WRP Technical Note VN-EM-3.2
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Basic Considerations for Vegetative Design of Wetlands

PURPOSE: This technical note addresses some conceptual or basic considerations for wetlands development or restoration with an emphasis on vegetation. A conceptual model is presented for this process.

BACKGROUND: Wetland development or restoration is often initiated without clear objectives of why the wetlands are being developed or restored other than to meet mitigation requirements. Little thought is given to the functions that wetland will perform and the economical and political requirements to develop or restore that wetland. More often than not, mitigation projects are implemented that do nothing more than plant some wetland vegetation so that legal restraints are satisfied and the project can proceed. Very little follow-up is done to check for plant establishment and that the wetlands are functioning as intended, if an intended function was indeed outlined at the beginning. Perhaps the problem is because, in part, there is not a conceptual model from which to plan the selection of wetland vegetation, planting techniques, handling, and aftercare that will, in part, determine the function or functions of the wetland. This technical note should be used as a conceptual design guide and in conjunction with a more specific design sequence presented in WRP Technical Note WG-RS-3.1.

MODEL COMPOSITION: This note draws largely upon similar thought processes presented by Leiser (1992) for use of vegetation and engineered structures for slope protection and erosion control. The processes are also similar for wetlands development and restoration and other areas of restoration ecology. The model involves the following stages:

Establishing objective(s)
⇓
Asking a series of questions/Developing answers to the questions
⇓
Development planning
⇓
Procuring plants, if necessary
⇓
Implementation, to include follow-up monitoring and management

- Establish objectives. Clear-cut objectives are needed to start any project, whether for wetlands development or restoration or any other project. The objectives may relate to developing wetlands to provide habitat, improve water quality, or a host of other desired functions. To meet these objectives, which are often driven by legal mandates, such as mitigation for dredging or filling wetlands, questions must be asked and answers provided before the project can proceed.

- Questions to be developed and answered. Any wetlands development/restoration project has several components or constraints. These components or constraints are interdependent and must be considered, thus generating an abundance of questions that should be answered, if possible.

They include the political, economic, climatatological, physical, edaphic (soils), and biological components of the project. All place constraints on the design of a project plan. Both the asking and answering of these questions relative to these components lead to the Plan of Development. Once the plan is well developed, procurement of plants may be required. After or concurrent with this procurement, implementation of the plan can proceed.

The political component includes governmental regulations, such as those presented in Section 404 of the The Clean Water Act (formerly known at the Federal Water Pollution Control Act, 33 U.S.C. 1344). It also includes public pressures, such as restricting wetlands development to the use of only native plant species or plants that are grown in a nursery as opposed to those borrowed or harvested from the wild. Governmental regulations and/or public pressures may also mandate that certain wetland functions be developed or restored. Lack of grazing controls, limitations on use of chemicals for rodent, insect, or weed control or fertilizers are other examples of these constraints and must be considered in any wetlands design criteria protocol. The political component also includes the negative human factors of vandalism and trespass by foot and off-road vehicles as well as the positive factor of public pressure for improvement of the environment.

The economic component is perhaps the most common limiting factor in wetlands development and restoration. This factor invariably affects the final decisions on the selection of plant species and planting densities, as well as pre-project experimentation and after-care activities. Often, construction and engineering of facilities take precedence and wetlands development or restoration for mitigation purposes is done with the concept of meeting legal requirements rather than what will work to obtain the desired functions of the wetland. A wetland design protocol must include funding for monitoring and allow for remedial planting and management of the site to meet the objectives of the project.

The climatatological component includes all of the aspects of the climate of a project site: rainfall (amount and distribution), temperature (heat and cold, time, duration, and intensity), humidity, day length, etc. Climatatological components affect wetland plant species selection, how those plants will be planted, and treatment after planting. With some exceptions, wetland projects in humid regions of the country with ample amounts of rainfall and along permanent-flowing streams will probably require less effort to develop than those along intermittent-flowing streams in dry climates. In desert climates, where fewer plants in the wetland inventory can be chosen than in humid climates, learning these plants' life requisites is essential for successful planting. The probability for wetlands development failure is higher with fewer species planted.

The physical component includes physical parameters of a project: site stability such as subsidence or accretion; aspect (compass bearing), which in turn influences environmental factors, such as temperature (south and southwest facing sites are hotter and evapotranspiration is higher than on other bearings); hydrodynamic aspects, such as water sources (groundwater, surface water), and water frequency, timing, depth, and duration; and energy sources such as wave and current action; and geomorphic features, such as landforms and terrain influences, such as the impacts of off-site water sources.

The edaphic component includes all the soil parameters: texture, structure, fertility, erodability, chemistry, etc. Soil texture, structure, and depth all affect the water-holding capacity of a soil and need to be considered when determining water retention requirements or supplemental irrigation requirements during dry periods of the year.

The biological component is one of the most important components and is interdependent with the other components. It includes habitat requirements of animal and plant species and can be modified to some extent to meet these requirements, if the life requisites of these species are known. This component also includes the availability of suitable plant species that, in part, make up the habitat for various wetland animals. Choices must be made between native and introduced species, obtaining plants from commercial nurseries, or from the wild. This component also includes the propagation and cultural practice for the plants, planting, and aftercare. It includes plant diseases, insects, predators, and the presence or absence of grazing animals. Protective screen sleeves or deer and grazing animal exclosures must be provided if these risks are present.

The potential for damage from insect, rodent, deer, and other predation must be considered and protection provided to planted wetland vegetation.

- Plan of development. Many of the questions regarding the above components can be answered off site, but a site analysis is mandatory before plants can be procured or before project implementation can occur. In the site analysis, each component must again be examined to include the various factors or parameters and what will influence wetland vegetation development or restoration. A general guideline for the site analysis, applies "Read" nature in the project area. From observations of a reference site, many answers can be found about what kinds of plants to use, invader species that are apt to occur, causes of problems, etc. The same or similar species that occur at the reference site should be procured. In a site analysis, much of the data from a reference wetland can be taken to answer the questions posed. Hydrological and soils data, for instance, may have to be procured, if they do not exist.

- Procurement of plants. Prior to the implementation of the project, procurement of plants must be made unless the project will use natural regeneration, e.g., reliance upon spread of existing plants, or spreading of mulch enriched with wetland plant seeds and propagules. To select vegetation for the project, vegetation existing on or near a site and on similar nearby areas which have revegetated naturally are the best indicators of the plant species to use. If commercial wetland plant sources are not available (USDA, Soil Conservation Service, 1992), then on- or off-site harvesting can be considered. When nourishing plants, care must be given to local or federal laws prohibiting such plant acquisition and decimating the natural stands of wetland plants must be avoided. Additionally, care must be taken to assure that pest species, such as purple loosestrife (*Lythrum salicaria*), are not collected and transferred to the project site.

  The availability of plants of the appropriate species, size, and quality is often a limiting factor in the final selection and plant procurement process. Some native plant species are very difficult to propagate and grow and many desirable species are not commonly available in commerce, or not available as good quality plants. As demand increases and nurserymen gain more experience in growing natives, this limitation should become less important (Leiser, 1992).

  Plant species composition and quantity can often be determined from the project objectives and wetland functions desired. As a general rule, it is advisable to specify as many species as possible and require the use of some minimum number of these species. Maximum and minimum numbers of any one species may be specified. Selection and acquisition of wetland plant species for wetland management projects is discussed more specifically in WRP Technical Note VN-EM-2.1.

- Implementation. This stage is the culmination of the conceptual and detailed design and includes site preparation and construction, planting, monitoring, and aftercare. For the vegetative design

to be successful, this stage must have close supervision throughout by someone familiar with implementation of wetland development and restoration. This stage requires close attention to detail. Presently, there are relatively few people in the United States that have had the experience in doing this work well. Many contractors have done hydroseeding or sowing of grass cover for revegetation, but few have installed integrated projects including water control structures, biotechnical or bioengineering works, if required, and wetland woody and herbaceous plantings. It is important when initiating a wetland development or restoration project to consider who is available and capable of actually carrying out the project. This may include a team of persons with disciplines in such fields as engineering, soils, geology, hydrology, biology, and plant science. Regarding vegetation, the person should possess both training and experience in wetlands plant science and development. They should be willing to furnish credentials and references to that effect. It is mandatory that person be on site during project construction and especially planting.

All of the efforts to address the various components of design will be in vain unless plants are handled and cared for properly when planted and even after planting in many cases.

Equipment and materials. In the plan of development, consideration should be given to the equipment and materials required for vegetation handling and planting at the implementation stage. The tools required and the planting techniques will depend on the type of vegetation, i.e., woody or herbaceous, the size of plants, soils, and the size of the project and site conditions. Freshwater herbaceous plantings with low wave or current energy environments may call for tools like spades, shovels, and buckets. In contrast, high-energy environments of waves and currents may require tools for biotechnical installations. Such tools includes chain saws, lopping and hand pruners for the preparation of woody cuttings, and materials for woody biotechnical methods; or heavy hammers and sledges for driving stakes in biotechnical treatments such as wattling and brush matting. Specialized equipment may be required when moving sod or mulches containing wetland plants or plant propagules.

Other equipment and materials may include fertilizers, soil amendments, (i.e. lime), fencing for plant protection, and irrigation equipment for keeping plants alive during dry conditions. Other equipment and materials for keeping plants alive before they are planted may include shading materials such as tarps, buckets with water for holding plants, and hydraulic water pumps and hoses for watering or water trucks.

Planting techniques. There are several planting techniques for wetlands development or restoration ranging from simple digging with shovels or spades and inserting sprigs (rooted stems) or cuttings to moving large pieces of sod or mulch. Other methods consist of direct seeding or drilling individual seeds such as acorns of wetland oak species.

Monitoring. Most importantly monitoring and necessary aftercare must be a part of any wetlands design and must be included in the plan of development. The intensity and frequency of monitoring and aftercare will depend on site conditions, such as harshness of climate, probability of animal disturbance, high wave or current conditions, etc., and on established success criteria. The duration of vegetation monitoring will depend on the intended functions of the wetland. As an example, a wetland constructed for wastewater treatment may only require monitoring until the plants are well developed and assimilating waste materials; in contrast, a wetland developed for wildlife habitat may need to be monitored until it acquires the life requisites for particular target wildlife species. From monitoring, it may be determined that remedial efforts of additional planting or aftercare will have to be implemented.

On many sites, it is essential to protect wetland plantings from damage by animals, such as waterfowl, or beaver and other mammals. In a prior research program, geese were prevented from extirpating emergent aquatic plants planted along a Nebraska reservoir shore by erecting a temporary fence using wooden stakes and string. A row of stakes was placed lakeward of the wetland plantings and three courses of cotton string were attached to them. The waterfowl apparently do not like to land in what appears to be a narrow corridor that may hamper their escape. Fencing the entire site may be necessary where deer populations are heavy or where domestic animals graze.

The use of irrigation may be required during aftercare and will improve growth and survival of plantings that are installed during dry seasons and in dry soils such as sites occurring in bottomland hardwood systems. The decision about irrigation must be made based on economics contrasting the need to irrigate with the cost of possible mortality and the consequences of failing to obtain the desired wetland functions.

ADDITIONAL RECOMMENDED READING:

Gray, D. H., and Leiser, A. T. 1982. "Biotechnical Slope Protection and Erosion Control," Van Nostrand Reinhold Company, New York.

Leiser, A. T. 1992. "Biogeotechnology for Slope Protection and Erosion Control," Unpublished Lecture Notes for "Reservoir Shoreline Erosion/Revegetation Workshop," Fergus Falls, Minnesota, June 1992, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

USAEWES. May 1992. "Wetlands Engineering: Design Sequence for Wetlands Restoration and Establishment," WRP Technical Note WG-RS-3.1, Wetland Research and Technology Center, Vicksburg, MS.

USAEWES. May 1992. "Design and Construction Requirements for Establishing Herbaceous Wetland Vegetation," WRP Technical Note VN-EM-3.1, Wetland Research and Technology Center, Vicksburg, MS.

USAEWES. Jan 1993. "Selection and Acquisition of Wetland Plant Species for Wetland Management Projects," WRP Technical Note VN-EM-2.1, Wetland Research and Technology Center, Vicksburg, MS.

USDA Soil Conservation Service, 1992. "Directory of Wetland Plant Vendors," WRP Technical Report WRP-SM-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

CONCLUSIONS: The conceptual wetland design model presented allows appropriate planning for assuring success wetlands development or restoration.

POINT OF CONTACT FOR ADDITIONAL INFORMATION: Mr. Hollis H. Allen, USAE Waterways Experiment Station, ATTN: CEWES-EN-S, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, Phone: (601) 634-3845, author.