# 2001 CONSOLIDATED MONITORING REPORT FOR RESTORED AREAS AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**
**FERNALD, OHIO**

ECDC CONTROLLED
COPY NO.
8797

**JUNE 2002**

**U.S. DEPARTMENT OF ENERGY**
**FERNALD AREA OFFICE**

**20900-RP-0016**
**REVISION 0**
**FINAL**

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| A1PI | Area 1, Phase I |
| A8PI | Area 8, Phase I |
| A8PII | Area 8, Phase II |
| CC | coefficient of conservatism |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| COE | U.S. Army Corp of Engineers |
| dbh | diameter at breast height |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| FEMP | Fernald Environmental Management Project |
| FQAI | Floristic Quality Assessment Index |
| FWS | U.S. Fish and Wildlife Service |
| $m^2$ | square meter |
| mg/L | milligrams per liter |
| mS/cm | microSiemens per centimeter |
| MSI | Modified Simpson's Index of Diversity |
| NCP | National Contingency Plan |
| NOAA | National Oceanic and Atmospheric Agency |
| NRIA | Natural Resource Impact Assessment |
| NRRDP | Natural Resource Restoration Design Plan |
| NRRP | Natural Resource Restoration Plan |
| NRT | Natural Resource Trustee |
| NTU | Nephelometric Turbidity Units |
| OEPA | Ohio Environmental Protection Agency |
| PVC | polyvinyl chloride |
| ROD | Record of Decision |
| USDA | U.S. Department of Agriculture |

# EXECUTIVE SUMMARY

The 2001 Consolidated Monitoring Report summarizes and presents data associated with monitoring, maintenance, and management of ecological restoration projects at the Fernald Environmental Management Project (FEMP). In 2001, FEMP ecological restoration projects include the Area 1, Phase I (A1PI) Wetland Mitigation Project and the Area 8, Phase II (A8PII) Forest Demonstration Project. For each of these projects, Implementation Phase monitoring requirements and results are discussed, along with replanting strategies, maintenance and management summaries, and lessons learned. The 2001 Consolidated Monitoring Report also summarizes the Functional Phase monitoring program and data collected in support of restoration research projects.

Implementation Phase monitoring requirements for the A1PI Wetland Mitigation Project include woody vegetation survival, herbaceous cover, and sampling for water quality, water elevations, hydric soils, and wildlife observations. Woody vegetation survival was improved in 2001, but some replanting effort will be needed to address impacts due to shifting hydrologic conditions and deer browsing and rubbing. Herbaceous cover was also improved, but non-native vegetation was still prevalent across much of the project area. Woody vegetation survival and herbaceous cover data for the Wetland Mitigation Project are provided in Appendix A of the Consolidated Monitoring Report. Replanting of woody vegetation will be shifted to the Radium Hot Spot, in order to minimize further impacts to the existing wetland project vegetation. Herbaceous plant plugs will be installed by hand within Basins 2, 4, 7 and 8. In general, water quality, water elevation, and hydric soils sampling indicate that wetland conditions are developing within the Wetland Mitigation Project, but they are limited to swales and deep pools within each basin. Maintenance activities within the Wetland Mitigation Project included invasive species control, repair of water control structures, and maintenance of wildlife amenities.

Implementation Phase monitoring requirements for the A8PII Forest Demonstration Project include woody vegetation survival, herbaceous cover, and an evaluation of invasive species across the project. Woody vegetation survival was adequate across most of A8PII. Heavy deer pressure was observed in the southeast portion of the project area. Therefore, a replanting strategy has been developed for 2002. With the exception of the savanna area, herbaceous cover was progressing well. Woody vegetation survival and herbaceous cover data for the Forest Demonstration Project are provided in Appendix B of the Consolidated Monitoring Report. Invasive species appeared to be reduced by fall 2001, following the second year of semi-annual "invasives sweeps," where all non-native woody vegetation is sprayed with

herbicide and/or mechanically removed across the project area. Maintenance activities focused on invasive species control and herbaceous cover maintenance.

Functional Phase monitoring activities involved the partial characterization of baseline conditions across the FEMP. Several site-specific habitats were identified and surveyed for herbaceous vegetation, woody vegetation, and several wildlife parameters. Baseline community characterization will be completed in Spring 2002. Data collected in 2001 is provided in Appendix C of the 2001 Consolidated Monitoring Report. Appendix E details the sampling and analysis methods used to characterize baseline communities at the FEMP.

The Area 8, Phase I (A8PI) Revegetation Research Plots were discussed in the Consolidated Monitoring Report. The goal of this project was revised to evaluate the effectiveness of deer controls (i.e., tubing) on saplings. The findings from 2001 indicate that tubing was very effective in reducing the amount of damage due to deer rubbing within the project area. Data for the Revegetation Research Plots are provided in Appendix D of the Consolidated Monitoring Report.

# 1.0 INTRODUCTION

The purpose of this report is to summarize and present data associated with monitoring, maintenance, and management of ecologically restored areas at the Fernald Environmental Management Project (FEMP) for Calendar Year 2001. This report is required as part of an overall restored area monitoring and maintenance strategy set forth in the FEMP Natural Resource Restoration Plan (NRRP, DOE 2002a). The NRRP specifies the submittal of an annual monitoring report at the end of each calendar year, starting in 2001.

## 1.1 BACKGROUND

The 1,050-acre FEMP site is undergoing large-scale environmental remediation pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Section 107 of CERCLA imposes responsible party liability for injury to natural resources resulting from the release of a hazardous substance. CERCLA and the National Contingency Plan (NCP) establish certain state and federal agencies as trustees for natural resources. The Natural Resource Trustee (NRT) representatives for the FEMP include the Ohio Environmental Protection Agency (OEPA) and the U.S. Fish and Wildlife Service (FWS). The U.S. Department of Energy (DOE) has a dual role as both a trustee and a potentially responsible party. In 1986, the State of Ohio filed a $206 million lawsuit against DOE as compensation for natural resource damages resulting from releases of hazardous substances at the FEMP. Action on the natural resource damage claim was stayed until the completion of all site Records of Decision (RODs). Since the signing of the Operable Unit 5 ROD in 1996, DOE has been in negotiations with the other NRTs. A summary of these NRT negotiations is provided below.

As stated above, NRT negotiations were underway by 1996. DOE actually identified the other FEMP NRTs and made initial contact in 1994. The NRTs agreed to meet and discuss resolution of the Ohio 1986 natural resource damage claim. From these discussions, the NRTs tentatively agreed to avoid further litigation and seek compensation for natural resource injuries through the implementation of on-property ecological restoration projects. In 1997, the NRTs signed a tri-party letter that was sent to the U.S. Environmental Protection Agency (EPA) stating this intent. The NRTs then developed a conceptual restoration plan for the FEMP site. This document, entitled the NRRP, was preceded by the Natural Resource Impact Assessment (NRIA, DOE 2002b). The NRIA used existing site data to quantify the extent of past and anticipated future natural resource injuries at the FEMP. The NRTs used this information to quantify compensatory restoration acreage through a process called Habitat Equivalency

Analysis. These processes are explained in greater detail within the NRRP. A draft final NRRP was produced in 1998, and DOE began implementation of several ecological restoration projects. Negotiations continued with the NRTs regarding the scope of restoration, compensation for groundwater injury, and the extent of monitoring. In 2001, the NRTs signed a Memorandum of Understanding that formalized the agreement to use on-property ecological restoration as the primary means of compensation. The NRTs also sought to compensate for groundwater injury through a cash settlement, which would be used to develop a series of groundwater education programs and possibly fund an on-site educational facility. The NRTs are currently finalizing the NRRP, with the goal of reaching final settlement in 2002.

The approach for site ecological restoration developed by the NRTs and set forth in the NRRP involves integration of ecological restoration projects into site remediation activities. This will result in the implementation of a series of projects across the site following remediation. In general, site restoration will involve grading to maximize the formation of wetlands or expanded floodplain, amending soil where topsoil is removed, and the establishment of native vegetation. Restoration projects will usually involve forest restoration, wetland construction, or seeding with native grasses and forbs. Further detail regarding the sitewide ecological restoration approach is provided in the NRRP.

The NRTs have agreed to implement the concept of "adaptive management" during the field implementation, monitoring, and maintenance of restoration projects at the FEMP. Adaptive management is defined pursuant to the final NRRP as a continuing process of planning, monitoring, and adjusting, with the objective of improving the project implementation and outcomes (Lessard 1998). The NRTs realize that flexibility is needed to successfully implement restoration and management. The field of ecological restoration is relatively new, and innovative techniques and approaches are being developed all the time. Also, ecological systems are dynamic and dependant on a variety of factors that are difficult to control, such as climate, predation, etc. Because of this, results presented in annual monitoring reports will be used to adjust implementation, maintenance, and monitoring approaches as needed, in order to optimize the progress of restored areas at the FEMP. It is important to note that implementation and management of restored areas will be bounded by the scope of work defined in the NRRP.

## 1.2 RESTORED AREA MONITORING REQUIREMENTS

Monitoring of restored areas will involve two phases. First, Implementation Phase monitoring will be conducted to ensure that restoration projects are completed pursuant to their Natural Resource Restoration Design Plans (NRRDPs). The second phase of monitoring is termed the Functional Phase. This effort

will consider projects in terms of their system-specific contribution to sitewide ecological communities. The NRRP provides a thorough overview of both Implementation and Functional Phase monitoring. The text below describes the specific requirements that will be evaluated for each phase.

### 1.2.1 Implementation Phase Monitoring

The main focus of Implementation Phase monitoring usually involves vegetation survival. The NRTs have negotiated that 80 percent survival of all planted vegetation must be achieved. In addition, seeded areas must obtain 90 percent cover. Plant survival rates will usually be calculated on an individual "patch by patch" basis. A patch is a planting unit about 0.25 acre in size that consists of a specific habitat template. This design approach will be used for most of the NRRDPs developed at the FEMP.

To determine vegetation survival, mortality counts will be conducted at the end of each growing season. Each balled and burlap or container-grown tree and shrub will be inspected and assigned one of three categories: alive, resprout, or dead. Trees and shrubs will be considered "alive" when their main stem and/or greater than 50 percent of the lateral stems are viable. "Resprout" trees and shrubs will have a dead main stem, with one or more new shoots growing from the stem or the root mass. Plants will also be categorized as "resprout" when less than 50 percent of its lateral branches are alive. Dead trees will have no signs of vitality at all.

Herbaceous cover will be estimated for all seeded areas within a restored area. Instead of the patch-specific approach used for planted vegetation, the restored area will be divided into specific seeded-area subsections. These subsections will generally be delineated by area and habitat-specific boundaries. In each subsection, at least three one-meter square quadrats will be randomly distributed and surveyed. Cover estimates for each quadrat will then be averaged to calculate herbaceous cover.

Specific NRRDPs may impose additional implementation phase monitoring requirements. For instance, water levels and the formation of hydric soils must be evaluated for wetland mitigation projects. The duration of implementation phase monitoring is also variable. Vegetation survival will generally be evaluated for two growing seasons following installation, while wetland mitigation requirements must be evaluated for three to five years. The NRRP provides a monitoring schedule based on these requirements in relation to anticipated project completion dates.

### 1.2.2 Functional Phase Monitoring

Functional Phase monitoring is not a pass/fail determination like Implementation Phase monitoring. Instead, functional monitoring will evaluate the progress of the restored community against pre-restoration baseline conditions and an ideal reference site. Vegetation indices will be used for comparisons, as well as several wildlife-based evaluations. The Ecological Restoration Functional Phase Monitoring Plan is provided as Appendix E of this report. This monitoring plan details the field methods and data analyses that will be used to implement Functional Phase monitoring at the FEMP. A summary of the specific parameters to be evaluated is discussed below.

The vegetation indices that will be used to assess restored areas include Floristic Quality Assessment Index (FQAI) and a modified Simpson's Index of Diversity (MSI). In general, FQAI provides a measure of the quality of vegetation inhabiting a particular area, while Simpson's Index quantifies the diversity of the vegetative community. FQAI is determined from species richness values and predetermined rankings of native species. Species richness and abundance measurements would typically be required for calculating Simpson's Index. For herbaceous vegetation, a modified approach will be utilized that calculates Simpson's Index using cover estimates instead of abundance values. The monitoring plan in Appendix E provides detail regarding the calculation of these parameters.

Several wildlife evaluations will be conducted in addition to vegetation surveys. These include breeding bird surveys, amphibian and macroinvertebrate sampling, and migratory waterfowl observations. Casual wildlife observations will also be recorded in each study area. The collection and treatment of these parameters is detailed in Appendix E.

The schedule for Functional Phase monitoring is provided in Appendix E and the NRRP. The schedule is set up so that only one type of ecological community will be evaluated in any given year. The first couple of years will be devoted to establishing baseline conditions and surveying ecological reference sites. Therefore, this year's consolidated monitoring report includes only baseline data. The baseline systems that were evaluated include grazed pasture, riparian forest, successional woodlot, pine plantation, and open water.

## 1.3 PROJECT SUMMARIES

The ecological restoration projects evaluated in this year's consolidated monitoring report include Implementation Phase monitoring of the Area 1, Phase I (A1PI) Wetland Mitigation Project and the Area 8, Phase II (A8PII) Forest Demonstration Project. Section 4.1 of the NRRP includes a summary of

these projects. Additional detail regarding the wetland mitigation project can be found in Sections 2.2 and 2.3 of the Wetland Monitoring Report for the Year 2000 (DOE 2001a). This consolidated monitoring report also describes the baseline ecological monitoring program as part of Functional Phase monitoring. Lastly, this report summarizes data collected as part of the Area 8, Phase I (A8PI) Revegetation Research Plots.

## 1.4 METEOROLOGICAL CONDITIONS

Site meteorological conditions effect several major components of ecological restoration projects. Precipitation irrigates planted and seeded vegetation, and charges water features. Because of this, site precipitation data is presented on Table 1-1. In general, the first half of 2001 received below-average rainfall, while the second half received above average precipitation. The Palmer drought Severity Index for southwest Ohio remained at the "near normal" level for most of the year [National Oceanic and Atmospheric Agency (NOAA) 2001]. Therefore, The FEMP site received adequate rainfall to support ecological restoration in 2001, and supplemental irrigation was not required for most of the year. It should be noted that water was introduced into the wetland mitigation project, in an effort to control invasive species. More information regarding this management activity is provided in Section 2.1.4.

## TABLE 1-1
## 2001 PRECIPITATION DATA

| Month | Average Site Precipitation (in.) | Actual Site Precipitation (in.) | Monthly Departure from Normal (in.) | Cumulative Departure from Normal (in.) | Palmer Drought Severity Index (as a function of cumulative precipitation) |
|---|---|---|---|---|---|
| January | 3.14 | 1.40 | -1.74 | -1.74 | Near Normal |
| February | 2.80 | 1.69 | -1.11 | -2.85 | Near Normal |
| March | 3.90 | 1.41 | -2.49 | -5.43 | Near Normal |
| April | 3.80 | 3.54 | -0.26 | -5.60 | Near Normal |
| May | 4.23 | 6.05 | +1.82 | -3.78 | Moderate Drought |
| June | 4.06 | 3.66 | -0.40 | -4.18 | Near Normal |
| July | 4.03 | 6.09 | +2.06 | -2.12 | Near Normal |
| August | 3.20 | 3.73 | +0.53 | -1.59 | Near Normal |
| September | 2.79 | 4.10 | +1.31 | -0.28 | Near Normal |
| October | 2.68 | 6.65 | +3.97 | +3.69 | Unusual Moist Spell |
| November | 3.33 | 3.51 | +0.18 | +3.87 | Unusual Moist Spell |
| December | 3.12 | tbd | tbd | tbd | tbd |

# 2.0 IMPLEMENTATION PHASE MONITORING

This section presents the project-specific requirements, results, and corrective measures for Implementation Phase monitoring at the FEMP. In 2001, the A1PI Wetland Mitigation Project and the A8PII Forest Demonstration Project are the only two projects undergoing Implementation Phase monitoring. This section also summarizes all maintenance and adaptive management activities conducted within these projects during 2001, and provides a discussion regarding lessons learned for each project.

## 2.1 A1PI WETLAND MITIGATION PROJECT

The wetland mitigation project involved the planting of 3,327 trees and shrubs within 86 different patches across the 12-acre project area (DOE 1999). Field implementation was conducted in several phases from 1999 to 2000. Also, a replanting effort was undertaken between 2000 and 2001, in order to address vegetation survival counts following the first growing season (DOE 2001a). The NRTs agreed to adjust the replanting strategy by focusing on wetland patches and buffer patches along the western side of the project area. As a result of these various planting efforts, the actual number of plants within a given patch is often different from the original design. Because of this, any discussion regarding patch-specific vegetation survival can become very confusing. Also, evaluating individual patches may not accurately reflect impacts to its corresponding community. Therefore, the Implementation Phase requirements and results for the wetland mitigation project will be discussed in terms of distinct areas instead of individual patches. The areas in the wetland mitigation project include the eight interconnected basins (Figure 2-1). All upland areas were also grouped into a single separate area. Patch-specific and community-specific information is included in Appendix A.

### 2.1.1 Requirements

The wetland mitigation design called for several Implementation Phase monitoring requirements. These requirements include planted vegetation survival, herbaceous cover estimates, measurements of water elevations and water quality, soil sampling, and documentation of wildlife observations. Unless otherwise noted, all monitoring was conducted pursuant to the methods set forth in the Wetland Monitoring Report for the Year 2000 (DOE 2001a). Each of these requirements is discussed in more detail below.

2.1.1.1 Vegetation Survival

Planted vegetation must meet 80 percent survival pursuant to the wetland mitigation design (DOE 1999). As discussed above, there are numerous differences between design quantities and field implementation quantities. The NRTs have agreed to compare survival numbers to the original design amounts instead of the actual amounts. Table A-1 in Appendix A provides both the actual survival percentages and the percentages based on the design quantities. The actual patch quantities are termed the "2001 Baseline" quantities, and were determined by adding the total number of individuals that were alive to the number of plants installed in 2001.

2.1.1.2 Herbaceous Cover

The wetland mitigation design called for 80 percent herbaceous cover following the first or second growing season (DOE 2001a). DOE will report the extent of herbaceous cover in terms of both total cover and native species cover.

The method for determining herbaceous cover has been modified from the original design. Instead of a patch-specific walkover survey, DOE used randomized quadrats (by an "over the shoulder" toss) to determine basin-specific cover estimates. For each quadrat, cover class estimates were recorded pursuant to the approach used for Functional Phase herbaceous surveys described in Appendix E. The original approach proved difficult to implement, because individual seeding patches could not be distinguished (DOE 2001a). Quadrat locations across the wetland mitigation project are shown on Figure 2-1.

DOE also made a determination regarding the presence of hydrophytic vegetation for each quadrat, pursuant to the methods established by the U.S. Army Corp of Engineers (COE) for delineating jurisdictional wetlands (COE 1987). A quadrat was designated as having hydrophytic vegetation present if greater than 50 percent of the dominant plant species observed were hydrophytic. The U.S. Fish and Wildlife Service Region 1 Wetland Indicator Status list was used to determine the extent of hydrophytic vegetation (USDA 2001). A basin was considered hydrophytic if the majority of its quadrats were hydrophytic.

2.1.1.3 Water Level and Water Quality Measurements

Adequate hydrology is the most important determinant of a successful wetland mitigation project (DOE 1999). The wetland mitigation design established several processes for measuring hydrology. First, shallow monitoring wells were installed in each basin. Next, staff gauge locations were established

to determine the water depth of several ponds. Water depth measurements were taken in several drainage swales as well. All water level monitoring points are identified on Figure 2-1. Pursuant to the monitoring schedule in the original design, measurements were taken twice in 2001.

Water quality samples were taken in Basins 1, 2, 4, 5, and 6, where ponding is expected (Figure 2-1). For each sample, the color, odor, temperature, pH, specific conductivity, turbidity, and dissolved oxygen were recorded. The intent of the water quality sampling is to status the health of the aquatic systems. Imbalances or other stresses to a system could result in measurement extremes. Water quality sampling was conducted twice in 2001.

#### 2.1.1.4 Other Requirements

Several other requirements were specified in the wetland mitigation design. Soil samples were taken in several locations in order to determine the presence of hydric conditions (Figure 2-1). The design called for samples to be taken one year after construction. However, samples were not collected in 2000 because of an extremely hard ground surface. Therefore, soil sampling was rescheduled for 2001 (DOE 2001a). The color, moisture content, and soil type were recorded for each sample. Samples were compared to Munsell Soil Color Charts to determine hydric conditions, pursuant to the COE Wetland Delineation Manual (COE 1987).

Wildlife observations were recorded pursuant to the wetland mitigation design. Casual observations have been conducted during field activities in 2001. In addition, several amphibian sampling efforts were conducted by OEPA.

### 2.1.2 Results and Discussion

The results of the A1PI Wetland Mitigation Project monitoring requirements are presented in Tables 2-1 through 2-6, and in Appendix A. Tables 2-1 and 2-2 provide basin-specific summary information, while Tables A-1 and A-2 in Appendix A provide patch-specific data. A discussion of the specific requirements is presented in Sections 2.1.2.1 to 2.1.2.4. A summary of findings is provided below.

The monitoring requirements established in the wetland mitigation design are intended to answer six questions (DOE 1999). Responses to these questions are provided below, based on the second year of Implementation Phase monitoring of the A1PI Wetland Mitigation Project.

1. Have the requirements of the reviewing agencies been met?

   Yes. Design, construction, and adaptive management of the A1PI Wetland Mitigation Project have resulted in a diverse and improving wetland ecosystem. Wetland experts from OEPA have noted that, as a mitigation project, the A1PI wetland system is very diverse (Mack 2001). DOE will continue to implement adaptive management principles in conjunction with the agencies and the NRTs, with the intent of improving the wetland system and maximizing the jurisdictional wetland acreage created.

2. Have sufficiently dense wetland plant communities been established?

   No. The wetland basins have not reached sufficient native cover. However, each basin has shown much improvement over 2000. Management activities, coupled with maturation of the system as a whole, have resulted in steady improvement across the wetland mitigation project.

3. Do surface and groundwater levels support wetland conditions?

   Yes. Water level measurements, herbaceous cover estimates, and soil samples demonstrate that surface and groundwater levels are sufficient. Further maintenance of several water control structures was initiated in 2001. These actions will be monitored closely to determine what additional activities (if any) will be required.

4. Do surface and groundwater quality fall within parameters indicative of a comparatively healthy system?

   Yes. The second year of monitoring demonstrates that water quality is normal, and that there is an abundance of aquatic life in the system.

5. Have animal populations adapted to wetland systems successfully colonized the site?

   Yes. Wildlife use of the wetland system has met or exceeded expectations.

6. Have wetland soils been created?

   Yes, in part. At least one hydric soil sample was collected in Basins 1, 2, 3, 6 and 7. However, the majority of samples collected across the project did not demonstrate hydric characteristics.

As stated above, further detail regarding the specific monitoring requirements used to answer these questions are provided in Sections 2.1.2.1 to 2.1.2.4 below.

### 2.1.2.1 Vegetation Survival Results

The survival rates presented in Table 2-1 show that Basins 1, 3, 6 and 8 achieved 80 percent survival in 2001. Several other basins almost met the 80 percent survival requirement (Basins 2, 4 and 7). As discussed in Section 2.1.1.1, the survival rates were determined according to the design quantities instead of the actual number planted. Therefore, the percent survival for Basin 3 is actually greater than

100 percent, since several patches within this basin were replanted with additional vegetation as part of the Fall 2000 replant effort (Table A-1). It appears that the precipitation levels in 2001, coupled with the maturation of amended soils and continued deer control efforts, have resulted in much better growing conditions than what was encountered in 1999.

Despite the improved growing conditions, survival rates in Basins 2, 4, 5 and 7, and the upland community, fall below 80 percent. Because of the reduced survival in several locations, DOE has proposed a replanting strategy, which is described in Section 2.1.3. Further discussion on survival rates in the wetland mitigation project is provided below.

It is suspected that the wetland vegetation planted in several basins is adjusting to the hydrologic conditions that have developed. Some of the wetland plants, particularly in Basins 2, 4 and 7, may have been installed in areas that are now either too dry or too wet. Basin 5 had the lowest survival rate of any community within the wetland mitigation project. Field observations over time have revealed that water levels in this basin fluctuate more than any other basin within the project area. Basin 5 receives runoff directly from the adjacent North Access Road, and is totally inundated following significant rain events. During this time, Basin 5 acts as a sediment trap, receiving a high amount of sediment carried from the road. It then slowly drains into Basin 1 via a pole drain, causing water levels to recede. As a result, much of Basin 5 acts almost as a mud flat, with little vegetation able to withstand the periodic high sediment loading and the wide fluctuations in water levels.

Deer impacts are also a concern. The FEMP Deer Management Plan (DOE 2002c) showed that deer have damaged almost 1,000 plants within the wetland mitigation project. Deer pressure is one of the primary reasons for reduced survival in the upland community.

#### 2.1.2.2 Herbaceous Cover Results

Herbaceous cover estimates for each basin and the upland community are presented in Table 2-2. The 80 percent cover requirement was met for all but one basin (Basin 5). However, the NRTs are also concerned with estimates of native cover in addition to total cover. When only native species are considered, none of the project area communities exceed 80 percent cover. However, much improvement was observed over the previous year. In 2000, native cover estimates did not exceed 25 percent in any basin (DOE 2001a). Table 2-2 demonstrates that every basin except one exceeded 25 percent native cover. Basins 1 and 6 both exceeded 50 percent native cover. It should be noted that different methods

were used to determine percent native cover in 2000 and 2001, so only qualitative comparisons can be made. Nevertheless, these results demonstrate that the percent native cover in the wetland mitigation project is improving steadily.

Improvement is also demonstrated by evaluating the extent of hydrophytic vegetation present in the wetland project. Table 2-2 shows that the quadrats sampled in Basins 1, 4 and 6 met the hydrophytic vegetation requirement established by COE (1987). Note that the extent of data collection was too limited to characterize the entire basin. However, the results on Table 2-2 and Table A-2 in Appendix A further demonstrate that native herbaceous vegetation, and more importantly wetland vegetation, is expanding in the wetland mitigation project. A systematic wetland delineation will be conducted at the end of the wetland mitigation monitoring period. At that time, the extent of hydrophytic vegetation across the project area will be characterized.

Several basins within the project area have high percentages of non-native vegetation (Table 2-2). Like the woody vegetation discussed in Section 2.1.2.1, the herbaceous vegetation is adjusting to the hydrologic regime that has developed within each basin. Many areas seeded with a wetland seed mix and/or planted with wetland plugs do not receive adequate moisture to support such vegetation. Invasive non-native vegetation quickly moves in to fill the void. The importance of water elevations was illustrated in Basin 6. For 2000, the percent native cover in Basin 6 was estimated at 5 to 25 percent (DOE 2001a). Water levels were subsequently manipulated to increase the amount of water in the basin. As a result, the percentage of native species increased to approximately 57 percent (Table 2-2). Section 2.1.4 provides additional detail regarding the manipulation of water levels within certain basins.

2.1.2.3 Water Level and Water Quality Measurement Results

Water levels of shallow wells, ponds, and swales are presented in Table 2-3. The shallow well water depths show a general trend towards increasing hydrological conditions. The fall water column depths were greater at every location except Basin 5. The shallow well measurements are also comparable to data collected in 2000 (DOE 2001a). It should be noted that the fall measurements may have been influenced by recent precipitation, as 0.42 inches of rain was recorded at the FEMP on the day before sampling. Water depths in the ponds and swales also indicate sustained water holding capacity in the system.

Water quality analyses are presented in Table 2-4. In general, the results show a balanced system, with no issues needing immediate attention. The relatively high turbidity measurement in Basin 5 is attributed to the high amount of runoff received from the North Access Road, as discussed in Section 2.1.2.1. Dissolved oxygen concentrations appear driven by temperature and the development of hydric soils, rather than environmental degradation.

2.1.2.4 Other Results

Results from soil sampling are provided in Table 2-5. Several samples exhibited hydric characteristics. In fact, hydric soils were delineated in at least one sample from Basins 1, 2, 3, 6 and 7. While not hydric, several additional samples were characterized as moist or damp. These findings correspond with the water elevation results discussed above where Basin 8 does not appear to be receiving much surface water runoff. Sample locations were randomized within each basin (Figure 2-1), so it is suspected that a more systematic sampling approach would reveal further development of hydric soils within inundated portions of each basin. It should be noted that in several basins, the extent of inundation is limited to swales and deep depressions.

Wildlife observations are summarized in Table 2-6. Observations from 2001 demonstrate increased use of the wetland mitigation project by wildlife. In 2000, 32 species of birds, four species of amphibians and reptiles, and five species of mammals were observed (DOE 2001a). All three wildlife categories increased in 2001. Forty-three species of birds were observed, along with seven species of herpetofauna and 12 species of mammals. The use of the wetland mitigation project by migratory waterfowl was particularly encouraging. Several clutches of wood duck fledged. In addition, a hooded merganser nested in Basin 4. The first county nesting record for this species was recorded several years earlier at Miami Whitewater Forest (Styer 2001). The adult did not survive, but one of the young successfully fledged.

2.1.3 Replanting Strategy

A replanting strategy is required to address reduced survival and native herbaceous cover in the wetland mitigation basins. Overall, DOE is pleased with the progress of vegetation in the A1PI Wetland Mitigation Project, especially within the shrub and herbaceous patches. As discussed above, DOE contends that some of the excessive mortality can be attributed to shifting hydrological conditions and extreme deer browse and rub impacts, as well as the severe drought conditions that were experienced during the initial planting.

For several reasons, the NRTs have agreed not to establish additional woody vegetation in the wetland mitigation project. First, the NRTs have decided that additional plantings in areas of heavy deer pressure should be avoided. Second, because of limited access and the density of existing vegetation, there is the potential for damage to existing woody and herbaceous plant material during installation of replacements. Third, the shifting hydrological conditions makes planting within the wetland basins risky. DOE should adjust the replant strategy to take advantage of these changing conditions by improving the herbaceous layer within the wetland basins. Therefore, herbaceous vegetation will be planted in several basins in order to increase the percentage of native vegetation. The approach for herbaceous planting in the wetland mitigation project is described below.

Areas selected for wetland planting in Spring 2002 are limited to portions of Basins 2, 4 and 7 (Figure 2-1). The areas to be planted have a low percent of native cover (Table 2-2) and contain areas that have not been previously planted with wetland plugs. Table 2-7 lists the grass and wildflower species to be included in the plantings. These species were chosen based on their affinity for wet conditions and their demonstrated success in the wetland mitigation project. Areas to be planted will be delineated on the ground and herbaceous stock will be planted on approximately 3-foot centers within these areas to augment existing wetland vegetation.

Basins 2, 4 and 7 were chosen as wetland replant areas for several reasons. Basins 3 and 5 were planted with herbaceous plugs in 2001 along with a portion of Basin 2; therefore these areas were not considered. The 2001 plantings in Basins 3 and 5, along with a portion of Basin 2, will be re-evaluated in the 2002 growing season to determine if the Spring 2001 plantings were successful. Significant improvements are expected in these areas for 2002. Basin 8 has not contained any areas that are favorable for wetland herbaceous species. Rainfall over the last two years has not been sufficient to sustain standing water within the basin. This coupled with the small size of the watershed, and the area drainage pattern has resulted in a lack of development towards hydric soils that would be favorable for wetland plant growth. Basins 1 and 6 have the highest percent of native cover. The conditions in these basins showed significant improvement in the last year and are expected to continue to improve over the next few years.

Upland prairie grasses and forbs will be planted in Basin 8 in an effort to increase native cover. The plant list for Basin 8 is also included in Table 2-7.

As stated above, the proposed replant strategy will not attempt to restore area-specific woody plant survival within the wetland mitigation project. Instead, the NRTs have negotiated to develop shrub patches within the Radium Hot Spot, where woody vegetation is limited (Figure 2-2). In 2000, a portion of Area 2, Phase III was excavated to address radium contamination. Following remediation, this "Radium Hot Spot" was graded to hold water. The area was seeded with a wetland grass/forb mix, and inoculated with wetland donor soil and clumps of bur reed (*Sparganium spp.*). However, woody vegetation is sparse. Therefore, a planting strategy has been developed for the Radium Hot Spot that will expand the coverage of woody vegetation within the project area. The area will also be developed as a plant source for future restoration projects at the FEMP. This approach is described in more detail below.

Planting within the Radium Hot Spot will consist of a series of single-species wetland shrub patches, installed pursuant to Figure 2-2. The species and quantities specified for each patch are presented in Table 2-8. Species were chosen so that they can provide live cuttings and/or seeds for future restoration projects. Also, most of these species have experienced limited deer damage on site. In addition, the patches are laid out so that the species that are less appealing to deer are placed on the outside patches, protecting the more palatable species. The plants will consist of seedlings and live dormant cuttings. Seedling plugs will be installed using dibble bars, while cuttings will be pushed or driven into the ground with a hammer.

### 2.1.4 Maintenance and Management Summary

The A1PI Wetland is a developing wetland that is subject to ongoing management and maintenance to optimize wetland function. Monitoring revealed several areas where maintenance was needed to retain the integrity of the area. Invasive and aggressive plant species were identified encroaching upon native communities. Plant damage by wildlife was recognized during various walk-throughs of the wetland project, demonstrating the need for preventive action. Maintenance of structures and safety equipment around the ponds was also found to be needed in 2001. Opportunities were discovered for improvement of wildlife habitat, quicker establishment of native plant communities, and improvement of the monitoring process.

Needs or concerns identified during monitoring were addressed in a timely manner. Maintenance actions were planned and implemented utilizing maintenance labor force for the FEMP. Activities included control, repair, and improvement of the wetland plants, structures, habitat, and processes.

Attempts were made to control invasive and aggressive plant species in the A1PI Wetland. Species such as thistle (*Cirsium* spp.), giant reed (*Phragmites australis*) and cattail (*Typha latiflolia*) were controlled through mowing, cutting, and herbicide application. Upland areas outside of sapling and shrub patches in Basins 7 and 8 were mowed to control thistle growth. Thistle within patches were cut using weed-eaters. Cattails were hand pruned below the water line in Basins 1 through 7 to drown as many as possible followed by swiping remaining cattail leaves with 3 percent Rodeo using a Walk-a-Wick applicator. Giant reed was controlled using both Glove-and-Bucket method and swiping method using a Walk-a-Wick to apply 3 percent Rodeo to leaf surface of giant reed in Basins 1, 6 and 7. To lessen the affects of deer and other wildlife upon the wetlands, deer repellent and garlic sticks were applied to plants to deter deer from browsing upon planted native species. Protective tree tubes were wrapped around saplings to prevent damage from deer rubs. Goose fence was erected to protect newly planted grasses and forbs from foraging geese. Each of these actions was taken to control problems identified during monitoring in the wetlands.

The affects from weather, water, and wildlife took their toll on some structures in the wetlands. Action was taken to repair a leaking headwall, to check erosion through spillways and drainage ways, to move native plant species in the footprint of a monitoring well that have to be elevated above standing water, to re-hang fallen signs and ring buoys around ponds, and to replace a rotted wren box post.

Every effort is made to improve the infrastructure and conditions within the wetland mitigation project. Brush piles in Sections 2 and 3 were enlarged to improve wildlife use capabilities. Minnows were stocked in Basin 4 pond twice to provide food for ducks. Initially, 6 pounds of Fathead Minnows (*Pimephales promelas*) and 2 pounds of Golden Shiners (*Notemigorus crysolencas*) were introduced to the pond (approximately 2,000 fish). Six additional pounds (approximately 1,800) of Fathead Minnows were stocked later in the summer. Plugs were purchased for installation in Basins 2, 3 and 5 which lacked sufficient cover.

Monitoring practices in the wetlands saw a couple of improvements. The monitoring of water levels in ponds was expedited by the installation of staff gauges. Percent vegetative cover determinations were formalized with random quadrat sampling within basins and upland areas of the project, as discussed in Section 2.1.1.2.

Fertilizer tablets that contain a systemic deer repellent were applied to several areas within the wetland mitigation project (WS6, WS23, US13, Appendix A, Figure A-1). An evaluation of the performance of this product will be reported in the next Consolidated Monitoring Report.

The tablets are not to be used in areas of standing water. The fertilizer could stimulate the growth of algae in the water. Use in areas adjacent to water should not be a problem, but care should be taken to prevent the inadvertent spillage of tablets into water.

The manufacturer (Gro-Power) indicated that other mammals browsing on foliage would find the plants distasteful. As long as there is a more palatable food source in the vicinity, animals should leave the Repellex vegetation alone. The manufacturer has made inquiries into the effect on bird populations. Repellex does not change the chemical composition or genetics, so it should not have an effect on fruit production. The taste of the fruit would be effected, but birds taste differently from mammals, so bird consumption should not be effected. The manufacturer did not have any data regarding the effects of Repellex on insect pollination. They did recognize that pollinating insects are very selective and may avoid Repellex vegetation.

In general, the production of fruit is not essential for the establishment of woody vegetation. Repellex tablets will be used twice over the next three years to prevent browse and allow for plant establishment. Repellex should be completely removed from the plant two years after the last application. Use of Repellex will be limited to woody vegetation. Herbaceous plants that require earlier pollination may be adversely effected by the use of Repellex.

### 2.1.5 Lessons Learned

Efforts were made to control some of the cattails in wetland swales. They were clipped below the water level, which allows water to infiltrate into the center stem of the cattail. Extended inundation with water will drown the plant. However, due to falling water levels in swales from transpiration, evaporation, and water outflow; efforts to drown the cattails in the wetlands were not very successful. Water levels were dropping sufficiently each day to expose that day's cut stems. More success was achieved after water was introduced into the swales from the water line running through the wetlands. This not only maintained water levels but also flooded the swales and some of the surrounding basins.

Another benefit was discovered during the flooding of basins. Non-native clover (*Trifolium spp.*) began to disappear from the flooded areas. These were replaced in part by seeded and planted native grasses and rushes. The native plant species were then able to maintain their establishment even after the water levels receded. Short term flooding in late spring to early summer was found to help control undesirable non-native species and to promote the establishment of desirable wetland species.

## 2.2 A8PII FOREST DEMONSTRATION PROJECT

The A8PII Forest Demonstration Project completed its second growing season in 2001. Most planting was completed in Spring 2000. Shrubs and most seedlings were planted in Fall 2000. Some remaining seedlings were planted in Spring 2001. As with the wetland mitigation project, monitoring results will be presented in terms of both system-specific and patch-specific quantities.

### 2.2.1 Requirements

Since this project does not satisfy regulatory-driven mitigation requirements, the Implementation Phase monitoring program is less involved than the wetland mitigation project. The forest demonstration project NRRDP established monitoring requirements for vegetation survival and herbaceous cover, as well as and evaluation of invasive species within the project area. These requirements are discussed in more detail below.

#### 2.2.1.1 Vegetation Survival

The A8PII NRRDP calls for 80 percent survival of all planted vegetation, with the exception of seedlings (DOE 2000). Mortality counts were conducted at the end of the growing season in 2001. All sapling trees and shrubs installed in A8PII were evaluated and assigned a viability category pursuant to the approach discussed in Section 1.2.1. Results of this effort are provided in Section 2.2.2.1 below.

#### 2.2.1.2 Herbaceous Cover

Seeded areas within the forest demonstration project must meet 90 percent cover. Like the wetland mitigation project, the A8PII NRRDP did not specify that native cover must reach 90 percent. However, the NRTs agreed to manage restored areas to maximize native cover.

Once quadrats were randomly placed via an "over the shoulder" toss, cover estimates were conducted pursuant to the process for Functional Phase monitoring set forth in Appendix E. This approach utilizes broad cover class estimates instead of specific cover percentages. Therefore, percent cover and percent

native cover is presented in Tables 2-10 and B-2 in terms of cover classes instead of percentages. These results are discussed in Section 2.2.2.2 below.

2.2.1.3 Other Requirements

The only other requirement for the A8PII Forest Demonstration Project specified in the NRRDP was a report on the status of invasive species across the project area. The status is provided in Section 2.2.2.3 below.

2.2.2 Results and Discussion

The results of Implementation Phase monitoring for the forest demonstration project are presented in Tables 2-9 and 2-10, and in Appendix B. Tables 2-9 and 2-10 provide summary information organized by vegetative communities, while Tables B-1 and B-2 provide more detailed patch-specific and quadrat-specific data. These monitoring results are discussed in greater detail below.

2.2.2.1 Vegetation Survival Results

Table 2-9 demonstrates that 24 of 39 patches met the 80 percent vegetation survival requirement. Patch locations are identified in Figure 2-3. When the project is viewed on a system basis, the only stressed community is the tallgrass savanna. Two factors seemed to control woody plant mortality. First, most of the non-savanna patches that did not reach 80 percent survival experienced heavy deer damage. Patches RP3, RP4, MM22, and BS30 are located in the southeastern portion of the project area, where some of the most severe deer damage was observed (DOE 2002c). Several saplings were literally snapped in two by rubbing bucks.

The second factor appeared to be simply a matter of not locating planted vegetation. Table B-1 shows that a number of individuals were unable to be located. Stringent quality control was maintained during field implementation, so it is not possible that the vegetation was never planted (DOE 2001b). Instead, the plants were not located during several rounds of field monitoring. There are several possible explanations for this. First, unlike the wetland mitigation project, many of the patches in A8PII are very large. Also, seeded areas and existing herbaceous vegetation grew tall, obscuring the view of many shrubs and hickory seedlings. The hickory seedlings were tabulated as part of the vegetation survival counts, because they were substituted for NRRDP-specified saplings that were commercially unavailable. Lastly, some shrubs planted in the savanna may have been mowed during tallgrass maintenance activities.

Aside from the difficulties associated with conducting the mortality counts, most vegetative communities established in A8PII appear to be progressing well.

2.2.2.2 Herbaceous Cover Results

As stated in Section 2.2.1.2 above, herbaceous cover estimates were presented in terms of cover class instead of actual percentages. Cover classes represent a range of percentages that are easier to assign in the field. Cover class 5 represents a percent cover of 75 to 100 percent. Table B-2 illustrates that all sample points were assigned a cover class of five, with the exception of one quadrat in the material handling area. Pursuant to the A8PII NRRDP, the material handling area does not need to meet the 90 percent cover requirement. It should be noted that additional notes on the herbaceous cover field forms indicated that total cover exceeded 90 percent in all but two quadrats. The two quadrats that did not exceed 90 percent cover were again located in the material handling area. In summary, field data indirectly demonstrate that total herbaceous cover exceeded 90 percent in all seeded areas except the material handling area.

A walk-through of A8PII leaves the observer with a general impression that seeded areas are progressing extremely well. Many native grasses grew quickly and went to seed in the first growing season. Also, a variety of forbs have been established, including black-eye Susan (*Rudbekia hirta*), bergamot (*Monarda fistulosa*), purple coneflower (*Echinacea purpurea*), ox-eye sunflower (*Heliopsis helianthoides*), and butterfly weed (*Asclepias tuberosa*). However, native cover did not exceed 60 percent in any seeded area (Table 2-10). Nevertheless, as stated above, most seeded areas within A8PII appear to be progressing well. Therefore, corrective actions will focus on expanding the extent of native vegetation in the tallgrass savanna, which had the second lowest percent native cover (44 percent, Table 2-10). This approach is described in Section 2.2.3 below.

2.2.2.3 Other Results

Invasive species across the forest demonstration project area have been reduced. FEMP maintenance personnel have conducted an "invasives sweep" across A8PII several times in both 2000 and 2001. Pursuant to the NRRDP, amur honeysuckle (*Lonicera mackii*) and multiflora rose (*Rosa multiflora*) are mechanically removed or sprayed with Roundup® herbicide in the spring and fall of each year. During the most recent sweep in Fall 2001, the amount of non-native species present within the project area was noticeably reduced. One problem area remained, along the northern drainage that separates the Beech-Maple forest type from the Savanna habitat type. A large patch of multiflora rose, amur

honeysuckle, and Russian olive (*Elaeagnus angustifolia*) could not be sprayed with Roundup herbicide because of their proximity to water. These plants will be mechanically removed in the Spring 2002 invasives sweep.

### 2.2.3 Replanting Strategy

As Section 2.2.2.1 described, 15 of 39 patches did not reach 80 percent survival. Because of this, a replant strategy is required to compensate for the reduced survival. The replanting effort must, to the extent feasible, meet the following criteria; replace lost species, maximize the chance for survival, and minimize impacts to existing restored areas. The replanting strategy described below addresses these criteria.

The first step is to determine the number of plants that need to be installed. Table B-1 calculates the number of plants required to raise failed patches to 85 percent survival. A total of 83 plants must be replanted within A8PII. Next, planting locations need to be determined. The majority of planted areas within A8PII are progressing very well. Most of the forest patches that failed are difficult to access. Also, in order to maximize future survival, additional plantings in some areas should be avoided. Therefore, instead of installing new trees and shrubs into failed patches, DOE proposes the formation of three new planting areas (Figure 2-4). Replant Areas 1 and 2 will be treated as independent patches during Implementation Phase monitoring in 2002. The siting of each replant area is discussed below. Replant Area 1 will address plantings needed for patch OS1. Planting within OS1 should be avoided, because the high nutrient content of the soil is suspected of reducing overall survival within the patch. The location of Replant Area 1 is at the end of a mowed path, so the area is very accessible.

Replant Area 2 will combine the plantings needed for RP3, RP4, MM22, and BS30. This additional planting area provides several benefits. First, it avoids some of the heaviest deer damage areas in the southeast corner of the project area. Second, it expands the overall coverage of forest restoration in A8PII. Lastly, it results in a single point of access and disturbance into the southern reaches of A8PII. An additional access will be needed to reach this area, but impacts to the surrounding patches should be minimal.

Replant Area 3 is the entire savanna habitat type. The area is level, open, and surrounded by a mowed buffer strip, so access is not an issue. Shrubs only will be used to restore patch quantities. By using

shrubs, the density of trees species within the savanna is kept low. Shrubs will generally be planted in single-species clumps, in order to mimic natural dispersion patterns.

The plant list for each replant patch is provided in Table 2-11. Species were selected based on the species-specific mortality within each patch, as well as the overall survival of the species within A8PII. All trees and shrubs used during replanting efforts will be container grown from local suppliers, if available. Appropriate deer controls will be implemented on all vegetation. Additional deer control measures may be implemented based on recommendations from local deer management experts, as called for in the FEMP Deer Management Plan. Also, extra-wide mulch rings will be used, especially around shrubs within the savanna patches, so that later field location is possible.

The approach for addressing native herbaceous cover will focus on further development of the tallgrass savanna. This area will be sprayed with a selective herbicide in Spring 2002, and then interseeded with a native grass and forb mix, if needed. Mowing of the area will also continue in order to reduce competition from non-native species. Intensive management (aside from mowing) of other seeded areas within A8PII would probably be counter-productive at this point.

### 2.2.4 Maintenance and Management Summary

Maintenance and management activities within the forest demonstration project focused on weed control, establishment of the tallgrass savanna, and deer protection. Invasive weeds were cut and/or sprayed on several occasions in 2001. Several patches of thistle (*Cirsium spp.*) were removed from the beech-maple area and the tallgrass savanna. The tallgrass savanna was also mowed several times, in an attempt to establish the native grasses and forbs seeded into the area in 2000. Deer tubes were replaced on several saplings across A8PII, and deer repellent was sprayed on all trees and shrubs susceptible to browsing. All of these efforts will require continued attention in 2002.

### 2.2.5 Lessons Learned

The first year of Implementation Phase monitoring for the forest demonstration project revealed two points that need to be addressed. First, the impact of deer on planted vegetation requires continued vigilance and new approaches. Despite protection of virtually all saplings with deer tubing and repellent sprays, deer significantly reduced survival in several patches. The tubes were usually successful in protecting the trunk of planted saplings, but the deer would snap off limbs above the tubing. On several occasions, tubes were scrunched down or completely ripped off the tree. As stated above, several trees

were literally snapped in two. It is anticipated that approaches described in the FEMP Deer Management Plan will reduce deer impacts to A8PII and other restoration projects across the site.

Second, seeding of the savanna resulted in low germination success. The low success is probably attributable to insufficient herbicide application prior to seeding. Only one application was conducted. Literature and field observations reveal that two or three applications would be required to kill existing vegetation. Also, the savanna was seeded prior to plant installation. The sequence of seeding was necessary in order to facilitate the use of the seed drill. Consequently, the seeded area experienced a high amount of disturbance from heavy equipment, materials, and personnel. In addition, the mowing frequency of the savanna was probably not optimal. More frequent mowing is necessary to allow native species to compete with other vegetation. This was observed in the field along the access path bordering the savanna. In 2000, the path was seeded and then mowed frequently to maintain access. In 2001, access was not needed as much, and the path was mowed only twice. As a result, a dense stand of native grasses went to seed along the access path in late Summer 2001. Apparently, the frequent mowing in year one overcame periodic disturbances from equipment and vehicles. Based on these findings, future seeding efforts will follow several herbicide applications, and mowing will be conducted on a more frequent basis during the first growing season.

Third, the inability to locate some planted vegetation requires a revised approach to marking vegetation. Several field visits were conducted across the project area. On each occasion, additional plants would be found. It is possible that more plants would have been found during additional searches. However, the search effort became too time consuming, and it was decided to record individuals as missing and assume that they were dead for the purposes of calculating survival percentages. In the future, planted vegetation will receive a 4-foot diameter mulch ring. This size ring was specified in the A8PII NRRDP, but it was not always correctly installed in the field. This requirement will be scrutinized more closely during future restoration projects. Also, shrubs and small trees that are planted in areas of high grass will be flagged for easier identification from heavy equipment. It is suspected that some shrubs were mowed over as part of maintenance activities in the tallgrass savanna.

**TABLE 2-1**
**A1PI WETLAND MITIGATION PROJECT**
**VEGETATION SURVIVAL SUMMARY**

| Basin | Survival Rate Based on No. Planned (%) |
|---|---|
| 1 | 81% |
| 2 | 78% |
| 3 | 105% |
| 4 | 75% |
| 5 | 49% |
| 6 | 93% |
| 7 | 79% |
| 8 | 93% |
| upland | 62% |

**TABLE 2-2**
**A1PI WETLAND MITIGATION PROJECT**
**HERBACEOUS COVER SUMMARY**

| Basin | Average Percent Cover | Average Percent Native Cover | Hydrophytic Vegetation Present? |
|---|---|---|---|
| 1 | 90 | 72 | Yes |
| 2 | 88 | 33 | No |
| 3 | 87 | 22 | No |
| 4 | 97 | 40 | Yes |
| 5 | 28 | 33 | No |
| 6 | 91 | 57 | Yes |
| 7 | 98 | 39 | No |
| 8 | 97 | 26 | No |
| upland | 94 | 27 | No |

# TABLE 2-3
# A1PI WETLAND MITIGATION PROJECT
# WATER LEVELS

*All values measured in feet*

| Basin No. | Spring Sample Date: 5/15/01 | | | Fall Sample Date: 11/20/01 | | | Pond Sample Date: 5/8/01 | | | Swale Sample Date: 5/8/01 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Well Depth | Depth to Water | Water Column Height | Well Depth | Depth to Water | Water Column Height | Water Elevation | Floor Elevation | Depth | Water Elevation | Floor Elevation | Depth |
| 1 | 1.45 | 0.95 | 0.50 | 1.52 | 0.40 | 1.12 | 600.36 | 598.46 | 1.9 | 600.36 | 598.46 | 1.9 |
| 2 | 1.57 | 1.24 | 0.33 | 1.56 | 0.58 | 0.98 | 606.01 | 604.27 | 1.74 | 605.36 | 604.64 | 0.72 |
| 3 | 1.47 | 0.9 | 0.57 | 1.54 | 0.60 | 0.94 | NA | NA | NA | 610.18 | 609.2 | 0.98 |
| 4 | 1.46 | 0.12 | 1.34 | Underwater | | NA | 612.4 | 611.1 | 1.3 | 612.17 | 611.05 | 1.12 |
| 5 | 1.46 | 0.73 | 0.73 | 1.54 | 1.20 | 0.34 | NA | NA | NA | NA | NA | NA |
| 6 | 1.45 | Dry | 0 | 1.54 | 0.82 | 0.72 | NA | NA | NA | Dry | Dry | Dry |
| 7 | 1.46 | Dry | 0 | 1.54 | 0.99 | 0.55 | NA | NA | NA | Dry | Dry | Dry |
| 8 | 1.18 | Dry | 0 | 1.25 | 1.25 | 0 | NA | NA | NA | NA | NA | NA |

**TABLE 2-4**
**A1PI WETLAND MITIGATION PROJECT**
**WATER QUALITY RESULTS**

| Location | Date | Color | Odor | Temperature (Celcius) | pH | Specific Conductivity (mS/cm) | Turbidity (NTU) | Dissolved Oxygen (mg/L) |
|---|---|---|---|---|---|---|---|---|
| **Basin 1 Pond** | 5/22/01 | clear | none | 20.7 | 8.11 | 0.833 | 1 | 7.58 |
| | 10/27/01 | clear | none | 10.8 | 7.95 | 0.411 | 3 | 10.32 |
| **Basin 2 Pond** | 5/22/01 | clear brown | none | 21.0 | 7.91 | 0.272 | 1 | 5.79 |
| | 10/27/01 | clear | none | 11.9 | 8.64 | 0.288 | 0 | 11.52 |
| **Basin 4 Pond** | 5/22/01 | clear brown | none | 20.8 | 8.02 | 0.238 | 11 | 6.39 |
| | 10/27/01 | clear | none | 11.3 | 8.08 | 0.302 | 9 | 10.58 |
| **Basin 5 Pond** | 5/22/01 | stained | none | 20.6 | 7.63 | 0.496 | 28 | 4.31 |
| | 10/27/01 | clay brown | none | 11.3 | 7.78 | 0.397 | 258 | 4.95 |
| **Basin 6 Pond** | 5/22/01 | clear orange | none | 20.6 | 7.36 | 0.950 | 3 | 2.74 |
| | 10/27/01 | clear | none | 9.6 | 7.99 | 0.686 | 3 | 11.65 |

mg/L – milligrams per liter
mS/cm – microSiemens per centimeter
NTU – Nephelometric Turbidity Units

Note – Time and weather conditions for sampling events: 5/22/01 = 10:45am – 11:15am, sunny, 62
10/27/01 = 1:30pm – 2:00pm, sunny, 65

# TABLE 2-5
# A1PI WETLAND MITIGATION PROJECT
# SOIL SAMPLING RESULTS

***Sample Date: 6/28/01***

| Sample ID | Basin | Sample length | Color | Hydric? | Moisture Content | Soil Type |
|---|---|---|---|---|---|---|
| W1-1 | 1 | 4" | 2" 10YR 4/2, brown<br>2" 10YR 3/2, brown | No | Damp | 1" Silty, sandy clay<br>3" Silty clay |
| W1-2 | 1 | 5" | 2.5Y 4/2, light olive, mottled | yes | Moist to wet | Silty clay, roots |
| W1-3 | 1 | Crumbled | *Top* 10YR 5/3, light brown<br>*Bottom* 10YR 4/2, brown | No | *Top* Dry<br>*Bottom* Damp | Silty clay |
| W1-4 | 1 | 3" | 10YR 4/2, brown | No | Dry to damp | Silty, sandy clay with mulch |
| W2-1 | 2 | 3" | 10YR 4/3, brown | No | Dry to damp | Silty clay |
| W2-2 | 2 | 4" | 10YR 4/3, brown, mottled | No | Damp to moist | Silty clay |
| W2-3 | 2 | 3" | 10YR 4/2, brown | No | 1" Damp<br>2" Damp to moist | 1" Silty clay<br>2" Clay |
| W2-4 | 2 | 3" | 10YR 4/3, brown | No | Dry | 1.5" Silty clay<br>1.5" Clay |
| W2-5 | 2 | Crumbled | *Top* 10YR 4/3, brown<br>*Bottom* 10YR 3/1, very, very dark brown (almost black) | Yes | NA | NA |
| W3-1 | 3 | 4" | 1" 10YR 6/3, light brown<br>3" 10YR 4/2, brown | No | 1" Dry<br>3" Damp | 1" Silty clay<br>3" Clay |
| W3-2 | 3 | 4" | 1" 2.5Y 6/3, light gray-brown<br>3" 2.5Y 5/2, light olive | No | 1" Dry<br>3" Damp | 1" Silty clay<br>3" Clay |
| W3-3 | 3 | 3" | 10YR 4/2, dark brown, mottled | Yes | Moist | Clay |
| W3-4 | 3 | 4" | 2.5YR 5/2, light olive, mottled | Yes | Moist to wet | Clay with mulch |
| W4-1 | 4 | 4" | 2" 10YR 4/2, brown<br>2" 10YR 5/3, light brown Mottled | No | 2" Moist to wet<br>2" Damp | Clay |
| W4-2 | 4 | 3" | 10YR 5/3, light brown | No | Dry | Clay |
| W4-3 | 4 | 4" | 10YR 5/3, light brown, mottled | No | Damp | Clay |
| W4-4 | 4 | 4" | 10YR 3/3, dark brown | No | Damp | Clay |
| W5-1 | 5 | NA | 10YR 4/2, brown | No | Damp | Silty, sandy clay with mulch |
| W5-2 | 5 | NA | 10YR 4/2, brown | No | Moist | Clay with mulch |
| W6-1 | 6 | 5" | 10YR 3/2, dark brown | No | Damp | Top silty clay<br>Bottom clay |

**TABLE 2-5**
**A1PI WETLAND MITIGATION PROJECT**
**SOIL SAMPLING RESULTS**
**(Continued)**

| Sample ID | Basin | Sample length | Color | Hydric? | Moisture Content | Soil Type |
|---|---|---|---|---|---|---|
| W6-2 | 6 | 2" | 10YR 4/2, brown | No | Dry to damp | Clay |
| W6-3 | 6 | Crumbled | 10YR 5/3, light brown | No | Dry | Silty, sandy, clay |
| W6-4 | 6 | Crumbled | *Top* 10YR 4/3, brown<br>*Bottom* 10YR 3/1 very, very, dark brown (almost black) | Yes | NA | Silty clay to clay |
| W7-1 | 7 | Crumbled | 10YR 3/2, dark brown | No | Dry to damp | Silty clay |
| W7-2 | 7 | 3" | 2.5Y 3/1, very dark olive gray | Yes | Moist to wet | Clay |
| W7-3 | 7 | Crumbled | 10YR 4/2, brown | No | Dry to damp | Silty clay to clay |
| W8-1 | 8 | Crumbled | 10YR 4/3, brown | No | Dry to damp | Silty clay |
| W8-2 | 8 | Crumbled | 10YR 3/2, dark brown | No | Dry to damp | Clay |

# TABLE 2-6
# A1PI WETLAND MITIGATION PROJECT
# WILDLIFE OBSERVATIONS

**Birds:**
*Agelaius phoeniceus* (Red-Winged Blackbird)
*Aix sponsa* (Wood Duck)
*Anas discors* (Blue-winged Teal)
*Anas platyrhynchos* (Mallard)
*Ardea herodias* (Great Blue Heron)
*Branta canadensis* (Canada Goose)
*Bucephala albeola* (Bufflehead)
*Buteo jamaicensis* (Red Tailed Hawk)
*Butorides striates* (Green Heron)
*Cardullis tristis* (Amerian Goldfinch)
*Carninalis cardinalis* (Northern Cardinal)
*Cathartes aura* (Turkey Vulture)
*Ceryle alcyon* (Belted Kingfisher)
*Charodrius vociferu* (Killdeer)
*Corus brachyrhynchos* (American Crow)
*Cyanocarax cristata* (Blue Jay)
*Falco sparverius* (Kestrel)
*Fulica americana* (American Coot)
*Gallinago gallinago* (Common Snipe)
*Hirundo rustic* (Barn Swallow)
*Lophodytes cucullatus* (Hooded Merganser)
*Meleagnes gallopavo* (North American Turkey)
*Meleagris gallopavo* (Wild Turkey)
*Mimus polyglottos* (Northern Mockingbird)
*Molothrus ater* (Brown-Headed Cowbird)
*Nycticorax nycticorax* (Black Crowned Night Heron)
*Passer domesticus* (House Sparrow)
*Passerina cyanea* (Indigo Bunting)
*Porzana carolina* (Sora)
*Progne subis* (Purple Martin)
*Quiscalus quiscula* (Common Grackle)
*Sialia sialis* (Eastern Bluebird)
*Sturnella magna* (Eastern Meadowlark)
*Sturnus vulgaris* (European Starling)
*Tachycineta bicolor* (Tree Swallow)
*Toxostoma rufum* (Brown Thrasher)
*Tringa flavipes* (Lesser Yellowlegs)
*Tringa melanoleuca* (Greater Yellowlegs)
*Tringa solitaria* (Solitary Sandpiper)
*Troglopytes aedon* (House Wren)
*Turdus migratorius* (American Robin)
*Tyrannus tyrannus* (Eastern Kingbird)
*Zenaida macroura* (Mourning Dove)

**Herpetofauna:**
*Acris crepitans* (Cricketfrog)
*Ambystoma opacum* (Marbled Salamander)
*Bufo americanus* (American Toad)
*Nerodia spiedon* (Northern Watersnake)
*Pseudacris crucifer* (Spring Peeper)
*Rana catesbeina* (Bullfrog)
*Rana clamitans* (Green Frog)

**Mammals:**
*Apodemus sp.* (Field Mouse)
*Canis latrans* (Coyote)
*Mephitis mephitis* (Striped Skunk)
*Microtus pennsylvanicus* (Meadow Vole)
*Mustela vison* (Mink)
*Odocoileus virginianus* (White-Tailed Deer)
*Procyon lotor* (North American Raccoon)
*Sciurus carolinensis* (Gray Squirrel)
*Sciurus niger* (Fox Squirrel)
*Sylvilagus floridanus* (Cottontail Rabbit)
*Urocyon cinereoarlenteus* (Gray Fox)
*Vulpes vulpes* (Red Fox)

**Other:**
Crayfish species

## TABLE 2-7
## A1PI WETLAND MITIGATION PROJECT
## HERBACEOUS LAYER REPLANT STRATEGY

| Plugs for Spring 2002 Planting | Basin(s) | CW | No. of Plugs |
|---|---|---|---|
| **Grasses/Sedges** | | | |
| Woolgrass (*Scirpus cyperinus*) | 2,4,7 | -4 | 128 |
| Blue Joint Grass (*Calamagrostis canadensis*) | 2,4,7 | -4 | 128 |
| Bottlebrush Sedge (*Carex lurida*) | 2,4,7 | -5 | 128 |
| Fox Sedge (*Carex stipata*) | 2,4,7 | -5 | 128 |
| Dark Green Bulrush (*Scirpus atrovirens*) | 2,4,7 | -5 | 128 |
| Prairie Cordgrass (*Spartina pectinata*) | 2,4,7 | -5 | 128 |
| **Wildflowers** | | | |
| Red Milkweed (*Asclepias incarnata*) | 2,4,7 | -5 | 96 |
| Butterflyweed (*Asclepias tuberosa*) | 8 | 5 | 24 |
| Smooth Aster (*Aster laevis*) | 8 | 5 | 24 |
| Wild Senna (*Cassia hebecarpa*) | 2,4,7 | 0 | 72 |
| Sweet Joe-Pye Weed (*Eupatorium maculatum*) | 2,4,7 | -3 | 96 |
| Ox-Eye Sunflower (*Heliopsis helianthoides*) | 8 | (no record) | 24 |
| Great Blue Lobelia (*Lobelia siphilitica*) | 2,4,7 | -4 | 96 |
| Cardinal Flower (*Lobelia cardinalis*) | 2,4,7 | -4 | 72 |
| Bergamot (*Monarda fistulosa*) | 2,4,7 | -5 | 72 |
| Cupplant (*Silphium perfoliatum*) | 8 | -2 | 24 |
| Stiff Goldenrod (*Solidago rigida*) | 8 | 4 | 24 |
| Culver's Root (*Veronicastrum virginicum*) | 8 | 0 | 24 |

CW = Coefficient of Wetness: This value corresponds with COE Wetland Indicator Status, with 5 being upland, 0 being facultative, and –5 being obligate wet.

## TABLE 2-8
## A1PI WETLAND MITIGATION PROJECT
## REPLANT STRATEGY FOR THE RADIUM HOT SPOT

| Patch No. | Common Name | Scientific Name | Installation Size | Propagation Method | Patch Size | Plants |
|---|---|---|---|---|---|---|
| 1 | False Indigo Bush | *Amorpha fruticosa* | Container – 1-ft | Root suckers | 0.06 ac. | 276 |
| 2 | Buttonbush | *Cephalanthus occidentalis* | Cutting | Seed, cuttings | 0.08 ac. | 368 |
| 3 | Silky Dogwood | *Cornus amomum* | Cutting | Cuttings | 0.02 ac. | 92 |
| 4 | Red-Osier Dogwood | *Cornus stolonifera* | Cutting | Cuttings | 0.02 ac. | 92 |
| 5 | Water Willow | *Decondon verticillatus* | Container – 1-ft | Cuttings | 0.02 ac. | 92 |
| 6 | Shrubby St. John's Wort | *Hypericum spathulatum* | Container – 1-ft | Root suckers | 0.03 ac. | 138 |
| 7 | Winterberry | *Ilex verticulata* | Container – 1-ft | Cuttings | 0.01 ac. | 46 |
| 8 | Swamp Rose | *Rosa palustris* | Container – 1-ft | Root suckers | 0.02 ac. | 92 |
| 9 | Pussy Willow | *Salix discolor* | Cutting | Cuttings | 0.045 ac. | 207 |
| 10 | Heart-Leaf Willow | *Salix eriocephala* | Cutting | Cuttings | 0.025 ac. | 115 |
| 11 | Black Willow | *Salix nigra* | Cutting | Cuttings | 0.025 ac. | 115 |
| 12 | Silky Willow | *Salix sericea* | Cutting | Cuttings | 0.035 ac. | 161 |
| 13 | Elderberry | *Sambucus canadensis* | Container – 1-ft | Cuttings | 0.025 ac. | 115 |
| 14 | Coralberry | *Sympnoricarpos orbiculatis* | Container – 1-ft | Root suckers | 0.045 ac. | 207 |

## TABLE 2-9
## A8PII FOREST DEMONSTRATION PROJECT
## VEGETATION SURVIVAL SUMMARY

**A8PI ECOLOGICAL RESTORATION VEGETATION SURVIVAL**

**Patch-Specific Survival:**

| Existing Riparian | | Mesophytic | | Beech Maple | | Oak Maple | | Savanna | | Buffer Area | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Patch** | **% Surv.** | **Patch** | **% Surv.** | **Patch** | **% Surv.** | **Patch** | **% Surv.** | **Patch** | **% Surv.** | **Patch** | **% Surv.** |
| RP1 | 83 | MM8 | 93 | BS23 | 90 | OS1 | 71 | SV1 | 58 | BF31 | 83 |
| RP2 | 82 | MM9 | 88 | BS24 | 83 | OS2 | 82 | SV2 | 50 | | |
| RP3 | 63 | MM10 | 85 | BS25 | 83 | OS3 | 84 | SV3 | 25 | | |
| RP4 | 44 | MM11 | 88 | BS26 | 82 | OS4 | 84 | SV4 | 78 | | |
| RP5 | 89 | MM12 | 80 | BS27 | 86 | | | SV5 | 60 | | |
| | | MM13 | 80 | BS28 | 86 | | | SV6 | 59 | | |
| | | MM14 | 83 | BS29 | 82 | | | SV7 | 50 | | |
| | | MM19 | 84 | BS30 | 75 | | | SV8 | 77 | | |
| | | MM20 | 83 | | | | | SV9 | 56 | | |
| | | MM21 | 81 | | | | | SV10 | 31 | | |
| | | MM22 | 73 | | | | | | | | |
| **Totals =** | **78%** | | **83%** | | **84%** | | **80%** | | **54%** | | **83%** |

## TABLE 2-10
## A8PI FOREST DEMONSTRATION PROJECT
## HERBACEOUS COVER SUMMARY

| Area | Average Cover Class | Percent Native Cover |
|---|---|---|
| Oak-Maple Habitat Type | 5 | 38 |
| Savanna Habitat Type | 5 | 44 |
| Wetland Area | 5 | 51 |
| Drainage Swales, Berms, and the Materials Handling Area | 4.75 | 59 |

Note: Cover classes were used instead of percent cover estimates. However, percent cover was noted on the field data forms. In all instances except for two, percent cover met or exceeded 90 percent.

# TABLE 2-11
# A8PII FOREST DEMONSTRATION PROJECT
# REPLANT STRATEGY

**Replant Area 1**

| Scientific Name | Common Name | Type | Size | Qty. | Addresses |
|---|---|---|---|---|---|
| *Acer saccharum* | sugar maple | Tree | 2 gal. | 1 | OS1 |
| *Carya ovata* | shagbark hickory | Tree | 2 gal. | 2 | OS1 |
| *Quercus imbricaria* | shingle oak | Tree | 2 gal. | 2 | OS1 |
| *Quercus muhlenbergii* | chinquapin oak | Tree | 2 gal. | 2 | OS1 |
| *Rhus glabra* | smooth sumac | Shrub | 1 gal. | 2 | OS1 |
| *Symphiocarpus orbiculatus* | Corralberry | Shrub | 1 gal. | 2 | OS1 |

**Total =** 11

**Replant Area 2**

| Scientific Name | Common Name | Type | Size | Qty. | Addresses |
|---|---|---|---|---|---|
| *Acer rubrum* | red maple | tree | 2 gal. | 4 | RP3, MM22 |
| *Acer saccharum* | sugar maple | tree | 2 gal. | 2 | BS30 |
| *Aesculus glabra* | Ohio buckeye | tree | 2 gal. | 2 | MM22 |
| *Asima triloba* | paw paw | tree | 2 gal. | 3 | RP3, RP4 |
| *Carya ovata* | shagbark hickory | tree | 2 gal. | 5 | RP3, RP4, BS30 |
| *Cercis canadensis* | redbud | tree | 2 gal. | 4 | RP3, RP4 |
| *Cornus florida* | flowering dogwood | tree | 2 gal. | 4 | RP3, RP4 |
| *Tilia americana* | American basswood | tree | 2 gal. | 2 | MM22 |

**Total =** 26

**Replant Area 3**

| Scientific Name | Common Name | Type | Size | Qty. | Patch |
|---|---|---|---|---|---|
| *Corylus americana* | hazel | shrub | 1 gal. | 1 | SV1 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 1 | SV1 |
| *Ceanothus americanus* | New Jersey tea | shrub | 1 gal. | 2 | SV2 |
| *Corylus americana* | hazel | shrub | 1 gal. | 1 | SV2 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 2 | SV2 |
| *Amorpha canescens* | leadplant | shrub | 1 gal. | 2 | SV3 |
| *Ceanothus americanus* | New Jersey tea | shrub | 1 gal. | 2 | SV3 |
| *Prunus americana* | wild plum | shrub | 1 gal. | 2 | SV3 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 2 | SV3 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 1 | SV4 |
| *Amorpha canescens* | leadplant | shrub | 1 gal. | 3 | SV5 |
| *Corylus americana* | hazel | shrub | 1 gal. | 2 | SV6 |
| *Prunus americana* | wild plum | shrub | 1 gal. | 2 | SV6 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 2 | SV6 |
| *Amorpha canescens* | leadplant | shrub | 1 gal. | 3 | SV7 |
| *Corylus americana* | hazel | shrub | 1 gal. | 1 | SV7 |
| *Hypericum spathulatum* | shrubby St. John's wort | shrub | 1 gal. | 2 | SV7 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 2 | SV7 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 1 | SV8 |
| *Corylus americana* | hazel | shrub | 1 gal. | 2 | SV9 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 3 | SV9 |
| *Amorpha canescens* | leadplant | shrub | 1 gal. | 1 | SV10 |
| *Ceanothus americanus* | New Jersey tea | shrub | 1 gal. | 2 | SV10 |
| *Hypericum spathulatum* | shrubby St. John's wort | shrub | 1 gal. | 2 | SV10 |
| *Rosa setigera* | prairie rose | shrub | 1 gal. | 2 | SV10 |

**Total =** 46

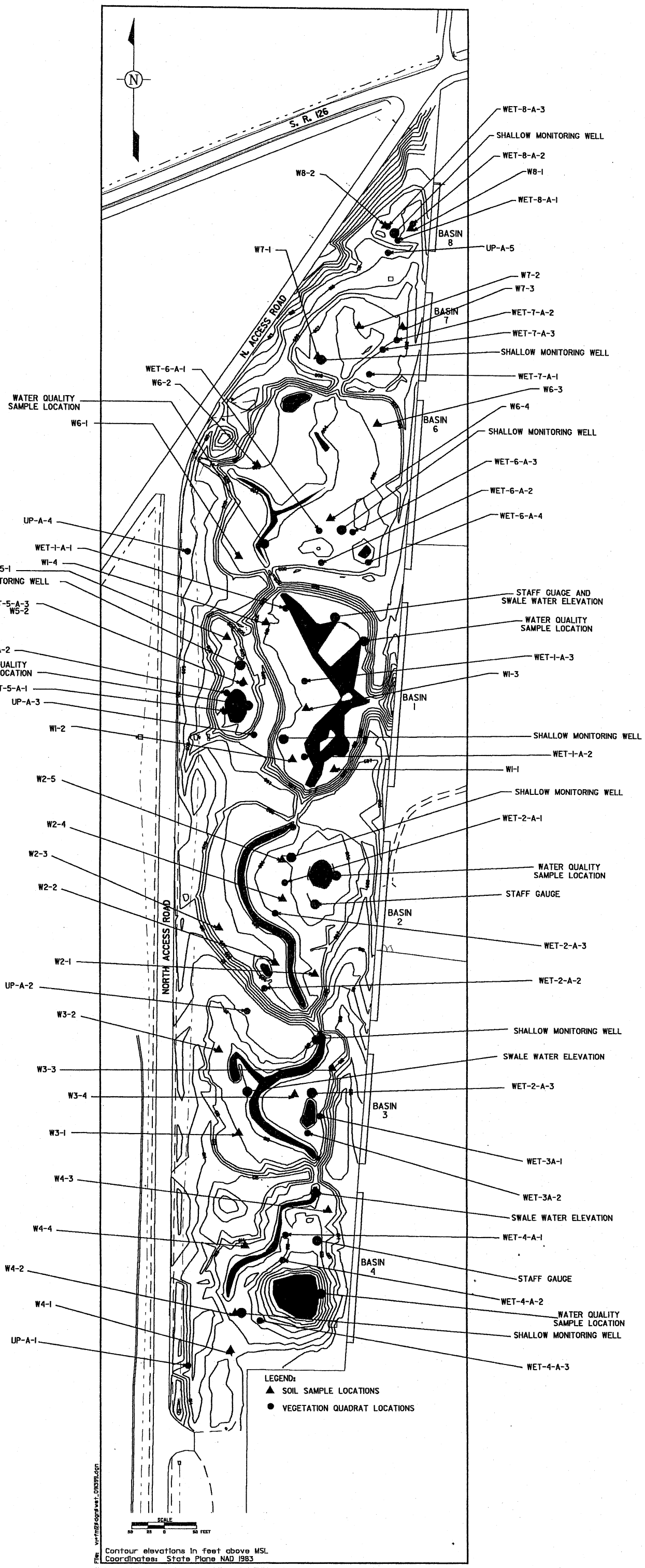


FIGURE 2-1. AIPI WETLAND MITIGATION PROJECT

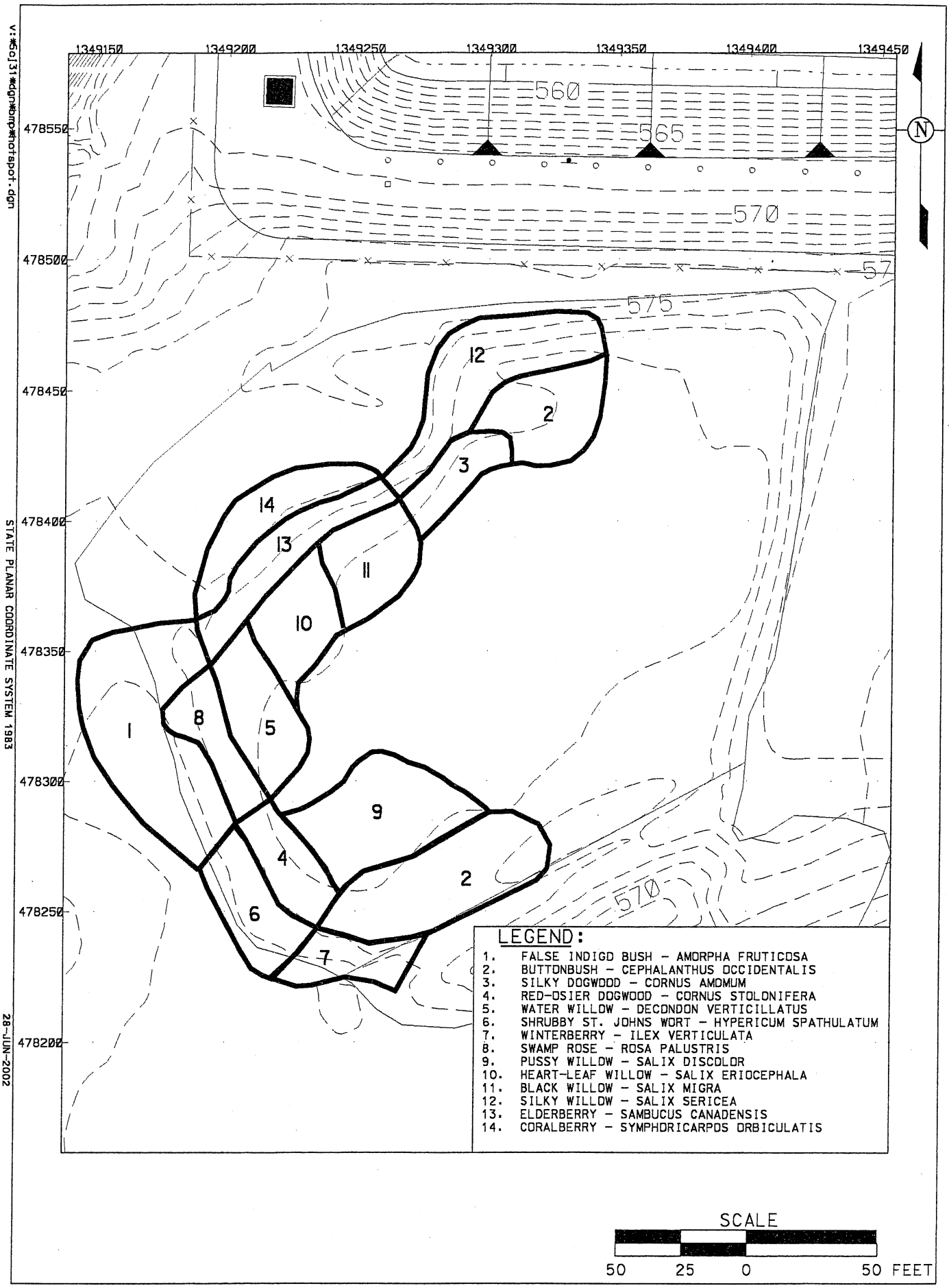


FIGURE 2-2. WETLAND MITIGATION PROJECT REPLANT STRATEGY AT THE RADIUM HOT SPOT

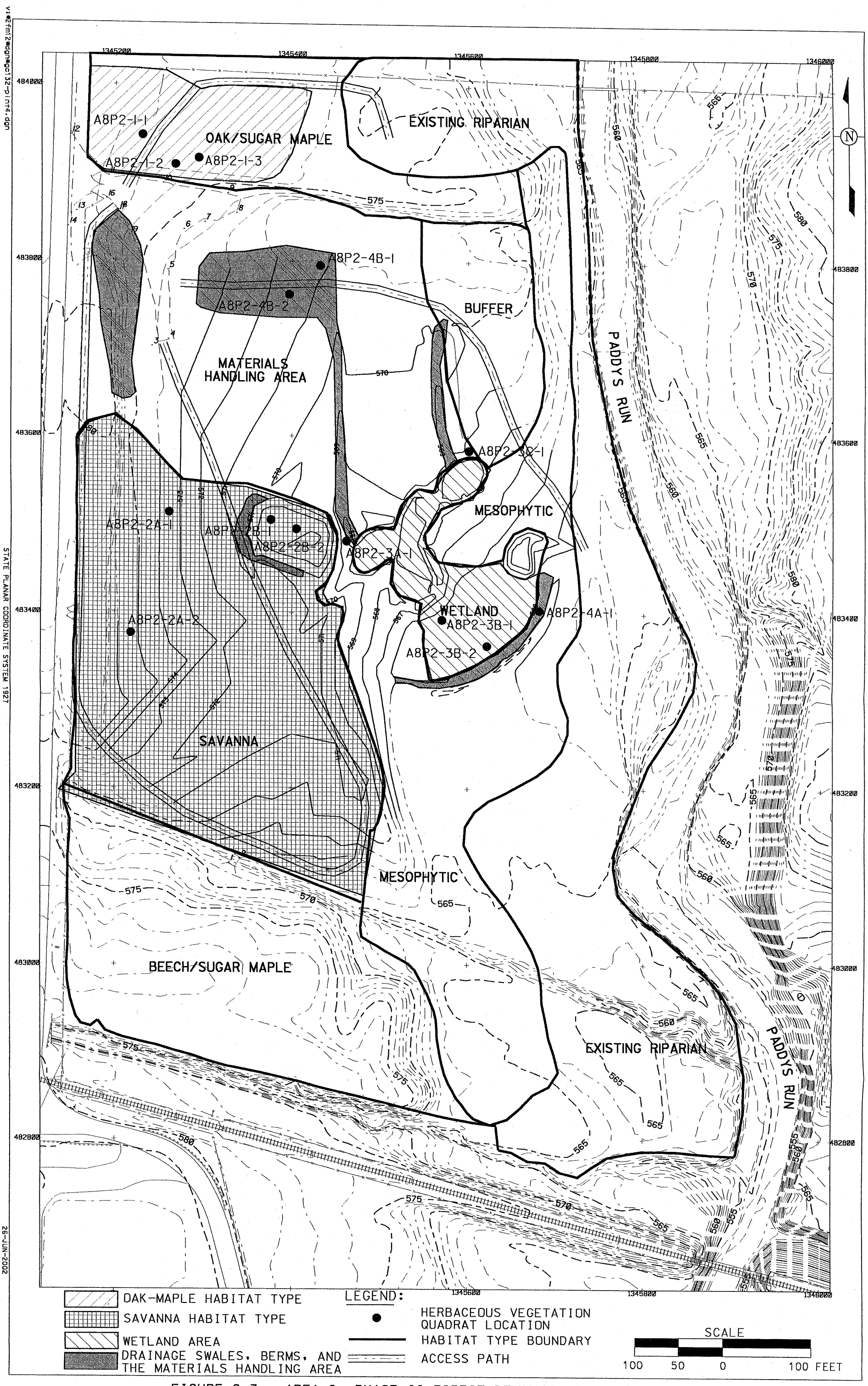


FIGURE 2-3. AREA 8, PHASE II FOREST DEMONSTRATION PROJECT

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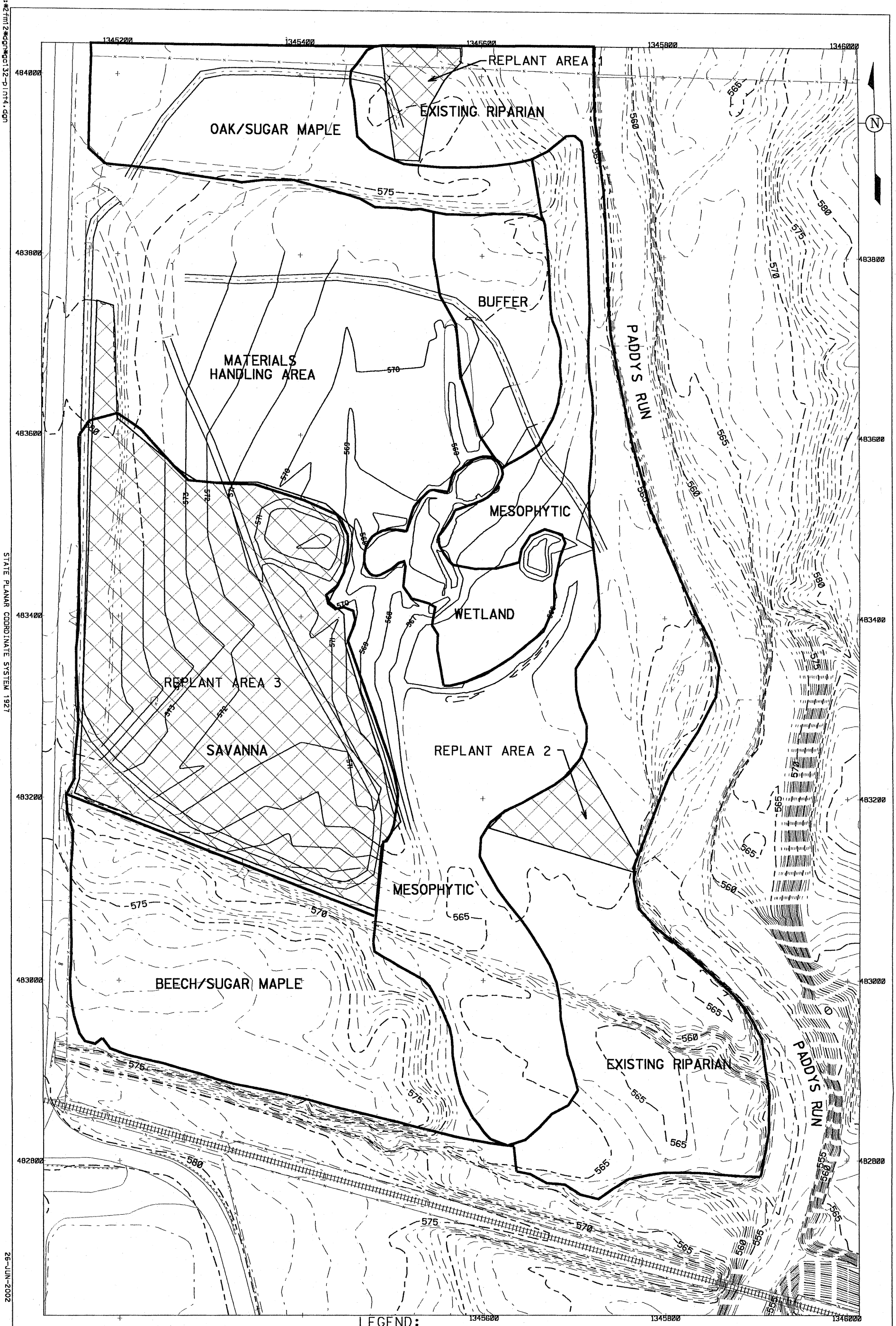


STATE PLANAR COORDINATE SYSTEM 1927

26-JUN-2002

FIGURE 2-4. AREA 8, PHASE II REPLANT STRATEGY

# 3.0 FUNCTIONAL PHASE MONITORING

The approach and methodology for Functional Phase monitoring is discussed in Section 1.2.2 and in Appendix E. As stated in Section 1.2.2, functional monitoring activities in 2001 consisted of establishing the baseline ecological conditions for representative communities at the FEMP. The interim results of the baseline monitoring effort are discussed below. An additional baseline survey will be conducted in the spring of 2002, so final baseline conditions will be presented in the 2002 monitoring report, along with an evaluation of ecological reference sites.

Summary calculations for each baseline community are presented in Table 3-1. Species lists for each area are provided in Tables C-1 through C-5 of Appendix C. The herbaceous data and woody data in Table 3-1 are presented separately. For the herbaceous layer, the FQAI and Simpson's Index calculations fell generally as expected, with a few exceptions. The successional woodlot had the highest FQAI value and second highest diversity, while the grazed pasture had the lowest FQAI score. Non-native grasses and forbs dominate the grazed pasture, which results in a low floristic quality value (Table C-1).

The FQAI value and diversity for the open water was unexpectedly high. This area was seeded with native grasses and forbs following excavation, so big bluestem (*Andropogon gerardi*), switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and partridge pea (*Chamaecrista fasciculata*) were all identified within the open water area (Table C-5). These species would not normally pioneer into recently disturbed subsoil, so their presence artificially inflates the vegetation indices for the open water system. If they were removed, the FQAI value would drop to 7.44, and diversity would be recalculated as 19.28. Since the intent of baseline characterization is to determine site conditions absent of any restoration activities, DOE proposes to adjust the final open water vegetation indices by removing seeded species. This approach is more efficient than developing a new open water baseline location, and will more accurately reflect what baseline conditions should be.

Several interesting herbaceous species were found in 2001, including a ragged fringed orchid (*Habenaria lacera*) in the pine plantation (Table C-4). Wild ginger (*Asarum canadense*) and showy tick trefoil (*Desmodium canadense*) were located in the riparian habitat (Table C-2).

Woody vegetation data was as expected, with the pine plantation showing a lower floristic quality and diversity than the riparian or woodlot systems (Table 3-1). The FQAI score would be even lower if the

non-native white pine (*Pinus strobus*) was given a zero score. Currently, white pine has a coefficient of conservatism (CC) value of six (Table C-4). Since it is not native to southwest Ohio, white pine should receive a value of zero. However, the CC values used for calculating FQAI scores are applicable to northeast Ohio instead of southwest Ohio. Statewide CC values have been developed and will be published soon (Mack 2001). Once statewide CC values are available, site FQAI scores will be recalculated and presented in the next consolidated monitoring report. The adjusted CC values will be more representative of ecological communities in southwest Ohio.

Results from breeding bird surveys and migratory waterfowl observations are presented in Tables 3-2 and 3-3, respectively. These results are also as expected. The successional woodlot had the highest number of species and individuals observed. Migratory waterfowl observations within the open water baseline location revealed that only Canada geese and mallards used the system.

Other parameters used to characterize baseline ecological systems at the FEMP include amphibian surveys, macroinvertebrate sampling, and butterfly surveys. These activities are controlled by OEPA, so they will not be reported on within this document.

In 2002, a spring survey will be conducted to complete the characterization of baseline conditions at the FEMP. Reference sites will also be established and characterized in 2002. As stated in Section 1.2.2, ecological systems within restored areas will be compared to appropriate reference sites. Specific reference sites need to be determined, but the communities to be characterized include upland beech-maple/oak hickory forest complex, wet forest, riparian forest, emergent wetlands with some open water, wet meadow/freshwater marsh, and tallgrass prairie. Further information regarding the selection and characterization of reference sites is provided in Appendix E.

# TABLE 3-1
# BASELINE ECOLOGICAL MONITORING INTERIM DATA SUMMARY

**Herbaceous Data**

| Area | Measurement Parameters (See Notes Below and Appendix E) | | | | |
|---|---|---|---|---|---|
| | Average CC | Total Spp. | FQAI | Total Cover | MSI |
| Open Water | 1.66 | 35 | 9.80 | 167 | 25.53 |
| Grazed Pasture | 0.47 | 32 | 2.65 | 304 | 12.19 |
| Riparian | 2.22 | 27 | 11.55 | 233 | 11.94 |
| Pinelot | 2.07 | 30 | 11.32 | 174 | 15.16 |
| Woodlot | 1.97 | 38 | 12.17 | 222 | 20.90 |

**Woody Data**

| Area | Measurement Parameters (See Notes Below and Appendix E) | | | | |
|---|---|---|---|---|---|
| | Average CC | Total Spp. | FQAI | Total Abundance | MSI |
| Riparian | 3.50 | 20 | 15.65 | 330 | 6.27 |
| Woodlot | 3.18 | 20 | 14.21 | 538 | 4.91 |
| Pinelot | 3.00 | 14 | 11.22 | 264 | 4.75 |

**Notes:**

Average CC = The mean Coefficient of Conservatism value for all species within each area
Total Spp. = The total number of species for each area
FQAI = Floristic Quality Assessment Index
Total Cover = Summed cover estimates for all species within each area
MSI = Modified Simpson's Index
Total Abundance = Summed number of individuals for all species within each area.

# TABLE 3-2
# BASELINE BREEDING BIRD SURVEY SUMMARY

**Grazed Pasture**

| Species | Qty. |
|---|---|
| red winged blackbird | 36 |
| eastern meadowlark | 21 |
| song sparrow | 10 |
| Barn swallow | 8 |
| mourning dove | 8 |
| American robin | 6 |
| American goldfinch | 5 |
| brown-headed cowbird | 5 |
| eastern kingbird | 5 |
| rough-winged swallow | 5 |
| common grackle | 3 |
| common yellowthroat | 2 |
| indigo bunting | 2 |
| Northern flicker | 2 |
| red-tailed hawk | 2 |
| American crow | 1 |
| belted kingfisher | 1 |
| blue jay | 1 |
| bobwhite quail | 1 |
| Carolina chicadee | 1 |
| Carolina wren | 1 |
| eastern bluebird | 1 |
| Field sparrow | 1 |
| Great blue heron | 1 |
| House finch | 1 |
| Killdeer | 1 |
| northern mockingbird | 1 |
| Red-bellied woodpecker | 1 |
| red-eyed vireo | 1 |

**Riparian**

| Species | Qty. |
|---|---|
| Carolina chicadee | 11 |
| Acadian flycatcer | 8 |
| northern cardinal | 8 |
| Red-eyed vireo | 8 |
| Carolina wren | 7 |
| wood thrush | 7 |
| American robin | 5 |
| tufted titmouse | 5 |
| blue-gray gnatcatcher | 4 |
| common flicker | 4 |
| Great crested flycather | 3 |
| eastern wood-peewee | 2 |
| red-bellied woodpecker | 2 |
| downy woodpecker | 1 |
| house wren | 1 |
| indigo bunting | 1 |
| Scarlet tanager | 1 |
| White breasted nuthatch | 1 |
| yellow-throated warbler | 1 |

**Successional Woodlot**

| Species | Qty. |
|---|---|
| American robin | 32 |
| northern cardinal | 32 |
| rufous-sided towhee | 29 |
| brown-headed cowbird | 19 |
| song sparrow | 18 |
| indigo bunting | 16 |
| field sparrow | 13 |
| American goldfinch | 12 |
| white-eyed vireo | 12 |
| Carolina chicadee | 11 |
| blue-gray gnatcatcher | 10 |
| common yellowthroat | 9 |
| cedar waxwing | 7 |
| European starling | 7 |
| house wren | 6 |
| gray catbird | 5 |
| mourning dove | 5 |
| blue jay | 4 |
| yellow-breasted chat | 4 |
| American crow | 3 |
| Carolina wren | 3 |
| downy woodpecker | 3 |
| eastern kingbird | 3 |
| scarlet tanager | 3 |
| yellow-throated warbler | 3 |
| bobwhite quail | 2 |
| common grackle | 2 |
| Cooper's hawk | 2 |
| eastern-wood peewee | 2 |
| red-bellied woodpecker | 2 |
| red-eyed vireo | 2 |
| acadian flycatcher | 1 |
| brown thrasher | 1 |
| common flicker | 1 |
| eastern bluebird | 1 |
| killdeer | 1 |
| orchard oriole | 1 |
| pileated woodpecker | 1 |
| red-tailed hawk | 1 |
| ruby-throated hummingbird | 1 |
| tufted titmouse | 1 |
| wood thrush | 1 |

**Pine Plantation**

| Species | Qty. |
|---|---|
| American goldfinch | 40 |
| northern cardinal | 31 |
| house wren | 22 |
| Carolina chicadee | 18 |
| yellow-throated warbler | 13 |
| indigo bunting | 12 |
| rufous-sided towhee | 11 |
| blue-gray gnatcatcher | 10 |
| Gray catbird | 9 |
| chipping sparrow | 6 |
| American crow | 4 |
| white-eyed vireo | 4 |
| Brown-headed cowbird | 3 |
| Carolina wren | 3 |
| Cedar waxwing | 3 |
| American robin | 2 |
| song sparrow | 2 |
| Downy woodpecker | 1 |
| tufted titmouse | 1 |

**TABLE 3-3**
**BASELINE OPEN WATER**
**MIGRATORY WATERFOWL OBSERVATIONS**

| Date | Species | Sex | Qty. |
|---|---|---|---|
| 3/22/01 | Canada goose | M | 1 |
| | Canada goose | F | 1 |
| | mallard | M | 1 |
| 3/26/01 | Canada goose | nd | 24 |
| | mallard | M | 4 |
| | mallard | F | 4 |
| 3/27/01 | Canada goose | nd | 9 |
| | mallard | M | 1 |
| | mallard | F | 1 |
| 3/28/01 | Canada goose | nd | 3 |
| | mallard | M | 1 |
| | mallard | F | 1 |
| 3/29/01 | (no waterfowl present) | | |

# 4.0 RESTORATION RESEARCH PROJECTS

This section provides data collected in support of the A8PI Revegetation Research Plots. This research effort was required as part of a dispute resolution between DOE and the regulatory agencies for missed milestones associated with Operable Unit 4. Miami University submitted a research plan that sought to determine the most effective density of saplings and seedlings for forest restoration at the FEMP site (DOE 1998). Since the initiation of the project, planting densities were negotiated between the NRTs. Also, the sapling trees planted within the research plots began to experience heavy deer pressure. Therefore, DOE decided to protect the saplings and close the research contract with Miami University. DOE committed to collecting sapling survival data, and to evaluate the effectiveness of deer control efforts within the research area. Vegetation survival was assessed in Fall 2001. These results are presented in Tables 4-1, 4-2 and Appendix D. A discussion of the results is provided below.

Table 4-1 shows the percent survival per plot. Sapling survival continues to remain high in all plots, with all plots exceeding 70 percent survival (excluding resprouts). Overall sapling survival was 73 percent. This is 5 percent lower than what was reported last year (DOE 2001c). However, given the extent of deer damage observed across the project area in 1999 and 2000, some increased mortality would be expected. It should be noted that many of the trees still showed signs of stress (i.e., early leaf drop), so future reductions may still occur.

Percent survival by species is presented in Table 4-2. Survival rates ranged from 88 percent for chinquapin oak (*Quercus muehlenbergii*) to 47 percent for green ash *(Fraxinus pennsylvanicum*). The low survival of green ash saplings within the research plots is due to the heavy deer pressure they received. Green ash saplings were more frequently and more severely rubbed than any other species within the research plots (Table D-1). It is suspected that rubbing deer preferred the light-colored, relatively smooth bark characteristics of green ash saplings.

Trunk diameters of all living saplings show that Ohio buckeye (*Aesculus glabra*) is experiencing the fastest rate of growth within the project area (Table 4-2). A number of buckeyes can be found in adjacent wooded areas, so it appears that this species is well suited for the location of the project. Also, during field installation of the saplings in 1999, 11 smaller, container-grown buckeyes were procured. All of these plants were installed in Plot H. These container-grown plants have generally grown at a faster rate than the balled and burlapped saplings (Table D-1). This is perhaps due to the fact that the

container-grown species are placed in the ground with an intact root mass, so energy can immediately be used to develop the aboveground portion of the plant. Balled and burlapped trees must expend resources to restore a root system during the first several growing seasons.

Seedling survival and volunteer recruitment were not quantified within the research plots. As stated above, planting densities were negotiated independently of this effort, so the focus of research shifted to sapling survival. Field observations revealed that a number of seedlings were surviving, and that volunteer recruits were populating both the control and research plots.

## TABLE 4-1
## A8PI REVEGETATION RESEARCH PLOTS
## SAPLING SURVIVAL SUMMARY

| Plot | No. Planted | No. Alive | No. Resprout | No. Dead | Percent Survival | Average Growth (mm) |
|---|---|---|---|---|---|---|
| A | 100 | 75 | 11 | 14 | 75% | 2.0 |
| D | 50 | 36 | 9 | 5 | 72% | 1.4 |
| E | 50 | 36 | 6 | 8 | 72% | 1.8 |
| H | 100 | 72 | 11 | 17 | 72% | 2.8 |

## TABLE 4-2
## A8PI REVEGETATION RESEARCH PLOTS
## SPECIES-SPECIFIC SURVIVAL SUMMARY

| Species | Common Name | No. Planted | No. Alive | No. Resprout | Percent Survival | Average Growth (mm) |
|---|---|---|---|---|---|---|
| *Aesculus glabra* | Ohio buckeye | 60 | 52 | 2 | 87% | 3.4 |
| *Celtis occidentalis* | hackberry | 60 | 47 | 3 | 78% | 1.5 |
| *Fraxinus pennsylvanicum* | green ash | 60 | 28 | 14 | 47% | 2.1 |
| *Juglans nigra* | black walnut | 60 | 39 | 13 | 65% | 1.7 |
| *Quercus muehlenbergii* | chinquapin oak | 60 | 53 | 5 | 88% | 1.7 |

# REFERENCES

Andreas, B. K., Lichvar, B. W., 1995, "Floristic Index for Establishing Assessment Standards: A Case Study for Northern Ohio," U.S. Army Corp of Engineers, Waterways Experiment Station, Wetlands Research Program Technical Report WRP-DE-8.

Brower, J. E., et. al., 1990, Field and Laboratory Methods for General Ecology, Third Ed., William C. Brown Publishers, Dubuque, IA.

Lessard, G., 1998, "An Adaptive Management Approach to Planning and Decision Making," Landscape and Urban Planning, Volume 40, pages 81-87.

Mack, J., 2001, personal communication.

National Oceanic and Atmospheric Agency (NOAA), 2001, National Climate Prediction Center Website, http://www.cpc.ncep.noaa.gov.

Packard, S., Mutel, C. F., 1997, The Tallgrass Restoration Handbook, Society for Ecological Restoration, Island Press, Washington, D.C.

Styer, D., 2001, personal communication.

U.S. Army Corp of Engineers, 1987, Wetlands Delineation Manual, Wetlands Research Program, Technical Report Y-87-1, Waterways Experiment Station, Vicksburg, MS.

U.S. Department of Agriculture, 2001, PLANTS Database website, http://plants.usda.gov/.

U.S. Department of Energy, 1998, "Work Plan for Ecological Restoration Research Grants for Operable Unit 4 Supplemental Project," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 1999, "Conceptual Wetland Mitigation Plan for the Area 1, Phase I Mitigation Site," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2000, "Area 8, Phase II Natural Resource Restoration Design Plan," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2001a, "Wetland Monitoring Report for the Year 2000, Area 1, Phase I Wetland Mitigation Project," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2001b, "Area 8, Phase II Natural Resource Restoration Project Completion and Lessons Learned Report," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2001c, "2000 Annual Report for Area 8, Phase I Revegetation Research Plots," Final, Miami University Task Order 12, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2002a, "Natural Resource Restoration Plan," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2002b, "Natural Resource Impact Assessment," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 2002c, "Fernald Environmental Management Project Site Deer Management Plan," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

# APPENDIX A

# A1PI WETLAND MITIGATION PROJECT DATA

**TABLE A-1**
**A1PI WETLAND MITIGATION PROJECT VEGETATION SURVIVAL DATA**

| Location | | Initial Planting | | 2000 Counts | | | | | Replant Data | | | 2001 Counts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patch | Basin | No. Individuals Planned | No. Individuals Planted in 1999 | No. Alive | No. Dead | No. Resprout | Survival Rate Based on No. Planted (%) | Survival Rate Based on No. Planned (%) | Total Individuals Planted in Fall 2000 | Total Individuals Planted and Alive 1999-2000 | Total Individuals Planted in Spring 2001 | 2001 Baseline | No. Alive | No. Dead | No. Resprout | Survival Rate Based on 2001 Baseline (%) | Survival Rate Based on # Planned (%) |
| UF1 | upland | 13 | 9 | 6 | 3 | 0 | 67 | 46 | 5 | 11 | | 51 | 9 | 1 | 3 | 18 | 69 |
| UF2 | upland | 48 | 36 | 10 | 26 | 6 | 28 | 21 | | 10 | | 21 | 11 | 4 | 5 | 53 | 23 |
| UF3 | upland | 35 | 19 | 8 | 11 | 6 | 42 | 23 | 16 | 24 | | 39 | 21 | 7 | 4 | 54 | 60 |
| UF4 | upland | 13 | 13 | 11 | 2 | 0 | 85 | 85 | 5 | 16 | | 90 | 7 | 5 | 3 | 8 | 54 |
| UF5 | upland | 26 | 27 | 16 | 11 | 5 | 59 | 62 | 5 | 21 | | 67 | 22 | 1 | 1 | 33 | 85 |
| UF6 | upland | 26 | 26 | 22 | 4 | 3 | 85 | 85 | | 22 | | 85 | 14 | 5 | 3 | 17 | 54 |
| UF7 | upland | 52 | 56 | 41 | 15 | 5 | 73 | 79 | 3 | 44 | | 82 | 25 | 15 | 4 | 31 | 48 |
| UF8 | upland | 39 | 39 | 28 | 11 | 2 | 72 | 72 | | 28 | | 72 | 24 | 4 | 1 | 33 | 62 |
| UF9 | upland | 78 | 79 | 56 | 23 | 6 | 71 | 72 | | 56 | | 72 | 47 | 12 | 5 | 65 | 60 |
| UF10 | upland | 13 | 13 | 3 | 10 | 1 | 23 | 23 | 8 | 11 | | 31 | 11 | 1 | 1 | 35 | 85 |
| UF11 | upland | 61 | 63 | 37 | 26 | 9 | 59 | 61 | 27 | 64 | | 88 | 61 | 7 | 3 | 70 | 100 |
| UF12 | upland | 70 | 68 | 39 | 29 | 13 | 57 | 56 | | 39 | | 56 | 38 | 6 | 0 | 68 | 54 |
| UF13 | upland | 57 | 50 | 31 | 19 | 2 | 62 | 54 | | 31 | | 54 | 28 | 3 | 1 | 51 | 49 |
| UF14 | upland | 52 | 54 | 15 | 39 | 9 | 28 | 29 | 30 | 45 | | 59 | 46 | 2 | 3 | 78 | 88 |
| UF15 | upland | 35 | 24 | 20 | 4 | 0 | 83 | 57 | | 20 | | 57 | 19 | 1 | 0 | 33 | 54 |
| UF16 | upland | 9 | 6 | 3 | 3 | 0 | 50 | 33 | 5 | 8 | | 38 | 8 | 0 | 0 | 21 | 89 |
| Upland Forest Summar | | 627 | 582 | 346 | 236 | 67 | 59 | 55 | 104 | 450 | | 960 | 391 | 74 | 37 | 41 | 62 |
| US1 | upland | 14 | 14 | 13 | 1 | 0 | 93 | 93 | | 13 | | 93 | 11 | 2 | 0 | 12 | 79 |
| US2 | upland | 41 | 35 | 18 | 17 | 3 | 51 | 44 | | 18 | | 44 | 16 | 4 | 1 | 36 | 39 |
| US3 | upland | 135 | 116 | 64 | 52 | 6 | 55 | 47 | | 64 | | 47 | 55 | 8 | 11 | 116 | 41 |
| US4 | upland | 14 | 15 | 12 | 3 | 1 | 80 | 86 | | 12 | | 86 | 12 | 2 | 0 | 14 | 86 |
| US5 | upland | 27 | 27 | 16 | 11 | 5 | 59 | 59 | | 16 | | 59 | 11 | 5 | 3 | 19 | 41 |
| US6 | upland | 14 | 10 | 9 | 1 | 0 | 90 | 64 | | 9 | | 64 | 5 | 2 | 2 | 8 | 36 |
| US7 | upland | 27 | 21 | 10 | 11 | 2 | 48 | 37 | 13 | 23 | 4 | 50 | 15 | 4 | 5 | 30 | 56 |
| US8 | upland | 27 | 25 | 14 | 11 | 7 | 56 | 52 | 16 | 30 | | 68 | 22 | 2 | 5 | 32 | 81 |
| US9 | upland | 14 | 14 | 6 | 8 | 0 | 43 | 43 | | 6 | | 43 | 3 | 2 | 1 | 7 | 21 |
| US10 | upland | 14 | 14 | 4 | 10 | 3 | 29 | 29 | | 4 | | 29 | 2 | -- | 2 | 7 | 14 |
| US11 | upland | 81 | 57 | 29 | 28 | 7 | 51 | 36 | 25 | 54 | | 61 | 46 | 6 | 3 | 76 | 57 |
| US12 | upland | 54 | 44 | 30 | 14 | 2 | 68 | 56 | | 30 | | 56 | 23 | 4 | 2 | 41 | 43 |
| US13 | upland | 54 | 43 | 21 | 22 | 3 | 49 | 39 | 16 | 37 | 3 | 55 | 36 | 7 | 3 | 66 | 67 |
| US14 | upland | 54 | 41 | 18 | 23 | 3 | 44 | 33 | 11 | 29 | 5 | 44 | 22 | 7 | 3 | 50 | 41 |
| US15 | upland | 27 | 16 | 13 | 3 | 2 | 81 | 48 | | 13 | | 48 | 10 | 1 | 3 | 21 | 37 |
| US16 | upland | 27 | 26 | 24 | 2 | 2 | 92 | 89 | | 24 | | 89 | 22 | 3 | 1 | 25 | 81 |
| US17 | upland | 81 | 63 | 44 | 19 | 4 | 70 | 54 | 9 | 53 | 5 | 63 | 51 | 4 | 5 | 81 | 63 |
| US18 | upland | 81 | 59 | 44 | 15 | 3 | 75 | 54 | 16 | 60 | 9 | 70 | 53 | 17 | 3 | 75 | 65 |
| US19 | upland | 27 | 20 | 18 | 2 | 1 | 90 | 67 | | 18 | | 67 | 16 | 1 | 2 | 24 | 59 |
| US20 | upland | 68 | 65 | 54 | 11 | 6 | 83 | 79 | | 54 | | 79 | 37 | 15 | 7 | 47 | 54 |
| US21 | upland | 54 | 52 | 39 | 13 | 7 | 75 | 72 | | 39 | | 72 | 35 | 8 | 2 | 48 | 65 |
| US22 | upland | 54 | 54 | 47 | 7 | 2 | 87 | 87 | | 47 | | 87 | 37 | 10 | 2 | 43 | 69 |

TABLE A-1
A1PI WETLAND MITIGATION PROJECT VEGETATION SURVIVAL DATA

| Location | | Initial Planting | | 2000 Counts | | | | | Replant Data | | | 2001 Counts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patch | Basin | No. Individuals Planned | No. Individuals Planted in 1999 | No. Alive | No. Dead | No. Resprout | Survival Rate Based on No. Planted (%) | Survival Rate Based on No. Planned (%) | Total Individuals Planted in Fall 2000 | Total Individuals Planted and Alive 1999-2000 | Total Individuals Planted in Spring 2001 | 2001 Baseline | No. Alive | No. Dead | No. Resprout | Survival Rate Based on 2001 Baseline (%) | Survival Rate Based on # Planned (%) |
| US23 | upland | 41 | 37 | 31 | 6 | 2 | 84 | 76 | | 31 | | 76 | 29 | 3 | 2 | 38 | 71 |
| US24 | upland | 27 | 23 | 19 | 4 | 1 | 83 | 70 | | 19 | | 70 | 16 | 1 | 2 | 23 | 59 |
| US25 | upland | 54 | 51 | 34 | 17 | 6 | 67 | 63 | 8 | 42 | 3 | 71 | 42 | 3 | 0 | 59 | 78 |
| US26 | upland | 41 | 34 | 23 | 11 | 6 | 68 | 56 | 6 | 29 | 6 | 62 | 27 | 9 | 0 | 43 | 66 |
| US27 | upland | 54 | 51 | 35 | 16 | 6 | 69 | 65 | 9 | 44 | 2 | 74 | 52 | 4 | 0 | 70 | 96 |
| US28 | upland | 108 | 90 | 51 | 39 | 6 | 57 | 47 | 29 | 80 | 11 | 76 | 82 | 12 | 5 | 108 | 76 |
| US29 | upland | 27 | 21 | 19 | 2 | 0 | 90 | 70 | 17 | 36 | 14 | 87 | 36 | 6 | 0 | 41 | 133 |
| US30 | upland | 54 | 47 | 23 | 24 | 2 | 49 | 43 | 21 | 44 | | 64 | 41 | 6 | 2 | 64 | 76 |
| US31 | upland | 54 | 31 | 16 | 15 | 5 | 52 | 30 | 0 | 16 | | 30 | 16 | 11 | 4 | 54 | 30 |
| US32 | upland | 41 | 40 | 38 | 2 | 0 | 95 | 93 | | 38 | | 93 | 38 | 6 | 0 | 41 | 93 |
| US33 | upland | 27 | 25 | 23 | 2 | 1 | 92 | 85 | | 23 | | 85 | 22 | 1 | 2 | 26 | 81 |
| Upland Shrub Summar | | 1517 | 1281 | 859 | 422 | 104 | 67 | 57 | 196 | 1055 | 62 | 2162 | 941 | 176 | 83 | 44 | 62 |
| WF1 | 7 | 22 | 19 | 9 | 10 | 2 | 47 | 41 | 10 | 19 | | 51 | 14 | 0 | 4 | 28 | 64 |
| WF2 | 7 | 17 | 17 | 10 | 7 | 3 | 59 | 59 | 4 | 14 | | 63 | 15 | 1 | 1 | 24 | 88 |
| WF3 | 6 | 35 | 25 | 10 | 15 | 3 | 40 | 29 | 19 | 29 | | 48 | 28 | 3 | 4 | 59 | 80 |
| WF4 | 6 | 35 | 32 | 22 | 10 | 2 | 69 | 63 | 8 | 30 | | 71 | 25 | 1 | 5 | 35 | 71 |
| WF5 | 6 | 30 | 27 | 17 | 10 | 3 | 63 | 57 | 10 | 27 | | 67 | 25 | 1 | 4 | 38 | 83 |
| WF6 | 1 | 26 | 23 | 17 | 6 | 2 | 74 | 65 | | 17 | | 65 | 16 | 1 | 2 | 24 | 62 |
| WF7 | 2 | 39 | 35 | 26 | 9 | 7 | 74 | 67 | 7 | 33 | | 74 | 33 | 3 | 0 | 45 | 85 |
| WF8 | 2 | 30 | 31 | 28 | 3 | 1 | 90 | 93 | | 28 | | 93 | 25 | 2 | 2 | 27 | 83 |
| WF9 | 2 | 39 | 39 | 28 | 11 | 8 | 72 | 72 | 4 | 32 | | 76 | 31 | 2 | 4 | 41 | 79 |
| WF10 | 3 | 30 | 29 | 23 | 6 | 0 | 79 | 77 | 39 | 62 | | 116 | 59 | 5 | 0 | 51 | 197 |
| Wet Forest Summary | | 303 | 277 | 190 | 87 | 31 | 69 | 63 | 101 | 291 | 0 | 723 | 271 | 19 | 26 | 37 | 89 |
| WS1 | 8 | 27 | 24 | 16 | 8 | 6 | 67 | 59 | 7 | 23 | 1 | 66 | 25 | 2 | 2 | 38 | 93 |
| WS2 | 7 | 41 | 21 | 18 | 3 | 1 | 86 | 44 | 16 | 34 | | 60 | 30 | 4 | 2 | 50 | 73 |
| WS3 | 7 | 27 | 27 | 26 | 1 | | 96 | 96 | | 26 | | 96 | 25 | 25 | 2 | 26 | 93 |
| WS4 | 6 | 27 | 26 | 11 | 15 | 11 | 42 | 41 | 18 | 29 | | 59 | 27 | 2 | 13 | 46 | 100 |
| WS5 | 6 | 54 | 54 | 53 | 1 | 0 | 98 | 98 | | 53 | | 98 | 53 | -- | -- | 54 | 98 |
| WS6 | 6 | 27 | 27 | 27 | 0 | 0 | 100 | 100 | | 27 | | 100 | 21 | 2 | 4 | 21 | 78 |
| WS7 | 6 | 27 | 25 | 7 | 18 | 8 | 28 | 26 | 17 | 24 | | 43 | 39 | 7 | 0 | 91 | 144 |
| WS8-A | 1 | 14 | 14 | 14 | 0 | | 100 | 100 | | 14 | | 100 | 14 | 0 | -- | 14 | 100 |
| WS9 | 1 | 162 | 171 | 118 | 53 | 19 | 69 | 73 | 17 | 135 | 1 | 90 | 115 | 17 | 34 | 128 | 71 |
| WS10 | 1 | 54 | 56 | 35 | 21 | 10 | 63 | 65 | 12 | 47 | | 77 | 56 | 4 | 4 | 73 | 104 |
| WS11 | 1 | 14 | 14 | 14 | 0 | | 100 | 100 | | 14 | | 100 | 14 | 0 | -- | 14 | 100 |
| WS12-A | 1 | 27 | 27 | 27 | 0 | | 100 | 100 | | 27 | | 100 | 27 | -- | -- | 27 | 100 |
| WS13 | 5 | 41 | 35 | 18 | 17 | 6 | 51 | 44 | 19 | 37 | | 63 | 20 | 13 | 6 | 32 | 49 |
| WS14 | 5 | 41 | 39 | 19 | 20 | 8 | 49 | 46 | 14 | 33 | 3 | 60 | 20 | 16 | 5 | 33 | 49 |
| WS15 | 2 | 28 | 27 | 25 | 2 | 0 | 93 | 89 | | 25 | | 89 | 20 | 5 | 0 | 22 | 71 |
| WS16-A | 2 | 41 | 41 | 41 | 0 | | 100 | 100 | | 41 | | 100 | 40 | 1 | -- | 40 | 98 |

TABLE A-1
A1PI WETLAND MITIGATION PROJECT VEGETATION SURVIVAL DATA

| Location | | Initial Planting | | 2000 Counts | | | | | Replant Data | | | 2001 Counts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Patch | Basin | No. Individuals Planned | No. Individuals Planted in 1999 | No. Alive | No. Dead | No. Resprout | Survival Rate Based on No. Planted (%) | Survival Rate Based on No. Planned (%) | Total Individuals Planted in Fall 2000 | Total Individuals Planted and Alive 1999-2000 | Total Individuals Planted in Spring 2001 | 2001 Baseline | No. Alive | No. Dead | No. Resprout | Survival Rate Based on 2001 Baseline (%) | Survival Rate Based on # Planned (%) |
| WS17 | 2 | 149 | 147 | 100 | 47 | 16 | 68 | 67 | 23 | 123 | 5 | 90 | 106 | 13 | 23 | 118 | 71 |
| WS18 | 3 | 41 | 38 | 29 | 9 | 6 | 76 | 71 | 9 | 38 | | 80 | 35 | 0 | 8 | 44 | 85 |
| WS19 | 3 | 95 | 75 | 51 | 24 | 17 | 68 | 54 | 50 | 101 | 5 | 104 | 102 | 9 | 15 | 98 | 107 |
| WS20 | 3 | 41 | 33 | 30 | 3 | 2 | 91 | 73 | | 30 | | 73 | 26 | 7 | 0 | 36 | 63 |
| WS21 | 3 | 27 | 27 | 27 | 0 | 0 | 100 | 100 | | 27 | | 100 | 27 | 0 | 0 | 27 | 100 |
| WS22 | 3 | 14 | 14 | 14 | 0 | 0 | 100 | 100 | | 14 | | 100 | 12 | -- | 2 | 12 | 86 |
| WS23 | 4 | 81 | 67 | 55 | 12 | 3 | 82 | 68 | | 55 | | 68 | 57 | 1 | 0 | 84 | 70 |
| WS24 | 4 | 68 | 57 | 51 | 6 | 2 | 89 | 75 | | 51 | | 75 | 52 | 1 | 0 | 69 | 76 |
| WS25 | 4 | 41 | 30 | 28 | 2 | 1 | 93 | 68 | | 28 | | 68 | 22 | 1 | 7 | 32 | 54 |
| WS26 | 4 | 27 | 27 | 26 | 1 | 0 | 96 | 96 | | 26 | | 96 | 26 | 0 | 0 | 27 | 96 |
| WS27 | 4 | 54 | 44 | 31 | 13 | 0 | 70 | 57 | 12 | 43 | 2 | 69 | 45 | 2 | 2 | 65 | 83 |
| Wet Shrub Summary | | 1290 | 1187 | 911 | 276 | 116 | 77 | 71 | 214 | 1125 | 17 | 2225 | 1056 | 132 | 129 | 47 | 82 |
| Total | | 6184 | 5467 | 3701 | 1766 | 520 | 68 | 60 | 1016 | 4717 | 141 | 9915 | 4262 | 670 | 421 | 43 | 69 |

▒▒▒ Denotes plots that have been replanted.

**TABLE A-2**
**A1PI WETLAND MITIGATION PROJECT HERBACEOUS COVER DATA**

| Basin | Quadrat | Survey Date | Percent Cover | Percent Native Cover | Cover Class Total | Species Total | Hydrophytic Vegetation Present? | Modified Simpson's Index | Average CC | FQAI |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Wet-1-A-1 | 07/23/2001 | 85 | 85 | 16 | 11 | yes | 17.14 | 2.64 | 8.74 |
| 1 | Wet-1-A-2 | 07/23/2001 | 85 | 100 | 14 | 8 | yes | 9.10 | 2.38 | 6.72 |
| 1 | Wet-1-A-3 | 07/23/2001 | 100 | 40 | 20 | 14 | no | 27.14 | 1.23 | 4.61 |
| 2 | Wet-2-A-1 | 07/23/2001 | 95 | 23 | 16 | 10 | no | 12.00 | 0.50 | 1.58 |
| 2 | Wet-2-A-2 | 07/24/2001 | 70 | 25 | 17 | 10 | no | 15.11 | 1.00 | 3.16 |
| 2 | Wet-2-A-3 | 07/24/2001 | 100 | 44 | 22 | 16 | no | 28.88 | 2.21 | 8.86 |
| 3 | Wet-3-A-1 | 07/25/2001 | 80 | 11 | 10 | 6 | no | 4.50 | 1.00 | 2.45 |
| 3 | Wet-3-A-2 | 07/25/2001 | 80 | 27 | 14 | 9 | no | 13.00 | 1.13 | 3.38 |
| 3 | Wet-3-A-3 | 07/25/2001 | 100 | 25 | 15 | 9 | no | 8.75 | 1.00 | 3.00 |
| 4 | Wet-4-A-1 | 07/25/2001 | 95 | 11 | 11 | 7 | no | 7.86 | 0.29 | 0.76 |
| 4 | Wet-4-A-2 | 07/25/2001 | 95 | 67 | 18 | 12 | yes | 25.50 | 2.91 | 10.08 |
| 4 | Wet-4-A-3 | 07/25/2001 | 100 | 36 | 19 | 12 | yes | 19.00 | 2.00 | 6.93 |
| 5 | Wet-5-A-1 | 07/25/2001 | 5 | 0 | 1 | 1 | no | 0.00 | 0.00 | 0.00 |
| 5 | Wet-5-A-2 | 07/25/2001 | 10 | 50 | 2 | 2 | no | 0.00 | 2.00 | 2.83 |
| 5 | Wet-5-A-3 | 07/25/2001 | 70 | 33 | 12 | 8 | yes | 13.20 | 2.40 | 6.79 |
| 6 | Wet-6-A-1 | 07/25/2001 | 80 | 62 | 18 | 10 | yes | 13.91 | 2.50 | 7.91 |
| 6 | Wet-6-A-2 | 07/25/2001 | 90 | 33 | 22 | 14 | no | 25.67 | 1.15 | 4.32 |
| 6 | Wet-6-A-3 | 07/25/2001 | 100 | 64 | 19 | 12 | yes | 14.00 | 1.91 | 6.61 |
| 6 | Wet-6-A-4 | 07/25/2001 | 95 | 78 | 13 | 7 | yes | 8.67 | 2.67 | 7.06 |
| 7 | Wet-7-A-1 | 07/25/2001 | 100 | 18 | 17 | 9 | no | 12.36 | 0.63 | 1.88 |
| 7 | Wet-7-A-2 | 07/25/2001 | 100 | 40 | 21 | 15 | no | 26.25 | 2.00 | 7.75 |
| 7 | Wet-7-A-3 | 07/26/2001 | 95 | 60 | 15 | 9 | yes | 15.00 | 2.63 | 7.88 |
| 8 | Wet-8-A-1 | 07/26/2001 | 95 | 25 | 17 | 10 | no | 10.46 | 1.25 | 3.95 |
| 8 | Wet-8-A-2 | 07/26/2001 | 95 | 27 | 20 | 15 | no | 38.00 | 0.62 | 2.38 |
| 8 | Wet-8-A-3 | 07/26/2001 | 100 | 25 | 18 | 14 | no | 13.91 | 1.31 | 4.89 |
| upland | UP-A-1 | 08/20/2001 | 75 | 47 | 18 | 14 | no | 30.60 | 2.00 | 7.48 |
| upland | UP-A-2 | 08/20/2001 | 95 | 15 | 17 | 10 | no | 10.46 | 1.25 | 3.95 |
| upland | UP-A-3 | 08/20/2001 | 100 | 33 | 18 | 12 | no | 12.75 | 1.75 | 6.06 |
| upland | UP-A-4 | 08/20/2001 | 100 | 33 | 16 | 9 | no | 17.14 | 1.75 | 5.25 |
| upland | UP-A-5 | 08/20/2001 | 100 | 7 | 20 | 11 | no | 14.62 | 0.55 | 1.81 |

CC = Coefficient of Conservatism

FQAI = Floristic Quality Assessment Index

# APPENDIX B

# A8PII FOREST DEMONSTRATION PROJECT DATA

TABLE B-1
A8PII FOREST DEMONSTRATION PROJECT
VEGETATION SURVIVAL AND REPLANT DATA

| Patch | No. Planted | No. Alive | No. Resprout | No. Dead | No. Missing | Percent Survival | Replant Amount |
|---|---|---|---|---|---|---|---|
| RP1 | 30 | 25 | 4 | 1 | 0 | 83% | |
| RP2 | 106 | 87 | 9 | 7 | 3 | 82% | |
| RP3 | 43 | 27 | 5 | 2 | 9 | 63% | 10 |
| RP4 | 16 | 7 | 3 | 6 | 0 | 44% | 7 |
| RP5 | 46 | 41 | 2 | 3 | 0 | 89% | |
| MM8 | 67 | 62 | 3 | 2 | 0 | 93% | |
| MM9 | 48 | 42 | 2 | 4 | 0 | 88% | |
| MM10 | 79 | 67 | 4 | 2 | 6 | 85% | |
| MM11 | 49 | 43 | 0 | 3 | 3 | 88% | |
| MM12 | 69 | 55 | 6 | 3 | 5 | 80% | |
| MM13 | 50 | 40 | 3 | 5 | 2 | 80% | |
| MM14 | 70 | 58 | 5 | 2 | 5 | 83% | |
| MM19 | 64 | 54 | 5 | 1 | 4 | 84% | |
| MM20 | 40 | 33 | 2 | 5 | 0 | 83% | |
| MM21 | 74 | 60 | 6 | 7 | 1 | 81% | |
| MM22 | 48 | 35 | 8 | 2 | 3 | 73% | 6 |
| BS23 | 70 | 63 | 0 | 3 | 4 | 90% | |
| BS24 | 42 | 35 | 2 | 3 | 2 | 83% | |
| BS25 | 75 | 62 | 4 | 6 | 3 | 83% | |
| BS26 | 38 | 31 | 3 | 3 | 1 | 82% | |
| BS27 | 63 | 54 | 2 | 3 | 4 | 86% | |
| BS28 | 35 | 30 | 3 | 1 | 1 | 86% | |
| BS29 | 50 | 41 | 4 | 1 | 4 | 82% | |
| BS30 | 36 | 27 | 1 | 1 | 7 | 75% | 3 |
| OS1 | 69 | 49 | 5 | 9 | 6 | 71% | 11 |
| OS2 | 62 | 51 | 4 | 3 | 4 | 82% | |
| OS3 | 79 | 66 | 1 | 10 | 2 | 84% | |
| OS4 | 58 | 49 | 2 | 5 | 2 | 84% | |
| SV1 | 12 | 7 | 0 | 0 | 5 | 58% | 2 |
| SV2 | 16 | 8 | 0 | 2 | 6 | 50% | 5 |
| SV3 | 16 | 4 | 1 | 1 | 10 | 25% | 8 |
| SV4 | 18 | 14 | 0 | 4 | 0 | 78% | 1 |
| SV5 | 10 | 6 | 1 | 2 | 1 | 60% | 3 |
| SV6 | 22 | 13 | 1 | 2 | 6 | 59% | 6 |
| SV7 | 22 | 11 | 3 | 4 | 4 | 50% | 8 |
| SV8 | 13 | 10 | 0 | 1 | 2 | 77% | 1 |
| SV9 | 16 | 9 | 0 | 3 | 4 | 56% | 5 |
| SV10 | 13 | 4 | 2 | 2 | 5 | 31% | 7 |
| BF31 | 60 | 50 | 0 | 8 | 2 | 83% | |
| **Totals =** | **1,794** | **1,430** | **106** | **132** | **126** | **80%** | **83** |

**TABLE B-2**
**A8PII FOREST DEMONSTRATION PROJECT**
**HERBACEOUS COVER DATA**

| Area | Quadrat | Survey Date | Cover Class | Percent Native Cover | Species Total | Modified Simpson's Index | Average CC | FQAI |
|---|---|---|---|---|---|---|---|---|
| Oak-Maple Habitat Type | A8P2-1-1 | 07/17/2001 | 5 | 27 | 14 | 25.3 | 0.62 | 2.3 |
| | A8P2-1-2 | 07/17/2001 | 5 | 0 | 9 | 9.23 | 0 | 0 |
| | A8P2-1-3 | 07/17/2001 | 5 | 67 | 14 | 17.25 | 3 | 11.22 |
| | A8P2-1-4 | 07/18/2001 | 5 | 44 | 17 | 34.5 | 1.63 | 6.7 |
| Savanna Habitat Type | A8P2-2a-1 | 07/18/2001 | 5 | 33 | 3 | 2.1 | 1.67 | 2.89 |
| | A8P2-2a-2 | 07/18/2001 | 5 | 54 | 12 | 21.38 | 1.27 | 4.41 |
| | A8P2-2b-1 | 07/18/2001 | 5 | 50 | 18 | 57.75 | 1.71 | 7.24 |
| | A8P2-2b-2 | 07/18/2001 | 5 | 27 | 11 | 26.25 | 2 | 6.63 |
| Wetland Area | A8P2-3a-1 | 07/18/2001 | 5 | 50 | 13 | 25.5 | 1.85 | 6.66 |
| | A8P2-3b-1 | 07/18/2001 | 5 | 47 | 11 | 11.4 | 1.5 | 4.97 |
| | A8P2-3b-2 | 07/18/2001 | 5 | 46 | 10 | 12 | 1.11 | 3.51 |
| | A8P2-3c-1 | 07/18/2001 | 5 | 53 | 14 | 34 | 1.93 | 7.22 |
| Drainage Swales, Berms, and the Materials Handling Area | A8P2-4c-1 | 07/18/2001 | 5 | 59 | 13 | 13.57 | 3.67 | 13.22 |
| | A8P2-4a-1 | 07/18/2001 | 5 | 86 | 11 | 11.83 | 4.78 | 15.85 |
| | A8P2-4b-1 | 07/18/2001 | 5 | 43 | 20 | 30 | 2.42 | 10.81 |
| | A8P2-4b-2 | 07/18/2001 | 4 | 45 | 10 | 17.14 | 2.11 | 6.68 |

CC = Coefficient of Conservatism
FQAI = Floristic Quality Assessment Index

# APPENDIX C

# FUNCTIONAL PHASE MONITORING DATA

**TABLE C-1**
**GRAZED PASTURE BASELINE SPECIES LIST**

| Herbaceous Species | Common Name | Type | CC | Avg. Cover |
|---|---|---|---|---|
| *Acalypha rhomboidea* | three-seeded mercury | Forb | 0 | 0.15 |
| *Achillea millefolium* | yarrow | Forb | 0 | 0.1 |
| *Ambrosia artemisiifolia* | common ragweed | Forb | 0 | 0.05 |
| *Capsella bursa-pastoris* | shepard's purse | Forb | 0 | 0.3 |
| *Cerastium vulgatum* | mouse-ear chickweed | Forb | 0 | 0.3 |
| *Ceratium arvense* | field chickweed | Forb | 2 | 0.05 |
| *Erigeron philadephicus* | fleabane | Forb | 2 | 0.05 |
| *Lactuca scariola* | prickly lettuce | Forb | 0 | 0.05 |
| *Lobelia inflata* | Indian tobacco | Forb | 1 | 0.05 |
| *Lysimachia nummularia* | moneywort | Forb | 0 | 0.05 |
| *Medicago lupulina* | black medic | Forb | 0 | 0.25 |
| *Oxalis stricta* | yellow woodsorrel | Forb | 0 | 0.1 |
| *Plantago lanceolata* | English plantain | Forb | 0 | 1.2 |
| *Plantago major* | common plantain | Forb | 0 | 0.1 |
| *Plantago rugelli* | red-stemmed plantain | Forb | 0 | 0.05 |
| *Sida spinosa* | prickly mallow | Forb | 0 | 0.05 |
| *Solanum carolinense* | horse nettle | Forb | 0 | 0.4 |
| *Taraxacum officinale* | dandelion | Forb | 0 | 1.6 |
| *Trifolium pratense* | red clover | Forb | 0 | 0.2 |
| *Trifolium repens* | white clover | Forb | 0 | 2.15 |
| *Vernonia gigantea* | giant ironweed | Forb | 3 | 0.75 |
| *Viola sororia* | common blue violet | Forb | 2 | 0.05 |
| *Agrostis gigantea* | redtop | Grass | 0 | 0.6 |
| *Echinochloa crusgalli* | barnyardgrass | Grass | 0 | 0.05 |
| *Festuca rubra* | red fescue | Grass | 0 | 1.8 |
| *Muhlenbergia schreberi* | nimblewill | Grass | 1 | 0.05 |
| *Phleum pratense* | timothy grass | Grass | 0 | 0.55 |
| *Poa spp.* | bluegrass | Grass | 0 | 0.7 |
| *Setaria glauca* | yellow foxtail | Grass | 0 | 0.05 |
| | grasses (mowed) | Grass | 0 | 2.25 |
| *Juncus tenius* | slender rush | Sedge | 1 | 0.3 |
| *Acer negundo* | box elder | Seedling | 3 | 0.2 |
| *Glechoma hederacea* | ground ivy | Vine | 0 | 0.6 |

CC = Coefficient of Conservatism
Avg. Cover = Summed cover class estimates divided by 20 (the total number of quadrats sampled)

## TABLE C-2
## RIPARIAN BASELINE SPECIES LIST

| Herbaceous Species | Common Name | Type | CC | Avg.Cover |
|---|---|---|---|---|
| *Allaria petiolata* | garlic mustard | forb | 0 | 0.6 |
| *Ambrosia artemisifolia* | common ragweed | forb | 0 | 0.05 |
| *Asarum canadense* | wild ginger | forb | 7 | 0.15 |
| *Boehmeria cylindrica* | false nettle | forb | 4 | 1.25 |
| *Cryptotaenia canadensis* | honewort | forb | 3 | 0.35 |
| *Desmodium canadense* | panicled tick trefoil | forb | 5 | 0.05 |
| *Eupatorium rugosum* | white snakeroot | forb | 4 | 2.3 |
| *Geum vernum* | spring avens | forb | 4 | 0.05 |
| *Pilea pumila* | clearweed | forb | 4 | 0.4 |
| *Polygonum persicaria* | spotted lady's thumb | forb | 0 | 0.4 |
| *Sanicula canadensis* | short-styled black snakeroot | forb | 4 | 0.65 |
| *Saponaria officinalis* | bouncing bet | forb | 0 | 0.1 |
| *Sida spiniosa* | prickly mallow | forb | 0 | 0.05 |
| *Smilax hispida* | bristly greenbrieer | forb | 5 | 0.1 |
| *Viola sororia* | common blue violet | forb | 2 | 0.65 |
| *Triticum aestivum* | wheat | grass | 0 | 0.8 |
| | unknown grass | grass | na | 0.2 |
| *Acer negundo* | box elder | seedling | 3 | 0.3 |
| *Fraxinus spp.* | ash spp. | seedling | na | 0.1 |
| *Lonicera maackii* | honeysuckle | seedling | 0 | 0.3 |
| *Platanus occidentalis* | sycamore | seedling | 7 | 0.05 |
| *Prunus serotina* | black cherry | seedling | 3 | 0.05 |
| *Rosa multiflora* | multiflora rose | seedling | 0 | 0.05 |
| *Ulmus americana* | american elm | seedling | 1 | 0.05 |
| *Ulmus spp.* | elm spp. | seedling | na | 0.05 |
| *Glechoma hederacea* | ground Ivy | vine | 0 | 1.45 |
| *Lonicera japonica* | vine honeysucke | vine | 0 | 0.05 |
| *Lysimachia nummularia* | moneywort | vine | 0 | 0.4 |
| *Mikania scandens* | climbing hempweed | vine | na | 0.05 |
| *Parthenocissus quinquefolia* | Virginia creeper | vine | 3 | 0.2 |
| *Toxicodendron radicans* | poison ivy | vine | 1 | 0.4 |

| Woody Species | Common Name | Type | CC | Avg. dbh | Abundance |
|---|---|---|---|---|---|
| *Lonicera maackii* | amur honeysuckle | shrub | 0 | na | 79 |
| *Rosa multiflora* | multiflora rose | shrub | 0 | na | 1 |
| *Acer negundo* | box elder | tree | 3 | 10.1 | 91 |
| *Aesculus glabra* | Ohio buckeye | tree | 6 | 6.1 | 33 |
| *Asimina triloba* | pawpaw | tree | 6 | na | 2 |
| *Celtis occidentalis* | hackberry | tree | 6 | 10.9 | 17 |
| *Cercis canandensis* | redbud | tree | 0 | 15.55 | 2 |
| *Fraxinus pennsylvanica* | green ash | tree | 6 | 4.85 | 12 |
| *Fraxinus quadrangulata* | blue ash | tree | 8 | 4.4 | 4 |
| *Gleditsia triacanthos* | honey locust | tree | 1 | 31.45 | 3 |
| *Juglans nigra* | black walnut | tree | 5 | 21.7 | 16 |
| *Maclura pomifera* | osage orange | tree | 0 | 12.0 | 5 |
| *Plantanus occidentalis* | sycamore | tree | 7 | 16.8 | 32 |
| *Populus deltoides* | cottonwood | tree | 5 | 13.50 | 1 |
| *Prunus serotina* | black cherry | tree | 3 | 9.8 | 9 |
| *Quercus macrocarpa* | bur oak | tree | 5 | 19.7 | 4 |
| *Robinia pseudoacacia* | black locust | tree | 0 | 18.6 | 10 |
| *Tilia americana* | American basswood | tree | 6 | 32.0 | 1 |
| *Ulmus americana* | American elm | tree | 1 | 19.5 | 7 |
| *Ulmus rubra* | slippery elm | tree | 2 | 2.5 | 1 |

CC = Coefficient of Conservatism

Avg. Cover = Summed cover class estimates divided by 20 (the total number of quadrats sampled)

Avg. dbh = Averaged Diameter at Breast Height measurement

TABLE C-3
SUCCESSIONAL WOODLOT BASELINE SPECIES LIST

| Herbaceous Species | Common Name | Type | CC | Avg. Cover |
|---|---|---|---|---|
| *Agrimonia parriflora* | harvest lice | forb | 2 | 0.05 |
| *Allaria petiolata* | garlic mustard | forb | 0 | 0.25 |
| *Aster pilosus* | heath aster | forb | 1 | 0.15 |
| *Bidens bipinnata* | Spanish needles | forb | 3 | 0.05 |
| *Chenopodium album* | lambsquarter | forb | 0 | 0.3 |
| *Cryptotaenia canadensis* | honewort | forb | 3 | 0.35 |
| *Eupatorium rugosum* | white snakeroot | forb | 4 | 1.45 |
| *Galium triflorum* | three-petal bedstraw | forb | 5 | 0.2 |
| *Geum vernum* | spring avens | forb | 4 | 0.45 |
| *Impatiens capensis* | touch-me-not | forb | 2 | 0.1 |
| *Lysimachia nummularia* | moneywort | forb | 0 | 0.45 |
| *Oxalis stricta* | yellowood sorrel | forb | 0 | 0.1 |
| *Pilea pumila* | clearweed | forb | 4 | 0.3 |
| *Polygonum persicaria* | spotted ladysthumb | forb | 0 | 0.3 |
| *Polygonum punctatum* | dotted smartweed | forb | 6 | 0.15 |
| *Sanicula canadensis* | short-styled black snakeroot | forb | 4 | 0.75 |
| *Taraxacum officinalis* | dandelion | forb | 0 | 0.05 |
| *Verbesina alternafolia* | common wing stem | forb | 4 | 0.15 |
| *Viola sororia* | common blue violet | forb | 2 | 0.25 |
| *Agrostis gigantea* | red top | grass | 0 | 0.05 |
| *Festuca spp.* | red fescue | grass | 0 | 0.05 |
| *Leersia virginica* | whitegrass | grass | 3 | 0.4 |
| *Panicum clandestinum* | deer tongue | grass | 3 | 0.05 |
| *Acer negundo* | box elder | seedling | 3 | 0.6 |
| *Acer nigrum* | black maple | seedling | na | 0.1 |
| *Acer saccharinum* | sugar maple | seedling | 3 | 0.05 |
| *Carya cordiformis* | bitternut hickory | seedling | 4 | 0.1 |
| *Cornus racemosa* | gray dogwood | seedling | 2 | 0.05 |
| *Fraxinus americana* | white ash | seedling | 4 | 0.1 |
| *Fraxinus spp.* | ash spp. | seedling | na | 0.4 |
| *Lonicera maackii* | amur honeysuckle | seedling | 0 | 1.05 |
| *Prunus serotina* | black cherry | seedling | 3 | 0.25 |
| *Rosa multiflora* | multiflora rose | seedling | 0 | 1 |
| *Rubus occidentalis* | black raspberry | seedling | 1 | 0.1 |
| *Ulmus americana* | american elm seedling | seedling | 1 | 0.15 |
| *Campsis radicans* | trumpet creeper | vine | 0 | 0.05 |
| *Glechoma hederacea* | ground ivy | vine | 0 | 0.55 |
| *Lonicera japonica* | vine honeysuckle | vine | 0 | 0.05 |
| *Parthenocissus quinquefolia* | Virginia creeper | vine | 3 | 0.5 |
| *Toxicodendron radicans* | poison ivy | vine | 1 | 0.15 |

| Woody Species | Common Name | Type | CC | Avg. dbh (cm) | Abundance |
|---|---|---|---|---|---|
| *Lonicera maackii* | amur honeysuckle | shrub | 0 | na | 162 (est.) |
| *Rosa multiflora* | mulitflora rose | shrub | 0 | na | 157 (est.) |
| *Rubus occidentalis* | black raspberry | shrub | 1 | na | 2 |
| *Acer negundo* | box elder | tree | 3 | 11.85 | 17 |
| *Acer nigrum* | black maple | tree | na | 14.52 | 19 |
| *Acer saccharum* | sugar maple | tree | 3 | 13.94 | 80 |
| *Carya cordiformis* | bitternut hickory | tree | 4 | 4.55 | 2 |
| *Carya laciniosa* | shellbark hickory | tree | 7 | 6.5 | 3 |
| *Celtis occidentalis* | hackberry | tree | 6 | 7.46 | 15 |
| *Cercis canadensis3* | red bud | tree | 0 | 11.5 | 1 |
| *Cornus racemosa* | gray dogwood | tree | 2 | 3.7 | 11 |
| *Fraxinus americana* | white ash | tree | 4 | 11.06 | 5 |
| *Fraxinus pennsylvanica* | green ash | tree | 6 | 38.8 | 1 |
| *Fraxinus spp.* | ash spp. | tree | na | 17.48 | 4 |
| *Juglans nigra* | black walnut | tree | 5 | 18.27 | 7 |
| *Prunus serotina* | black cherry | tree | 3 | 28.63 | 14 |
| *Quercus rubra* | red oak | tree | 7 | 20 | 1 |
| *Quercus shumardii* | shumard oak | tree | na | 39.4 | 1 |
| *Ulmus americana* | american elm | tree | 1 | 13.63 | 25 |
| *Ulmus rubra* | slippery elm | tree | 2 | 14.09 | 11 |

CC = Coefficient of Conservatism
Avg. Cover = Summed cover class estimates divided by 20 (the total number of quadrats sampled)
Avg. dbh = Averaged Diameter at Breast Height measurement

## TABLE C-4
## PINE PLANTATION BASELINE SPECIES LIST

| Herbaceous Species | Common Name | Type | CC | Avg. Cover |
|---|---|---|---|---|
| *Allaria officinalis* | garlic mustard | forb | 0 | 0.85 |
| *Apocynum cannabinum* | Indian hemp | forb | 3 | 0.1 |
| *Eupatorium rugosum* | white snakeroot | forb | 4 | 1.5 |
| *Glechoma hederacea* | ground ivy | forb | 0 | 0.05 |
| *Habenaria lacera* | ragged fringed orchid | forb | 6 | 0.05 |
| *Hackelia virginia* | Virginia stickseed | forb | 2 | 0.05 |
| *Oxalis stricta* | yellowood sorrel | forb | 0 | 0.2 |
| *Phytolacca americana* | pokeweed | forb | 2 | 0.35 |
| *Pilea pumila* | clearweed | forb | 4 | 0.4 |
| *Polygonum pensylvanicum* | knotweed | forb | 1 | 0.05 |
| *Polygonum persicaria* | spotted ladysthumb | forb | 0 | 0.35 |
| *Polygonum punctatum* | dotted smartweed | forb | 6 | 0.4 |
| *Toxicodendron radicans* | poison ivy | forb | 1 | 0.45 |
| *Vernonia gigantea* | giant ironweed | forb | 3 | 0.15 |
| *Viola sororia* | common blue violet | forb | 2 | 0.2 |
| *Digitaria spp.* | crabgrass spp. | grass | 0 | 0.85 |
| *Festuca spp.* | fescue spp. | grass | 0 | 0.25 |
| *Acer negundo* | box elder | seedling | 3 | 0.25 |
| *Celtis occidentalis* | hackberry seedling | seedling | 6 | 0.1 |
| *Fraxinus american* | white ash seedling | seedling | 4 | 0.15 |
| *Lonicera maackii* | amur honeysuckle | seedling | 0 | 0.05 |
| *Prunus serotina* | black cherry seedling | seedling | 3 | 0.05 |
| *Prunus serotina* | black cherry seedling | seedling | 3 | 0.15 |
| *Rosa multiflora* | multiflora rose | seedling | 0 | 0.15 |
| *Rubus occidentalis* | black raspberry | seedling | 1 | 0.35 |
| *Ulmus spp.* | elm seedling | seedling | na | 0.05 |
| *Calystegia sepium* | hedge false bindweed | vine | 1 | 0.15 |
| *Campsis radicans* | trumpet creeper | vine | 0 | 0.15 |
| *Lonicera japonica* | vine honeysuckle | vine | 0 | 0.05 |
| *Mikania scandens* | climbing hempweed | vine | na | 0.1 |
| *Partenocissus quinequefolia* | Virginia creeper | vine | 3 | 0.65 |
| *Vitus riparia* | riverbank grape | vine | 4 | 0.05 |

| Woody Species | Common Name | Type | CC | Avg. dbh | Abundance |
|---|---|---|---|---|---|
| *Lonicera maackii* | amur honeysuckle | shrub | 0 | na | 65 |
| *Rosa multiflora* | multiflora rose | shrub | 0 | na | 7 |
| *Rubus occidentalis* | black raspberry | shrub | 1 | na | 13 |
| *Acer negundo* | box elder | tree | 3 | 9.81 | 7 |
| *Celtis occidentalis* | hackberry | tree | 6 | 2.3 | 2 |
| *Fraxinus americana* | white ash | tree | 4 | 2 | 2 |
| *Fraxinus spp.* | ash spp. | tree | na | 2 | 1 |
| *Juglans nigra* | black walnut | tree | 5 | 20.9 | 1 |
| *Morus rubra* | red mulberry | tree | 6 | 7.53 | 4 |
| *Pinus nigra* | Austrian pine | tree | 0 | 23.95 | 48 |
| *Pinus strobus* | white pine | tree | 6 | 22.96 | 86 |
| *Prunus serotina* | black cherry | tree | 3 | 4.79 | 26 |
| *Quercus shumardii* | shumard oak sapling | tree | na | 2.2 | 1 |
| *Ulmus rubra* | slippery elm | tree | 2 | 3.5 | 1 |

CC = Coefficient of Conservatism

Avg. Cover = Summed cover class estimates divided by 20 (the total number of quadrats sampled)

Avg. dbh = Averaged Diameter at Breast Height measurement

## TABLE C-5
## OPEN WATER BASELINE SPECIES LIST

| Herbaceous Species | Common Name | Type | CC | Avg. Cover |
|---|---|---|---|---|
| *Ambrosia artemisfolia* | common ragweed | forb | 0 | 0.25 |
| *Aster pilosus* | heath aster | forb | 4 | 0.15 |
| *Bidens connata* | swamp beggarticks | forb | 0 | 0.05 |
| *Carduus nutans* | nodding thistle | forb | 0 | 0.05 |
| *Cerastium vulgatum* | mouse-ear chickweed | forb | 0 | 0.05 |
| *Chamaecrista fasciculata* | partridge pea | forb | 3 | 0.3 |
| *Cirisium discolor* | field thistle | forb | 6 | 0.2 |
| *Conyza canadensis* | horseweed | forb | 0 | 0.15 |
| *Daucas carota* | Queen Anne's lace | forb | 0 | 0.15 |
| *Erigeron annuus* | daisy fleabane | forb | 1 | 0.05 |
| *Lactuca scariola* | prickly lettuce | forb | 0 | 0.1 |
| *Medicago lupulina* | black medic | forb | 0 | 0.35 |
| *Plantago lanceolata* | English plantain | forb | 0 | 0.55 |
| *Plantago major* | common plantain | forb | 0 | 0.1 |
| *Polygonum hydropiper* | common smartweed | forb | 3 | 0.25 |
| *Polygonum persicaria* | spotted ladysthumb | forb | 0 | 0.15 |
| *Potentilla canadensis* | Dwarf cinquefoil | forb | 3 | 0.05 |
| *Rumex crispus* | curled dock | forb | 0 | 0.05 |
| *Sida spinosa* | prickly mallow | forb | 0 | 0.4 |
| *Taraxacum officinale* | dandelion | forb | 0 | 0.15 |
| *Trifolium pratense* | red clover | forb | 0 | 0.3 |
| *Trifolium repens* | white clover | forb | 0 | 0.75 |
| *Typha latifolia* | common cattail | forb | 2 | 0.4 |
| *Andropogon gerardi* | big bluestem | grass | 6 | 0.6 |
| *Bromus ciliatus* | fringed brome | grass | 7 | 0.1 |
| *Echinochloa crusgalli* | barnyardgrass | grass | 0 | 1 |
| *Festuca spp.* | fescue spp. | grass | 0 | 0.2 |
| *Panicum clandestinum* | deer tonge | grass | 3 | 0.05 |
| *Panicum virgatum* | switchgrass | grass | 4 | 0.3 |
| *Setaria glauca* | yellow foxtail | grass | 0 | 0.2 |
| *Sorghastrum nutans* | Indian grass | grass | 6 | 0.1 |
| *Triticum aestivum* | wheat | grass | 0 | 0.15 |
| *Cyperus esculentus* | yellow nutsedge | sedge | 2 | 0.25 |
| *Populus deltoides* | cottonwood | seedling | 5 | 0.1 |
| *salix nigra* | black willow | shrub | 3 | 0.25 |
| *Mikania scandens* | climing hempweed | vine | na | 0.05 |

CC = Coefficient of Conservatism

Avg. Cover = Summed cover class estimates divided by 20 (the total number of quadrats sampled)

# APPENDIX D

# A8PI REVEGETATION RESEARCH PLOTS DATA

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| A | 54 | *Aesculus glabra* | 26.4 | A | | 1 | 3 | A | A | 27.1 | | | | X | A | 28.4 | | | 3 | |
| A | 59 | *Aesculus glabra* | 32.9 | A | | | | A | A | 34.0 | | | | | A | 36.4 | | | | |
| A | 77 | *Aesculus glabra* | 27.7 | A | | 1 | 1 | A | A | 27.9 | | | | X | A | 30.4 | | | | |
| A | 78 | *Aesculus glabra* | 30.0 | A | | | | A | A | 31.5 | | | | | A | 38.5 | | | | |
| A | 79 | *Aesculus glabra* | 21.7 | A | | 3 | 3 | A | A | 21.8 | | | 2 | | A | 30.6 | | | 3 | |
| A | 81 | *Aesculus glabra* | 23.0 | A | | 2 | | A | A | 26.2 | | | 2 | | A | 28.2 | | | 2 | |
| A | 90 | *Aesculus glabra* | 20.3 | A | | 1 | | A | A | 23.3 | | | | | A | 27.0 | | | | |
| A | 92 | *Aesculus glabra* | 26.5 | A | | 1 | 2 | A | A | 30.9 | | | | | A | 37.5 | | | 3 | |
| A | 96 | *Aesculus glabra* | 31.6 | A | | 1 | | A | A | 34.1 | | | 3 | | A | 44.5 | | | 3 | |
| A | 97 | *Aesculus glabra* | 33.0 | A | | | | A | A | 33.9 | | | 1 | | A | 38.0 | | | 1 | |
| A | 98 | *Aesculus glabra* | 27.1 | A | | 1 | | A | A | 27.5 | | | | | A | 31.9 | | | | |
| A | 101 | *Aesculus glabra* | 39.9 | A | | | | A | A | 45.8 | | | | | A | 46.1 | | | | |
| A | 103 | *Aesculus glabra* | 21.7 | A | 2 | | | A | A | 22.9 | | | | | A | 23.1 | | | | X |
| A | 105 | *Aesculus glabra* | 23.3 | A | | 1 | | A | A | 32.6 | | | | | A | 33.7 | | | | |
| A | 110 | *Aesculus glabra* | 36.4 | A | | | | A | A | 36.8 | | | | X | A | 38.1 | | | 1 | |
| A | 115 | *Aesculus glabra* | 22.9 | A | | | | A | A | 26.2 | | | | | A | 27.1 | | | 2 | |
| A | 118 | *Aesculus glabra* | 34.8 | A | | | | A | A | 35.6 | | | | | A | 35.7 | | | | |
| A | 138 | *Aesculus glabra* | 21.6 | A | | | | A | A | 27.4 | | | | X | A | 32.7 | | | | |
| A | 142 | *Aesculus glabra* | 20.3 | A | | 1 | | A | A | 23.3 | | | | | A | 23.7 | | | | |
| A | 145 | *Aesculus glabra* | 29.7 | A | | | | A | A | 29.8 | | | | | A | 34.6 | | | | |
| A | 57 | *Celtis occidentalis* | 34.6 | A | | | | A | A | 38.4 | | | | X | A | 38.9 | | | | |
| A | 65 | *Celtis occidentalis* | 32.8 | A | | | | A | A | 34.6 | | | | | A | 37.0 | | | | |
| A | 67 | *Celtis occidentalis* | 31.6 | A | | | | A | A | 32.6 | | | | | A | 33.5 | | | | |
| A | 68 | *Celtis occidentalis* | 34.6 | A | | | | A | A | 36.9 | | | | X | A | 40.3 | | | | |
| A | 82 | *Celtis occidentalis* | 40.0 | A | | | | A | A | 41.2 | | | | | A | 39.8 | | | | |
| A | 85 | *Celtis occidentalis* | 43.2 | D | | | | D | D | | | | | | D | | | | | |
| A | 94 | *Celtis occidentalis* | 29.9 | D | | | | D | D | | | | | | D | | | | | |
| A | 100 | *Celtis occidentalis* | 30.9 | A | | | | A | A | 39.6 | | | | X | A | 38.8 | | | | |
| A | 104 | *Celtis occidentalis* | 38.3 | A | | | | A | A | 38.5 | | | | | A | 38.5 | | | | |
| A | 112 | *Celtis occidentalis* | 34.8 | A | | | | A | A | 34.8 | | | | X | A | 35.5 | | | | X |
| A | 119 | *Celtis occidentalis* | 34.6 | A | | | | A | A | 35.3 | | | | | A | 35.1 | | | | |
| A | 122 | *Celtis occidentalis* | 40.0 | A | | | | A | A | 41.7 | | | | | A | 41.8 | | | | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| A | 126 | *Celtis occidentalis* | 36.4 | A | | | | A | A | 38.9 | | | | X | A | 42.3 | | | | |
| A | 130 | *Celtis occidentalis* | 39.3 | A | | | | A | A | 39.6 | | | | | A | | | | | |
| A | 133 | *Celtis occidentalis* | 29.7 | D | | | | RS | RS | 29.7 | | | | | RS | | | | | |
| A | 135 | *Celtis occidentalis* | 34.5 | A | | | | A | A | 37.2 | | | | | A | 38.1 | | | | |
| A | 136 | *Celtis occidentalis* | 34.5 | A | | | | A | A | 34.5 | | | | | A | 35.7 | | | | |
| A | 146 | *Celtis occidentalis* | 39.8 | A | | | | A | A | 40.1 | | | | | A | 40.6 | | | | |
| A | 147 | *Celtis occidentalis* | 30.2 | A | | | | A | A | 32.4 | | | | | A | 32.8 | | | | |
| A | 150 | *Celtis occidentalis* | 35.0 | A | | | | A | A | 36.4 | | | | X | A | | | | | |
| A | 52 | *Fraxinus pennsylvanicum* | 34.6 | A | | | 1 | RS | RS | | | | | | D | | | | 4 | |
| A | 53 | *Fraxinus pennsylvanicum* | 35.0 | A | | | 4 | RS | RS | | | 3 | | | D | | | | 4 | |
| A | 64 | *Fraxinus pennsylvanicum* | 48.0 | A | | | | RS | | | | 4 | | | D | | | | 4 | |
| A | 70 | *Fraxinus pennsylvanicum* | 36.1 | A | | | 2 | A | A | 36.5 | | | | | D | | | | 4 | |
| A | 74 | *Fraxinus pennsylvanicum* | 38.0 | A | 3 | | | RS | D | | | | | | D | | | | | |
| A | 76 | *Fraxinus pennsylvanicum* | 39.5 | A | 3 | | 1 | A | A | 39.8 | | | | | A | | | | 3 | |
| A | 80 | *Fraxinus pennsylvanicum* | 41.3 | A | | | 2 | A | A | 43.1 | | | | | D | | | | 3 | |
| A | 84 | *Fraxinus pennsylvanicum* | 35.9 | A | | | 3 | A | RS | | | | | | RS | | | | | |
| A | 89 | *Fraxinus pennsylvanicum* | 37.9 | A | | | | RS | D | | | | | | D | | | | | |
| A | 95 | *Fraxinus pennsylvanicum* | 36.6 | A | | | | A | A | 39.4 | | | 3 | | A | 41.4 | | | 3 | |
| A | 102 | *Fraxinus pennsylvanicum* | 48.0 | A | 3 | | | D | D | | | | | | RS | | | | | |
| A | 107 | *Fraxinus pennsylvanicum* | 36.2 | A | 2 | | | RS | D | | | | | | D | | | | | |
| A | 111 | *Fraxinus pennsylvanicum* | 34.8 | A | 3 | | | A | A | 36.8 | | | | | D | | | | | |
| A | 113 | *Fraxinus pennsylvanicum* | 31.8 | A | 4 | | | A | RS | 31.8 | | | | | RS | | 2 | | | |
| A | 123 | *Fraxinus pennsylvanicum* | 49.3 | A | | | 2 | A | A | 49.7 | | | | | A | | | | | |
| A | 124 | *Fraxinus pennsylvanicum* | 39.6 | A | | 1 | | A | A | 40.3 | | | | | RS | | | | | |
| A | 127 | *Fraxinus pennsylvanicum* | 36.7 | A | | | 2 | A | A | 40.7 | | | | | A | 40.3 | | | 3 | |
| A | 134 | *Fraxinus pennsylvanicum* | 34.9 | A | | | 2 | A | A | 37.1 | | | 1 | | A | 37.4 | | | 2 | |
| A | 144 | *Fraxinus pennsylvanicum* | 37.8 | A | | | 2 | A | A | 39.4 | | | | X | A | 40.6 | | | 3 | |
| A | 148 | *Fraxinus pennsylvanicum* | 41.5 | A | | | 2 | A | A | 41.5 | | | | | A | 44.2 | | | 3 | |
| A | 56 | *Juglans nigra* | 32.9 | A | | | | A | A | 36.4 | | | | | A | 36.4 | | | | |
| A | 58 | *Juglans nigra* | 40.0 | A | | | | A | RS | | | | | | A | 42.2 | | | | |
| A | 62 | *Juglans nigra* | 35.0 | A | | | 2 | A | RS | | | 3 | | | A | 35.4 | | | 3 | |
| A | 69 | *Juglans nigra* | 31.4 | A | | | 2 | A | RS | | | 4 | | | D | | | | 4 | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| A | 71 | *Juglans nigra* | 34.6 | D | | | | A | RS | | | 2 | | | RS | | | | 2 | |
| A | 72 | *Juglans nigra* | 37.7 | A | | | | A | RS | | | | | X | D | | | | | X |
| A | 86 | *Juglans nigra* | 33.0 | A | | | | A | A | 35.5 | | | | | A | 37.1 | | | | |
| A | 88 | *Juglans nigra* | 34.8 | D | | | | A | A | 34.8 | | | | | RS | | | | | X |
| A | 91 | *Juglans nigra* | 31.6 | A | | | | A | A | 32.0 | | 2 | | | RS | | | | 2 | |
| A | 93 | *Juglans nigra* | 36.5 | D | | | | A | D | | | | | | D | | | | | |
| A | 99 | *Juglans nigra* | 37.9 | A | | | | A | A | 37.9 | | | | X | A | 41.8 | | | | X |
| A | 108 | *Juglans nigra* | 35.2 | A | | | | A | A | 37.5 | | | | | A | 39.2 | | | | X |
| A | 114 | *Juglans nigra* | 26.6 | A | | | | A | A | 28.7 | | | | | A | 30.0 | | | | X |
| A | 121 | *Juglans nigra* | 31.4 | A | | | | A | A | 33.2 | | | | | A | 36.2 | | | | X |
| A | 125 | *Juglans nigra* | 39.5 | A | | | 3 | A | A | 40.6 | | | | | A | 45.6 | | | | |
| A | 128 | *Juglans nigra* | 36.6 | A | | | | A | A | 38.1 | | | | | A | 40.2 | | | | |
| A | 132 | *Juglans nigra* | 33.3 | A | | | | A | A | 36.1 | | | | X | A | 38.2 | | | | X |
| A | 137 | *Juglans nigra* | 36.2 | A | | | | A | A | 36.5 | | | | X | A | 37.1 | | | | X |
| A | 139 | *Juglans nigra* | 29.5 | A | | | | A | A | 30.3 | | | | | A | 30.6 | | | | X |
| A | 149 | *Juglans nigra* | 36.4 | A | | | | A | A | 39.7 | | | | | A | 40.1 | | | | |
| A | 51 | *Quercus muehlenbergii* | 26.2 | A | | 1 | 3 | RS | RS | | | | | | RS | | | | 4 | |
| A | 55 | *Quercus muehlenbergii* | 26.5 | A | | 2 | 3 | RS | RS | | | 2 | | | RS | | | | 4 | |
| A | 60 | *Quercus muehlenbergii* | 21.5 | A | | 2 | 3 | A | A | 28.1 | | | | X | A | 29.7 | | | 3 | |
| A | 61 | *Quercus muehlenbergii* | 18.5 | A | | 2 | 1 | A | A | 20.6 | | | | X | A | 19.8 | | | 2 | |
| A | 63 | *Quercus muehlenbergii* | 24.7 | A | | | 1 | A | A | 26.0 | | | | X | A | 26.9 | | | 1 | |
| A | 66 | *Quercus muehlenbergii* | 18.3 | A | | 2 | | A | A | 21.5 | | | | X | A | 21.8 | | 2 | 2 | |
| A | 73 | *Quercus muehlenbergii* | 20.3 | A | | 2 | | A | A | 22.1 | | | | | A | 24.1 | | 1 | | |
| A | 75 | *Quercus muehlenbergii* | 18.3 | A | | 2 | | A | A | 19.8 | | | 1 | | RS | | | 2 | 3 | |
| A | 83 | *Quercus muehlenbergii* | 23.1 | A | | 2 | | A | A | 24.1 | | | 3 | | A | 29.2 | | | 2 | |
| A | 87 | *Quercus muehlenbergii* | 19.9 | A | | 3 | | A | A | 23.6 | | | | | A | 24.8 | | | 2 | |
| A | 106 | *Quercus muehlenbergii* | 20.1 | A | | 2 | | A | A | 20.5 | | | | X | A | 24.0 | | | | |
| A | 109 | *Quercus muehlenbergii* | 23.1 | A | | 1 | | A | A | 25.9 | | | | | A | 27.1 | | 1 | | |
| A | 116 | *Quercus muehlenbergii* | 18.3 | A | | 2 | | A | A | 20.0 | | | | X | A | 22.3 | | | 2 | X |
| A | 117 | *Quercus muehlenbergii* | 21.6 | A | | 2 | 2 | A | A | 27.3 | | | | | A | 28.6 | | | 4 | |
| A | 120 | *Quercus muehlenbergii* | 23.1 | A | | 2 | | A | A | 24.1 | | | | | A | 27.4 | | | | X |
| A | 129 | *Quercus muehlenbergii* | 21.8 | A | | 1 | | A | A | 25.6 | | | | | A | 26.2 | | | 2 | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| A | 131 | *Quercus muehlenbergii* | 18.4 | A | | 1 | 1 | A | A | 24.4 | | | | | A | 22.1 | | | 2 | |
| A | 140 | *Quercus muehlenbergii* | 24.6 | A | | 2 | | A | A | 25.9 | | | | X | A | 29.2 | | | | |
| A | 141 | *Quercus muehlenbergii* | 24.6 | A | | 1 | | A | A | 25.4 | | | | | A | 29.2 | | 3 | | |
| A | 143 | *Quercus muehlenbergii* | 23.5 | A | | 2 | 2 | A | RS | 25.7 | | | | X | A | 27.8 | | 3 | 3 | |
| D | 5 | *Aesculus glabra* | 27.8 | A | | | | A | A | 31.2 | | | | | A | 36.3 | | | | |
| D | 12 | *Aesculus glabra* | 31.5 | A | | | | A | A | 31.9 | | | | | A | 34.7 | | | | |
| D | 20 | *Aesculus glabra* | 23.3 | A | | | | A | A | 23.7 | | | 2 | | A | 24.2 | | | 3 | |
| D | 25 | *Aesculus glabra* | 33.0 | A | | | | A | A | 23.4 | 2 | | | | A | 23.9 | | | 2 | X |
| D | 26 | *Aesculus glabra* | 32.9 | A | | | | A | A | 33.8 | | | | | A | 39.3 | | | | |
| D | 27 | *Aesculus glabra* | 24.4 | A | | | | A | A | 24.8 | | | | | A | 24.5 | | | | |
| D | 28 | *Aesculus glabra* | 27.9 | A | | 1 | | A | A | 28.5 | | | 3 | | A | 34.1 | | | 3 | |
| D | 30 | *Aesculus glabra* | 30.9 | A | | | | A | A | 31.2 | | | | X | A | 32.2 | | | 1 | |
| D | 31 | *Aesculus glabra* | 21.6 | A | | 1 | | A | A | 22.8 | | | | | A | 23.2 | | | 1 | |
| D | 42 | *Aesculus glabra* | 21.4 | D | | | 2 | A | A | 21.7 | | | | | RS | | | | 3 | |
| D | 49 | *Aesculus glabra* | 21.6 | A | | 1 | | A | A | 21.9 | | | | | A | 24.6 | | | 1 | |
| D | 1 | *Celtis occidentalis* | 36.1 | D | | | | A | A | 36.9 | | | | | A | 37.8 | | | | |
| D | 2 | *Celtis occidentalis* | 38.8 | A | | | | A | A | 39.6 | | | | | A | 39.6 | | | | |
| D | 3 | *Celtis occidentalis* | 38.2 | A | | | | A | A | 39.5 | | | | | A | 32.9 | | | | |
| D | 13 | *Celtis occidentalis* | 36.4 | D | | | | A | A | 37.2 | | | | X | A | 38.6 | | | | |
| D | 24 | *Celtis occidentalis* | 35.9 | A | | | | A | A | 36.2 | | | | | A | 39.7 | | | | |
| D | 33 | *Celtis occidentalis* | 33.3 | D | | | | A | A | 35.6 | | | | | A | 36.8 | | | | |
| D | 37 | *Celtis occidentalis* | 33.1 | D | | | | A | A | 32.1 | | | | X | RS | | | | | |
| D | 41 | *Celtis occidentalis* | 34.7 | D | | | | A | A | 37.4 | | | | X | A | 39.2 | | | | |
| D | 43 | *Celtis occidentalis* | 34.7 | D | | | | A | A | 35.3 | | | | | A | 36.4 | | | | |
| D | 45 | *Celtis occidentalis* | 41.5 | D | | | | A | D | | | | | | D | | | | | |
| D | 6 | *Fraxinus pennsylvanicum* | 54.3 | A | 3 | | | RS | RS | | | | | | RS | | | | 4 | |
| D | 9 | *Fraxinus pennsylvanicum* | 40.6 | A | | | | A | A | 41.6 | | | | | RS | | | | 4 | |
| D | 10 | *Fraxinus pennsylvanicum* | 36.0 | A | | | | A | A | 36.9 | | | | | A | 38.2 | | | 3 | |
| D | 22 | *Fraxinus pennsylvanicum* | 36.1 | A | 2 | | 3 | A | A | 37.5 | | | | | A | 39.4 | 2 | | 4 | |
| D | 29 | *Fraxinus pennsylvanicum* | 38.0 | A | | | 2 | A | A | 38.8 | | | | | A | 38.7 | 2 | | | |
| D | 32 | *Fraxinus pennsylvanicum* | 43.0 | A | | 1 | 2 | A | A | 44.1 | | | | | A | 45.3 | | | 2 | |
| D | 34 | *Fraxinus pennsylvanicum* | 34.6 | A | | | | A | A | 36.1 | | | | | A | 37.7 | | | | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| D | 38 | *Fraxinus pennsylvanicum* | 42.8 | A | | | | A | A | 44.0 | | | | | A | 46.9 | | | | |
| D | 39 | *Fraxinus pennsylvanicum* | 37.3 | A | | | | A | A | 40.1 | | | | | A | 43.9 | | | | |
| D | 47 | *Fraxinus pennsylvanicum* | 44.5 | D | | | | A | RS | | | 4 | | | D | | | | | |
| D | 4 | *Juglans nigra* | 31.2 | A | | 1 | | A | A | 31.6 | | | | | A | 33.1 | | | | |
| D | 8 | *Juglans nigra* | 38.9 | D | | 2 | | A | A | 39.5 | | | | | A | 38.3 | | | | |
| D | 11 | *Juglans nigra* | 34.6 | A | | | | RS | RS | | | 2 | | | RS | | | | | X |
| D | 15 | *Juglans nigra* | 39.6 | D | | | | D | D | | | | | | DR | | | | | |
| D | 17 | *Juglans nigra* | 40.8 | A | | | | RS | RS | | | 3 | | | RS | | | | | X |
| D | 23 | *Juglans nigra* | 35.8 | D | | | | A | A | 36.4 | | | | | RS | | | | | X |
| D | 35 | *Juglans nigra* | 33.1 | D | | | | D | D | | | | | | D | | | | | X |
| D | 40 | *Juglans nigra* | 33.4 | A | | | | A | RS | | | | | | RS | | | | | |
| D | 44 | *Juglans nigra* | 35.1 | A | | | | RS | RS | | | 2 | | | RS | | | | | |
| D | 48 | *Juglans nigra* | 41.0 | D | | | | A | A | 43.0 | | 4 | | | D | | | | | |
| D | 7 | *Quercus muehlenbergii* | 29.4 | A | | 2 | | A | A | 31.2 | | 1 | | | A | 33.0 | | 1 | | |
| D | 14 | *Quercus muehlenbergii* | 26.2 | A | | 2 | | A | A | 28.0 | | | | | A | 28.6 | | 1 | 1 | |
| D | 16 | *Quercus muehlenbergii* | 29.5 | A | | 2 | | A | A | 30.3 | | | | | A | 30.7 | | | | |
| D | 18 | *Quercus muehlenbergii* | 27.7 | A | | 2 | | A | A | 29.7 | | | | | A | 30.7 | | | | |
| D | 19 | *Quercus muehlenbergii* | 31.1 | A | | 2 | | A | A | 33.0 | | | | | A | 34.0 | | 1 | | |
| D | 21 | *Quercus muehlenbergii* | 26.5 | A | | 2 | | A | A | 26.9 | | | | | A | 28.8 | | 2 | | |
| D | 36 | *Quercus muehlenbergii* | 26.7 | A | | 2 | | A | A | 28.1 | | | | | A | 28.4 | | | 2 | |
| D | 46 | *Quercus muehlenbergii* | 27.9 | A | | 2 | | A | A | 31.1 | | | | | A | 32.2 | | 1 | | |
| D | 50 | *Quercus muehlenbergii* | 24.9 | A | | 2 | 1 | A | A | 26.4 | | | | | A | 27.0 | | 1 | 1 | |
| E | 152 | *Aesculus glabra* | 20.1 | A | | 1 | | A | A | 22.6 | | | | | A | 21.6 | | | | |
| E | 167 | *Aesculus glabra* | 19.9 | A | | 1 | | A | A | 20.1 | | | | | A | 22.2 | | | | |
| E | 171 | *Aesculus glabra* | 20.1 | A | | 1 | | A | A | 21.3 | | | | | A | 21.8 | | | 2 | |
| E | 173 | *Aesculus glabra* | 23.2 | A | | | | A | A | 25.8 | | | 1 | | A | 28.0 | | | | |
| E | 175 | *Aesculus glabra* | 26.7 | A | | 1 | 1 | A | A | 27.8 | | | | | A | 31.1 | | | 1 | |
| E | 177 | *Aesculus glabra* | 21.3 | A | 2 | | | A | A | 24.4 | | | | | A | 28.6 | | | 2 | |
| E | 178 | *Aesculus glabra* | 21.7 | A | | | | A | A | 24.8 | | | | | A | 33.7 | | | | |
| E | 187 | *Aesculus glabra* | 16.8 | A | | | | A | A | 17.5 | | | | | A | 26.3 | | | | |
| E | 189 | *Aesculus glabra* | 18.2 | A | | | | A | A | 18.6 | | | 1 | | A | 22.4 | | | 1 | |
| E | 199 | *Aesculus glabra* | 22.9 | A | | 1 | | A | A | 23.0 | | | | X | A | 32.1 | | | 1 | X |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| E | 156 | *Celtis occidentalis* | 39.7 | A | | | | A | A | 40.3 | | | | | A | 41.5 | | | | |
| E | 157 | *Celtis occidentalis* | 37.9 | A | | | | A | A | 38.5 | | | | | A | 38.8 | | | | |
| E | 160 | *Celtis occidentalis* | 41.0 | D | | | | A | A | 41.9 | | | | X | A | 38.4 | | | | |
| E | 162 | *Celtis occidentalis* | 33.4 | D | | | | A | A | 38.9 | | | | | A | 34.7 | | | | |
| E | 168 | *Celtis occidentalis* | 33.3 | A | | | | A | A | 35.4 | | | | X | A | 36.1 | | | | |
| E | 172 | *Celtis occidentalis* | 33.4 | A | | | | A | A | 33.7 | | | | | A | 33.3 | | | | |
| E | 184 | *Celtis occidentalis* | 34.7 | D | | | | A | A | 34.9 | | | | X | A | 33.8 | 1 | | | |
| E | 196 | *Celtis occidentalis* | 38.1 | A | | | | A | A | 38.1 | | | | | A | 39.8 | | | | |
| E | 198 | *Celtis occidentalis* | 33.0 | D | | | | RS | D | | | | | | D | | | | | |
| E | 200 | *Celtis occidentalis* | 38.0 | A | | | | A | A | 38.9 | | | | | A | 41.4 | | | | |
| E | 154 | *Fraxinus pennsylvanicum* | 38.1 | A | 2 | | | RS | RS | | | 3 | | | D | | 2 | | | |
| E | 161 | *Fraxinus pennsylvanicum* | 39.3 | A | | | | A | A | 39.8 | | | | | A | 41.6 | | | | |
| E | 166 | *Fraxinus pennsylvanicum* | 40.9 | A | | | | A | A | 41.4 | | | | | A | 44.0 | | | | |
| E | 169 | *Fraxinus pennsylvanicum* | 37.8 | A | 1 | | 4 | A | A | 47.2 | | | 1 | | A | 50.4 | | | | |
| E | 170 | *Fraxinus pennsylvanicum* | 37.9 | A | 1 | | 4 | RS | RS | | | | | | RS | | | | 4 | |
| E | 176 | *Fraxinus pennsylvanicum* | 41.2 | A | | | | RS | RS | | | | | | D | | 1 | 2 | 4 | |
| E | 186 | *Fraxinus pennsylvanicum* | 40.9 | A | | | | A | A | 41.3 | | | | | D | | | | 4 | |
| E | 190 | *Fraxinus pennsylvanicum* | 43.2 | A | | | 3 | A | A | 44.2 | | | | | D | | | | | |
| E | 192 | *Fraxinus pennsylvanicum* | 40.0 | A | | | | A | A | 42.3 | | | | | A | | | | 4 | |
| E | 197 | *Fraxinus pennsylvanicum* | 41.5 | A | | | 3 | A | RS | | | | 1 | | RS | | | | | |
| E | 153 | *Juglans nigra* | 36.4 | A | | | | A | A | 36.5 | | | | | A | 38.0 | | | | |
| E | 159 | *Juglans nigra* | 36.5 | A | | | | A | A | 37.7 | | 3 | | | A | | | | | |
| E | 163 | *Juglans nigra* | 36.2 | A | | | | A | A | 37.8 | | | | | A | 38.4 | | 1 | | |
| E | 165 | *Juglans nigra* | 38.0 | A | | | | A | RS | | | | 1 | | RS | | | | | |
| E | 180 | *Juglans nigra* | 39.6 | A | | | | A | RS | 39.6 | | | | | A | 35.5 | | | | |
| E | 182 | *Juglans nigra* | 35.1 | A | | | | D | D | | | | | | D | | | | | |
| E | 185 | *Juglans nigra* | 36.2 | A | | | | A | RS | | | | | | RS | | | | | |
| E | 193 | *Juglans nigra* | 35.0 | D | | | | A | RS | | | | | | RS | | | | | |
| E | 194 | *Juglans nigra* | 38.1 | A | | | | A | A | 40.2 | | | | | A | 42.9 | 1 | | | |
| E | 195 | *Juglans nigra* | 37.9 | A | | | | A | RS | | | 1 | | | RS | | | | | |
| E | 151 | *Quercus muehlenbergii* | 28.1 | A | | 2 | | A | A | 30.0 | | | | X | A | 30.6 | | | 2 | |
| E | 155 | *Quercus muehlenbergii* | 24.9 | A | | | | A | D | | | | | | D | | | | | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| E | 158 | *Quercus muehlenbergii* | 29.8 | A | | 2 | | A | A | 30.5 | | | | | A | 31.3 | 3 | | 1 | |
| E | 164 | *Quercus muehlenbergii* | 34.7 | A | | 1 | | A | A | 34.8 | | | | X | A | 34.9 | | | | |
| E | 174 | *Quercus muehlenbergii* | 20.2 | A | | 2 | | A | A | 21.2 | | | | | A | 23.9 | | | 2 | |
| E | 179 | *Quercus muehlenbergii* | 25.2 | A | | 1 | | A | A | 27.2 | | | | X | A | 27.4 | | | | |
| E | 181 | *Quercus muehlenbergii* | 23.4 | A | | 2 | | A | A | 27.4 | 2 | | | | A | 25.6 | | | 1 | |
| E | 183 | *Quercus muehlenbergii* | 24.6 | A | | 1 | | A | A | 25.5 | 3 | | | | A | 27.8 | | | 1 | |
| E | 188 | *Quercus muehlenbergii* | 23.2 | A | | 2 | | A | A | 24.3 | | | 3 | | A | 32.0 | | | 3 | |
| E | 191 | *Quercus muehlenbergii* | 20.0 | A | | 1 | | A | A | 20.0 | | | 3 | | D | | | 4 | | |
| H | 214 | *Aesculus glabra* | 5.0 | D | | | | D | D | | | | | | | | | | | |
| H | 226 | *Aesculus glabra* | 8.3 | D | | | 4 | D | D | | | | | | | | | | | |
| H | 230 | *Aesculus glabra* | 6.5 | A | | | | A | A | 9.5 | | | | | A | 11.3 | | | | |
| H | 234 | *Aesculus glabra* | 5.3 | A | | | | A | A | 6.2 | | | | | A | 7.7 | | | | |
| H | 242 | *Aesculus glabra* | 4.9 | A | | | | A | A | 5.2 | | | | | D | | | | | |
| H | 250 | *Aesculus glabra* | 18.4 | A | | | | A | A | 20.8 | | | | | A | 24.3 | | | | |
| H | 252 | *Aesculus glabra* | 33.1 | A | | | | A | A | 35.6 | | | | | A | 35.3 | | | | |
| H | 253 | *Aesculus glabra* | 16.7 | A | | 1 | | A | A | 18.3 | | | | | A | 25.3 | | | 1 | |
| H | 255 | *Aesculus glabra* | 5.1 | A | | | | D | D | | | | | | D | | | | | |
| H | 257 | *Aesculus glabra* | 7.8 | A | | | | A | A | 8.9 | | | | | A | 11.5 | | | | |
| H | 262 | *Aesculus glabra* | 41.1 | A | | | | A | A | 42.3 | | | | | A | 48.3 | | | | |
| H | 271 | *Aesculus glabra* | 31.7 | A | | 2 | | A | A | 33.7 | | | | | A | 42.3 | | | | |
| H | 275 | *Aesculus glabra* | 28.2 | A | | | | A | A | 31.9 | | | | | A | 34.2 | | | | |
| H | 287 | *Aesculus glabra* | 26.5 | A | | | 1 | A | A | 37.3 | | | 3 | | RS | | | | 4 | |
| H | 291 | *Aesculus glabra* | 23.0 | A | | 1 | | A | A | 25.4 | | | | | A | 29.3 | | | | |
| H | 297 | *Aesculus glabra* | 5.3 | A | 1 | | | A | A | 6.8 | | | | | | | | | | |
| H | 298 | *Aesculus glabra* | 5.4 | A | 3 | | | A | A | 5.9 | | | | | A | 8.8 | 1 | | | |
| H | 299 | *Aesculus glabra* | 5.2 | D | 4 | | | D | D | | | | | | | | | | | |
| H | 203 | *Celtis occidentalis* | 41.2 | D | | | | A | A | 41.6 | | | | X | A | 46.7 | | | | |
| H | 205 | *Celtis occidentalis* | 40.9 | D | | | 1 | A | A | 42.0 | | | | | D | | | | | |
| H | 209 | *Celtis occidentalis* | 34.8 | D | | | | A | A | 35.3 | | | | X | D | | | | | |
| H | 213 | *Celtis occidentalis* | 39.7 | D | | | | A | A | 39.7 | | | | X | A | 39.7 | | | | |
| H | 215 | *Celtis occidentalis* | 33.1 | D | | | 3 | A | A | 34.7 | | | | | A | 35.5 | | | | |
| H | 223 | *Celtis occidentalis* | 35.0 | D | | | | A | A | 37.1 | | | | | A | 40.5 | | | | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| H | 225 | *Celtis occidentalis* | 41.3 | A | | | | A | A | 42.8 | | | | | A | 42.2 | | | | |
| H | 231 | *Celtis occidentalis* | 31.3 | D | | | | RS | RS | | | | | | RS | | | | | |
| H | 232 | *Celtis occidentalis* | 42.9 | A | | | | RS | D | | | | | | D | | | | | |
| H | 235 | *Celtis occidentalis* | 33.4 | A | | | | A | A | 36.4 | | | | X | A | 36.9 | | | | |
| H | 239 | *Celtis occidentalis* | 35.1 | A | | | | A | A | 36.9 | | | | X | A | 37.7 | | | | |
| H | 240 | *Celtis occidentalis* | 33.1 | D | | | | D | D | | | | | | D | | | | | |
| H | 246 | *Celtis occidentalis* | 44.4 | A | | | | A | A | 44.4 | | | | X | A | 46.6 | | | | X |
| H | 260 | *Celtis occidentalis* | 37.8 | D | | | | A | A | 40.6 | | | | X | A | 43.7 | | | | |
| H | 267 | *Celtis occidentalis* | 36.1 | D | | | | A | A | 36.5 | | | | | A | 40.3 | | | | |
| H | 269 | *Celtis occidentalis* | 37.9 | D | | | 2 | A | A | 40.0 | | | | X | A | 38.7 | | | | |
| H | 276 | *Celtis occidentalis* | 38.1 | D | | | | RS | RS | | | | | | D | | | | | |
| H | 278 | *Celtis occidentalis* | 30.8 | D | | | | A | D | | | | | | A | 36.2 | | | | |
| H | 280 | *Celtis occidentalis* | 35.0 | D | | | | RS | D | | | | | | D | | | | | X |
| H | 290 | *Celtis occidentalis* | 36.1 | A | | | | A | A | 37.3 | | | | X | A | 39.7 | | | | |
| H | 202 | *Fraxinus pennsylvanicum* | 37.8 | A | | | | A | A | 38.7 | | | | | A | 40.3 | | | | |
| H | 208 | *Fraxinus pennsylvanicum* | 36.6 | A | | 1 | 3 | A | A | 36.5 | | | | | RS | | | | 4 | |
| H | 211 | *Fraxinus pennsylvanicum* | 40.0 | A | | 1 | | A | A | 42.3 | | | 2 | | RS | | | | 2 | |
| H | 212 | *Fraxinus pennsylvanicum* | 39.0 | A | | | | A | A | 40.4 | | | 3 | | RS | | | | 3 | |
| H | 216 | *Fraxinus pennsylvanicum* | 45.9 | A | | 2 | | A | A | 46.7 | | | | | A | 48.3 | | | 4 | |
| H | 220 | *Fraxinus pennsylvanicum* | 34.6 | A | | 1 | | A | RS | | | | 3 | | D | | | | | |
| H | 222 | *Fraxinus pennsylvanicum* | 36.4 | A | | | 3 | A | RS | | | | | | RS | | | | | |
| H | 229 | *Fraxinus pennsylvanicum* | 41.1 | A | | | 3 | A | RS | | | | | | D | | | | 4 | |
| H | 247 | *Fraxinus pennsylvanicum* | 36.1 | A | | | 1 | A | A | 38.2 | | | | | A | 39.5 | | | 2 | |
| H | 251 | *Fraxinus pennsylvanicum* | 39.5 | A | | | 2 | RS | RS | 39.6 | | | | | D | | | | 4 | |
| H | 259 | *Fraxinus pennsylvanicum* | 34.8 | A | | | 3 | D | D | | | | | | D | | | | 4 | |
| H | 263 | *Fraxinus pennsylvanicum* | 44.5 | A | | | 3 | A | A | 47.2 | | | | | A | 51.6 | | | 3 | |
| H | 268 | *Fraxinus pennsylvanicum* | 43.2 | A | | | 4 | RS | RS | | | | 3 | | RS | | | | | |
| H | 273 | *Fraxinus pennsylvanicum* | 41.4 | D | | | 3 | A | A | 41.9 | | | | | A | 45.3 | | | 4 | |
| H | 274 | *Fraxinus pennsylvanicum* | 39.8 | A | | | 3 | A | A | 41.9 | | | | | A | | | | 3 | |
| H | 283 | *Fraxinus pennsylvanicum* | 48.1 | A | | | 2 | A | A | 49.7 | | | | | A | 51.7 | | | 2 | |
| H | 284 | *Fraxinus pennsylvanicum* | 49.7 | A | | | 2 | A | A | 49.4 | | | | | RS | | | | 4 | |
| H | 288 | *Fraxinus pennsylvanicum* | 38.1 | A | | | 1 | A | A | 41.6 | | | 3 | | A | 46.5 | | | 4 | |

# TABLE D-1
# A1PI REVEGETATION RESEARCH PLOTS
# SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| H | 294 | *Fraxinus pennsylvanicum* | 44.5 | A | | | 3 | A | A | 46.3 | | | | | A | 49.8 | | | | |
| H | 295 | *Fraxinus pennsylvanicum* | 33.2 | A | | | 2 | A | A | 36.5 | | | | | A | 39.0 | | | 2 | |
| H | 206 | *Juglans nigra* | 40.8 | A | | | | A | A | 43.7 | | | | | A | 42.6 | 1 | | | |
| H | 207 | *Juglans nigra* | 42.9 | A | | | | A | A | 42.9 | | | | | A | 43.8 | | | | |
| H | 210 | *Juglans nigra* | 43.1 | A | | | | A | A | 47.4 | | | | | A | 45.1 | | | | |
| H | 221 | *Juglans nigra* | 46.2 | D | | | | A | A | 47.8 | | | | | A | 51.4 | | | | X |
| H | 224 | *Juglans nigra* | 39.6 | A | | | | A | RS | | | | | | RS | | | | | |
| H | 233 | *Juglans nigra* | 41.4 | D | | | | A | A | 45.4 | | | | | A | 44.4 | | | | |
| H | 236 | *Juglans nigra* | 41.5 | A | | | | A | A | 42.8 | | | | | A | 42.8 | | | | X |
| H | 241 | *Juglans nigra* | 40.0 | D | | | | A | A | 43.6 | | | | X | A | 42.5 | | | | X |
| H | 243 | *Juglans nigra* | 38.2 | D | | | | A | A | 39.4 | | | | | A | 42.4 | | | | X |
| H | 244 | *Juglans nigra* | 40.1 | A | | | | A | A | 41.4 | | | | | A | 44.0 | | | | |
| H | 248 | *Juglans nigra* | 46.2 | D | | | | RS | RS | 47.4 | | | | | D | | | | | X |
| H | 254 | *Juglans nigra* | 39.5 | A | | | | A | A | 39.6 | | | | X | A | 43.5 | | | | X |
| H | 256 | *Juglans nigra* | 40.0 | D | | | | A | A | 40.7 | | | | | A | 43.0 | | | | |
| H | 258 | *Juglans nigra* | 24.6 | A | | 1 | | A | A | 24.7 | | | | | A | 27.9 | | | | |
| H | 265 | *Juglans nigra* | 44.5 | A | | | | A | A | 45.4 | | | | | A | 49.4 | | | | |
| H | 266 | *Juglans nigra* | 39.4 | A | | | | A | A | 41.4 | | | | | A | 47.9 | | | | X |
| H | 272 | *Juglans nigra* | 49.5 | D | | | | A | RS | | | | | | A | 47.2 | | | | X |
| H | 277 | *Juglans nigra* | 30.3 | A | | | 1 | A | A | 32.0 | | | | | A | 34.9 | | | | |
| H | 281 | *Juglans nigra* | 44.5 | D | | | | A | A | 46.6 | | | | | A | 47.3 | | | | |
| H | 282 | *Juglans nigra* | 43.2 | A | | | 4 | A | A | 45.7 | | | 3 | | A | | | | | |
| H | 285 | *Juglans nigra* | 40.1 | A | | | 1 | A | A | 41.3 | | | | | A | 46.4 | | | | |
| H | 201 | *Quercus muehlenbergii* | 24.8 | A | | 2 | | A | A | 24.9 | | | | | A | 26.8 | | 2 | 1 | |
| H | 204 | *Quercus muehlenbergii* | 16.6 | A | | 2 | | A | A | 22.6 | | | | | A | 20.8 | | 2 | 2 | |
| H | 217 | *Quercus muehlenbergii* | 26.3 | A | | 2 | | A | A | 26.9 | | | | | A | 26.1 | | | | |
| H | 218 | *Quercus muehlenbergii* | 23.4 | A | | 2 | | A | A | 30.6 | | | | | A | 32.1 | | | 1 | |
| H | 219 | *Quercus muehlenbergii* | 25.1 | A | | | | A | A | 27.3 | | | | | A | 28.7 | | | 2 | |
| H | 227 | *Quercus muehlenbergii* | 16.4 | A | | 2 | 1 | A | A | 18.6 | | | | | A | 21.3 | | | 2 | |
| H | 228 | *Quercus muehlenbergii* | 24.9 | A | | 2 | | A | A | 27.3 | | | | | A | 30.5 | | | | |
| H | 237 | *Quercus muehlenbergii* | 29.4 | A | | 2 | | A | A | 30.0 | | | | | A | 32.3 | | | | |
| H | 238 | *Quercus muehlenbergii* | 24.7 | A | | 2 | 2 | A | A | 24.9 | | | | | A | 26.3 | | | 2 | |

## TABLE D-1
## A1PI REVEGETATION RESEARCH PLOTS
## SAPLING DATA

| | | | Fall-99 | | Damage Severity (1 to 4) | | | Spring-00 | Fall-00 | | Damage Severity (1 to 4) | | | | Fall-01 | | Damage Severity (1 to 4) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plot | ID | Species | Diam. (mm) | Dead (D), Alive (A), or Resprout (RS) | Vole | Deer | Rub | Dead (D), Alive (A), or Resprout (RS) | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present | Dead (D), Alive (A), or Resprout (RS) | Diam. (mm) | Vole | Deer | Rub | Fungus Present |
| H | 245 | *Quercus muehlenbergii* | 19.8 | A | | 2 | | RS | RS | 22.6 | | | | | A | 22.3 | | | | |
| H | 249 | *Quercus muehlenbergii* | 25.1 | A | | 2 | | A | A | 27.7 | | | | | A | 30.4 | | | | |
| H | 261 | *Quercus muehlenbergii* | 26.5 | A | | 2 | 1 | A | A | 32.1 | | | | | A | 38.4 | 1 | | | |
| H | 264 | *Quercus muehlenbergii* | 24.9 | A | | 1 | | A | A | 33.3 | | | | | A | 36.8 | | | | |
| H | 270 | *Quercus muehlenbergii* | 23.1 | A | | 2 | | A | A | 26.0 | | | | | A | 27.1 | | | | |
| H | 279 | *Quercus muehlenbergii* | 28.3 | A | | 2 | | A | A | 25.7 | | | | | A | 28.0 | | | | |
| H | 286 | *Quercus muehlenbergii* | 21.8 | A | | 1 | 4 | RS | RS | | | | 2 | | RS | | | | 4 | |
| H | 289 | *Quercus muehlenbergii* | 26.5 | A | | 2 | 1 | A | A | 28.4 | | | 2 | | A | 31.7 | | | 2 | |
| H | 292 | *Quercus muehlenbergii* | 24.6 | A | | 2 | | A | A | 26.0 | | | | | A | 33.6 | | | | |
| H | 293 | *Quercus muehlenbergii* | 24.9 | A | | 2 | 1 | A | A | 30.5 | | | | | A | | | | | |
| H | 296 | *Quercus muehlenbergii* | 21.4 | A | | 2 | 4 | RS | RS | 21.4 | | | | | RS | | | | 4 | |
| H | 300 | nd | nd | nd | nd | nd | nd | ND | ND | | | | | | | | | | | |

# APPENDIX E

# ECOLOGICAL RESTORATION
# FUNCTIONAL PHASE MONITORING PLAN

# APPENDIX E
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# APPENDIX E
# ECOLOGICAL RESTORATION FUNCTIONAL PHASE MONITORING PLAN

## 1.0 INTRODUCTION

The Functional Phase Monitoring Plan presents the field collection, data analysis, and reporting methods that will be used to implement the ecological restoration Functional Phase monitoring program at the FEMP. This information is included as an appendix to the 2001 Consolidated Monitoring Report for Restored Areas at the FEMP. This plan will be updated as needed and included as an appendix in future Consolidated Monitoring Reports. Functional Phase monitoring will be the primary means of evaluating the progress of ecological restoration at the FEMP. In general, Functional Phase monitoring involves the characterization of ecological systems within restored areas, and comparison of those systems to both the baseline pre-remediation conditions and an appropriate reference site. Characterization will require the collection and analysis of several ecological parameters, which will then be reported and used as a basis of comparison between the restored system, the baseline condition, and the end-point reference site. Section 1.2.2 of the Consolidated Monitoring Report provides an overview of the Functional Phase monitoring approach.

The scope of this monitoring plan is limited to the methods needed to conduct Functional Phase monitoring. Field activities required for Implementation Phase monitoring, such as mortality counts, are described in project-specific Natural Resource Restoration Design Plans (NRRDPs), as well as Section 1.2.1 of the Consolidated Monitoring Report. However, it should be noted that certain Implementation Phase monitoring requirements might utilize the methods described in this plan. For example, herbaceous cover estimates may be implemented pursuant to the process described in Section 3.2 of this plan. When such methods are used, this appendix will be referenced in the discussion of the Implementation Phase monitoring results.

## 2.0 FUNCTIONAL PHASE MONITORING COMPONENTS

Baseline sites, restored areas, and reference sites will be evaluated using two main components: vegetation characterization and wildlife observations. Vegetation characterization will involve the development of a suite of measured and calculated parameters, including Floristic Quality Assessment Index (FQAI), modified Simpson's Index of diversity (MSI), percent native cover, and plant size. Wildlife observations will involve surveys for breeding birds, migratory waterfowl, amphibians, butterflies, and macroinvertebrates. The processes for data collection and analysis of the vegetation characterization and bird surveys are provided in Sections 3.0 and 4.0 of this plan. Amphibian, butterfly,

and macroinvertebrate surveys are conducted by OEPA, so sample and analysis methods are not discussed in this plan.

## 3.0 VEGETATION CHARACTERIZATION

Vegetation characterization using the parameters discussed above will require that species richness, abundance (for woody plants), cover (for herbaceous plants), and size (for woody plants) is collected from each baseline, reference site, and restoration project. The sampling methods and processes for data analysis are discussed below.

### 3.1 Sample Design

Most of the study areas that will be characterized are too large for an analysis of the entire plant population. Therefore, random samples must be taken to characterize the system. Vegetation sampling will be conducted through the systematic random location of quadrats. Two different types of quadrats will be used, depending on the type of vegetation to be surveyed. One square meter ($m^2$) quadrats will be established for herbaceous vegetation. Woody vegetation will be surveyed with 100 $m^2$ quadrats. The process for locating quadrats within the study area is described below.

Samples must be randomly chosen in order to provide an unbiased characterization of the community. To accomplish this, the following system has been developed. First, establish a permanent transect that approximates the longitudinal axis of the study area. Flag each end of the transect and measure its distance in meters. Record the bearing of the transect so that it can be followed even if dense vegetation obscures the stakes and/or flags used to mark it.

Ten quadrats will be randomly located off of this transect during each sampling event. For the first quadrat, establish a random starting point from 5 to 30 meters out at one end of the transect by rolling a die and assigning multiples of five, as follows:

| | | | | | |
|---|---|---|---|---|---|
| 1(5m) | 2(10m) | 3(15m) | 4(20m) | 5(25m) | 6(30m) |

Divide the remaining length of the transect by nine in order to establish ten transect points from which quadrats will be established. During each sampling event, establish points starting from the same end of the transect.

To position quadrats off of the transect, roll the die to determine whether the quadrat will be placed to the left or right of the quadrat. (A roll of one to three would send the quadrat to the left of the transect, while a roll of four to six would go to the right.) Lastly, roll the die one more time to determine the distance of the quadrat from the transect. The distance from the transect will depend on the overall width of the study area. Determine the distance from the transect to the edge of the study area, then divide by six to obtain distance intervals that will be determined by rolling a die. For example, a 60-meter area would result in the following intervals:

| | | | | | |
|---|---|---|---|---|---|
| 1(10m) | 2(20m) | 3(30m) | 4(40m) | 5(50m) | 6(60m) |

Note that the quadrat location may need to be adjusted due to obstructions that would prevent sampling, such as roads, bodies of water, etc.

For wetlands where a small strip of vegetation surrounds an open water area, the transect will run the length of the water's edge. Quadrat locations will be placed on regular intervals following a randomized start point, as described above.

The steps outlined above will determine random sample points from which vegetation quadrats can be laid out. Quadrats should be established parallel to the transect, with the top right corner of the quadrat set at the sample point. Use a compass to orient the quadrat parallel to the transect. For instance, if a transect runs north to south across a study area and the survey was initiated at the southern end, each sample point would comprise the northeast corner of the quadrat. In areas where woody vegetation is present, establish the 100-$m^2$ woody vegetation quadrat first, and then nest the herbaceous quadrat within the woody quadrat, using the same top right corner location. Be careful not to trample the herbaceous vegetation when establishing the quadrats and sampling the woody vegetation. One $m^2$ herbaceous quadrats are delineated with pre-measured PVC pipe. The inside dimensions of the square measure 1 meter on each side. Woody vegetation 100-$m^2$ quadrats are flagged in the field by measuring out a 10-meter by 10-meter square.

As stated above, ten quadrats of each vegetation layer should be established during each sample event. Additional quadrats may be surveyed in order to characterize features that are of particular interest, such as wetlands. Additional vegetation samples will be treated separately from the randomized quadrats, since including them could bias the results of the data analysis.

In order to identify all vegetation within the study area, three separate sampling events should be completed during the growing season. Conduct the first survey in early spring, the second in early summer, and the third in late summer. This approach will account for early and late-blooming species that may not be recorded if just one survey was conducted. Also, it increases to 30 the number of quadrats used to characterize the study area, thereby strengthening the statistical representation of the data.

3.2 Data Collection

Once the quadrat location is established, begin data collection. Field forms will be used to organize and record field data (Figures E-1 and E-2). A Vegetation Field Survey Gear List is also provided as Figure E-3. A separate field form will be used for herbaceous and woody vegetation. A unique identification code will be assigned to each quadrat surveyed. The generation of ID codes is described below.

Each quadrat identification code will consist of an area designation, the survey number, the survey type, and the quadrat number. One or more letters will be used as a study area code. Next, the survey number will be designated using "A, B, or C," with "A" being the first survey, etc. The survey type will be either woody (W) or herbaceous (H). Lastly, quadrats will be numbered one to ten. As an example of this approach, G-B-H-5 represents the fifth herbaceous quadrat sampled during the second survey of the grazed pasture baseline site. Each species identified within a quadrat will also be numbered, so that it is uniquely identified as well. Using the same example from above, G-B-H-5-2 is the identification code assigned to the second species identified in the fifth herbaceous quadrat of the second survey of the grazed pasture.

Once the quadrat code information is entered, record the necessary administrative information onto the field forms. Required information includes the date, the quadrat survey start time, the survey team, a general description of the weather, the quadrat location in relation to the transect (i.e., 30 meters west of transect at 85 meters), and a brief narrative description of the quadrat, such as "canopy gap with much understory growth." Photograph the quadrat with a 35-mm SLR camera equipped with a 50-mm lens. Include a label in the photo indicating the survey date and the quadrat ID code. Next, estimate and record the total herbaceous cover and the total canopy cover of the quadrat, using the following cover class estimates:

0(0%) 1(1-5%) 2(6-25%) 3(26-50%) 4(51-75%) 5(76-100%)

When cover estimates are being used to comply with Implementation Phase monitoring, make an additional note regarding whether the total cover exceeds 90 percent.

Species-specific information can now be gathered. First, list each species identified within the quadrat. Unidentified species should be assigned an ID number and listed as "unknown." Photograph the species or take a voucher for later identification. Off site, vouchers will only be collected if permission and appropriate collection permits are in place. On site, one voucher will be taken for each native species identified across all baseline and restored areas, unless the species is threatened or endangered. If a voucher is collected, label it with its identification number, date, and species name (if known). Note on the field form if a voucher was collected.

For each species, record the type of vegetation it is (grass, forb, tree, etc.). Next, estimate the cover of the species using the cover class designations listed above. For woody vegetation, record the diameter at breast height (dbh) for trees greater than 2 meters in height, or the diameter of shrubs less than 2 meters in height, so that foliage area can be calculated. Since dbh or foliage area measurements will be made for each woody plant, individuals shall be listed on the field form. For herbaceous vegetation, only the species present will be listed. Abundance will not be recorded but rather inferred from species-specific cover class estimates.

Lastly, note any special conditions or other comments onto the field form. Record the end time on the form and break down the quadrat, leaving the sample point (top right corner) flagged and labeled with the date and quadrat ID code. For off-site reference sites, make sure that sample flags are permitted.

### 3.3 Data Analysis

From the data collected in the field, several characterization parameters can be developed. As stated in Section 2.0 of this plan, the vegetation parameters include FQAI, MSI, percent native cover, and plant size. Each of these parameters is discussed in more detail below. However, in order to develop these parameters, the survey area data must be organized. First, a list shall be compiled of all species identified during each sample event. Tabulate the woody vegetation abundance and mean dbh/foliage area for each species. For herbaceous species, calculate the mean cover class as follows. First, combine all "1" and "2" cover class assignments to obtain a single cover class of "1." The combined cover class designation represents a cover range of 1 to 25 percent. The remaining three cover classes then need to be adjusted down one unit. In this way, a field-recorded cover class of "3" would be assigned a "2." Four would become 3, and 5 would become 4. These steps are needed to make a linear scale from which to average.

Then sum all cover classes and divide by 30 to obtain a mean cover class for each species. Individual vegetation parameters can now be calculated.

### 3.3.1 FQAI

The calculation of FQAI requires that a coefficient of conservatism (CC) value is assigned to each species identified in the study area. A CC is a number from 1 to 10 that ranks the degree to which a species represents a quality system. A widespread species that is often found in degraded systems would have a low CC, while a rare plant with very specific habitat requirements be assigned a high CC. Non-native species are always assigned a CC of 0. A statewide list of CC values is being developed (Mack 2001). Once published, all species identified during Functional Phase monitoring will be assigned a statewide CC value. Until then, CC values for northeast Ohio developed for evaluation of wetlands will be used (Andreas 1995). FQAI for each study area is then calculated using the following formula:

$$FQAI = C\sqrt{n}$$

Where:

C = the mean CC value of all species
$n$ = the total number of species recorded

The FQAI is a value that can be used to compare the extent of floristic quality between baseline sites, restored areas, and reference sites (Packard 1997). It is suspected that baseline sites will have a relatively low FQAI when compared to reference sites. Restored areas should show some increase in FQAI values over time. The use of FQAI to compare sites is discussed in Section 5.3 below.

### 3.3.2 MSI

MSI provides a measure of species diversity for a study area (Brower 1990). Normally, the calculation of Simpson's Index is a calculation of species dominance, and it would require abundance values for each species identified in the study area. The abundance of woody vegetation will be tabulated for each study area. However, since the abundance of herbaceous vegetation will not be collected, a modified approach using herbaceous cover estimates is needed. Therefore, the mean cover estimates for each species will be used as a surrogate for species abundance. In terms of calculating Simpson's Index, this would mean that each herbaceous species would have an abundance of one to four. Because of this, the calculation of Simpson's Index would be bunched very close together and thus difficult to compare. To rectify this, the formula for calculating Simpson's Index must be inverted. This change in the equation, along with the

use of cover class estimates instead of abundance values, results in the establishment of an MSI value. MSI is calculated as follows:

$$MSI = \frac{N(N-1)}{\sum[n_i(n_i-1)]}$$

Where:

N = sum of all cover classes
$n_i$ = species-specific cover class

Since abundance will be available for all woody vegetation, separate MSI calculations will be conducted for woody and herbaceous layers. For woody vegetation, N = the total number of individuals recorded in a study area, and $n_i$ = the abundance for each species. For woody vegetation, the MSI will represent the number of times needed to take pairs of individuals at random to find a pair of the same species within a study area (Brower 1990). This same statement probably does not hold true for herbaceous vegetation, since cover class estimates are used to calculate MSI instead of abundance. Instead, the MSI for herbaceous vegetation provides a relative comparison of diversity between study areas.

### 3.3.3 Percent Native Cover

The percent native cover is calculated with the converted native cover classes discussed above. Sum all native species converted cover classes, then divide into the cover class total for the study area. The resulting value will represent a range between the four mean cover class values. Native species will be designated by their CC. If a species has a CC between 1 and 10, it is included as a native species. Non-native species will always have a CC of 0.

### 3.3.4 Plant Size

This survey parameter applies only to woody vegetation. The mean dbh and foliage area of each study area will be established by obtaining species-specific dbh and foliage area measurements in the field. The mean dbh of a study area should be calculated and reported. Foliage area needs to be calculated for each species before it can be averaged. Assume that all shrubs are circular, and calculate foliage area by using $A = \prod r^2$. Then calculate the mean foliage area for shrubs within the study area.

## 4.0 BIRD SURVEYS

Breeding bird surveys will be conducted in each survey area. Also, migratory waterfowl observations will be made in open water areas. Field implementation and data analysis is not as involved as the requirements for vegetation characterization. Each process is described in more detail below.

4.1 Breeding Bird Surveys

To conduct breeding bird surveys, establish a walking transect across the project area. The walking transect is separate from the vegetation characterization transect described in Section 3.1 of this plan. The walking transect must be an accessible, repeatable route that allows for observation of the entire study area. The entire transect route should be able to be completed in 0.5 to 1 hour. The transect route should be identified on a map of the project area.

Three surveys shall be conducted during the month of June. Survey the study area in the morning, during the time of peak bird activity. For each survey, record all individuals seen or heard along the transect. Two individuals should participate in the survey: a local birding expert and a recordkeeper. The birding expert shall name the species and quantity while walking along the transect, followed by the recordkeeper. The recordkeeper is responsible for recording additional information as well, including the date, start time, end time, weather conditions, and any additional notes of interest. Species and quantity lists will be consolidated from the three surveys, resulting in a species richness and abundance list for breeding birds within each study area. Calculate MSI for each study area pursuant to the formula in Section 3.3.2 of this plan.

4.2 Migratory Waterfowl Observations

Migratory waterfowl observations shall be conducted in March, during the peak of the spring migration season. Observe the water body in the morning from the same location on five occasions, recording species and quantities observed. Record the date, time, weather, observation location, and observer. After all surveys are conducted, sum the species and quantities, and calculate MSI.

5.0 REPORTING

Once all measurement parameters are calculated for each study area, they must be compared in order to demonstrate the extent of progress for restored areas. As stated in Section 1.0 of this plan, restored ecosystems at the FEMP will be compared to pre-remediation baseline conditions and to off-property reference sites. This evaluation of restored areas is discussed in more detail below.

5.1 Baseline Conditions

The FEMP site has been divided into six different pre-remediation baseline conditions: grazed pasture, riparian forest, successional woodlot, pine plantation, open water, and developed. A representative baseline system will be characterized using the processes discussed in Sections 3.0 and 4.0 of this plan. These representative systems will serve as the baseline template for similar areas across the site. Once an

area is ecologically restored, the ecological system components that comprise the restored area will be compared to the baseline conditions present prior to restoration. Project-specific NRRDPs will specify the applicable baseline condition for the project area. Usually, only one baseline condition will be assigned to a project area. Larger restoration projects may require comparisons to several baseline conditions.

Most of the restoration projects will be established on developed land. In this case, ecological baseline conditions would be considered non-existent. For other areas, however, the restored ecosystems will be compared to the measurement parameters calculated for the applicable baseline condition. It is important to note that baseline conditions are area-based, while restored area evaluations will be ecosystem based. For example, a grazed pasture is restored to an emergent wetland and a wet meadow. When Functional Phase monitoring for the emergent wetland is conducted, it will be compared to the area-specific conditions that were present prior to the restoration effort. In this example, the baseline comparison would be to the grazed pasture template. These comparisons are applicable, since the same measurement parameters will be calculated for each system.

## 5.2 Reference Sites

Restored area comparisons to reference sites will also be conducted. To accomplish this, a series of reference sites will be established and characterized using similar measurement parameters. The reference sites for FEMP ecological restoration include the following:

- Upland beech-maple/oak hickory forest complex
- Wet forest
- Riparian forest
- Emergent wetland/open water area
- Wet meadow/marsh
- Tallgrass prairie.

The location and access to each reference site is to be determined. The selected reference site for each system should be as close to the FEMP site as possible, and should be approximately the same size as the planned restored areas at the FEMP. Once specific reference sites are established, they will be characterized using the same monitoring parameters as the restored areas and baseline conditions. Unlike the baseline conditions, reference sites and restored areas will be compared on a system-specific bases. Using the example from above, the emergent wetland component of the restored area will be compared to the emergent wetland reference site, while the wet meadow component of the restoration project is compared to the wet meadow/marsh reference site.

5.3 Project Comparisons

As described above, the restored systems will be compared to both baseline conditions and appropriate reference sites. These comparisons will be reported as part of the annual consolidated monitoring report. The intent is to demonstrate that the restored system has achieved some level of progress from the baseline condition towards its corresponding reference site. To do this, statistical comparisons will be made between restored systems, baseline conditions, and reference sites using standard t-Tests (given that the sample data do not severely violate the assumptions of normality). The normality assumption will be tested using the Shapiro-Wilk test procedure. If the normality assumption can not be justified then a log-transformation of the data will be attempted to 'normalize' the data. If the data can not be normalized then the Wilcoxon Rank-Sum (non-parametric) procedure will be employed to test for differences between the restored system and either the baseline or reference data.

It is anticipated that the restored system will show initial improvement from the baseline, then a much slower progression towards its reference site conditions. Similarity to reference sites will probably take decades to achieve, if ever. The scope of Functional Phase monitoring at the FEMP probably does not include the timeframes for monitoring that would be necessary to demonstrate attainment of reference site similarity. Therefore, an alternative approach has been developed to assess the progress of the restored system within the timeframes planned for monitoring. A linear rate of progress from baseline conditions towards the reference site will be assumed for each measurement parameter. The number of years for reference system maturation will be decided jointly by the NRTs. This "system progression" can then be displayed as a function of time, and compared to the restored system. An example of this quasi-technical approach to visualize progress is shown in Figure E-4. The diagonal line indicates a linear progression from baseline to reference (in this fictitious example, FQAI going from 5 to 40, with a maturation time of 10 years). The solid diamond represents average for the year and the vertical bar represents the confidence bound on the estimate. If the confidence bound overlaps the "estimated progress line" then restoration would be considered "on schedule."

In reality, the quality and diversity of vegetation and wildlife in a maturing ecosystem would rarely progress linearly. Vegetation diversity, for instance, would probably peak during the early successional stages of forest development, when the system is transitioning from an old field to a forest community. However, as stated above, these changes would often take decades and even centuries to develop. Therefore, an assumption of linear progression may prove useful for system comparisons within the 10-year functional monitoring window. Alternative methods of comparison agreed to by the NRTs will be described and presented in future annual consolidated monitoring reports.

## 6.0 SCHEDULE

The schedule for Functional Phase monitoring is set up to evaluate a single type of system on an annual rotation. In other words, all wetland restoration projects will be evaluated in year one, all prairies and savannas in year two, and all forest systems in year three. This rotation will be repeated at least once, starting in 2003. Baseline and reference sites will be characterized in 2001 and 2002

ID Code _____

FIGURE E-1

# HERBACEOUS VEGETATION

Page ___ of ___

| Date | Area | Survey No. |
|---|---|---|
| St. Time / End Time / Quadrat | | Weather |
| Team | | |
| Total Cover | Canopy Cover | Cover Class: 0 (0%) 1 (1-5%) 2 (6-25%) 3 (26-50%) 4 (51-75%) 5(76-100%) |
| Quadrat Location | | |
| Quadrat Description | | |

| No. | Species | Common Name | Type | Cover | CC | Voucher? |
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*(Use additional sheets if necessary)*

**Comments**

ID Code _____

FIGURE E-2

# WOODY VEGETATION

Page ___ of ___

| Date | Area | Survey No. |
|---|---|---|
| St. Time / End Time / Quadrat | | Weather |
| Team | | |
| Total Cover | Canopy Cover | Cover Class: 0 (0%) 1 (1-5%) 2 (6-25%) 3 (26-50%) 4 (51-75%) 5(76-100%) |
| Quadrat Location | | |
| Quadrat Description | | |

| No. | Species | Common Name | Type | Cover | dbh/Fol. Area | CC | Voucher? |
|---|---|---|---|---|---|---|---|
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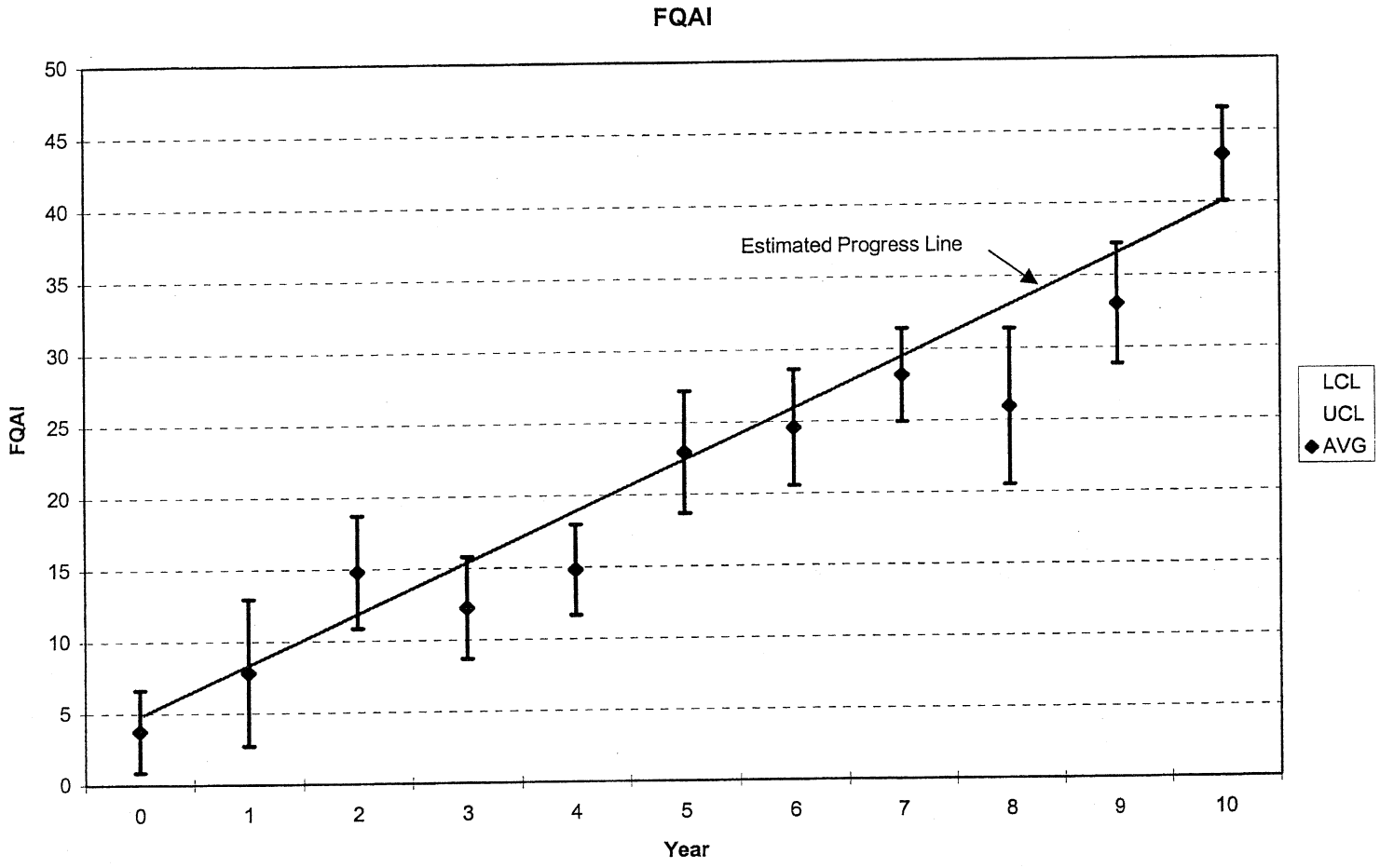
*(Use additional sheets if necessary)*

**Comments**

## FIGURE E-3
## BASELINE ECOLOGICAL MONITORING
## VEGETATION SURVEY GEAR LIST

___radio/cell phone
___bug spray
___field log
___field forms
___site map
___graph paper
___clipboard
___pencils
___sharpie
___plant press w/materials
___hand lens
___30cm ruler
___field books/keys
___ziploc bags
___camera/film
___film roll ID sheets
___calculator
___compass (2)
___50m measuring tape
___100m measuring tape
___10m dbh tape
___marking flags
___hand trowel
___scissors

## FIGURE E-4
## EXAMPLE GRAPH SHOWING SYSTEM PROGRESS