



Missouri
Department of
Natural Resources

Biological Assessment Report

**West Fork Tebo Creek
Henry County**

April 10, 2001

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Pollution Control Program

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1.0 Introduction

At the request of the Water Pollution Control Program (WPCP), the Environmental Services Program (ESP) Water Quality Monitoring Section (WQMS) conducted a biological assessment of West Fork Tebo Creek, northeast of Clinton in western Missouri. West Fork Tebo Creek was added to the 303(d) list of impaired waters in 1998 due to a suspected elevation in sulfate levels. Much of the watershed supplying this creek consists of abandoned mine land (AML) that was formerly strip mined for coal.

East Fork Honey Creek, a nearby drainage free of AML influence which is located north northwest of Clinton, was selected as a control site to compare with West Fork Tebo Creek. This comparison was to determine whether a biological impairment exists in a system with elevated sulfate levels. Sampling at West Fork Tebo and East Fork Honey creeks was conducted on April 10 and April 19, 2001, respectively, to provide data to the WPCP for use in evaluating and comparing the biological integrity of the two streams. Dave Michaelson, Cecilia Campbell, and others of the Environmental Services Program, Air and Land Protection Division conducted the sampling.

On March 22, 2001 a study plan was submitted to the WPCP (Appendix A). Because standard statistical methods were proposed in the study plan, a null hypothesis of no difference between macroinvertebrate communities of a high sulfate stream and a control was stated. Six contiguous stations were sampled at each study site.

2.0 Study Area

West Fork Tebo Creek originates in northern Henry County near the town of Shawnee Mound and flows southeast through an upper watershed dominated by grasslands (see Table 1) with extensive areas of abandoned mine land. The stream reach assessed is class "C" with beneficial use designations of "livestock and wildlife watering" and "warm water aquatic life protection, human health/fish consumption."

East Fork Honey Creek originates in southern Johnson County near the town of Post oak and flows southwest through a watershed dominated by grasslands (see Table 1). The stream reach assessed is within 0.5 mi. of the confluence with Honey Creek, a class "C" stream with beneficial use designations of "livestock and wildlife watering" and "warm water aquatic life protection, human health/fish consumption." This stream was chosen as a control in the study due to several factors: its close proximity to the study stream within the same Ecological Drainage Unit (EDU); a watershed of comparable size; and a lack of observable AML within the watershed.

West Fork Tebo and East Fork Honey creeks are located within the Plains/Osage EDU. An EDU is a region in which biological communities and habitat conditions can be expected to be similar. Please see Appendix B for maps of the EDUs and the 14 digit Hydrologic Units (HU), #10290108190004 and #10290108150001, that contain the sampling reaches for West Fork Tebo and East Fork Honey creeks, respectively. See

Table 1 for a comparison of land use for the 14 digit HU. Land cover data were derived from the Thematic Mapper satellite data from 1991-1993, and interpreted by the Missouri Resource Assessment Partnership (MoRAP).

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest	Swamp
EDU	0.2	23.0	54.9	17.9	0.3
EF Honey HU	0.0	26.6	53.2	18.2	0.0
WF Tebo HU	0.0	28.6	50.8	19.3	0.0

3.0 Site Descriptions

West Fork Tebo Creek Stations #1 through #6 (NW ¼ sec. 24, T. 42 N., R. 25 W. & NE ¼ sec. 23, T. 42 N., R. 25 W.) were located downstream from County Road NE 581 1.5 mi. north of State Road YY west northwest of Clinton. The sample reach was located on property owned by the U.S. Army Corps of Engineers and managed by the Missouri Department of Conservation as the Harry S. Truman Reservoir Wildlife Management Lands. Average stream width was 38 feet; the total length of stream sampled was approximately 4560 feet. Geographic coordinates at the downstream terminus of Station #1 are Lat. 38.41827°, Long. -93.63839°. Discharge was measured at 45.45 cubic feet/second (cfs). Geographic coordinates at the upstream terminus of Station #6 are Lat. 38.41778°, Long. -93.64561°. Discharge was measured at 26.24 cfs. The watershed at the most downstream segment was approximately 19.5 mi².

East Fork Honey Creek Stations #1 through #6 (NW ¼ sec. 19, T. 43 N., R. 26 W.) were located both upstream and downstream from County Road NW 501 1.5 mi. south of State Road N south of Petersburg. Average stream width was 37 feet; the total length of stream sampled was approximately 4440 feet. Geographic coordinates at the downstream terminus of Station #1 are Lat. 38.49988°, Long. -93.84837°. Discharge was measured at 4.82 cfs. Geographic coordinates at the upstream terminus of Station #6 are Lat. 38.50622°, Long. -93.84043°. Discharge was measured at 4.57 cfs. The watershed at the most downstream segment was approximately 16.9 mi².

4.0 Methods

4.1 Macroinvertebrate Collection

A single standard habitat (non-flowing water with depositional substrate) was sampled at each of the stations as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Other habitats available during the spring sample season (coarse substrate, large woody debris, and rootmat) were not sampled due to their potential ephemeral nature at these sites. It was decided that only the depositional areas (i.e., pools) were likely to have been hydrated during the previous months and that

sampling this habitat would provide the best assessment of the macroinvertebrate community. A standardized sample collection procedure was followed as described in the SMSBPP.

4.2 Discharge Measurements

Stream velocity was measured using a Marsh-McBirney Flo-Mate Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113 (Flow Measurement in Open Channels).

4.3 Macroinvertebrate Analysis

A standardized sample analysis procedure was followed as described in the SMSBPP. One deviation was made to the metrics that are calculated in the project procedure. The Biotic Index was not calculated because it is a general indicator of organic pollution and this study was specific to sulfate.

4.4 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the SMSBPP.

4.5 Stream Habitat Assessment

A standardized assessment analysis procedure was followed as described for Glide/Pool Habitat in the Stream Habitat Assessment Project Procedure.

4.6 Statistical Methods

Macroinvertebrate biological indices (Total Richness, EPT Index, and Shannon Diversity Index) and Habitat Assessment scores were compared among sites using a two-tailed t-test at the $\alpha = 0.05$ level. A two-tailed test is used for comparing the means from two populations when the variance is unknown and the data are collected in pairs (i.e., for each sample collected at West Fork Tebo Creek one was also collected at East Fork Honey Creek). This study was designed for data to be collected in pairs in an effort to obtain observations that were alike in all respects except for the biological indices we were comparing. Upon completion of the two-tailed test, the null hypothesis (equal means) among sites was either accepted or rejected. In cases where the null hypothesis was rejected, means of the various biological indices were compared to determine which site, the control or the test, was elevated in diversity.

Because the t-test is a parametric method, each data set was tested for normality before proceeding. All statistical interpretations were conducted using SigmaStat[®] (version 2.03, Jandel Scientific, San Rafael, California) software. An *a priori* p-value of <0.05 was selected to determine statistically significant differences among data sets.

5.0 Observations

Macroinvertebrate samples were collected at West Fork Tebo Creek when stream stage was elevated and rising due to recent rainfall in the watershed. All available habitats were submerged by flowing water.

Stream stage at East Fork Honey Creek appeared to be at base flow, with all available habitat types submerged by flowing water. There was no evidence of recent high water events. The three sample reaches upstream of County Road NW 501 were in an area of stream that had been channelized and leveed. The riparian corridor along much of the right descending bank was much reduced or missing. Although situated in the Plains/Osage EDU, both streams exhibited characteristics consistent with a riffle/pool regime.

6.0 Data Results and Analysis

6.1 Water Chemistry

The results of six West Fork Tebo Creek water chemistry samples collected from 1998 to 2001 were provided by the WPCP. All water quality samples were collected at the County Road NE 581 bridge, just upstream of the study site. Of those samples, none exhibited sulfate concentrations in excess of 1000 mg/L, the upper limit for state water quality standards. The mean concentration of sulfate in samples was 705 mg/L, ranging from 328-954 mg/L.

In addition, the results of three East Fork Honey Creek water chemistry samples collected in April 2001 were provided by the WPCP. All samples were collected at the study site with the exception of one, which was collected approximately three river miles upstream. The mean concentration of sulfate in samples was 60 mg/L, ranging from 52-72 mg/L.

6.2 Habitat Assessment

Following macroinvertebrate collection, habitat assessment scores (see Table 2) were recorded for each sample reach at both sites according to methods described in the Stream Habitat Assessment Project Procedure. According to the project procedure, for a study site to fully support a biological community, the total score from the physical habitat assessment should be 75% to 100% similar to the total score of the reference site. The mean habitat score of West Fork Tebo Creek was 133% of the mean habitat score of East Fork Honey Creek.

Additionally, a two-tailed t-test used to compare habitat assessment scores between sites showed that the mean habitat score of 133.5 (of a possible 200) for six reaches sampled on West Fork Tebo Creek was significantly different than the East Fork Honey Creek mean score of 100.5 ($p < 0.001$).

Although neither comparison is meant to provide an absolute distinction between sites, it does provide a method for determining whether substantial differences exist between a study site and its reference. In this study, both the project procedure and the statistical analysis lead to the conclusion that the study site should support a comparable biological community.

Table 2
 Habitat Scores

Stream	Station #1	Station #2	Station #3	Station #4	Station #5	Station #6	Mean
WF Tebo	137	138	128	134	135	129	133.5
EF Honey	107	110	107	82	96	101	100.5

6.3 Biological Assessment

Macroinvertebrate metrics were not significantly different among sites (see Table 3). The West Fork Tebo Creek mean Taxa Richness of 31.50 was not significantly different than the mean of 31.67 at East Fork Honey Creek ($p = 0.944$). The mean Shannon Diversity Index of 2.38 at West Fork Tebo Creek was not significantly different than the mean of 2.40 at East Fork Honey Creek ($p = 0.887$). Also, the mean EPT Taxa Index for West Fork Tebo Creek of 2.83 was not significantly different than the mean of 2.17 at East Fork Honey Creek ($p = 0.378$). For Taxa Richness, Shannon Diversity Index, and EPT Taxa Index the null hypothesis of no difference would be accepted.

Table 3
 Macroinvertebrate Metrics

Stream/metric	Station #1	Station #2	Station #3	Station #4	Station #5	Station #6	Mean
WF Tebo Taxa Richness	28	37	27	26	34	37	31.50
EF Honey Taxa Richness	31	36	31	32	32	28	31.67
WF Tebo EPT Taxa	2	4	2	2	2	5	2.83
EF Honey EPT Taxa	3	4	2	2	1	1	2.17
WF Tebo Shannon Index	2.35	2.39	2.48	2.27	2.33	2.46	2.38
EF Honey Shannon Index	2.33	2.57	2.38	2.67	2.65	1.80	2.40

Chironomidae taxa made up the majority of the total count at both sites, comprising an average of 56% of individuals in samples and 38% of Taxa Richness at West Fork Tebo Creek. At East Fork Honey Creek, Chironomidae taxa made up 58% of individuals and 31% of Taxa Richness.

The highest number of taxa found at a single sample station was 37 at West Fork Tebo Creek; at East Fork Honey Creek, the highest number of taxa was 36. As is common in prairie streams as well as the depositional habitat from which samples were collected, few EPT taxa were found. No more than eight species of EPT taxa were found at either location and generally, with the exception of one mayfly species at West Fork Tebo Creek, very few individuals of each taxon were present in samples.

7.0 Discussion

Although sulfate concentrations in West Fork Tebo Creek water samples were higher than the control site, it did not appear to have impaired the macroinvertebrate community during spring 2001. None of the metrics used showed a statistically significant difference in the macroinvertebrate community among sites.

In summary, habitat scores were higher at the West Fork Tebo Creek study segment. Despite seemingly better habitat, however, there was no statistically significant difference in the macroinvertebrate community from the permanent pools in the 303(d) listed stream compared to the control stream as measured by three of the four metrics used for biological criteria in Missouri streams.

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Appendix A

Proposed Bioassessment Study Plan
West Fork Tebo Creek
March 22, 2001

Missouri Department of Natural Resources
Proposed Bioassessment Study Plan
West Tebo Creek, Mulberry Creek, and 2nd Nicholson Creek
April 10, 2001

Objective

Compare macroinvertebrate communities between 303(d) streams listed for sulfate and non-sulfate impaired control streams.

Hypothesis

Null = No difference between macroinvertebrate communities of high sulfate streams and controls.

Background

All high sulfate streams have relatively small watersheds and are considered either temporary or intermittent. Because of this situation any biological assessment must be accomplished when the streams are well hydrated. The time period that coincides with established MDNR macroinvertebrate bioassessments is mid-March through mid-April. All streams will be sampled only one year, one season, unless environmental conditions dictate further sampling.

Study Design

General: Although over eight years of work has been invested in biological criteria development in wadeable and perennial streams by MDNR, the streams in question are in a different classification and require adapting standard procedures. Ecoregional reference streams for this size class are not currently available, thus a paired watershed approach is proposed. Considerable caution was taken in selecting controls that are of comparable size and uninfluenced by coal mining. West Tebo Creek (watershed area 19 sq. mi.) is paired with East Fork of Honey Creek (watershed area 17 sq. mi.); Mulberry Creek (watershed area 33 sq. mi.) with upper Miami Creek (watershed area 47 sq. mi.); and 2nd Nicholson Creek (watershed area 14 sq. mi.) with Little Drywood Creek (watershed area 10 sq. mi.).

Sampling units will be at the reach scale. Each stream will be sampled in six reaches. Each reach will be determined as twenty average stream widths, which is consistent with the MDNR Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Stream reaches will be selected within one segment of stream in which conditions can be expected to be approximately the same. To account for potential influences that would affect some segments but not all segments, discharge, water chemistry, and habitat measures will be taken during sampling.

Biological Sampling Methods: The MDNR SMSBPP will be modified to fit the smaller stream size of this study. Only one of the three standard habitats normally collected in larger streams will be sampled. This habitat, non-flowing water over depositional substrate, will standardize samples between reaches. Each reach sample will be a composite of six, approximately 1 square meter, sub-samples from various pools within the reach. The advantage of taking a composite sample in small intermittent streams that dry to varying degrees is the ability to minimize the problems associated with the past hydration of each individual pool.

Physical and Habitat Sampling Methods: The MDNR Stream Habitat Assessment Project Procedure (SHAPP) will be utilized at all locations. The habitat score will, in part, allow a measure of the variability of factors that might influence macroinvertebrate communities between reaches. Discharge will also be measured at the most upstream and most downstream locations. Because no major tributaries are to be present between the most upstream and downstream reaches, flow conditions and water quality are expected to be similar between all reaches.

Chemical Sampling Methods: All streams will be sampled for sulfate, conductivity, chloride, pH, and dissolved oxygen on a quarterly basis to establish the background and range of conditions. Control streams are expected to have sulfate levels well below state standards.

Laboratory Methods: Macroinvertebrates collected at all sampling locations will be processed and identified as stated in the MDNR SMSBPP and the MDNR Standard Operating Procedure MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification.

Data Recording and Analysis: Data recording will be done in a Microsoft Access database according to the MDNR Standard Operating Procedure MDNR-WQMS-214, Quality Control Procedures for Data Processing. Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP. One of these, the Biotic Index, is designed to respond to organic enrichment and will not be utilized in this study. The remaining metrics of Total Taxa (TT), Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT), and the Shannon Index (SI) will be calculated for each reach. The six reach samples for each stream will be used for mean comparison analysis (unpaired t-test) if data is normally distributed or Mann-Whitney Rank Sum Test if data cannot fit the normality distribution. The probability level for concluding a significant difference will be $p < 0.05$. Analysis will be done on a paired watershed approach and, since all sites are within the same ecological region, the possibility exists of attempting to pool all control data if variability allows. This possibility would also allow for analyses consistent with biological criteria as developed for wadeable/perennial streams.

Data Reporting: Results of the study will be written in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

Attachments

Standard Operating Procedures

Taxonomic Levels for Macroinvertebrate Identification (MDNR-FSS-209)
Quality Control Procedures for Data Processing (MDNR-WQMS-214)

Project Procedures

Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure
Stream Habitat Assessment Project Procedure

Appendix B

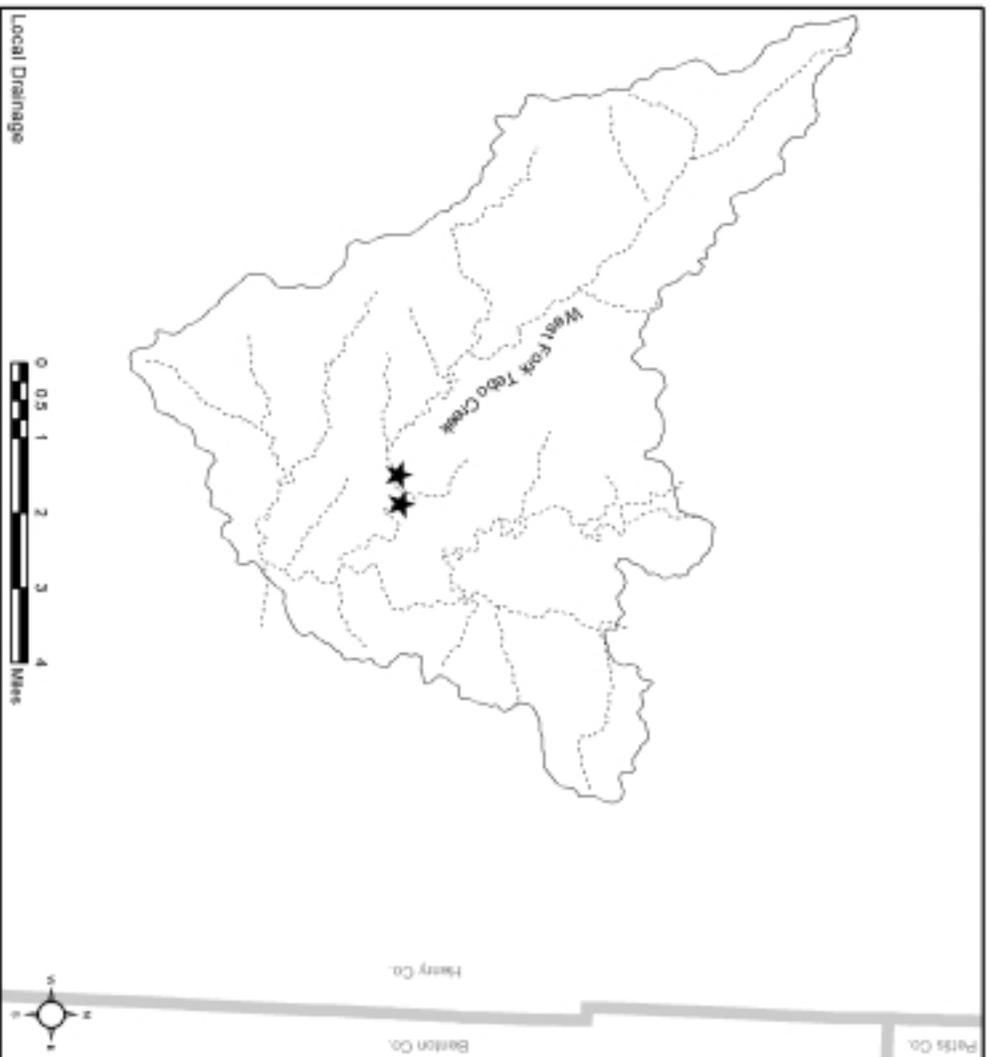
Maps

West Fork Tebo Creek
Prairie/Osage EDU

&

East Fork Honey Creek
Prairie/Osage EDU

West Fork Tebo Creek Study Site



- ★ Sampling Location
- ▭ County Boundary
- ▭ Local Drainage
- Stream/River

Local Drainage and Biologic Sampling Site Location

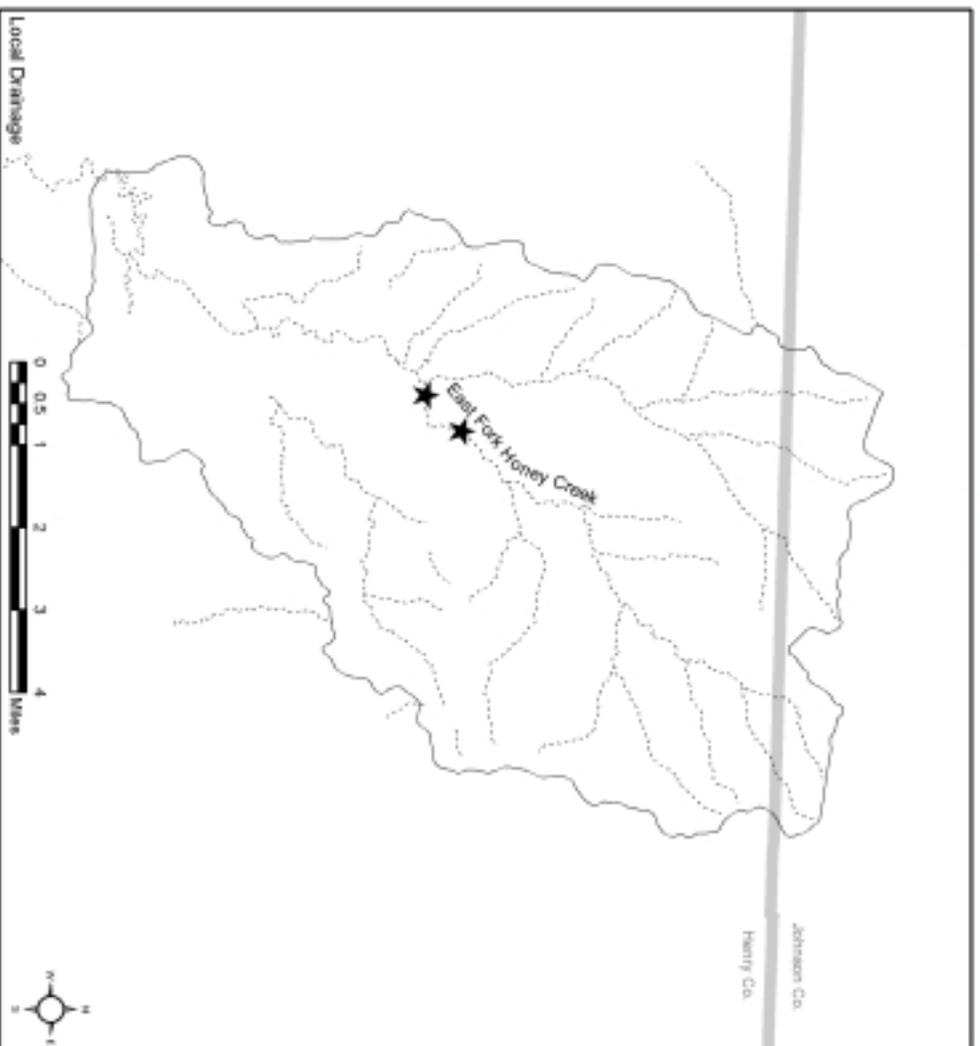
Ecological Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as a 14 Digit Hydrologic Unit, is shown in the main map set left. This area is a portion of the local watershed. Missouri is split into over 1500 such units.



Ecological Drainage Unit

East Fork Honey Creek Study Site



- ★ Sampling Location
- ▭ County Boundary
- ▭ Local Drainage
- Stream/River

Local Drainage and Biologic Sampling Site Location

Ecological Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as a 14 Digit Hydrologic Unit, is shown in the main map at left. This area is a portion of the local watershed. Missouri is split into over 1500 such units.



Ecological Drainage Unit