under the Windows XP/Vista/7 operating system in a networked environment. Information Resources staff are responsible for assuring hardware configurations meet the requirements for running current and future data management/database software as well as providing technical support. Software development and database administration are also the responsibility of the information resources department. Information Resources develops applications based on user requests and assures full system compatibility prior to implementation.

Information Resource Management Requirements
The agency's information technology (IT) policy is available at http://nis.tamu.edu/Home/IT_Policy.php .

Quality Assurance/Control
See Section D of this QAPP.

C1 Assessments and Response Actions

Table C1.1 Assessments and Response Requirements

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Status Monitoring Oversight, etc.	Continuous	AgriLife Project Manager	Monitoring of the project status and records to ensure requirements are being fulfilled.	Report to TCEQ in Quarterly Report
Monitoring Systems Audit	Dates to be determined by TCEQ	TCEQ QAS	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Field sampling, handling and measurement; facility review; and data management as they relate to the NPS Project	30 days to respond in writing to the TCEQ to address corrective actions
Laboratory Inspection	Based on work plan and or discretion of contractor	AgriLife QAO	Analytical and quality control procedures employed at the laboratory and the contract laboratory	30 days to respond in writing to the contractor QAO to address corrective actions

Assessment Activity	Approximate Schedule	Responsible Party	Scope	Response Requirements
Monitoring Systems Audit	Based on work plan and or discretion of contractor	AgriLife QAO	The assessment will be tailored in accordance with objectives needed to assure compliance with the QAPP. Field sampling, handling and measurement; facility review; and data management as they relate to the NPS Project	30 days to respond in writing to the contractor QAO to address corrective actions
Site Visit	Dates to be determined by TCEQ	TCEQ PM	Status of activities. Overall compliance with work plan and QAPP	As needed

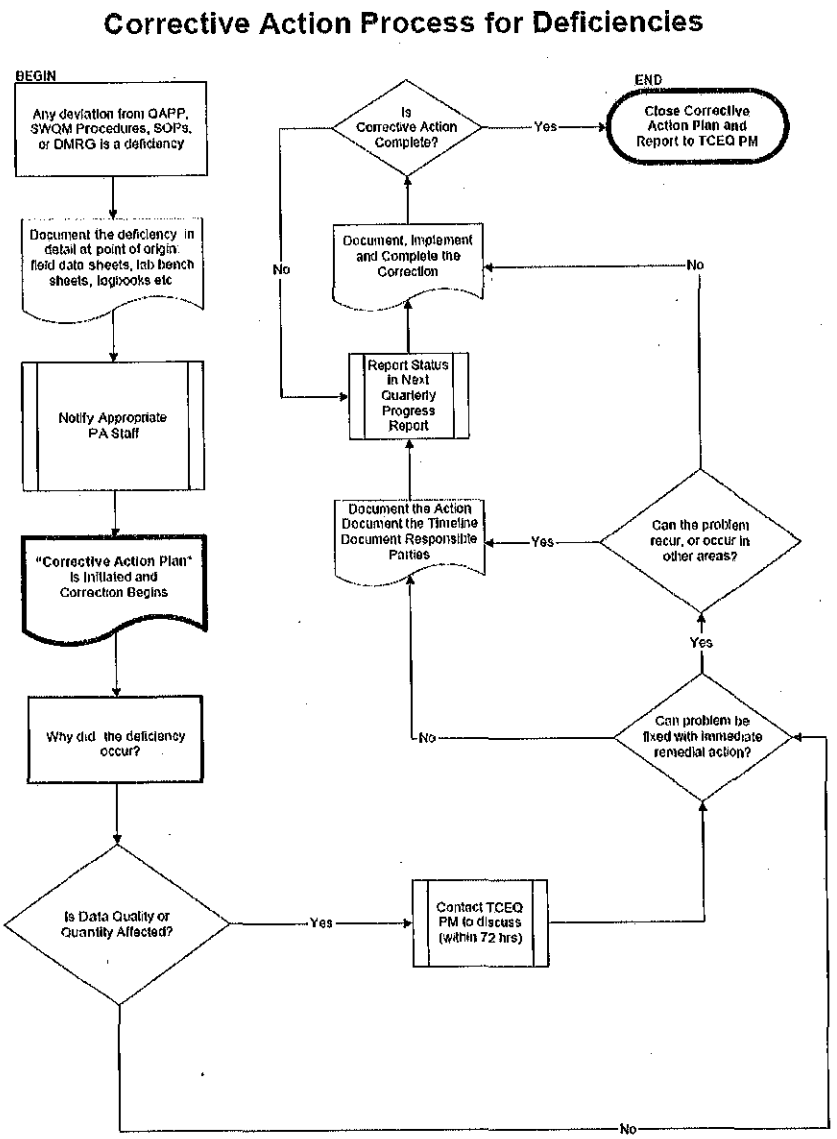
Corrective Action Process for Deficiencies
Deficiencies are any deviation from the QAPP, SWQM Procedures Manual, SOPs, or Data Management Reference Guide. Deficiencies may invalidate resulting data and may require corrective action. Corrective action may include for samples to be discarded and re-collected. Deficiencies are documented in logbooks, field data sheets, etc. by field or laboratory staff. It is the responsibility of the AgriLife Project Manager, in consultation with the AgriLife QAO, to ensure that the actions and resolutions to the problems are documented and that records are maintained in accordance with this QAPP. In addition, these actions and resolutions will be conveyed to the NPS Project Manager both verbally and in writing in the project progress reports and by completion of a corrective action plan (CAP).

Corrective Action
CAPs should:

- Identify the problem, nonconformity, or undesirable situation
- Identify immediate remedial actions if possible
- Identify the underlying cause(s) of the problem
- Identify whether the problem is likely to recur, or occur in other areas
- Evaluate the need for Corrective Action
- Use problem-solving techniques to verify causes, determine solution, and develop an action plan
- Identify personnel responsible for action
- Establish timelines and provide a schedule
- Document the corrective action

To facilitate the process a flow chart has been developed (see figure C1.1: Corrective Action Process for Deficiencies).

Figure C1.1 Corrective Action Process for Deficiencies



Status of CAPs will be documented on the Corrective Action Status Table (See Appendix L) and included with Quarterly Progress Reports. In addition, significant conditions (i.e., situations which, if uncorrected, could have a serious effect on safety or on the validity or integrity of data) will be reported to the TCEQ immediately.

The AgriLife Project Manager is responsible for implementing and tracking corrective actions. Corrective action plans will be documented on the Corrective Action Plan Form (See Appendix M) and submitted, when complete, to the TCEQ Project Manager. Records of audit findings and corrective actions are maintained by both the TCEQ and the AgriLife QAO. Audit reports and corrective action documentation will be submitted to the TCEQ with the Quarterly Progress Report.

If audit findings and corrective actions cannot be resolved, then the authority and responsibility for terminating work are specified in the TCEQ QMP and in agreements in contracts between participating organizations.

C2 Reports to Management

Reports to TCEQ Project Management

All reports detailed in this section are contract deliverables and are transferred to the TCEQ in accordance with contract requirements.

Laboratory data reports- Data will be submitted quarterly to the TCEQ in the event/result format specified in the TCEQ Data Management Reference Guide (DMRG; January 2012 or most recent version) for upload to the Surface Water Quality Monitoring Information System (SWQMIS).

Monitoring Systems Audit Report and Response - Following any audit that is performed, a report of findings, recommendations and response is sent to the TCEQ in the quarterly progress report.

Quarterly Progress Report - Summarizes the Contractor's activities for each task; reports monitoring status, problems, delays, and corrective actions; and outlines the status of each task's deliverables.

Monitoring System Audit Response - The contractor will respond in writing to the TCEQ within 30 days upon receipt of a monitoring system audit report to address corrective actions.

Contractor Evaluation - AgriLife participates in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards.

Final Project Report - Summarizes the Contractor's activities for the entire project period including a description and documentation of major project activities; evaluation of the project results and environmental benefits; and a conclusion.

Reports to Contractor Project Management
Laboratory test reports (Section A9) will be submitted to AgriLife Project Management on a quarterly basis. The laboratory test reports contain QC information which is reviewed by the AgriLife Project Manager/QAO. Project status, assessments and significant QA issues will be dealt with by the Agri-Life Research Project Manager who will determine whether it will be included in reports to the TCEQ Project Management.

Reports by TCEQ Project Management
Contractor Evaluation - The Contractor participates in a Contractor Evaluation by the TCEQ annually for compliance with administrative and programmatic standards. Results of the evaluation are submitted to the TCEQ Financial Administration Division, Procurement and Contracts Section.

D1 Data Review, Verification, and Validation

For the purposes of this document, data verification is a systematic process for evaluating performance and compliance of a set of data to ascertain its completeness, correctness, and consistency using the methods and criteria defined in the QAPP. Validation means those processes taken independently of the data-generation processes to evaluate the technical usability of the verified data with respect to the planned objectives or intention of the project. Additionally, validation can provide a level of overall confidence in the reporting of the data based on the methods used.

All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives which are listed in Section A7. Only those data which are supported by appropriate quality control data and meet the measurement performance specification defined for this project will be considered acceptable and submitted to the TCEQ for entry into SWQMIS.

The procedures for verification and validation of data are described in Section D2, below. The AgriLife Field Supervisor is responsible for ensuring that field data are properly reviewed and verified for integrity. The Laboratory Supervisor is responsible for ensuring that laboratory data are scientifically valid, defensible, of acceptable precision and bias, and reviewed for integrity. The AgriLife Data Manager will be responsible for ensuring that all data are properly reviewed and verified, and submitted in the required format to TCEQ for loading in SWQMIS. The AgriLife QAO is responsible for validating a minimum of 10% of the data produced in each task. Finally, the AgriLife Project Manager, with the concurrence of the AgriLife QAO, is responsible for validating that all data to be reported meet the objectives of the project and are suitable for reporting to TCEQ.

D2 Verification and Validation Methods

All data will be verified to ensure they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to project specifications. The staff and management of the respective field, laboratory, and data management tasks are responsible for the integrity, validation and verification of the data each task generates or handles throughout each process. The field and laboratory tasks ensure the verification of raw data, electronically generated data, and data on chain-of-custody forms and hard copy output from instruments.

Verification, validation and integrity review of data will be performed using self-assessments and peer review, as appropriate to the project task, followed by technical review by the manager of the task. The data to be verified (listed in Table D2.1) are evaluated against project performance specifications (Section A7) and are checked for errors, especially errors in transcription, calculations, and data input. If a question arises or an error is identified, the manager of the task responsible for generating the data is contacted to resolve the issue. Issues which can be corrected are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the task manager consults with the higher level project management to establish the appropriate course of action, or the data associated with the issue are rejected and not reported to the TCEQ for storage in SWQMIS. The performance of these tasks is documented by completion of the Data Review Checklist and Summary (Appendix C).

The AgriLife Project Manager and QAO are each responsible for validating that the verified data are scientifically valid, defensible, of known precision, bias, integrity, meet the data quality objectives of the project, and are reportable to TCEQ. One element of the validation process involves evaluating the data again for anomalies. Any suspected errors or anomalous data must be addressed by the manager of the task associated with the data, before data validation can be completed.

A second element of the validation process is consideration of any findings identified during the monitoring systems audit conducted by the TCEQ QAS assigned to the project. Any issues requiring corrective action must be addressed, and the potential impact of these issues on previously collected data will be assessed. Finally, the AgriLife Project Manager, with the concurrence of the QAO validates that the data meet the data quality objectives of the project and are suitable for reporting to TCEQ.

Table D2.1. Data Verification Procedures

Data to be Verified	Field Task	Laboratory Task	Texas AgriLife Research Data Manager Task
Sample documentation complete; samples labeled, sites identified	Y	Y	
Field QC samples collected for all analytes as prescribed in the TCEQ *SWQM Procedures Manual*	Y		
Standards and reagents traceable	Y	Y	
Chain of custody complete/acceptable	Y	Y	
Sample preservation and handling acceptable	Y	Y	
Holding times not exceeded	Y	Y	
Collection, preparation, and analysis consistent with SOPs and QAPP	Y	Y	Y
Field documentation (e.g., biological, stream habitat) complete	Y		
Instrument calibration data complete	Y	Y	
QC samples analyzed at required frequency	Y	Y	Y
QC results meet performance and program specifications	Y	Y	Y
Analytical sensitivity (Minimum Analytical Levels/Ambient Water Reporting Limits) consistent with QAPP		Y	Y
Results, calculations, transcriptions checked	Y	Y	
Laboratory bench-level review performed		Y	
All laboratory samples analyzed for all parameters		Y	
Corollary data agree	Y	Y	Y
Nonconforming activities documented	Y	Y	Y
Outliers confirmed and documented; reasonableness check performed			Y
Dates formatted correctly			Y
TAG IDs correct			Y
TCEQ ID number assigned			Y
Valid parameter codes			Y
Codes for submitting entity(ies), collecting entity(ies), and monitoring type(s) used correctly			Y
Time based on 24-hour clock			Y
Absence of transcription error confirmed	Y	Y	Y
Absence of electronic errors confirmed	Y	Y	Y
Sampling and analytical data gaps checked (e.g., all sites for which data are reported are on the coordinated monitoring	Y	Y	Y

Data to be Verified	Field Task	Laboratory Task	Texas AgriLife Research Data Manager Task
schedule)			
Field QC results attached to data review checklist			Y
Verified data log submitted			Y
10% of data manually reviewed			Y

D3 Reconciliation with User Requirements

Extension education programs are designed to target specific audiences and to deliver current, unbiased, science-based information and technology. The objective of the evaluation conducted under this QAPP is to provide the Extension education program with unbiased, science-based, quality assured data on the effectiveness of low impact development best management practices for reducing nutrient and sediment contamination of storm water. No other decisions will be made by the project team based on the data collected.

TCEQ seeks quality assured data that establish the difference in pollutant loads entering and leaving each of the experimental BMPs, in order to estimate load reductions that will result from further installation of similar BMPs. For this purpose, the load reduction will be calculated for each pollutant in each BMP by using the following equation for all storm events for the monitoring period:

$$Load\ Reduction = \sum_{i=1}^{n} (V_{inflow\ i} \times C_{inflow\ i} - V_{outflow\ i} \times C_{outflow\ i})$$

n = total number of storms; V = Volume; C= pollutant concentration

For the BMPs with automatic samplers, continuous flow measurement will be acquired, which then is used to calculate the total storm volume for a particular event. Based on the monitoring methods previously described, flow rates and water quality sample measurements will be representative for each storm event.

For BMPs that do not use automatic samplers, a representative portion of the entire storm (Rainwater Harvesting) or the entire storm(green roof) volume will be captured. Grab samples from these would be analyzed for pollutant concentrations. Statistical analysis will be used only for the green roof BMP, as it is the only BMP with a fully replicated experimental design (randomized complete block design), the data from which will be analyzed using a two- way anova.

These data, and data collected by other organizations, may however be subsequently analyzed and used for model development. Thus, data which do not meet project data quality objectives will not be submitted to the TCEQ nor will be considered appropriate for any of the uses noted above.

References

Ampim, P., F. Jaber, J. Sloan, and R. Cabrera 2011. Evaluation of the effectiveness of best management practices for reducing N, P, and sediment losses from cultivated and pasture agricultural lands. A final report on Agricultural NPS Remediation in the Cedar Creek Reservoir Watershed submitted to the Texas State Soil and Water Conservation Board, Section 319(h) NonPoint Source Program. Texas AgriLife Research and Extension, Dallas, Texas.

Dietz, M. 2007. Low Impact Development Practices: A Review of Current Research and Recommendations for Future Directions. *Water, Air and Soil Pollution*, 186(1-4), 351-363.

Standards and Sustainable Sites Initiative, 2007. Standards and Guidelines: Preliminary report. http://www.sustainablesites.org/SustainableSitesInitiative_PreliminaryReport_110107.pdf

Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods, RG-415, August 2012, Austin, TX or most recent version
http://www.tceq.texas.gov/publications/rg/rg-415/index.html

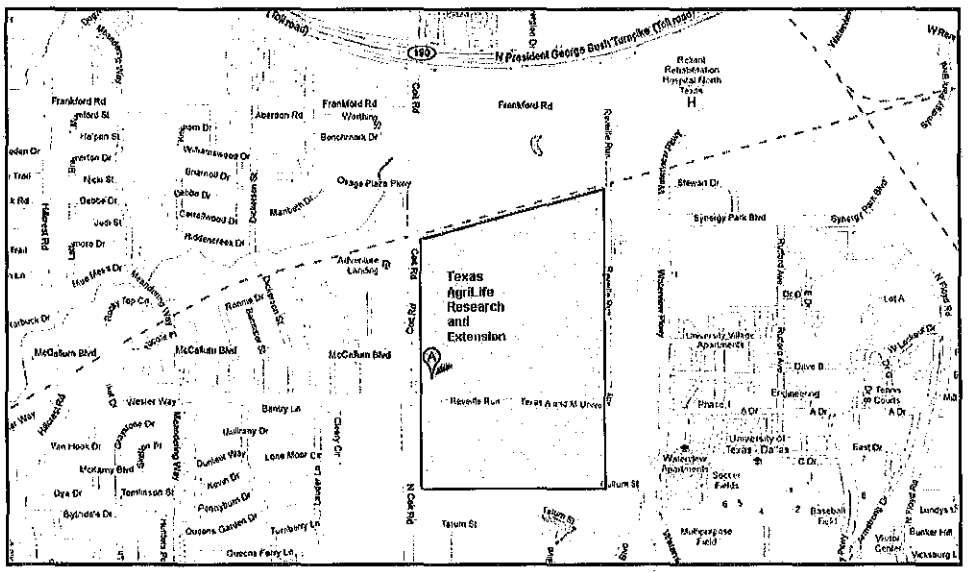
Surface Water Quality Monitoring Data Management Reference Guide (January 2012, or most current version)
http://www.tceq.texas.gov/waterquality/data-management/dmrg_index.html

TCEQ. 2008a. Texas 303(d) list.
http://www.tceq.texas.gov/assets/public/compliance/monops/water/08twqi/2008_303d.pdf

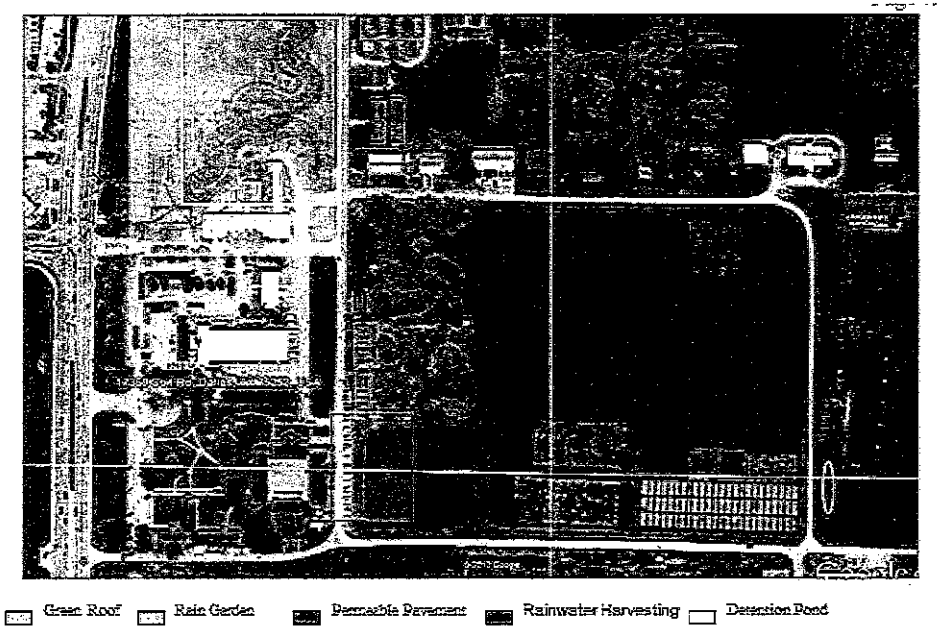
TCEQ. 2008b. Water Bodies with Concerns for Use Attainment and Screening Levels. Texas Water Quality Inventor, 2008.
http://www.tceq.texas.gov/assets/public/compliance/monops/water/08twqi/2008_concerns.pdf

USEPA. 1996. Pointer No. 1: Nonpoint Source Pollution: The Nation's Largest Water Quality Problem. EPA 841-F-96-004A.

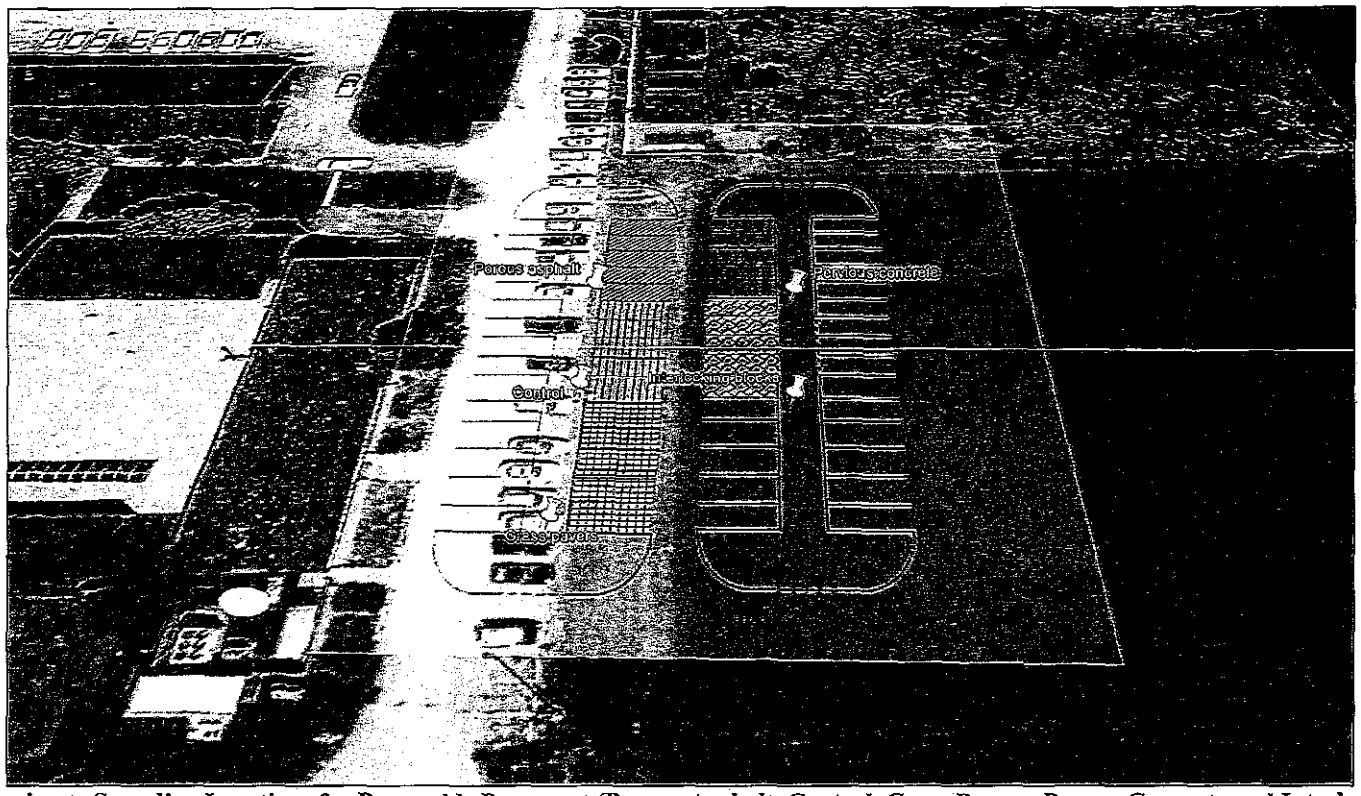
Appendix A. Site map and Diagrams



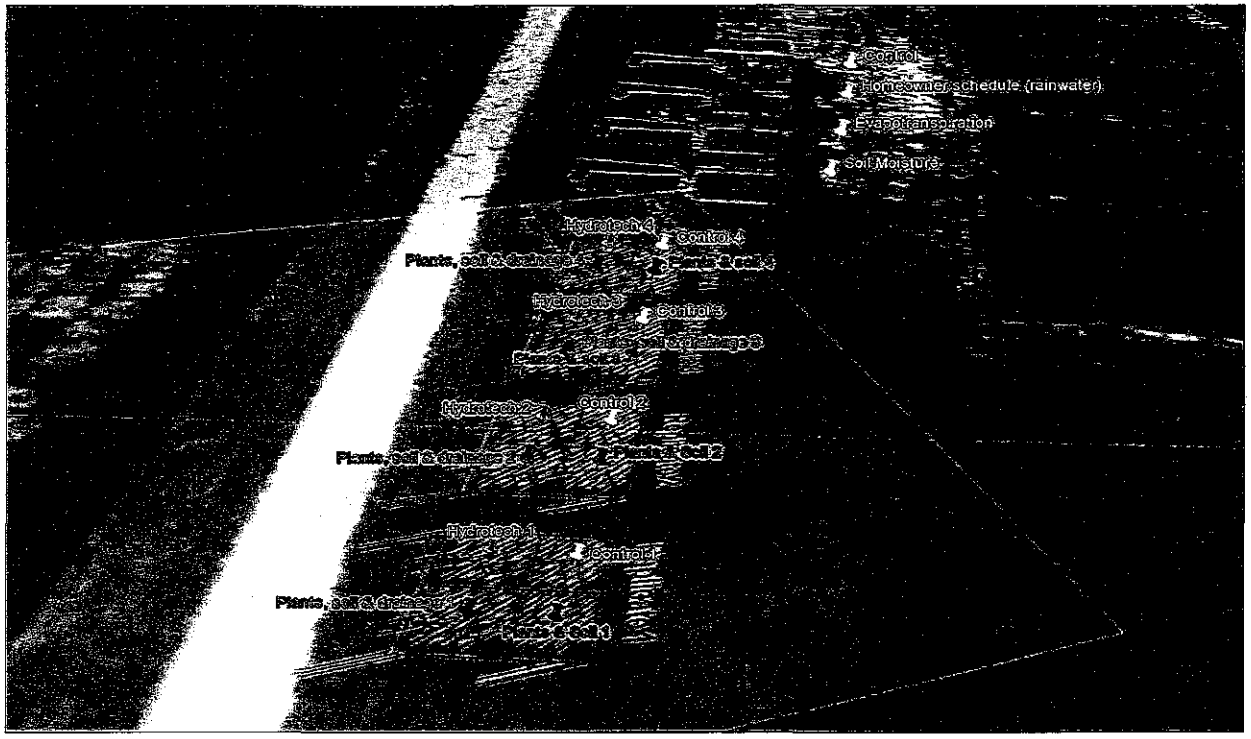
AgriLife (Dallas) Campus Location



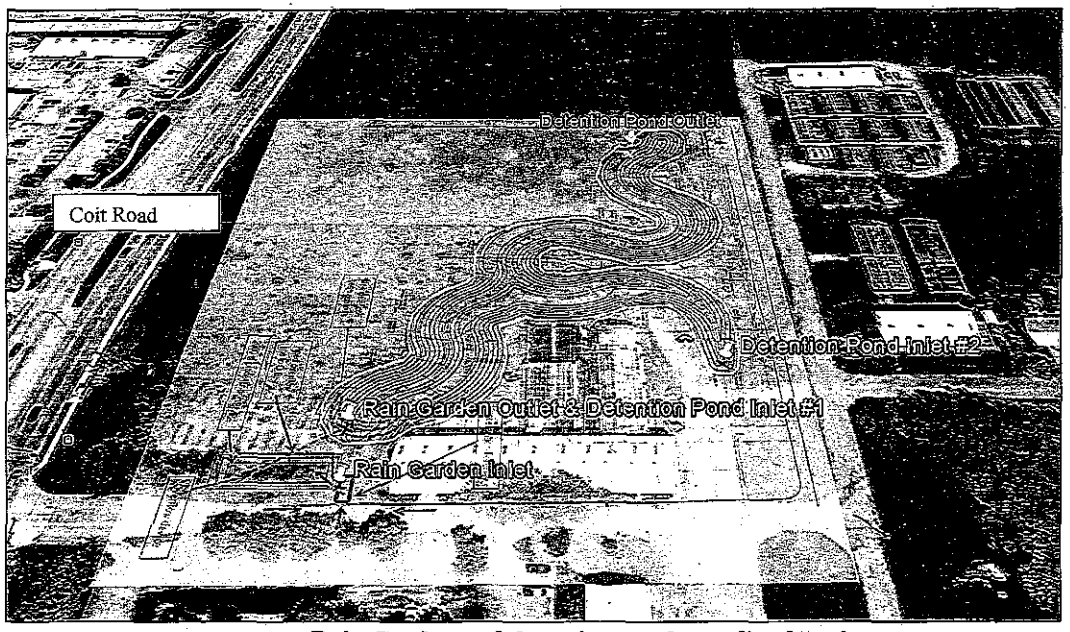
Location of the different BMPs on AgriLife Property



Approximate Sampling Locations for Permeable Pavement (Porous Asphalt, Control, Grass Pavers, Porous Concrete and Interlocking Blocks)



Approximate Sampling Locations for Rainwater Harvesting Plots and Green Roofs



Rain Garden and detention pond sampling locations

Appendix B. Work Plan

SCOPE OF WORK

Tasks, Objectives and Schedules

Task 2:
Construct and evaluate bio-retention low-impact development BMPs

Objective:
To reduce NPS pollution as well as total and peak storm water runoff from selected parking lots and buildings. To accomplish this goal, the AgriLife Urban Solutions Center will design, construct, and evaluate the effectiveness of innovative bio-retention BMPs for stormwater volume and peak flow reduction and water quality improvement in urban areas. In addition to their immediate water quality benefits properties, the bio-retention BMPs will be used to generate engineering data, serve as a long-term demonstration, and as an educational tool to increase implementation of appropriate stormwater BMPs.

Subtask 2.1:
Identification of Locations and Design - The AgriLife Urban Solutions Center will select one or more locations for the bio-retention areas in the Center parking lot to collect and treat the most runoff. The selection will be based on the parking lot design as well as the integration of the BMP into the landscape design to increase its appeal to the general public. The bio-retention areas will be designed to retain 15 inches of per square foot of runoff. The square footage of the bio-retention areas will be designed to retain the first 1.5 inches of rainfall on the catchment area which consists of 5.3 acres of impervious areas and 4.9 acres of green spaces. Only part of this area's runoff will be treated by the bio-retention areas based on the selection criteria stated above.

Subtask 2.2:
Bio-Retention BMP Construction – The AgriLife Urban Solutions Center will subcontract with appropriate companies for excavating and hauling the native soil and replacing it with gravel, and a mixture of high infiltration compost-native soil mixture. Perforated pipes, geotextile, overflow boxes and plant material will be appropriately installed for the optimal operation of the bio-retention area.

Subtask 2.3:
Evaluation - The AgriLife Urban Solutions Center will select appropriate equipment to collect water quality samples, water inflow and outflow, rainfall, and storage data. The equipment will be installed in the bio-retention area. The data will be compiled and summarized on quarterly, seasonal, and annual bases. The monitoring data will be used to quantify total water input (rainfall), output (runoff, and infiltration), storage (soil water storage), and pollutant balances for the bio-retention areas. Progress of the experiment and problems encountered will be described.

Deliverables
The AgriLife Urban Solutions Center will provide draft engineering plans of the bio-retention pond to TCEQ prior to beginning construction activities.
The AgriLife Urban Solutions Center and TCEQ will conduct a conference to discuss the engineering plans prior to beginning construction activities.
The AgriLife Urban Solutions Center will provide TCEQ copies of the final certified engineering plans for the bio-retention pond.
The AgriLife Urban Solutions Center will provide a report that summarizes activities related to construction of the bio-retention pond.

Task 3:
Construct and evaluate permeable pavement LID BMPs

Objective:
To design, construct, and evaluate the effectiveness of innovative permeable pavement BMPs for stormwater volume and peak flow reduction and water quality improvement in urban areas. The demonstration will include several types of porous pavements for comparison as well as water quality monitoring to demonstrate the treatment functions of permeable pavements.

Subtask 3.1:
Identification of Locations and Design - The AgriLife Urban Solutions Center will select thirteen adjacent parking spaces in the Center parking lot for this demonstration. The selection will be based on an average parking traffic on the demonstration location as well as ease of data collection (e.g., adjacent to a parking lot island where equipment can be placed). The design of the demonstration will include sub-grade and sub-base design and perforated pipes as recommended by the literature. The design will include provisions to hydrologically separate the parking spots from each other.

Subtask 3.2:
Permeable Pavement Construction – The AgriLife Urban Solutions Center will subcontract with appropriate companies for excavating and hauling the existing impervious pavement. The sub-grade and sub-base preparation, the batching and mixing of pervious concrete and pervious asphalt as well as the installation will also be subcontracted. Perforated pipes and drainage boxes will be appropriately installed for the optimal operation of the permeable pavement as well as data collection.

Subtask 3.3:
Evaluation - The AgriLife Urban Solutions Center will select appropriate equipment to collect runoff samples from the surface, infiltrate from the perforated pipes and rainfall to demonstrate the efficiency of this BMP and comparing the various types of permeable pavement material. The permeable pavements will be compared to a monitored control impermeable pavement.

Deliverables:

The AgriLife Urban Solutions Center will provide draft engineering plans of the permeable pavement to TCEQ prior to beginning construction activities.
The AgriLife Urban Solutions Center and TCEQ will conduct a conference to discuss the engineering plans prior to beginning construction activities.
The AgriLife Urban Solutions Center will provide TCEQ copies of the final certified engineering plans for the permeable pavement.
Report that summarizes activities related to construction of the permeable pavement.
Tasks, Objectives and Schedules (Replicate or modify table as needed)

Task 4:
Construct and evaluate rainwater harvesting LID BMPs
Objective:
To design, construct, and evaluate the effectiveness of an innovative Rainwater Harvesting System (RHS) BMP. The RHS combined with an effective irrigation system will control the stormwater peak flow and demonstrate water quality improvements in urban areas. The demonstration will also show the expected water quality from rainwater harvested from roofs.

Subtask 4.1:
Rainwater Harvesting System Construction - The AgriLife Urban Solutions Center will construct three RHS at the Center. Each RHS will consist of a catchment area built from a common roof material, a gutter with leaf guard and a downspout, a first flush diverter and a water collection barrel. Each setup would be a small scale representation of an average house in North Central Texas area. The four plots will represent three different irrigation management methods with RHS and a control site without RHS. The three irrigation methods will represent:
Time-based irrigation scheduling
Evapotranspiration (ET) based scheduling
Soil-moisture-based irrigation scheduling.
Irrigation systems will be installed to water emulated lawns. All RHS will be constructed and built by AgriLife staff.

Subtask 4.2:
Evaluation - The AgriLife Urban Solutions Center will select and install equipment to determine tank volume, rainfall amounts, runoff volumes and soil moisture data. The demonstration will show stakeholders the optimum way to use harvested rainwater in order to reduce runoff volumes. It will also provide information on the quality of harvested rainwater.

Deliverables
The AgriLife Urban Solutions Center will provide draft engineering plans of the RHS to TCEQ prior to beginning construction activities.
The AgriLife Urban Solutions Center and TCEQ will conduct a conference to discuss the engineering plans prior to beginning construction activities.
The AgriLife Urban Solutions Center will provide TCEQ copies of the final certified engineering plans for the RHS.

The AgriLife Urban Solutions Center will provide a report that summarizes activities related to construction of the RHS.

Task 5:
Construct and evaluate green roof LID BMPs
Objective:
To install a green roof as a stormwater BMP on a suitable campus building. The demonstration will aim at showing the requirement to install green roofs as well as the effectiveness of green roofs as a stormwater BMP.

Subtask 5.1:
Selection of Location and Design - The AgriLife Urban Solutions Center will select a building on the Center grounds to install a green roof demonstration. The building will be selected based on the roof slope, sun exposure and ease of access. The green roof will be designed to conform to scientifically accepted standards. The roof will be divided into four separate sections to compare four types of growing media that will include different rates of organic material and native soil ratios. Plants will be selected to withstand minimal maintenance.

Subtask 5.2:
Green Roof Construction - The AgriLife Urban Solutions Center will construct a green roof to include a high quality water proofing and root repellant system, a drainage system, filter cloth, a lightweight growing medium and plants. The plants and the soil will be prepared in movable interlocking grids.

Subtask 5.3:
Evaluation - The AgriLife Urban Solutions Center will monitor rainfall, soil storage and runoff on a continuous basis. Water samples will be collected from the runoff to demonstrate the effectiveness of green roofs in removing pollutants.

Deliverables
The AgriLife Urban Solutions Center will provide draft engineering plans of the green roof BMP to TCEQ prior to beginning construction activities.
The AgriLife Urban Solutions Center and TCEQ will conduct a conference to discuss the engineering plans prior to beginning construction activities.
The AgriLife Urban Solutions Center will provide TCEQ copies of the final certified engineering plans for the green roof BMP.
The AgriLife Urban Solutions Center will provide a report that summarizes activities related to construction of the green roof BMP.

Task 6:
Construct and evaluate detention pond LID BMPs
Objective:

To construct a large detention pond to collect, retain and treat runoff from parking lots at the Center. The scale of the pond will provide a demonstration for housing communities. The design as well as the management of the pond will be part of the educational purpose of this BMP.

Subtask 6.1:
Selection of Location and Design - The AgriLife Urban Solutions Center will select the best location to collect the most runoff based on surveys and watershed delineation. The pond will be designed to retain 1.5 inches of runoff. The pond will be designed to encourage bank vegetation to reduce erosion as well as act as filter strips. The width to length ratio will also be taken into consideration to maximize sediment retention and nutrient intake.

Subtask 6.2:
Detention Pond Construction - The AgriLife Urban Solutions Center will subcontract with an engineering firm to construct a detention pond to fulfill the design requirements listed in Task 6.1

Subtask 6.3:
Evaluation - The AgriLife Urban Solutions Center will continuously monitor the inflow, outflow and storage of the pond. Water samples will be collected regularly to demonstrate the effectiveness of the BMP. Appropriate equipment will be selected and installed for this purpose.

Deliverables:
The AgriLife Urban Solutions Center will provide draft engineering plans of the detention pond to TCEQ prior to beginning construction activities.
The AgriLife Urban Solutions Center and TCEQ will conduct a conference to discuss the engineering plans prior to beginning construction activities.
The AgriLife Urban Solutions Center will provide TCEQ copies of the final certified engineering plans for the detention pond.
The AgriLife Urban Solutions Center will provide hydrologic and water quality data collection, compilation and analysis reports.
The AgriLife Urban Solutions Center will provide a report that summarizes activities related to construction and hydrologic data of the detention pond.

Task 8:
Collect water quality/quantity engineering data
Objective:
To collect engineering data needed to document the effectiveness of and model the performance of the BMPs in improving stormwater quality and reducing its total and peak flows

Subtask 8.1:
Data Quality Objectives - The AgriLife Urban Solutions Center will develop data quality objectives which will clarify the purpose of the monitoring and/or modeling study, define the

most appropriate type of data to collect, and help determine the most appropriate methods and conditions under which to collect them.

Subtask 8.2:

Conduct a Data Review – The AgriLife Urban Solutions Center will conduct a data review to identify data gaps, and to determine the types of data needed to achieve the data quality objectives.

Subtask 8.3:

Develop a Water Quality Monitoring Plan – The AgriLife Urban Solutions Center will summarize the specific objectives of the project's monitoring effort interpretation to be used in the project, and determine preliminary locations, times and other details of planned monitoring activities. The monitoring plan will demonstrate how the planned activities support the data quality objectives.

Deliverables

The AgriLife Urban Solutions Center will provide a Draft and Final Sampling Plan, including DQOs and data review.

Task 9:

Develop Quality Assurance Project Plan

Subtask 9.1:

QAPP Planning Meetings – The AgriLife Urban Solutions Center will schedule QAPP planning meetings with the TCEQ Project Manager, Quality Assurance staff, technical staff, management, and contractors, to implement a systematic planning process, based on the elements of the TCEQ NPS QAPP Shell. The information developed during the planning meetings will be incorporated into a QAPP. Additional planning meetings may also be conducted to determine if any changes need to be made to an existing QAPP.

Subtask 9.2:

QAPP for Monitoring – The AgriLife Urban Solutions Center will develop and submit to the TCEQ a QAPP with project specific data quality objectives consistent with the *EPA Requirements for Quality Assurance Project Plans (QA/R5)* format and the TCEQ NPS QAPP Shell 120 days prior to the initiation of any data collection. All of the monitoring procedures and methods prescribed in the QAPP will be consistent with the guidelines detailed in the TCEQ Surface Water Quality Monitoring Procedures, Volume 1 and 2. The QAPP will be developed by the AgriLife Urban Solutions Center with technical assistance from the TCEQ Project Manager, Quality Assurance staff, technical staff, management, and contractors. The QAPP will be approved by the TCEQ.

Subtask 9.3:

Data Collection - The AgriLife Urban Solutions Center will develop a monitoring program and conduct monitoring, as outlined in the QAPP, to achieve data quality objectives.

Subtask 9.4:
QAPP Update – The AgriLife Urban Solutions Center will provide input annually throughout the project period and will provide input to TCEQ 60 days prior to the end of the effective period of the QAPP. The AgriLife Urban Solutions Center will develop annual QAPP revisions no less than 45 days prior to the end of the effective period of the QAPP.

Subtask 9.5:
QAPP Amendments - The AgriLife Urban Solutions Center will document amendments to the QAPP and the reasons for the changes and revised pages will be forwarded-to all persons on the QAPP distribution list by the Contractor Quality Assurance Officer. Amendments shall be reviewed, approved, and incorporated into a revised QAPP during the annual revision process or within 120 days of the initial approval in cases of significant changes.

Subtask 9.6
Data Submittals - The AgriLife Urban Solutions Center will review, verify, and validate water quality monitoring data before it is submitted to the TCEQ. Data will be submitted to TCEQ quarterly and at least 1 month prior to use, or prior to presenting to stakeholders. A semi-annual report of water quality data consistent with TCEQ formatting requirements will be submitted for upload into the Surface Water Quality Monitoring Information System (SWQMIS).

Deliverables:
- QAPP Planning Meeting
- Draft and Final QAPP
- Draft and Final QAPP Annual Updates
- Draft and Final QAPP Amendments
- Data Submittals
- Water quality monitoring non-conformances will be reported to TCEQ Project Manager and included in quarterly progress reports.

EXHIBIT A

SCHEDULE OF DELIVERABLES

Task	Deliverable	Original Due Date	Amended Due Date
01.2.01	QPR	6/15/2010	6/15/2010
01.2.02	QPR	9/15/2010	9/15/2010
01.2.03	QPR	12/15/2010	12/15/2010
01.2.04	QPR	3/15/2011	3/15/2011
01.2.05	QPR	6/15/2011	6/15/2011
01.2.06	QPR	9/15/2011	9/15/2011
01.2.07	QPR	12/15/2011	12/15/2011
01.2.08	QPR	3/15/2012	3/15/2012
01.2.09	QPR	6/15/2012	6/15/2012

Task	Deliverable	Original Due Date	Amended Due Date
01.2.10	QPR	8/15/2012	9/15/2012
01.2.11	QPR		12/15/2012
01.2.12	QPR		3/15/2013
01.3.01	Invoice	6/30/2010	6/30/2010
01.3.02	Invoice	9/30/2010	9/30/2010
01.3.03	Invoice	12/31/2010	12/31/2010
01.3.04	Invoice	3/31/2011	3/31/2011
01.3.05	Invoice	6/30/2011	6/30/2011
01.3.06	Invoice	9/30/2011	9/30/2011
01.3.07	Invoice	12/30/2011	12/30/2011
01.3.08	Invoice	3/31/2012	3/31/2012
01.3.09	Invoice	6/30/2012	6/30/2012
01.3.10	Invoice	7/30/2012	9/30/2012
01.3.11	Invoice	8/31/2012	12/30/2013
01.3.12	Invoice	9/30/2012	1/31/2013
01.3.13	Invoice		2/28/2013
01.3.14	Invoice		3/31/2013
01.4.1	Post Award Meeting Notes (6/3/10 at TAMU)	7/11/2010	10/15/2010
01.4.2	Quarterly Conference Call with TCEQ (Notes)	10/31/2010	10/31/2010
01.4.3	Quarterly Conference Call with TCEQ (Notes)	1/31/2011	1/31/2011
01.4.4	Quarterly Conference Call with TCEQ (Notes)	4/30/2011	4/30/2011
01.4.5	Quarterly Conference Call with TCEQ (Notes)	7/31/2011	7/31/2011
01.4.6	Quarterly Conference Call with TCEQ (Notes)		10/31/2011
01.4.7	Quarterly Conference Call with TCEQ (Notes)		1/31/2012
01.4.8	Quarterly Conference Call with TCEQ (Notes)		4/30/2012
01.4.9	Quarterly Conference Call with TCEQ (Notes)		7/31/2012
01.4.10	Quarterly Conference Call with TCEQ (Notes)		10/31/2012
01.4.11	Quarterly Conference Call with TCEQ (Notes)		1/31/2013
01.5.1	Response to Contractor Evaluation	9/30/2011	9/30/2011
01.5.2	Response to Contractor Evaluation		9/30/2012
01.5.3	Response to Final Contractor Evaluation		4/30/2013
01.6.1	Project Fact Sheet - original	7/11/2010	7/11/2010
01.6.2	Project Fact Sheet - update	8/15/2011	8/15/2011
01.6.3	Project Fact Sheet – update		8/15/2012
01.6.4	Project Fact Sheet – final		3/15/2013
01.7.1	Annual Report Article	9/15/2010	9/15/2010
01.7.2	Annual Report Article	8/15/2011	8/15/2011
01.7.3	Annual Report Article		8/15/2012
01.7.4	Annual Report Article – final		3/1/2013
02.1.1	Bioretention Draft Engineering Plan	10/15/2010	1/15/2011
02.2.1	Bioretention Engineering Conference Notes	11/15/2010	11/15/2010
02.3.1	Bioretention Final Engineering Plan	1/15/2011	3/15/2010

Task	Deliverable	Original Due Date	Amended Due Date
02.4.1	Bioretention Summary Report/As-Built Plan	5/15/2011	5/15/2011
03.1.1	Permeable Pavement Draft Engineering Report	10/15/2010	1/15/2011
03.2.1	Permeable Pavement Engineering Conf Notes	11/15/2010	11/15/2010
03.3.1	Permeable Pavement Final Engineering Plan	1/15/2011	3/15/2010
03.4.1	Permeable Pavement Summary/As-Built Plan	5/15/2011	5/15/2011
04.1.1	Rainwater Harvest Draft Engineering Plan	10/15/2010	1/15/2011
04.2.1	Rainwater Harvest Engineering Conf Notes	11/15/2010	11/15/2010
04.3.1	Rainwater Harvest Final Engineering Report	1/15/2011	3/15/2010
04.4.1	Rainwater Harvest Summary/As-Built Plans	5/15/2011	5/15/2011
05.1.1	Green Roofs Draft Engineering Plan	10/15/2010	1/15/2011
05.2.1	Green Roofs Engineering Conference Notes	11/15/2010	11/15/2010
05.3.1	Green Roofs Final Engineering Report	1/15/2011	3/15/2010
05.4.1	Green Roofs Summary Report/As-Built Plans	5/15/2011	5/15/2011
06.1.1	Detention Pond Draft Engineering Plan	10/15/2010	1/15/2011
06.2.1	Detention Pond Engineering Conf Notes	11/15/2010	11/15/2010
06.3.1	Detention Pond Final Engineering Report	1/15/2011	3/15/2010
06.4.1	Detention Pond Summary/As-Built Plans	5/15/2011	5/15/2011
07.1.1	Electronic Copies of Training Materials	12/31/2010	3/31/2011
07.1.2	Training Event Documentation	8/31/2011	11/31/2011
07.1.3	Training Event Schedule	12/31/2010	3/31/2011
07.2.1	Stormwater BMP Website Initiated	11/30/2010	1/31/2011
07.2.2	Stormwater BMP Website Final Update	8/15/2011	8/15/2011
07.3.1	Training Survey Instrument & Plan	11/30/2010	1/31/2011
07.3.2	Documentation of Survey Results	8/15/2011	11/15/2011
08.1.1	WQ Monitoring Plan to include DQOs and a Data Review	7/31/2010	7/31/2010
09.1.1	QAPP Planning Meeting (6/15/10 at TAMU)	7/31/2010	10/31/2010
09.2.1	Draft QAPP	8/10/2010	10/31/2010
09.3.1	Final QAPP	9/10/2010	11/31/2010
09.4.1	Final QAPP Updates	TBD	TBD
09.5.1	Final QAPP Amendments	TBD	TBD
09.6.1	Data Submittal	12/15/2010	12/15/2010
09.6.2	Data Submittal	3/15/2011	3/15/2011
09.6.3	Data Submittal	6/15/2011	6/15/2011
09.6.4	Data Submittal	9/15/2011	9/15/2011
09.6.5	Data Submittal	12/15/2011	12/15/2011
09.6.6	Data Submittal	3/15/2012	3/15/2012
09.6.7	Data Submittal	6/15/2012	6/15/2012
09.6.8	Data Submittal	9/15/2012	9/15/2012
09.6.9	Data Submittal		12/15/2012
09.6.10	Data Submittal		3/15/2013
10.1.1	Draft Report	7/15/2012	2/15/2013
10.1.2	Final Report	8/15/2012	3/15/2013

Appendix C. Data Review Checklist and Summary

NPS DATA REVIEW CHECKLIST AND SUMMARY

Field Code Changed

A completed checklist must accompany all data sets submitted to the TCEQ by the Contractor.

QAPP Title: _____

Field Code Changed

Effective Date of QAPP: _____

Data Format and Structure		**Y, N, or N/A**
A.	Are there any duplicate *Tag Id* numbers in the Events file?	
B.	Do the *Tag* prefixes correctly represent the entity providing the data?	
C.	Have any *Tag Id* numbers been used in previous data submissions?	
D.	Are TCEQ station location (SLOC) numbers assigned?	
E.	Are sampling *Dates* in the correct format, MM/DD/YYYY with leading zeros?	
F.	Are the sampling *Times* based on the 24 hour clock (e.g. 13:04) with leading zeros?	
G.	Is the *Comment* field filled in where appropriate (e.g. unusual occurrence, sampling problems, unrepresentative of ambient water quality)?	
H.	*Submitting Entity, Collecting Entity, and Monitoring Type* codes used correctly?	
I.	Are the sampling dates in the *Results* file the same as the one in the *Events* file for each Tag Id?	
J.	Are values represented by a valid parameter code with the correct units?	
K.	Are there any duplicate parameter codes for the same *Tag Id*?	
L.	Are there any invalid symbols in the *Greater Than/Less Than* (*GT/LT*) field?	
M.	Are there any *Tag Ids* in the *Results* file that are not in the *Events* file or vice versa?	
Data Quality Review		**Y, N, or N/A**
A.	Are all the "less-than" values reported at the LOQ? **If no, explain on next page.**	
B.	Have the outliers been verified and a "1" placed in the *Verify_flg* field?	
C.	Have checks on correctness of analysis or data reasonableness been performed? e.g.: Is ortho-phosphorus less than total phosphorus? Are dissolved metal concentrations less than or equal to total metals?	
D.	Have at least 10% of the data in the data set been reviewed against the field and laboratory data sheets?	
E.	Are all parameter codes in the data set listed in the QAPP?	
F.	Are all stations in the data set listed in the QAPP?	
Documentation Review		**Y, N, or N/A**
A.	Are blank results acceptable as specified in the QAPP?	
B.	Were control charts used to determine the acceptability of field duplicates?	
C.	Was documentation of any unusual occurrences that may affect water quality included in the *Event* table's *Comments* field?	
D.	Were there any failures in sampling methods and/or deviations from sample design requirements that resulted in unreportable data? **If yes, explain on next page.**	
E.	Were there any failures in field and/or laboratory measurement systems that were not resolvable and resulted in unreportable data? **If yes, explain on next page.**	
F.	Was the laboratory's NELAC Accreditation current for analysis conducted?	

Data Set Information

Data Source:

Date Submitted:

Tag_ID Range:

Date Range:

Comments:

Please explain in the space below any data discrepancies discovered during data review including:

- Inconsistencies with AWRL specifications or LOQs
- Failures in sampling methods and/or laboratory procedures that resulted in data that could not be reported to the TCEQ
- Include completed Corrective Action Reports with the applicable Progress Report

_____
_____
_____
_____
_____
_____
_____
_____

□ I certify that all data in this data set meets the requirements specified in Texas Water Code Chapter 5, Subchapter R (TWC §5.801 et seq) and Title 30 Texas Administrative Code Chapter 25, Subchapters A & B.

□ This data set has been reviewed using the Data Review Checklist.

AgriLife Data Manager:

Date:

Appendix D. Automated Sampler SOP

ISCO 6712 Field SOP

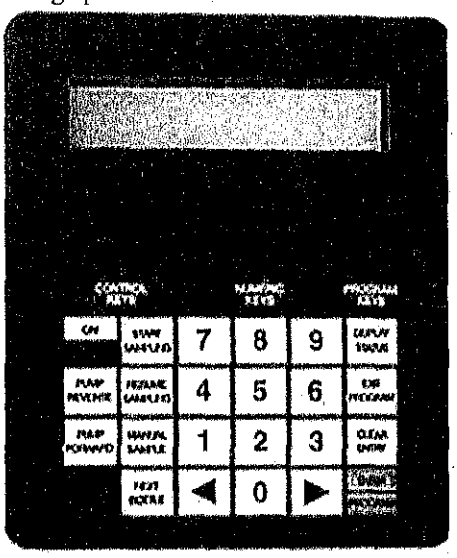
The ISCO 3700 automatic sampler is a portable programmable liquid sampler. The sampler can be set in a flow based sample collection mode, the triggers for which will be determined after the initial few storm events during the sampling period. The sampler is set to hold 24 wide mouthed polypropylene bottles of 1000 ml each for composite or discrete sampling.

Procedure:
The equipment will be configured and programmed according to the manufacturer's guidelines. The following is the SOP for obtaining samples from the ISCO 6712 after a rain event.

Take to the field:

Empty ISCO bottles in bases
ISCO bottles lids
ISCO base lids
Scoop for emptying the stilling wells
Stilling well sample bottles (1/2 liter Nalgene)
Gloves

Use this ISCO button interface graphic as reference:



1. Important note: Do NOT step in the flumes!
2. When you get to a plot, use the 3 black rubbery hooks to unlatch the top of the ISCO from the base. This will open to the control panel part.
3. The screen should read:

```
SAMPLER INHIBITED!
10:35        20-JUN-04
```

4. If there is a flashing star after the date, that means the sampler collected samples. If there is not a star, close the lid back up, and move on to the next plot. If there is a star, continue with the directions.
5. Press the "Display Status" button.
6. With "Review" flashing, press the "Enter" button.

```
[REVIEW, PRINT]
PROGRAM INFORMATION
```

7. Press the right arrow button twice so that "Results" in flashing. Press the "Enter" button.

```
PRINT PROGRAM [NO,
SETTINGS, RESULTS]
```

8. The first few screens will tell you about the program that is running: When it was started and the volume of the samples. Use the right arrow button to scroll though these screens.
9. As you scroll through (using the right arrow button), the sample times will show up. Record the following things:
   a. Bottle number
   b. Date sampled
   c. Time sampled
   d. The date you collected the samples
10. You can use the Chain Of Custody (COC) form, or use your own form and then transcribe the data onto a clean COC form.
11. The Sample ID is done in the form:
    Plot letter Event Number – Bottle Number
    (for example, plot E, event 18, bottle 3 would be E18-3)
12. In the third column of the COC, three timestamps should be listed per line.
13. Also in the COC, the "retrieval date" is the date when you collected the samples from the field, and the "collection date" is when the ISCO actually sucked the water up (the date on the ISCO screen).
14. When you're done downloading (writing down) the data from the ISCO screen, the last screen will look like this:

```
REVIEW PROGRAM [NO,
SETTINGS, RESULTS]
```

15. With "No" flashing, press the "Enter" button.
16. Now press the "Stop" button.
17. Press the "Start Sampling" button.
18. With "Start" flashing, press the "Enter" button.
19. The next screen will ask at which bottle to start. Bottle 1 should already be there, so press the "Enter" button.

```
START SAMPLING
BOTTLE  1  (1-24)
```

20. Replace the lid of the top of the ISCO, and fasten with the black rubbery hooks.
21. Unfasten the 3 metal hooks farther down the ISCO.

22. Take the top of the ISCO off and set it aside. Be careful of the many wires that are attached to the different parts of the machine. Also, try not to set it down in a really muddy place.
23. Cap all of the bottles in the ISCO base, and label them by number.
24. Remove the base from the concrete pad, and place a new base in its place.
25. Replace the top section of the ISCO, and fasten the metal hooks back.
26. If you want, you can use the lids to the ISCO bases for easier transport back to the car. They have handles that are easier to hold.
27. Stir the water in the stilling well around to get the sediments back into suspension. Take a sample in a labeled bottle.
28. Clean out the stilling wells by bailing out the water with the scoop. When you get to the end, pull the plug out and let the remaining water drain out. Be sure to put the cork back in.
29. Take the samples back to the lab for preservation and packaging to be sent out to the NELAC lab.

References:

Teledyne ISCO, 2010, *6712 Portable Automatic Sampler Instruction Manual*, Lincoln, NE

Appendix E. Field Data Reporting Form

Upper Trinity Watershed Green Building Infrastructure for Stormwater Management

AgriLIFE RESEARCH & EXTENSION
Texas A&M System

FIELD DATA SHEET

Date: _____ Collected by: _____ Rain event #_____ Inches: _____ Air Temperature: _____

Permeable Pavement

Treatment	# Bottles Collected	Remarks
Porous concrete		
Interlocking pavers		
Grass Pavers		
Porous Asphalt		
Impervious Concrete		

Rain Garden

Sampling location	# Bottles collected	Remarks
Inflow		
Outflow		

Detention Pond

Sampling location	# Bottles collected	Remarks
Inflow		
Outflow		

Upper Trinity Watershed Green Building Infrastructure for Stormwater Management

AgriLIFE RESEARCH & EXTENSION
Texas A&M System

FIELD DATA SHEET

Date: _____ Collected by: _____ Rain event #_____ Inches: _____ Air Temperature: _____

RAINWATER HARVESTING

Experimental plots

Plot ID	Water meter reading	Grab sample collection		Remarks
P1		Y	N	
P2		Y	N	
P3		Y	N	
P4		Y	N	

Rainwater Barrels

Barrel type	Water meter reading	Remarks
300 L		
500 L		
1500 L		
2500 L		

Upper Trinity Watershed Green Building Infrastructure for Stormwater Management

AgriLIFE RESEARCH & EXTENSION
Texas A&M System

FIELD DATA SHEET

GREEN ROOF

Treatment	Replicate	Grab sample collected		Remarks
T 1	R 1	Y	N	
T 1	R 2	Y	N	
T 1	R 3	Y	N	
T 1	R 4	Y	N	
T 2	R 1	Y	N	
T 2	R 2	Y	N	
T 2	R 3	Y	N	
T 2	R 4	Y	N	
T 3	R 1	Y	N	
T 3	R 2	Y	N	
T 3	R 3	Y	N	
T 3	R 4	Y	N	
T 4	R 1	Y	N	
T 4	R 2	Y	N	
T 4	R 3	Y	N	
T 4	R 4	Y	N	

Appendix F. Chain-of-Custody Form

Chain-of-Custody Form (COC)

Upper Trinity Watershed Green Building Infrastructure for Stormwater Management

Texas AgriLife Research , 17360 Coit Road, Dallas, TX 75252, Phone: 972-952-9260

(Permeable Pavement/Rain Garden/Detention Pond)

Plot ID_____ Retrieval Date_____ Rainfall Event # _____ Collected by_____

Sample ID	Collection Date	Time of Collection

Relinquished By----------Date----------Time----------

Received By----------Date----------Time ----------

Relinquished By----------Date----------Time ----------

Received By----------Date---------- Time ----------

Chain-of-Custody Form (COC)

Upper Trinity Watershed Green Building Infrastructure for Stormwater Management

Texas AgriLife Research , 17360 Coit Road, Dallas, TX 75252, Phone: 972-952-9260

(Rainwater Harvesting/Green Roof)

Retrieval Date_____ Rainfall Event # _____Collected by_____

Plot ID	Sample ID	Collection Date	Time of Collection

Plot ID	Sample ID	Collection Date	Time of Collection

Plot ID	Sample ID	Collection Date	Time of Collection

Plot ID	Sample ID	Collection Date	Time of Collection

Relinquished By----------Date----------Time----------

Received By----------Date----------Time ----------

Relinquished By----------Date----------Time ----------

Received By----------Date---------- Time ----------

Field Code Changed

Appendix G. Automated Sampler Testing and Maintenance Requirements

Obtained from manufacturer's website:
http://www.isco.com/products/manuals1.asp?PL=201&GP=20110

Appendix H. Automated Sampler Testing and Calibration Requirements

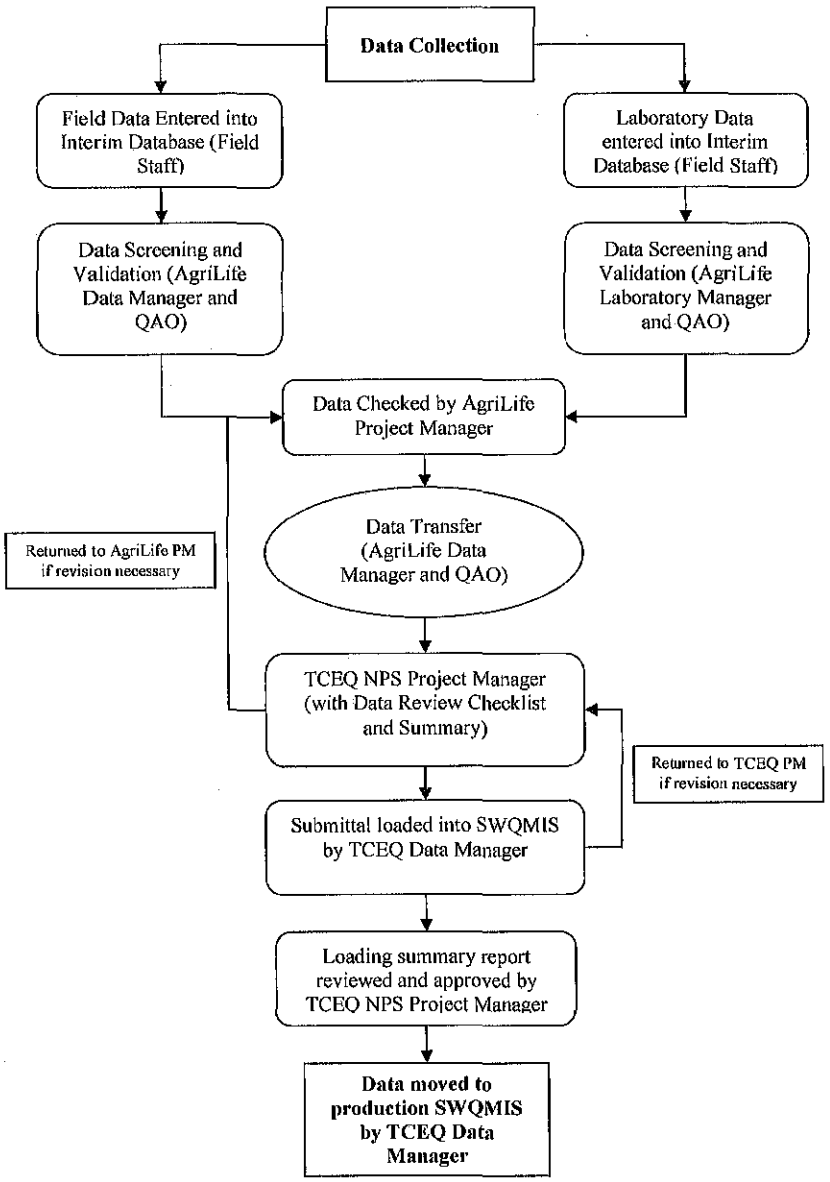
Obtained from manufacturer's website:
http://www.isco.com/products/manuals1.asp?PL=201&GP=20110

Appendix I. Field and Laboratory Data Sheets

All documentation from TTI labs Arlington, TX provided as separate PDF file

Appendix J. Data Management Flow Chart

Draft NPS Data Management Process Flow Chart



Appendix K. Corrective Action Status Table

Appendix K - Corrective Action Status Table

Corrective Action #	Date Issued	Description of Deficiency	Action Taken	Date Closed

Appendix L. Corrective Action Plan Form

Appendix L - Corrective Action Plan Form

Corrective Action Plan
Issued by:_____ **Date Issued**_____ **Report No.**_____
Description of deficiency
Root Cause of deficiency
Programmatic Impact of deficiency
Does the seriousness of the deficiency require immediate reporting to the TCEQ? If so, when was it?
Corrective Action to address the deficiency and prevent its recurrence
Proposed Completion Date for Each Action
Individual(s) Responsible for Each Action
Method of Verification
Date Corrective Action Plan Closed?

Appendix M. Example Letter to Document Adherence to QAPP

APPENDIX M
Example Letter to Document Adherence to the QAPP

TO: (name)
(organization)

FROM: (name)
(organization)

RE: Texas AgriLife Research and Extension, Upper Trinity Watershed Green Building Infrastructure for Storm Water Management

Please sign and return this form by (date) to:

(address)

I acknowledge receipt of the "Upper Trinity Watershed Green Building Infrastructure for Storm Water Management , Revision Date". I understand that the document describes quality assurance, quality control, data management and reporting, and other technical activities that must be implemented to ensure the results of work performed will satisfy stated performance criteria.

My signature on this document signifies that I have read and approved the document contents. Furthermore, I will ensure that all staff members participating in activities covered under this QAPP will be required to familiarize themselves with the document contents and adhere to the contents as well.

Signature Date

Copies of the signed forms should be sent by the Contractor to the TCEQ NPS Project Manager within 60 days of TCEQ approval of the QAPP.