

PERFORMANCE STANDARDS AND MONITORING PROTOCOL FOR PERMITTEE-
RESPONSIBLE NONTIDAL WETLAND MITIGATION SITES IN MARYLAND

April, 2015

- A. Nontidal wetland mitigation sites shall conform to the following performance standards by the end of the monitoring period, unless otherwise determined by the Maryland Department of the Environment (MDE) and the U.S. Army Corps of Engineers (Corps).
- B. Reporting and Performance Standards: All required documentation, including monitoring reports and as-built surveys shall be submitted to MDE and the Corps. MDE and the Corps will use best professional judgment, visual observation, and monitoring reports to evaluate attainment of performance standards and in determining whether part of or the entire mitigation site is successful or whether corrective actions are warranted. Success will be determined on a plot, well, field, or cell basis. Presenting averages or means of plot data across a site is not satisfactory to demonstrate success. All of the following standards will be used to assess project success and credit releases and must be achieved each monitoring year:
1. Wetland Area(s):
 - I. **Wetland Vegetation Dominance:** Wetland vegetation dominance, defined as a vegetation community where more than 50% of all dominant plant species across all strata are rated obligate (“OBL”), facultative wet (“FACW”), or facultative (“FAC”), using the vegetation sampling procedures as described in the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual, must be achieved; and
 - II. **Aerial Cover Vegetative Standards:**
 - a. By the end of monitoring year one, a minimum of 50% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native (FAC or wetter) species.
 - b. By the end of monitoring year two, a minimum of 60% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native (FAC or wetter) species.
 - c. By the end of monitoring year three, a minimum of 70% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native (FAC or wetter) species.
 - d. By the end of monitoring year five and each monitoring year thereafter, a minimum of 85% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native (FAC or wetter) species.
 - e. Volunteer species should support functions consistent with the project design goals.
 - III. **Invasive Species:** No more than 10% of relative plant cover¹ over the entire mitigation site shall be made up by non-native or invasive species, with no individual colony greater than or equal to 5% of relative plant cover. No more than 5% of relative plant cover over the entire site shall be made up of *Phragmites australis*, *Persicaria perfoliata*, or *Lythrum salicaria*. Native status will be based on the Natural Resources Conservation Service Plants Database. Invasive species are identified on the 2010 National Park Service/U.S.

¹ “Relative plant cover” is defined as the cover of a particular species as a percentage of total plant cover. Thus, relative cover will always total 100%, even when total absolute cover is quite low.

Fish and Wildlife Service document Plant Invaders of Mid-Atlantic Natural Areas (<http://www.nps.gov/plants/alien/pubs/midatlantic/>) and the Maryland Invasive Species Council Invasive Species of Concern in Maryland (http://www.mdinvasivesp.org/invasive_species_md.html). *Phalaris arundinacea* and *Typha* spp. may also be considered as invasive species by MDE and the Corps; and

IV. **Wetland Species Richness:**

- a. For scrub/shrub wetlands, establish a minimum of three species of native wetland shrubs (FAC or wetter) with each wetland shrub species having an aerial cover of at least 15%. No more than 50% shall be FAC.
- b. For forested wetlands, establish a minimum of three species of native wetland trees and two species of native wetland shrubs (FAC or wetter) with each wetland tree and shrub species having an aerial cover of at least 15%. No more than 50% shall be FAC; and

V. **Wetland Vegetation Density for Scrub-Shrub and Forested Wetlands:** For scrub-shrub or forested wetlands, native wetland plant density of at least 435 living trees/shrubs with a minimum height of 10 inches per acre (FAC or wetter) shall be achieved by the end of the first growing season following planting and maintained each monitoring year thereafter through the end of the monitoring period; and

VI. **Wetland Vegetation Cover for Forested Wetlands:** For forested wetlands, average tree height of tallest five native wetland trees within each sample plots shall be at least three feet in height at year three and at least five feet in height at year five and each monitoring year thereafter. Canopy cover² of native wetland trees and shrubs must be at least 30% by the end of the monitoring period; and

VII. **Wetland Hydrology:** Wetland hydrology, defined as 14 consecutive days of flooding or ponding, or a water table 12 inches (30 cm) or less below the soil surface, during the growing season at a minimum frequency of 5 years in 10 (50 percent or higher probability). For the purpose of this determination, the growing season is based on two indicators of biological activity that are readily observable in the field: (1) above-ground growth and development of vascular plants and (2) soil temperature as an indicator of soil microbial activity. These indicators of biological activity shall be used for determinations of growing season and are more fully described in the appropriate regional supplement to the Corps of Engineers Wetland Delineation Manual.

VIII. **Wetland Soils:** The entire wetland restoration or creation area must meet the Hydric Soil Technical Standard (Technical Note 11) developed by the National Technical Committee for Hydric Soils for saturated conditions and aerobic conditions:

- a. Free water must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days; and
- b. Anaerobic conditions must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days. Anaerobic conditions may be determined by one of the following methods, as detailed in the Hydric Soil Technical Standard:
 - i. Positive reaction to alpha-alpha dipyrindyl, determined as least weekly.
 - ii. Reduction of iron determined with IRIS tubes installed for 30 days.
 - iii. Measurement of redox potential (Eh) using platinum electrodes, determined

² “Canopy cover” is defined as the percentage of ground covered by tree and shrub leaves, when the edges of the leaves are mentally projected down to the ground surface.

at least weekly.

2. Buffer Area(s):

I. **Aerial Cover Vegetative Standards:**

- a. By the end of monitoring year one, a minimum of 50% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native species.
- b. By the end of monitoring year two, a minimum of 60% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native species.
- c. By the end of monitoring year three, a minimum of 70% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native species.
- d. By the end of monitoring year five and each monitoring year thereafter, a minimum of 85% of the mitigation site shall be vegetated (either by planted or volunteer plants) by native species.
- e. Volunteer species should support functions consistent with the project design goals.

II. **Invasive Species:** No more than 10% of relative plant cover¹ over the entire site shall be made up by non-native or invasive species, with no individual colony greater than or equal to 5% of relative plant cover. No more than 5% of relative plant cover over the entire site shall be made up of *Phragmites australis*, *Persicaria perfoliata*, or *Pueraria montana*. Native status will be based on the Natural Resources Conservation Service Plants Database. Invasive species are identified on the National Park Service/U.S. Fish and Wildlife Service document *Plant Invaders of Mid-Atlantic Natural Areas* (<http://www.nps.gov/plants/alien/pubs/midatlantic/>) and the Maryland Invasive Species Council *Invasive Species of Concern in Maryland* (http://www.mdinvasivesp.org/invasive_species_md.html); and

III. **Buffer Species Richness:** For forested buffers, establish a minimum of three species of native trees and two species of native shrubs with each tree and shrub species having an aerial cover of at least 15%; and

IV. **Vegetation Density for Forested Buffers:** For forested buffers, native plant density of at least 435 living trees/shrubs with a minimum height of 10 inches per acre shall be achieved by the end of the first growing season following planting and maintained each monitoring year thereafter through the end of the monitoring period; and

V. **Vegetation Cover for Forested Buffers:** For forested buffers, average tree height of tallest five native trees within each sample plots shall be at least three feet in height at year three and at least five feet in height at year five and each monitoring year thereafter. Canopy cover² of native trees and shrubs must be at least 30% by the end of the monitoring period;

C. **Monitoring Timeframe:** The Permittee will be responsible for submitting monitoring reports to MDE and the Corps for a period of time specified in the Phase II Mitigation Plan Approval Letter or the Permit. Monitoring reports should be concise and effectively provide the information necessary to assess the status of the compensatory mitigation project. Reports should provide information necessary, including supporting data such as plans, maps, and photographs, to illustrate site conditions and whether the compensatory mitigation project is meeting its objectives and performance standards. If five years of monitoring is required, monitoring reports shall be submitted annually. If ten years of monitoring is required, monitoring reports shall be submitted for years 1, 2,

3, 5, 7, and 10 (“monitoring years”) following completion of construction of the mitigation site or phase thereof. Monitoring reports, paper copies and an electronic version, must be submitted to MDE and the Corps by December 31 of each monitoring year. Monitoring must be conducted a minimum of once per year during the monitoring years. Monitoring may be terminated or the extent of monitoring may be reduced over part or the entire site at the discretion of the MDE and the Corps. Conversely, MDE or the Corps may extend the original monitoring period upon a determination that performance standards have not been met or the mitigation site is not on track to meet them.

D. Monitoring Reports: The first monitoring report is due the year the mitigation planting occurs, unless planting occurs after April 15, in which case the first monitoring report will not be due until the end of the next year. For each monitoring report, vegetative monitoring shall be conducted between May 1 and September 30 for forested/scrub-shrub systems and between June 15 and September 30 for emergent systems. Site visits should preferably be during a period with normal precipitation and groundwater levels. The following information must be included with the monitoring report:

1. Overview / Background Data:

- I. Title page indicating the permit name, permit tracking number (parent tracking number and NT number), mitigation site name (if applicable), phase (if applicable), monitoring year, and preparer identification (name, address, phone number, and email address).
- II. Written description of the location, any identifiable landmarks of the mitigation site, including information to locate the site perimeter(s), and coordinates of the mitigation site (expressed as latitude and longitude).
- III. Date(s) of site inspections.
- IV. A brief paragraph describing the purpose of the mitigation site, including the authorized impact acreage and type of aquatic resource impacted, proposed mitigation acreage and aquatic resource type approved as part of the Phase II Wetland Mitigation Plan or Permit. Include the dates the mitigation construction was started and the planting was completed.
- V. A brief narrative description of the mitigation site addressing its position in the landscape, adjacent waterbodies, and adjacent land use.
- VI. A short statement on whether the performance standards are being met.
- VII. A narrative description of existing site conditions and how the mitigation site has or has not achieved the goals, objectives and performance standards established for the project.
- VIII. Dates of any recent corrective or maintenance activities conducted since the previous report submission.
- IX. Specific recommendations for any additional corrective or remedial actions.
- X. Estimate the percent of the mitigation site that is establishing into wetland and the type of wetland system (ex: forested, scrub-shrub, emergent). If this differs from what was planned, show the boundaries of the actual wetland area/types on the plans or maps.
- XI. Estimate the percent of the mitigation site buffer that is establishing into forested buffer. If this differs from what was planned, show the boundaries of the actual forested buffer.

area on the plans or maps.

XII. Discussion of growing season and how it was determined for this site.

2. Requirements: List the monitoring requirements and performance standards, as specified in the Phase II Wetland Mitigation Plan Approval Letter, and/or special conditions of the permit and evaluate whether the compensatory mitigation project site is successfully achieving the approved performance standards or trending towards success. A table is a recommended option for comparing the performance standards to the conditions and status of the developing mitigation site.
3. Summary data: Summary data should be provided to substantiate the success and/or potential challenges associated with the compensatory mitigation project. Take one set of photographs from established photographic points any time during May through September of each monitoring year (pictures should be taken at the same time of year when possible). Photo location points should be identified on the appropriate maps and labeled with the direction in which the photo was taken. Submitted photos should be formatted to print on a standard 8.5 by 11-inch piece of paper, dated, and clearly labeled with the direction from which the photo was taken. The photo location points should also be identified on the appropriate maps.
4. Maps and Plans: Maps should be provided to show the location of the compensatory mitigation site relative to other landscape features, habitat types, locations of photographic reference points, transects, sampling data points, and/or other features pertinent to the mitigation plan. In addition, the submitted maps and plans should clearly delineate the mitigation site perimeter(s), which will assist the project managers in locating the mitigation area(s) during subsequent site inspections. Each map or diagram should be formatted to print on a standard 8.5 by 11-inch piece of paper and include a legend and the location of any photos submitted for review. As-built plans may be included.
5. Conclusions: A general statement shall be included that describes the conditions of the compensatory mitigation project. If performance standards are not being met, a brief explanation of the difficulties and potential remedial actions proposed by the Permittee, including a timetable, must be provided. MDE and the Corps will ultimately determine if the mitigation site is successful for a given monitoring period.
6. Monitoring Report Measurements:
 - I. Wetland Area(s):
 - a. Vegetation:
 - i. For each monitoring year, estimate the actual and relative percent cover by dominant plant species (including volunteer plants) and any invasive plant species. Estimate percent cover by plants with a wetland indicator status of FAC or wetter. Estimate the percent survival of woody planted material and number of native trees/shrubs per acre (including native volunteer woody species taller than ten inches). Please note that projects where the vegetation is inconsistent throughout the site may not meet the performance standards (e.g. a site where some portions have high densities of woody species but other portions have low densities).
 - ii. For forested wetlands, measure the height of the tallest five trees within each sample plot in each monitoring year. In year ten or the final year of

- iii. monitoring, measure canopy cover of trees and shrubs.
- iii. Measurements of vegetation based upon performance standard and methods used to evaluate the vegetative success of the mitigation site.
- iv. For each monitoring year, summarize the results from the vegetation plot study, including the density trees/shrubs and percent cover of wetland species present in order of dominance and for each vegetative stratum. Data should be summarized for each plot and also by field or cell. **Do not include the raw plot data in your monitoring report.**

b. Hydrology:

- i. Estimate percent of site that is inundated or saturated to the surface on the dates of the site visits.
- ii. Monitoring data for surface water and groundwater, including hydrograph of measured depth to water table, after calibrating for above-ground height of well. Data should be included for each well separately and then summarized by field or cell. Well locations should be identified on the appropriate maps.
- iii. Discuss how precipitation during this monitoring year compares with historical precipitation data for that location.

c. Soils:

- i. Monitoring data to determine if hydric soils are actively developing. This must include evidence that saturated and anaerobic soil conditions are being met, as measured by alpha-alpha Dipyrindyl, IRIS tubes, or platinum electrodes. Locations of soil tests should be identified on the appropriate maps.
- ii. Provide a soil profile description with accompanying soil photos for each soil location tested above. Photo location points should be identified on the appropriate maps.

d. Remediation:

- i. Describe any problems observed within the mitigation site, such as: excessive inundation, insufficient hydrology, seasonal drought conditions, invasion by undesirable species of plants or wildlife, disease condition for plants, poor plant establishment, adverse water quality impacts (i.e., excessive sediment loading, water pollution, etc.), human encroachment, and slope failures or erosion problems.
- ii. Describe the proposed remedial measures to address the problems noted above.

- e. Remedial measures proposed by the Permittee are subject to review and approval by MDE and the Corps prior to implementation. In the event that remedial measures are implemented, the monitoring period may be extended on a case-by-case basis. The treatment of non-native invasive plant species does not need the approval of MDE and the Corps, but should be completed at the correct time of year by someone with a current pesticide applicator certification and the required MDE toxic materials permit.

II. Buffer Area(s):

a. Vegetation

- i. For each monitoring year, estimate the actual and relative percent cover by

dominant plant species (including volunteer plants) and any invasive plant species. Estimate the percent survival of woody planted material and number of native trees/shrubs per acre (including native volunteer woody species taller than ten inches). Please note that projects where the vegetation is inconsistent throughout the site may not meet the performance standards (e.g. a site where some portions have high densities of woody species but other portions have low densities).

- ii. For forested buffers, measure the height of the tallest five trees within each sample plot in each monitoring year. In year ten or the final year of monitoring, measure canopy cover of trees and shrubs.
 - iii. Measurements of vegetation based upon performance standard and methods used to evaluate the vegetative success of the mitigation site.
 - iv. For each monitoring year, summarize the results from the vegetation plot study, including the density trees/shrubs and percent cover of native species present in order of dominance and for each vegetative stratum. Data should be summarized for each plot and also by field or cell. **Do not include the raw plot data in your monitoring report.**
- b. Remediation:
- i. Describe any problems observed within the upland buffer, such as: invasion by undesirable species of plants or wildlife, disease condition for plants, poor plant establishment, human encroachment, and slope failures or erosion problems.
 - ii. Describe the proposed remedial measures to address the problems noted above.
- c. Remedial measures proposed by the Permittee are subject to review and approval by MDE and the Corps prior to implementation. In the event that remedial measures are implemented, the monitoring period may be extended on a case-by-case basis. The treatment of non-native invasive plant species does not need the approval of MDE and the Corps, but should be completed at the correct time of year by someone with a current pesticide applicator certification and the required MDE toxic materials permit.

Below are the recommended techniques for monitoring mitigation sites. Alternate techniques may be considered, but must be approved in writing by the MDE and the Corps prior to the commencement of the monitoring period.

Recommended Wetland Vegetation Density Measurement Technique

- a. For mitigation sites with a five-year monitoring period, the following method for measuring the success of the vegetative colonization should be conducted annually, subsequent to the completion of the construction of the mitigation project, unless an alternate schedule is agreed upon by MDE and the Corps. For mitigation sites with a ten-year monitoring period, the following method for measuring the success of the vegetative colonization should be conducted once during the first, second, third, fifth, seventh, and tenth growing seasons, subsequent to the completion of the construction of the mitigation project, unless an alternate schedule is agreed upon by MDE and the Corps. Vegetative monitoring shall be conducted between May 1 and September 30 for forested/scrub-shrub systems and between June 15 and September 30 for emergent systems.
- b. Vegetation sample plots shall be located on a stratified random basis over the site in order to sample all areas of restored/constructed wetlands at locations adjacent to each photo location marker. The following minimum numbers of samples will be required:
 - i. If the site is < 5 acres, then a minimum of 3 plots/acre is necessary.
 - ii. If the site is > 5 acres but less than 20 acres, then a minimum of 3 plots/acre is required for the first 5 acres, then 2 plots/acre is required for the remaining acreage.
 - iii. If the site is > 20 acres, then a minimum of 2 plots/acre is required for the first 20 acres, then 1 plot/acre is required for the remaining acreage.
 - iv. All cells, fields, or blocks shall be sampled. A targeted vegetation monitoring approach that correlates monitoring stations with vegetative signatures on aerial photography may be useful for larger mitigation sites.
- c. Each plot shall be of a size no less than 400 square feet for woody plants and 3'x3' for herbaceous plants (or circular with approximately the same surface area). The vegetation data shall be collected during the growing season and shall include:
 - i. Dominant vegetative species identification
 - ii. Percent ground cover assessment
 - iii. Number of woody plant stems greater than 10 inches in height (total and #/acre)
 - iv. The percentage of dominant species FAC or wetter
 - v. Percent survival by planted species
 - vi. An invasive/noxious species assessment including percent cover

Recommended Buffer Vegetation Density Measurement Technique

- a. For mitigation sites with a five-year monitoring period, the following method for measuring the success of the vegetative colonization should be conducted annually, subsequent to the completion of the construction of the mitigation project, unless an alternate schedule is agreed upon by MDE and the Corps. For mitigation sites with a ten-year monitoring period, the following method for measuring the success of the vegetative colonization should be conducted once during the first, second, third, fifth, seventh, and tenth growing seasons, subsequent to the completion of the construction of the mitigation project, unless an alternate schedule is agreed upon by MDE and the Corps. Vegetative monitoring shall be conducted between May 1 and September 30 for forested/scrub-shrub systems and between June 15 and September 30 for emergent systems.
- b. Vegetation sample plots shall be located on a stratified random basis over the site in order to sample all areas of wetland buffer at locations adjacent to each photo location marker. The following

minimum numbers of samples will be required:

- i. If the site is < 5 acres, then a minimum of 3 plots/acre is necessary.
 - ii. If the site is > 5 acres but less than 20 acres, then a minimum of 3 plots/acre is required for the first 5 acres, then 2 plots/acre is required for the remaining acreage.
 - iii. If the site is > 20 acres, then a minimum of 2 plots/acre is required for the first 20 acres, then 1 plot/acre is required for the remaining acreage.
 - iv. All cells, fields, or blocks shall be sampled. A targeted vegetation monitoring approach that correlates monitoring stations with vegetative signatures on aerial photography may be useful for larger mitigation sites.
- c. Each plot shall be of a size no less than 400 square feet for woody plants (or circular with approximately the same surface area). The vegetation data shall be collected during the growing season and shall include:
- i. Dominant vegetative species identification
 - ii. Percent ground cover assessment
 - iii. Number of woody plant stems greater than 10 inches in height (total and #/acre)
 - iv. Percent survival by planted species
 - v. An invasive/noxious species assessment including percent cover

Recommended Groundwater Well Placement and Data Collection

- a. Determine if this wetland is groundwater fed or has a perched water table. Soil profile descriptions must be assessed prior to well installation to identify any restrictive layers to downward water movement. Wells should be installed so they do not penetrate the restrictive layer, but are instead no deeper than the top of the restrictive layer (as discussed in the 2005 Corps document entitled *Technical Standard for Water-Table Monitoring of Potential Wetland Sites ERDC TN-WRAP-05-02*). In most cases, a standard monitoring well installed to 15 inches below the soil surface should be used. Shallower installation depths should be utilized if restrictive soil depths are located within 15 inches of the soil surface. Well design and installation shall be consistent with current Corps guidance.
- b. Specific details on the groundwater monitoring wells and locations shall be provided in the mitigation plan, and must be approved by MDE and the Corps.
- c. The following minimum numbers of groundwater wells will be required:
 - i. If the site is < 10 acres, then a minimum of 1 well/acre is necessary.
 - ii. If the site is 10 to 20 acres, then a minimum of 1 well/acre is necessary for the first 10 acres, then 1 well/2 acres is necessary for the remaining acreage.
 - iii. If the site is > 20 acres, then a minimum of 1 well/acre is necessary for the first 10 acres, 1 well/2 acres is necessary for the next 10 acres, and 1 well/5 acres is necessary for the remaining acreage.
 - iv. Hydrologic zones differentiated by a 1-foot change in elevation should have a minimum of one groundwater monitoring well installed.
 - v. For sites with multiple cells, each cell should have at least one well.
- d. Begin the collection of groundwater well data within fourteen days of the start of the growing season. Take groundwater well readings once every 7 days for the first two months of the growing season and every 30 days for the remainder of the growing season. Record to the nearest inch. Well data should be collected every year during the monitoring period. If well data confirms the presence of wetland hydrology during multiple years of monitoring, the Permittee may request that well data not be required every year. MDE and the Corps will consider the evidence of hydrology, based on the monitoring reports, site visits, and local precipitation, to approve or deny this request.
- e. The growing season (as further detailed in the Regional Supplement to the Corps of Engineers Wetland Delineation Manual) has begun on a site in a given year when two or more different non-evergreen vascular plant species growing in the wetland or surrounding areas begin to exhibit visible

- aboveground growth or soil temperature measured at the 12 inch depth is 41°F (5°C).
- f. Measure and record any surface water present at the monitoring wells.
 - g. Include a copy of the plan showing the location of the wells and surface elevation beside each well. Summarize the information regarding groundwater and surface water elevations, and provide monthly rainfall data for the areas.

Indicator of Saturated and Anaerobic Conditions to Demonstrate the Presence of Active Hydric Soil Conditions

- a. The Hydric Soil Technical Standard (HSTS) developed by the National Technical Committee for Hydric Soils (Technical Note 11) requires documentation of anaerobic conditions and saturated conditions for a soil to be considered hydric:
 - i. For a soil to meet the Saturated Conditions part of the HSTS, free water must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days; and
 - ii. Anaerobic conditions must exist within 10 inches (25 cm) of the ground surface for at least 14 consecutive days. Anaerobic conditions may be determined by one of the following methods, as detailed in the HSTS:
 - (1) Positive reaction to alpha-alpha-Dipyridyl, determined at least weekly.
 - (2) Reduction of iron determined with IRIS tubes installed for 30 days.
 - (3) Measurement of redox potential (Eh) using platinum electrodes, determined at least weekly.

Methods to demonstrate the presence of anaerobic conditions are outlined at (http://soils.usda.gov/use/hydric/ntchs/tech_notes/index.html).

- b. If using alpha-alpha Dipyridyl to show soil reduction, soils should be measured at least weekly during the growing season, at a depth of six inches. Note that alpha-alpha Dipyridyl is also available as paper strips for easier measurement.
- c. Plot locations shall be determined after baseline hydrology data are collected for two years to select areas that represent various hydroperiods. At least one soil sample plot location should be established for each hydroperiod present at the mitigation site. Soil sample plots shall be located within five feet of the monitoring well, and shall be performed during each monitoring year. Additional soil monitoring plots may need to be established where saturation occurs between 5% and 12.5% of the growing season to provide corroborative evidence that wetland hydrology is present. Additional soil monitoring may also be required if soil monitoring occurs during extremely wet or dry years.
- d. Include a copy of the plan showing the location of the data collection, summarize the information, and provide monthly rainfall data for the area.
- e. If soil testing confirms the presence of actively reducing soil conditions during multiple years of monitoring, the Permittee may request that soil testing not be required every year. MDE and the Corps will consider the evidence of anaerobic soil conditions, based on the monitoring reports, site visits, and local precipitation, to approve or deny this request.

Recommended Indicator of Reduction in Soils (IRIS) Tube Placement and Data Collection (summarized from the 2008 document entitled *Protocol for Using and Interpreting IRIS Tubes*).

- a. IRIS Tubes should be installed during the time of the growing season anticipated to have the highest amount of soil reduction (often in the early growing season). They should be installed in a representative portion of the mitigation site, rather than in the lowest/wettest areas. Additional IRIS tube samples should be taken for larger sites and sites with higher changes in elevation.
- b. Create a pilot hole in the soil using a 7/8" push probe.
- c. Be sure tubes are labeled.

- d. Insert the IRIS tube into the hole until the mark on the tube is at the soil surface (50 cm). If they are installed to shallower depths, mark the depth of the soil surface with a permanent marker.
- e. Install five replicates, up to a meter apart, within the study area.
- f. Tubes should be left in place for two to four weeks. Then should be removed and replacement tubes can be installed in the same holes for an additional two to four weeks.
- g. Gently wash off any adhering soil from the tubes.
- h. Estimate the amount of paint removed from each tube.
- i. To improve accuracy, have two people estimate the amount of paint removed, then average the two sets of data.
- j. Find a six inch area on the tube, entirely within the upper 12 inches, with the most paint removed. Estimate the percentage of paint removed from this six inch area.
- k. To meet the Technical Standard for reducing soil conditions as currently specified in the National Technical Committee on Hydric Soils, 30% or more of paint within this six inch section must be removed.
- l. At least three of the five replicates must show this paint removal for the soil to demonstrate that it is reducing.
- m. Include a copy of the plan showing the location of the IRIS tubes, summarize the information, and, if relevant, provide monthly rainfall data for the areas.

Recommended Method of Application of the Alpha-Alpha Dipyrindyl Paper Test Strips

- a. Locate a representative sample area with similar micro topography, vegetative community, etc. as is recommended for most sampling approaches in the Regional Supplements. The area should represent the average condition and not one extreme or another.
- b. Excavate a soil pit to a depth at least the length of your sharp shooter, generally 14-16 in length*. A fresh slice of the profile should be cut from the side of the pit and laid out for observation and characterization. Apply the test strips to the targeted layer(s) at several locations within the representative area to ensure that the majority of the layer is reduced. Document at what depth the positive reaction(s) to the test occurred. The procedure for problematic soils (Step 4d) discussed in Chapter 5 of the Regional Supplements requires that at least 60% of a layer 4 inches or more thick and located within 12 inches of the surface, react positively from liquid alpha-alpha dipyrindyl solution. **Note: The depth of soil excavations for profile characterization can be much deeper depending upon the required depth and thickness requirements of some hydric soil indicators.*
- c. It is important that the test strips are applied only to a fresh, broken face of the desired layer(s). Do not add moisture to soil samples or rub soil against or on to the paper, simply press the paper against a fresh, broken ped face on the soil sample(s). Be sure not to test soil samples that have been exposed to digging equipment to prevent false positive reactions. Record all observations of soil moisture, limit of saturation and the depth to water table on a data form and or in your notes.
- d. A positive reaction on the paper (turning pink or red) should occur in a few moments but can take longer especially during colder periods. The manufacturer indicates that the reaction normally takes place within about 30 seconds.
- e. To increase the validity of your findings, test the targeted layers at several different locations within the same representative area and any other layers which meet an indicator.
- f. Testing multiple samples can exhaust your supply quickly but you can double your reserves by cutting the strips in half. Be careful not to use cutting instruments that could contaminate a sample.
- g. The test should be performed as soon as you remove the sample and all information (depths, layers, etc.) recorded in the appropriate fields of the data form (i.e. hydrology remarks, soil layer comments, soil remarks, etc.). Your soil profile description should also be performed as soon as possible using one of the representative pits. In addition to photo documenting your soil profile, document the application of the strips before and after any potential reaction.

- h. If the soil is allowed to dry before implementing the test strips or characterization of the profile, dig another representative pit and start over.