Agricultural Best Management Practice (BMP) Evaluation

Evaluating and Practicing Innovative Conservation (EPIC) Project

Final Project Report

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1 Introduction

1.1 Project Background

The Evaluating and Practicing Innovative Conservation (EPIC) project, was developed by the Environmental Resources Coalition (ERC), a 501(c)3 non-profit corporation located in Jefferson City Missouri. This project was funded by the U.S. Department of Agriculture (USDA-NRCS) Conservation Innovative Grant (CIG) – NRCS 69-3A75-9-136. Matching funds for this project were generously provided by the Missouri Corn Growers Association (MCGA) and the Missouri Corn Merchandising Council (MCMC).

The EPIC project was a three year (2010-2012) project, composed of two primary components: the Agricultural Best Management Practices (BMP) Evaluation component, and the Environmental Trading Program Development component. The Agricultural Best Management Practices (BMP) Evaluation component will be detailed in this report. The information and deliverables from the Environmental Trading Program Development component are provided as separate deliverables. All deliverables and project products are posted to our project website located on ERC's web site (www.erc-env.org).

The Environmental Resources Coalition (ERC) was the lead organization for the Agricultural BMP Evaluation portion of this project. Other project partners for this grant component include the U.S. Department of Agricultural-Agricultural Research Service (USDA-ARS) Cropping Systems and Water Quality Research Unit, University of Missouri Columbia; University of Missouri Extension and Geosyntec Consultants. Laboratory work was conducted by U.S. Department of Agricultural-Agricultural Research Service (USDA-ARS) Cropping Systems and Water Quality Research Unit and by the University of Missouri Soil and Plant Testing Laboratory. Data quality assurance and compilation, data analyses and interpretation for this project report were completed by ERC.

1.2 Purpose

In 2009 the U.S. Environmental Protection Agency (EPA) National Water Quality Inventory reported that 44 percent of all river miles and 64 percent of lake and reservoirs in the nation are impaired (US EPA, 2009). This report further identifies that excessive nutrients as the leading cause of impairment in lakes and, behind siltation, the second leading cause of impairment in rivers. EPA has listed agricultural nonpoint source as one of the predominant causes of the nutrient enrichment of these waterbodies. Omernik (1977) reported that nutrients (specifically nitrogen) were nine times greater downstream from agricultural lands than from forested land. In his national assessment, he identified the highest concentration of nutrients in streams in the Corn Belt states of the Midwest.

Nutrient enrichment is of a particular concern for our coastal waters; it has contributed to eutrophication and degradation of marine ecosystems and estuaries on a global scale (NRC, 2000). This has resulted in the development of one of the world's largest hypoxic zone, an area of low dissolved oxygen (<2.0 mg/L) largely devoid of marine life, in the northern Gulf of Mexico (Rabalais et al. 2002, 2007). The Mississippi and Atchafalaya rivers supply about 80 percent of the freshwater discharge to the Gulf of Mexico and about 90 percent of the total nitrogen load (Dunn 1996). Nitrogen, along with other nutrients, lead to increased production of algae and have been implicated as the leading cause of hypoxia in the Northern Gulf. The size of the hypoxic zone is related to the nutrient flux (or load) of nutrients entering the Gulf (Turner and Rabalais, 1991, 1994; Goolsby et al., 1999).

The U.S. Geological Survey recently modeled nutrient flux, yield, and concentration in the Mississippi River basin using the SPARROW model (Spatially Referenced Regressions on Watershed attributes). Model outputs include total nutrient load (both flux and transport), delivered load, concentration, and nutrient sinks (i.e. land, stream, and reservoirs). Nutrient loads were calculated by estimating sources, land-to-water transport, and aquatic transport and uncertainty measures. Out of the 31 states in the Mississippi River basin, Missouri is listed as one of the nine states that reportedly contribute 75 percent of the total nitrogen and phosphorus loading to the Gulf (Goolsby et al., 1999). In addition, the USGS has demonstrated that increasing growth of the hypoxic zone. The eutrophication of the Gulf of Mexico is correlated with the growth in fertilizer usage beginning in the 1950s. Without reduction in nutrient loads from watersheds within the Mississippi River basin, coastal water quality degradation will likely continue or worsen.

The USDA agrees with USGS in that Midwestern watersheds have a high potential for runoff of phosphorus, nitrogen, sediment and agricultural chemicals (Ribaudo et al., 2011). In addition, claypan soils in Missouri, Illinois, and Kansas are particularly suitable to nutrient and herbicide transport (USDA NRCS, 2000, Lerch and Blanchard, 2003). The EPIC study is located in the Mark Twain Reservoir watershed in northeastern Missouri, which has claypan soils particularly susceptible to nutrient and herbicide transport (Lerch and Blanchard 2003).

This project installed and evaluated two innovative conservation practices--a pair of edge of field constructed wetlands and pair of agricultural bioreactors. These farm scale practices were designed to reduce nutrient concentrations, sediment, and agricultural chemicals in runoff from actively farmed row-cropped fields. The adoption of these practices within existing federal, state, and local conservation programs we believe could result in significant reductions in nutrient and other pollutant loading into Missouri's streams and reservoirs. Use of these important conservation practices throughout the Midwest could reduce the load of nutrients and sediment to the Gulf of Mexico. In particular, through denitrification, constructed edge of field wetlands have tremendous potential for removing nitrogen, a highly soluble nutrient that is otherwise difficult to address. Ancillary economic benefits of constructed wetlands for producers are the nutrient and/or carbon credits and the hunting leases they could generate.

Currently there is a scarcity of studies that evaluate the performance of the various agricultural BMPs (both structural and non-structural). Determining BMP performance is important for federal, state and local conservation programs to correctly select practices that match the localized stream impairments (targeting). This information could also be used by conservation programs to assign higher incentives to better performing practices, which could help offset some of the expense of these more advanced treatments (e.g. construction, maintenance, and additional land). In addition, evaluating and valuing nutrient removal efficiencies is extremely important because this information is critical to the development of accurate nutrient credits which could be used in water quality nutrient trading.

In addition to these two structural BMP, this project studied nitrogen use efficiency in corn production. This portion of the study takes an in-field nitrogen management approach rather than treating runoff through a structural BMP. Stalk nitrate tests can be conducted to evaluate the producer's nitrogen fertilizer use efficiency. Plants suffering from inadequate nitrogen availability remove nitrogen from the lower corn stalks during the grain filling period. Corn plants that have more than adequate nitrogen available than it needs to attain maximum yields tend to accumulate nitrate in the lower stalk at the end of the growing season. With results of this test, coupled with nitrogen management details from each field sampled, we can develop a picture of nitrogen management practices that result in an efficient use of nitrogen fertilizer.

1.3 Project Objectives

The primary objective for the Agricultural BMP evaluation component of the Evaluating and Practicing Innovative Conservation (EPIC) project was to quantify the efficacy of each of these structural BMPs (edge of field wetlands and agricultural bioreactors) in the removal of nutrients, sediment and herbicides. Data collected for this study complement the BMP monitoring efforts of Missouri Department of Natural Resources, Soil and Water Conservation Program. The in-field nitrogen management component primary objective was to evaluate producers' nitrogen management practices and work to develop a nitrogen (N) use efficiency curve for the Goodwater Creek Watershed (071100060102).

1.3.1 Structural BMP Objectives

The specific objectives for the Agricultural BMP evaluation component of the Evaluating and Practicing Innovative Conservation (EPIC) project were the following:

- Measure the value and effectiveness of edge of field wetlands and agricultural bioreactors;
- Determine the most cost effective wetland size to drainage area ratio for reducing nitrogen, phosphorus, sediment, and other agricultural chemicals loadings in runoff from a small row cropped watersheds, and value the reductions;
- Calculate the estimated load reductions for nitrogen, phosphorus, sediment, and other agricultural chemical loadings realized if large-scale implementation of innovative agricultural conservation practices were adopted within the Mark Twain reservoir watershed; and
- Increase the adoption and awareness of these innovative agricultural conservation practices.

1.3.2 In Field Nitrogen Use Monitoring Objectives

The objectives for the in-field nitrogen management component of this study were the following:

- Construct a robust database of producer nutrient and herbicide use within Goodwater Creek watershed (071100060102), work with the grower stakeholder group in the watershed to sample corn fields for stalk nitrate samples.
- Develop a nitrogen use curve for Goodwater Creek watershed, after gathering data in the watershed with stalk nitrate samples and with the survey.
- Provide outreach and feedback information to growers in the watershed about their nitrogen use efficiency.
- Provide overall project results to the Missouri Corn Growers Association. Summaries of yearly data are provided to inform staff and board members regarding information acquired throughout the year.

2 Study Area

2.1 Project Location / Watersheds

The Evaluating and Practicing Innovative Conservation Project (EPIC) constructed two edge-of-field wetlands and two agricultural bioreactors, and conducted in-field nitrogen use efficacy assessments in the Mark Twain Reservoir watershed. The Mark Twain Reservoir watershed drains 2,914 square miles of northeastern Missouri covering all or part of twelve counties (Adair, Audrain, Boone, Callaway, Knox, Macon, Monroe, Pike, Ralls, Randolph, Schuyler, and Shelby). This basin is located in Northeastern Missouri in the Glaciated Plains physiographic region (Thom and Wilson, 1980). The Glaciated Plains region extends south from Iowa to Osage Plains and Ozark Boarder Natural Divisions and is characterized by relatively young soils and topography that resulted from Kansan glaciation that occurred in the Palestine era. The structural BMP component of this project was constructed in the North Fork of the Salt River watershed (HUC 8 – 07110005) and the in-field nitrogen use efficiency assessment was conducted in the South Fork of the Salt River watershed (HUC 8 – 07110006).

2.1.1 North Fork of the Salt River Basin sub-watersheds

The North Fork of the Salt River watershed is located in the Northeastern most portion of the Mark Twain or Salt River Drainage (Figure 1). The North Fork of the Salt River watershed covers 893 square miles (approximately 571,543 acres), which covers parts of Adair, Knox, Macon, Monroe, Schuyler, and Shelby counties. It is the longest stream in the North Fork of the Salt River, which originates in Schuyler County and flows southeast approximately 119 miles until it meets the South Fork Salt River in Mark Twain reservoir. This watershed in predominately rural, but it does include all or portions or Kirksville, Shelbyville, Shelbina, and a handful of other smaller unincorporated towns. The total population for this watershed is 26,953 persons based on the 2000 census.

The North Fork sub-basin is composed of the following five sub-watersheds (10-digit HUCs):

- Bear Creek (0711000501),
- Black Creek (0711000502),
- Ten Mile Creek (0711000503),
- Crooked Creek (0711000504), and
- Otter Creek (0711000505).

The Bear Creek watershed drains 231,259 acres and is the largest sub-watershed. It is located in the northernmost portion of the basin and includes portions of Adair, Knox, Macon and Shelby counties. It is the most populous of the North Fork of the Salt River sub-watersheds, which includes just under 75 percent of the population of the entire watershed (based on the 2000 Census). This sub-watershed is composed of just over 250 miles of streams; the largest are the North Fork of the Salt River (56.0 miles), Bear Creek (47.0 miles) and Floyd Creek (17.1 miles).

The Black Creek watershed drains 71,864 acres and is located in the eastern edge of the larger North Fork of the Salt River basin and includes portions of Knox and Shelby counties. This sub-watershed includes the towns of Shelbyville and Leonard, Missouri. The largest streams within this watershed are the Black Creek (52.0 miles), Pollard Branch (9.3 miles), and Perry Branch (9.2 miles).

Ten Mile Creek is located just south of the Black Creek and the Bear Creek watersheds. This sub-watershed drains 82,649 acres, which includes portions of Macon and Shelby counties. It includes 322 miles of streams, the largest are the North Fork of the Salt River (34.6 miles), Ten Mile Creek (16.8 miles) and Biggs Branch (6.6 miles). Our project site locations for the BMP evaluation portion of this project are located in the southeastern portion of this sub-watershed (Figure 2).

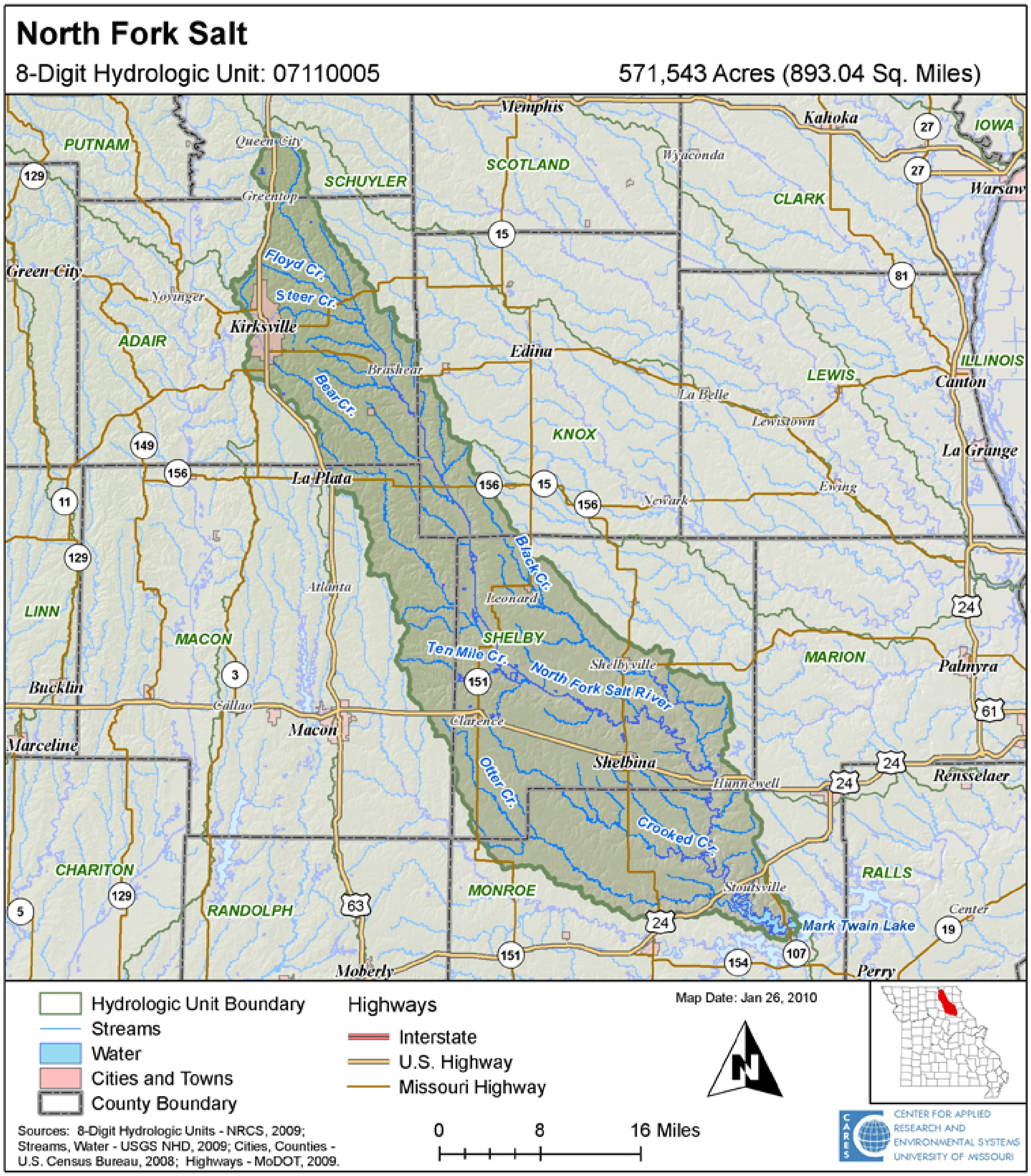


Figure 1: North Fork of the Salt River Watershed

Crooked Creek watershed drains 101,299 acres and is located just south of the Ten Mile Creek and Black Creek watersheds. This watershed includes portions of Monroe, and Shelby counties and includes the towns of Shelbina and Clarence, Missouri. The largest streams within this watershed are the Crooked Creek (37.7 miles), North Fork of the Salt River (14.9 miles), Clear Creek (14.1 miles) and Brush Creek (11.8 miles).

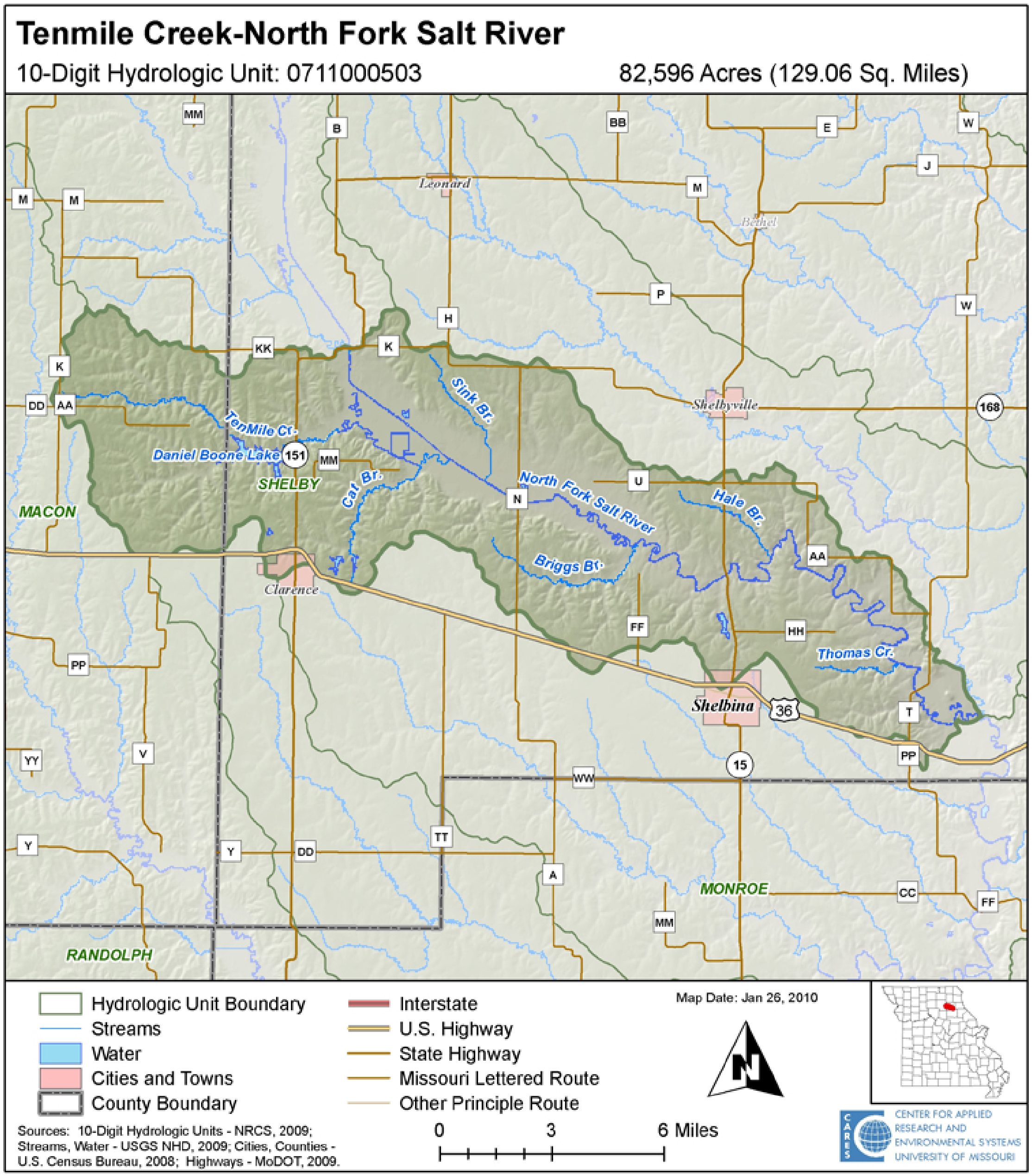


Figure 2: Ten Mile Creek Sub-watershed

Otter Creek sub-watershed drains 84,853 acres and is located just south of the Crooked Creek sub-watershed. This sub-watershed includes portions of Monroe, Shelby and Macon counties and includes the rural town of Stoutsville, Missouri. It is the least populous of the North Fork of the Salt River sub-watersheds which, as of the 2000 Census, included just 986 people (7.44 persons/sq. mile). This sub-watershed is composed of just over 280 miles of streams; the largest are the Otter Creek (51.87 miles), the North Fork of the Salt River (16.58 miles), Little Otter Creek (8.17 miles) and Buck Creek (5.83 miles). The North Fork of the Salt River arm of the Mark Twain Reservoir is located at the terminus of this watershed.

2.1.2 South Fork of the Salt River basin

The South Fork of the Salt River watershed (HUC 8-07110006) is located in the Southwestern portion of the Mark Twain or Salt River Drainage (Figure 3). The South Fork of the Salt River watershed covers approximately 1,214 square miles (776,784 acres), including parts of Audrain, Callaway, Macon and Monroe counties. The longest stream in this watershed is the Middle Fork of the Salt River, which originates near the town of La Plata in northern Macon County and flows southeasterly approximately 115 miles until meeting the South Fork Salt River in Mark Twain Lake. This watershed in predominately rural, but it does include all or portions of Macon, Moberly, Paris, Mexico, Centralia and Auxvasse and a handful of other smaller unincorporated towns. The total population for this watershed is 47,961 persons based on the 2000 census. The in-field nitrogen management component of this study is located in the Goodwater Creek watershed (071100060102). This sub-watershed was selected to conduct the in-field monitoring since ERC has a long history of working with producers in this watershed.

2.1.2.1 Goodwater Creek Sub-watershed

The Goodwater Creek sub-watershed (HUC 12- 071100060102) in located in the southwestern portion of the South Fork of the Salt River watershed. The Goodwater Creek watershed drains 19,386 acres in Boone and Audrain counties (Figure 4). This sub-watershed originates near the town of Centralia, Missouri and flows in a northeasterly direction to the confluence with Youngs Creek. Our in-field nitrogen management assessment portion of the project is located on corn producers' fields throughout sub-watershed. The Goodwater Creek sub-watershed, along with four other sub-watersheds (Scattering Branch-Long Branch (071100060101), Wabash Lake-Youngs Creek (071100060103), Youngs Creek (071100060104), and Long Branch (071100060105), compose the Long Branch Creek watershed (HUC 10-0711000601).

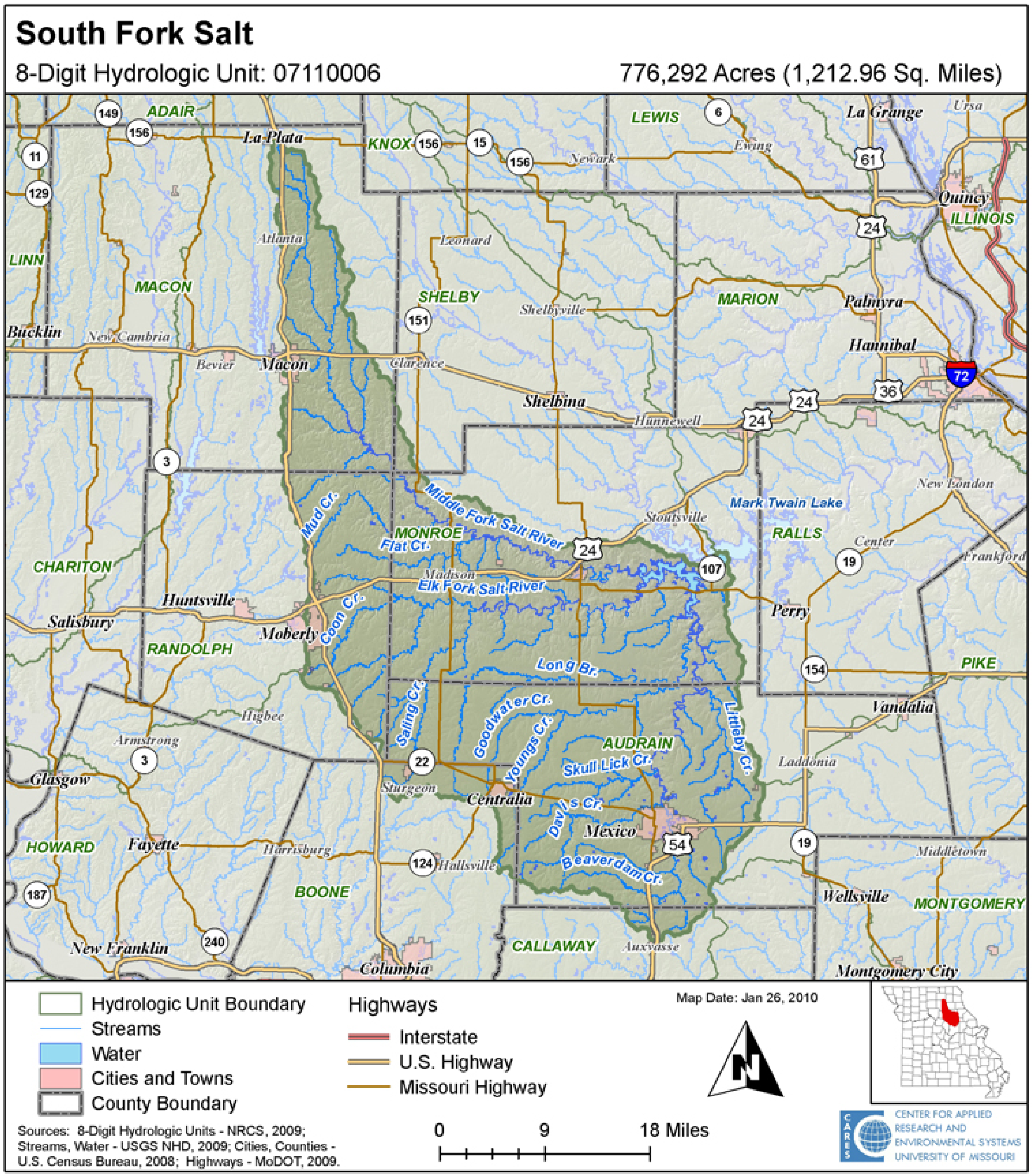


Figure 3: South Fork of the Salt River Watershed

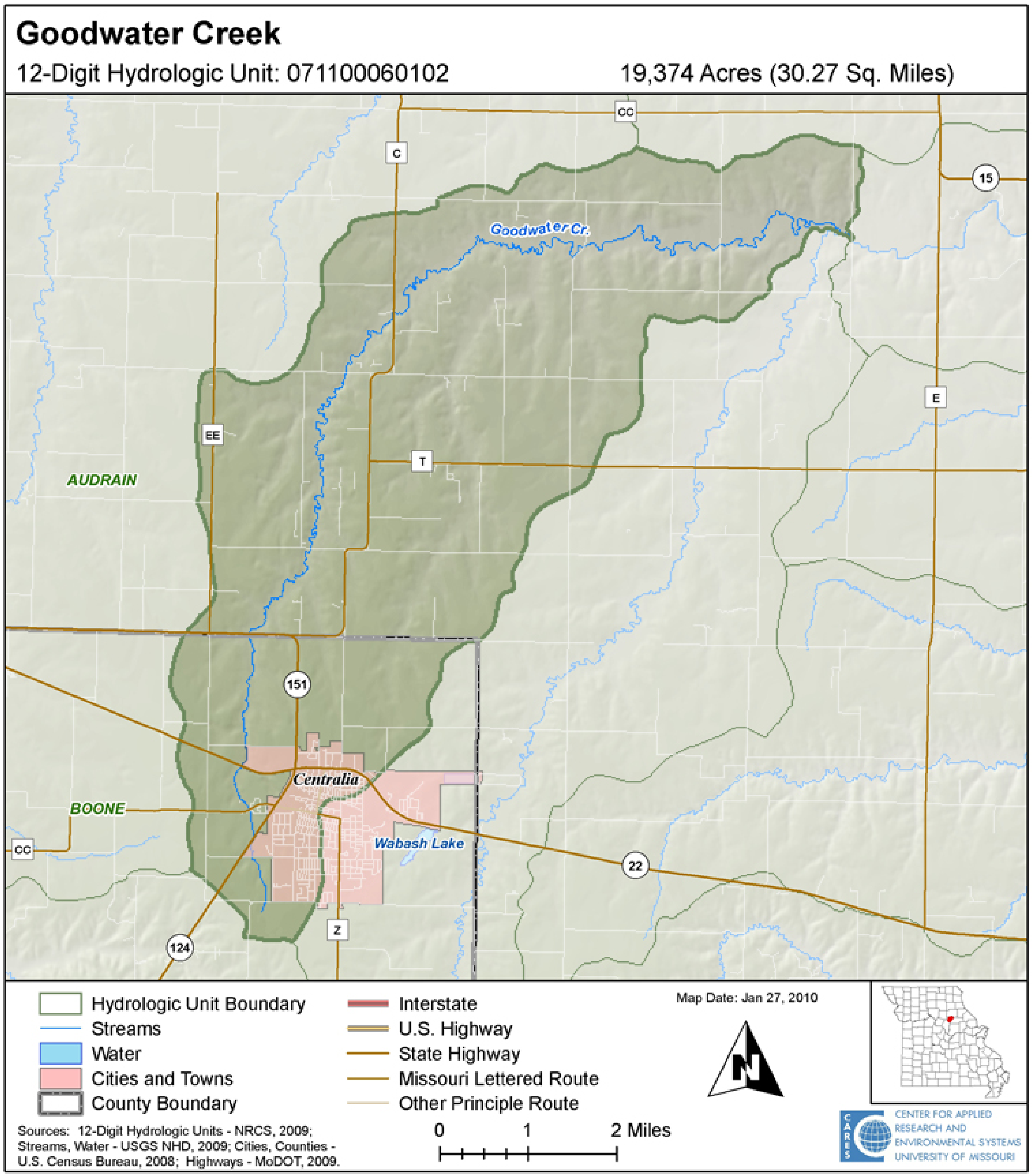


Figure 4: Goodwater Creek Sub-Watershed

2.2 Physiology and Soils Characteristics

The North Fork and South Fork of the Salt River watersheds are both located in the Eastern section of the Glaciated Plains physiographic region (Thom and Wilson, 1980). This region is drained by streams that flow east to the Mississippi River or flow south into the lower Missouri River. The basin is characterized by flat to gently rolling topography with a predominance of claypan soils that result in high runoff potential (Lerch et al. 2008). This basin encompasses the heart of the Central Claypan Region major land resource area MLRA-113 (USDA Natural Resources Conservation Service, 2006). These soils are characterized by a subsoil horizon with an abrupt and large increase in clay content within a short vertical distance in the soil profile (Soil Science Society of America 2001). Results from cropping system best management practice studies in this region showed that no-till cropping systems did not reduce surface runoff compared to tilled systems, and no-till led to increased transport of soil-applied herbicides (ERC, 2007 and others). The elevation for the North Fork of the Salt River basin ranges from a maximum of 1,005 ft. msl to 606 ft. msl (the normal operating pool of Mark Twain reservoir). The South Fork of the Salt River basin elevation changes from a maximum of 944 ft. msl to a 606 ft. msl when it reaches Mark Twain reservoir. The North Fork of the Salt River has the greatest physical relief and has 5.6 percent less area with a gentle slope (less than 3 percent slope) than the South Fork of the Salt basin.

The Ten Mile Creek and Goodwater Creek watersheds are predominately composed of Mexico, Leonard and Putnam silt loams. The Mexico and Putnam soils are formed in thicker loess than the Leonard series. Putnam soils are found on nearly level surfaces while Mexico soils are typically found on 2 to 5 percent slopes and Leonard soils on 5 to 9 percent slopes. All three soils are in the hydrologic class D, the class which is characterized by very slow water permeability (<0.06 inches/hour). These soils are poorly drained and have a high potential to generate surface runoff.

Our BMP evaluation sites were located in the Ten Mile Creek watershed in terraced fields which had predominately Mexico with some Leonard soils. The Mexico soils series occurs on 1 to 4 percent slopes and is classified as fine, montmorillonitic, mesic Udollic Ochraqualf. It is in hydrologic class D with very slow permeability and infiltration rates. Mexico soils have an 8 inch thick silt loam surface horizon underlain by a 50 to 70 inch thick silty clay argillic horizon that restricts downward water movement. The Leonard soil series occurs downslope from Mexico soils on 5 to 9 percent slopes in loess that is thinner than for Mexico soils. Leonard soils are classified as fine, montmorillonitic, mesic Vertic Ochraqualf and also fall into hydrologic class D. Leonard soils have an 8 inch silt loam surface horizon and a 50 to 70 inch thick silty clay argillic horizon. Like Mexico soils they have very slow permeability and medium to high runoff generating potential.

The Goodwater Creek sub-watershed where we conducted our in-field nitrogen use efficiency assessments had predominately Mexico silt loam (over 50 percent) and Putman silt loam soils. The Mexico soils series occurs on 1 to 4 percent slopes and has an 8 inch thick silt loam surface horizon underlain by a 50 to 70 inch thick silty clay argillic horizon that restricts downward water movement. Putman silt loam occurs on 0 to 1 percent slopes commonly occurring on ridges and uplands. Putman soils in this region are characterized as poorly drained with a slow permeability (USDA Natural Resources Conservation Service, 2012).

2.3 Land Use Characteristics

The major land use within the North Fork and South Fork of the Salt River basins are cropland (40%), followed by grassland (36%) and forested acreage (15%). Urban development accounts for approximately 5% of the land use. The primary row crops are soybean, corn, wheat, and sorghum. Forage production is mainly tall fescue. Livestock production is mostly beef cattle, but swine operations are increasing in the region.

The Goodwater and Ten Mile Creek watersheds exhibited similar land use distributions as the North Fork and South Fork of the Salt River basins. These watersheds (Goodwater and Ten Mile Creek) are both dominated by agricultural land uses (cropland and grasslands), accounting for 86 percent and 73 percent of the area in these watersheds respectively (Table 1). Although the Goodwater Creek sub-watershed (12-digit HUC) is a smaller drainage area, it has approximately 16 percent greater proportion of the total acreage in row crops compared to larger Ten Mile Creek watershed (10-digit HUC). However, land use delineations do not change appreciably when we apply the larger 10-digit HUC Long Branch Creek watershed (0711000601) as compared to the smaller the Goodwater Creek sub-watershed. The Long Branch watershed land uses are cropland (63%), followed by grassland (22%), and forested acreage (6%).

Table1: Land Use Distribution in Goodwater and Ten Mile Creek Watersheds

Goodwater Creek (HUC 12- 071100060102)

	Cropland	Grassland	Forest	Wetland	Developed	Water
Acres	12,929	3,838	711	408	1,405	95
Percent (%)	66.70	19.78	3.67	2.11	7.25	0.49

Ten Mile Creek (HUC 10 – 0711000503)

	Cropland	Grassland	Forest	Wetland	Developed	Water
Acres	33,713	27,027	13,092	4,362	3,609	850
Percent (%)	40.79	32.70	15.84	5.28	4.37	1.03

Source: U.S. Geological Survey National Land Cover Database, 2001.

3 Material and Methods

The BMP evaluation portion of the EPIC project was to evaluate a series of innovative conservation practices that would enhance economic and environmental sustainability and reduce runoff of nutrients and herbicides from row crop fields. The specific BMPs evaluated were: edge of field wetlands, agricultural bioreactors and in-field assessment of existing producer nutrient management. A Quality Assurance Project Plan (QAPP) was developed to guide data collection activities for the structural BMP portion of this project. The latest QAPP was titled *Quality Assurance Project Plan: Evaluating and Practicing Conservation Project (EPIC); Version 5; dated July 29, 2011*. A QAPP was also developed for in-field assessment of nutrient management for a previous study and was utilized for the EPIC project. The QAPP for the in-field nutrient management assessment was titled *Quality Assurance Project Plan: Nutrients and effective Application Rates (NEAR); Version 3; dated August 1, 2011*. These QAPPs serve as the technical reference for all sampling and laboratory activities and are available from ERC upon request.

The following structural BMP site identification naming convention was used.

- First charter denotes if the it is the North (**N**) 3 cell wetland or the South (**S**) full scale wetland; or for the bio-reactors if it is located in field L (**L**) or located in field G (**G**)
- Second charter denotes if it is a wetland (**W**) or a bio-recactor (**R**)
- Third charter denotes if is an automated sampler location (**A**), or a grab sample location (**G**) or a standpipe location (**S**). (Note: that multi-parameter data sondes and levelloggers are located at the near grab sample location)
- Forth charter denotes the numeric site location for the sampling sites within the wetlands; for the bio-reactor (**1**) is the inlet, (**2**) is the outlet, and the remaining are standpipe locations numbered right to left as you progress from the inlet to the outlet.

Table 2: Description of Monitoring Locations for the EPIC project Study Season 2012

Site (ID)	Site Description (narrative)	Sampling Location	Sampler Type	BMP Type
NWA-1	3 cell wetland	Inlet	Sigma Sampler	Wetland
NWA-2	3 cell wetland -deepest cell	Outlet	Sigma Sampler	Wetland
NWG-1	3 cell wetland -deepest cell	Pool	YSI Sonde and Levellogger	Wetland
NWA-3	3 cell wetland medium depth cell	Outlet	Sigma Sampler	Wetland
NWG-2	3 cell wetland -medium deepest cell	Pool	YSI Sonde and Levellogger	Wetland
NWA-4	3 cell wetland -shallow cell	Outlet	Sigma Sampler	Wetland
NWG-3	3 cell wetland - shallow cell	Pool	YSI Sonde and Levellogger	Wetland
SWA-1	Full scale wetland	North Inlet	Sigma Sampler	Wetland
SWA-2	Full scale wetland	East Inlet	Sigma Sampler	Wetland
SWA-3	Full scale wetland	Outlet	Sigma Sampler	Wetland
SWG-1	Full scale wetland	Pool	YSI Sonde and Levellogger	Wetland
LRA-1	Field L - Bio-reactor	Inlet	Sigma Sampler	Bio-reactor
LRA-2	Field L - Bio-reactor	Outlet	Sigma Sampler	Bio-reactor
LRS-1	Field L - Bio-reactor	stand pipe 1	YSI Sonde	Bio-reactor
LRS-2	Field L - Bio-reactor	stand pipe 2	YSI Sonde	Bio-reactor
LRS-3	Field L - Bio-reactor	stand pipe 3	YSI Sonde	Bio-reactor
LRS-4	Field L - Bio-reactor	stand pipe 4	YSI Sonde	Bio-reactor
LRS-5	Field L - Bio-reactor	stand pipe 5	YSI Sonde and Levellogger	Bio-reactor
LRS-6	Field L - Bio-reactor	stand pipe 6	YSI Sonde	Bio-reactor
LRS-7	Field L - Bio-reactor	stand pipe 7	YSI Sonde	Bio-reactor
LRS-8	Field L - Bio-reactor	stand pipe 8	YSI Sonde	Bio-reactor
LRS-9	Field L - Bio-reactor	stand pipe 9	YSI Sonde	Bio-reactor
GRA-1	Field G - Bio-reactor	Inlet	Sigma Sampler	Bio-reactor
GRA-2	Field G - Bio-reactor	Outlet	Sigma Sampler	Bio-reactor
GRS-1	Field G - Bio-reactor	stand pipe 1	YSI Sonde	Bio-reactor
GRS-2	Field G - Bio-reactor	stand pipe 2	YSI Sonde	Bio-reactor
GRS-3	Field G - Bio-reactor	stand pipe 3	YSI Sonde	Bio-reactor
GRS-4	Field G - Bio-reactor	stand pipe 4	YSI Sonde	Bio-reactor
GRS-5	Field G - Bio-reactor	stand pipe 5	YSI Sonde and Levellogger	Bio-reactor
GRS-6	Field G - Bio-reactor	stand pipe 6	YSI Sonde	Bio-reactor
GRS-7	Field G - Bio-reactor	stand pipe 7	YSI Sonde	Bio-reactor
GRS-8	Field G - Bio-reactor	stand pipe 8	YSI Sonde	Bio-reactor
GRS-9	Field G - Bio-reactor	stand pipe 9	YSI Sonde	Bio-reactor

3.1 Structural BMP Design

The structural BMPs designed, constructed and evaluated for this project are a three cell wetland, a full scale wetland and two agricultural bio-reactors. All of these structural BMPs were constructed in existing grass waterways, where runoff is naturally channeled and focused. Each of these BMPs were designed and constructed for medium size terraced row crop fields, which are typical for Missouri. Currently there is limited information and experience constructing and evaluating these types of practices for treating terrace runoff.

Professional engineers at Geosyntec Consultants were tasked to design each of these BMPs specifically for terraced fields. However, in order for these practices to be acceptable to producers they must take the least amount of land out of production. Therefore these engineers were also tasked to develop designs with the smallest footprint to be effective. We decided to create more than one of each type of BMP to providing needed replication for this study.

Newly constructed BMPs can require several growing seasons to become fully established and functional. Wetland plants and the repair of the grass waterway post construction can easily take a full growing season, if not two, to become fully functional and established. As a result of excessive wet weather early in the project, construction was delayed. Additionally, excessively dry weather in the last year of the project hampered wetland plant establishment. Upon completion of this project, the project partners plan to seek additional funding in partnership with the Missouri Department of Natural Resources to extend the water sampling and data gathering an additional three years so that proper evaluation of the BMPs is assured.

Edge of Field Cell Wetlands

This project was designed to evaluate the effectiveness of two edge-of-field constructed wetlands in reducing runoff of nutrients, sediment, and herbicides from row-crop fields. The North field wetland was divided into three cells in which the inflows and outflows of each cell was monitored. By dividing the wetland into three separate cells this should have allowed us to efficiently collect a lot of wetland performance data over the short project. The second is a single cell wetland to show producers the actual size (or footprint) of this practice and is more reflective of the type of practice that would be built for edge of field nutrient retention. Both wetlands were constructed at a 100:1 drainage area to wetland surface area ratio.

This study design would have allowed us to evaluate the effectiveness of the wetland for nutrient, sediment and herbicide removal, and to determine the most cost-effective wetland size and the effect of the mean hydraulic depth. The data generated would have allowed for load reduction estimations if large scale edge of field wetland implementation were adopted throughout the Mark Twain watershed.

These two edge-of-field wetlands were constructed in the Ten Mile Creek sub-watershed within the greater North Fork of the Salt River watershed (HUC-8, 07110005) in a small to medium sized row-cropped field. Wetland vegetation was planted in the wetland cells in mid-November 2011. This vegetation includes 9 different wetland plant species such as rushes, bulrushes, grasses, sedges, and cattails (Table 6). These wetland cells were designed to capture and treat row-crop runoff. Previous studies (Livingston 1989, Mitsch 1993, Witthar 1993, Environmental Resources Coalition 2007a, Environmental Resources Coalition 2007b) suggest that the following ranges of nutrients, sediment and herbicide concentrations can be expected in row-crop runoff:

Total Nitrogen	(0.5 – 100 mg/L)
Total Phosphorus	(0.1 – 40 mg/L)
Nitrate / Nitrite	(0.1 – 70 mg/L)
Total Ammonia	(0.2 – 30 mg/L)
Total Suspended Solids	(50 – 10,000 mg/L)
Herbicides	(0.1 – 1,000 µg/L)

A photograph of the constructed three cell edge-of-field wetland is shown in Figure 5. ERC staff can be seen in Figure 6 planting 6400+ plants and plugs in the wetland structures. A site map of the wetland illustrates the location of the wetland and the inlet and outlet sampling points, Figure 7. The wetland inlet automated sampling point is located in the middle chamber of the inlet weir located in the surface runoff collection berm. The wetland outlet sampling locations are located in the Agri-Drain weirs on the west side of each wetland cell. A project map of the location of the North Fork of the Salt River watershed (Huc-8, 07110005), where the edge-of-field wetlands was constructed are displayed in Figure 8. Please refer to Appendix C – Form and Plans, for the official wetland design and evaluation forms for the wetland sites.

3.1.1 Bio-reactors

Agricultural denitrification bio-reactors are a promising new technology for removing nitrogen from row cropped fields. These bio-reactors have a significant benefit over other nitrogen reduction conservation practices due to their small footprint. This practice can also be placed in grassed buffers, which will not require valuable land to be removed from production. However, there is very limited information and experience with treating terrace runoff through agricultural denitrification bioreactors. The purpose of this study was to demonstrate and document the efficacy of agricultural denitrification bioreactors in improving water quality from terrace discharge from a typical corn / soybean rotation.

Having more than one of each type of BMP available for study was to benefit the project by providing needed replication and to collect data more quickly, rather than requiring an additional season. Please refer to Appendix E to view a better glimpse of all structures through many phases of the project. Also refer to Appendix C – Forms and Plans, for official design plans for both bio-reactor sites.

Figure 5: Three Cell Edge-Of-Field Wetland

Figure 6: Wetland Planting Collage November 2011

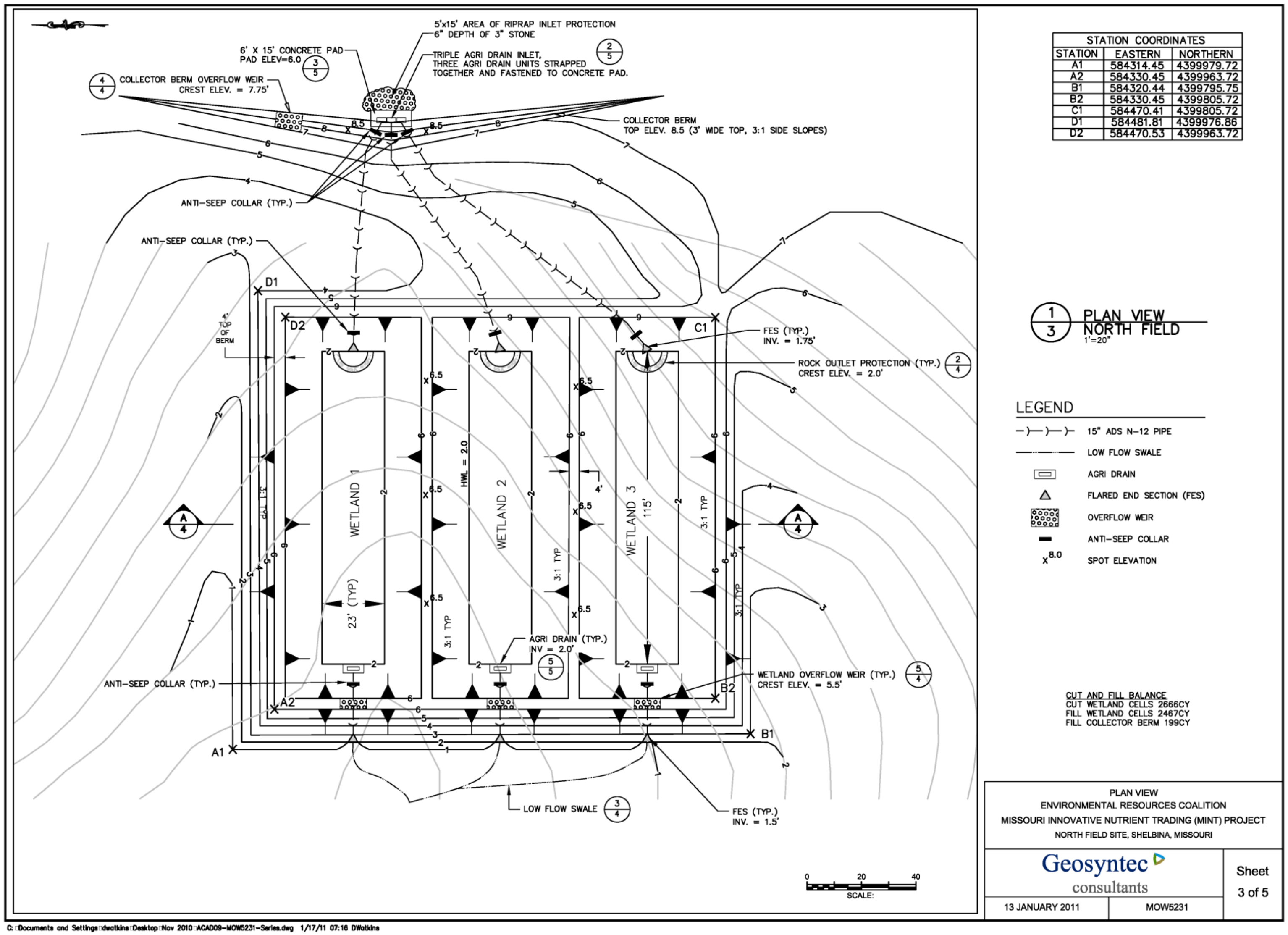


Figure 7: Three Cell Wetland Design

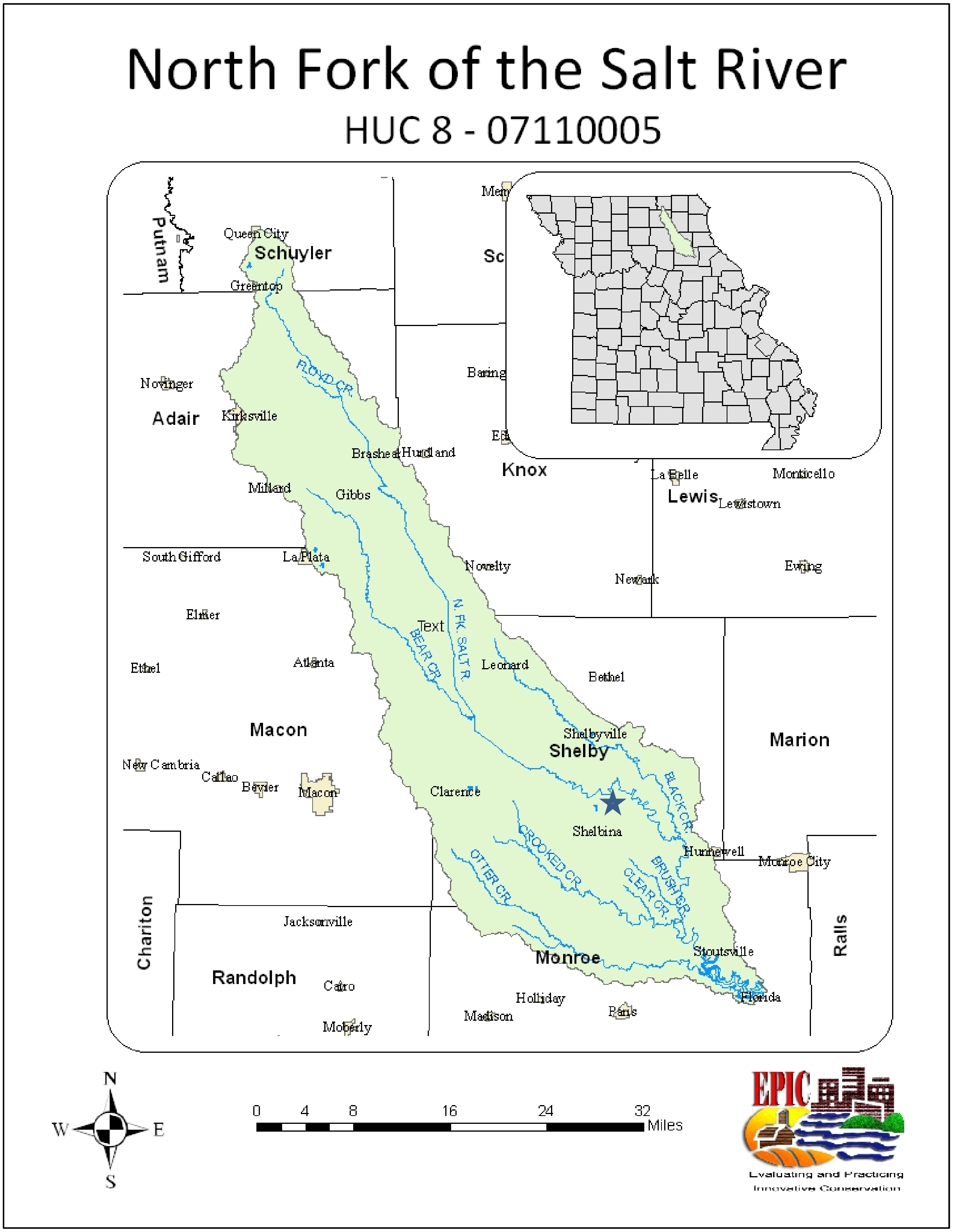


Figure 8: Project Map

3.2 Water Sampling

The following water quality monitoring and sampling design schedule was established to meet the data quality objectives for this project. The specific water quality parameters to be collected, comprehensive list of monitoring locations, sampling frequency and type of analysis for each BMP are listed below in Table 3. The types, frequency and anticipated number of QA samples anticipated to evaluate the data quality are listed in Table 4.

Table 3: Water Quality Sampling Schedule

BMP Type	Description	# of Locations	Sample Type & (# of samples)	Frequency	Analyses
Edge of Field Wetland	Runoff samples from wetland inlet / outlets	Inlet – 3*, Outlet – 4	Flow-paced composite (max. of 140/yr.)	Runoff events (max. of 20)	TN, $NO_{2/3}$, NH_3, TP, SRP TSS, VSS, NVSS, Herbicides
	Non-runoff samples from wetland cells near outlets	Wetland Cells - 4	Grab Samples (max. of 96/yr.)	Biweekly (max. of 16)	TN, $NO_{2/3}$, NH_3, TP, SRP TSS, VSS, NVSS, Herbicides
Agricultural Bioreactor	Runoff samples from bio-reactor inlet / outlet	Inlet – 2, Outlet – 2	Flow paced composite (max. of 80)	Runoff events (max. of 20)	TN, $NO_{2/3}$, NH3, TP, SRP TSS, VSS, NVSS, Herbicides
	Ground water samples in bioreactor	Stand Pipes – 18	Grab samples collected through Peizometers (max. of 288/yr.)	Biweekly (max of 16)	ODO, ODO Sat, Cond, pH, eH, $NO_{2/3}$, SO_4

Abbreviations:

TN = Total Nitrogen
$NO_{2/3}$ = Nitrate + Nitrite
NH_3 = Ammonia as Nitrogen
TP = Total Phosphorus
SRP = Soluble Reactive Phosphorus
TSS = Total Suspended Solids
NVSS = Non-Volatile Suspendered Solids
VSS = Volatile Suspended Solids

ODO = Optical Dissolved Oxygen
ODO Sat. = ODO Saturation
Cond. = Specific Conductance
pH = power (potenz) hydrogen (pH)
eH = reduction potential
SO4 = Sulfate

Herbicides Include:

Atrazine (ATR)
Deethylatazine (DEA)
Deisopropylatrazine (DIA)
Metribuzin (MTR)
Terbutylazine (TER)
Acetochlor (ACE)
Alachlor (ALA)
Metolachlor (MTO)
Cyanazine (CYN)

* **note**: single cell wetland has two inlets due to topography at site

Table 4: QA Sampling Schedule

QA Sample Type	BMP	QA Measurement Criteria	Frequency	# of Samples Anticipated	Purpose
Duplicate Runoff Field Samples	Edge of Field Wetland	Precision and Representativeness	10 percent	20	Measure precision and representativeness of field sampling methods
Duplicate Grab Field Samples	Edge of Field Wetland	Precision and Representativeness	10 percent	8	Measure precision and representativeness of field sampling methods
Field Blanks	Edge of Field Wetland	Accuracy	10 percent	20 runoff blanks + 8 grab blanks = 28 blanks	Measure accuracy of field sampling methods
Equipment Blanks	Edge of Field Wetland	Accuracy	2 percent	2	Measure accuracy of field sampling methods
Duplicate Runoff Field Samples	Agricultural Bioreactor	Precision and Representativeness	10 percent	10	Measure precision and representativeness of field sampling methods
Duplicate Groundwater Field Samples	Agricultural Bioreactor	Precision and Representativeness	10 percent	32	Measure precision and representativeness of field sampling methods
Field Blanks	Agricultural Bioreactor	Accuracy	10 percent	10 runoff blanks and 32 groundwater blanks = 42	Measure accuracy of field sampling methods
Equipment Blanks	Agricultural Bioreactor	Accuracy	2 percent	2	Measure accuracy of field sampling methods

Field duplicate and field blank samples were to be prepared for approximately ten percent all samples collected. A field blank was to be included in each runoff event and grab set of samples. The field blank was to be carried to each collection site, uncapped during the collection process, capped and carried to the next site. Any additional partitioning or splitting of the collected samples was to occur in the laboratory. The laboratory was to also conduct all sample filtration and processing.

ERC field managers were responsible for all field monitoring and water quality sample collection. Sample volumes, appropriate containers, preservatives, and holding times are listed in Table 5. If a failure occurred in any of the sampling systems during the study, field staff were to immediately notify the ERC QA manager. ERC would decide the corrective action needed and was to be responsible for implementing the corrective actions. ERC's QA manager documented all failures and corrective actions taken, and determined the effectiveness of the corrective actions.

All water quality samples collected were to be labeled in accordance with the following identification scheme: project name, site identification, sample location, sample type, date / time, field technician's initials, and sample identification number. Any additional sample splitting or partitioning was to occur in the laboratory, which would have been assigned a unique alphanumeric identification number for each sample or aliquot. A monitoring station field log (Figure B3-1) was to be filled out each time a station was sampled by the Field Manager. All sample labeling, packing, transportation, and chain-of-custody procedures were to follow U.S. EPA and U.S. Department of Transportation (U.S. DOT) sampling handling and shipping protocols.

Table 5: Sample Container, Preservative, and Holding Times for Selected Analytes

Analyte	Container (a)	Sample Volume (mL)	Preservative (b)	Maximum Holding Time (c)
Total Nitrogen	P, FP, or G	500 mL	≤ 4° C, H_2SO_4 to pH < 2	60 days
Nitrate – Nitrite – N	P, FP, or G	200 mL	≤ 4° C, H_2SO_4 to pH < 2	28 days
Ammonia – N	P, FP, or G	200 mL	≤ 4° C, H_2SO_4 to pH < 2	28 days
Total Phosphorus	P, FP, or G	200 mL	≤ 4° C, H_2SO_4 to pH < 2	60 days
Soluble Reactive Phosphorus	P, FP, or G	200 mL	≤ 4° C, H_2SO_4 to pH < 2	28 days
Suspend Solids (TSS, VSS and NVSS) (Soil & Plant Testing Laboratory)	P, FP, or G	1,000 mL	≤ 4° C	7 days
Herbicides	G, FP-lined cap	1,000 mL	≤ 4° C, no acid preservation	7 days until extraction, 40 days after extraction
Sulfate (Soil & Plant Testing Laboratory)	P or FP	200 mL	≤ 4° C	28 days

(a) Polyethylene (P), Fluoropolymer (FP), Glass (G).

(b) Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved immediately after sample splitting is completed.

(c) Samples should be analyzed as soon as possible after collection. The times listed in the table are the maximum time that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the laboratory has data on file that show that, for the specific types of samples under study. Or if the analytes are stable for longer time periods and has received variance from the EPA Regional Administrator under §136.3(e). Some samples may not be stable for the maximum time period given in the table. The analytical laboratory is obligated to hold the sample for a shorter period if it knows that a shorter time period is necessary to maintain sample stability.

Note: * Volumes listed are per parameter. Recommended volumes are: nutrients (one liter), suspended solids (one liter), and herbicides (two liters). All sample splitting and filtration will occur in the laboratory.

Reference: This table includes the some requirements of U.S. Environmental Protection Agency, as published in the Code of Federal Regulations, Title 40, Part 136, Volume 72, Number 47, dated April 11, 2007, pages 11,199 – 11,249.

3.2.1 Wetland

3.2.1.1 Runoff Sampling Methods

American Sigma 900 MAX automatic samplers with flow meters, Sigma 77065-030 Sub-Area Velocity (AV) sensors, and Agri-Drain V-notch weirs were used to measure the volume and concentrations of runoff flowing into and out of each wetland cell. During significant runoff events, one composite sample was to be collected from runoff entering the wetland - at inlet weir, and one composite sample was to be collected of runoff flowing out of each wetland – at the outlet weir of each wetland cell. We anticipated monitoring a maximum of 20 runoff events each sampling year.

3.2.1.2 Grab Samples Methods and Locations

During non-runoff periods grab samples were to be collected from each of the wetland cells near the outlet on a bi-weekly basis during the field season (April through November). A maximum of 16 non-runoff grab samples were to be collected in total for each wetland cell. These samples were to assess the wetlands denitrification and herbicide degradation kinetics.

3.2.1.3 Wetland Plant Species and Density

Wetland plant species were selected specifically to assist in the reduction of nutrient, sediment and herbicide concentrations. Hardy wetland plant species were selected to fit our growing region and that could take periods of inundation, desiccation and freezing. The functions of the wetland plants are to slow/reduce water movement, provide surface area for microscopic plants and bacteria, and directly utilize nutrients. All three of these pathways in addition to evaporation, infiltration, volatilization, and sedimentation would assist in fulfilling the goals of this project.

Nine different wetland plant species were selected and procured to provide an approximate plant density of one wetland plant per every two square feet of wetland surface area (at normal pool elevation). The live wetland plants were shipped and planted as live plugs and buried in the wetland sediment. The wetlands were planted in mid-November 2011 after a prolonged late summer and early fall dry period, which postponed planting. The following is a list of wetland plants species, numbers, and specific locations planted (Table 6).

Table 6: Wetland Plant Species and Densities for each Wetland Cell

Wetland Plant (scientific name)	Total Inventory	North Wetland (deepest cell)	North Wetland (mid-depth cell)	North Wetland (shallow cell)	South Wetland (Full Scale)
Porcupine sedge (Carex hystricina)	300	56	56	56	132
Pointed broom sedge (Carex scoparia)	341	64	64	64	149
Creeping spike rush (Eleocharis palustris)	500	94	94	94	218
Baltic rush (Juncus balticus)	500	94	94	94	218
Hardstem bulrush (Scirpus acutus)	1,000	188	188	188	436
Common three square rush (Scirpus americanus)	1,000	188	188	188	436
Three square rush (Scirpus pungens)	800	150	150	150	350
Softstem bulrush (Scirpus validus)	1,000	188	188	188	436
Narrow-leaved Cattail (Scirpus, angustifolia)	1,000	188	188	188	436

3.2.2 Bio-Reactors

3.2.2.1 Runoff Sampling Methods

American Sigma 900 MAX automatic samplers with flow meters, Sigma 77065-030 Sub-Area Velocity (AV) sensors, and Agri-Drain V-notch weirs were used to measure the volume and concentrations of runoff flowing into and out of each agricultural denitrification bioreactor. During significant runoff events, one composite sample was to be collected from runoff entering the bioreactor inlet pipe and one composite sample was to be collected runoff flowing out of each bioreactor outlet pipe. We anticipated monitoring a maximum of 20 runoff events each year for each innovative BMP location.

3.2.2.2 Standpipe Sampling Methods

The standpipe field within each bio-reactor was to be sampled bi-weekly during non-runoff periods for a maximum of 16 samples collected. A multi-parameter YSI data sonde was used to assess the DO, ODO, specific conductance, pH and eH. In addition, a water sample was to be collected and water depth was to be noted for each stand pipe. The water samples were to be assessed for $NO_{2/3}$ and SO_4.

3.3 In-field Stalk Nitrate Nitrogen Use Efficiency Assessment

Stalk nitrate was assessed through the collection of fifteen stalks samples randomly collected per field. These stalk samples were combined into a composite sample, which was used to estimate total field stalk nitrate. Since the amount of acreage under corn production varies year to year, our goal was to sample the majority of the corn acres within Goodwater Creek and to work with growers in the watershed to expand the project yearly on corn producing fields. During our sampling we made every attempt to capture and document as many different nutrient practices occurring within each watershed as possible. An effort was also made to distribute the acreage that we sampled throughout the entire watershed spatially (figure 9). All samples were delivered to the laboratory for analysis within the allotted holding time, which is listed below in Table 3.

End of season stalk nitrate samples were collected using simple garden shears following the procedures developed at Iowa State University (Blackmer and Mallarino 1996). Stalk samples were collected one to three weeks after 80 percent of the kernels reached the black layer stage (physiological maturity). Fifteen representative plants were randomly sampled throughout each field or sub-field. Care was taken to insure that samples were collected randomly throughout the entire field and that samples represented an accurate characterization of the variation in soil and topography within the field. A stalk sample is comprised of an 8-inch stalk segment (without leaves) beginning at 6-inches above the ground. All 15 samples were placed in a paper bag and labeled with date, field identification number and field tech initials for shipment to a qualified testing laboratory within 48 hours. Appendix C also contains an example Laboratory Delivery Form used to show samples delivered and the specifications of the samples for ease of processing and data validation.

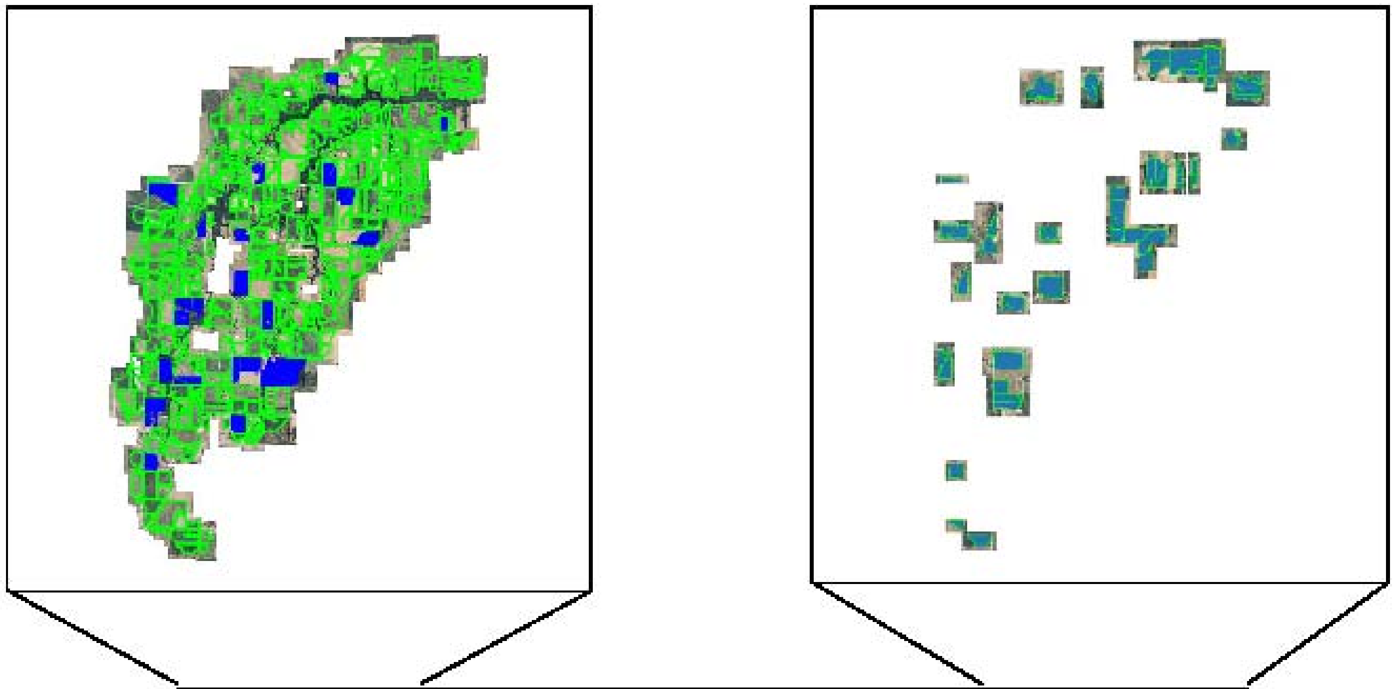
All plant samples collected were labeled in accordance with the following identification scheme: date, time, field id, and sample number. Additional sample partitioning occurred in the laboratory, which assigned a unique alphanumeric identification number for each sample or aliquot. At each field or sub-field sampled the Field Manager will complete a Stalk Nitrate Data Collection Form and the Stalk Nitrate Challenge Data Collection Form (see Appendix D). All sample labeling, packing, transportation, and chain-of-custody procedures followed U.S. EPA and U.S. Department of Transportation (U.S. DOT) sampling handling and shipping protocols. A collage of photos shown in Figure 10 is compiled of images captured in the watershed during the project that illustrate procedures were followed.

Table 3: Sample Container, Preservative, and Holding Time

Sample	Container	Sample	Preservative	Maximum Holding Time
Stalk Nitrate	Paper Sack	15 stalks per field	Refrigerate samples ($\leq$ 6°C)	Dried samples 28 days

Stalk Nitrate Sample Dispersal

*Blue fields indicate field was sampled for stalk nitrate



2010	GOODWATER CREEK	2011
4050	Corn acres in watershed	4075
80	Total number of corn fields in watershed	86
~23	# of corn fields in project	~37
1200+	Approximate acres in project	2000+

Note: Software formatting changed between 2010 and 2011 which is the reason for the mapping layout change. A 2012 map is not included due extreme drought which significantly decreased yield potential and ceased the project on dry land corn.

Figure 9: Stalk Sample and Field Distribution

Figure 10: Stalk Procedure Followed in Watershed

3.4 Weather Station Data

For this project we deployed a Campbell Scientific weather station outfitted with a CR200x data logger, barometric pressure sensor (CS100), air temperature /relative humidity sensor (CS215), wind speed and direction sensor (03002), Pyranometer to measure total sun and solar radiation (CS300), and a rain gage with a tipping bucket (TE525M). This weather station was deployed adjacent to the three cell wetland and within the same 10-digit watershed as all of the project's BMPs.

3.4.1 Weather Stations Variables

The following weather stations parameters were collected on both an hourly and a daily time step during this project (Table 4).

Table 4: Weather Station Parameters Collected

Parameter	Measurement	Unit
Barometric Pressure	Average	mmHg
Barometric Pressure	Maximum	mmHg
Barometric Pressure	Minimum	mmHg
Rainfall	Total	mm
Air Temperature	Average	Degrees C
Air Temperature	Maximum	Degrees C
Air Temperature	Minimum	Degrees C
Evapotranspiration (ETo)	Average	ETo
Relative Humidity	Average	percent
Relative Humidity	Maximum	percent
Relative Humidity	Minimum	percent
Solar Radiation	Average	kW/m^2
Solar Radiation	Maximum	kW/m^2
Solar Radiation	Minimum	kW/m^2
Solar Radiation	Total	MJ/m^2
Wind Speed	Average	m/sec
Wind Speed	Maximum	m/sec
Wind Speed	Minimum	m/sec
Wind Direction	Sample	degrees

Note: maximum and minimum measurements are also accompanied with a time stamp.

3.4.2 Weather Station Sampling Intervals

Data collection for this weather station began on December 17, 2011 and concluded on September 5, 2012. Data was downloaded from the weather station data logger on a monthly basis. All parameters were sampled on a ten second time interval and the data was analyzed to provide hourly and daily averages or to determine maximums or minimums. Daily averages were calculated and compiled for all parameters and are included in this report in Appendix B.

3.5 Data Validation

All collected data was subject to a multi-level review, verification and validation method, which is outlined in the Missouri Regional Dissolved Oxygen Criteria Plan (ERC, 2010). The data collected for this study was compiled with both initial measurements and validated results into an Access database. A copy of the Access database will be provided as a deliverable and can be obtained by contacting ERC.

3.5.1 Water Quality Data Validation

Unfortunately due to the 2012 drought no runoff samples were collected during the initial field season.

3.5.2 Hydrology Data Validation

No hydrology runoff data was collected; therefore, no hydrology data validation was possible.

3.6 Dataset Completeness

3.6.1 Weather

The Campbell Scientific CR200x weather station was downloaded by ERC staff on a monthly basis to preserve any weather information that the equipment had acquired had. Data was saved to wait for proper analysis at the end of the project. The following graphs and table In Table 4 and Figures 11 and 12 depict the extreme hot and dry conditions that were present during 2012.

2012 Rainfall and Temperature Analysis EPIC Site Shelby County				
	Total Rainfall mm	Total Rainfall In	Daily Ave Temp C	Daily Ave Temp F
January	6.40	0.25	-0.07	31.87
February	12.80	0.50	2.33	36.20
March	30.30	1.19	13.03	55.45
April	49.80	1.96	13.53	56.35
May	13.40	0.53	20.47	68.84
June	25.20	0.99	23.26	73.87
July	34.10	1.34	27.81	82.06
August	7.10	0.28	23.64	74.55

Table 4: 2012 Rainfall and Temperature Analysis

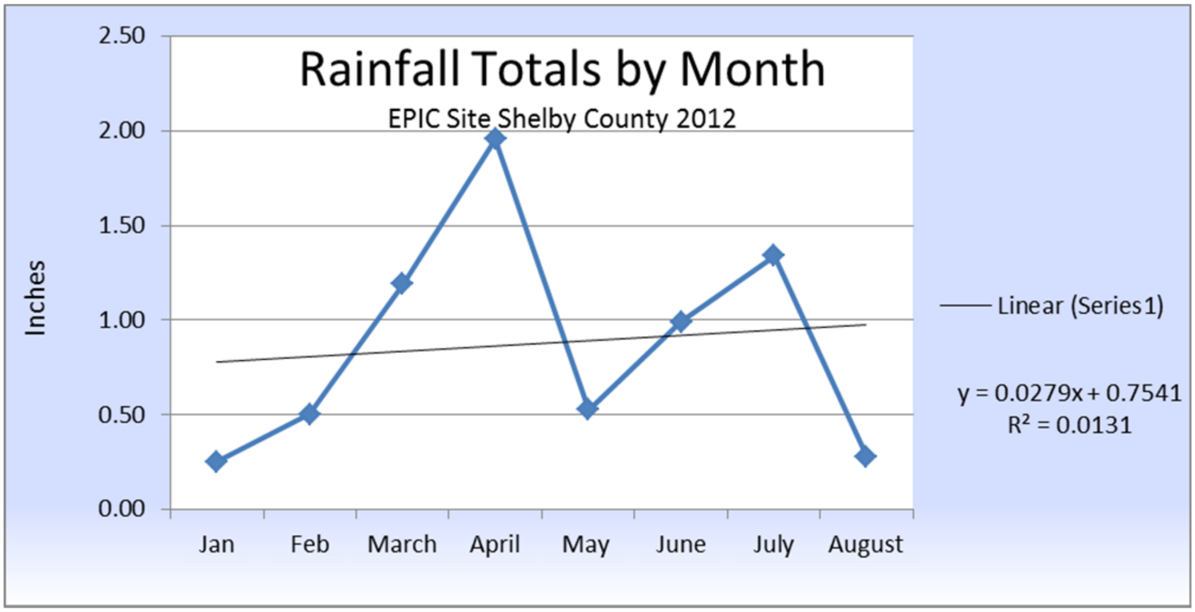
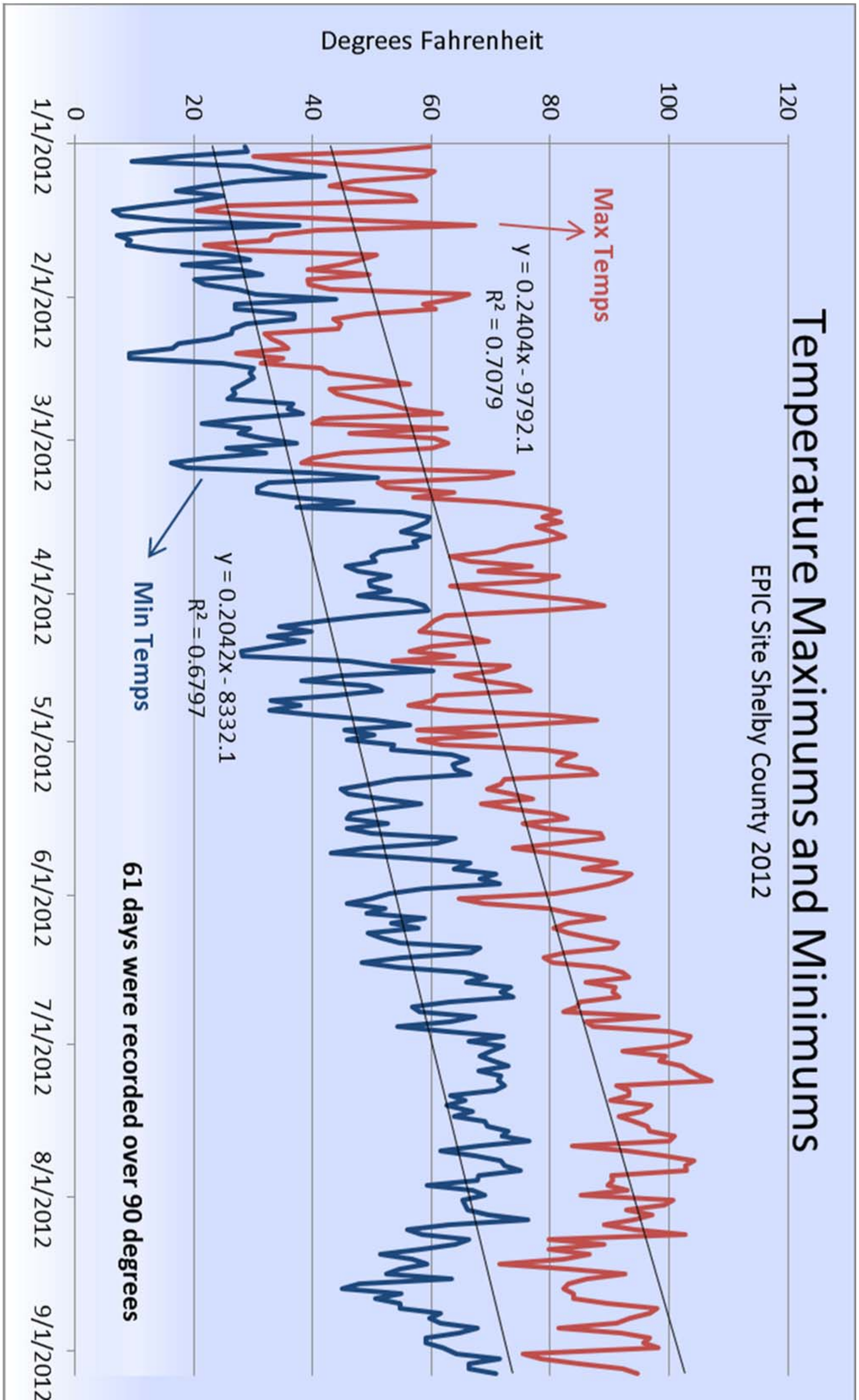


Figure 11: 2012 Monthly Rainfall Totals

Figure 12: 2012 EPIC Site Temperature Analyses



3.6.2 Runoff / Number of Storms

No runoff events were captured (0 storms/events) during the initial (set-up) field season. Therefore, the runoff sampling data collection is determined as incomplete as per the EPIC QAPP. However, the initial field season was fully used to establish plants, condition the bio-reactor and to calibrate and adjust field data collection and sampling equipment.

3.6.3 Water Quality Samples

No water quality samples (0 samples/events) during the initial (set-up) field season. The historic drought of 2012 did not provide enough runoff for reliable and meaningful data collection. Therefore, the water quality sample data collection is determined as incomplete as per the EPIC QAPP.

3.6.4 In-field Stalk Nitrate Nitrogen Use Efficacy Assessment

Over the last three years approximately 25% of the tilled acres (See Table 1) in corn production in the Goodwater Creek watershed were sampled for stalk nitrate levels. Growers in the area can be described as proactive, well educated, progressive and generally aware of environmental issues. Volunteering farmers are not only able to capture a yearly record of their field's nitrogen level at the end of the season, but are also able to compare their management to others in the watershed. This is part of the adaptive management feedback loop that is so important. The project is gaining base knowledge of nutrient application practices through the help of grower input. Having the sample results to gauge application effectiveness in the watershed is essential for being able to create BMPs regarding nitrogen use and efficacy in the area. This small dataset has already shown us that in general, growers are not over applying nitrogen in the watershed. BMPs such as use of inhibitors, split application of nitrogen and spring application of nitrogen are increasing nitrogen use efficiency in the area. Due to the EPIC project, farmer acceptance and adoption of stalk nitrate sampling as a diagnostic tool has increased. Interest in the program continues to outpace resources.

Relationships and personal contact have been two important components of this project. Trust has proven to be critical as farmers weigh the benefits of proper nutrient management. Growers are individually contacted at various times throughout the year by the field service representative to gauge interest in the program and locate fields to be sampled. Field inputs are gathered for data and lab purposes (see Figure 13). Growers are then visited one-on-one to review Stalk Nitrate Plant Analysis Report (See Appendix D) regarding fields and overall watershed outcomes of the growing season. Primarily stalk nitrate tests have shown that growers use NH_3 86 percent of the time as their dominate nitrogen source for the season. Applications of nitrogen are done 66 percent of the time in the spring with the average rate of nitrogen for any total season being around 160 lbs. Over three years 60 percent of growers used a one-pass nitrogen application system while the other 40 percent used two or more passes for their total application. Staff has observed that growers are becoming more conscious of their nitrogen placement. For many farm operations, the amount of nutrients applied depends upon price and optimum time for plant usage.

After review of the stalk nitrate results from 2010 and 2011 (See Appendix C) sampling season we have concluded the following:

2010 - Significant rainfall, wet weather and very wet soil conditions early in the growing season contributed to the low nitrogen levels or loss in the watershed causing samples to be predominately LOW in NO_3-N. Another factor impacting growers was a shortage of anhydrous ammonia which limited application timing and product selection. Fall application from 2009 was minimal due to limited weather opportunities.
2011 - The fall of 2010 provided ample time for tillage and application of nitrogen. The spring was followed up by wet weather as growers had a hard time getting all the planting done early with adequate stands of corn. Conditions for the later part of 2011 were dry.
2012 – Although we had intended to take many stalk samples during 2012 (Partner with University of Missouri - http://nmplanner.missouri.edu/tools/Stalk_Nitrate_Challenge.asp), the extreme drought caused drastic yield losses in the watershed and across the state, hindering this project. Only a few irrigated fields were sampled after black layer. However, field staff used this time to survey growers regarding their nutrient and other best management practices used in the watershed.

The 2012 Nutrient Management & Trading Survey in Appendix D was given to growers in the Goodwater Creek and Long Branch Creek watersheds to gain better knowledge on a bigger scale of nutrient practices and interest in future trading opportunities. Growers were polled anonymously to answer multiple choice questions regarding operation size, types of fertilizer commonly used, preferred nitrogen application timing and number passes, use of nitrification inhibitors, participation of state programs, along with gauge of use and willingness to utilize different BMPs on their operations. There was a 93 percent response rate along with good personal feedback after the survey completion. This survey also included questions pertaining to nutrient trading; Geosyntec Consultants refer to and analyzed that portion of the survey. Please see Appendix D for the list of questions asked and refer to Appendix C for results found when surveying growers in the area.

The growers polled proved to be a wide range of 250-3000+ acre operations. This provided a solid glimpse into the average practices that growers use in their farming businesses on any given year. We know that NH_3 has risen in price and at times was in short supply in the last several years. However, it is the preferred choice of nitrogen application among growers 90 percent of the time. The timing of nitrogen, NH_3 or another source is preferred to be applied in spring 60 percent of the time, but growers are split equally regarding their preferences to apply their nitrogen in one or two passes. However, comments were made that this application depends on weather and available days for tillage. To have the extra reassurance that their N source is staying where applied, growers are using some sort of nitrification inhibitor 80 percent of the time. Other tools growers predominately rely on in the watersheds to aid in farm management include: yield monitors-73percent;, tissue/stalk sampling- 63 percent, grid soil sampling- 57% percent, soil and yield maps- 47 percent, variable N application -30 percent. One may ask what other BMPs these growers implement to help with nutrient management: one-pass tillage-90 percent, no-till-90 percent, terraces- 67 percent, buffer strips- 57 percent, cover crops- 40percent. Future interest for growers lies in cover crops- 67%percent, buffer strips- 60 percent, NMPs- 60 percent, bio-reactors- 20 percent, wetlands- 17 percent. The tillage (and non-tillage) options stay just as high as the current utilization. Operations have an increased need for decreasing weed pressure, keeping products on the field and trying to capture anything that may escape by utilizing least cost, highly effective, small foot print structures.

2011 Goodwater Creek
Stalk Nitrate Aggregate Results

	First Application							Second Application						N Samples taken		
Field ID	Date Applied	Form / Product Used	Rate Applied (lbs)	Method	Incorp Y/N	Inhibitor Used Y/N	Irrigated Y/N	Done Y/N	Date	Form / Product Used	Method	Applied (lbs)	Ave. Harvest Yield	Date	Time	N Test Results (ppm)
02_01_01	Mid Nov	NH_3	190	injection		Y	Y	Y	10-Jul	UAN	liquid	40	190	12-Sep	9:30 AM	1230
02_01_01n	Mid Nov	NH_3	190	injection		Y	N	N					110	30-Aug	4:35 PM	2744
02_03_04	Early April	NH_3	130	injection		N	N	N					105	26-Sep	10:35 AM	215
02_03_50	4/10/2011	NH_3	160	injection		Y	Y	Y	End April	Ammoniun	Dry spread	28	195	24-Oct	10:45 AM	41
02_04_01	Late Oct	chicken manure	65	dry spread	Y	N	N	Y	Late April	NH_3	injection	150	100	30-Aug	4:00 PM	1581
02_04_05	Late April	NH_3	125	injection		N	N	Y	Mid June	NH_3	injection	50	100	12-Sep	9:40 AM	239
02_04_09	Late April	NH_3	125	injection		N	N	Y	Mid June	NH_3	injection	40	77	30-Aug	3:10 PM	1357
02_04_11	Late April	NH_3	125	injection		N	N	Y	Mid June	NH_3	injection	133	90	12-Sep	11:45 AM	1162
02_05_01	4/12/2011	NH_3	135	injection		Y	N	Y	13-Jun	UAN	liquid	28	115	12-Sep	12:15 PM	612
02_05_04	4/12/2011	NH_3	150	injection		Y	N	Y	13-Jun	UAN	liquid	28	140	30-Aug	3:33 PM	1489
02_06_05	Mid April	NH_3	140	injection		Y	N	N					90	12-Sep	9:50 AM	3705
02_11_03	4/11/2011	Urea	110	Dry spread	Y	N	N	N					86	24-Aug	8:15 AM	897
02_11_04	5/7/2011	UAN	110	Liquid spread	Y	N	N	N					86	30-Aug	2:49 PM	197
02_13_11	10/22/2011	Ammonium Nitrate	22	dry spread	Y	N	N	Y	Late Oct	NH_3	injection	150	126	12-Sep	11:55 AM	1071
02_14_01	Early april	NH_3	165	injection		Y	N	N					100	17-Oct	3:00 PM	452
02_22_03	Early April	NH_3	160	injection		N	N	N					91	12-Sep	8:50 AM	1579
02_23_01	Late April	NH_3	150	injection		Y	N	N					100	12-Sep	9:10 AM	1454
02_24_03	Mid Oct	hog manure	?	Liquid spread	Y	N	N	N	12-Apr	NH_3	injection	200	80	30-Aug	2:25 PM	2658
02_27_03	1-May-11	NH_3	150	injection		N	N	N					79	12-Sep	10:05 AM	548
02_27_08	1-Apr-11	Ammonium Nitrate	125	dry spread	Y	N	N	N					48	17-Oct	3:45 PM	103
02_28_04	15-Apr-11	NH_3	150	injection		N	N	N					80	12-Sep	10:40 AM	2121
02_28_07	16-Apr-11	NH_3	150	injection		N	N	N					75	12-Sep	10:50 AM	1940
02_29_01	13-Apr-11	NH_3	155	injection		Y	N	Y	mid June	Ammoniun	Dry spread	30	99	12-Sep	8:45 AM	1596
02_29_02	Late Oct	NH_3	155	injection		Y	N	Y	early June	Ammoniun	Dry spread	30	94	24-Aug	10:00 AM	4220
02_32_01	Late Nov	NH_3	150	injection -hp		Y	N	N					87	24-Aug	9:15 AM	1493
02_32_50	Late Nov	NH_3	150	injection		Y	N	N					95	12-Sep	11:00 AM	48
02_43_03w	11-Apr	NH_3	135	injection		Y	N	N					114	12-Sep	10:15 AM	1388
02_43_03e	11-Apr	NH_3	135	injection		Y	N	N					115	12-Sep	10:25 AM	768
02_61_04	11-Apr	UAN	125	Liquid spread	Y	N	N	N					75	24-Aug	8:45 AM	294
02_09_18out	Mid May	cattle manure	60	dry spread	N	N	N	Y	24-Jun	Ammoniun	Dry spread	100	102	4-Oct	11:15 AM	79
02_09_18In	Mid May	cattle manure	60	dry spread	N	N	N	Y	12-Jul	UAN	liquid	variable 60	81	16-Oct	11:15 AM	24
02_09_08	Late Nov	NH_3	150	injection		Y	N	N					100	12-Sep	11:25 AM	51
02_09_13	Late Nov	NH_3	150	injection		Y	N	N					90	12-Sep	11:15 AM	2316
BBB_01	Late Nov	Ammonium Nitrate	30	dry spread	N	N	N	Y	late april	NH_3	injection	120	90	19-Sep	1:00 PM	27
BBB_02	Late Nov	Ammonium Nitrate	30	dry spread	N	N	N	Y	late april	NH_3	injection	120	70	19-Sep	2:00 PM	252
BBB_03	Late Nov	Ammonium Nitrate	30	dry spread	N	N	N	Y	late april	NH_3	injection	120	95	18-Oct	11:15 AM	166
BBB_04	Late Nov	Ammonium Nitrate	30	dry spread	N	N	N	Y	late april	NH_3	injection	120	90	18-Oct	10:45 AM	23
BBB_05	Late Nov	Ammonium Nitrate	30	dry spread	N	N	N	Y	late april	NH_3	injection	120	115	18-Oct	10:00 AM	832

Figure 13: Example; Participant Field Inputs and Yearly Summary

4 Results

4.1 Weather

On July 17, 2012 the United States Department of Agriculture (USDA) declared 97 counties in Missouri (including Shelby County) "primary natural disaster areas due to damage and losses caused by drought and excessive heat that began April 1, 2012". (USDA, Vilsack) On July 23, Governor Nixon declared a state of emergency due to the drought and extreme heat. See Appendix E for official document.

4.2 Hydrology

4.2.1 Wetlands

ERC staff presented the EPIC project and design (See Appendix E) at the 2011 Soil and Water Conservation Services (SWCS) annual meeting in Washington D.C. At the presentation staff focused on the scarcity of studies that evaluate the performance of the various agriculture BMPs. Importance of evaluating and valuing nutrient removal efficiencies is critical to the development of accurate nutrient removal credits. The data collected from these conservation practices will be valuable in developing future planning and trading frameworks for achieving nutrient, sediment, and herbicide reduction goals. These practices will help comply with water quality criteria; thereby, reducing the likelihood of waters being placed on the impaired waters list. If successful, these practices could become important BMPs for addressing Gulf of Mexico hypoxia problems and water quality nutrient issues specific to the state of Missouri. However, these practices will only be accepted by growers if they make economic sense; therefore, will also demonstrate the cost-effectiveness of implementation.

The wetlands and bio-reactors were also visited by National NRCS staff from Fort Worth, TX, David Buland, Economist and Richard Weber, Constructed Wetlands Specialist in October of 2012. The lasting drought effects were evident. The unique design of the 3-cell wetlands and bio-reactors draining terrace runoff along with their small footprint were viewed in person (See Figure 14).

Figure 14: Nation USDA-NRCS Tour Drought Stricken Wetlands and Bio-Reactors in October 2012

Unfortunately, due to the 2012 drought, no runoff samples were collected during the initial field season. No hydrology runoff data was collected. Therefore no hydrology data validation was possible. No runoff events were captured (0 storms/events) during the initial (set-up) field season. Therefore, the runoff sampling data collection is determined as incomplete as per the EPIC QAPP. However, the initial field season was fully used to establish plants, condition the bio-reactor and to calibrate and adjust field data collection and sampling equipment. No water quality samples (0 samples/events) during the initial (set-up) field season. The historic drought of 2012 did not provide enough runoff for reliable and meaningful data collection. Therefore, the water quality sample data collection is determined as incomplete as per the EPIC QAPP. However, the initial field season was fully used to establish plants, condition the bio-reactor and to calibrate and adjust field data collection and sampling equipment.

It is the opinion of the ERC and Geosyntec consultants that future projects requiring the construction of best management practices like wetlands and bio-reactors, should allow (at a minimum) two years for practice construction and establishment and an additional three years for monitoring water quality effects. A three or four year project timeline is inadequate to properly construct and monitor practices that require plant species establishment. This is a lesson learned and should be considered by future projects.

ERC Executive Director Mark White presented preliminary results from the EPIC project during a panel discussion at the 2013 Commodity Classic in Kissimmee, FL. The panel discussion was titled *Water Quality: Not Just Their Problem.* The session was well attended with many questions regarding nutrient trading.

4.2.2 Bio-Reactor

4.3 Water Quality (Incomplete due to weather)

4.3.1 Wetlands

4.3.2 Bio-Reactor

5 Discussion (Incomplete due to weather)

5.1 BMP Construction Cost and Effectiveness of Nutrient Removal

5.1.1 Cost of BMP construction

Costs of constructed BMPs for an interested landowner in the future could vary from the below costs. EPIC project costs were increased by requirements for valid water quality analysis. Items such as washed rock, clean chips, polyethylene liner, pipe, types and quantity of wetland plants, etc. would fluctuate depending on the chosen site.

Table 5: Cost of BMP Construction

Cost of Survey and Design - Wetlands and Bio-Reactors	
Tasks provided by contractor - Experimental Design, BMPs of filter strips and wetlands, site visits, data management and data analysis	
	$49,000

North Field Wetland One-Cell - Supplies and Construction Cost	
Design, Evaluation and Construction of Large One Cell Wetland	10,500
Dual wall HDPE pipe and fittings, assorted fittings	
AgriDrain Inlet flow control structure, concrete, Geotechnical Fabric	11,996
Clean Rock (3" or larger)	650
Wetland plants	4,000
	$27,146.00

Bio Reactor North Field - Supplies and Construction Cost	
Design, Evaluation and Construction of Large Bio-Reactor	9,690
PVC pipe, various fittings, Polyethylene Liner	5,392
Washed Rock (1")	4,267
Wood - Chips	7,936
	$27,285.00

5.1.2 Effectiveness of BMP in Nutrient Removal

5.2 Load Reductions (Incomplete due to weather)

5.2.1 Wetlands

5.2.2 Bio-Reactors

5.2.3 Value of BMP (cost per pound removed per year)

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7 Appendix A – Water Quality Data (Incomplete due to weather)

8 Appendix B – Weather Station Data (Daily Mean)

TIMESTAMP mm/dd/yyyy	RECORD RN	Barometric Pressure (mmHg) Daily Average	Total Rainfall (mm) Daily Total	Relative Humidity (%) Daily Average	Max. Rel. Humidity (%) Daily Maximum	Max. Rel. Humidity Time of Max. (24:00)	Min. Rel. Humidity (%) Daily Minimum	Min. Rel. Humidity Time of Min. (24:00)
12/17/2011	0	774.61	0.0	80.22	93.88	21:14	54.17	16:21
12/18/2011	1	772.34	0.0	78.71	99.53	22:46	52.96	16:00
12/19/2011	2	768.39	0.0	78.35	100.00	5:32	48.98	15:25
12/20/2011	3	765.43	6.5	76.27	97.10	23:19	55.71	0:00
12/21/2011	4	763.34	4.4	99.83	100.00	2:08	96.32	0:03
12/22/2011	5	760.45	1.0	90.25	100.00	0:00	61.75	16:06
12/23/2011	6	768.17	0.0	94.92	100.00	5:03	82.53	23:35
12/24/2011	7	773.84	0.0	77.63	85.52	0:51	64.54	16:04
12/25/2011	8	772.76	0.0	75.23	93.63	5:43	47.58	15:20
12/26/2011	9	773.06	0.0	71.60	97.52	23:56	39.82	16:30
12/27/2011	10	769.06	0.2	88.59	100.00	21:37	65.26	14:52
12/28/2011	11	762.45	0.4	80.71	100.00	0:00	55.15	15:45
12/29/2011	12	764.73	0.0	73.06	98.10	7:09	39.39	15:56
12/30/2011	13	757.91	0.0	66.44	79.20	23:36	49.60	13:56
12/31/2011	14	756.33	0.1	70.84	84.10	9:23	57.55	14:20
1/1/2012	15	759.67	0.0	66.16	100.00	4:12	32.13	18:01
1/2/2012	16	768.63	0.1	55.72	93.94	4:45	28.00	16:21
1/3/2012	17	775.99	0.0	50.89	65.07	5:50	33.53	16:19
1/4/2012	18	772.73	0.0	58.66	93.53	6:28	27.63	15:25
1/5/2012	19	767.37	0.0	59.75	77.08	21:53	41.32	16:54
1/6/2012	20	764.56	0.0	54.75	74.34	8:41	33.79	15:59
1/7/2012	21	760.03	0.0	50.03	61.79	8:47	38.42	14:18
1/8/2012	22	767.97	0.0	62.00	81.55	21:50	42.24	16:50
1/9/2012	23	772.17	0.0	83.54	98.96	22:48	59.14	15:42
1/10/2012	24	769.83	0.0	76.49	98.95	1:58	41.39	15:22
1/11/2012	25	764.27	0.0	63.40	91.65	3:04	29.85	15:52
1/12/2012	26	756.49	0.0	70.52	98.33	8:43	25.66	15:35
1/13/2012	27	760.29	0.0	78.75	93.49	4:22	62.99	10:36
1/14/2012	28	765.82	0.0	74.33	89.88	23:24	57.88	17:28
1/15/2012	29	767.31	0.4	78.64	97.40	2:41	69.20	8:05
1/16/2012	30	767.57	0.0	72.34	99.15	3:55	44.84	15:49
1/17/2012	31	758.46	0.0	69.46	87.53	22:31	45.21	16:23
1/18/2012	32	766.07	2.3	80.95	98.09	3:23	64.63	16:07
1/19/2012	33	768.86	0.0	73.54	93.90	5:17	44.98	15:05
1/20/2012	34	765.81	0.0	63.19	81.33	7:27	52.94	15:56
1/21/2012	35	765.46	0.0	67.14	85.33	23:50	57.84	13:31
1/22/2012	36	768.08	0.0	83.50	92.59	5:16	70.52	16:15
1/23/2012	37	756.18	0.0	97.45	100.00	6:03	90.62	18:55
1/24/2012	38	758.92	0.0	80.85	100.00	0:04	69.94	14:49
1/25/2012	39	770.39	0.0	78.63	98.55	8:37	47.96	16:26
1/26/2012	40	768.97	0.0	87.92	98.37	23:02	74.84	16:12
1/27/2012	41	761.13	0.0	86.23	100.00	5:03	49.58	18:26
1/28/2012	42	764.01	0.0	88.14	100.00	7:06	54.84	14:13
1/29/2012	43	769.93	3.4	75.75	100.00	0:00	50.60	20:24
1/30/2012	44	769.84	0.2	52.59	65.06	22:24	29.87	17:22
1/31/2012	45	763.90	0.0	56.67	74.77	5:28	33.70	17:13

TIMESTAMP mm/dd/yyyy	RECORD RN	Barometric Pressure (mmHg) Daily Average	Total Rainfall (mm) Daily Total	Relative Humidity (%) Daily Average	Max. Rel. Humidity (%) Daily Maximum	Max. Rel. Humidity Time of Max. (24:00)	Min. Rel. Humidity (%) Daily Minimum	Min. Rel. Humidity Time of Min. (24:00)
2/1/2012	46	762.15	0.0	74.18	89.51	21:02	64.61	13:12
2/2/2012	47	767.73	0.0	78.26	100.00	5:46	43.41	17:11
2/3/2012	48	770.88	0.0	66.09	100.00	3:02	32.21	16:26
2/4/2012	49	770.77	5.9	75.93	98.00	21:11	60.15	0:43
2/5/2012	50	767.26	2.1	99.17	100.00	4:57	92.01	0:45
2/6/2012	51	772.30	0.3	89.36	100.00	0:00	65.91	14:04
2/7/2012	52	771.09	0.0	90.98	100.00	0:15	63.32	17:05
2/8/2012	53	771.91	0.0	97.10	100.00	0:00	88.64	10:46
2/9/2012	54	775.37	0.0	85.82	98.51	0:25	62.34	18:07
2/10/2012	55	771.79	0.0	84.09	97.16	4:27	70.86	17:33
2/11/2012	56	768.06	0.0	78.31	91.29	8:36	56.38	16:32
2/12/2012	57	778.53	0.0	54.06	73.34	2:36	29.61	17:22
2/13/2012	58	776.66	0.0	49.84	76.61	22:45	20.74	15:30
2/14/2012	59	764.95	0.6	81.60	100.00	18:11	38.16	5:40
2/15/2012	60	762.22	0.4	91.54	100.00	0:00	68.42	16:59
2/16/2012	61	763.73	1.0	96.20	100.00	19:55	89.75	12:48
2/17/2012	62	768.94	0.1	79.13	100.00	0:00	41.39	16:24
2/18/2012	63	768.25	0.0	69.14	96.39	2:42	39.83	15:36
2/19/2012	64	769.37	0.0	67.62	85.74	4:59	44.88	16:43
2/20/2012	65	768.50	0.0	62.74	84.14	7:34	32.67	17:26
2/21/2012	66	765.49	0.0	64.26	83.63	7:47	46.15	17:11
2/22/2012	67	759.13	0.5	69.16	98.55	8:51	37.02	17:40
2/23/2012	68	753.84	0.0	56.13	76.08	23:48	38.20	14:16
2/24/2012	69	749.80	0.9	77.65	97.39	6:02	43.65	16:00
2/25/2012	70	762.42	0.1	72.44	97.20	5:36	44.10	16:42
2/26/2012	71	770.94	0.0	57.20	81.73	0:05	33.46	18:05
2/27/2012	72	765.57	0.0	46.52	76.82	23:01	28.40	14:11
2/28/2012	73	774.60	0.0	57.39	91.59	2:43	32.89	17:27
2/29/2012	74	767.22	0.9	63.84	93.78	23:59	39.65	15:13
3/1/2012	75	756.21	0.1	57.72	95.02	2:59	39.36	14:56
3/2/2012	76	759.07	0.0	62.61	94.98	8:03	34.11	16:16
3/3/2012	77	755.46	1.3	84.99	100.00	15:18	63.44	0:01
3/4/2012	78	762.42	0.0	67.24	100.00	23:50	47.02	18:13
3/5/2012	79	763.31	0.0	79.81	98.50	3:25	53.20	15:31
3/6/2012	80	771.09	0.0	62.48	97.01	7:51	32.26	17:49
3/7/2012	81	763.13	0.0	39.81	59.17	7:36	17.30	16:49
3/8/2012	82	761.48	0.9	58.24	94.85	23:57	46.41	0:03
3/9/2012	83	770.74	4.4	70.65	98.13	6:45	37.42	16:53
3/10/2012	84	777.39	0.0	49.68	73.36	3:14	21.18	17:02
3/11/2012	85	773.11	0.0	47.88	75.14	7:43	24.85	17:44
3/12/2012	86	766.96	5.1	74.86	100.00	19:22	42.28	0:16
3/13/2012	87	760.91	0.0	83.09	100.00	0:51	50.92	17:03
3/14/2012	88	765.42	0.0	72.30	100.00	0:00	31.46	17:23
3/15/2012	89	763.88	0.0	68.73	87.59	6:45	49.07	16:42
3/16/2012	90	765.38	0.0	73.90	91.83	7:40	58.66	17:45
3/17/2012	91	764.86	0.0	74.90	92.85	7:20	50.30	15:07

TIMESTAMP mm/dd/yyyy	RECORD RN	Barometric Pressure (mmHg) Daily Average	Total Rainfall (mm) Daily Total	Relative Humidity (%) Daily Average	Max. Rel. Humidity (%) Daily Maximum	Max. Rel. Humidity Time of Max. (24:00)	Min. Rel. Humidity (%) Daily Minimum	Min. Rel. Humidity Time of Min. (24:00)
3/18/2012	92	764.17	0.0	81.53	98.60	7:21	56.61	16:28
3/19/2012	93	763.39	0.0	76.64	100.00	0:37	52.46	13:47
3/20/2012	94	760.75	0.0	71.62	92.35	23:58	44.79	14:51
3/21/2012	95	761.58	3.1	82.18	100.00	2:31	42.40	17:25
3/22/2012	96	763.64	1.3	77.77	100.00	0:03	46.04	17:54
3/23/2012	97	764.06	4.3	84.50	100.00	4:23	60.76	17:45
3/24/2012	98	761.81	1.9	85.86	100.00	2:52	57.20	13:36
3/25/2012	99	762.59	0.1	89.07	99.93	23:59	75.22	17:07
3/26/2012	100	766.30	0.0	79.83	100.00	0:31	44.47	17:30
3/27/2012	101	767.56	0.0	77.35	100.00	0:30	51.56	16:49
3/28/2012	102	763.88	0.0	63.61	80.80	7:29	41.37	17:11
3/29/2012	103	764.52	0.0	52.00	98.64	7:23	23.58	16:40
3/30/2012	104	763.07	7.8	84.72	100.00	10:14	45.04	0:25
3/31/2012	105	759.32	0.0	80.28	95.30	1:42	62.51	17:50
4/1/2012	106	760.71	0.0	82.96	99.89	7:09	58.49	17:58
4/2/2012	107	755.97	0.0	67.65	97.51	7:16	37.46	16:09
4/3/2012	108	757.22	0.0	64.59	93.60	7:23	29.31	17:47
4/4/2012	109	760.31	3.5	72.15	100.00	22:01	51.37	12:49
4/5/2012	110	760.75	0.0	77.20	86.55	0:23	57.09	22:30
4/6/2012	111	763.08	2.3	72.17	97.57	6:18	38.51	16:38
4/7/2012	112	769.27	0.0	63.20	82.52	22:54	38.28	17:05
4/8/2012	113	769.84	0.1	78.96	100.00	22:34	60.58	10:29
4/9/2012	114	772.26	0.0	62.15	100.00	0:00	22.74	14:30
4/10/2012	115	768.26	0.0	41.05	89.25	7:04	18.38	11:05
4/11/2012	116	769.50	0.0	40.11	82.24	7:03	23.52	18:19
4/12/2012	117	771.96	0.0	50.73	94.54	23:53	26.22	17:19
4/13/2012	118	769.22	0.0	60.22	100.00	4:56	27.08	16:06
4/14/2012	119	764.86	7.8	84.88	97.53	15:14	56.75	7:26
4/15/2012	120	760.57	3.1	90.22	100.00	4:29	72.91	23:42
4/16/2012	121	755.24	4.4	81.87	100.00	17:15	71.55	23:59
4/17/2012	122	763.91	0.0	65.78	99.25	23:57	42.05	16:41
4/18/2012	123	771.93	0.0	71.43	100.00	0:20	39.45	16:23
4/19/2012	124	766.94	0.0	65.89	90.48	6:35	41.63	16:52
4/20/2012	125	760.87	1.5	63.94	99.83	23:59	37.84	18:05
4/21/2012	126	763.10	0.9	84.27	100.00	0:01	67.89	19:28
4/22/2012	127	765.59	0.6	74.95	100.00	2:48	42.41	16:35
4/23/2012	128	765.91	0.1	81.51	100.00	3:55	50.51	18:34
4/24/2012	129	767.20	0.0	72.30	100.00	2:48	37.25	17:46
4/25/2012	130	758.8527	0	64.31	98.65	0:52	39.46	16:29
4/26/2012	131	754.5103	0	69.47	100.00	2:39	41.43	17:47
4/27/2012	132	762.3195	0	56.95	88.16	6:24	37.61	16:24
4/28/2012	133	765.2271	0.2	47.45	72.10	23:45	30.09	9:55
4/29/2012	134	762.1068	0	75.45	93.19	6:52	61.32	14:18
4/30/2012	135	765.9099	25.3	96.61	100.00	10:39	84.16	0:04
5/1/2012	136	764.1491	2.6	95.18	100.00	0:00	83.58	19:45
5/2/2012	137	760.6794	8.2	90.32	100.00	0:00	64.98	16:41

TIMESTAMP mm/dd/yyyy	RECORD RN	Barometric Pressure (mmHg) Daily Average	Total Rainfall (mm) Daily Total	Relative Humidity (%) Daily Average	Max. Rel. Humidity (%) Daily Maximum	Max. Rel. Humidity Time of Max. (24:00)	Min. Rel. Humidity (%) Daily Minimum	Min. Rel. Humidity Time of Min. (24:00)
5/3/2012	138	760.4827	0	81.33	96.22	11:07	52.60	17:53
5/4/2012	139	762.0078	0	83.75	96.05	5:44	66.20	18:41
5/5/2012	140	762.1857	1	85.99	100.00	5:28	63.72	15:02
5/6/2012	141	761.8287	0	85.02	100.00	2:31	59.55	16:33
5/7/2012	142	761.4594	1.1	82.69	100.00	1:36	50.88	14:20
5/8/2012	143	763.1335	0.3	81.20	100.00	2:29	47.10	19:07
5/9/2012	144	764.6805	0	59.84	95.84	23:46	29.02	12:28
5/10/2012	145	764.9606	0	73.52	100.00	23:30	40.15	17:18
5/11/2012	146	764.3199	0	68.21	100.00	0:00	36.14	17:18
5/12/2012	147	766.6581	0	69.60	96.53	4:14	42.15	14:17
5/13/2012	148	769.9559	0	80.81	97.41	6:06	65.96	15:36
5/14/2012	149	769.8234	0	68.09	100.00	1:47	31.82	17:04
5/15/2012	150	767.7355	0	61.83	100.00	0:27	17.13	13:19
5/16/2012	151	765.1044	0	63.81	100.00	1:37	33.44	16:17
5/17/2012	152	766.1881	0	54.42	98.46	3:54	32.02	16:44
5/18/2012	153	766.1993	0	50.57	93.18	2:09	22.11	15:30
5/19/2012	154	763.6164	0	53.81	88.18	4:14	31.02	15:11
5/20/2012	155	763.4863	0	52.14	70.50	6:20	34.03	14:10
5/21/2012	156	765.8495	0	63.70	83.50	22:31	51.67	16:50
5/22/2012	157	769.4515	0	56.84	93.69	23:54	28.36	16:36
5/23/2012	158	765.2329	0	58.61	100.00	3:01	25.44	17:02
5/24/2012	159	758.9159	0	50.71	77.33	6:04	29.18	14:45
5/25/2012	160	755.0852	0	51.66	81.24	23:59	32.09	13:10
5/26/2012	161	763.0782	0	68.58	92.26	5:16	40.89	15:04
5/27/2012	162	764.1613	0	69.72	88.15	23:59	47.08	16:10
5/28/2012	163	762.3061	0	59.74	91.93	0:57	30.69	15:20
5/29/2012	164	759.6068	0.2	56.12	80.09	22:11	38.82	23:58
5/30/2012	165	762.5218	0	45.92	87.06	6:45	19.71	12:05
5/31/2012	166	763.4882	0	48.43	85.72	6:52	30.04	16:40
6/1/2012	167	761.5948	2.2	80.28	97.75	15:46	48.57	1:46
6/2/2012	168	763.5533	0	73.24	100.00	2:21	36.16	16:32
6/3/2012	169	761.366	0.2	64.92	94.23	5:01	33.71	16:15
6/4/2012	170	761.5249	0	68.53	99.95	3:37	39.77	16:40
6/5/2012	171	760.6791	0	76.59	100.00	1:24	47.32	13:35
6/6/2012	172	763.6777	0	62.00	100.00	4:04	37.82	13:44
6/7/2012	173	765.6624	0.0	54.09	77.67	5:52	32.13	17:14
6/8/2012	174	767.6066	0.0	57.07	99.13	4:30	28.81	16:44
6/9/2012	175	765.842	0.0	55.60	99.34	5:42	26.07	17:56
6/10/2012	176	761.8614	0.0	51.64	93.38	3:51	28.53	15:45
6/11/2012	177	760.7418	0.0	60.32	77.49	5:42	41.89	15:58
6/12/2012	178	762.1132	6.9	77.47	100.00	6:41	57.23	19:34
6/13/2012	179	767.7354	0.0	57.36	99.56	4:25	25.04	18:47
6/14/2012	180	767.3046	0.0	64.24	100.00	4:56	35.04	18:02
6/15/2012	181	764.7833	0.0	56.74	94.80	6:30	26.99	17:00
6/16/2012	182	763.6862	2.7	66.16	98.95	23:09	41.25	14:34
6/17/2012	183	764.1891	12.4	78.84	100.00	19:04	40.88	16:09

TIMESTAMP mm/dd/yyyy	RECORD RN	Barometric Pressure (mmHg) Daily Average	Total Rainfall (mm) Daily Total	Relative Humidity (%) Daily Average	Max. Rel. Humidity (%) Daily Maximum	Max. Rel. Humidity Time of Max. (24:00)	Min. Rel. Humidity (%) Daily Minimum	Min. Rel. Humidity Time of Min. (24:00)
6/18/2012	184	762.5807	0.1	80.76	100.00	0:00	59.23	12:04
6/19/2012	185	758.6016	0.0	66.10	85.71	3:52	43.64	17:22
6/20/2012	186	761.9864	0.0	66.20	86.50	6:20	50.73	16:09
6/21/2012	187	763.3097	0.0	63.62	80.59	6:11	45.07	17:41
6/22/2012	188	765.1032	0.5	72.17	98.86	7:28	41.54	15:32
6/23/2012	189	765.9946	0.0	67.03	100.00	1:15	31.50	14:50
6/24/2012	190	764.5483	0.2	76.51	97.00	4:25	51.20	15:00
6/25/2012	191	763.0655	0.0	59.02	83.96	23:54	36.33	17:31
6/26/2012	192	763.8685	0.0	67.52	93.93	3:46	47.05	17:00
6/27/2012	193	763.9069	0.0	56.04	81.09	6:29	28.13	14:28
6/28/2012	194	761.8333	0.0	46.61	75.31	0:54	32.54	18:06
6/29/2012	195	762.0858	0.0	52.70	79.36	2:49	34.09	16:31
6/30/2012	196	761.6823	0.0	50.10	90.42	5:17	17.18	15:43
7/1/2012	197	760.9418	1.9	58.62	87.58	16:40	32.93	15:13
7/2/2012	198	763.2935	0.2	77.91	100.00	4:09	43.48	14:14
7/3/2012	199	763.9614	0.0	67.53	100.00	4:26	34.17	16:51
7/4/2012	200	762.7875	0.0	63.89	92.41	5:43	36.03	16:19
7/5/2012	201	762.8531	0.0	51.19	81.96	5:40	21.39	16:12
7/6/2012	202	764.0508	0.0	58.00	90.06	5:57	27.04	16:30
7/7/2012	203	764.4929	0.0	56.05	96.45	5:28	23.23	18:36
7/8/2012	204	764.3226	0.0	51.87	90.22	5:29	21.83	18:04
7/9/2012	205	765.2333	0.0	63.95	85.99	6:25	47.99	15:56
7/10/2012	206	766.0748	0.0	50.11	80.67	5:27	24.43	18:05
7/11/2012	207	765.8864	0.1	63.69	95.79	6:15	35.06	16:56
7/12/2012	208	766.756	2.9	62.53	91.89	3:48	39.56	16:44
7/13/2012	209	765.61	0.0	56.97	95.18	5:26	27.04	16:43
7/14/2012	210	765.6042	18.7	76.18	100.00	15:54	34.59	12:53
7/15/2012	211	765.8425	0.0	79.98	100.00	0:00	43.46	18:14
7/16/2012	212	766.0039	0.0	73.67	100.00	3:46	39.30	17:47
7/17/2012	213	763.92	0.0	74.76	100.00	6:21	41.07	16:21
7/18/2012	214	762.2338	0.0	67.41	98.73	0:11	37.83	16:31
7/19/2012	215	762.2432	0.0	62.86	99.48	4:56	32.29	17:04
7/20/2012	216	762.9368	0.0	53.68	76.00	23:42	29.13	16:14
7/21/2012	217	766.5099	0.0	78.50	95.61	5:03	55.14	17:14
7/22/2012	218	766.9024	0.0	71.07	100.00	2:11	29.17	17:48
7/23/2012	219	766.2284	0.0	59.78	89.50	4:00	28.47	18:18
7/24/2012	220	765.2155	0.0	54.27	84.69	23:32	27.41	17:03
7/25/2012	221	763.1683	0.0	56.27	86.66	6:25	30.73	16:08
7/26/2012	222	759.5887	0.0	52.86	90.01	3:01	29.45	16:31
7/27/2012	223	760.2329	3.6	78.84	100.00	5:23	6.23	18:54
7/28/2012	224	763.5178	0.0	64.42	97.20	0:07	35.91	15:45
7/29/2012	225	767.58	0.0	67.98	100.00	3:48	38.16	16:55
7/30/2012	226	764.7626	6.7	76.45	100.00	6:01	47.55	18:26
7/31/2012	227	763.0374	0.0	89.97	100.00	6:40	68.77	19:20
8/1/2012	228	763.3218	0.0	72.21	100.00	0:00	36.63	16:34
8/2/2012	229	762.6539	0.0	63.10	100.00	5:13	24.57	17:45

TIMESTAMP mm/dd/yyyy	RECORD RN	Barometric Pressure (mmHg) Daily Average	Total Rainfall (mm) Daily Total	Relative Humidity (%) Daily Average	Max. Rel. Humidity (%) Daily Maximum	Max. Rel. Humidity Time of Max. (24:00)	Min. Rel. Humidity (%) Daily Minimum	Min. Rel. Humidity Time of Min. (24:00)
8/3/2012	230	760.1312	0.0	72.30	98.18	23:49	48.80	17:32
8/4/2012	231	760.5334	0.0	76.92	100.00	1:17	36.49	15:48
8/5/2012	232	761.1735	0.0	73.38	95.32	6:47	53.05	16:32
8/6/2012	233	767.8217	0.0	60.91	100.00	5:05	29.85	16:11
8/7/2012	234	767.6415	0.0	60.26	100.00	5:23	22.29	15:57
8/8/2012	235	764.3588	0.0	54.44	96.78	6:09	18.81	16:30
8/9/2012	236	763.9268	3.0	83.16	100.00	21:54	62.21	0:08
8/10/2012	237	762.3958	0.0	74.79	100.00	5:21	45.73	14:21
8/11/2012	238	764.8951	0.0	72.11	98.40	3:58	41.18	16:32
8/12/2012	239	765.7576	0.0	66.17	100.00	1:09	25.76	18:13
8/13/2012	240	763.7304	1.1	75.65	94.04	11:40	48.24	16:44
8/14/2012	241	763.3212	0.0	87.40	100.00	5:12	72.12	17:36
8/15/2012	242	764.8878	0.0	74.99	100.00	0:00	42.09	18:10
8/16/2012	243	763.0387	0.0	67.11	100.00	3:17	33.30	17:05
8/17/2012	244	762.7105	0.0	62.24	78.03	3:57	45.12	17:40
8/18/2012	245	766.2148	0.0	58.38	100.00	6:27	23.10	17:25
8/19/2012	246	764.8486	0.0	58.52	100.00	6:37	25.40	15:47
8/20/2012	247	764.5244	0.0	54.54	88.39	6:34	23.07	16:10
8/21/2012	248	764.8739	0.1	69.28	99.89	6:23	35.81	17:11
8/22/2012	249	765.8065	0.0	52.97	98.27	5:29	24.37	17:04
8/23/2012	250	765.6284	0.0	47.11	83.37	6:56	17.77	15:45
8/24/2012	251	765.4293	0.0	45.37	78.68	6:20	21.62	15:45
8/25/2012	252	764.517	0.0	46.08	79.58	7:15	24.44	16:38
8/26/2012	253	763.8031	1.3	67.87	97.35	17:39	38.31	13:14
8/27/2012	254	764.1638	1.6	91.65	100.00	21:00	74.38	18:49
8/28/2012	255	767.2941	0.0	75.32	100.00	0:00	31.77	17:17
8/29/2012	256	767.2318	0.0	66.61	100.00	1:17	26.04	16:54
8/30/2012	257	765.3615	0.0	62.97	100.00	6:16	28.78	16:47
8/31/2012	258	764.4877	0.0	55.48	98.85	6:27	21.83	15:42
9/1/2012	259	764.2656	18.6	89.73	100.00	12:45	61.20	0:42
9/2/2012	260	760.4538	6.1	97.42	100.00	0:00	85.94	15:53
9/3/2012	261	762.0267	0.2	92.06	100.00	0:00	67.55	18:08
9/4/2012	262	762.8279	0.0	81.21	100.00	1:30	49.79	17:08
9/5/2012	263	761.9047	0.3	75.31	100.00	0:00	39.55	14:42

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (degrees C) Daily Average	Relative Humidity (%) Daily Average	Solar Radiation (kW/m^2) Daily Average	Wind Speed (m/sec) Daily Average	Evapotranspiration Daily Total
12/17/2011	0	-0.54	80.22	0.1546	0.668	0.14730
12/18/2011	1	1.11	78.71	0.0944	1.389	0.36991
12/19/2011	2	4.39	78.35	0.0837	1.893	0.59982
12/20/2011	3	7.73	76.27	0.0196	2.168	0.49922
12/21/2011	4	2.85	99.83	0.0108	2.588	0.00912
12/22/2011	5	3.06	90.25	0.0701	2.051	0.23780
12/23/2011	6	-0.07	94.92	0.0139	2.288	0.08302
12/24/2011	7	-2.25	77.63	0.0828	2.125	0.32305
12/25/2011	8	0.51	75.23	0.1095	1.748	0.45191
12/26/2011	9	2.46	71.60	0.1140	1.477	0.49194
12/27/2011	10	-0.54	88.59	0.0471	1.606	0.29544
12/28/2011	11	2.35	80.71	0.0950	2.024	0.46168
12/29/2011	12	2.25	73.06	0.1103	1.431	0.62155
12/30/2011	13	7.01	66.44	0.0990	2.106	0.77697
12/31/2011	14	8.19	70.84	0.0460	3.374	0.97735
1/1/2012	15	7.16	66.16	0.1158	3.420	1.63909
1/2/2012	16	3.06	55.72	0.1203	3.996	1.25836
1/3/2012	17	-3.70	50.89	0.1219	3.163	0.89555
1/4/2012	18	-4.53	58.66	0.1164	2.264	0.84421
1/5/2012	19	3.26	59.75	0.1198	1.578	0.66559
1/6/2012	20	7.52	54.75	0.1190	2.260	1.23158
1/7/2012	21	9.82	50.03	0.1210	2.201	1.33240
1/8/2012	22	3.17	62.00	0.1152	1.109	0.52092
1/9/2012	23	-0.55	83.54	0.0574	0.672	0.18856
1/10/2012	24	-0.22	76.49	0.1223	0.952	0.48993
1/11/2012	25	3.47	63.40	0.1262	1.029	0.72662
1/12/2012	26	1.96	70.52	0.1242	1.524	0.57857
1/13/2012	27	-9.13	78.75	0.0728	3.447	0.26216
1/14/2012	28	-10.36	74.33	0.1044	1.981	0.23930
1/15/2012	29	-5.15	78.64	0.0832	1.844	0.25233
1/16/2012	30	0.62	72.34	0.1305	3.866	1.05503
1/17/2012	31	9.73	69.46	0.1146	2.963	1.16869
1/18/2012	32	-3.09	80.95	0.0663	2.725	0.30507
1/19/2012	33	-6.63	73.54	0.1014	2.323	0.49834
1/20/2012	34	-6.75	63.19	0.0883	3.329	0.51178
1/21/2012	35	-9.09	67.14	0.0223	3.513	0.43663
1/22/2012	36	-6.70	83.50	0.0584	3.048	0.25040
1/23/2012	37	2.39	97.45	0.0309	4.330	0.06193
1/24/2012	38	1.48	80.85	0.0394	3.484	0.45072
1/25/2012	39	-1.16	78.63	0.1339	0.730	0.22473
1/26/2012	40	0.13	87.92	0.0435	2.133	0.23312
1/27/2012	41	2.91	86.23	0.0673	1.617	0.26218
1/28/2012	42	-0.18	88.14	0.0616	1.055	0.21045
1/29/2012	43	-0.70	75.75	0.0672	1.889	0.39639
1/30/2012	44	0.29	52.59	0.1492	1.708	0.66361

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (degrees C) Daily Average	Relative Humidity (%) Daily Average	Solar Radiation (kW/m^2) Daily Average	Wind Speed (m/sec) Daily Average	Evapotranspiration Daily Total
1/31/2012	45	8.74	56.67	0.1364	3.036	1.58564
2/1/2012	46	12.04	74.18	0.0904	2.815	0.94570
2/2/2012	47	5.21	78.26	0.1357	0.500	0.27684
2/3/2012	48	6.63	66.09	0.1291	0.822	0.60575
2/4/2012	49	6.39	75.93	0.0342	2.843	0.56853
2/5/2012	50	4.26	99.17	0.0195	4.088	0.02479
2/6/2012	51	2.14	89.36	0.1497	2.429	0.26252
2/7/2012	52	0.01	90.98	0.1142	1.267	0.16200
2/8/2012	53	-1.22	97.10	0.0400	1.672	0.07052
2/9/2012	54	-1.28	85.82	0.0416	1.642	0.14140
2/10/2012	55	-2.89	84.09	0.0424	0.972	0.17580
2/11/2012	56	-2.26	78.31	0.0859	2.782	0.35903
2/12/2012	57	-8.35	54.06	0.1748	3.035	0.63046
2/13/2012	58	-6.19	49.84	0.1798	1.698	0.59320
2/14/2012	59	-1.65	81.60	0.0550	3.070	0.26452
2/15/2012	60	0.67	91.54	0.1072	1.736	0.18512
2/16/2012	61	2.66	96.20	0.0487	1.475	0.08290
2/17/2012	62	3.60	79.13	0.1782	1.188	0.36625
2/18/2012	63	5.01	69.14	0.1824	1.858	0.92689
2/19/2012	64	1.26	67.62	0.1840	2.284	0.67370
2/20/2012	65	0.75	62.74	0.1889	1.626	0.63426
2/21/2012	66	2.79	64.26	0.1324	3.939	1.11897
2/22/2012	67	6.21	69.16	0.1706	3.189	1.00044
2/23/2012	68	7.34	56.13	0.1180	1.969	1.11419
2/24/2012	69	8.01	77.65	0.1432	2.606	0.73567
2/25/2012	70	1.78	72.44	0.1529	3.461	0.68740
2/26/2012	71	-1.34	57.20	0.2117	2.362	0.67157
2/27/2012	72	7.54	46.52	0.2057	4.348	2.11440
2/28/2012	73	2.02	57.39	0.2138	1.774	0.78159
2/29/2012	74	6.55	63.84	0.1163	4.210	1.39266
3/1/2012	75	9.98	57.72	0.1908	5.463	2.05874
3/2/2012	76	5.71	62.61	0.2078	2.316	1.20779
3/3/2012	77	2.97	84.99	0.0776	2.853	0.31557
3/4/2012	78	0.22	67.24	0.1500	2.374	0.68030
3/5/2012	79	-2.07	79.81	0.0880	1.050	0.28154
3/6/2012	80	1.83	62.48	0.2301	2.717	1.01166
3/7/2012	81	14.19	39.81	0.2198	6.024	4.01640
3/8/2012	82	17.27	58.24	0.0864	5.622	2.63882
3/9/2012	83	3.69	70.65	0.1415	2.569	0.60720
3/10/2012	84	3.90	49.68	0.2463	1.912	1.03069
3/11/2012	85	8.14	47.88	0.2462	2.639	1.86760
3/12/2012	86	8.59	74.86	0.0760	3.230	0.60792
3/13/2012	87	14.73	83.09	0.1787	2.566	0.76395
3/14/2012	88	14.55	72.30	0.2408	1.602	1.30066
3/15/2012	89	20.15	68.73	0.1719	3.282	1.61899

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (degrees C) Daily Average	Relative Humidity (%) Daily Average	Solar Radiation (kW/m^2) Daily Average	Wind Speed (m/sec) Daily Average	Evapotranspiration Daily Total
3/16/2012	90	20.88	73.90	0.2018	2.385	1.10811
3/17/2012	91	20.69	74.90	0.2142	3.198	1.48924
3/18/2012	92	18.85	81.53	0.1335	3.660	1.17987
3/19/2012	93	19.75	76.64	0.1895	3.858	1.71043
3/20/2012	94	21.51	71.62	0.1793	4.092	2.07017
3/21/2012	95	18.00	82.18	0.1978	3.400	1.78023
3/22/2012	96	18.51	77.77	0.1065	2.114	0.99960
3/23/2012	97	14.36	84.50	0.1808	2.595	0.59687
3/24/2012	98	13.12	85.86	0.1105	1.476	0.46545
3/25/2012	99	14.73	89.07	0.0947	1.111	0.24552
3/26/2012	100	16.27	79.83	0.2360	0.502	0.35656
3/27/2012	101	14.30	77.35	0.2092	3.424	1.29720
3/28/2012	102	19.22	63.61	0.2000	4.068	2.02929
3/29/2012	103	19.65	52.00	0.2776	1.275	1.26592
3/30/2012	104	13.38	84.72	0.0787	2.796	0.35261
3/31/2012	105	16.76	80.28	0.2462	2.293	0.72989
4/1/2012	106	15.92	82.96	0.2383	2.572	0.77187
4/2/2012	107	21.87	67.65	0.2768	1.767	1.42109
4/3/2012	108	22.66	64.59	0.2788	1.772	1.57394
4/4/2012	109	20.38	72.15	0.1591	1.454	0.81374
4/5/2012	110	13.02	77.20	0.0655	3.452	0.83121
4/6/2012	111	9.76	72.17	0.1851	3.095	1.07544
4/7/2012	112	8.53	63.20	0.3111	2.478	1.12547
4/8/2012	113	9.77	78.96	0.0900	1.734	0.62119
4/9/2012	114	10.65	62.15	0.3152	1.010	1.01862
4/10/2012	115	14.09	41.05	0.3025	1.631	1.78121
4/11/2012	116	9.31	40.11	0.3185	2.016	1.50040
4/12/2012	117	6.15	50.73	0.3309	1.642	1.08396
4/13/2012	118	8.93	60.22	0.2948	1.921	1.54069
4/14/2012	119	10.27	84.88	0.0508	4.248	0.58393
4/15/2012	120	17.49	90.22	0.1658	3.371	0.53584
4/16/2012	121	19.22	81.87	0.0742	5.594	1.08915
4/17/2012	122	12.77	65.78	0.3104	3.234	1.31474
4/18/2012	123	12.42	71.43	0.3106	1.448	0.96779
4/19/2012	124	16.36	65.89	0.3209	2.636	1.63992
4/20/2012	125	17.97	63.94	0.2296	2.941	2.02233
4/21/2012	126	8.75	84.27	0.0947	2.530	0.42518
4/22/2012	127	8.59	74.95	0.2588	0.757	0.38497
4/23/2012	128	8.17	81.51	0.1510	2.037	0.59569
4/24/2012	129	8.93	72.30	0.2854	1.250	0.87876
4/25/2012	130	16.08	64.31	0.3109744	1.635533	1.38870
4/26/2012	131	21.58	69.47	0.2776781	1.174386	1.00987
4/27/2012	132	19.61	56.95	0.32239	2.303726	1.74039
4/28/2012	133	10.81	47.45	0.1260936	5.207748	2.47792
4/29/2012	134	15.57	75.45	0.2140764	2.713118	0.88048

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (degrees C) Daily Average	Relative Humidity (%) Daily Average	Solar Radiation (kW/m^2) Daily Average	Wind Speed (m/sec) Daily Average	Evapotranspiration Daily Total
4/30/2012	135	10.16	96.61	0.04297657	2.95485	0.09923
5/1/2012	136	13.99	95.18	0.1065994	0.7922363	0.07781
5/2/2012	137	18.37	90.32	0.2172544	2.006615	0.42969
5/3/2012	138	22.58	81.33	0.205535	3.260596	1.23606
5/4/2012	139	23.11	83.75	0.1964464	3.412723	1.01873
5/5/2012	140	21.90	85.99	0.2054974	2.908282	0.76877
5/6/2012	141	24.26	85.02	0.2784832	1.414712	0.72129
5/7/2012	142	23.96	82.69	0.2101435	1.470977	0.53206
5/8/2012	143	18.17	81.20	0.1811509	2.123287	0.69562
5/9/2012	144	16.59	59.84	0.3293345	1.204299	1.22337
5/10/2012	145	13.69	73.52	0.290787	0.983727	0.67315
5/11/2012	146	16.10	68.21	0.3533137	1.013438	0.99052
5/12/2012	147	18.26	69.60	0.3120999	1.850238	1.35936
5/13/2012	148	16.67	80.81	0.2376648	2.253568	0.77672
5/14/2012	149	16.86	68.09	0.3519588	2.333908	1.60704
5/15/2012	150	17.09	61.83	0.3648864	0.591805	0.81081
5/16/2012	151	19.15	63.81	0.3537861	1.096324	1.23234
5/17/2012	152	18.31	54.42	0.3658297	1.941109	1.70202
5/18/2012	153	17.48	50.57	0.3652128	1.727034	1.99542
5/19/2012	154	21.55	53.81	0.3655314	2.407046	2.56602
5/20/2012	155	25.34	52.14	0.2916952	3.659856	3.32573
5/21/2012	156	22.97	63.70	0.2442895	2.392081	1.46284
5/22/2012	157	15.97	56.84	0.3834883	2.623671	2.19309
5/23/2012	158	17.30	58.61	0.3729369	1.016525	1.31485
5/24/2012	159	22.08	50.71	0.3677267	4.093333	3.67749
5/25/2012	160	25.17	51.66	0.2982371	4.43452	3.79217
5/26/2012	161	23.01	68.58	0.2441739	2.467491	1.62123
5/27/2012	162	27.25	69.72	0.2720801	2.502604	1.84442
5/28/2012	163	26.91	59.74	0.3521881	2.682873	2.47849
5/29/2012	164	27.02	56.12	0.308313	3.034792	2.52902
5/30/2012	165	23.47	45.92	0.3717215	1.361589	1.62645
5/31/2012	166	19.90	48.43	0.3695548	1.888067	1.69122
6/1/2012	167	13.38	80.28	0.06716426	3.017737	0.63999
6/2/2012	168	13.54	73.24	0.3295608	1.313382	0.82353
6/3/2012	169	18.11	64.92	0.3487846	1.521175	1.22984
6/4/2012	170	20.51	68.53	0.2463195	1.108475	1.13013
6/5/2012	171	23.06	76.59	0.31263	2.136754	1.32614
6/6/2012	172	21.60	62.00	0.3505729	1.68934	1.65980
6/7/2012	173	20.96	54.09	0.3343444	1.741188	1.62660
6/8/2012	174	20.13	57.07	0.3572607	1.001056	1.31514
6/9/2012	175	21.66	55.60	0.3594456	1.22943	1.71493
6/10/2012	176	24.30	51.64	0.3507795	2.426755	2.84327
6/11/2012	177	26.26	60.32	0.3322168	3.89	2.90506
6/12/2012	178	23.11	77.47	0.1740327	1.508634	0.50240
6/13/2012	179	19.93	57.36	0.3853164	1.498272	1.64015

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (degrees C) Daily Average	Relative Humidity (%) Daily Average	Solar Radiation (kW/m^2) Daily Average	Wind Speed (m/sec) Daily Average	Evapotranspiration Daily Total
6/14/2012	180	19.01	64.24	0.3350532	1.743251	1.59065
6/15/2012	181	22.97	56.74	0.3590409	2.431616	2.71044
6/16/2012	182	24.77	66.16	0.2852813	2.817513	2.30427
6/17/2012	183	24.99	78.84	0.2821052	2.0905	1.40434
6/18/2012	184	24.57	80.76	0.3208497	1.709074	0.88362
6/19/2012	185	27.45	66.10	0.3554143	3.923835	2.68887
6/20/2012	186	27.46	66.20	0.3489732	4.110854	2.63504
6/21/2012	187	27.99	63.62	0.3401661	3.84829	2.66465
6/22/2012	188	23.81	72.17	0.3210345	1.408316	0.93570
6/23/2012	189	22.03	67.03	0.3797673	0.8144438	1.03468
6/24/2012	190	21.47	76.51	0.1630513	1.46323	0.99589
6/25/2012	191	28.06	59.02	0.3315433	1.6623	1.73228
6/26/2012	192	25.36	67.52	0.3420831	2.464742	1.80805
6/27/2012	193	21.79	56.04	0.3730794	2.004089	2.02720
6/28/2012	194	27.86	46.61	0.3547077	2.668136	3.23548
6/29/2012	195	31.45	52.70	0.3542989	1.503677	1.97986
6/30/2012	196	30.20	50.10	0.3647455	1.256268	2.08920
7/1/2012	197	29.69	58.62	0.3045724	1.519156	1.56920
7/2/2012	198	26.38	77.91	0.1649843	0.5592068	0.50975
7/3/2012	199	28.20	67.53	0.3354539	1.060354	1.26519
7/4/2012	200	29.18	63.89	0.3367282	1.320928	1.51643
7/5/2012	201	30.75	51.19	0.3529544	1.365381	2.15453
7/6/2012	202	29.90	58.00	0.3184742	0.8183181	1.34223
7/7/2012	203	31.50	56.05	0.3398083	0.6232752	1.13232
7/8/2012	204	31.99	51.87	0.3372328	0.9029021	1.42895
7/9/2012	205	27.43	63.95	0.2717921	1.974655	1.61142
7/10/2012	206	27.29	50.11	0.3513811	1.719754	2.07631
7/11/2012	207	25.72	63.69	0.2467391	1.095066	1.10580
7/12/2012	208	24.83	62.53	0.2888486	1.657652	1.36963
7/13/2012	209	26.89	56.97	0.3496259	0.7293566	1.05804
7/14/2012	210	24.59	76.18	0.2256136	1.152094	0.94096
7/15/2012	211	24.83	79.98	0.3322201	0.4845796	0.40170
7/16/2012	212	27.15	73.67	0.3489311	0.7497123	0.77999
7/17/2012	213	27.97	74.76	0.3375507	0.6863678	0.69063
7/18/2012	214	29.36	67.41	0.3403158	1.045865	1.20989
7/19/2012	215	30.41	62.86	0.314018	1.021072	1.35177
7/20/2012	216	31.22	53.68	0.3386801	2.01402	2.06054
7/21/2012	217	23.46	78.50	0.2189902	1.652698	0.80251
7/22/2012	218	25.13	71.07	0.3041314	0.628165	0.71153
7/23/2012	219	28.02	59.78	0.3005554	0.9184662	1.30062
7/24/2012	220	31.13	54.27	0.3369432	1.090193	1.50558
7/25/2012	221	31.42	56.27	0.3292914	0.9628956	1.40186
7/26/2012	222	31.90	52.86	0.3415249	1.76632	2.47657
7/27/2012	223	26.00	78.84	0.2157413	1.450792	0.74952
7/28/2012	224	25.98	64.42	0.3303793	1.428586	1.35226

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (degrees C) Daily Average	Relative Humidity (%) Daily Average	Solar Radiation (kW/m^2) Daily Average	Wind Speed (m/sec) Daily Average	Evapotranspiration Daily Total
7/29/2012	225	24.20	67.98	0.3383464	0.9108413	1.01505
7/30/2012	226	25.40	76.45	0.3056203	1.997137	1.12174
7/31/2012	227	24.20	89.97	0.1028327	0.5903776	0.17520
8/1/2012	228	27.79	72.21	0.3275214	0.5884902	0.63223
8/2/2012	229	27.75	63.10	0.317591	0.6527593	0.78641
8/3/2012	230	25.74	72.30	0.1901579	0.5314117	0.47881
8/4/2012	231	27.40	76.92	0.2821934	0.8282108	0.78798
8/5/2012	232	28.65	73.38	0.154469	1.354011	0.79091
8/6/2012	233	24.96	60.91	0.3395682	1.192302	1.43144
8/7/2012	234	23.83	60.26	0.3442267	0.7263242	1.00124
8/8/2012	235	27.25	54.44	0.325098	0.7236927	1.23721
8/9/2012	236	22.58	83.16	0.07654399	0.7713048	0.30095
8/10/2012	237	23.94	74.79	0.3014409	1.474311	1.10114
8/11/2012	238	20.34	72.11	0.2904784	2.010036	1.19561
8/12/2012	239	20.21	66.17	0.3269177	0.7073928	0.90033
8/13/2012	240	20.27	75.65	0.1590065	1.050932	0.69141
8/14/2012	241	18.92	87.40	0.08142453	1.597906	0.44063
8/15/2012	242	20.12	74.99	0.235916	0.7175544	0.67394
8/16/2012	243	22.81	67.11	0.3159554	1.344521	1.54261
8/17/2012	244	24.29	62.24	0.2357416	1.809536	1.41616
8/18/2012	245	19.17	58.38	0.3402298	1.025097	1.18695
8/19/2012	246	18.78	58.52	0.2600389	0.7355922	0.96372
8/20/2012	247	20.70	54.54	0.2958224	1.311443	1.45128
8/21/2012	248	18.96	69.28	0.2470112	0.7159439	0.81287
8/22/2012	249	22.60	52.97	0.3262656	0.9914654	1.32904
8/23/2012	250	24.44	47.11	0.3165726	0.7139835	1.16716
8/24/2012	251	26.28	45.37	0.2926386	1.066141	1.78700
8/25/2012	252	25.86	46.08	0.2652716	1.484047	2.21262
8/26/2012	253	24.47	67.87	0.1957165	1.748904	1.46080
8/27/2012	254	23.77	91.65	0.1136545	1.181294	0.20673
8/28/2012	255	24.59	75.32	0.294694	1.332729	1.01288
8/29/2012	256	24.69	66.61	0.2857576	0.5817476	0.91525
8/30/2012	257	25.08	62.97	0.2880669	1.009457	1.41607
8/31/2012	258	26.51	55.48	0.2952288	1.150829	1.72268
9/1/2012	259	22.09	89.73	0.03447809	1.834287	0.08237
9/2/2012	260	23.26	97.42	0.1047496	2.195086	0.10985
9/3/2012	261	23.10	92.06	0.1380407	1.702095	0.26633
9/4/2012	262	25.74	81.21	0.2729053	0.7133849	0.58481
9/5/2012	263	27.14	75.31	0.2546546	0.8360176	0.58797

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (C°) Daily Average	Max. Air Temp. (C°) Daily Maximum	Max. Air Temp. Time (24:00)	Air Temp. Min. Daily Minimum	Air Temp. Min. Time (24:00)	Solar Radiation (kW/m^2) Daily Average	Solar Radiation (MJ/m^2) Daily Total	Wind Speed (m/sec) Daily Average	Wind Speed (kW/m^2) Sum (of hourly average)
12/17/2011	0	-0.54	2.70	16:10	-3.77	21:10	0.1546	6.6268	0.668	2.310
12/18/2011	1	1.11	7.86	15:48	-2.49	22:42	0.0944	8.1581	1.389	2.266
12/19/2011	2	4.39	12.44	15:31	-4.09	5:49	0.0837	7.2289	1.893	2.008
12/20/2011	3	7.73	11.05	0:00	2.33	23:55	0.0196	1.6975	2.168	0.472
12/21/2011	4	2.85	3.90	15:21	1.30	7:08	0.0108	0.9349	2.588	0.260
12/22/2011	5	3.06	7.26	16:26	0.61	22:48	0.0701	6.0604	2.051	1.683
12/23/2011	6	-0.07	1.10	0:04	-1.25	23:58	0.0139	1.1969	2.288	0.332
12/24/2011	7	-2.25	0.07	16:09	-3.50	9:32	0.0828	7.1536	2.125	1.987
12/25/2011	8	0.51	7.97	16:06	-4.91	5:35	0.1095	9.4575	1.748	2.627
12/26/2011	9	2.46	9.92	15:33	-2.93	23:47	0.1140	9.8480	1.477	2.736
12/27/2011	10	-0.54	4.32	15:00	-5.97	5:51	0.0471	4.0717	1.606	1.131
12/28/2011	11	2.35	6.80	14:48	-2.02	23:57	0.0950	8.2041	2.024	2.279
12/29/2011	12	2.25	10.73	15:53	-4.86	9:06	0.1103	9.5288	1.431	2.647
12/30/2011	13	7.01	12.62	15:53	3.04	8:54	0.0990	8.5494	2.106	2.375
12/31/2011	14	8.19	10.61	13:55	5.45	0:00	0.0460	3.9721	3.374	1.103
1/1/2012	15	7.16	15.33	16:17	-1.94	7:09	0.1158	10.0056	3.420	2.779
1/2/2012	16	3.06	10.26	0:00	-1.66	23:55	0.1203	10.3899	3.996	2.886
1/3/2012	17	-3.70	-1.08	14:28	-7.94	23:59	0.1219	10.5282	3.163	2.925
1/4/2012	18	-4.53	3.50	16:35	-12.52	8:28	0.1164	10.0580	2.264	2.794
1/5/2012	19	3.26	9.50	15:55	-1.25	8:35	0.1198	10.3477	1.578	2.874
1/6/2012	20	7.52	15.90	16:34	0.93	0:12	0.1190	10.2852	2.260	2.857
1/7/2012	21	9.82	15.02	15:22	5.54	23:50	0.1210	10.4515	2.201	2.903
1/8/2012	22	3.17	8.40	16:49	-2.06	8:38	0.1152	9.9496	1.109	2.764
1/9/2012	23	-0.55	6.05	15:41	-5.53	0:00	0.0574	4.9607	0.672	1.378
1/10/2012	24	-0.22	9.65	15:24	-8.39	7:25	0.1223	10.5657	0.952	2.935
1/11/2012	25	3.47	13.63	15:29	-3.92	2:57	0.1262	10.9079	1.029	3.030
1/12/2012	26	1.96	14.17	15:58	-6.66	7:29	0.1242	10.7319	1.524	2.981
1/13/2012	27	-9.13	-3.50	0:00	-10.89	16:16	0.0728	6.2905	3.447	1.747
1/14/2012	28	-10.36	-6.42	16:26	-14.24	21:58	0.1044	9.0228	1.981	2.506
1/15/2012	29	-5.15	-0.67	16:42	-13.55	0:06	0.0832	7.1895	1.844	1.997
1/16/2012	30	0.62	9.22	16:38	-9.02	6:03	0.1305	11.2791	3.866	3.133
1/17/2012	31	9.73	19.67	16:16	3.20	5:01	0.1146	9.8978	2.963	2.749
1/18/2012	32	-3.09	4.78	0:00	-9.70	23:55	0.0663	5.7287	2.725	1.591
1/19/2012	33	-6.63	0.79	17:07	-13.84	6:02	0.1014	8.7568	2.323	2.432
1/20/2012	34	-6.75	0.38	2:32	-12.56	23:59	0.0883	7.6269	3.329	2.119
1/21/2012	35	-9.09	-5.63	16:19	-12.88	1:16	0.0223	1.9262	3.513	0.535
1/22/2012	36	-6.70	-2.57	16:43	-9.95	6:04	0.0584	5.0475	3.048	1.402
1/23/2012	37	2.39	10.40	20:53	-3.62	0:00	0.0309	2.6661	4.330	0.741
1/24/2012	38	1.48	8.97	0:23	-1.43	23:54	0.0394	3.4004	3.484	0.945
1/25/2012	39	-1.16	7.13	16:29	-7.78	8:23	0.1339	11.5704	0.730	3.214
1/26/2012	40	0.13	3.96	16:12	-2.30	3:47	0.0435	3.7618	2.133	1.045
1/27/2012	41	2.91	9.72	17:02	-0.24	7:57	0.0673	5.8137	1.617	1.615
1/28/2012	42	-0.18	4.04	14:58	-6.56	8:03	0.0616	5.3201	1.055	1.478
1/29/2012	43	-0.70	4.13	17:10	-5.63	8:29	0.0672	5.8020	1.889	1.612
1/30/2012	44	0.29	6.15	15:26	-2.57	20:44	0.1492	12.8907	1.708	3.581
1/31/2012	45	8.74	19.09	16:50	-0.85	0:34	0.1364	11.7846	3.036	3.273
2/1/2012	46	12.04	17.49	13:11	6.62	6:50	0.0904	7.8094	2.815	2.169
2/2/2012	47	5.21	14.77	17:10	-2.75	6:59	0.1357	11.7217	0.500	3.256
2/3/2012	48	6.63	16.01	16:25	-2.83	6:09	0.1291	11.1541	0.822	3.098
2/4/2012	49	6.39	9.38	15:51	2.75	4:45	0.0342	2.9542	2.843	0.821
2/5/2012	50	4.26	6.36	0:00	2.77	23:59	0.0195	1.6832	4.088	0.468
2/6/2012	51	2.14	7.05	15:27	-1.80	23:45	0.1497	12.9379	2.429	3.594
2/7/2012	52	0.01	6.91	17:05	-3.00	8:08	0.1142	9.8652	1.267	2.740

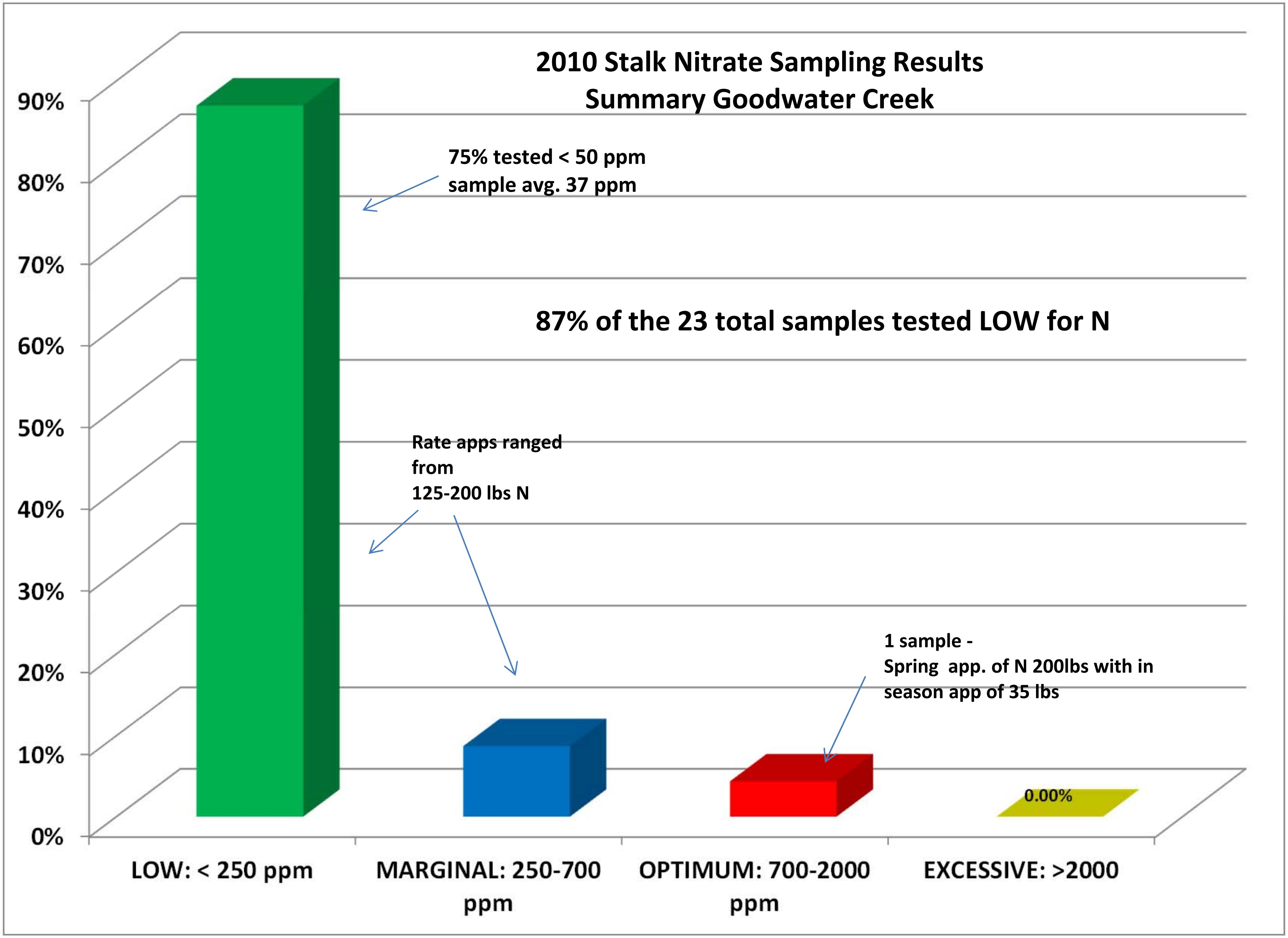
TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (C°) Daily Average	Max. Air Temp. (C°) Daily Maximum	Max. Air Temp. Time (24:00)	Air Temp. Min. Daily Minimum	Air Temp. Min. Time (24:00)	Solar Radiation (kW/m^2) Daily Average	Solar Radiation (MJ/m^2) Daily Total	Wind Speed (m/sec) Daily Average	Wind Speed (kW/m^2) Sum (of hourly average)
2/8/2012	53	-1.22	-0.10	13:56	-3.09	8:42	0.0400	3.4534	1.672	0.959
2/9/2012	54	-1.28	0.49	16:33	-4.72	23:08	0.0416	3.5970	1.642	0.999
2/10/2012	55	-2.89	1.54	17:51	-8.11	3:15	0.0424	3.6656	0.972	1.018
2/11/2012	56	-2.26	2.15	9:22	-8.67	23:58	0.0859	7.4218	2.782	2.062
2/12/2012	57	-8.35	-2.68	16:52	-12.72	8:20	0.1748	15.0985	3.035	4.194
2/13/2012	58	-6.19	1.68	16:59	-12.70	8:03	0.1798	15.5336	1.698	4.315
2/14/2012	59	-1.65	-0.43	7:01	-3.98	0:00	0.0550	4.7516	3.070	1.320
2/15/2012	60	0.67	5.28	16:58	-1.13	0:00	0.1072	9.2594	1.736	2.572
2/16/2012	61	2.66	5.95	17:57	-1.41	0:41	0.0487	4.2071	1.475	1.169
2/17/2012	62	3.60	9.66	17:17	-1.11	22:57	0.1782	15.3976	1.188	4.277
2/18/2012	63	5.01	13.59	16:29	-2.06	2:02	0.1824	15.7582	1.858	4.377
2/19/2012	64	1.26	6.03	16:39	-3.08	7:53	0.1840	15.8946	2.284	4.415
2/20/2012	65	0.75	6.79	16:31	-2.77	8:33	0.1889	16.3246	1.626	4.535
2/21/2012	66	2.79	8.79	14:46	-3.46	2:40	0.1324	11.4416	3.939	3.178
2/22/2012	67	6.21	11.39	16:16	2.57	23:17	0.1706	14.7366	3.189	4.094
2/23/2012	68	7.34	13.03	17:07	2.13	7:59	0.1180	10.1992	1.969	2.833
2/24/2012	69	8.01	16.54	16:01	3.49	0:26	0.1432	12.3735	2.606	3.437
2/25/2012	70	1.78	5.42	16:38	-2.10	23:54	0.1529	13.2085	3.461	3.669
2/26/2012	71	-1.34	4.45	17:10	-5.93	7:51	0.2117	18.2898	2.362	5.081
2/27/2012	72	7.54	17.01	16:37	-1.41	0:00	0.2057	17.7765	4.348	4.938
2/28/2012	73	2.02	7.89	17:45	-2.47	7:19	0.2138	18.4744	1.774	5.132
2/29/2012	74	6.55	15.86	15:22	-0.26	0:00	0.1163	10.0472	4.210	2.791
3/1/2012	75	9.98	17.09	2:42	2.98	23:59	0.1908	16.4824	5.463	4.579
3/2/2012	76	5.71	15.56	16:42	-3.57	7:54	0.2078	17.9557	2.316	4.988
3/3/2012	77	2.97	7.22	0:01	0.10	13:58	0.0776	6.7029	2.853	1.862
3/4/2012	78	0.22	4.43	15:36	-5.41	23:59	0.1500	12.9560	2.374	3.599
3/5/2012	79	-2.07	3.43	16:00	-8.77	7:28	0.0880	7.5996	1.050	2.111
3/6/2012	80	1.83	9.58	17:28	-7.27	7:48	0.2301	19.8815	2.717	5.523
3/7/2012	81	14.19	23.18	15:26	4.21	0:31	0.2198	18.9883	6.024	5.275
3/8/2012	82	17.27	20.82	16:21	10.51	0:00	0.0864	7.4687	5.622	2.075
3/9/2012	83	3.69	10.51	0:00	0.35	6:32	0.1415	12.2299	2.569	3.397
3/10/2012	84	3.90	11.31	17:41	-0.69	7:06	0.2463	21.2808	1.912	5.911
3/11/2012	85	8.14	17.74	16:30	-0.68	6:54	0.2462	21.2756	2.639	5.910
3/12/2012	86	8.59	13.86	11:59	2.64	4:34	0.0760	6.5627	3.230	1.823
3/13/2012	87	14.73	21.74	17:01	8.27	23:59	0.1787	15.4404	2.566	4.289
3/14/2012	88	14.55	25.79	16:52	3.01	7:05	0.2408	20.8078	1.602	5.780
3/15/2012	89	20.15	27.63	17:04	12.86	6:45	0.1719	14.8529	3.282	4.126
3/16/2012	90	20.88	25.93	16:49	15.44	7:39	0.2018	17.4359	2.385	4.843
3/17/2012	91	20.69	27.65	15:52	15.18	7:20	0.2142	18.5051	3.198	5.140
3/18/2012	92	18.85	25.44	12:07	14.15	23:59	0.1335	11.5371	3.660	3.205
3/19/2012	93	19.75	26.86	15:12	12.76	1:39	0.1895	16.3699	3.858	4.547
3/20/2012	94	21.51	28.04	14:31	15.36	0:00	0.1793	15.4875	4.092	4.302
3/21/2012	95	18.00	25.93	14:59	13.89	6:58	0.1978	17.0862	3.400	4.746
3/22/2012	96	18.51	23.03	15:45	14.28	7:14	0.1065	9.2021	2.114	2.556
3/23/2012	97	14.36	21.51	0:26	10.81	6:56	0.1808	15.6199	2.595	4.339
3/24/2012	98	13.12	17.37	14:00	9.96	6:34	0.1105	9.5448	1.476	2.651
3/25/2012	99	14.73	19.17	17:04	10.30	6:49	0.0947	8.1830	1.111	2.273
3/26/2012	100	16.27	24.95	17:53	7.56	7:11	0.2360	20.3892	0.502	5.664
3/27/2012	101	14.30	19.94	16:46	8.71	6:20	0.2092	18.0736	3.424	5.020
3/28/2012	102	19.22	27.53	16:49	11.76	1:12	0.2000	17.2785	4.068	4.800
3/29/2012	103	19.65	25.56	15:39	9.80	7:27	0.2776	23.9834	1.275	6.662
3/30/2012	104	13.38	17.31	17:07	9.90	10:23	0.0787	6.8014	2.796	1.889
3/31/2012	105	16.76	20.95	13:26	11.65	1:55	0.2462	21.2745	2.293	5.910

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (C°) Daily Average	Max. Air Temp. (C°) Daily Maximum	Max. Air Temp. Time (24:00)	Air Temp. Min. Daily Minimum	Air Temp. Min. Time (24:00)	Solar Radiation (kW/m^2) Daily Average	Solar Radiation (MJ/m^2) Daily Total	Wind Speed (m/sec) Daily Average	Wind Speed (kW/m^2) Sum (of hourly average)
4/1/2012	106	15.92	25.10	18:01	8.71	7:07	0.2383	20.5901	2.572	5.719
4/2/2012	107	21.87	29.46	17:33	13.47	7:13	0.2768	23.9159	1.767	6.643
4/3/2012	108	22.66	31.73	16:30	14.92	7:20	0.2788	24.0918	1.772	6.692
4/4/2012	109	20.38	25.90	13:14	15.26	5:49	0.1591	13.7428	1.454	3.817
4/5/2012	110	13.02	16.88	0:13	9.82	7:29	0.0655	5.6592	3.452	1.572
4/6/2012	111	9.76	15.81	16:23	5.72	5:44	0.1851	15.9893	3.095	4.441
4/7/2012	112	8.53	15.12	17:26	1.38	6:57	0.3111	26.8755	2.478	7.465
4/8/2012	113	9.77	14.47	15:28	4.28	3:28	0.0900	7.7786	1.734	2.161
4/9/2012	114	10.65	18.86	16:12	0.29	6:52	0.3152	27.2325	1.010	7.565
4/10/2012	115	14.09	20.91	17:13	3.62	7:04	0.3025	26.1401	1.631	7.261
4/11/2012	116	9.31	15.64	18:07	0.69	6:58	0.3185	27.5144	2.016	7.643
4/12/2012	117	6.15	13.51	17:04	-2.24	6:55	0.3309	28.5865	1.642	7.941
4/13/2012	118	8.93	17.65	16:07	-2.06	6:51	0.2948	25.4675	1.921	7.074
4/14/2012	119	10.27	11.96	19:56	7.88	9:38	0.0508	4.3923	4.248	1.220
4/15/2012	120	17.49	22.92	17:00	11.07	0:06	0.1658	14.3262	3.371	3.980
4/16/2012	121	19.22	21.45	0:29	15.68	23:53	0.0742	6.4111	5.594	1.781
4/17/2012	122	12.77	17.75	17:17	7.01	23:59	0.3104	26.8195	3.234	7.450
4/18/2012	123	12.42	20.29	15:06	3.37	6:47	0.3106	26.8364	1.448	7.455
4/19/2012	124	16.36	23.69	16:31	9.68	6:33	0.3209	27.7257	2.636	7.702
4/20/2012	125	17.97	24.77	17:44	10.95	6:51	0.2296	19.8343	2.941	5.509
4/21/2012	126	8.75	16.06	0:38	6.41	9:05	0.0947	8.1859	2.530	2.274
4/22/2012	127	8.59	15.68	17:26	0.51	6:37	0.2588	22.3620	0.757	6.212
4/23/2012	128	8.17	13.40	15:10	3.34	5:43	0.1510	13.0422	2.037	3.623
4/24/2012	129	8.93	17.34	16:35	0.45	5:34	0.2854	24.6618	1.250	6.851
4/25/2012	130	16.08	26.65	18:30	4.87	1:22	0.3110	26.8680	1.636	7.463
4/26/2012	131	21.58	31.02	17:51	10.27	4:34	0.2777	23.9913	1.174	6.664
4/27/2012	132	19.61	23.63	15:46	13.55	6:35	0.3224	27.8543	2.304	7.737
4/28/2012	133	10.81	14.28	17:11	7.42	8:12	0.1261	10.8945	5.208	3.026
4/29/2012	134	15.57	21.55	14:17	10.17	6:24	0.2141	18.4960	2.713	5.138
4/30/2012	135	10.16	14.37	23:21	7.68	10:39	0.0430	3.7132	2.955	1.031
5/1/2012	136	13.99	16.59	18:34	12.07	7:56	0.1066	9.2102	0.792	2.558
5/2/2012	137	18.37	26.12	17:57	11.82	0:54	0.2173	18.7707	2.007	5.214
5/3/2012	138	22.58	29.09	17:59	17.46	11:31	0.2055	17.7582	3.261	4.933
5/4/2012	139	23.11	27.80	18:38	19.00	5:36	0.1964	16.9729	3.413	4.715
5/5/2012	140	21.90	27.35	16:57	17.56	10:09	0.2055	17.7548	2.908	4.932
5/6/2012	141	24.26	30.49	16:06	17.79	4:23	0.2785	24.0608	1.415	6.684
5/7/2012	142	23.96	31.06	13:30	19.19	23:57	0.2101	18.1560	1.471	5.043
5/8/2012	143	18.17	22.44	17:55	12.26	22:59	0.1812	15.6514	2.123	4.348
5/9/2012	144	16.59	22.07	15:23	9.91	23:59	0.3293	28.4543	1.204	7.904
5/10/2012	145	13.69	20.79	17:17	7.07	6:26	0.2908	25.1238	0.984	6.979
5/11/2012	146	16.10	23.13	17:04	7.76	3:11	0.3533	30.5264	1.013	8.480
5/12/2012	147	18.26	25.04	14:17	11.01	4:01	0.3121	26.9654	1.850	7.490
5/13/2012	148	16.67	20.22	15:41	14.57	6:11	0.2377	20.5341	2.254	5.704
5/14/2012	149	16.86	22.95	15:56	10.92	0:00	0.3520	30.4090	2.334	8.447
5/15/2012	150	17.09	26.79	18:33	8.03	5:52	0.3649	31.5262	0.592	8.757
5/16/2012	151	19.15	28.26	16:54	7.65	5:52	0.3538	30.5668	1.096	8.491
5/17/2012	152	18.31	24.08	16:52	11.44	4:07	0.3658	31.6076	1.941	8.780
5/18/2012	153	17.48	26.21	16:01	7.72	6:17	0.3652	31.5543	1.727	8.765
5/19/2012	154	21.55	31.34	16:40	9.96	5:14	0.3655	31.5820	2.407	8.773
5/20/2012	155	25.34	31.62	14:07	17.78	6:20	0.2917	25.2025	3.660	7.001
5/21/2012	156	22.97	27.56	13:59	16.02	22:33	0.2443	21.1063	2.392	5.863
5/22/2012	157	15.97	23.18	17:36	9.40	6:12	0.3835	33.1339	2.624	9.204
5/23/2012	158	17.30	26.63	15:39	6.13	6:10	0.3729	32.2220	1.017	8.950

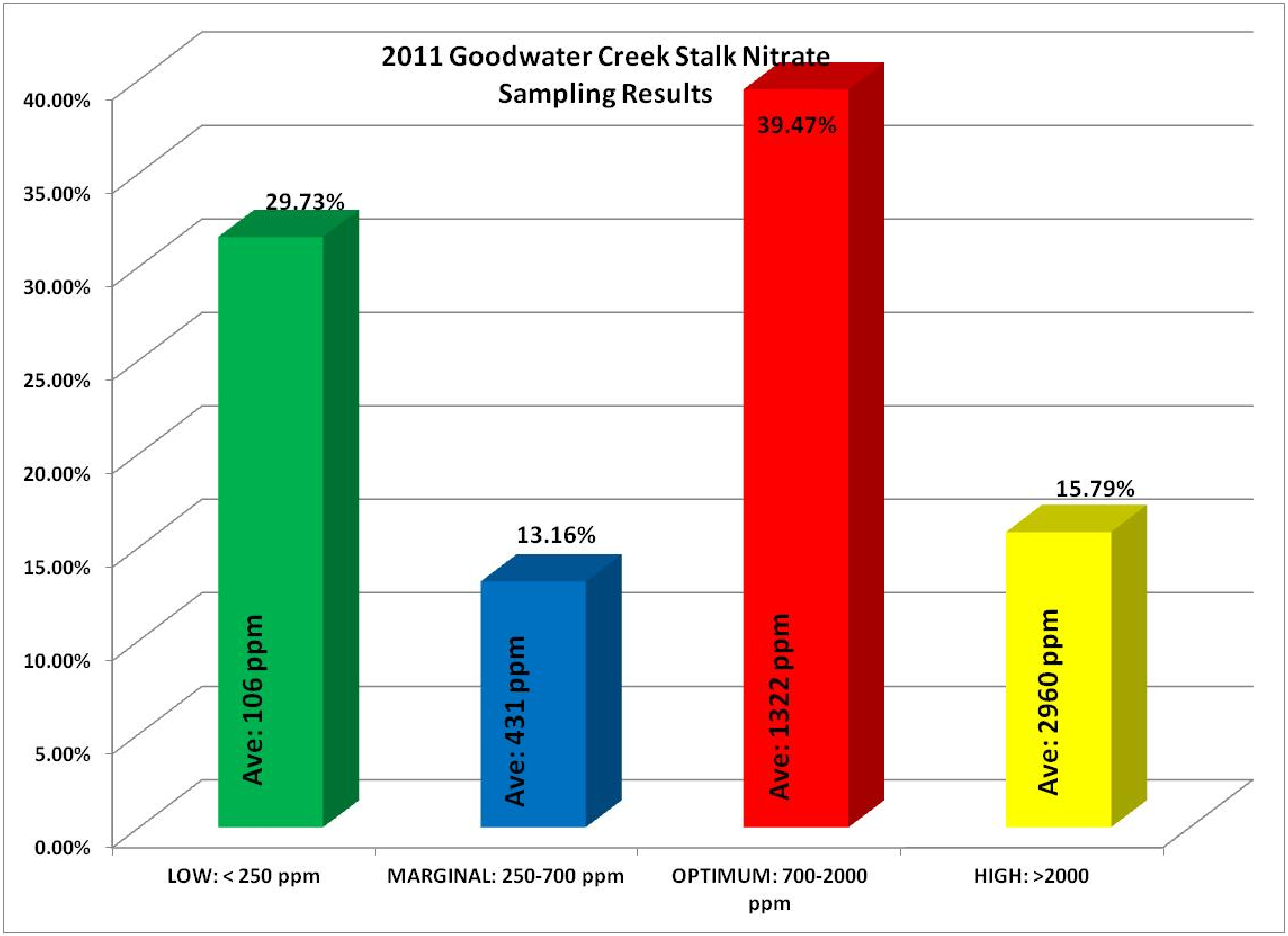
TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (C°) Daily Average	Max. Air Temp. (C°) Daily Maximum	Max. Air Temp. Time (24:00)	Air Temp. Min. Daily Minimum	Air Temp. Min. Time (24:00)	Solar Radiation (kW/m^2) Daily Average	Solar Radiation (MJ/m^2) Daily Total	Wind Speed (m/sec) Daily Average	Wind Speed (kW/m^2) Sum (of hourly average)
5/24/2012	159	22.08	29.71	15:11	13.36	4:59	0.3677	31.7715	4.093	8.825
5/25/2012	160	25.17	32.84	14:25	19.14	6:36	0.2982	25.7676	4.435	7.158
5/26/2012	161	23.01	29.81	16:40	17.72	6:47	0.2442	21.0964	2.467	5.860
5/27/2012	162	27.25	34.27	15:56	21.62	6:08	0.2721	23.5075	2.503	6.530
5/28/2012	163	26.91	33.62	15:52	20.07	6:26	0.3522	30.4288	2.683	8.453
5/29/2012	164	27.02	32.25	16:47	21.99	22:15	0.3083	26.6381	3.035	7.400
5/30/2012	165	23.47	29.84	14:23	14.82	6:49	0.3717	32.1170	1.362	8.921
5/31/2012	166	19.90	27.06	17:15	11.60	6:28	0.3696	31.9295	1.888	8.869
6/1/2012	167	13.38	18.16	1:31	9.98	23:59	0.0672	5.8030	3.018	1.612
6/2/2012	168	13.54	20.50	17:25	7.70	4:49	0.3296	28.4739	1.313	7.909
6/3/2012	169	18.11	26.58	17:43	11.26	0:01	0.3488	30.1349	1.521	8.371
6/4/2012	170	20.51	28.63	14:22	9.51	5:46	0.2463	21.2819	1.108	5.912
6/5/2012	171	23.06	31.78	13:34	14.92	4:23	0.3126	27.0111	2.137	7.503
6/6/2012	172	21.60	28.28	15:53	11.85	5:27	0.3506	30.2893	1.689	8.414
6/7/2012	173	20.96	27.04	18:01	14.37	6:09	0.3343	28.8874	1.741	8.024
6/8/2012	174	20.13	28.43	17:11	9.58	6:05	0.3573	30.8670	1.001	8.574
6/9/2012	175	21.66	30.57	15:39	10.84	5:55	0.3594	31.0558	1.229	8.627
6/10/2012	176	24.30	33.04	15:44	12.64	3:48	0.3508	30.3072	2.427	8.419
6/11/2012	177	26.26	32.53	16:05	20.10	5:41	0.3322	28.7036	3.890	7.973
6/12/2012	178	23.11	28.08	17:49	19.34	23:51	0.1740	15.0364	1.509	4.177
6/13/2012	179	19.93	26.15	16:25	12.74	5:55	0.3853	33.2919	1.498	9.248
6/14/2012	180	19.01	26.90	16:07	9.09	6:03	0.3351	28.9484	1.743	8.041
6/15/2012	181	22.97	31.76	16:59	12.55	6:09	0.3590	31.0210	2.432	8.617
6/16/2012	182	24.77	33.47	16:17	18.71	5:05	0.2853	24.6480	2.818	6.847
6/17/2012	183	24.99	33.99	16:08	20.69	23:10	0.2821	24.3735	2.091	6.770
6/18/2012	184	24.57	29.99	17:00	18.84	6:08	0.3208	27.7211	1.709	7.700
6/19/2012	185	27.45	32.79	17:06	22.97	5:23	0.3554	30.7075	3.924	8.530
6/20/2012	186	27.46	32.54	16:37	22.04	6:02	0.3490	30.1513	4.111	8.375
6/21/2012	187	27.99	33.10	16:33	23.21	5:49	0.3402	29.3904	3.848	8.164
6/22/2012	188	23.81	29.38	18:33	17.22	23:59	0.3210	27.7371	1.408	7.705
6/23/2012	189	22.03	29.16	17:51	13.79	5:49	0.3798	32.8124	0.814	9.114
6/24/2012	190	21.47	27.92	14:59	14.46	4:15	0.1631	14.0878	1.463	3.913
6/25/2012	191	28.06	36.84	17:16	19.62	6:16	0.3315	28.6452	1.662	7.957
6/26/2012	192	25.36	30.02	16:56	17.33	23:53	0.3421	29.5558	2.465	8.210
6/27/2012	193	21.79	30.68	16:51	12.37	6:12	0.3731	32.2344	2.004	8.954
6/28/2012	194	27.86	37.78	17:40	17.09	1:37	0.3547	30.6465	2.668	8.513
6/29/2012	195	31.45	39.78	17:15	22.31	2:47	0.3543	30.6112	1.504	8.503
6/30/2012	196	30.20	39.41	15:57	19.11	6:18	0.3647	31.5138	1.256	8.754
7/1/2012	197	29.69	37.67	15:28	22.30	6:11	0.3046	26.3150	1.519	7.310
7/2/2012	198	26.38	33.47	16:36	21.16	6:23	0.1650	14.2547	0.559	3.960
7/3/2012	199	28.20	37.46	16:51	20.16	4:52	0.3355	28.9829	1.060	8.051
7/4/2012	200	29.18	36.86	16:25	21.32	5:39	0.3367	29.0933	1.321	8.081
7/5/2012	201	30.75	39.00	16:23	22.75	23:44	0.3530	30.4951	1.365	8.471
7/6/2012	202	29.90	39.63	16:07	19.96	5:55	0.3185	27.5161	0.818	7.643
7/7/2012	203	31.50	40.60	17:22	22.11	5:48	0.3398	29.3593	0.623	8.155
7/8/2012	204	31.99	41.80	18:03	21.79	5:41	0.3372	29.1366	0.903	8.094
7/9/2012	205	27.43	32.86	15:02	22.39	5:53	0.2718	23.4831	1.975	6.523
7/10/2012	206	27.29	34.04	16:31	21.50	0:00	0.3514	30.3591	1.720	8.433
7/11/2012	207	25.72	34.01	16:27	17.29	6:07	0.2467	21.3179	1.095	5.922
7/12/2012	208	24.83	32.26	16:47	18.76	6:19	0.2888	24.9564	1.658	6.932
7/13/2012	209	26.89	36.05	17:58	17.03	5:13	0.3496	30.2075	0.729	8.391
7/14/2012	210	24.59	35.29	12:59	19.37	23:13	0.2256	19.4929	1.152	5.415
7/15/2012	211	24.83	33.11	16:18	17.74	6:24	0.3322	28.7036	0.485	7.973

TIMESTAMP mm/dd/yyyy	RECORD RN	Air Tem. (C°) Daily Average	Max. Air Temp. (C°) Daily Maximum	Max. Air Temp. Time (24:00)	Air Temp. Min. Daily Minimum	Air Temp. Min. Time (24:00)	Solar Radiation (kW/m^2) Daily Average	Solar Radiation (MJ/m^2) Daily Total	Wind Speed (m/sec) Daily Average	Wind Speed (kW/m^2) Sum (of hourly average)
7/16/2012	212	27.15	34.54	17:01	20.54	5:43	0.3489	30.1473	0.750	8.374
7/17/2012	213	27.97	35.79	17:13	20.75	6:03	0.3376	29.1641	0.686	8.101
7/18/2012	214	29.36	36.02	16:37	22.81	6:29	0.3403	29.4031	1.046	8.168
7/19/2012	215	30.41	38.30	16:39	22.15	6:26	0.3140	27.1309	1.021	7.536
7/20/2012	216	31.22	37.84	15:39	24.70	23:43	0.3387	29.2617	2.014	8.128
7/21/2012	217	23.46	28.75	17:14	19.95	5:00	0.2190	18.9208	1.653	5.256
7/22/2012	218	25.13	33.93	17:47	16.47	6:32	0.3041	26.2769	0.628	7.299
7/23/2012	219	28.02	37.39	18:17	19.70	4:09	0.3006	25.9679	0.918	7.213
7/24/2012	220	31.13	40.09	17:02	22.07	1:54	0.3369	29.1117	1.090	8.087
7/25/2012	221	31.42	39.29	18:15	22.39	6:26	0.3293	28.4507	0.963	7.903
7/26/2012	222	31.90	39.45	17:17	23.87	3:36	0.3415	29.5075	1.766	8.197
7/27/2012	223	26.00	32.43	17:52	19.99	23:37	0.2157	18.6400	1.451	5.178
7/28/2012	224	25.98	32.55	17:21	19.90	1:26	0.3304	28.5446	1.429	7.929
7/29/2012	225	24.20	32.11	16:55	15.19	6:16	0.3383	29.2331	0.911	8.120
7/30/2012	226	25.40	33.88	18:26	19.40	6:55	0.3056	26.4055	1.997	7.335
7/31/2012	227	24.20	29.55	19:19	20.54	23:56	0.1028	8.8847	0.590	2.468
8/1/2012	228	27.79	38.21	18:14	18.54	5:07	0.3275	28.2977	0.588	7.861
8/2/2012	229	27.75	37.42	17:02	18.73	5:46	0.3176	27.4398	0.653	7.622
8/3/2012	230	25.74	33.84	18:11	18.92	2:05	0.1902	16.4295	0.531	4.564
8/4/2012	231	27.40	36.26	15:56	20.88	6:35	0.2822	24.3814	0.828	6.773
8/5/2012	232	28.65	34.51	16:31	24.56	0:00	0.1545	13.3461	1.354	3.707
8/6/2012	233	24.96	31.73	17:18	17.23	23:42	0.3396	29.3385	1.192	8.150
8/7/2012	234	23.83	34.59	17:53	13.34	4:57	0.3442	29.7410	0.726	8.261
8/8/2012	235	27.25	39.35	17:26	14.73	5:46	0.3251	28.0882	0.724	7.802
8/9/2012	236	22.58	26.59	11:47	19.11	22:02	0.0765	6.6134	0.771	1.837
8/10/2012	237	23.94	31.73	15:30	17.80	6:32	0.3014	26.0444	1.474	7.235
8/11/2012	238	20.34	26.59	16:32	14.63	23:59	0.2905	25.0972	2.010	6.971
8/12/2012	239	20.21	30.31	18:11	10.83	6:29	0.3269	28.2456	0.707	7.846
8/13/2012	240	20.27	27.93	16:44	13.77	1:22	0.1590	13.7382	1.051	3.816
8/14/2012	241	18.92	21.95	15:54	15.18	23:59	0.0814	7.0351	1.598	1.954
8/15/2012	242	20.12	28.36	18:10	12.65	4:57	0.2359	20.3831	0.718	5.662
8/16/2012	243	22.81	33.75	17:45	11.31	5:05	0.3160	27.2985	1.345	7.583
8/17/2012	244	24.29	30.11	11:08	17.49	23:59	0.2357	20.3680	1.810	5.658
8/18/2012	245	19.17	28.39	16:53	8.77	6:14	0.3402	29.3956	1.025	8.166
8/19/2012	246	18.78	27.99	15:47	7.18	6:27	0.2600	22.4673	0.736	6.241
8/20/2012	247	20.70	28.85	17:38	12.76	6:41	0.2958	25.5587	1.311	7.100
8/21/2012	248	18.96	28.80	17:05	10.26	6:06	0.2470	21.3415	0.716	5.928
8/22/2012	249	22.60	32.11	17:14	12.64	5:20	0.3263	28.1892	0.991	7.830
8/23/2012	250	24.44	36.70	15:44	12.66	5:54	0.3166	27.3517	0.714	7.598
8/24/2012	251	26.28	36.00	14:53	16.36	6:15	0.2926	25.2839	1.066	7.023
8/25/2012	252	25.86	34.20	16:21	15.44	6:57	0.2653	22.9194	1.484	6.367
8/26/2012	253	24.47	32.92	12:56	16.40	6:49	0.1957	16.9097	1.749	4.697
8/27/2012	254	23.77	27.52	18:49	19.88	23:32	0.1137	9.8198	1.181	2.728
8/28/2012	255	24.59	33.31	16:35	18.16	23:49	0.2947	25.4615	1.333	7.073
8/29/2012	256	24.69	36.04	16:52	14.99	6:40	0.2858	24.6894	0.582	6.858
8/30/2012	257	25.08	35.38	16:53	15.08	6:11	0.2881	24.8890	1.009	6.914
8/31/2012	258	26.51	36.83	16:42	16.63	5:18	0.2952	25.5077	1.151	7.085
9/1/2012	259	22.09	24.11	9:26	17.91	5:50	0.0345	2.9789	1.834	0.827
9/2/2012	260	23.26	25.82	15:51	21.91	23:34	0.1047	9.0504	2.195	2.514
9/3/2012	261	23.10	29.44	17:47	19.12	8:46	0.1380	11.9267	1.702	3.313
9/4/2012	262	25.74	33.49	17:13	19.08	6:21	0.2729	23.5791	0.713	6.550
9/5/2012	263	27.14	34.89	18:01	21.59	8:18	0.2547	22.0023	0.836	6.112

9 Appendix C– In Field Nitrogen Efficiency Data

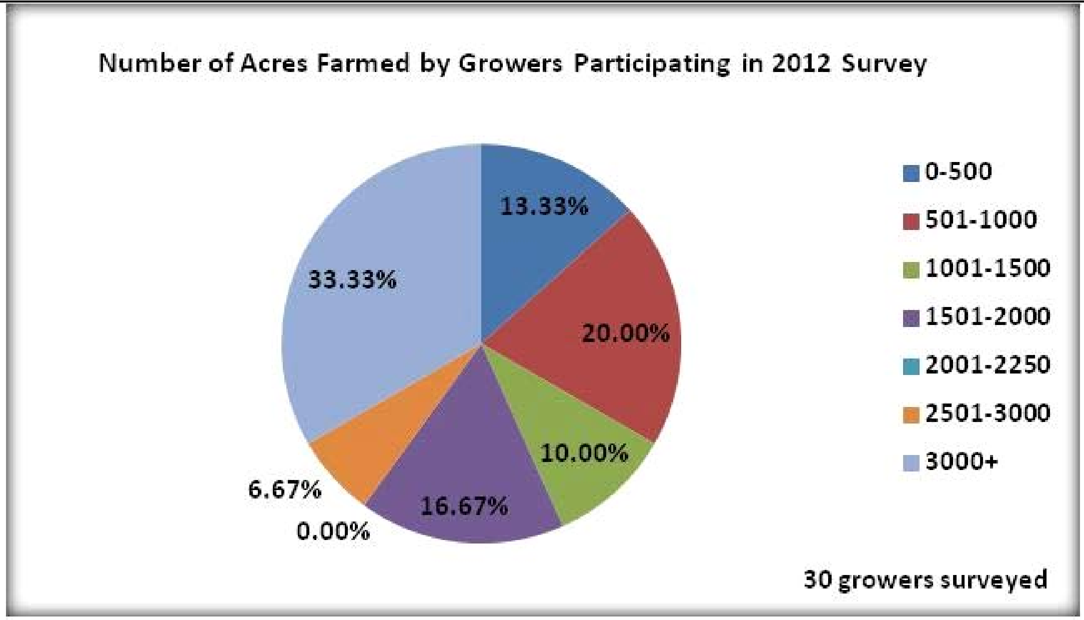


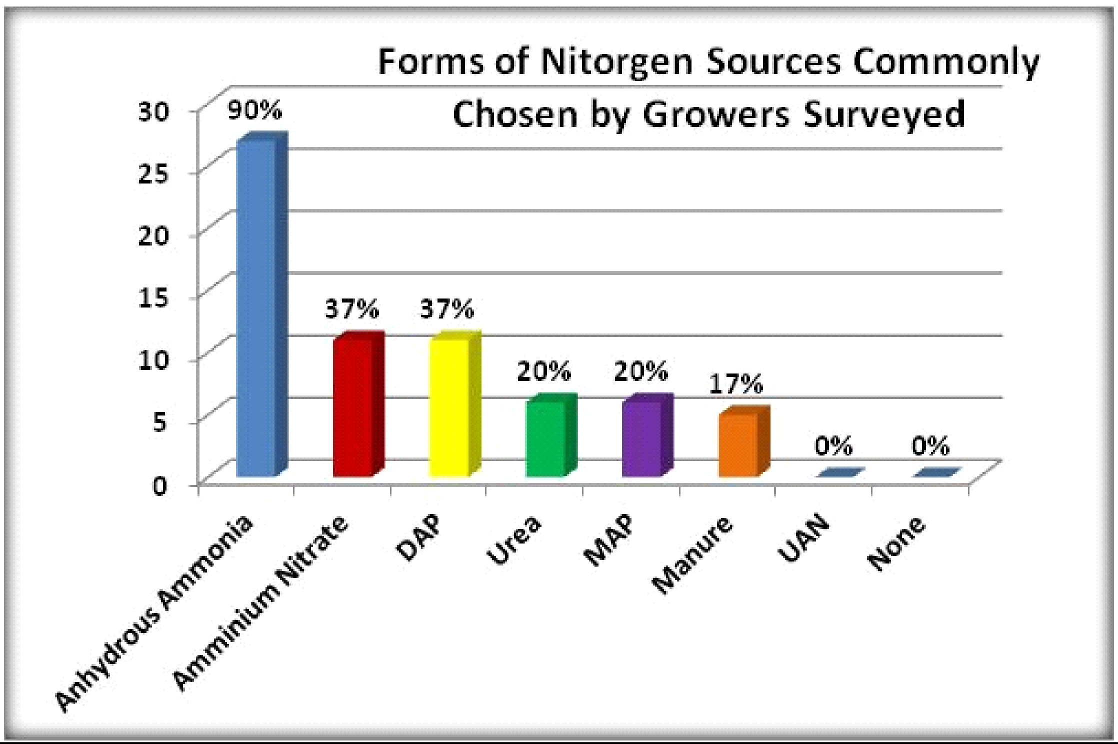
2010 Stalk Sample Results



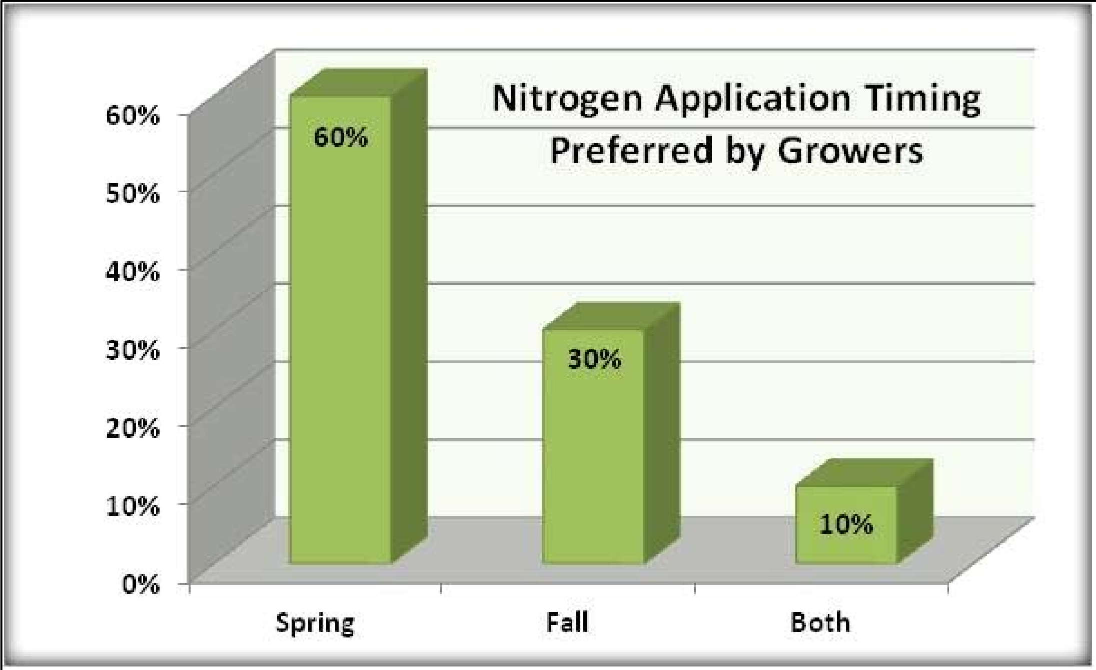
2011 Stalk Sample Results

Q3. Acres in Operation?
Answer →



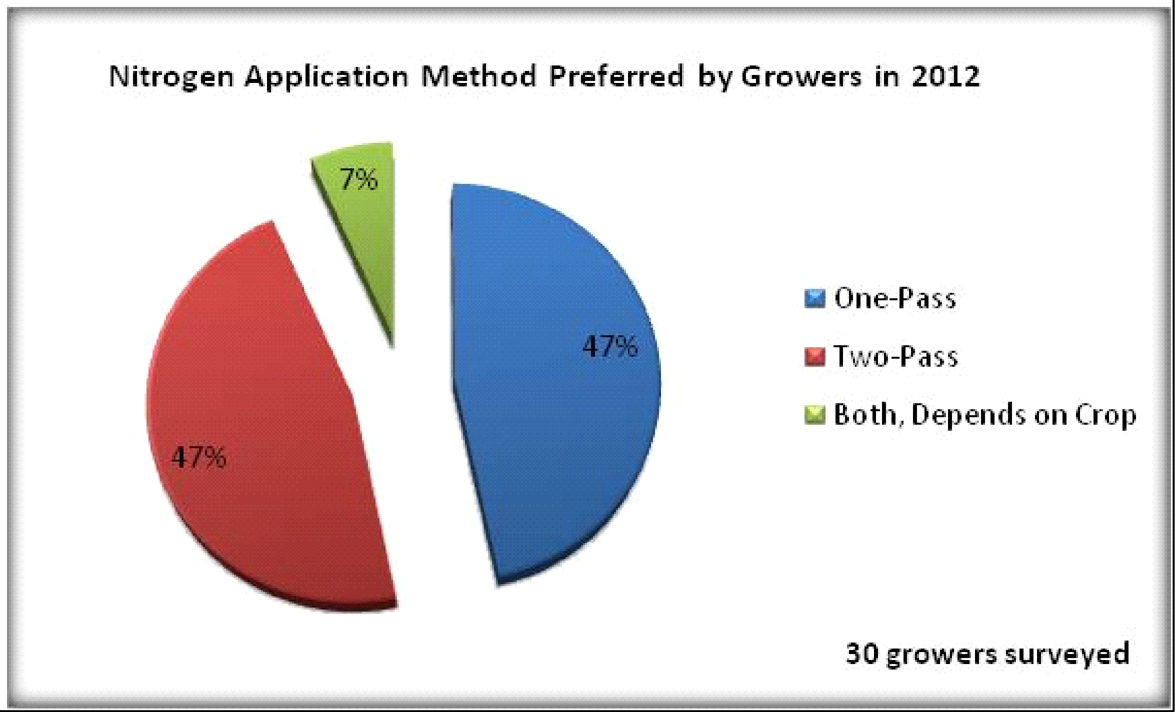


Q5. Types of Fertilizer Used?
← **Answer**

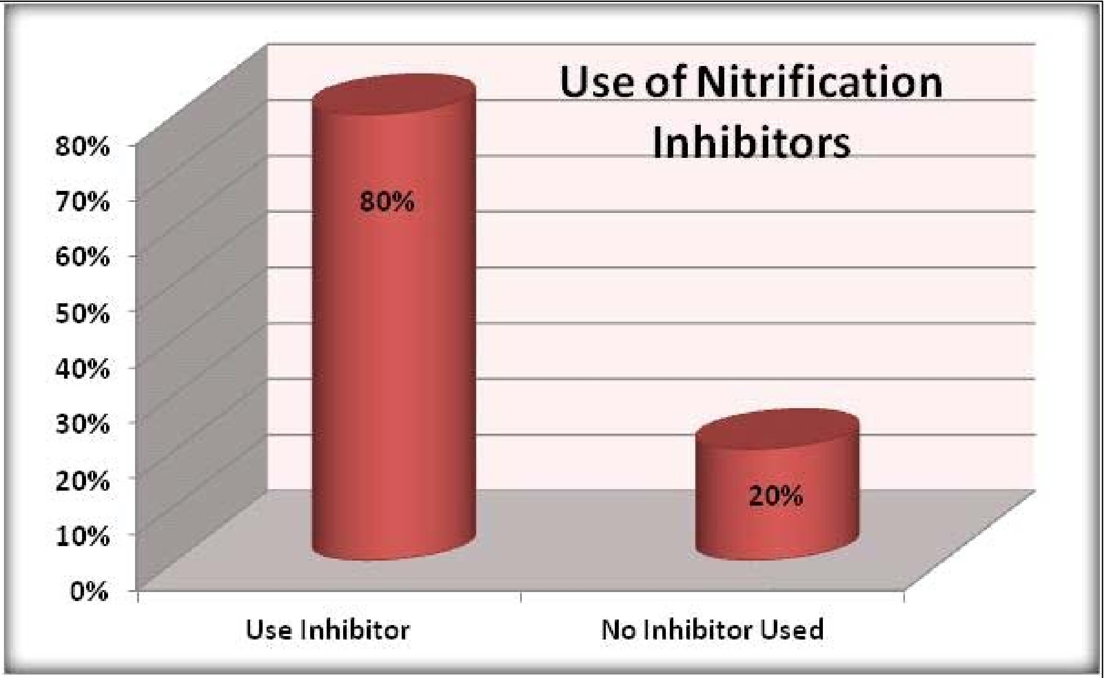


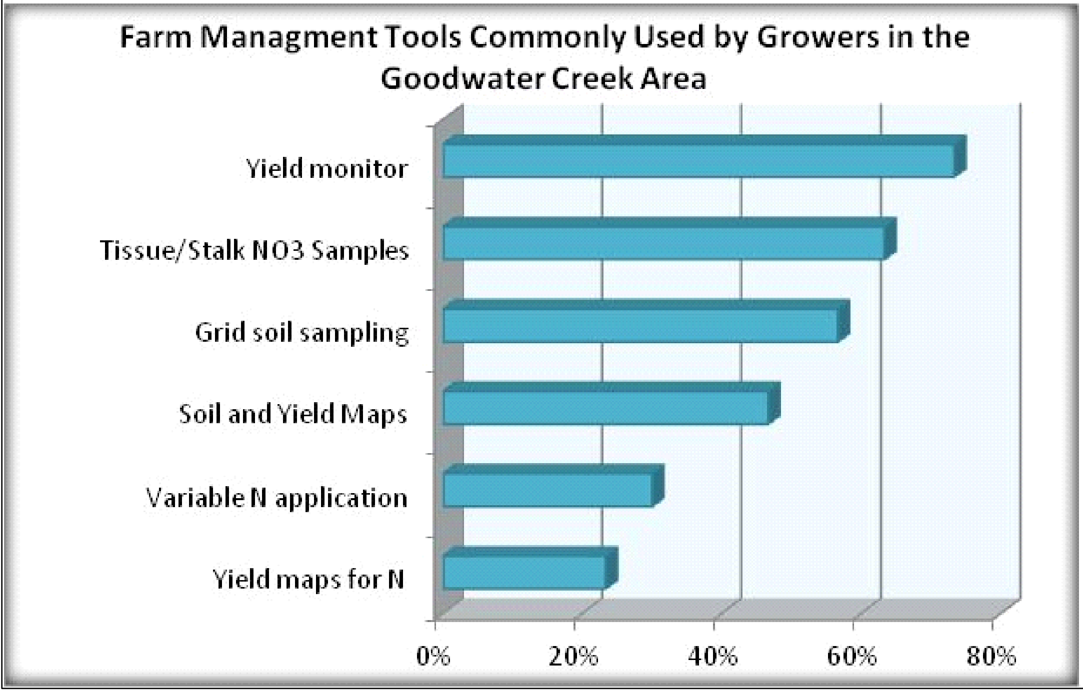
Q6. Fertilizer Application Timing?
Answer

Q7. Nitrogen Application Used?
Answer

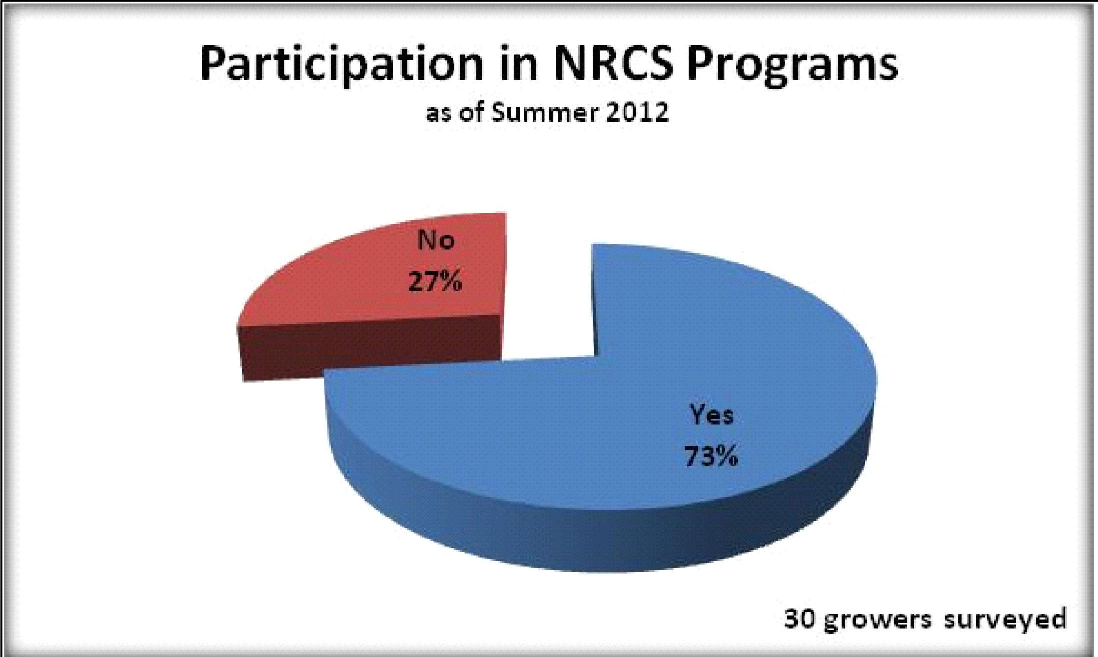


Q8. Nitrogen Inhibitor Used?
Answer →





Q9. Practices Used on Farm?
← **Answer**

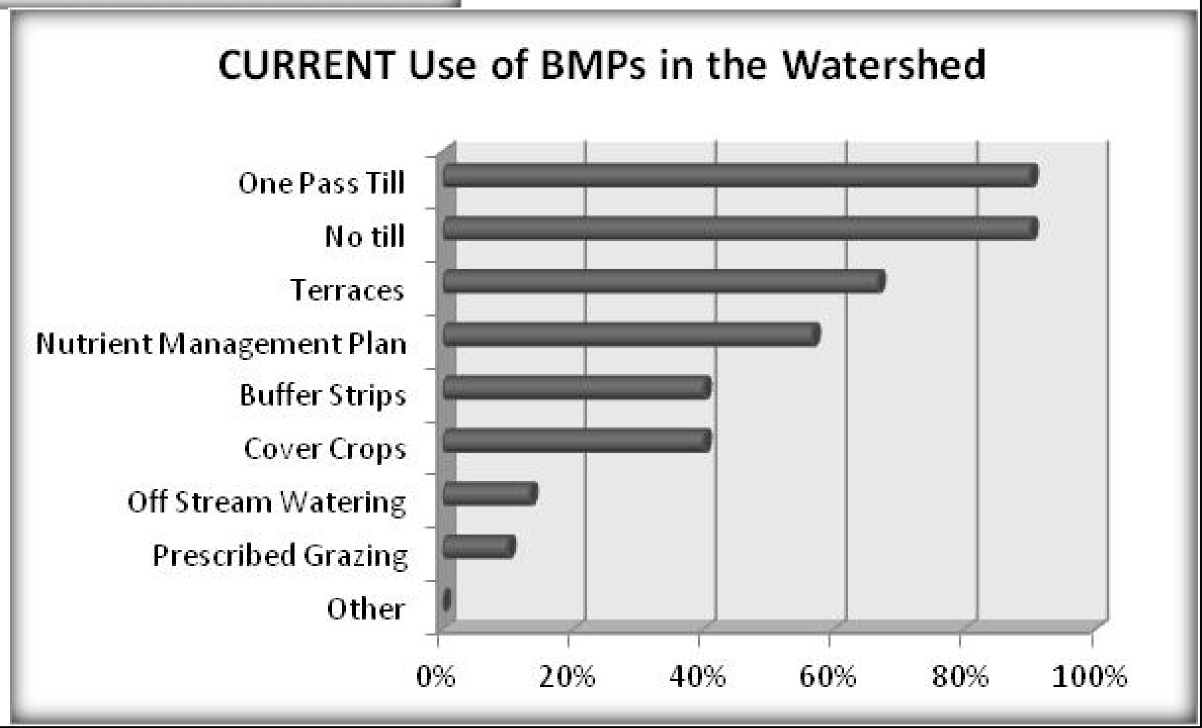


Q11. Participate In NRCS Programs?

← **Answer**

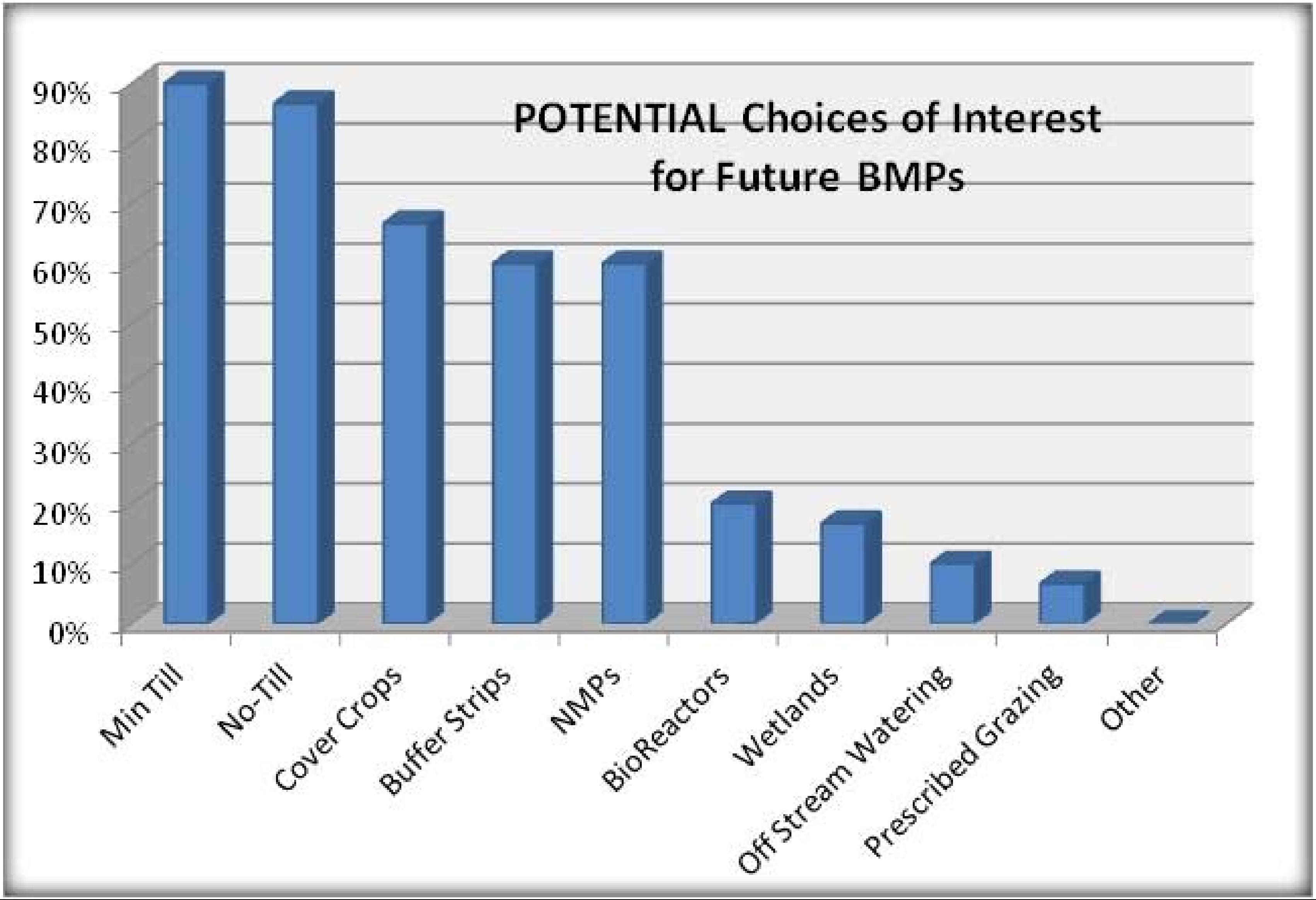
Q17. Current BMPs Used?

Answer →



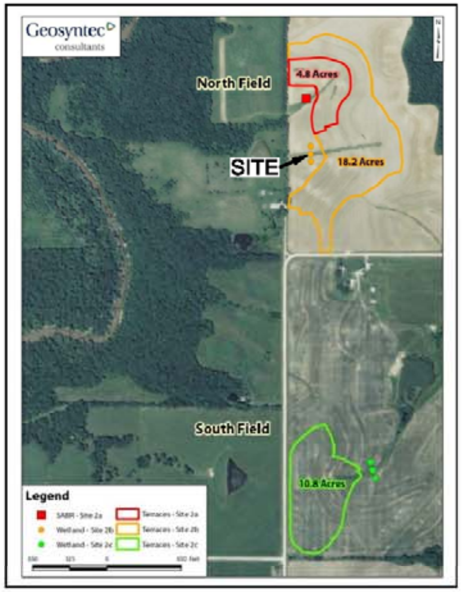
Q18. Potential BMPs Interest in the Future?

Answer



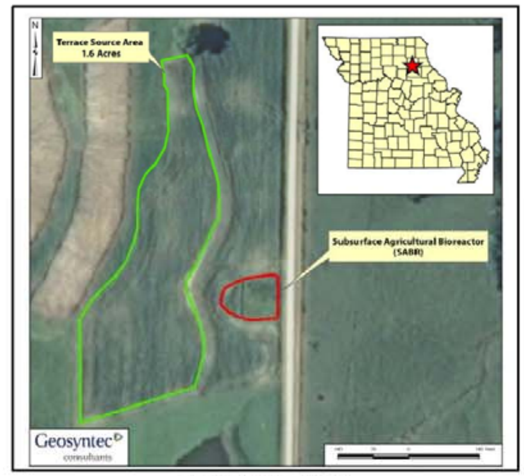
10 Appendix D – Forms and Plans

ENVIRONMENTAL RESOURCES COALITION
MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
DESIGN AND EVALUATION OF CONSTRUCTED SURFACE WATER WETLANDS (CSWWs)
NORTH FIELD SITE
SHELBINA, MISSOURI
JANUARY 2011



VICNITY MAP

LIST OF DRAWINGS	
SHEET NUMBER	DRAWING TITLE
1	TITLE SHEET
2	SPECIFICATIONS
3	PLAN VIEW
4	SECTIONS AND DETAILS
5	SECTIONS AND DETAILS



LOCATION MAP

TITLE SHEET ENVIRONMENT RESOURCES COALITION MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT NORTH FIELD SITE, SHELBINA, MISSOURI		
Geosyntec consultants		Sheet 1 of 5
13 JANUARY 2011	MOW5231	

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GENERAL

1. THE STANDARD SPECIFICATIONS LISTED ON THESE CONSTRUCTION PLANS AND SUBSEQUENT DETAILS ARE ALL TO BE CONSIDERED AS PART OF THE CONTRACT DOCUMENTS. INCIDENTAL ITEMS OR ACCESSORIES NECESSARY TO COMPLETE THIS WORK MAY NOT BE SPECIFICALLY NOTED BUT ARE TO BE CONSIDERED A PART OF THE CONTRACT.
2. NO CONSTRUCTION PLANS SHALL BE USED FOR CONSTRUCTION UNLESS SPECIFICALLY MARKED "FOR CONSTRUCTION". PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AFFECTING THEIR WORK WITH THE ACTUAL CONDITIONS AT THE JOB SITE. IF THERE ARE ANY DISCREPANCIES FROM WHAT IS SHOWN ON THE CONSTRUCTION PLANS, HE MUST IMMEDIATELY REPORT SAME TO THE ENGINEER BEFORE DOING ANY WORK, OTHERWISE THE CONTRACTOR ASSUMES FULL RESPONSIBILITY. IN THE EVENT OF DISAGREEMENT BETWEEN THE CONSTRUCTION PLANS, STANDARD SPECIFICATIONS AND/OR SPECIAL DETAILS, THE CONTRACTOR SHALL SECURE WRITTEN INSTRUCTIONS FROM THE ENGINEER PRIOR TO PROCEEDING WITH ANY PART OF THE WORK AFFECTED BY OMISSIONS OR DISCREPANCIES. FAILING TO SECURE SUCH INSTRUCTION, THE CONTRACTOR WILL BE CONSIDERED TO HAVE PROCEEDED AT HIS OWN RISK AND EXPENSE. IN THE EVENT OF ANY DOUBT OR QUESTION ARISING WITH RESPECT TO THE TRUE MEANING OF THE CONSTRUCTION PLANS OR SPECIFICATIONS, THE DECISION OF THE ENGINEER SHALL BE FINAL AND CONCLUSIVE.
3. ALL WORK PERFORMED UNDER THIS CONTRACT SHALL BE GUARANTEED AGAINST ALL DEFECTS IN MATERIALS AND WORKMANSHIP OF WHATEVER NATURE BY THE CONTRACTOR AND HIS SURETY FOR A PERIOD OF 12 MONTHS FROM THE DATE OF FINAL ACCEPTANCE OF THE WORK BY THE ENGINEER.
4. BEFORE ACCEPTANCE BY THE OWNER AND FINAL PAYMENT, ALL WORK SHALL BE INSPECTED AND APPROVED BY THE OWNER OR HIS REPRESENTATIVE. FINAL PAYMENT WILL BE MADE AFTER ALL OF THE CONTRACTORS' WORK HAS BEEN APPROVED AND ACCEPTED, AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
5. DURING CONSTRUCTION OPERATIONS THE CONTRACTOR SHALL INSURE POSITIVE DRAINAGE AT THE CONCLUSION OF EACH DAY.
6. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REMOVE FROM THE SITE ANY AND ALL MATERIALS AND DEBRIS WHICH RESULT FROM CONSTRUCTION OPERATIONS.
7. THE CONTRACTOR SHALL COMPLY WITH AND OBSERVE THE RULES AND REGULATIONS OF O.S.H.A AND APPROPRIATE AUTHORITIES REGARDING SAFETY PROVISIONS.
8. THE ENGINEER AND OWNER ARE NOT RESPONSIBLE FOR THE CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES, TIME OF PERFORMANCE, PROGRAMS OR FOR ANY SAFETY PRECAUTIONS USED BY THE CONTRACTOR. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR EXECUTION OF HIS WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND SPECIFICATIONS.
9. ALL CONTRACTORS AND THEIR SUBCONTRACTORS OR ANY TIER SHALL INDEMNIFY THE OWNER AND ENGINEER FROM ALL LIABILITY RESULTING FROM ANY NEGLIGENT ACT OR OMISSION WITH THEIR CONSTRUCTION, INSTALLATION, AND TESTING OF WORK ON THIS PROJECT AND SHALL NAME THEM AS ADDITIONAL INSURED ON THEIR COMMERCIAL GENERAL LIABILITY POLICIES FOR CLAIMS ARISING OUT OF THE WORK ON THIS PROJECT. A PROPER CERTIFICATE OF INSURANCE SHALL BE ISSUED PRIOR TO THE START OF CONSTRUCTION.
10. ELECTRIC, TELEPHONE, NATURAL GAS, AND OTHER UTILITY COMPANIES MAY HAVE UNDERGROUND AND/OR OVERHEAD SERVICE FACILITIES IN THE VICINITY OF THE PROPOSED WORK. THE CONTRACTOR SHALL BE RESPONSIBLE FOR HAVING THE UTILITY COMPANIES LOCATE THEIR FACILITIES IN THE FIELD PRIOR TO CONSTRUCTION AND SHALL ALSO BE RESPONSIBLE FOR THE MAINTENANCE AND PRESERVATION OF THESE FACILITIES. THE CONTRACTOR SHALL **CALL 811** FOR UTILITY LOCATIONS.
11. THE CONTRACTOR SHALL HAVE A COMPETENT SUPERINTENDENT ON THE PROJECT SITE AT ALL TIMES IRRESPECTIVE OF THE AMOUNT OF WORK SUBLET. THE SUPERINTENDENT SHALL BE CAPABLE OF READING AND UNDERSTANDING THE PLANS AND SPECIFICATIONS, SHALL HAVE FULL AUTHORITY TO EXECUTE ORDERS TO EXPEDITE THE PROJECT, AND SHALL BE RESPONSIBLE FOR SCHEDULING AND HAVE CONTROL OF ALL WORK AS THE AGENT OF THE CONTRACTOR. FAILURE TO COMPLY WITH THIS PROVISION WILL RESULT IN A SUSPENSION OF WORK.
12. THE CONTRACTOR SHALL KEEP A SET OF "APPROVED" CONSTRUCTION PLANS ON THE JOB SITE, AND SHALL MAINTAIN (AS INDICATED HEREIN AND ELSEWHERE WITHIN THESE CONSTRUCTION NOTES, SPECIFICATIONS, AND PLANS) A LEGIBLE RECORD ON SAID PLANS OF ANY FIELD TILE ENCOUNTERED, ANY MODIFICATIONS/ALTERATIONS TO ALIGNMENT AND/OR TO PLANS AND SPECIFICATIONS OF PROPOSED IMPROVEMENTS, ETC. UPON COMPLETION OF THE CONTRACTORS' WORK, SAID PLANS AND INFORMATION SHALL BE PROVIDED TO ENGINEER. FINAL CONTRACT PAYMENT SHALL NOT COME DUE UNTIL THIS INFORMATION IS RECEIVED BY THE ENGINEER.
13. THESE PLANS ARE NOT SUITABLE FOR MACHINE GUIDANCE USE OR PURPOSES. THE ELEVATIONS AND CONTOURS ON THE PLANS ARE RELATIVE TO A LOCAL DATUM AND ARE NOT ASSOCIATED TO A STANDARD DATUM.
14. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER AND SEQUENCE THAT EROSION AND AIR AND WATER POLLUTION ARE MINIMIZED AND HELD WITHIN LEGAL LIMITATIONS. CONSTRUCTION METHODS THAT ENHANCE FISH AND WILDLIFE WILL BE USED WHERE PRACTICAL. TREES, STUMPS, AND BRUSH REMOVED FROM THE CONSTRUCTION AREA MAY BE PILED OR PLACED FOR FISH AND WILDLIFE HABITAT WHEN APPROVED BY THE LAND OWNER.
15. THE COMPLETED JOB SHALL CONFORM TO THE LAYOUT, ELEVATIONS, AND SPECIFICATIONS CONTAINED WITHIN THE PLAN SET AND THIS DOCUMENT.

EARTHWORK

1. PRIOR TO ONSET OF GRADING OPERATIONS, THE CONTRACTOR SHALL FAMILIARIZE THE CREW WITH THE SOIL EROSION CONTROL SPECIFICATIONS. THE INITIAL ESTABLISHMENT OF EROSION CONTROL PROCEDURES AND THE PLACEMENT OF FILTER FENCING, ETC. TO PROTECT ADJACENT PROPERTY AND ROAD RIGHT OF WAY SHALL OCCUR BEFORE GRADING BEGINS, AND IN ACCORDANCE WITH THE SOIL EROSION CONTROL CONSTRUCTION SCHEDULE.
2. THE GRADING OPERATIONS ARE TO BE CLOSELY SUPERVISED AND INSPECTED, PARTICULARLY DURING THE REMOVAL OF UNSUITABLE MATERIAL AND THE CONSTRUCTION OF EMBANKMENTS OR BUILDING PADS, BY THE CONTRACTOR.
3. THE PROPOSED GRADING ELEVATIONS SHOWN ON THE PLANS ARE FINISHED GRADE. TOPSOIL OF THE THICKNESS SHOWN IN THE STANDARDS AND DETAILS ON THE CONSTRUCTION PLANS IS TO BE PLACED BEFORE FINISHED GRADE ELEVATIONS ARE ACHIEVED.
4. THE SELECTED STRUCTURAL FILL MATERIAL FOR THE EMBANKMENT SHALL BE PLACED IN LEVEL UNIFORM LAYERS SO THAT THE COMPACTED THICKNESS IS APPROXIMATELY SIX INCHES. EACH LAYER SHALL BE THOROUGHLY MIXED DURING SPREADING TO INSURE UNIFORMITY.
5. EMBANKMENT MATERIAL AND CLAY CORE WITHIN EACH BERM SURROUNDING EACH WETLAND SHALL BE COMPACTED TO A MINIMUM OF NINETY PERCENT (95%) OF MAXIMUM DENSITY IN ACCORDANCE WITH ASTM SPECIFICATION D_1557 (MODIFIED PROCTOR METHOD), OR TO SUCH OTHER DENSITY AS MAY BE DETERMINED APPROPRIATE BY THE ENGINEER.
6. WITHIN THE INTERIOR OF THE WETLAND CELLS, THE SUBSOIL SHALL BE DISCED TO A DEPTH OF 6 - 8 INCHES WITH A CHISEL PLOW BEFORE SPREADING TOPSOIL OR PERFORMING FINAL GRADING FOR SEEDING.
7. THE WETLAND AND EMBANKMENT AREAS SHALL BE CLEARED OF TREES, LOGS, STUMPS, ROOTS, BRUSH, BOULDERS, SOD, AND RUBBISH.
8. TO THE EXTENT NEEDED, ALL SUITABLE MATERIAL REMOVED FROM BORROW AREAS SPECIFIED BY THE LANDOWNER SHALL BE USED IN THE CONSTRUCTION OF THE EARTHEN LEVEE AND BERMS (EMBANKMENTS). ALL EARTHEN SPOIL MATERIAL NOT USED IN THE CONSTRUCTION OF THE PROPOSED FACILITIES SHALL BE EITHER RETURNED TO THE BORROW AREA OR STOCKPILED AT THE DETERMINATION OF THE LANDOWNER.
9. BORROW EXCAVATION SHALL BE LOCATED NOT CLOSER THAN 30 FEET FROM THE TOE OF THE EMBANKMENTS SO AS NOT TO CAUSE SLOPE INSTABILITY OR SEEPAGE PROBLEMS.
10. THE PLACING AND SPREADING OF THE FILL MATERIAL SHALL BE STARTED AT THE LOWEST POINT OF THE FOUNDATION AND THE FILL SHALL BE BROUGHT UP IN APPROXIMATELY HORIZONTAL LAYERS NOT EXCEEDING 3 INCH LIFTS FOR HAND COMPACTION AND 4 INCH LIFTS FOR RUBBER TIRED AND MANUALLY DIRECTED POWER TAMPERS. EACH LAYER SHALL BE SPREAD, PROCESSED, AND COMPACTED. THE MOISTURE CONTENT OF THE FILL MATERIAL AND FOUNDATIONS SHALL BE SUCH THAT THE REQUIRED COMPACTION CAN BE OBTAINED.

MATERIALS

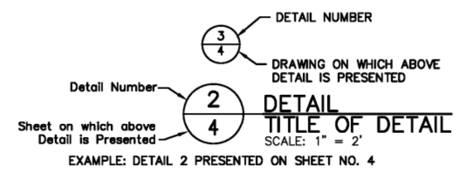
1. MATERIALS REQUIRED AND FABRICATION DETAILS SHALL BE AS SPECIFIED ON THE DRAWINGS AND AS WITHIN THIS DOCUMENT. THE CONTRACTOR SHALL CONFORM WITH MANUFACTURE DETAILS AND INSTALLATION METHODS.
2. WATER CONTROL STRUCTURES SHALL BE INLET WATER LEVEL CONTROL STRUCTURE AS MANUFACTURED BY AGRI DRAIN. THE STRUCTURE SHALL ACCEPT A 15 INCH PIPE AND SHALL BE 4 FOOT HIGH (INLET04X15P). TWO 5 INCH AND TWO 7 INCH STOP LOGS SHALL BE PROVIDED FOR EACH STRUCTURE.
3. PIPES SHALL BE 15 ADS N-12 HP AS MANUFACTURED BY ADS (ADVANCED DRAINAGE SYSTEMS). PIPES SHALL HAVE A SMOOTH INTERIOR AND ANNULAR EXTERIOR CORRUGATIONS AND MEET ASTM F2736. AN APPROPRIATE FLARED END SECTIONS (FES) SHALL BE INSTALLED AT THE END OF EACH PIPE WHERE AN AGRI-DRAIN STRUCTURE IS NOT UTILIZED.
4. PIPE CONDUITS SHALL BE PLACED ON A FIRM FOUNDATION TO THE LAYOUT AND ELEVATIONS SHOWN ON THE DRAWINGS. THE PIPE FOUNDATION SHALL BE COVERED WITH 1 INCH OF LOOSE, MOIST, FRIABLE ML OR CL SOIL MATERIAL IMMEDIATELY PRIOR TO PIPE PLACEMENT.
5. ANTI-SEEP COLLARS SHALL BE INSTALLED AT EACH LOCATION THE PIPE PASSES THROUGH THE TREATMENT WETLAND EMBANKMENT OR AS SPECIFIED ON THE DRAWINGS WITH WATERTIGHT CONNECTIONS. ANTI-SEEP COLLARS SHALL BE OF MATERIAL COMPATIBLE WITH THE PIPE.
6. SELECTED BACKFILL OF FRIABLE ML OR CL MATERIAL SHALL BE PLACED AROUND STRUCTURES, PIPES CONDUITS AND ANTI-SEEP COLLARS AT APPROXIMATELY THE SAME RATE ON ALL SIDES TO PREVENT UNEQUAL PRESSURES. RUBBER TIRE, HAND, OR MANUALLY DIRECTED POWER TAMPER WILL BE USED ON BACKFILL AROUND ALL CONDUITS OR STRUCTURES. A MAXIMUM OF 3 INCH LIFTS SHALL BE USED FOR HAND COMPACTION AND 4 INCH LIFTS FOR RUBBER TIRED AND MANUALLY DIRECTED POWER TAMPERS. EXTREME CAUSE MUST BE EXERCISED IN BACKFILL AND COMPACTION AROUND STRUCTURES OR CONDUITS TO PREVENT DAMAGE, MOVEMENT, OR DEFLECTION. COMPACTION ON THE BOTTOM HALF OF CONDUITS MUST BE FIRM TO FILL ALL VOIDS AND SUPPLY LATERAL SUPPORT. LIGHT WEIGHT CONDUITS MAY NEED TO BE HELD IN PLACE TO PREVENT UPLIFT DURING COMPACTION. FILL IMMEDIATELY ADJACENT TO CONDUITS SHALL BE HAND TAMPED, POWER TAMPERS MAY CAUSE UPLIFTING DURING COMPACTION.
7. EQUIPMENT SHALL NOT BE OPERATED OVER ANY STRUCTURE OR CONDUIT UNTIL THERE IS SUFFICIENT BACKFILL TO PREVENT DAMAGE. THIS MINIMUM COVER IS 3 FEET FOR THE SPECIFIED ADS PIPES.

SOIL EROSION AND SEDIMENT CONTROL

1. SOIL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE IN ACCORDANCE WITH NPDES GENERAL PERMIT. ANY SOIL EROSION CONTROL OR SEDIMENT CONTROL MEASURES, IN ADDITION TO THOSE OUTLINED IN THESE PLANS AND WHICH ARE DEEMED NECESSARY BY THE OWNER, ENGINEER AND/OR CITY ENGINEER, SHALL BE IMPLEMENTED IMMEDIATELY BY THE CONTRACTOR.
2. ALL DRAINAGE STRUCTURES, PIPES, SWALES, AND WETLAND BASINS AND OTHER AREAS ACCUMULATING SEDIMENT ARE TO BE CLEANED AT THE END OF THE PROJECT PRIOR TO FINAL ACCEPTANCE. CLEANING MAY ALSO BE REQUIRED DURING THE COURSE OF THE CONSTRUCTION OF THE PROJECT IF IT IS DETERMINED THAT THE SILT AND DEBRIS TRAPS ARE NOT FUNCTIONING PROPERLY OR EXCESS DEBRIS HAS COLLECTED.
3. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REMOVE FROM THE SITE ANY AND ALL MATERIALS AND DEBRIS WHICH RESULT FROM CONSTRUCTION OPERATIONS.
4. ALL BORROW AREAS SHALL BE REGRADED PER THE DRAWINGS, PROTECTED FROM EROSION, AND SEEDED.
5. THE EMBANKMENTS SHALL BE SEEDED AND COVERED WITH NORTH AMERICAN GREEN (NAG) S-75 EROSION CONTROL MAT OR APPROVED EQUAL. THE MAT SHALL BE INSTALLED AND STAPLED PER MANUFACTURE SPECIFICATIONS.
6. THE SWALES AND FROM 3 FT ABOVE AND 3 FT BELOW SHALL BE COVERED WITH NAG S-150 EROSION CONTROL MAD OR APPROVED EQUAL. THE MAT SHALL BE INSTALLED AND STAPLED PER MANUFACTURE SPECIFICATIONS.
7. THE EMBANKMENT AND ALL DISTURBED AREAS, INCLUDING ONE FOOT BELOW THE NORMAL WATER LEVEL OF THE WETLAND BASIN SHALL BE SEEDED IN ACCORDANCE WITH MODOT SECTION 805. THE SEED USED SHALL BE OF MIDWESTERN ECOTYPE AND SHALL BE IN PLS (PURE LIVE SEED) POUNDS. A SEED MIXTURE AND APPLICATION RATE SHALL BE SUBMITTED TO THE ENGINEER AND OWNER FOR APPROVAL. RECEIPTS FROM A REPUTABLE SOURCE MUST BE ABLE TO BE PROVIDED.
8. THE WETLAND AREA FROM 1 FOOT VERTICALLY, 3 FEET HORIZONTALLY, ABOVE THE NORMAL WATER LEVEL TO THE BOTTOM SHALL BE SEEDED WITH AN APPROPRIATE WETLAND MIX. THE SEED APPLICATION OVERLAP BETWEEN THE EMBANKMENT SEED AND THE WETLAND SEED MIX IS INTENTIONAL TO PROVIDE DIVERSITY OF VEGETATION DURING INITIAL VEGETATION ESTABLISHMENT. A SEED MIXTURE AND APPLICATION RATE SHALL BE SUBMITTED TO THE ENGINEER AND OWNER FOR APPROVAL. RECEIPTS FROM A REPUTABLE SOURCE MUST BE ABLE TO BE PROVIDED. THE CONTRACTOR SHALL MANAGE THE SOIL MOISTURE AND WATER LEVEL WITHIN THE WETLAND AREA TO ENSURE SEED GERMINATION AND ESTABLISHMENT. THE CONTRACTOR MAY UTILIZE AND ADJUST THE AGRI-DRAIN OUTFALL STOP LOG WEIRS TO MANAGE THE WATER LEVEL WITHIN THE WETLAND COMPLEX.
9. WITHIN ONE YEAR AND AT THE TIME OF FINAL ACCEPTANCE BY THE OWNER, THE EMBANKMENT VEGETATION SHALL ACHIEVE 90% SURFACE COVERAGE. LESS THAN 10 PERCENT OF THE PLANTS SHALL NOT BE THOSE SPECIFICALLY PLACED BY SEED AND SPECIFIED ON THE PLANS. THE WETLAND VEGETATION FROM THE NORMAL WATER LEVEL TO A DEPTH OF 1 FOOT SHALL ACHIEVE 90 % COVERAGE. LESS THAN 10 PERCENT OF THE PLANTS SHALL NOT BE THOSE SPECIFICALLY PLACED BY SEED AND SPECIFIED ON THE PLANS. NO MORE THAN ONE SQUARE FOOT SHALL BE VOID OF VEGETATION.

SITE RESTORATION AND PLANTING

1. THE SHORELINE AND WETLAND BASIN BOTTOM SHALL HAVE 6" OF TOPSOIL (WEED FREE) SPREAD PRIOR TO SEEDING. AFTER THE AREAS TO BE SEEDED HAVE BEEN BROUGHT TO THE GRADES INDICATED ON THE ACCOMPANYING PLANS, ANY GROSS IRREGULARITIES IN THE SURFACE RESULTING FROM OTHER OPERATIONS SHALL BE SMOOTHED OUT BEFORE SEEDING OPERATIONS ARE BEGUN. ALL UNSUITABLE MATERIAL LARGER THAN ONE (1) INCH IN ANY DIMENSION SHALL BE REMOVED AND DISPOSED OF DURING THIS OPERATION. THE GRADING OF THE NATIVE SEEDING AREAS MUST BE COMPLETED WITH LOW GROUND PRESSURE VEHICLES WITH MINIMAL COMPACTION OF BOTH SUBSOIL AND TOPSOIL (I.E., TO LESS THAN 275 PSI). WHERE SUBSOIL COMPACTION CANNOT BE AVOIDED, DISC THE SUBSOIL TO A DEPTH OF 6 - 8 INCHES WITH A CHISEL PLOW BEFORE SPREADING TOPSOIL OR PERFORMING FINAL GRADING FOR SEEDING.
2. SEED SHALL BE INSTALLED INTO RECENTLY GRADED SOIL BY USE OF A NO-TILL DRILL SEEDER DESIGNED SPECIFICALLY TO HANDLE NATIVE SEEDS. AN APPROPRIATE COVER CROP SHOULD BE INSTALLED WITH ALL SEED MIXES. SEEDING SHOULD OCCUR IN THE LATE FALL OR SPRING AND EARLY SUMMER. THE IDEAL SEEDING TIME FOR FORBS IS LATE FALL TO ALLOW FOR COLD STRATIFICATION TO ENHANCE GERMINATION. IF A FALL PLANTING IS PERFORMED ATTENTION SHOULD BE PAID TOWARDS PROTECTING THE SEED FROM EROSION DURING THE WINTER MONTHS. THE DRILL SEEDER OPERATOR SHOULD PLANT PERPENDICULAR TO THE DIRECTION OF THE SLOPE TO ENSURE SEED STABILITY. IF LATE FALL PLANTING IS NOT PRACTICABLE, THEN THE FOLLOWING SHALL APPLY. SEEDING NOT TO BE CONDUCTED FROM JUNE 15 THROUGH SEPTEMBER 15 UNLESS APPROPRIATE WATERING TECHNIQUES ARE USED. SEED SHALL BE DRILLED WITH OVERLAPPING PLANTING ZONES IN DRY AREAS AND TIMES. FOR SHORELINE AND EMERGENT SEED, ALLOW THE SEED TO GERMINATE PRIOR TO FLOODING WITH SIGNIFICANT AMOUNTS OF WATER, AND/OR PROVIDE WATER LEVEL CONTROL TO ENABLE GERMINATION IN NON-INUNDATION CONDITIONS.
3. TO MINIMIZE EROSION AFTER SEEDING, EROSION BLANKET SHALL BE INSTALLED IN SWALES, ON WETLAND BASIN SIDE SLOPES, AND ANY SLOPES STEEPER THAN 10 PERCENT TO MAINTAIN SOIL MOISTURE AND MINIMIZE EROSION AS SPECIFIED IN THE SOIL EROSION AND SEDIMENT CONTROL SECTION.



DETAIL IDENTIFICATION LEGEND

SPECIFICATIONS
ENVIRONMENTAL RESOURCES COALITION
MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
SOUTH FIELD SITE, SHELBINA, MISSOURI

Geosyntec consultants

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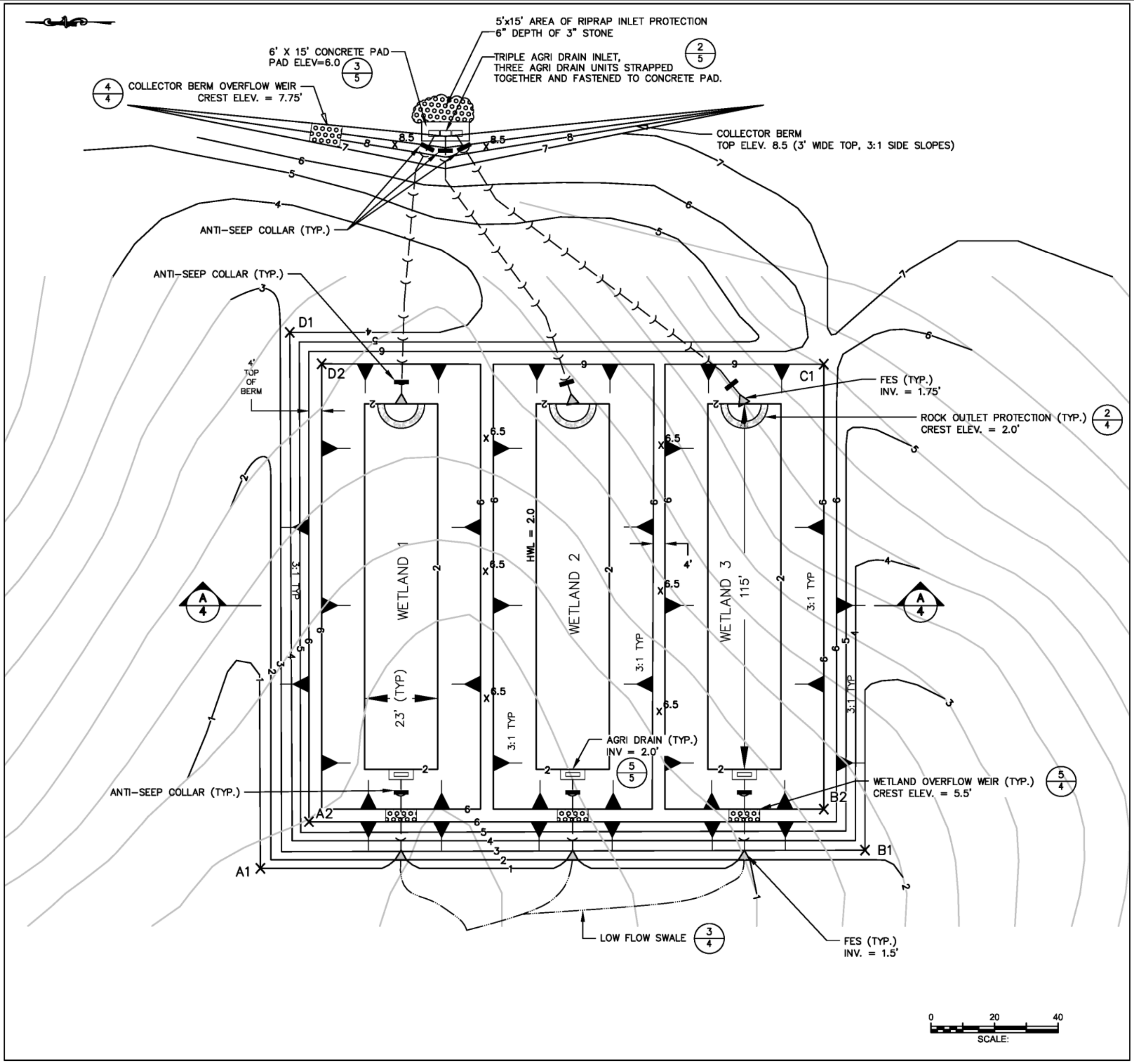

STATION COORDINATES		
STATION	EASTERN	NORTHERN
A1	584314.45	4399979.72
A2	584330.45	4399963.72
B1	584320.44	4399795.75
B2	584330.45	4399805.72
C1	584470.41	4399805.72
D1	584481.81	4399976.86
D2	584470.53	4399963.72

1/3 PLAN VIEW NORTH FIELD
1"=20"

LEGEND

- 15" ADS N-12 PIPE
- LOW FLOW SWALE
- AGRI DRAIN
- FLARED END SECTION (FES)
- OVERFLOW WEIR
- ANTI-SEEP COLLAR
- x 8.0 SPOT ELEVATION

CUT AND FILL BALANCE
CUT WETLAND CELLS 2666CY
FILL WETLAND CELLS 2467CY
FILL COLLECTOR BERM 199CY

PLAN VIEW
ENVIRONMENTAL RESOURCES COALITION
MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
NORTH FIELD SITE, SHELBINA, MISSOURI

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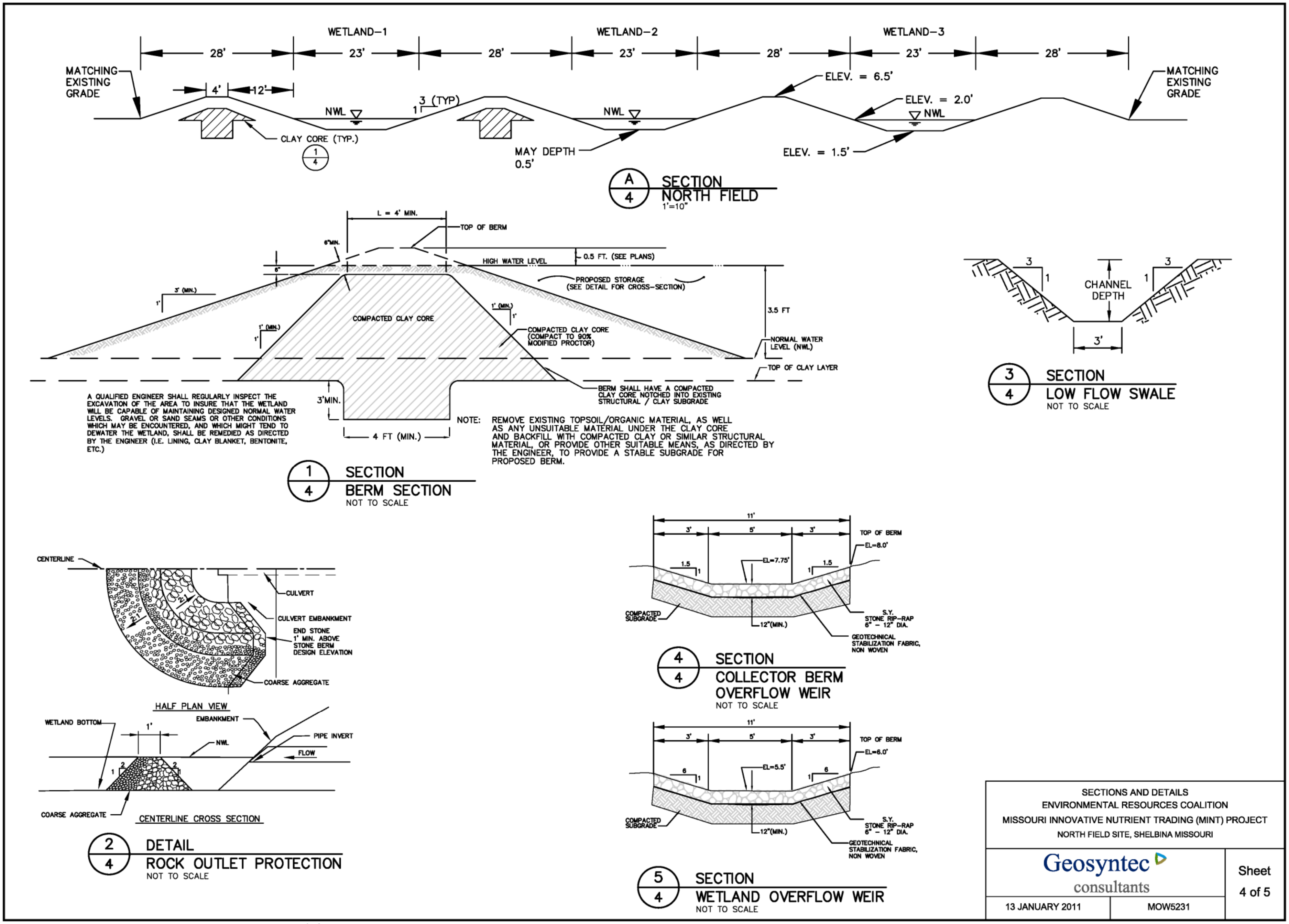
Wetland Design



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Wetland Design

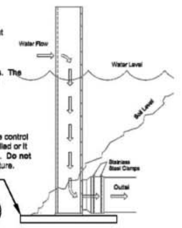
Inlet Water Control Structure Installation Instructions

1. *EXCAVATION AND GRADING*
   The structure base, and the outlet pipe must be set on firm, flat surfaces of compacted soil or concrete pad to provide a solid, stable base. This will prevent settling and reduce stress or misalignment of pipe connections.

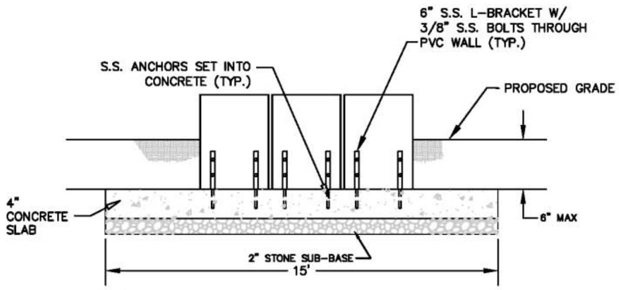
2. *PIPE CONNECTION*
   Remove black tape from outlet flex coupler exposing the stainless steel clamps. The flex coupler must be placed directly over the outside diameter of the pipe; then secured by tightening the stainless steel clamps as shown in the illustration.

3. *BACK FILL AND COMPACTION*
   Level the structure vertically before permanently anchoring. Backfill around the control structure by hand in 6" lifts. This structure must be anchored down when installed or it may have a tendancy to float. Hand tamp only - **do not** mechanically compact. **Do not** use a backhoe or blade to place backfill directly against the water control structure.

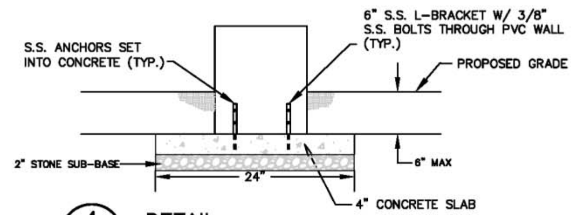
Excessive compaction may cause structural damage or failure.



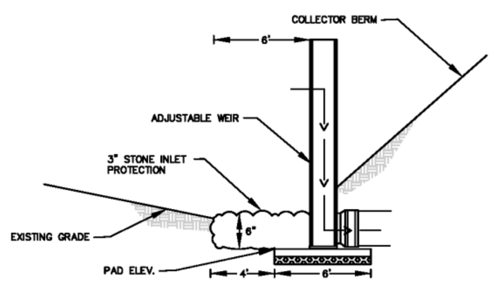
1 / 5 DETAIL
AGRI–DRAIN INSTALLATION
NOT TO SCALE



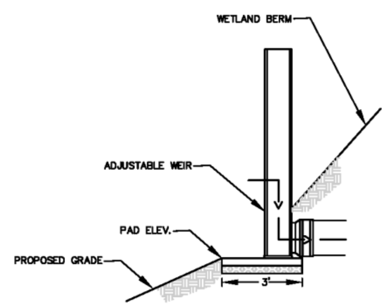
2 / 5 DETAIL
6' X 15' CONCRETE PAD AND
TRIPLE AGRI DRAIN INLET
NOT TO SCALE



4 / 5 DETAIL
2' X 3' CONCRETE PAD AND
SINGLE AGRI DRAIN INLET
NOT TO SCALE



3 / 5 SECTION
6' X 15' CONCRETE PAD AND
TRIPLE AGRI DRAIN INLET
NOT TO SCALE



5 / 5 SECTION
2' X 3' CONCRETE PAD AND
SINGLE AGRI DRAIN INLET
NOT TO SCALE

SECTIONS AND DETAILS
ENVIRONMENTAL RESOURCES COALITION
MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
NORTH FIELD SITE, SHELBINA, MISSOURI

Geosyntec consultants

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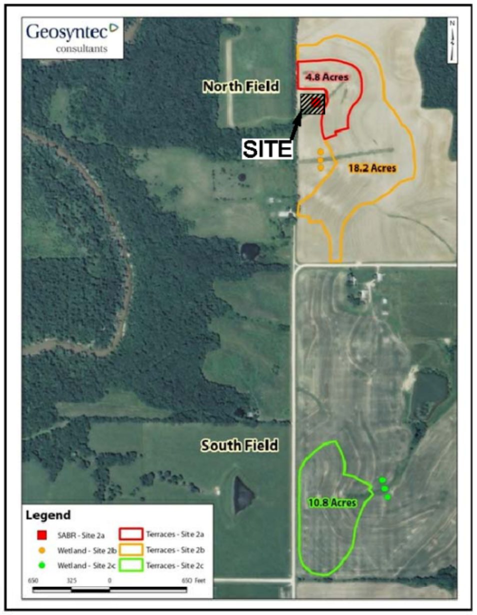
Wetland Design

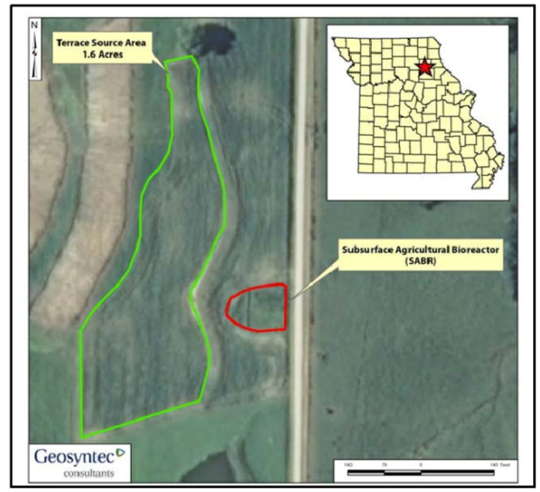
MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
DESIGN AND EVALUATION OF CONSTRUCTED SUBSURFACE AGRICULTURAL BIOREACTOR (SABR)
SHELBINA, MISSOURI
JANUARY 2011



NORTH FIELD LOCATION MAP

LIST OF DRAWINGS

SHEET NUMBER	DRAWING TITLE
1	TITLE SHEET
2	SPECIFICATIONS
3	PLAN VIEW
4	SECTIONS AND DETAILS



GERRISH LOCATION MAP

TITLE SHEET

MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
NORTH FIELD SITE, SHELBINA, MISSOURI

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GENERAL

1. THE STANDARD SPECIFICATIONS LISTED ON THESE CONSTRUCTION PLANS AND SUBSEQUENT DETAILS ARE ALL TO BE CONSIDERED AS PART OF THE CONTRACT DOCUMENTS. INCIDENTAL ITEMS OR ACCESSORIES NECESSARY TO COMPLETE THIS WORK MAY NOT BE SPECIFICALLY NOTED BUT ARE TO BE CONSIDERED A PART OF THE CONTRACT.
2. NO CONSTRUCTION PLANS SHALL BE USED FOR CONSTRUCTION UNLESS SPECIFICALLY MARKED "FOR CONSTRUCTION". PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AFFECTING THEIR WORK WITH THE ACTUAL CONDITIONS AT THE JOB SITE. IF THERE ARE ANY DISCREPANCIES FROM WHAT IS SHOWN ON THE CONSTRUCTION PLANS, HE MUST IMMEDIATELY REPORT SAME TO THE ENGINEER BEFORE DOING ANY WORK, OTHERWISE THE CONTRACTOR ASSUMES FULL RESPONSIBILITY. IN THE EVENT OF DISAGREEMENT BETWEEN THE CONSTRUCTION PLANS, STANDARD SPECIFICATIONS AND/OR SPECIAL DETAILS, THE CONTRACTOR SHALL SECURE WRITTEN INSTRUCTIONS FROM THE ENGINEER PRIOR TO PROCEEDING WITH ANY PART OF THE WORK AFFECTED BY OMISSIONS OR DISCREPANCIES. FAILING TO SECURE SUCH INSTRUCTION, THE CONTRACTOR WILL BE CONSIDERED TO HAVE PROCEEDED AT HIS OWN RISK AND EXPENSE. IN THE EVENT OF ANY DOUBT OR QUESTION ARISING WITH RESPECT TO THE TRUE MEANING OF THE CONSTRUCTION PLANS OR SPECIFICATIONS, THE DECISION OF THE ENGINEER SHALL BE FINAL AND CONCLUSIVE.
3. ALL WORK PERFORMED UNDER THIS CONTRACT SHALL BE GUARANTEED AGAINST ALL DEFECTS IN MATERIALS AND WORKMANSHIP OF WHATEVER NATURE BY THE CONTRACTOR AND HIS SURETY FOR A PERIOD OF 12 MONTHS FROM THE DATE OF FINAL ACCEPTANCE OF THE WORK BY THE ENGINEER.
4. BEFORE ACCEPTANCE BY THE OWNER AND FINAL PAYMENT, ALL WORK SHALL BE INSPECTED AND APPROVED BY THE OWNER OR HIS REPRESENTATIVE. FINAL PAYMENT WILL BE MADE AFTER ALL OF THE CONTRACTORS' WORK HAS BEEN APPROVED AND ACCEPTED, AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
5. DURING CONSTRUCTION OPERATIONS THE CONTRACTOR SHALL INSURE POSITIVE DRAINAGE AT THE CONCLUSION OF EACH DAY.
6. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REMOVE FROM THE SITE ANY AND ALL MATERIALS AND DEBRIS WHICH RESULT FROM CONSTRUCTION OPERATIONS.
7. THE CONTRACTOR SHALL COMPLY WITH AND OBSERVE THE RULES AND REGULATIONS OF O.S.H.A AND APPROPRIATE AUTHORITIES REGARDING SAFETY PROVISIONS.
8. THE ENGINEER AND OWNER ARE NOT RESPONSIBLE FOR THE CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES, TIME OF PERFORMANCE, PROGRAMS OR FOR ANY SAFETY PRECAUTIONS USED BY THE CONTRACTOR. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR EXECUTION OF HIS WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND SPECIFICATIONS.
9. ALL CONTRACTORS AND THEIR SUBCONTRACTORS OR ANY TIER SHALL INDEMNIFY THE OWNER AND ENGINEER FROM ALL LIABILITY RESULTING FROM ANY NEGLIGENT ACT OR OMISSION WITH THEIR CONSTRUCTION, INSTALLATION, AND TESTING OF WORK ON THIS PROJECT AND SHALL NAME THEM AS ADDITIONAL INSURED ON THEIR COMMERCIAL GENERAL LIABILITY POLICIES FOR CLAIMS ARISING OUT OF THE WORK ON THIS PROJECT. A PROPER CERTIFICATE OF INSURANCE SHALL BE ISSUED PRIOR TO THE START OF CONSTRUCTION.
10. ELECTRIC, TELEPHONE, NATURAL GAS, AND OTHER UTILITY COMPANIES MAY HAVE UNDERGROUND AND/OR OVERHEAD SERVICE FACILITIES IN THE VICINITY OF THE PROPOSED WORK. THE CONTRACTOR SHALL BE RESPONSIBLE FOR HAVING THE UTILITY COMPANIES LOCATE THEIR FACILITIES IN THE FIELD PRIOR TO CONSTRUCTION AND SHALL ALSO BE RESPONSIBLE FOR THE MAINTENANCE AND PRESERVATION OF THESE FACILITIES. THE CONTRACTOR SHALL **CALL 811** FOR UTILITY LOCATIONS.
11. THE CONTRACTOR SHALL HAVE A COMPETENT SUPERINTENDENT ON THE PROJECT SITE AT ALL TIMES IRRESPECTIVE OF THE AMOUNT OF WORK SUBLET. THE SUPERINTENDENT SHALL BE CAPABLE OF READING AND UNDERSTANDING THE PLANS AND SPECIFICATIONS, SHALL HAVE FULL AUTHORITY TO EXECUTE ORDERS TO EXPEDITE THE PROJECT, AND SHALL BE RESPONSIBLE FOR SCHEDULING AND HAVE CONTROL OF ALL WORK AS THE AGENT OF THE CONTRACTOR. FAILURE TO COMPLY WITH THIS PROVISION WILL RESULT IN A SUSPENSION OF WORK.
12. THE CONTRACTOR SHALL KEEP A SET OF "APPROVED" CONSTRUCTION PLANS ON THE JOB SITE, AND SHALL MAINTAIN (AS INDICATED HEREIN AND ELSEWHERE WITHIN THESE CONSTRUCTION NOTES, SPECIFICATIONS, AND PLANS) A LEGIBLE RECORD ON SAID PLANS OF ANY FIELD TILE ENCOUNTERED, ANY MODIFICATIONS/ALTERATIONS TO ALIGNMENT AND/OR TO PLANS AND SPECIFICATIONS OF PROPOSED IMPROVEMENTS, ETC. UPON COMPLETION OF THE CONTRACTORS' WORK, SAID PLANS AND INFORMATION SHALL BE PROVIDED TO ENGINEER. FINAL CONTRACT PAYMENT SHALL NOT COME DUE UNTIL THIS INFORMATION IS RECEIVED BY THE ENGINEER.
13. THESE PLANS ARE NOT SUITABLE FOR MACHINE GUIDANCE USE OR PURPOSES. THE ELEVATIONS AND CONTOURS ON THE PLANS ARE RELATIVE TO A LOCAL DATUM AND ARE NOT ASSOCIATED TO A STANDARD DATUM.
14. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER AND SEQUENCE THAT EROSION AND AIR AND WATER POLLUTION ARE MINIMIZED AND HELD WITHIN LEGAL LIMITATIONS. CONSTRUCTION METHODS THAT ENHANCE FISH AND WILDLIFE WILL BE USED WHERE PRACTICAL. TREES, STUMPS, AND BRUSH REMOVED FROM THE CONSTRUCTION AREA MAY BE PILED OR PLACED FOR FISH AND WILDLIFE HABITAT WHEN APPROVED BY THE LAND OWNER.
15. THE COMPLETED JOB SHALL CONFORM TO THE LAYOUT, ELEVATIONS, AND SPECIFICATIONS CONTAINED WITHIN THE PLAN SET AND THIS DOCUMENT.

EARTHWORK

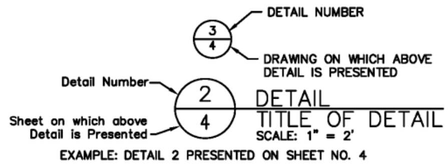
1. PRIOR TO ONSET OF GRADING OPERATIONS, THE CONTRACTOR SHALL FAMILIARIZE THE CREW WITH THE SOIL EROSION CONTROL SPECIFICATIONS. THE INITIAL ESTABLISHMENT OF EROSION CONTROL PROCEDURES AND THE PLACEMENT OF FILTER FENCING, ETC. TO PROTECT ADJACENT PROPERTY AND ROAD RIGHT OF WAY SHALL OCCUR BEFORE GRADING BEGINS, AND IN ACCORDANCE WITH THE SOIL EROSION CONTROL CONSTRUCTION SCHEDULE.
2. THE GRADING OPERATIONS ARE TO BE CLOSELY SUPERVISED AND INSPECTED, PARTICULARLY DURING THE REMOVAL OF UNSUITABLE MATERIAL AND THE CONSTRUCTION OF EMBANKMENTS BY THE CONTRACTOR.
3. THE PROPOSED GRADING ELEVATIONS SHOWN ON THE PLANS ARE FINISHED GRADE. TOPSOIL OF THE THICKNESS SHOWN IN THE STANDARDS AND DETAILS ON THE CONSTRUCTION PLANS IS TO BE PLACED BEFORE FINISHED GRADE ELEVATIONS ARE ACHIEVED.
4. THE FILL MATERIAL FOR THE EMBANKMENT SHALL BE PLACED IN LEVEL UNIFORM LAYERS SO THAT THE COMPACTED THICKNESS IS APPROXIMATELY SIX INCHES. EACH LAYER SHALL BE THOROUGHLY MIXED DURING SPREADING TO INSURE UNIFORMITY.
5. EMBANKMENT MATERIAL FOR EACH BERM SURROUNDING EACH BIOREACTOR SHALL BE COMPACTED TO A MINIMUM OF NINETY PERCENT (95%) OF MAXIMUM DENSITY IN ACCORDANCE WITH ASTM SPECIFICATION D_1557 (MODIFIED PROCTOR METHOD), OR TO SUCH OTHER DENSITY AS MAY BE DETERMINED APPROPRIATE BY THE ENGINEER. THE IMPERMEABLE LINER SHALL BE PLACED AS SHOWN ON THE PLANS.
6. WITHIN THE INTERIOR OF THE WETLAND CELLS, THE SUBSOIL SHALL BE DISCED TO A DEPTH OF 6 - 8 INCHES THE BIOREACTOR CELLS SHALL BE LINED WITH A 10 MIL. POLYETHYLINE IMPERMEABLE LINER BEFORE THE PLACEMENT OF THE COARSE HARDWOOD CHIPS (WOOD MULCH) BIOREACTOR CORE.
7. THE BIOREACTOR CELLS AND EMBANKMENT AREAS SHALL BE CLEARED OF TREES, LOGS, STUMPS, ROOTS, BRUSH, BOULDERS, SOD, AND RUBBISH.
8. TO THE EXTENT NEEDED, ALL SUITABLE MATERIAL REMOVED FROM BORROW AREAS SPECIFIED BY THE LANDOWNER SHALL BE USED IN THE CONSTRUCTION OF THE EARTHEN LEVEE AND BERMS (EMBANKMENTS). ALL EARTHEN SPOIL MATERIAL NOT USED IN THE CONSTRUCTION OF THE PROPOSED FACILITIES SHALL BE EITHER RETURNED TO THE BORROW AREA OR STOCKPILED AT THE DETERMINATION OF THE LANDOWNER.
9. BORROW EXCAVATION SHALL BE LOCATED NOT CLOSER THAN 30 FEET FROM THE TOE OF THE EMBANKMENTS SO AS NOT TO CAUSE SLOPE INSTABILITY OR SEEPAGE PROBLEMS.
10. THE PLACING AND SPREADING OF THE FILL MATERIAL SHALL BE STARTED AT THE LOWEST POINT OF THE FOUNDATION AND THE FILL SHALL BE BROUGHT UP IN APPROXIMATELY HORIZONTAL LAYERS NOT EXCEEDING 3 INCH LIFTS FOR HAND COMPACTION AND 4 INCH LIFTS FOR RUBBER TIRED AND MANUALLY DIRECTED POWER TAMPERS. EACH LAYER SHALL BE SPREAD, PROCESSED, AND COMPACTED. THE MOISTURE CONTENT OF THE FILL MATERIAL AND FOUNDATIONS SHALL BE SUCH THAT THE REQUIRED COMPACTION CAN BE OBTAINED.

MATERIALS

1. MATERIALS REQUIRED AND FABRICATION DETAILS SHALL BE AS SPECIFIED ON THE DRAWINGS AND AS WITHIN THIS DOCUMENT. THE CONTRACTOR SHALL CONFORM WITH MANUFACTURE DETAILS AND INSTALLATION METHODS.
2. PIPES SHALL BE SCHEDULE 40 RIDGID WALLED PVC, EITHER PERFORATED OR SOLID WALLED AS NOTED ON THE PLANS. ALL JOINTS SHALL BE SOLVENT WELDED.
3. PIPE CONDUITS SHALL BE PLACED ON A FIRM FOUNDATION TO THE LAYOUT AND ELEVATIONS SHOWN ON THE DRAWINGS. THE PIPE FOUNDATION SHALL BE COVERED WITH 1 INCH OF LOOSE, MOIST, FRIABLE ML OR CL SOIL MATERIAL IMMEDIATELY PRIOR TO PIPE PLACEMENT.
4. ANTI-SEEP COLLARS SHALL BE INSTALLED AT EACH LOCATION THE PIPE PASSES THROUGH THE BIOREACTOR EMBANKMENT OR AS SPECIFIED ON THE DRAWINGS WITH WATERTIGHT CONNECTIONS. ANTI-SEEP COLLARS SHALL BE OF MATERIAL COMPATIBLE WITH THE PIPE.
5. SELECTED BACKFILL OF FRIABLE ML OR CL MATERIAL SHALL BE PLACED AROUND STRUCTURES, PIPES CONDUITS AND ANTI-SEEP COLLARS AT APPROXIMATELY THE SAME RATE ON ALL SIDES TO PREVENT UNEQUAL PRESSURES. RUBBER TIRE, HAND, OR MANUALLY DIRECTED POWER TAMPER WILL BE USED ON BACKFILL AROUND ALL CONDUITS OR STRUCTURES. A MAXIMUM OF 3 INCH LIFTS SHALL BE USED FOR HAND COMPACTION AND 4 INCH LIFTS FOR RUBBER TIRED AND MANUALLY DIRECTED POWER TAMPERS. EXTREME CAUSE MUST BE EXERCISED IN BACKFILL AND COMPACTION AROUND STRUCTURES OR CONDUITS TO PREVENT DAMAGE, MOVEMENT, OR DEFLECTION. COMPACTION ON THE BOTTOM HALF OF CONDUITS MUST BE FIRM TO FILL ALL VOIDS AND SUPPLY LATERAL SUPPORT. LIGHT WEIGHT CONDUITS MAY NEED TO BE HELD IN PLACE TO PREVENT UPLIFT DURING COMPACTION. FILL IMMEDIATELY ADJACENT TO CONDUITS SHALL BE HAND TAMPED, POWER TAMPERS MAY CAUSE UPLIFTING DURING COMPACTION.
6. EQUIPMENT SHALL NOT BE OPERATED OVER ANY STRUCTURE OR CONDUIT UNTIL THERE IS SUFFICIENT BACKFILL TO PREVENT DAMAGE. THIS MINIMUM COVER IS 3 FEET FOR THE SPECIFIED PIPES.

SOIL EROSION AND SEDIMENT CONTROL

1. SOIL EROSION AND SEDIMENT CONTROL MEASURES SHALL BE IN ACCORDANCE WITH NPDES GENERAL PERMIT. ANY SOIL EROSION CONTROL OR SEDIMENT CONTROL MEASURES, IN ADDITION TO THOSE OUTLINED IN THESE PLANS AND WHICH ARE DEEMED NECESSARY BY THE OWNER, ENGINEER AND/OR CITY ENGINEER, SHALL BE IMPLEMENTED IMMEDIATELY BY THE CONTRACTOR.
2. SEDIMENT SHALL BE PREVENTED FROM ENTERING ALL DRAINAGE STRUCTURES, PIPES, SWALES, AND BIOREACTOR. ACCUMULATING SEDIMENT WITHIN THE BIOREACTOR WILL CLOG THE SYSTEM, NECESSITATING THE CONTRACTOR TO RECONSTRUCT THE BIOREACTOR CELL AT HIS OWN COST. CLEANING MAY ALSO BE REQUIRED DURING THE COURSE OF THE CONSTRUCTION OF THE PROJECT IF IT IS DETERMINED THAT THE SILT AND DEBRIS TRAPS ARE NOT FUNCTIONING PROPERLY OR EXCESS DEBRIS HAS COLLECTED.
3. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REMOVE FROM THE SITE ANY AND ALL MATERIALS AND DEBRIS WHICH RESULT FROM CONSTRUCTION OPERATIONS.
4. ALL BORROW AREAS SHALL BE REGRADED PER THE DRAWINGS, PROTECTED FROM EROSION, AND SEEDED.
5. THE EMBANKMENTS SHALL BE SEEDED AND COVERED WITH NORTH AMERICAN GREEN (NAG) S-75 EROSION CONTROL MAT OR APPROVED EQUAL. THE MAT SHALL BE INSTALLED AND STAPLED PER MANUFACTURE SPECIFICATIONS.
6. THE SWALES AND FROM 3 FT ABOVE AND 3 FT BELOW SHALL BE COVERED WITH NAG S-150 EROSION CONTROL MAD OR APPROVED EQUAL. THE MAT SHALL BE INSTALLED AND STAPLED PER MANUFACTURE SPECIFICATIONS.
7. THE EMBANKMENT AND ALL DISTURBED AREAS, SHALL BE SEEDED IN ACCORDANCE WITH MODOT SECTION 805. THE SEED USED SHALL BE OF MIDWESTERN ECOTYPE AND SHALL BE IN PLS (PURE LIVE SEED) POUNDS. A SEED MIXTURE AND APPLICATION RATE SHALL BE SUBMITTED TO THE ENGINEER AND OWNER FOR APPROVAL. RECEIPTS FROM A REPUTABLE SOURCE MUST BE ABLE TO BE PROVIDED.
8. WITHIN ONE YEAR AND AT THE TIME OF FINAL ACCEPTANCE BY THE OWNER, THE EMBANKMENT VEGETATION SHALL ACHIEVE 90% SURFACE COVERAGE. LESS THAN 10 PERCENT OF THE PLANTS SHALL NOT BE THOSE SPECIFICALLY PLACED BY SEED AND SPECIFIED ON THE PLANS. NO MORE THAN ONE SQUARE FOOT SHALL BE VOID OF VEGETATION.



DETAIL IDENTIFICATION LEGEND

SPECIFICATIONS

MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT

NORTH FIELD SITE, SHELBINA, MISSOURI

Geosyntec consultants

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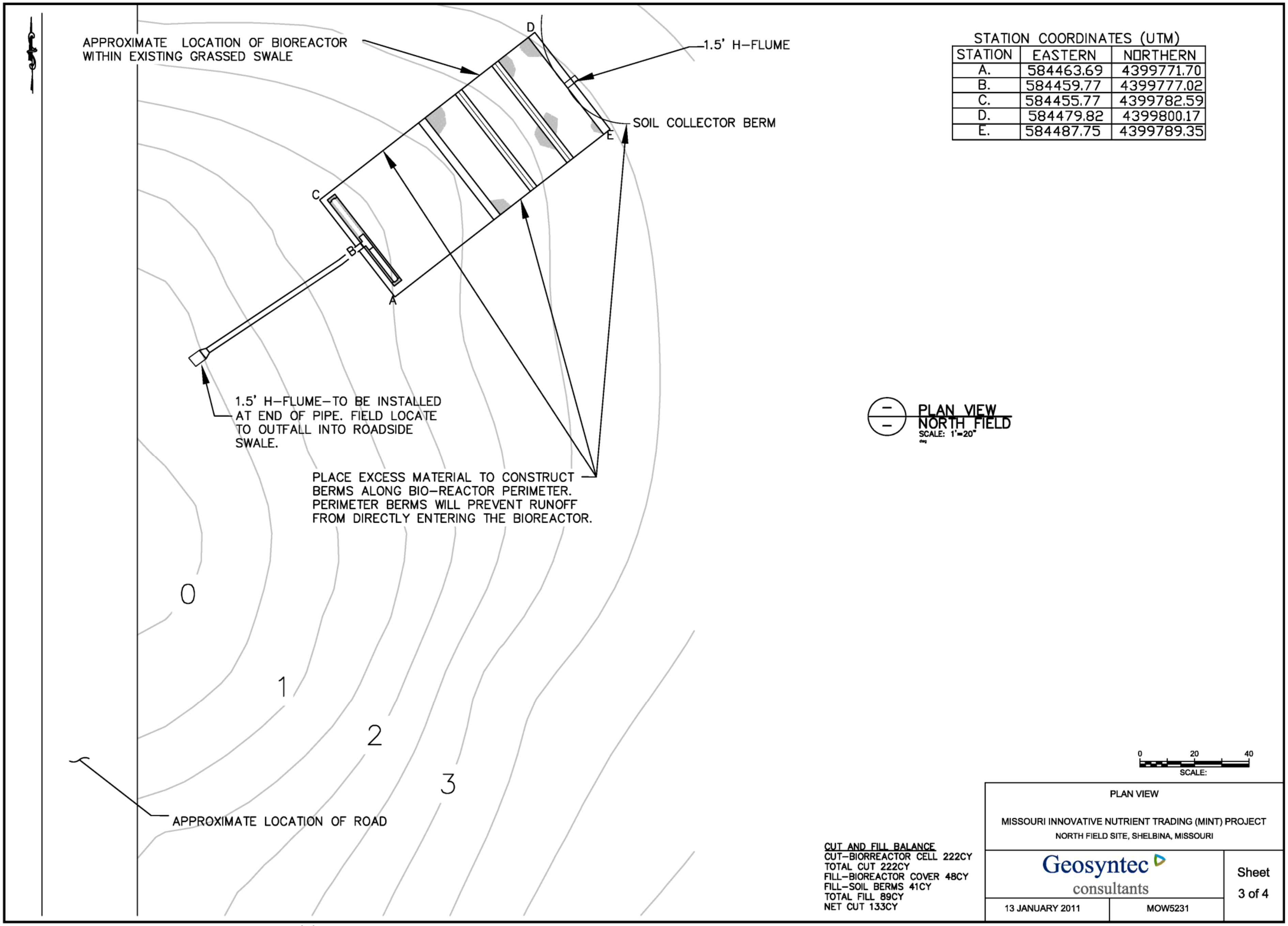

STATION COORDINATES (UTM)

STATION	EASTERN	NORTHERN
A.	584463.69	4399771.70
B.	584459.77	4399777.02
C.	584455.77	4399782.59
D.	584479.82	4399800.17
E.	584487.75	4399789.35

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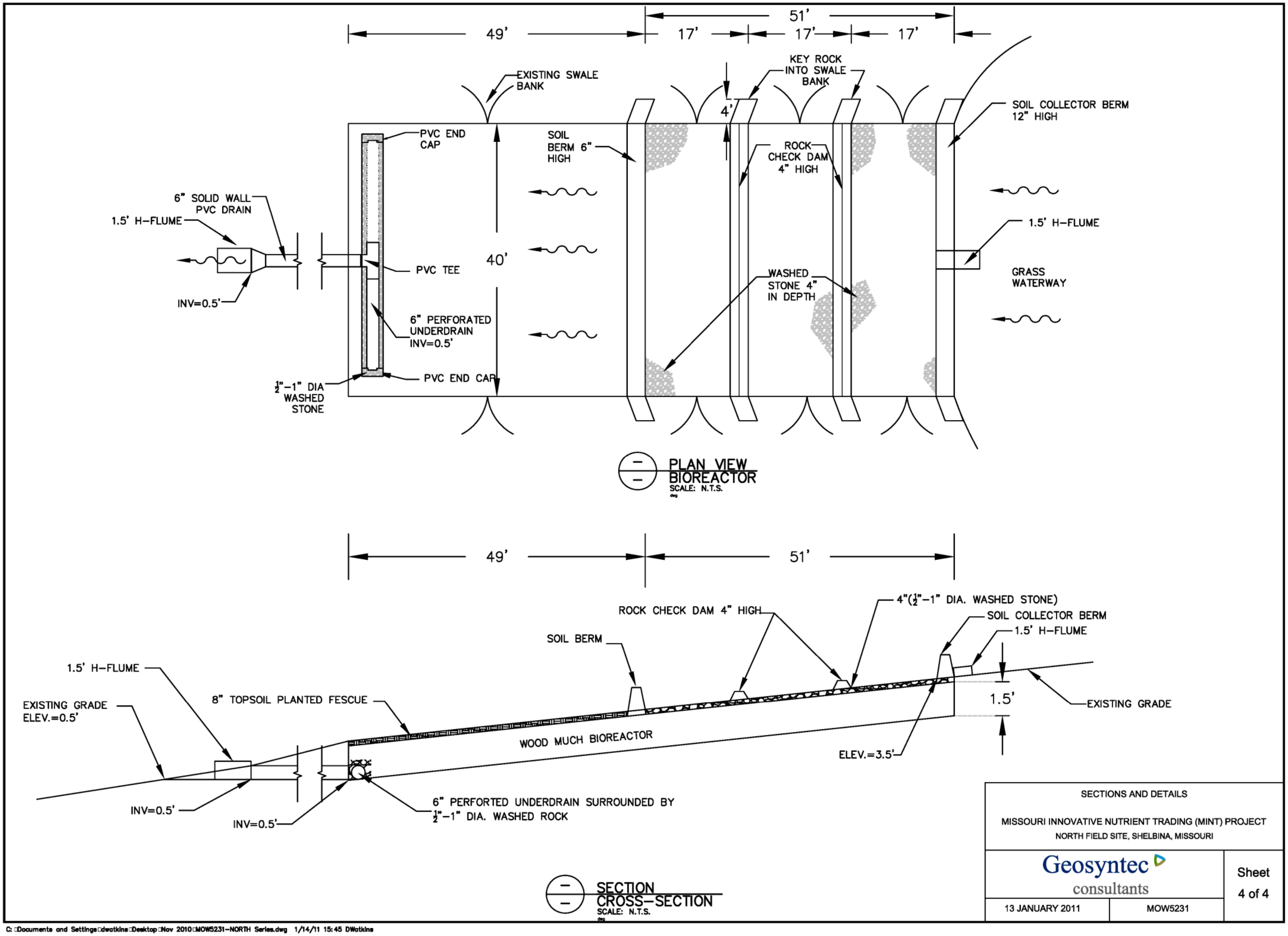
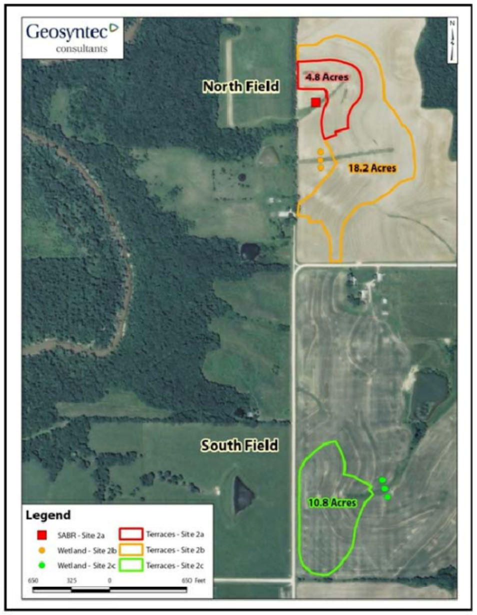
Bio-Reactor Design



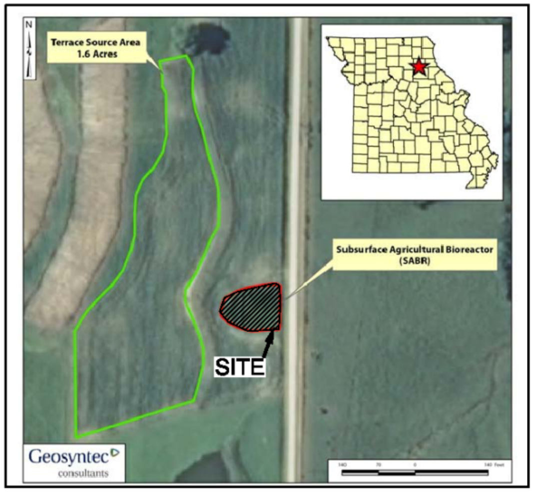
Bio-Reactor Design

MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
DESIGN AND EVALUATION OF
CONSTRUCTED SUBSURFACE AGRICULTURAL BIOREACTOR (SABR)
SHELBINA, MISSOURI
JANUARY 2011



VICINTY LOCATION MAP

LIST OF DRAWINGS	
SHEET NUMBER	DRAWING TITLE
1	TITLE SHEET
2	SPECIFICATIONS
3	PLAN VIEW
4	SECTIONS AND DETAILS



GERRISH LOCATION MAP

TITLE SHEET		
MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT GERRISH FIELD SITE, SHELBINA, MISSOURI		
Geosyntec consultants		Sheet 1 of 4
13 JANUARY 2011	MOW5231	

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GENERAL

1. THE STANDARD SPECIFICATIONS LISTED ON THESE CONSTRUCTION PLANS AND SUBSEQUENT DETAILS ARE ALL TO BE CONSIDERED AS PART OF THE CONTRACT DOCUMENTS. INCIDENTAL ITEMS OR ACCESSORIES NECESSARY TO COMPLETE THIS WORK MAY NOT BE SPECIFICALLY NOTED BUT ARE TO BE CONSIDERED A PART OF THE CONTRACT.
2. NO CONSTRUCTION PLANS SHALL BE USED FOR CONSTRUCTION UNLESS SPECIFICALLY MARKED "FOR CONSTRUCTION". PRIOR TO COMMENCEMENT OF CONSTRUCTION, THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND CONDITIONS AFFECTING THEIR WORK WITH THE ACTUAL CONDITIONS AT THE JOB SITE. IF THERE ARE ANY DISCREPANCIES FROM WHAT IS SHOWN ON THE CONSTRUCTION PLANS, HE MUST IMMEDIATELY REPORT SAME TO THE ENGINEER BEFORE DOING ANY WORK, OTHERWISE THE CONTRACTOR ASSUMES FULL RESPONSIBILITY. IN THE EVENT OF DISAGREEMENT BETWEEN THE CONSTRUCTION PLANS, STANDARD SPECIFICATIONS AND/OR SPECIAL DETAILS, THE CONTRACTOR SHALL SECURE WRITTEN INSTRUCTIONS FROM THE ENGINEER PRIOR TO PROCEEDING WITH ANY PART OF THE WORK AFFECTED BY OMISSIONS OR DISCREPANCIES. FAILING TO SECURE SUCH INSTRUCTION, THE CONTRACTOR WILL BE CONSIDERED TO HAVE PROCEEDED AT HIS OWN RISK AND EXPENSE. IN THE EVENT OF ANY DOUBT OR QUESTION ARISING WITH RESPECT TO THE TRUE MEANING OF THE CONSTRUCTION PLANS OR SPECIFICATIONS, THE DECISION OF THE ENGINEER SHALL BE FINAL AND CONCLUSIVE.
3. ALL WORK PERFORMED UNDER THIS CONTRACT SHALL BE GUARANTEED AGAINST ALL DEFECTS IN MATERIALS AND WORKMANSHIP OF WHATEVER NATURE BY THE CONTRACTOR AND HIS SURETY FOR A PERIOD OF 12 MONTHS FROM THE DATE OF FINAL ACCEPTANCE OF THE WORK BY THE ENGINEER.
4. BEFORE ACCEPTANCE BY THE OWNER AND FINAL PAYMENT, ALL WORK SHALL BE INSPECTED AND APPROVED BY THE OWNER OR HIS REPRESENTATIVE. FINAL PAYMENT WILL BE MADE AFTER ALL OF THE CONTRACTORS' WORK HAS BEEN APPROVED AND ACCEPTED, AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
5. DURING CONSTRUCTION OPERATIONS THE CONTRACTOR SHALL INSURE POSITIVE DRAINAGE AT THE CONCLUSION OF EACH DAY.
6. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO REMOVE FROM THE SITE ANY AND ALL MATERIALS AND DEBRIS WHICH RESULT FROM CONSTRUCTION OPERATIONS.
7. THE CONTRACTOR SHALL COMPLY WITH AND OBSERVE THE RULES AND REGULATIONS OF O.S.H.A AND APPROPRIATE AUTHORITIES REGARDING SAFETY PROVISIONS.
8. THE ENGINEER AND OWNER ARE NOT RESPONSIBLE FOR THE CONSTRUCTION MEANS, METHODS, TECHNIQUES, SEQUENCES OR PROCEDURES, TIME OF PERFORMANCE, PROGRAMS OR FOR ANY SAFETY PRECAUTIONS USED BY THE CONTRACTOR. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR EXECUTION OF HIS WORK IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND SPECIFICATIONS.
9. ALL CONTRACTORS AND THEIR SUBCONTRACTORS OR ANY TIER SHALL INDEMNIFY THE OWNER AND ENGINEER FROM ALL LIABILITY RESULTING FROM ANY NEGLIGENT ACT OR OMISSION WITH THEIR CONSTRUCTION, INSTALLATION, AND TESTING OF WORK ON THIS PROJECT AND SHALL NAME THEM AS ADDITIONAL INSURED ON THEIR COMMERCIAL GENERAL LIABILITY POLICIES FOR CLAIMS ARISING OUT OF THE WORK ON THIS PROJECT. A PROPER CERTIFICATE OF INSURANCE SHALL BE ISSUED PRIOR TO THE START OF CONSTRUCTION.
10. ELECTRIC, TELEPHONE, NATURAL GAS, AND OTHER UTILITY COMPANIES MAY HAVE UNDERGROUND AND/OR OVERHEAD SERVICE FACILITIES IN THE VICINITY OF THE PROPOSED WORK. THE CONTRACTOR SHALL BE RESPONSIBLE FOR HAVING THE UTILITY COMPANIES LOCATE THEIR FACILITIES IN THE FIELD PRIOR TO CONSTRUCTION AND SHALL ALSO BE RESPONSIBLE FOR THE MAINTENANCE AND PRESERVATION OF THESE FACILITIES. THE CONTRACTOR SHALL CALL 811 FOR UTILITY LOCATIONS.
11. THE CONTRACTOR SHALL HAVE A COMPETENT SUPERINTENDENT ON THE PROJECT SITE AT ALL TIMES IRRESPECTIVE OF THE AMOUNT OF WORK SUBLET. THE SUPERINTENDENT SHALL BE CAPABLE OF READING AND UNDERSTANDING THE PLANS AND SPECIFICATIONS, SHALL HAVE FULL AUTHORITY TO EXECUTE ORDERS TO EXPEDITE THE PROJECT, AND SHALL BE RESPONSIBLE FOR SCHEDULING AND HAVE CONTROL OF ALL WORK AS THE AGENT OF THE CONTRACTOR. FAILURE TO COMPLY WITH THIS PROVISION WILL RESULT IN A SUSPENSION OF WORK.
12. THE CONTRACTOR SHALL KEEP A SET OF "APPROVED" CONSTRUCTION PLANS ON THE JOB SITE, AND SHALL MAINTAIN (AS INDICATED HEREIN AND ELSEWHERE WITHIN THESE CONSTRUCTION NOTES, SPECIFICATIONS, AND PLANS) A LEGIBLE RECORD ON SAID PLANS OF ANY FIELD TILE ENCOUNTERED, ANY MODIFICATIONS/ALTERATIONS TO ALIGNMENT AND/OR TO PLANS AND SPECIFICATIONS OF PROPOSED IMPROVEMENTS, ETC. UPON COMPLETION OF THE CONTRACTORS' WORK, SAID PLANS AND INFORMATION SHALL BE PROVIDED TO ENGINEER. FINAL CONTRACT PAYMENT SHALL NOT COME DUE UNTIL THIS INFORMATION IS RECEIVED BY THE ENGINEER.
13. THESE PLANS ARE NOT SUITABLE FOR MACHINE GUIDANCE USE OR PURPOSES. THE ELEVATIONS AND CONTOURS ON THE PLANS ARE RELATIVE TO A LOCAL DATUM AND ARE NOT ASSOCIATED TO A STANDARD DATUM.
14. CONSTRUCTION OPERATIONS SHALL BE CARRIED OUT IN SUCH A MANNER AND SEQUENCE THAT EROSION AND AIR AND WATER POLLUTION ARE MINIMIZED AND HELD WITHIN LEGAL LIMITATIONS. CONSTRUCTION METHODS THAT ENHANCE FISH AND WILDLIFE WILL BE USED WHERE PRACTICAL. TREES, STUMPS, AND BRUSH REMOVED FROM THE CONSTRUCTION AREA MAY BE PILED OR PLACED FOR FISH AND WILDLIFE HABITAT WHEN APPROVED BY THE LAND OWNER.
15. THE COMPLETED JOB SHALL CONFORM TO THE LAYOUT, ELEVATIONS, AND SPECIFICATIONS CONTAINED WITHIN THE PLAN SET AND THIS DOCUMENT.

EARTHWORK

1. PRIOR TO ONSET OF GRADING OPERATIONS, THE CONTRACTOR SHALL FAMILIARIZE THE CREW WITH THE SOIL EROSION CONTROL SPECIFICATIONS. THE INITIAL ESTABLISHMENT OF EROSION CONTROL PROCEDURES AND THE PLACEMENT OF FILTER FENCING, ETC. TO PROTECT ADJACENT PROPERTY AND ROAD RIGHT OF WAY SHALL OCCUR BEFORE GRADING BEGINS, AND IN ACCORDANCE WITH THE SOIL EROSION CONTROL CONSTRUCTION SCHEDULE.
2. THE GRADING OPERATIONS ARE TO BE CLOSELY SUPERVISED AND INSPECTED, PARTICULARLY DURING THE REMOVAL OF UNSUITABLE MATERIAL AND THE CONSTRUCTION OF EMBANKMENTS BY THE CONTRACTOR.
3. THE PROPOSED GRADING ELEVATIONS SHOWN ON THE PLANS ARE FINISHED GRADE. TOPSOIL OF THE THICKNESS SHOWN IN THE STANDARDS AND DETAILS ON THE CONSTRUCTION PLANS IS TO BE PLACED BEFORE FINISHED GRADE ELEVATIONS ARE ACHIEVED.
4. THE FILL MATERIAL FOR THE EMBANKMENT SHALL BE PLACED IN LEVEL UNIFORM LAYERS SO THAT THE COMPACTED THICKNESS IS APPROXIMATELY SIX INCHES. EACH LAYER SHALL BE THOROUGHLY MIXED DURING SPREADING TO INSURE UNIFORMITY.
5. EMBANKMENT MATERIAL FOR EACH BERM SURROUNDING EACH BIOREACTOR SHALL BE COMPACTED TO A MINIMUM OF NINETY PERCENT (95%) OF MAXIMUM DENSITY IN ACCORDANCE WITH ASTM SPECIFICATION D_1557 (MODIFIED PROCTOR METHOD), OR TO SUCH OTHER DENSITY AS MAY BE DETERMINED APPROPRIATE BY THE ENGINEER. THE IMPERMEABLE LINER SHALL BE PLACED AS SHOWN ON THE PLANS.
6. WITHIN THE INTERIOR OF THE WETLAND CELLS, THE SUBSOIL SHALL BE DISCED TO A DEPTH OF 6 - 8 INCHES THE BIOREACTOR CELLS SHALL BE LINED WITH A 10 MIL. POLYETHYLINE IMPERMEABLE LINER BEFORE THE PLACEMENT OF THE COARSE HARDWOOD CHIPS (WOOD MULCH) BIOREACTOR CORE.
7. THE BIOREACTOR CELLS AND EMBANKMENT AREAS SHALL BE CLEARED OF TREES, LOGS, STUMPS, ROOTS, BRUSH, BOULDERS, SOD, AND RUBBISH.
8. TO THE EXTENT NEEDED, ALL SUITABLE MATERIAL REMOVED FROM BORROW AREAS SPECIFIED BY THE LANDOWNER SHALL BE USED IN THE CONSTRUCTION OF THE EARTHEN LEVEE AND BERMS (EMBANKMENTS). ALL EARTHEN SPOIL MATERIAL NOT USED IN THE CONSTRUCTION OF THE PROPOSED FACILITIES SHALL BE EITHER RETURNED TO THE BORROW AREA OR STOCKPILED AT THE DETERMINATION OF THE LANDOWNER.
9. BORROW EXCAVATION SHALL BE LOCATED NOT CLOSER THAN 30 FEET FROM THE TOE OF THE EMBANKMENTS SO AS NOT TO CAUSE SLOPE INSTABILITY OR SEEPAGE PROBLEMS.
10. THE PLACING AND SPREADING OF THE FILL MATERIAL SHALL BE STARTED AT THE LOWEST POINT OF THE FOUNDATION AND THE FILL SHALL BE BROUGHT UP IN APPROXIMATELY HORIZONTAL LAYERS NOT EXCEEDING 3 INCH LIFTS FOR HAND COMPACTION AND 4 INCH LIFTS FOR RUBBER TIRED AND MANUALLY DIRECTED POWER TAMPERS. EACH LAYER SHALL BE SPREAD, PROCESSED, AND COMPACTED. THE MOISTURE CONTENT OF THE FILL MATERIAL AND FOUNDATIONS SHALL BE SUCH THAT THE REQUIRED COMPACTION CAN BE OBTAINED.

MATERIALS

1. MATERIALS REQUIRED AND FABRICATION DETAILS SHALL BE AS SPECIFIED ON THE DRAWINGS AND AS WITHIN THIS DOCUMENT. THE CONTRACTOR SHALL CONFORM WITH MANUFACTURE DETAILS AND INSTALLATION METHODS.
2. PIPES SHALL BE SCHEDULE 40 RIDGID WALLED PVC, EITHER PERFORATED OR SOLID WALLED AS NOTED ON THE PLANS. ALL JOINTS SHALL BE SOLVENT WELDED.
3. PIPE CONDUITS SHALL BE PLACED ON A FIRM FOUNDATION TO THE LAYOUT AND ELEVATIONS SHOWN ON THE DRAWINGS. THE PIPE FOUNDATION SHALL BE COVERED WITH 1 INCH OF LOOSE, MOIST, FRIABLE ML OR CL SOIL MATERIAL IMMEDIATELY PRIOR TO PIPE PLACEMENT.
4. ANTI-SEEP COLLARS SHALL BE INSTALLED AT EACH LOCATION THE PIPE PASSES THROUGH THE BIOREACTOR EMBANKMENT OR AS SPECIFIED ON THE DRAWINGS WITH WATERTIGHT CONNECTIONS. ANTI-SEEP COLLARS SHALL BE OF MATERIAL COMPATIBLE WITH THE PIPE.
5. SELECTED BACKFILL OF FRIABLE ML OR CL MATERIAL SHALL BE PLACED AROUND STRUCTURES, PIPES CONDUITS AND ANTI-SEEP COLLARS AT APPROXIMATELY THE SAME RATE ON ALL SIDES TO PREVENT UNEQUAL PRESSURES. RUBBER TIRE, HAND, OR MANUALLY DIRECTED POWER TAMPER WILL BE USED ON BACKFILL AROUND ALL CONDUITS OR STRUCTURES. A MAXIMUM OF 3 INCH LIFTS SHALL BE USED FOR HAND COMPACTION AND 4 INCH LIFTS FOR RUBBER TIRED AND MANUALLY DIRECTED POWER TAMPERS. EXTREME CAUSE MUST BE EXERCISED IN BACKFILL AND COMPACTION AROUND STRUCTURES OR CONDUITS TO PREVENT DAMAGE, MOVEMENT, OR DEFLECTION. COMPACTION ON THE BOTTOM HALF OF CONDUITS MUST BE FIRM TO FILL ALL VOIDS AND SUPPLY LATERAL SUPPORT. LIGHT WEIGHT CONDUITS MAY NEED TO BE HELD IN PLACE TO PREVENT UPLIFT DURING COMPACTION. FILL IMMEDIATELY ADJACENT TO CONDUITS SHALL BE HAND TAMPED, POWER TAMPERS MAY CAUSE UPLIFTING DURING COMPACTION.
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2. SEDIMENT SHALL BE PREVENTED FROM ENTERING ALL DRAINAGE STRUCTURES, PIPES, SWALES, AND BIOREACTOR. ACCUMULATING SEDIMENT WITHIN THE BIOREACTOR WILL CLOG THE SYSTEM, NECESSITATING THE CONTRACTOR TO RECONSTRUCT THE BIOREACTOR CELL AT HIS OWN COST. CLEANING MAY ALSO BE REQUIRED DURING THE COURSE OF THE CONSTRUCTION OF THE PROJECT IF IT IS DETERMINED THAT THE SILT AND DEBRIS TRAPS ARE NOT FUNCTIONING PROPERLY OR EXCESS DEBRIS HAS COLLECTED.
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5. THE EMBANKMENTS SHALL BE SEEDED AND COVERED WITH NORTH AMERICAN GREEN (NAG) S-75 EROSION CONTROL MAT OR APPROVED EQUAL. THE MAT SHALL BE INSTALLED AND STAPLED PER MANUFACTURE SPECIFICATIONS.
6. THE SWALES AND FROM 3 FT ABOVE AND 3 FT BELOW SHALL BE COVERED WITH NAG S-150 EROSION CONTROL MAD OR APPROVED EQUAL. THE MAT SHALL BE INSTALLED AND STAPLED PER MANUFACTURE SPECIFICATIONS.
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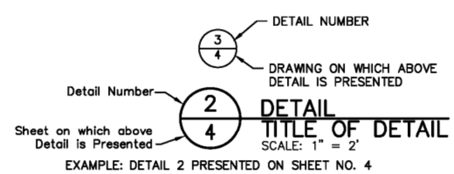
8. WITHIN ONE YEAR AND AT THE TIME OF FINAL ACCEPTANCE BY THE OWNER, THE EMBANKMENT VEGETATION SHALL ACHIEVE 90% SURFACE COVERAGE. LESS THAN 10 PERCENT OF THE PLANTS SHALL NOT BE THOSE SPECIFICALLY PLACED BY SEED AND SPECIFIED ON THE PLANS. NO MORE THAN ONE SQUARE FOOT SHALL BE VOID OF VEGETATION.



DETAIL IDENTIFICATION LEGEND

SPECIFICATIONS

MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT

GERRISH FIELD SITE, SHELBINA, MISSOURI

Geosyntec consultants

Sheet 2 of 4

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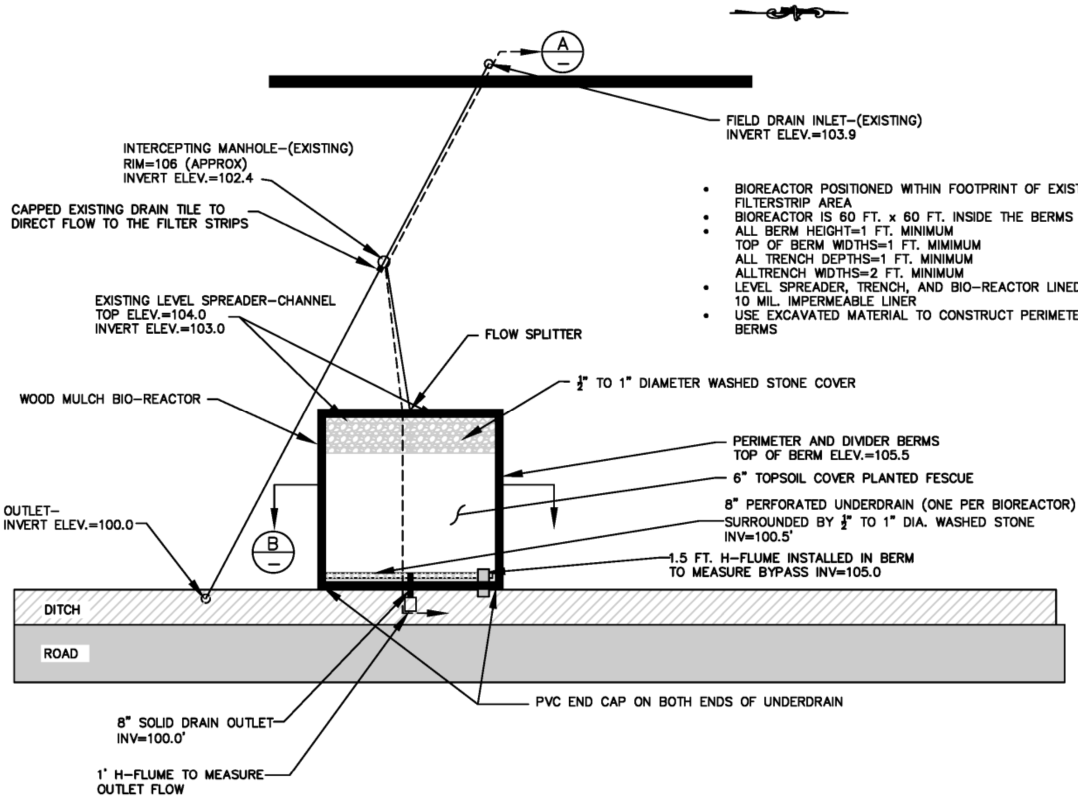
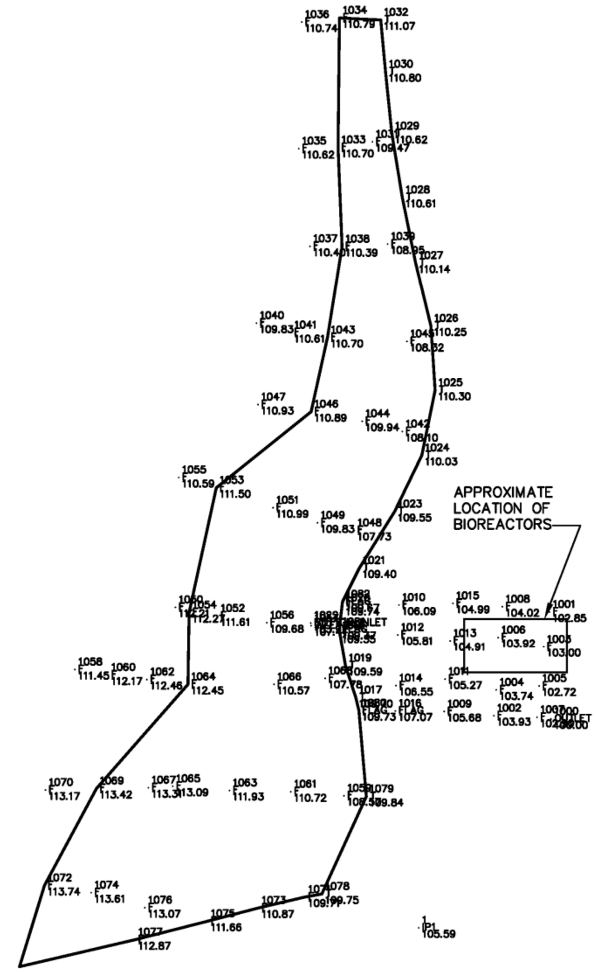


- BIOREACTOR POSITIONED WITHIN FOOTPRINT OF EXISTING FILTERSTRIP AREA
- BIOREACTOR IS 60 FT. x 60 FT. INSIDE THE BERMS
- ALL BERM HEIGHT=1 FT. MINIMUM
  TOP OF BERM WIDTHS=1 FT. MIMIMUM
  ALL TRENCH DEPTHS=1 FT. MINIMUM
  ALLTRENCH WIDTHS=2 FT. MINIMUM
- LEVEL SPREADER, TRENCH, AND BIO-REACTOR LINED IN 10 MIL. IMPERMEABLE LINER
- USE EXCAVATED MATERIAL TO CONSTRUCT PERIMETER BERMS

PLAN VIEW
BIOREACTOR AT GERRISH SITE
N.T.S.



PLAN VIEW
GERRISH SITE
N.T.S.

CUT AND FILL BALANCE
CUT–BIOREACTOR CELL 333CY
TOTAL CUT 333CY
FILL–SOIL BERM 63CY
FILL–BIOREACTOR COVER 67CY
TOTAL FILL 130CY
NET CUT 203CY

PLAN VIEW

MISSOURI INNOVATIVE NUTRIENT TRADING (MINT) PROJECT
GERRISH FIELD SITE, SHELBINA, MISSOURI

Geosyntec consultants

Sheet 3 of 4

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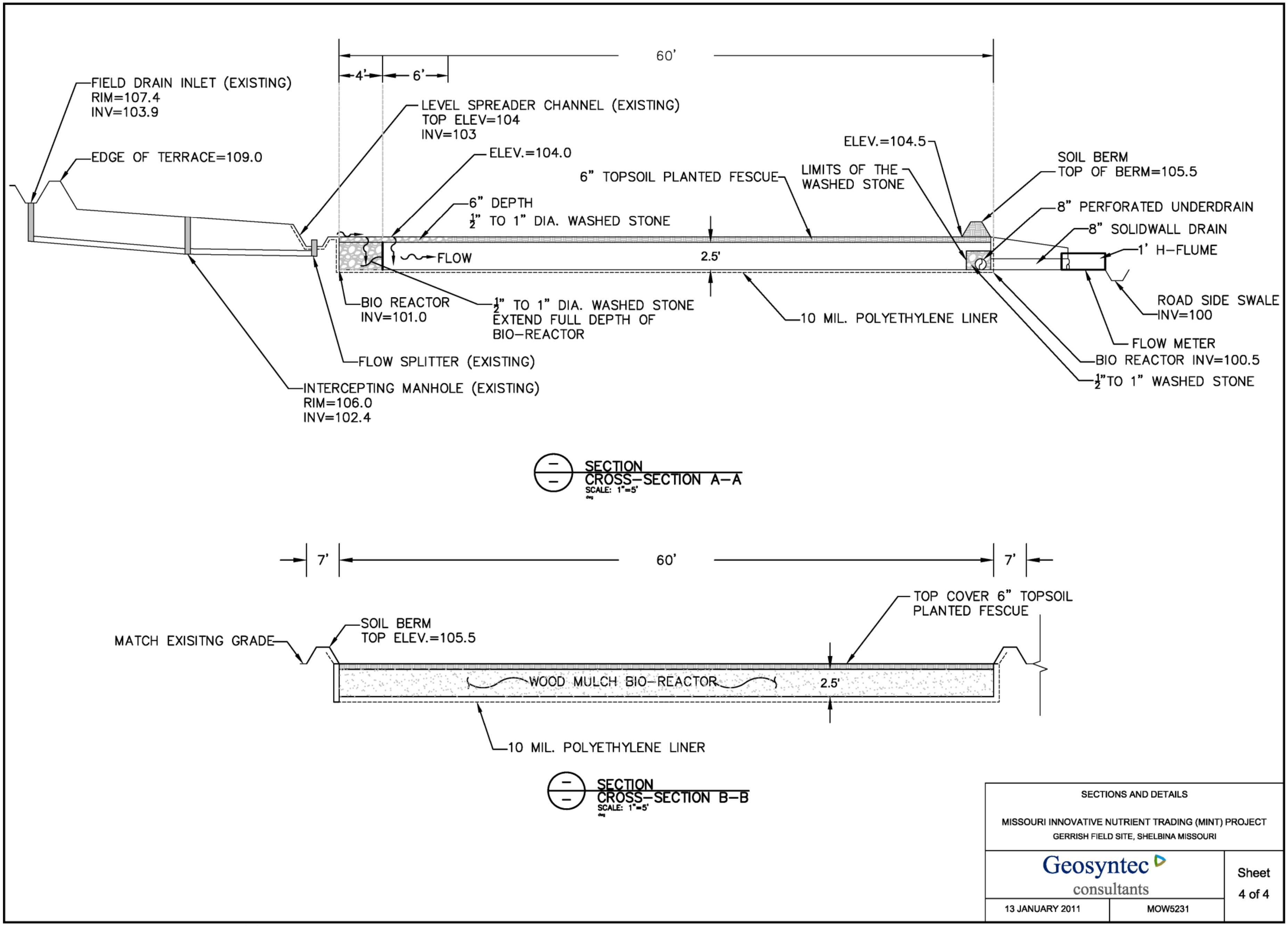
Bio-Reactor Design



Bio-Reactor Design

Water Quality Data Sheet for Edge of Field Wetlands

Environmental Resources Coalition

EPIC - Conservation Innovation Grant

Sampling Site: ____________ **Weather:** ____________

Time of Arrival: ____________ Cloud Coverage ____________ **Personnel:** ____________

Time of Departure: ____________ Temperature ____________ **Date:** ____________

Dissolved Oxygen Calibration and Quality Assurance Measurements

Sample Type	Date & Time (24:00)	*Depth (m)	Spec. Cond. (uS/cm)	Water Temp (°C)	pH			ODO** (mg/L)	ODO Sat.** (%)	Battery (volts)
Arrival QA Sonde Reading										
Pre-Calibration Field Sonde										
1st QA Sonde Reading										
Field Sonde after Cleaning										
Field Sonde Calibration								Initial DO%	Cal. DO%	
Post-Cal. Field Sonde										
2nd QA Sonde Reading										
Last 3 Sonde Readings										

Batteries Replaced ?: ________ Days of Battery Life: ________ Voltage: ________ Gain ODO: ________ Sonde Post Condition: ________

Sonde Status Active ?: ________ Sonde Probe Condition: ________

Levelogger Downloaded ?: ________ 650 Barometer Reading: ________ Probe maintenance: ________

Comments: ____________________

*DO NOT RECALIBRATE SONDE ONCE DEPLOYED **ROX ONLY RECALIBRATED EVERY WEEKLY DURING SERVICING

Water Quality Measurements & Observations

	Site	Time	Sample ID
Sample:			
Duplicate:			
Blank:			

	Time	Reading
Levelogger		
Staff Gage		
pH		
specific conductance		
Temperature		

Comments: ____________________

Collector: ____________________ **Date** ____________________

QA Personnel: ____________________ **Date** ____________________

Water Quality Data Sheet – Wetland

Environmental Resources Coalition

Automated Sampler Field Log

EPIC - National Conservation Innovation Grant

BMP Location ____________________ Date ____________________

Site ID ____________________ Arrival Time (24 format) ____________________

Departure Time (24 hr format) ____________________

1	Levellogger Data		
a	Sampler Serial Number		
b	Battery Voltage	d	Date / Time first sample taken
c	Level Readout	e	Date / Time last sample taken
f	Total Samples		
g	Successful Samples		
h	Problems Sampling Y / N	i	Remarks:
j	Total Volume (cf)	k	Average Event Flow (cfs)
		l	Event Rainfall (inches)

2	Data Download
a	Was sampler downloaded?
b	Channel number used
c	DTU Identification #

3	Sample Collection		
a	Type of Sample: Composite		
b	Sample Volume (mL):	c	Sample Identification #:
Sample Duplicate			
d	Sample Volume (mL):	e	Sample Identification #:
Sample Blank			
f	Sample Volume (mL):	g	Sample Identification #:

4	Equipment Examination			
a	Was debris found on...	i	Sensor mount	Y / N
		ii	Sampler hose	Y / N
		iii	Weir	Y / N
b	Was debris removed...	i	Sensor mount	Y / N
		ii	Sampler hose	Y / N
		iii	Weir	Y / N
c	Water level in weir (in.)			
d	Sampler Sensor desiccant color	e	Desiccant Replaced	Y / N
	Note: Active descant is blue. Replace desiccant if pink			

5	Changes to Monitoring Station			
a	Were any changes made to the sample program? Y / N			
	If yes, what change were made			
b	Was sampler calibrated?	i	Level Sensor	Y / N
		ii	Sample Volume	Y / N
	Calibration remarks:			
c	Were repairs or parts replaced to sampler or monitoring system? Y / N			
d	Repair remarks:			

6	Final Check
a	Has data been downloaded? Y / N
b	Is sampler left in running (sampling) mode> Y / N

Remarks:

Field Staff Signature ____________________

Automated Sampler Field Log

Water Quality Data Sheet for Bio-reactor's Peizometer Field

EPIC - Conservation Innovation Grant

BMPLocation ID: ____________ **Weather:** ____________

Time of Arrival: ____________ Cloud Coverage ____________ **Personnel:** ____________

Time of Departure: ____________ Temperature ____________ **Date:** ____________

Dissolved Oxygen Calibration and Quality Assurance Measurements

Sample Type	Time (24:00)	*Depth (cm)	Spec. Cond. (uS/cm)	Water Temp (°C)	pH	Water Quality Sample ID #	ODO** (mg/L)	ODO Sat.** (%)	Battery (volts)
Peizometer 1 (P1)									
Peizometer 2 (P2)									
Peizometer 3 (P3)									
Peizometer 4 (P4)									
Peizometer 5 (P5)									
Peizometer 6 (P6)									
Peizometer 7 (P7)									
Peizometer 8 (P8)									
Peizometer 9 (P9)									

Levelogger Downloaded ?: ____________ 650 Barometer Reading: ____________

Comments: ____________

*WATER DEPTH FROM BOTTOM OF STAND PIPE **ROX PROBE CALIBRATED DAILY BEFORE MEASUREMENTS

Water Quality Measurements & Observations

	Site	Time	Sample ID #
Duplicate:			
Blank:			

	Time	Reading
Levelogger		

Comments: ____________

Collector: ____________ **Date** ____________

QA Personnel: ____________ **Date** ____________

Piezometer Field Water Quality Data Sheet

Stalk Nitrate Challenge Data Form

Your Name: ____________________ Your phone # or email address: __________________

Your address: ____

Field location (You can get lat/long of a point at http://maps.google.com/ (right click and select "what's here")):

____

Corn Variety: ___________________ Planting date: __________

Yield goal: _______ bu/A Actual/expected yield: _________ bu/A

Winter cover/trap crop? (if yes, what crop?): ____________________________

Crop(s) previous year: _______________________________________

Source of Nitrogen 1:

Fertilizer type __________________________ Date of Application: ____________

Method of application: __________________ Target N rate: ________ lbs/A

If surface applied: Incorporated (yes/no): _______ Days to incorporation: ___________

N loss inhibitor used (yes/no) _________ Type used _____________________________

Source of Nitrogen 2 (if needed):

Fertilizer type __________________________ Date of Application: ____________

Method of application: __________________ Target N rate: ________ lbs/A

If surface applied: Incorporated (yes/no): _______ Days to incorporation: ___________

N loss inhibitor used (yes/no) _________ Type used _____________________________

Source of Nitrogen 3 (if needed):

Fertilizer type __________________________ Date of Application: ____________

Method of application: __________________ Target N rate: ________ lbs/A

If surface applied: Incorporated (yes/no): _______ Days to incorporation: ___________

N loss inhibitor used (yes/no) _________ Type used _____________________________

Stalk Nitrate Sample Information: Date of sampling: __________

Number of stalks included: _______ Area represented by sample ______ Acres

---

There will be **no analysis cost for your first 10 samples** if you provide the requested information. Test cost typically is $12/sample. Discount may be available for more samples, contact me.

Sample Handling: Sample anytime from ¼ milk line to three weeks after black layer formation. Sample at least **15 stalks** from the sampling area. For each stalk remove the 8-inch section from six inches above the ground to 14 inches above the ground. Select representative plants and do not include heavily diseased or damaged plants. Place the sample in a paper bag (not plastic). *Do not freeze sample.* Refrigerate if samples are shipped more than one day after sampling.

Mail the sample plus this data sheet to: Missouri Soil Testing Lab, Attn: Stalk Nitrate Test Challenge, 23 Mumford Hall, University of Missouri, Columbia MO 65211 or MU Delta Regional Soil Testing Lab, 147 State Hwy T, Portageville. MO 63873. You must include a completed form with each sample to receive no-cost analysis.

Questions? Contact John Lory (LoryJ@missouri.edu; 573-884-7815).

Stalk Nitrate Challenge Data Form

Three Year Summary
Stalk Nitrate
Plant Analysis Report

	Sample ID	Total N Applied	Yield bu/ac	Dominat N Source	Inhibitor used	# of N apps	Nitrate Results	Nutrient Level Position											
								Low			Marginal			Optimum			High		
2012																			
2011																			
2010																			

** Plant analysis performed by the Soil and Plant Testing Lab, Division of Plant Sciences, University of Missouri

** No dry land samples could be taken in 2012 due to the extreme dry conditions

Interpretations:

A stalk NO_3-N test value of less than **250** ppm is interpreted as **low**, nitrogen was probably deficient during the growing season.

Test valules of **250-700** ppm is **marginal**, it is possible that nitrogen shortage limited yield in this range.

Test values of **700-2000** is **optimum**, yeild was not limited by a shortage of nitrogen in this range.

Test values of **2000** ppm means **high**, nitrogen rate was too high or some production factor (like drought or hail damage) caused a yield reduction.

Stalk Nitrate Plant Analysis Report Form (3 year summary example)

2012 Nutrient Management
&
Trading Survey

1. Primary county of farming operation: Boone / Audrain / Monroe / Other:___________
2. Which watershed do you farm in? Goodwater Creek / Long Branch Creek
3. Acres in Operation: 0-500 501-1000 1001-1500 1501-2000 2001-2500 2501-3000 3000+
4. Type of farming operation (circle all that apply):
   Corn / Soybeans / Grain Sorghum / Wheat / Cattle / Poultry / Swine
5. Types of nitrogen source most commonly used (circle all that apply):
   Anhydrous Ammonia / Urea / Urea-Ammonium Nitrate (UAN) / Ammonium Nitrate / Manure / DAP – Diammonium Phosphate / MAP – Monoammonium Phosphate / None
6. Timing (ideally) preferred for nitrogen application: Fall / Spring
7. Program typically used in your nitrogen application: One pass / Two Pass
8. Do you typically use a nitrification inhibitor such as N-Serve or Agrotain? Yes / No
9. Do you actively use or have any of the following practices in your operation? (check all that apply)

   __ Grid soil sampling
   __ Yield monitor
   __ Tissue or stalk nitrate samples
   __ Variable nitrogen application
   __ Use of yield maps for N use
   __ Overly of soil & yield maps

10. Have you participated in the Missouri Corn Growers Stalk Nitrate testing program? Yes / No
11. Do you actively participate in any NRCS programs? Yes / No
12. Do you participate in the EQIP program through NRCS? Yes / No
13. Will you likely continue practices that EQIP promotes or other cultural practices in the future if funding is removed from these NRCS projects? Yes / No
14. Do you follow a nutrient management plan for your farm? Yes / No
15. Note: A formal nutrient management plan keeps track of soil tests values and applied fertilizer as well as nutrients removed with the crop. If you do not follow a formal nutrient management plan would you be willing to in the future? Yes / No

OVER

2012 Survey Form (Page 1)

A nutrient trading program would potentially offer growers an opportunity to sell nutrient reduction credits to publically owned wastewater treatment plants. The nutrient credits would be generated by growers who add nutrient reduction Best Management Practices (BMPs) to their operation.

16. Would you potentially be willing to participate in a Nutrient Trading Program if it were available in the area?
Yes / No

17. Which Best Management Practices do you use on your farm? (check all that apply)

__ Cover Crops
__ Terraces
__ Nutrient Management Plans
__ No-Till
__ Prescribed Grazing
__ Off Stream Watering
__ Buffer Strips
__ One Pass Tillage
Other: ____________________

18. What Best Management Practices are you interested in or would you be willing to participate in on your farm(s)? (check all that apply)

__ Cover Crops
__ Minimum Tillage – one pass
__ Buffer Strips
__ Nutrient Management Plans
__ No-Till
__ Wetlands
__ Bio-Reactors
__ Prescribed Grazing
__ Off Stream Watering
Other:_____________________

19. Rate your level of concern for participation in a nutrient trading program.
(1 = Low Concern 5 = High Concern) – Leave blank if NO CONCERN

This is somehow going to cost me money	1	2	3	4	5
I don't want anyone to know what runs off of my farm	1	2	3	4	5
This sounds like a lot of time with little reward	1	2	3	4	5
How can there be enough money for everyone to participate, some people are going to get favored	1	2	3	4	5
The problem isn't farmers', why should we do this	1	2	3	4	5
Will an adequate number of growers participate to make a difference or make the trade worthwhile	1	2	3	4	5

Other comments/concerns:

20. If interested, would you be willing to sign a long term (5-10 year) contract for trading? Yes / No

21. Would you be willing to allow a soil and water professional to confirm nutrient trading BMPs by conduction site visits on your farm? Yes / No

We greatly appreciate your participation.

2012 Survey Form (Page 2)

11 Appendix E – Project Outcomes

USDA

United States Department of Agriculture

Office of the Secretary
Washington, D.C. 20250

JUL 17 2012

The Honorable Jeremiah W. Nixon
Governor
State of Missouri
Jefferson City, Missouri 65102

Dear Governor Nixon:

Thank you for your letter of July 10, 2012, requesting a disaster designation for all Missouri counties due to losses caused by drought and related disasters that have occurred during the 2012 growing season.

The Department of Agriculture has reviewed the Loss Assessment Reports and has determined that there were sufficient production losses in Missouri to warrant a Secretarial natural disaster designation. Therefore, I am designating 97 Missouri counties as primary natural disaster areas due to losses caused by drought and excessive heat that occurred during the period of April 1, 2012, and continuing. Those counties are:

Adair	Cole	Iron	Moniteau	St. Charles
Andrew	Cooper	Jackson	Monroe	St. Clair
Atchison	Crawford	Jasper	Montgomery	Ste. Genevieve
Audrain	Dade	Jefferson	Morgan	St. Francois
Barry	Dallas	Johnson	Newton	St. Louis
Barton	Daviess	Knox	Nodaway	Saline
Benton	De Kalb	Laclede	Oregon	Schuyler
Boone	Dent	Lafayette	Osage	Scotland
Buchanan	Douglas	Lawrence	Pettis	Shannon
Caldwell	Franklin	Lewis	Phelps	Shelby
Callaway	Gasconade	Lincoln	Pike	Stone
Camden	Gentry	Linn	Platte	Sullivan
Carroll	Greene	Livingston	Polk	Texas
Cass	Grundy	McDonald	Pulaski	Vernon
Cedar	Harrison	Macon	Putnam	Warren
Chariton	Henry	Maries	Ralls	Washington
Christian	Hickory	Marion	Randolph	Webster
Clark	Holt	Mercer	Ray	Worth
Clay	Howard	Miller	Reynolds	Wright
Clinton	Howell			

Missouri Disaster Letter (Page 1)

The Honorable Jeremiah W. Nixon
Page2

In accordance with section 321(a) of the Consolidated Farm and Rural Development Act, Bates, Carter, Madison, Ozark, Perry, Ripley, Taney, and Wayne Counties, and the independent city of St. Louis, Missouri, are named as contiguous disaster areas.

On July 12, 2012, I designated the remaining 17 Missouri counties as primary natural disaster counties due to this disaster. Consequently, those counties are already eligible for Farm Service Agency (FSA) assistance.

A Secretarial disaster designation makes farm operators in both primary and contiguous disaster areas eligible to be considered for assistance from the FSA, provided eligibility requirements are met. This assistance includes FSA emergency loans. Farmers in eligible counties have 8 months from the date of a Secretarial disaster declaration to apply for emergency loan assistance. FSA will consider each emergency loan application on its own merits, taking into account the extent of production losses, security available, and repayment ability

Local FSA offices can provide affected farmers with further information.

Sincerely,

Thomas J. Vilsack
Secretary

Missouri Disaster Letter (Page 2)

Evaluating and Demonstrating the Effectiveness Edge of Field Wetlands and Agricultural Bio-reactors in the Removal of Nutrients and Herbicides.

Robert R. Bacon
Environmental Resources Coalition (ERC)

Introduction

This study will quantitatively evaluate the effectiveness of edge-of-field constructed wetlands and agricultural bioreactors for their removal of nutrients, sediment, and herbicides from actively row cropped fields. These innovative best management practices (BMPs) will be used to capture surface runoff directly from row cropped fields and from terrace tile outlets.

Currently there is a scarcity of studies that evaluate the performance of the various agricultural BMPs. Evaluating and valuing nutrient removal efficiencies are extremely important because this information is critical to the development of accurate nutrient credits for water quality trading. The data collected from these conservation practices will be valuable in developing future planning and trading frameworks for achieving nutrient, sediment, and herbicide reduction goals. These practices will help comply with water quality criteria; thereby, reducing the likelihood of waters being placed on the impaired waters list. If successful, these practices could become important BMPs for addressing Gulf of Mexico hypoxia problems and water quality nutrient issues specific to the state of Missouri. However, these practices will only be accepted by growers only if they make economic sense; therefore, we will also demonstrate the cost-effectiveness of implementation.

Phase

This study is currently in the construction phase. We anticipate completion by the end of July and plan to deploy the automated samplers and other monitoring equipment soon thereafter. Water quality sample collection and analyses will begin later this summer.

We envision that the agricultural bioreactors will be fully functional upon completion of construction. However, the edge of field wetlands will become progressively more functional over time as the wetland plants develop and become established. We anticipate full functionality of the wetlands at the beginning of the 2012 cropping season.

Location / Site

This project is located in Northeastern Missouri near Shelbina, Missouri in the North Fork of the Salt River watershed (HUC 8, 07110005). This watershed was selected because of its claypan soils, which are particularly susceptible to nutrient and herbicide transport (Lerch and Blanchard 2003). The four project sites are located in separate field drainages on two privately owned farms, which are under a typical corn / soybean rotation.

Study Objectives

- Estimate the effectiveness (both cost and performance) of each of the constructed BMPs in reducing nutrient, sediment, and herbicide concentrations and loading in agricultural row crop production runoff
- Estimate denitrification and herbicide degradation kinetics of the wetland cells during non-runoff periods
- Evaluate the appropriate BMP to drainage ratio needed to provide transferability to other fields.

Parameters to be Measured

This following table lists the number of sampling locations, the sample type, and sampling frequency for each parameter to be analyzed for each BMP type.

BMP Type	Description	# of Locations	Sample Type & (# of samples)	Frequency	Analyses
Edge of Field Wetland	Runoff samples from wetland inlet / outlets	Inlet – 2, Outlet – 6	Flow-paced composite (max. of 160/yr.)	Runoff events (max. of 20)	TN, TDN $NO_{2/3}$, NH_3, TP, TDP, SRP TSS, VSS, NVSS, PSD, Herbicides
	Non-runoff samples from wetland cells near outlets	Wetland Cells - 6	Grab Samples (max. of 96/yr.)	Biweekly (max. of 16)	TN, TDN $NO_{2/3}$, NH_3, TP, TDP, SRP TSS, VSS, NVSS, PSD, Herbicides
Agricultural Bioreactor	Runoff samples from bio-reactor inlet / outlet	Inlet – 2, Outlet – 2	Flow paced composite (max. of 80)	Runoff events (max. of 20)	TN, TDN $NO_{2/3}$, NH3, TP, TDP, SRP TSS, VSS, NVSS, PSD, Herbicides
	Ground water samples in bioreactor	Stand Pipes – 18	Grab samples collected through Peizometers (max. of 288/yr.)	Biweekly (max of 16)	ODO, ODO Sat, Cond, pH, eH, $NO_{2/3}$, SO_4

Abbreviations:

TN = Total Nitrogen
TDN = Total Dissolved Nitrogen
$NO_{2/3}$ = Nitrate + Nitrite
NH_3 = Ammonia as Nitrogen
TP = Total Phosphorus
TDP = Total Dissolved Phosphorus
SRP = Soluble Reactive Phosphorus
TSS = Total Suspended Solids
NVSS = Non-Volatile Suspendered Solids
VSS = Volatile Suspended Solids

PSD = LISST Particle Size Distribution
ODO = Optical Dissolved Oxygen
ODO Sat. = ODO Saturation
Cond. = Specific Conductance
pH = power (potenz) hydrogen (pH)
eH = reduction potential
SO4 = Sulfate

Herbicides Include:

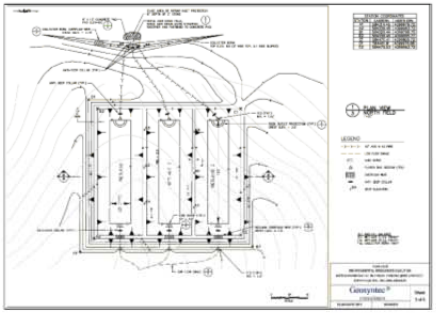
Atrazine (ATR)
Deethylatazine (DEA)
Deisopropylatrazine (DIA)
Metribuzin (MTR)
Terbutylazine (TER)
Acetochlor (ACE)
Alachlor (ALA)
Metolachlor (MTO)
Cyanazine (CYN)

Environmental Resources Coalition MissouriCorn NRCS

BMP Design

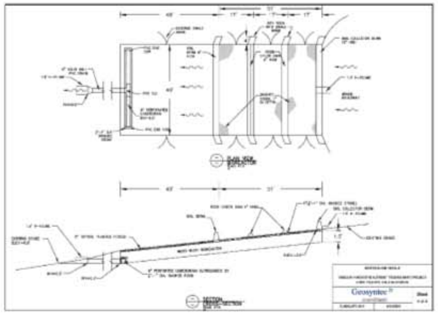
Edge of Field Wetland

We have designed and are currently constructing two edge-of-field wetlands to capture the surface runoff coming off actively row cropped fields. These wetlands are being constructed at a 100:1 drainage area to wetland ratio. Each of these wetlands is divided into three equal cells to maximize data collection over the life of the project.



Agricultural Bio-reactor

This project will evaluate two agricultural bio-reactors in two separate field drainages. These bio-reactors will capture and treat surface runoff from a terrace tile or surface runoff flowing though a grass waterway. The intent of this study is to demonstrate and document the efficacy of agricultural denitrification bioreactors in improving water quality runoff from a typical corn / soybean rotation.



Project Poster for SWCS Presentation

ERC EPIC

(final project report)

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Appendix E:

Project Outcomes

Wetland and Bio-Reactor

project overview pictures

Location: Shelby County, MO

Three Cell Wetland


Construction 2011


Construction Summer2011

Wetland Planting Fall 2011

Wetland Planting Fall 2011

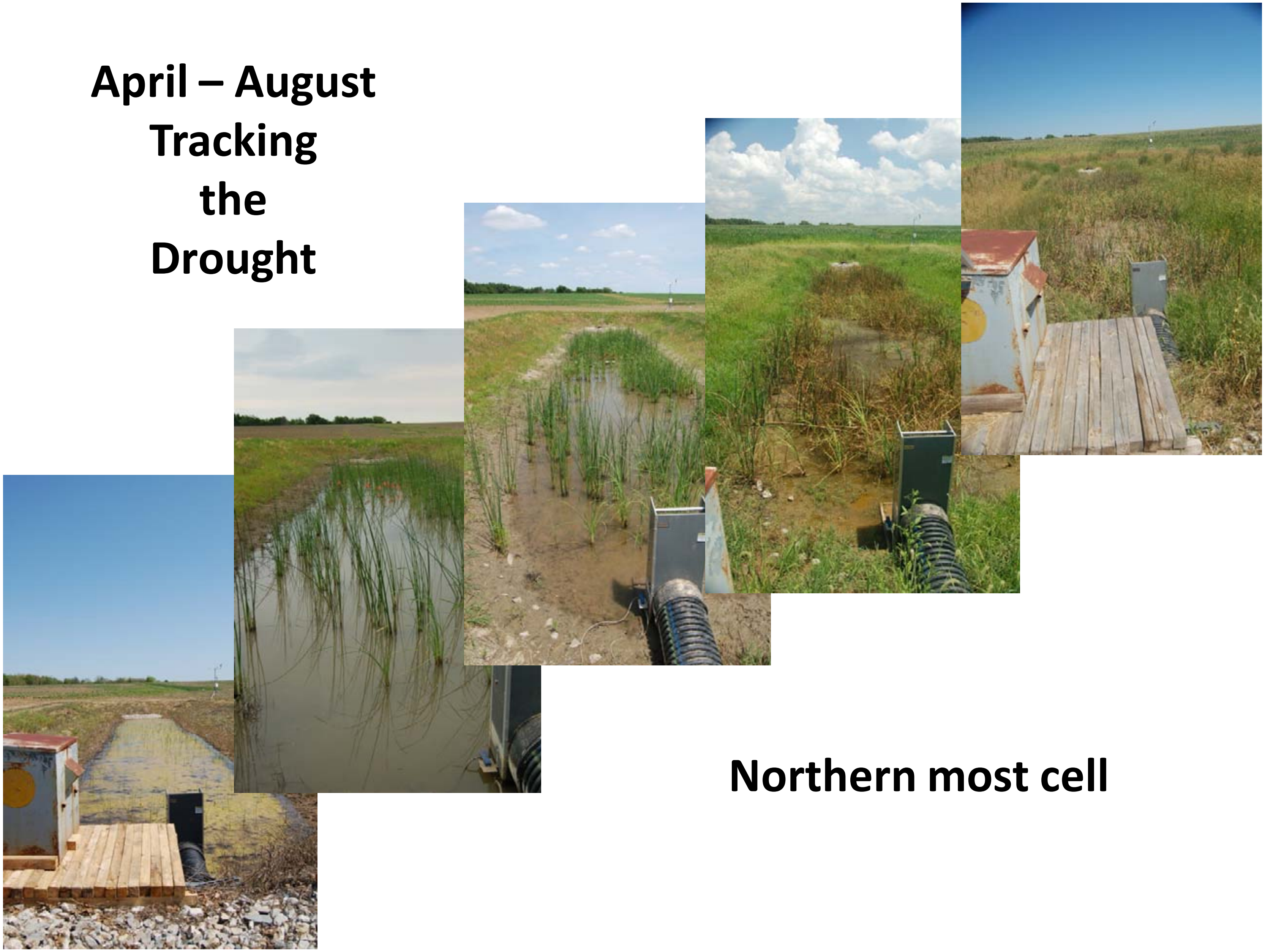
Sampler Install Spring 2012

EPIC

Site

Equipment

April – August Tracking the Drought



Northern most cell

Large One-Cell Wetland


Construction 2011


Construction Summer 2011

Wetland Planting Fall 2011

Sampler Install Spring 2012

Summer 2012

Tracking the Drought

Small Bio-Reactor


Construction 2011


Construction 2011

Sampler Install Spring 2012

Large Bio-Reactor

Construction 2011


Construction 2011


Sampler Install Spring 2011

Summer 2012

Tracking the Drought