



General Natural Area, Detention/ Water Quality Pond and Drainage Corridor Design Guidelines

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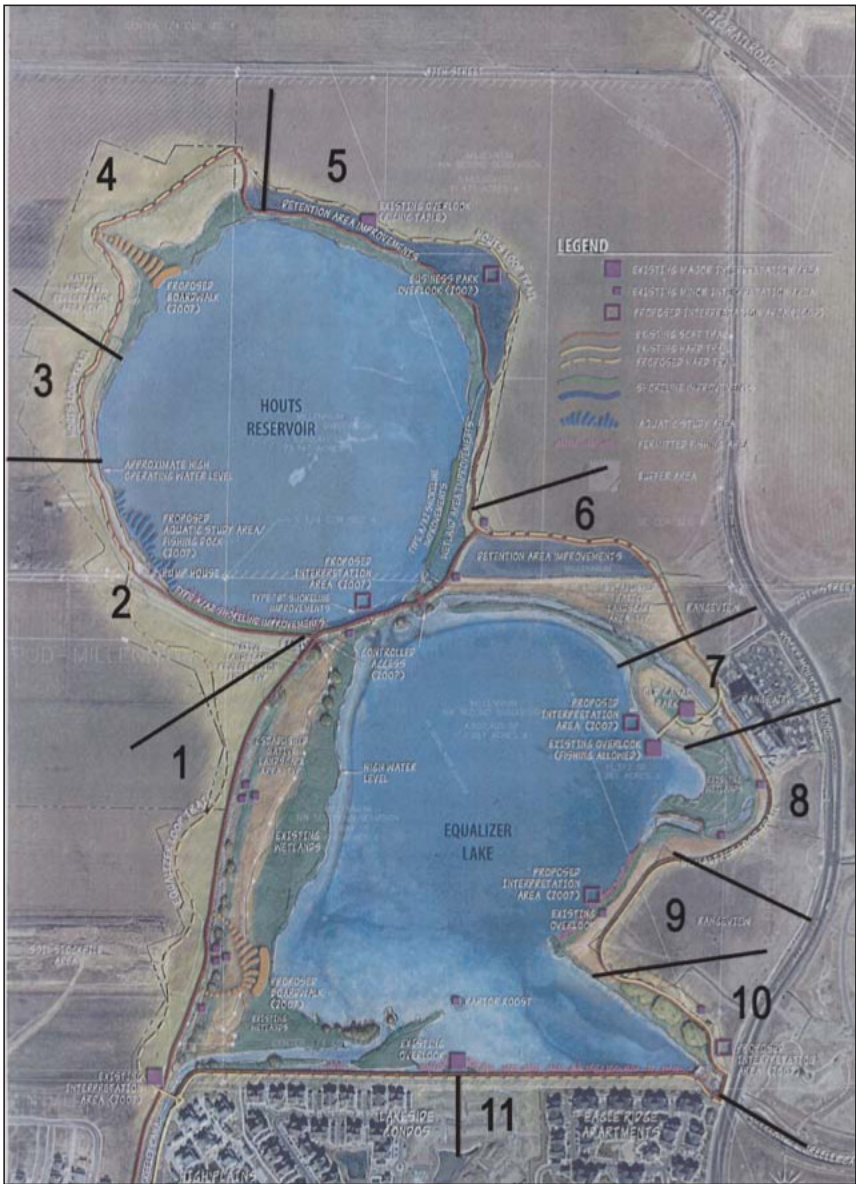
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July 2026

Introduction: Conservation Vision

To create, restore, enhance, and protect diverse, healthy, and visually appealing historic native ecosystems that serve a variety of site appropriate landscape functions (ecosystem goods and services). These ecosystems will shape visitor movement and use patterns, wildlife use and movement, resource interpretation, and provide a backdrop for which conservation can occur.

High Plains Environmental Center and Centerra Habitat Guidelines



Habitat restoration in urban and suburban environments involves mimicking the proper composition and structure of food, water, shelter, and space as found in natural habitats. Additionally, it involves the functional processes necessary to perpetuate the habitat composition and structure. Restoration involves educating visitors about ethical wildlife viewing and habitat appreciation. It also involves ecological designs that direct visitor activities and shape visitor use patterns. In some areas guidelines may require excluding visitors whereas other areas may be open and enhance visitor experiences with good views and interpretive areas.

Within Centerra, many areas of open space have been dedicated to serve as sustainable landscape for recreational enjoyment and as habitat for plants and wildlife. To make this open space the best habitat it can be, habitat goals have been established that will provide a larger opportunity for wildlife and plant habitat. The following guidelines have been developed to aid design teams and installation contractors in creating sustainable ecosystems to provide all of the desired landscape values - sense of place; landscape functions; as well as habitat for the conservation of plants and animals.

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Habitat Goals and Objectives:

1.0 Plant and Animal Diversity

- Create and protect habitat for a diverse array of plants and animals, particularly birds, butterflies, amphibians, and rare wetland plants.
- 1.1 Increase plant species diversity including the number and variety of butterfly host grasses, forbs, and shrubs as well as the number of nectar plants and shelter plants.
- 1.2 Increase the number and variety of native shrubs and trees that provide valuable cover, berries, insects, nest sites and other resources for migratory, nesting, and wintering birds.
- 1.3 Increase the number and variety of wetland-dependent reptiles and amphibians, especially creating better places for amphibian breeding to occur.

2.0 Aesthetic Appeal

- Create a beautiful landscape that visitors will enjoy and appreciate without sacrificing its value for wildlife and plant habitat.
- 2.1 Increase the amount of shade and resting areas along trails and open spaces while providing habitat for wildlife and viewing opportunities for visitors.
- 2.2 Use plant species that maintain their beauty in a variety of seasons, such as a species with colorful and showy flowers, fall leaf color, winter texture, and grasses that persist through the winter while they provide good wildlife habitat.
- 2.3 Use vegetation to frame viewsheds and enhance the natural aesthetic qualities of the site.

3.0 Stormwater Function

- 3.1 Maintain the primary functions of detention ponds and stream drainages to attenuate floods and improve water quality while creating and improving wildlife habitat.
- 3.2 Manage vegetation to insure proper drainage functions are maintained while allowing habitat values to be expressed to the extent possible.

4.0 Shape Visitor Use Patterns

Use available high water tables and stormwater runoff to create opportunities to improve and restore habitat while shaping visitor use patterns to improve the conservation value of the land.

- 4.1 Create ecosystems where habitat can be established for American Black Currant, Giant Burreed, Sweet Flag, Tulip Gentian, and other rare and interesting wetland plants. Use these resources to restore tallgrass prairie plant communities and other rare plant communities.
- 4.2 Create ecosystems that will buffer high quality resources such as Western Grebe nesting areas from visitor disturbance and future community development.
- 4.3 Improve duck nesting habitat by increasing the total tall wetland and subirrigated prairie as nesting cover, reducing susceptibility to predators and disturbance by visitors.
- 4.4 Use water to wet areas and create denser plant communities that are attractive to wildlife while limiting human presence in these areas.
- 4.5 Use water to enhance the overall site’s species, habitat, and landscape diversity.

5.0 Sense of Place

Fit the character and context of the site and create a sense of place with the planned habitat modifications.

Habitat Guidelines Planning and Adaptive Management Process Overview

The following guidelines provide step by step instruction for applicants use during development of site design of natural areas, detention ponds and stream channels within Centerra. The steps are summarized below and then illustrated in more detail in the following paragraphs.

I.0 Inventory

- 1.1 Assess the ecological and cultural site conditions of the proposed natural area, detention pond, stream channel (“project area”), and the adjacent lands.

2.0 Identification

- 2.1 Determine the primary landscape functions (aesthetics, water and sediment, wildlife and plant conservation) that are important to the project area, any unique opportunities, and primary project constraints.

3.0 Zoning

- 3.1 Delineate the project area into functional groups - those that have similar aesthetic needs and desires, similar water and sediment functions, and similar wildlife and animal conservation opportunities and constraints.

4.0 Design

- 4.1 Develop a plan which mimics the specific ecological attributes and conditions found in high quality natural areas to achieve the landscape function and specific conservation goals desired in the project area. Use the design guidelines on NAT 4-6 and Appendix Charts 4-7. The description of Design Principles, coupled with specific Design Guidelines and Standards is intended to assist in the identification and implementation of a strong, consistent design direction and level of quality. Standards are to be treated as techniques that are mandatory. Guidelines reinforce the intent of the Principles, but may be subject to interpretation by the designer as approved by the Design Review Committee.

5.0 Implementation

- 5.1 Create the design in the project area making appropriate on-site adjustments to fit the specific site conditions.

6.0 After Care

- 6.1 Manage the project area making mid-course corrections and adapting the design to site conditions to achieve the landscape function and conservation goals.
- 6.2 Provide a two year (minimum) management period. The period begins at the time of substantial completion for restoration areas.

7.0 Monitoring and Assessment

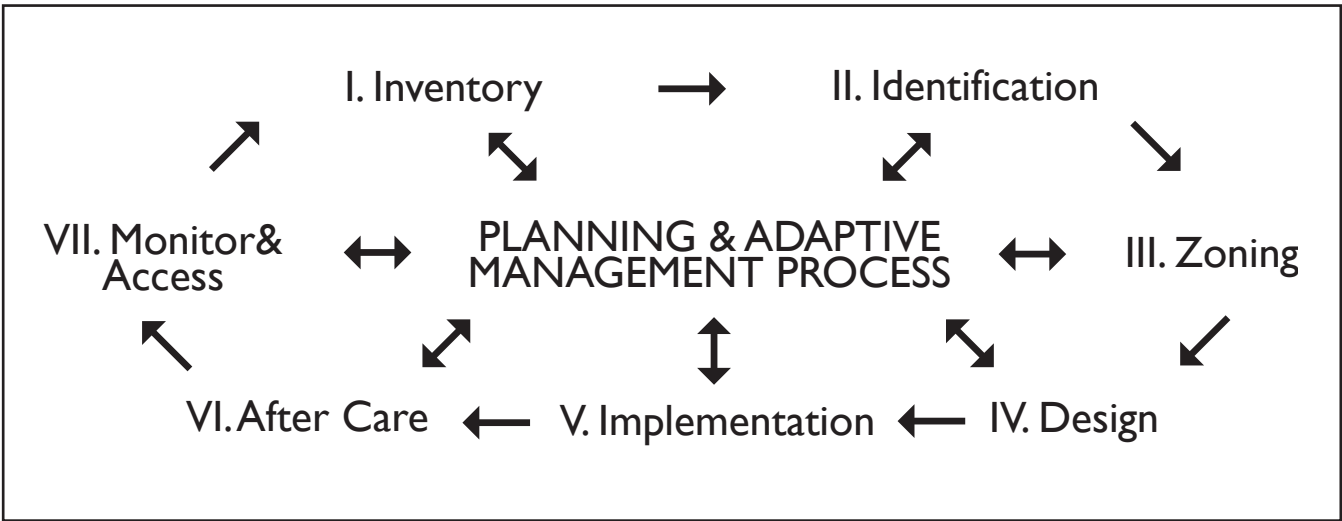
- 7.1 Create photo points, plots, transects, and collect appropriate information on the composition, structure, and functions on the project including the desired landscape functions and conservation goals.
- 7.2 Feed this information back into the next project.

Habitat Guidelines Planning and Adaptive Management Process

I.0 Inventory

Obtain information on the following topics prior to developing a detention pond or natural area landscape plan.

- 1.1 Topography, slope, and aspect (Civil).
- 1.2 Determine hydrology including depth to groundwater (Geotechnical), and flood frequency intervals (Hydrology).
- 1.3 Obtain agronomic soil tests from topsoil and subgrade. Submit soil samples to soil testing laboratory for an agronomic evaluation of texture, pH, salinity, and nutrients.
- 1.4 Inventory existing undisturbed and disturbed plant communities, including noxious weeds. Evaluate wildlife potential as part of an environmental analysis.
- 1.5 Evaluate the biological conservation potential of the project site and adjoining parcels including habitat patch size, corridors and connectivity, edge effects, and buffer potential. Evaluate cultural conditions and regional influences on the site such as proposed adjacent developments and other potentially connecting open lands. In addition, evaluate the relationship of the site to current and anticipated trails, developed recreation sites, level of human presence, and other recreational facilities.



2.0 Identification

- 2.1 Based on the inventory, identify landscape functions that might be needed or best expressed on the site and determine the site’s overall potential as a natural ecosystem including the opportunities and constraints of the site
- 2.2 Typical landscape functions might include the following (See NAT Appendix D for a detailed description of the various functions):

2.2.1 Aesthetic Considerations:

- Tall Visual Screen
- Low Visual Screen
- Trail Screen
- Viewshed
- Viewshed Framing
- Auditory Screen
- Wind Moderator
- Temperature Moderator

2.2.2 Water and Sediment

- Water Quality Filter
- Flood Attenuation
- Erosion Control
- Sediment Storage

2.2.3 Wildlife and Plant Conservation

- Movement Corridor
- Stepping Stone
- Buffers
- Wildlife Breeding
- Wildlife Feeding
- Wildlife Resting
- Migratory Stopover
- Targeted Restoration Area
- Protection of Local Existing Historic
- Herbaceous Wetlands
- Riparian Shrubland
- Upland Shrubland
- Park-like and Shrubby Woodlands
- Short, Medium and Tallgrass Prairie

3.0 Zoning

Use Charts 1-7 in the NAT Appendix C, compiled with collected data to identify appropriate ecosystems and plant communities (additional plantlists can be found in the NAT Appendix B).

3.1 Delineate land areas into functional groups which have similar desired landscape function.

4.0 Design

4.1 General Design Considerations

- 4.1.1 Create an ecosystem that is as diverse and practical as possible to accomplish the habitat goals as set forth in the goals section of these guidelines, keeping in mind the context of the site, including aesthetics and landscape functions.
- 4.1.2 **S** Mimic existing native ecosystems that are found in Colorado, from the base of the Rocky Mountains to the eastern edge of the state.
- 4.1.3 Restore the site’s composition (components), structure (horizontal and vertical arrangement), and to the extent possible the functions (processes and stressors).
- 4.1.4 Detention ponds should be designed so that natural processes such as fire, flooding, grazing, and soil disturbances can be prescriptively applied on the site. These functional process help to reduce the dominance of aggressive plants, allowing opportunities for other conservative native plants to become established and aid in biological diversity.
- 4.1.5 **S** Create unique opportunities for diversity by making flat areas more topographically diverse by creating a variety of slopes, aspects, and depths to ground water. Plant forbs, shrubs, or trees that compete better in these environments less suitable for grasses and grass-like plants, which generally dominate and out compete other plants in flat areas. Combine these techniques to create an array of diverse soils and exposures for plants and animals to thrive.
- 4.1.6 **S** Use appropriate native plant materials from the closest ecotypes available in the seed and plant market (e.g.: Western Native Seed, Pawnee Buttes Seed Company, Arkansas Valley Seed).

4.2 Other Design Considerations

4.2.1 General Wildlife Considerations

- a) If possible, open channel drainage into the detention ponds shall be used to facilitate habitat connectivity and reduce culvert maintenance issues. Oversize culverts to facilitate flood flow conveyance, wildlife movement through the structures, and easier access for maintenance.
- b) Design detention ponds to the extent possible with positive grades to the outlet to limit mosquito production.



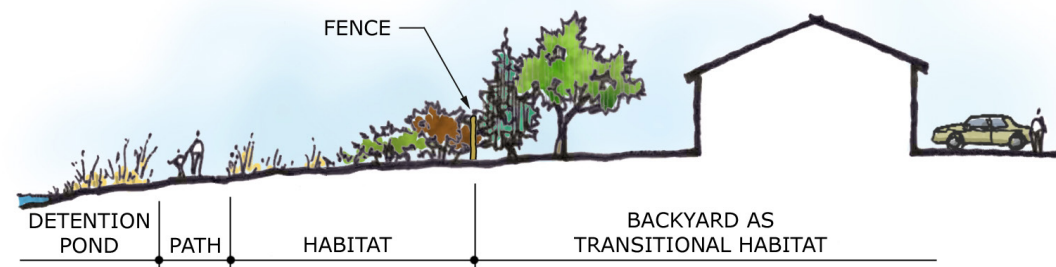
- c) Fallen logs, old tree trunks, or large limbs can be added to the pond to provide perching sites for birds, basking areas for reptiles and amphibians, loafing sites for waterfowl, and add structural habitat elements to the detention basin. These need to be anchored to the bottom so that when water is in the basin they do not float up and clog outlet structures.

4.2.2 Sedimentation, Erosion, and Water Flow

- a) **S** Critical flow areas, especially at inlets and outlets where erosion is possible, should be planted with wetland plugs and/or should be armored with permanent turf reinforcement mats as a substitute for at-grade riprap. Riprap may be used below-grade in certain situations, but should be limited on the surface to achieve a more natural appearance at the ponds and to improve water quality.
- b) **S** Proper grading should be used to facilitate the flow of water from outlet structures and to dissipate its energy.
- c) **S** Outlets need to be designed in such a way that the lakeshore, downstream wetlands or riparian areas are not degraded. Elevations need to be precise and field fit to make sure they work and do not degrade the area near the outlet. Run down channels may need to be created to a lower water line elevation depending on the slope of the lakeshore or the stream at the outlet. It will be important to design these outfalls correctly so as not to adversely impact high quality areas or, high quality receiving areas need to be created to be able to receive the additional flows. Knowledge of outlet release flows and velocities will be important, as well as current vegetation composition and structure at these outfall points.
- d) **S** Design drop structures to be aesthetically pleasing while still achieving energy dissipation characteristics.

Drop Structure Examples:

- e) Sediment catchments of unnatural sources such as parking lots and roads should be created as close to the sediment source as possible to improve the water quality of receiving waters and downstream detention ponds. Design sediment traps for easy cleaning.
- f) In addition to 2e, or as a substitute, pre-forebays can be designed adjacent to detention ponds to act as a first filter before the main water quality or detention ponds. Design forebays for ease of maintenance and cleaning.



- g) **S** Design sides of ponds with a 4:1 or flatter slope to reduce the possibility of rill and gully erosion on slopes, improve the ability to manage these slopes, and to create wider planting zones for wetland and subirrigated plant species. Employ erosion control fabric or similar erosion control measures on slopes steeper than 6:1.
- h) **S** Depending on the water surface elevations and the size of the ponds, most ponds should be created with some topographic diversity on the bottom including high spots, low areas, and peninsulas of higher ground while maintaining positive drainage to the outlet. Retention of water is not permitted as per guidelines from the Loveland Airport. Some flat bottom ponds are permissible to add a diversity of ponds to the overall palette, but generally topographic variability adds to plant species diversity, structural complexity, aesthetic interest, and generally creates better habitat.

4.2.3 Aesthetics and Visitor Management

- a) **S** Detention ponds should be integrated into the existing landscape so as not to be a visual intrusion but an enhancement to the topography and an aesthetic amenity.
- b) **S** Detention ponds in identified sensitive natural areas should be used strategically to shape visitor use patterns, to allow people to view wildlife and scenery while acting as a wildlife blind to screen movement of visitors. Properly sized berms integrated with the proper elevation of trail corridors can achieve this balance between good viewing opportunities while screening visitor movement. Vegetation on pond berms can help balance viewing lanes with screening as well. Detention ponds including berms and vegetation should be used to reduce the trail's zone of influence on the surrounding habitat. A well scaled cross sectional drawing including walkers (children and adults), bicyclists and vegetated berms can aid in designing these features. A variety of recreational and visual experiences are desired.
- c) **S** Access by trails should generally not encircle the entire pond in a loop fashion, unless the trail is screened or set back far enough so as not to disturb the whole shoreline.

4.2.4 Relationship to the Built Environment

- a) **S** Generally buildings and homes constructed next to detention ponds and other habitats should "back" to these areas and act as a viewing blind. The activities of people and associated facilities such as parking lots, public entrances, and primary doors should generally be on the opposite side from the detention ponds and other habitat areas.
- b) **S** Buildings and homes should be set back to the degree possible so as to buffer high quality habitats. This will help to limit the intrusion of light, noise and pets into the open space.
- c) **S** Landscaping on the habitat side of the building should consist of native plantings, to the degree possible, and provide a natural transition between the built environment, detention ponds, stream corridors, and other habitat areas.
- d) **S** All native and natural planting areas should use plants depicted in the NAT Appendix B.
- e) **S** All horticultural or non-native plants should be screened for invasiveness into natural areas by using the Nature Conservancy's Nature Serve Explorer web site as well as using a general Internet search with the "species name" and the word "invasiveness". Invasive and aggressive non-native or horticultural plants should be strictly avoided, especially adjacent to natural areas, open spaces, or detention pond habitats where additional moisture may aid in the establishment and reproduction of these non-native plants. Nature Serve Website: <http://www.natureserve.org/explorer/servlet/NatureServe?init=Species>
- f) **S** Access trails or other entrance points into detention pond habitat and open space areas, especially HPEC lands, should be limited by design to selected areas that are not adjacent to high quality habitat.
- g) **S** The intrusion of light and noise should be limited in quality habitat areas. Install only low-level or ground level lights and cutoff lights so as to reduce impacts of light on wildlife, night time educational programs, and star viewing. The use of well designed berms with vegetation and other types of vegetated landscape buffers can be used to reduce noise and the effects of lighting. All lighting within the 20' boundary of natural areas should be 0.1 tenth footcandle or lower.
- h) **S** Dogs and cats can have a tremendous impact on native wildlife, particularly small mammals and songbirds. Provide appropriate signage that requires all pets to be leashed and kept on trails.

4.2.5 Trees, Shrubs and Vines

- a) Plant trees, shrubs, and vines after drill seeding, generally in the early spring or fall. This can be done right after the initial seeding effort or after herbaceous plants are established and weeds are under control. Remember that established grasses compete well with woody plants for water and nutrients, especially in fine textured soils. Planting woody plants in bare areas, providing supplemental water for two to three years, and mulching are helpful to get plants established. One gallon vines and five gallon trees and shrubs are recommended for good establishment.
- b)  Concentrate or mass woody plants into beds or planting zones to create more habitat impact for wildlife more quickly. This will also reduce watering, weeding, and other management costs. Steel header shall not be used to edge planting beds in natural areas.
- c)  Plant each species in the optimal moisture zones as per the tree and shrub list on page NAT Appendix B-4.
- d)  Select woody plants that can be used strategically above and around inlets and outlets to lessen the negative aesthetic affects of such man-made structures.
- e)  Trees and shrubs should be caged for several years to keep voles, cottontail rabbits, and beavers from chewing on the bark. Cages consist of an 18" to 24" diameter ring of ½" hardware cloth or narrow gauge chicken wire held down by rebar and landscape staples. Cages shall be installed prior to substantial completion.
- f)  Construct tree wells around each woody plant with 3-4" of wood chip mulch to help hold moisture, increase mycorrhizal activity, reduce weed and grass encroachment and competition, and direct supplemental water to the roots.
- g) Masses of plants can be treated like a bed with each tree or shrub having an individual tree well. However, the entire bed may be caged as a group and the whole planting mass mulched. This reduces installation costs and may save wire.

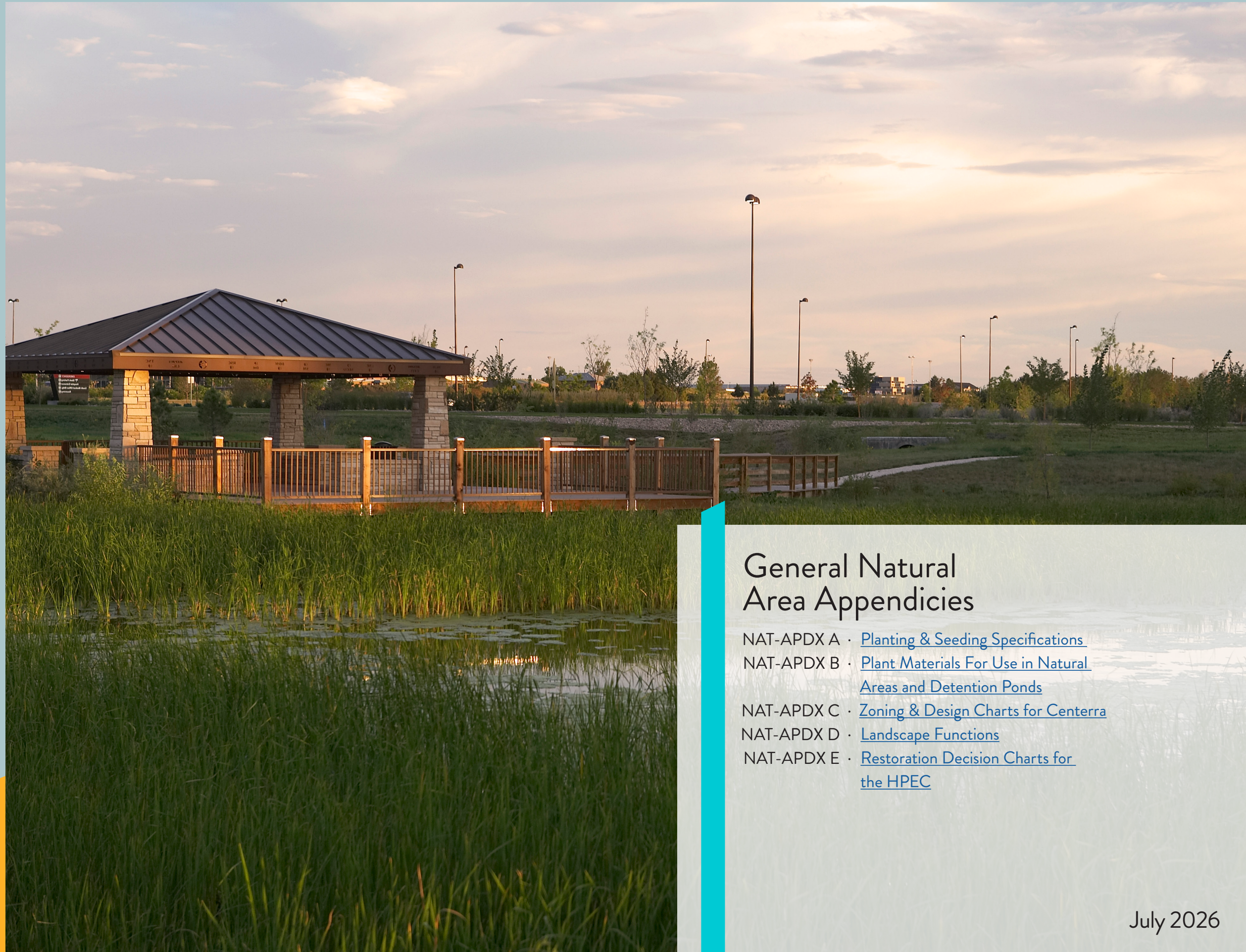
4.2.6 Wetland and Sub-irrigated Plugs

- a) Generally, plugs are planted after drill seeding from mid-May through July. Planting small plugs in the fall is not generally recommended because of plant loss due to Canada geese herbivory. Planting plugs can be done right after the initial seeding effort or after seeded herbaceous plants are established and weeds are under control. This could be 2 to 5 seasons after initial seeding. For these later plantings, wetland plugs should be concentrated in bare areas and areas needing erosion protection.
- b) Plant wetland and subirrigated plugs in super cells, 2.5" pots, deep pots, or one gallon plants for good establishment.
- c) Concentrate or mass wetland plugs in critical areas where erosion is anticipated or where moisture regimes favor establishment and growth of the particular species. Because water regimes are not always clearly known and weather patterns are not predictable,
- d)  Plant each species in the optimal moisture zones as per the tree and shrub list on page NAT Appendix B-4.
- e)  In addition to the above planting technique, if the hydrology is very unpredictable, use species with wider tolerances to moisture conditions and species with a taller stature so that they do not become completely inundated.
- f) Critical areas may be planted on one foot centers or two foot centers and can be protected with turf reinforcement mats, jute or other erosion control blankets, depending on the situation. With landowner permission and on non-jurisdictional sites, larger plugs may be selectively hand dug from open space areas to supplement purchased plant material, especially for stabilization of critical sites. See the Sedimentation, Erosion, and Water Flow Section, Page NAT-4 for use of plugs on inlets and outlets.
- g) Plugs can be used to improve habitat, add color and aesthetic interest, improve species diversity, or increase populations of unique and rare wetland plants.
- h. Selected wetland and subirrigated plugs can be used strategically around inlets and outlets to lessen the negative aesthetic affects of such man-made structures.

- i. If herbivory by geese, muskrats or other animals is anticipated or becomes a major problem, plugs can be caged or covered with chicken wire, jute, or other products to protect them. Grids of string slightly above the water elevation can also be laid out across the site to reduce waterfowl access to newly planted wetlands.
- j)  Wetland plugs may be necessary in areas that cannot be seeded due to constant inundation or extreme saturation of the pond bottom or periodic inundation during the seasonal seeding windows. Pumping water out of the pond to seed or waiting for a dry period to seed may be another option to putting in plugs.
- k)  Follow the specifications in the NAT Appendix A for seeding.

SEE APPENDIX FOR:

[5.0 Implementation](#)
[6.0 After Care](#)
[7.0 Monitoring & Assessment](#)



General Natural Area Appendices

NAT-APDX A · [Planting & Seeding Specifications](#)

NAT-APDX B · [Plant Materials For Use in Natural Areas and Detention Ponds](#)

NAT-APDX C · [Zoning & Design Charts for Centerra](#)

NAT-APDX D · [Landscape Functions](#)

NAT-APDX E · [Restoration Decision Charts for the HPEC](#)

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NATURAL AREA APPENDIX

GENERAL
DESIGN
GUIDELINES

NAT Appendix A - Planting and Seeding Specifications

INDEX:	
A. General Seeding for Detention Ponds	Pages NAT APDX A-1 to A-2
B. Detention Pond Easements, Construction and Restoration	Pages NAT APDX A-2 to A-5
C. Wildflower Restoration	Pages NAT APDX A-5 to A-7
D. After Care, Monitoring & Assessment	Page NAT APDX A-8

5.0 Implementation

5.1 General Seeding Guidelines for Ecological Zones in Detention Ponds Depending on Their Hydrological Regime

5.1.1 Planting Prior to Site Development

If the detention pond is being created several years before the development occurs and before the pond will experience any consistent water regime, use the following seeding guidelines:

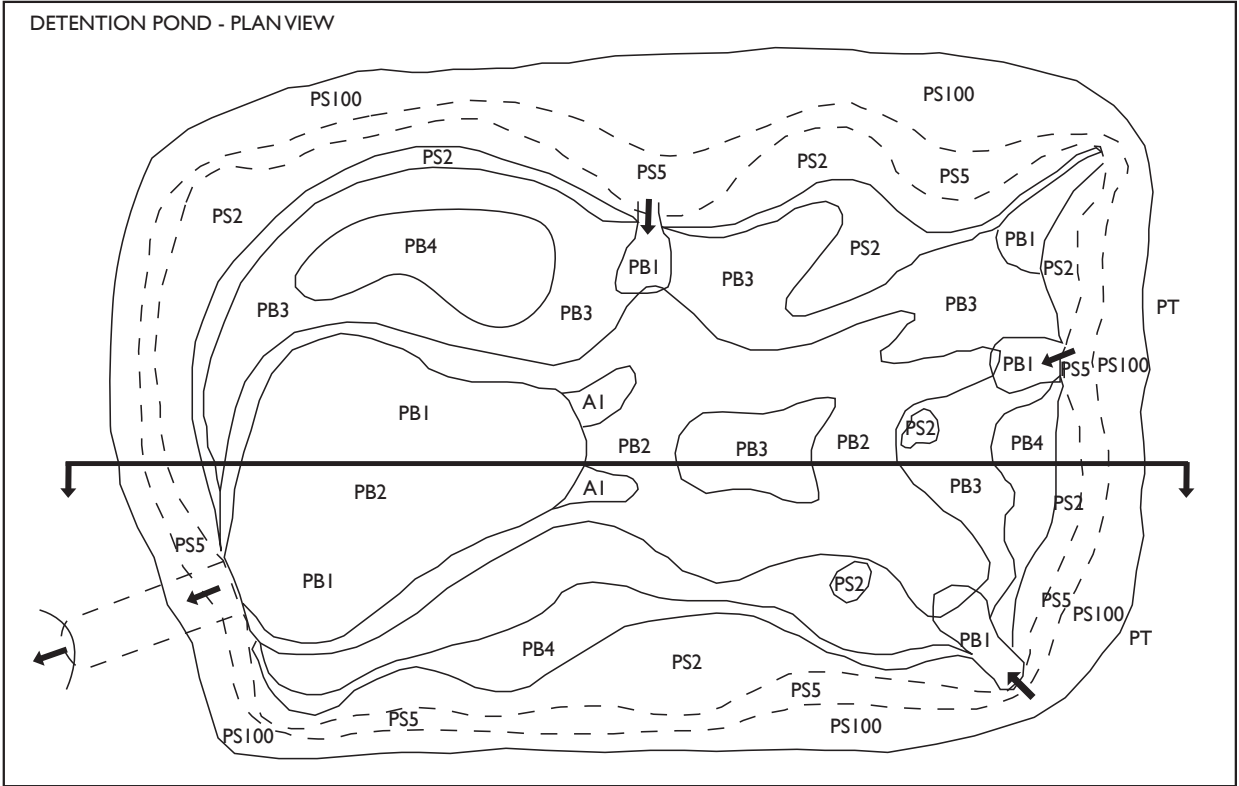
- a) Apply herbicides to weeds prior to beginning detention pond development to reduce noxious weeds and other aggressive non-desirable plants. Several seasons of weed control could greatly improve the establishment of desirable native vegetation. When controlling weeds just before the detention ponds are constructed, proper herbicide selection is important, preventing weeds from persisting in the soil, affecting seedling establishment or water quality.
- b) Seed with a Pre-development Mix which is a diverse mix with a wide ecological amplitude. In this mix there are species that can tolerate a wide array of moisture conditions. There are a few species that grow well in wet conditions, several species that can handle mesic conditions, and few species that grow in dry conditions (Seed Mix A).
- c) OR, if the water from the development will be arriving to the pond within one year, one could substitute a cover crop like Regreen, Quick Guard, or sterile oats for the Pre-development Mix. Do NOT use Cereal Rye (*Secale cereale*) or Wheat (*Triticum aestivum*), or other crop or non-native species that will persist or reseed after one year's growth. Cover crops should be sterile hybrids which are unable to reseed.
- d) Detention ponds need to be assessed the year before development is completed to determine if there is a need to reseed.
- e) Assessment should be ongoing as local or regional conditions in the watershed change which may affect the water regime, including periods of drought, frequent flooding, accelerated or delayed development schedules, or other factors which may affect establishment or survival of species seeded into detention ponds.

5.1.2 High Ground Water Detention Ponds

Defined as ponds where the bottom soil surface elevation is within 18" of the ground water and soils are loamy to clayey, or the bottom is within 12" to 6" of the ground water and soils are sandy to gravelly (See Detention Pond Plan and page NAT APDX C-4 for Zone Descriptions).

- a) If the bottom of the pond is not too wet to support equipment, drill seed wetland subirrigated grass seed (part of the wetland subirrigated grass and shrub mix) into the bottom of the pond and lower side slopes in zones PB1, PB2, PB3, PB4, and PS2 and PS5. Make two passes in opposite directions (15 to 45 degree angles), each pass applying half the total rate, except in the PS5 Zone where one pass is needed.
- b) OR, if the pond bottom is too wet, broadcast or hydro seed wetland subirrigated grass seed (part of the wetland subirrigated grass and shrub mix) into the bottom of the pond and lower side slopes in zones PB1, PB2, PB3, PB4, and PS2 and PS5). Raking or harrowing this grass seed into the soil will be necessary, especially on pond slopes.
- c) Drill one pass of the upland grass and shrub mix in the PS5 zone which has received one pass with the wetland subirrigated grass and shrub mix, and 2 passes on the rest of the slope and the top of the pond above slope (PS100 and PT). This completes the drill seeding.

- d) Broadcast the rest of the wetland mix (packaged separately) including wetland wildflowers (if applicable) onto the bottom of the pond (PB1, PB2, PB3, PB4). Make two passes in opposite directions, each pass applying half the total rate.
- e) Broadcast the upland slope wildflowers on the slopes of the pond in zones PS5, PS100 and PT. Make two passes in opposite directions, each pass applying half the total rate.
- f) Apply appropriate erosion control blankets or mulch per specification on page NAT APDX A-2.



5.1.3 Normal Detention Ponds

Defined as ponds where the bottom soil surface elevation is greater than 18" above the ground water and soils are loamy to clayey, or the bottom is greater than 12" to 6" above ground water and soils are sandy to gravelly (See Detention Pond Plan above and page NAT APDX C-4 for Zone Descriptions).

- a) Drill seed the bottom of the pond with the subirrigated grass and shrub seed mix up to the 5 year water surface elevation (PS5), using only one pass on low spots and near inlets and outlets (PB1), one pass on slopes (PS2 and PS5), and two passes in all other areas (PB2, PB3, and PB4). Each drill seeding pass should be seeding only half of the desired total rate of grass seed (about 4-5 lbs per acre).
- b) Drill one pass of the upland grass and shrub mix in the PS2 and PS5 zone which has received one pass with the subirrigated grass mix, and 2 passes on the rest of the slope and the top of the pond above slope (PS100 and PT). This completes the drill seeding.
- c) Broadcast the wetland seed mix including wetland wildflowers on the bottom of the pond near any inlet or outlet structure and in all low spots within the pond (PB1). Make two passes in opposite directions, each pass applying half the total rate.

- d) Broadcast the subirrigated wildflowers on the bottom of the pond in zones PB2, PB3, PB4, and PS2. Make two passes in opposite directions, each pass applying half the total rate.
- e) Broadcast the upland slope wildflowers on the slopes of the pond in zones PS5, PS100 and PT. Make two passes in opposite directions, each pass applying half the total rate.
- f) Apply appropriate erosion control blankets or mulch per specification on page NAT APDX A-2.

5.1.4 Application of Erosion Control Blankets and Mulch

- a) The side slope of the detention ponds should not be graded steeper than 3:1. 4:1 or flatter is preferred
- b) Because vegetation on hotter south-facing and west-facing slopes is more difficult to establish, especially if the pond slopes are not irrigated, these slopes should be blanketed to improve surface soil moisture and thus improve germination.
- c) All slopes steeper than 6:1 should be covered with erosion control blankets.
- d) Erosion control blankets should last for a minimum of two full growing seasons, and thus, if installed in the fall, should be a 24 month blanket and if installed in spring should be an 18 month blanket. Natural fiber blankets such as North American Green Straw Coconut 150 BioNet or North American Green Coconut 125 BioNet are preferred to synthetic blankets because the synthetic tend to trap and kill reptiles and amphibians.
- e) All blankets should be installed per manufacturer's recommendations.
- f) Especially in close proximity to developed sites, hydromulch should be used at 1500 to 2000 pounds per acre to mulch the site. Blankets or hydromulch are preferred over crimped hay or straw due to the reduced chance of introducing weeds, and because they do not blow off site. In addition, they have a cleaner look if next to a developed site.
- g) OR, on more remote sites, certified weed-free hay or certified weed-free straw with no seed heads can be crimped into the seedbed after seeding.
- h) Very wet to moist pond bottoms may not be able to be mulched.
- i) Periodic inspections should occur to insure that no erosion is occurring on-site, especially around inlet and outlet structures, on steep slopes, and around irrigation heads.

5.2 Construction and Restoration for Native Areas Adjacent to Development Areas

5.2.1 Guidelines, Activities and Restrictions

- a) Construction shall be limited to as small as possible size to complete the work in a timely and efficient manner without unnecessary disruption to native open space. The location of staging areas and development access should be designated by the contractor and agreed upon by the Centerra DRC. (Example: For a one acre or smaller detention pond, it is recommended to have a 15 to 20 foot permanent easement from the top of the pond and a 30 to 50 foot construction easement with one 50 by 50 foot staging area. A larger easement to act as a conservation buffer could be included in Centerra.)
- b) All installation of woody plants shall be done by a Landscape Architect or qualified party.
- c) Construction, including any staging area, shall be fenced with standard orange construction fencing to clearly define the limits of work. Sensitive natural areas shall be protected with orange construction fencing.
- d) Vegetation of significance that is agreed upon as a disturbance free zone that will not be cleared, grubbed, or disturbed shall be fenced. No work or disturbance shall occur in these zones.
- e) Limit construction and disturbance envelope to minimize disturbance to the site. Keep construction activities within 20' of the property line.
- f) Equipment and materials must stay within the designated construction area and out of disturbance free zones.

- g) Fines shall be issued to the contractor on a per square foot basis for uplands and wetlands disturbed outside the easement or in disturbance free zones agreed upon and fenced within the easement. Fines range from \$100 to \$500 per square yard of damage outside of the easement, depending on the type and location of damage.
- h) Fines shall be issued on a per tree and per shrub basis for damage done outside the easement or in disturbance free zones agreed upon and fenced within the easement. Fines are issued on a per individual basis. Tree and shrub species, diameter, and size are used to determine replacement and establishment costs.
- i) Cash shall be required up front or a "bond" from the CONTRACTOR or OWNER on a "per square foot disturbed" basis. These funds will be used to restore or fix areas outside of the easement or in disturbance free zones as designated within the easement. They also ensure that proper restoration has occurred within the construction easement.
- j) A pre-construction meeting shall be held on the work site with all personnel who will be working onsite so that all "workers and especially equipment operators" clearly understand the limitations and locations of approved activities and the consequences if they don't follow the easement restrictions. This should include a walk through of the entire easement.
- k) Any new workers starting after the beginning of the work shall be informed of the easement restrictions.
- l) A three to five year weed control plan and restoration guarantee shall be included in the easement documents. Restoration guarantees shall include establishment of 75% of target species, percent cover requirements of target species equal to 75% of pre-construction cover, and percent cover of weeds equal to or less than that of pre-construction conditions.

5.2.2 Selection of Qualified Contractors

- a) The contractor and subcontractors shall be selected by an evaluation process in addition to the bid process to ensure that they can do quality work in a native open space setting.
- b) Contractors and their subcontractors must submit a list of their previous work in sensitive open space sites or environmentally sensitive areas, references for this work, and they must be approved by LANDOWNER or LANDOWNER'S REPRESENTATIVE before the final award of bid is given to the contractor.
- c) All contractor documents and specification should be approved by the LANDOWNER or LANDOWNER'S REPRESENTATIVE prior to their issuance.

5.2.3 Above Ground Design Guidelines

- a) All manholes or other above ground utility structures, except those indicated below, should be within 3" of existing grade so as not to be a visual intrusion or to impair future open space mowing and management operations.
- b) Taller structures such as air vents, transformers, etc. must be painted "Sandalwood Tan" or an appropriate color to blend in with the existing vegetation during the majority of the year .
- c) Outlet structures and inlet pipes must blend in with the side slope grade and not protrude into the pond unless necessary to perform the desired function, and approved by the DRC.
- d) Outlet structures and inlet pipes shall not be placed in drainage ways, flood plains, or flood prone areas.

5.2.4 General Construction Practices

- a) The CONTRACTOR or OWNER must notify the LANDOWNER or LANDOWNER'S REPRESENTATIVE one week prior to any access or commencement of construction activities.
- b) Absolutely no vehicles, equipment, or materials are allowed outside the construction easement at any time before, during, or after the construction operations.
- c) Work should be halted during moderate to heavy rains or snows to reduce the erosion of soils offsite and for the protection of downstream waterways.

- d) All dewatering techniques and activities, if necessary, shall follow Colorado Department of Health guidelines, or guidelines approved by the LANDOWNER or LANDOWNER'S REPRESENTATIVE.
- e) Where needed, the open space shall be protected from sedimentation with a silt fence, straw bales, and other standard sediment control practices.
- f) If required, all plant salvage operations required of the CONTRACTOR shall be protected from damage with fencing and must be reinstalled as soon as topsoil has been replaced.

5.2.5 Restoration: Finish, Grading, Clean-Up and Damage Repair, Topsoil, Scope of Work, Seed Quality, Materials, Execution - Restoration and Seeding

a) Finish Grading of Natural Areas and Detention Ponds

1. Upon completion of other construction work and prior to final payment, the CONTRACTOR shall remove all construction debris, material and equipment. They shall restore the existing area to as clean of a condition as existed before their operations began. All stockpiles of topsoil shall be used on disturbed areas and all excess bedding, subsoils, or other backfill materials shall be removed as directed by the OWNER, LANDOWNER, or LANDOWNER'S REPRESENTATIVE. All remaining areas shall be worked as herein specified.
2. The CONTRACTOR shall then grade the entire site designated as a natural area or detention pond to a finished grade, leaving small irregularities and rough spots to provide microhabitat and topographic diversity to aid in plant establishment. Rough grading may be sufficient to meet this specification if approved by the OWNER, LANDOWNER, or LANDOWNER'S REPRESENTATIVE and the SEEDING CONTRACTOR. The CONTRACTOR shall meet existing grades at the boundaries of the limit of work. Allowance shall be made for topsoil and any other surface material, which is called for in the Contract Drawings and Specifications.

b) Clean-up and Damage Repair

1. All debris and excess excavated material shall be disposed of offsite by the CONTRACTOR and at their own expense. All fences, gates, signs, and any other structures damaged shall be repaired or replaced as necessary. All damage shall be repaired as soon as possible by the CONTRACTOR and at their own expense after all initial restoration and seeding operations are completed.

c) Amendment of Existing Onsite Topsoil

1. This work consists of providing and replacing suitable topsoil at locations and thicknesses shown as existing prior to construction and called for elsewhere in these Specifications, but in no case shall it be less than 4" unless approved by the OWNER, LANDOWNER, or LANDOWNER'S REPRESENTATIVE. No imported topsoil is required.
2. Topsoil shall consist of loose, friable native soils that existed prior to construction. These soils shall be reasonably free of admixtures of subsoil, refuse, stumps, roots, rocks, brush, weeds or other material which would be detrimental to the proper development of vegetative growth.
3. Topsoil has living components and thus should be placed in small piles adjacent to detention pond installation operations where it will not be mixed with bedding materials, subsoils, and other contaminants. Large piles of topsoil placed for more than a few days, especially during warm conditions, is not an acceptable practice. Topsoil shall not be replaced until the areas to be covered have been properly prepared and the detention pond, compaction, and subsoil grading operations have been completed for a particular area of the pond.
4. Topsoil shall be keyed to the underlying material by the use of harrows, roto tillers, rollers, or other equipment suitable for the purpose.

d) Scope of Work

1. Seeding shall consist of furnishing and sowing seed at locations shown on plans, or as designated, in conformity with the requirements of these specifications. This item includes any necessary ground preparation prior to seeding, including but not limited to chiseling, disking, and hand raking as necessary to prepare the soil for seeding. It shall also include the furnishing and application of Colorado certified weed-free native grass hay mulch or approved equivalent.

e) Seed Quality

1. All brands furnished shall be free from such noxious seeds as Canadian Thistle, Russian Thistle, Bindweed, Leafy Spurge, Diffuse Knapweed, and all noxious weeds listed by the State of Colorado. Additionally, all brands furnished for use in native areas shall be free of undesirable non-native grasses such as Smooth Brome, Intermediate Wheatgrass, Tall Fescue, Kentucky Bluegrass or Crested Wheatgrass.
2. The landscape contractor shall furnish to the LANDOWNER or LANDOWNER'S REPRESENTATIVE a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable.

f) Materials

1. Seed

- a. Owner shall designate the type of seed mix. No changes or substitutions shall be made without permission from the LANDOWNER or LANDOWNER'S REPRESENTATIVE two weeks prior to restoration and seeding.
- b. Seed types and amount of pure live seed (PLS) required per acre are based on soil type and irrigation regime.
- c. Seed mixes at the rate indicated on the mix in PLS when drill seeding. For slopes 3:1 or greater, double the PLS per acre when broadcast seeding.
- d. If seed available on the market does not meet the minimum purity and germination percentages specified, the landscape contractor must compensate for a lesser percentage of purity or germination by furnishing sufficient additional seed to equal the specified product. The tags from the seed mixes must be supplied to owner.
- e. Pack seeds of the latest season's crop for delivery in suitable rodent proof bags in accordance with standard commercial practices. If seed is stored after delivery to the work site, store in cool, dry, and weatherproof place in a manner that protects the seed from deterioration and permits easy access for inspection. All labeling required by law shall be intact and legible.
- f. The formula used for determining the quality of PLS shall be: (Pounds of seed) x (purity) x (germination) = pounds of PLS.

2. Hay Mulch

- a. The material will be certified weed-free native grass hay. Each delivery of certified weed-free native grass hay shall have the proper weed-free certifications, transit certificate, and weight slip. Hay shall not be musty, moldy, decayed, caked or of otherwise low quality. Hay shall be free of weeds and viable seeds.
- b. At least 75% of the hay by weight shall be 10" or more in length.
- c. Do not conduct the mulching application when wind conditions may cause the mulch to blow from the intended target area.

g) Execution - Restoration and Seeding

1. Submittals

- a. CONTRACTOR shall notify LANDOWNER or LANDOWNER'S REPRESENTATIVE 48 hours prior to seeding.
- b. CONTRACTOR shall supply LANDOWNER or LANDOWNER'S REPRESENTATIVE with tags from every bag of seed and all load tickets for native hay mulch at the time of execution.

2. Site Preparation

- a. Area should be shaped and graded according to pre-construction topographic features or appropriate restoration plan. Existing drainage patterns upstream and downstream of the detention pond should be maintained unless specifically stated otherwise.
- b. Topsoil and strippings removed by the CONTRACTOR prior to construction shall be placed to a minimum depth of 6" prior to tilling, unless approved otherwise by the LANDOWNER or LANDOWNER'S REPRESENTATIVE. Remove tree limbs, trash, large rocks, and other debris.
- c. The top 4" of the surface shall be chiseled, disked, and/or tilled, and roughed parallel to slope contours to prepare soil for seeding.
- d. Finished graded areas shall be protected from damage by vehicular and pedestrian traffic and erosion.

3. Fertilizer Application and Organic Amendment – None shall be applied.

4. Seeding

- a. Native grass and wildflowers seeding shall be accomplished in one or another of two seeding seasons within a calendar year; namely the "spring seeding season" from February 21 through May 15 and the "fall seeding season" from October 15 through December 15. Either of these seasons shall be understood to comprise that period of time in the spring or fall, respectively, favoring the healthy growth of native grasses and wildflowers in the locality in which the seeding is done.
- b. Seeding of portions of the areas designated may be permitted before the construction is completed in order to take advantage of growing conditions, but should be protected from vehicles, compaction, erosion, and other disturbances that may disrupt future germination and establishment of seeded species.
- c. Seed shall not be sown during windy weather, or when ground is frozen or otherwise un-tillable.
- d. Method of Seeding
 1. Drills: A grass drill shall be used unless the LANDOWNER or LANDOWNER'S REPRESENTATIVE approves another method. Grass drills are to be used to seed native grasses only, not native wildflowers unless specifically directed by the LANDOWNER or LANDOWNER'S REPRESENTATIVE. The drill should be equipped with a satisfactory feeding mechanism, agitator, double disk furrow openers, depth adjustment mechanism, and packer wheels. Depending upon the seeding recommendation, it may be necessary to have separate boxes for fluffy grasses, small seeded grasses and for legumes. Drill seeding shall be at approximately 6" to 7" spacing, to a depth of ¼" to ½". All seeding on slopes shall be parallel to the contours unless otherwise approved by the Owner. In areas where the smallest dimension (width or length) exceeds 300 feet, the site shall be cross-seeded at an angle of approximately 45 degrees.

2. Hydraulic Equipment: This shall be restricted to areas inaccessible to drills as determined by the LANDOWNER or LANDOWNER'S REPRESENTATIVE. If hydromulch is to be applied, the seed should be applied in a separate operation prior to mulching. Hydraulic mulching equipment shall include a pump capable of being operated at 100 gallons per minute and 100 pounds per square inch pressure, unless otherwise directed. The equipment shall have an acceptable pressure gauge and a nozzle adaptable to hydraulic seeding requirements. Storage tanks shall have a means of agitation and a means of estimating the volume used or remaining in the tank.
3. Hand Application: Broadcast seeding by hand or a manually operated broadcast type seeder is to be used to seed native wildflowers. For grasses, it is only acceptable on small areas and areas not accessible to drills as determined by the LANDOWNER or LANDOWNER'S REPRESENTATIVE. Native grass seed only will be covered ¼" to ½" deep by raking or harrowing. Application rate shall be increased by 50% for all native grasses to be hand seeded at the sole expense of the Contractor.
4. Native wildflower seed will be mixed with 6 parts perlite to one part native wildflower seed. This native wildflower seed mix will be broadcast after grasses have been seeded and before native grass, hay mulching, or hydromulching.

5. Mulch

- a. All areas to be seeded shall be mulched. Hay mulch shall be used in all locations except when conditions require the use of hydromulch with the permission of the OWNER and the LANDOWNER or LANDOWNER'S REPRESENTATIVE.
- b. Hay Mulch: Use only in remote areas with low human presence and without immediate adjacent development. After seeding has been completed, a rate of 4,000 lbs. of hay per acre, or as directed, shall be applied uniformly, crimped in with a crimper. Anchor hay mulch to the soil by crimping hay into the soil with a crimping disc on appropriate contours 2" to 3" deep at no wider than 8" pacing. Use V-type wheel land packers, scalloped disc packers, or other suitable equipment. No less than 75% of the hay shall remain on the surface after anchoring. The LANDOWNER or LANDOWNER'S REPRESENTATIVE may order the employment of hand-crimping operations on such areas where excessively steep slopes or confined areas would cause unsatisfactory crimping to result by mechanical methods. Start mulching on the windward side of relatively flat areas or on the upper part of steep slopes, uniformly covering the area. Mulch that remains clumped or bunched after application shall be separated and re-spread. The seeded area shall be mulched and crimped within 24 hours after seeding. Areas not mulched and crimped within 24 hours after seeding must be reseeded with the specified seed mix at the landscape contractor's expense prior to mulching and crimping. On steep slopes, drainage ways or other specific areas, which are difficult to mulch and crimp by conventional methods, jute mesh or other blanketing materials may be used when approved by the LANDOWNER or LANDOWNER'S REPRESENTATIVE. These materials properly installed, anchored, and secured as per manufacturer's recommendations. These areas will have seed mixes specifically designed for site conditions.
- c. Hydromulch: As required, cellulose fiber mulch shall be added with the proportionate quantities of water and other approved materials in the slurry tank. All ingredients shall be mixed to form a homogenous slurry. Using the color of the mulch as a metering agent, the operator shall spray apply the slurry mixture uniformly over the designated seeded area. Unless otherwise ordered for specific areas, wood cellulose fiber mulch shall be applied at the minimum rate of 1,720 lbs. per acre. Hydraulic mulching shall not be done in the presence of free surface water resulting from rains, melting snow or other causes. Wood fiber mulch shall be "Conwed, Hydromulch 2000" which is manufactured by the Conwed Corporation or approved equal.

6. Protection

- a. Immediately after seeding, protect seeded areas against traffic or other use by erecting temporary fencing or barricades and providing signage as directed by the LANDOWNER or LANDOWNER'S REPRESENTATIVE. Retill, seed and mulch any areas impacted by traffic as directed by the ENGINEER, OWNER, LANDOWNER or LANDOWNER'S REPRESENTATIVE.

7. Clean Up

- a. THE CONTRACTOR shall be responsible for clean up of the site, including removal of all wires, ties, bags, etc. Failure to clean the site shall result in withholding of payment.

5.3 Wildflower (Forbs) Restoration Specifications and Prescriptions for High Plains Environmental Center

5.3.1 Why Wildflowers (Forbs)

- a) Wildflowers are an essential part of most native plant communities, including natural detention ponds like playas and streamside plant communities. Wildflowers are essential to create a more diverse habitat that attracts many more species of wildlife to a site. The following process will help contractors to more successfully establish wildflowers.

5.3.2 Site Selection

- a) Before seeding wildflowers it is essential to assess the condition of the site. The ecological opportunities and constraints of the site must be considered, including soil type, soil moisture, soil nutrients, slope, aspect, light regime, hydrology, topographic features, as well as the existing vegetation. Most wildflowers in the plains of Colorado thrive in full sun or light partial shade. They generally survive best where ecological conditions are not favorable to grasses, including course texture soils with a higher content of sand, gravel, and rocks. Also, wildflowers are more abundant on rocky sites and steep areas with adequate moisture for establishment, which may otherwise be environmentally harsh. Areas that are densely dominated by rhizomatous grasses, or are dominated by diverse and extensive infestations of perennial weeds and/or annual weeds, are poor candidates for wildflower seeding without intensive manipulation of the site with considerable expenditures of time and money. These conditions can be created on a detention pond site by adding a sand, gravel or rock component to the soil from excess pipe or culvert bedding materials.

5.3.3 Design a Seed Mix with Proper Seeding Rates

- a) Plant palettes should be selected carefully to match the existing site conditions. A restoration ecologist should design an appropriate site specific mix based on the conditions of the site and the goals for the project. Wildflower seeding rates vary from 4-10 lbs per acre for wildflower plantings, to 10-12 lbs per acre for wildflower/grass plantings. Rates should achieve a minimum of 15-20 and a maximum of 60 - 80 live seeds per square foot of forbs. On drier sites, or during dry years, the seeding rate should be 35 -45 live seeds per square foot maximum.

5.3.4 Seeding Wildflowers with Grasses

- a) Wildflowers can be sown alone or with grasses depending on the goals for the restoration site. Wildflowers generally perform best when sown alone because of the competitive nature of grasses. If grasses are desired on the site with forbs, then the following special design modifications should be considered to allow forbs the competitive advantage they need to get established. These are: 1) Grasses and forbs can be separated spatially, with patches of grass only and patches of forbs only. Forbs will perform best in shallow, course, irregular soils, or steep slopes; grasses will perform best in fine textured and deeper soils on flat to moderate slopes. 2) Grasses can be seeded at lower rates (1/3 or less) to make them less competitive. 3) Seed only with bunch grasses because they are less competitive and leave more space for forbs to get established. Good cool season bunch grasses include Green Needlegrass, Indian Ricegrass, Prairie Junegrass, and Slender Wheatgrass. Some of the best warm season bunch grasses include Little Bluestem, Sideoats Grama, and Blue Grama (can form a sod if mowed or grazed extensively). 4) Forbs can be purchased in pots or grown and planted to establish populations.

5.3.5 Preparing the Seed

- a) Cold-moist stratification: (Only necessary if seed is planted in the spring). This is the process where seed is stored in a moist medium, such as Perlite or Vermiculite, generally for 30 to 90 days to break seed dormancy. Mix one part seed with two parts Perlite or Vermiculite, and soak until very moist in a zip lock bag. Pour off additional free water and store in a refrigerator at 34°F to 40°F for 30 to 90 days as specified for the particular species.
- b) Soaking: Many seeds will germinate best if they have been allowed to imbibe water prior to sowing. Thus soaking seeds, especially those with a hard seed coat may be necessary to improve germination. Some seeds also do best with a hot soak.
- c) Scarification: This is the process whereby the seed coat is weakened by either mechanical or chemical means. This process helps to break down the seed coat so that the seed can more easily imbibe the water that is essential to the germination process. Mechanical scarification can be done by placing the seed in an open box and scratching it with medium to course grit sandpaper, or for larger seeds by scratching the hard seed coat with a file or knife. Chemical scarification (or acidification) is done with a dilute solution of sulfuric acid. This method helps to reduce chemical inhibitors to germination and it helps to break down resistant seed coats. Generally, the seeds that need chemical scarification are found in fleshy fruits like Solomon's Seal, plums, cherries, or hawthorns. Check with your seed supplier for their recommendations on the treatment of seeds prior to sowing. The key to germination is for moisture to reach the embryo which is in the interior of the seed. Additional germination requirements are good seed/soil contact, warm temperatures (over 55°F for cool season plants and 75°F for warm season plants), and overcoming external or internal dormancy.

5.3.6 When to Seed Wildflowers

- a) Seeding in the fall: Because many wildflowers need a cold-moist stratification for 30 to 90 days to break dormancy, the natural time to seed them is in the fall, also called dormant seeding. Dormant wildflower seeding should occur after the soil temperature has cooled to below 55°F, or generally in late October, November, or early December, before the ground freezes. Dormant seeding of perennial wildflowers is the preferred approach, although there may be some situations where spring seeding is conducted.
- b) Seeding in the spring: Annuals and species that germinate readily can be seeded in the early spring with great success. The main advantage to seeding in the spring is the opportunity to kill Colorado's many cool season weeds that have germinated in early spring, thus reducing competition for moisture and nutrients.
- c) The primary objective at a restoration site where a diversity of forbs is desired is to clear the area of existing vegetation, especially non-native species, aggressive perennial sod forming grasses, and noxious weeds.

Fall seeding scenario:

1. Chisel or disk the ground in the spring.
2. Allow weeds to germinate and spray with glyphosate (e.g. Roundup) or till weeds to prevent establishment.
3. In the fall before seeding, spray, shallow till, or scarify with a harrow once more to get the ground as clean and weed-free as possible. Glyphosate can be used to kill these early germinating weeds and seeding can occur right after spraying. Or, a pre-emergence application of imazapic (e.g. Plateau) can be used (4 oz active ingredient/acre) to control weeds. Please carefully read and follow label directions on all herbicides prior to their purchase and use.
4. If necessary, add sand, gravel, or rock to the soil in the areas where wildflowers are going to be seeded to increase their competitive advantage.

5.3.7 Seeding Depth

- a) The depth that wildflower seed is planted is critical to its success. Most wildflower seed should be surface sowed, or very lightly raked in not more than 1/8". Generally, a seed should not be planted deeper than the diameter of the seed. For example, a 1/16" diameter seed should be sown to a 1/16" depth. Seeds sown in sand can be planted at two times that depth, unless otherwise specified by the seed supplier or restoration ecologist. If sown in the fall or early spring, most wildflower seed can be sown on the surface and allow precipitation and freeze/thaw action to incorporate the seed into the soil and to achieve good seed to soil contact.

5.3.8 Seed Application

- a) Wildflower seed is generally small and should be broadcasted either by hand, with an adjustable hand-held broadcast seeder, a drop seeder/spreader, or a rotary seeder/spreader. Seed can also be very lightly drilled to 1/8" or less in sandier or courser soils. Steep areas can also be broadcast seeded and hydromulched at a rate of 1500 to 2300 pounds per acre. If seeding with grasses, wildflowers should always be seeded last, as grasses are seeded deeper than forbs.
- b) Mix seed with Perilite in a ratio of one part seed to five parts Perilite. Perilite gives the small wildflower seeds more bulk, which acts to spread the seed across the site and, because it is white and stands out against the darker soils, it helps the person seeding to cover all areas with the desired species and at the desired rates. If more even coverage is required, the quantity of seed can be split in half. One half can be seeded in a north-south direction and the remaining half will be seeded perpendicular to the first in an east-west direction. On a smooth seedbed, larger seeded species can be incorporated into the soil by lightly raking it or with a chain harrow. Seed can also be seeded into a roughed seedbed just prior to a fall or spring snowstorm which aids in incorporating the seed into the seedbed. Sowing too deeply can prevent germination or hinder the growth of young seedlings, especially in heavy clayey soils
- c) Apply a light weed-free hay or straw mulch at a rate of 2000 to 3000 pounds per acre, covering from 30% to 50% of the ground surface. This helps hold moisture, prevent soil crusting, reduce wind erosion, and absorb excess free nitrogen, which aids in reducing weed competition. This step may be skipped especially if supplemental irrigation is going to be provided.
- d) Good soil to seed contact is essential for germination to occur. A firm seedbed is also important for good soil to seed contact, and to ensure small seeds don't get buried too deeply. As a general rule of thumb, a foot should not sink more than 1/4" into the soil when walking across the prepared seedbed.

5.3.9 Watering

- a) To increase the success of germination and establishment of wildflower stands, if possible, water the area to keep the seedbed moist for a period of three to six weeks. Once seedlings reach the three-leaf stage, irrigation frequency can be gradually reduced, but should be longer in duration.

5.3.10 Management of Wildflower Stands

- a) Management of wildflowers includes selectively spraying weeds, mowing, and possibly burning or grazing the stand. Spot spraying broadleaf weeds and spraying early season weeds with a non-residual broadleaf herbicide prior to green up of flowers has proven successful. Undesirable annual and perennial grasses can be controlled with grass specific herbicides such as Poast (Vantage), Fusilade, Ornamec, or Select. These post-emergent herbicides can be applied over wildflowers because they do not affect broadleaf plants. They are best applied on new growth and young plants. Do not use if desirable grasses are present or have been seeded. Also, mowing 2-4 times per year in problem areas can help to reduce the canopy of weeds that shade the slower growing wildflower seedlings below. The number of mowing cycles depends on the weed cover, yearly precipitation, and to a lesser extent, soil type. Once weeds are under control, mowing or burning can be done on a 3-7 year cycle, depending on the extent of cover, growing conditions, plant community health, and seasonal weather

Wildflower Restoration Calendar - Begin in the fall to access site to seed in the fall of the following year. ©Ark Ecological Services, 303-985-4849														
Goal (Project)	Objective	Process	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Restore native wildflowers to HPEC	Identify areas that need to have wildflowers restored	Walk the site looking for slopes, rocky areas, or poorly developed soils, areas that don't have deep fine textured soils, or areas that don't have good grass cover												
	Analyze site characteristics and select species to match site.	Use wildflower list to select restoration spp.												
	Mechanically prepare seedbed	Chisel, disc, harrow, or hand prepare seedbed												
	Chemically control annual, biennial, & perennial broadleaf and grass weeds	Spray noxious weeds with herbicide*					One Applic.					One Applic.		
	Gather and purchase enough seed to restore chosen areas	Hand collect native wildflower seed from local sources & dry												
	Gather and purchase enough seed to restore chosen areas	Purchase seed from Western Native Seed												
	Prepare seed to be planted	Scarify and soak seed just prior to planting												
	Sow wildflower seed before the ground freezes	Broadcast or lightly drill seed												
	Ensure germination, establishment, and plant vigor if resources are available	Water ¼ inch three times each day for 4 weeks, then ½ inch once a week through mid September				¼" 3 times per day	¼" 3 times per day	¼" 3 times per day	½" once per week	½" once per week	½" once per week			
	Reduce compaction and damage to new seedlings	Restrict access to the area												
	Reduce compaction and damage to new seedlings	Restrict access to the area at the beginning of the next year												
	Reduce weed competition	Spot spray, mow, or hand pull weeds				One Applic.	If needed					One Applic.	If needed	
*If both grass weeds and broadleaf weeds are present in the spring, use either glyphosate (e.g. Roundup), or a combination of glyphosate and imazapic (e.g. Plateau), or a new product called Journey. Use a broadleaf herbicide (e.g. 2,4-D, Curtail) in the spring if only broadleaf weeds are present. In the fall use only glyphosate because you can plant soon after spraying, there is no residual activity like with imazapic. Follow label closely. See Wildflower Restoration Specifications and Prescriptions for HPEC for more details.														

conditions. Generally, burning should take place on non-drought years, after plants have reached maturity and may be declining, and where cover is high. Moist plant communities can be burned more frequently (3-5 years), whereas drier communities should be burned less frequently (5-7 + years). Grazing can be used as well but requires more time and may not be appropriate for certain areas or at certain times in the open space.

- b) Mowing can also be used as an end of the growing season treatment to disperse wildflower seeds. At least two weeks after all of the flowers have faded, and when most of the seeds appear to be mature, the wildflower stand can be mowed if desired. Seeds are mature when they are hard and usually dark in color, often brown, reddish, or black. If the seeds are inspected at various times in the post flower process, one can determine the stages of seed development and recognize which color and hardness indicates a mature seed for a particular species. Once this is determined, the stand can be mowed at a height of 4" to 6" off the ground, high enough not to damage the wildflowers. The process of mowing aids in seed dispersal and reduces the competition of some weeds and some grasses. Additionally, it allows more sunlight to reach the ground, which is often necessary for additional wildflower germination and seedling growth. Mowing also aids in the survival of low-growing wildflowers.

Summary and Conclusion

Well-planned ecological restoration must consider the composition, structure, and function of native ecosystems to create healthy and sustainable landscapes. Wildflowers are essential components of these landscapes and must be considered as a part of each restoration project. Wildflowers enhance diversity, structural complexity, food and shelter for wildlife, beauty, color, fragrance, texture, form, seasonal interest, and educational opportunities. To fulfill the goals of natural resource conservation and education at High Plains Environmental Center, the restoration of wetland, riparian, and prairie communities should include the use of a diverse array of site appropriate, native wildflowers.

6.0 After Care

6.1 Weed Management After Seeding and Initial Restoration Activities

- 6.1.1 For the first two to three years after seeding, the main practice for weed control should be mowing or weed whacking to prevent weed seeds from being produced. Careful spot spraying is also acceptable if over spray reaching the soil surface can generally be limited or avoided. Many herbicides affect seedling grasses and non-target plants and may reduce or inhibit germination of plants. Other herbicides, like Plateau, are selective in their affect on seedlings, young grasses and wildflowers and can be used to help establish many warm season grasses and wildflowers while killing weeds and inhibiting their germination. Always read and follow label directions.
- 6.1.2 The selectivity of herbicides on target and non-target plants, and seed in the soil seed bank is affected by the type of herbicide and its mode of action, the application rate, the timing of the application, the life stage of the plants, soil moisture conditions, temperature, the surfactant used and rate, and other factors. Pesticide applicators should be well versed in the affects of the herbicide being used and in the environmental conditions in which the herbicide is being used. If in doubt in newly seeded areas, use mechanical controls or cultural practices to the fullest extent possible where practical. Biological controls may also be an option, but generally take a longer time period which may not be acceptable at this stage of the restoration process.
- 6.1.3 After the initial establishment period, if chemical weed controls are needed in the pond bottoms of wet to wet mesic detention areas, herbicides and surfactants with aquatic labels should be selected. Aquatic approved herbicides often used in wetland areas such as detention ponds include Aquatic 2, 4-D amine, Renovate 3, Rodeo, Habitat, or Garlon 3A, depending on the weeds being targeted.
- 6.1.4 Even though the herbicides are approved for aquatic use, if possible, most spraying applications should occur during periods of dry weather and dryer conditions to reduce the amount of herbicide that gets into the water itself.
- 6.1.5 Slide slopes, generally above the high water line, can be sprayed with non-aquatic approved herbicides as per the herbicide label.
- 6.1.6 Careful attention should be paid to the herbicide being used in high water table areas. Herbicides with the active ingredient of dicamba, often under the trade name of Banvel, or picloram, often under the trade name of Tordon, should not be used in high water table areas or under trees, due to their mobility in the soil.
- 6.1.7 Cattails will generally come in to all of the created detention ponds through natural dispersal and establishment. They should be eradicated or suppressed in detention ponds for the first three to five growing seasons to allow less aggressive native plants to get established. Cattails, although they are a native plant, are often so competitive that they become a monoculture if not managed.
- 6.1.8 Cattail management includes using soils that are free of cattail tubers during construction, hand pulling small plants, wick applications with gloves, spot spraying with backpacks using an aquatic approved glyphosate product like Rodeo. Mid-summer applications work well due to the large leaf surface area to which to apply the herbicide. Hand pulling works well in the spring and in early years of the pond establishment before the cattails have developed an extensive root system.
- 6.1.9 Reed Canarygrass is another aggressive non-native wetland grass that may go unnoticed, but which should be controlled to achieve a diverse, healthy, and functional detention pond.
- 6.1.10 Woody plants that spread via rhizomes should be discouraged from establishing in front of and immediately adjacent to inlet and outlet structures. These plants can be controlled using cut stump treatments with a high concentration (generally 25 to 50% active ingredient) of Garlon, Rodeo, or Roundup. Read and follow the label directions.

6.2 Stormwater Management

6.2.1 Erosion problems should be quickly fixed using appropriate bioengineering technologies.

6.2.2 Sediment traps should be cleaned out after large storm events, or as the need dictates.

7.0 Monitoring and Assessment

- 7.1 Set up photo points, plots, and transects at stratified random locations to determine the frequency and percent cover of desirable plants, weeds, bare ground, leaf litter, and rock. Take photos in four directions, N, E, S, W, or NE, SE, SW, NW, at least twice per year from the photo point.
- 7.2 Assess the site at least twice a year to determine the level of success in hydrologic function, aesthetics, screening and buffering, and other site goals and objectives (See landscape functions on Page NAT APDX D-1).
- 7.3 Assessments should be done during storm events and just after the water has dissipated to determine how the ponds have functioned. Look for erosion and sedimentation sites, determine if inlets and outlets functioned properly, assess how plant materials responded to the event. Determine if the outlet structures' water quality plates need to be cleaned.
- 7.4 Assess the success of the establishment of the desired future plant community over a three to five year period. Determine if desired target plants are getting established or just beginning to establish. Where weeds are under control, undesirable bare soil areas could be re-seeded or planted with the rarest appropriate plants suitable to the location. If a fairly healthy native plant community is establishing, be patient to allow wildflowers an opportunity to come in.
- 7.5 Use adaptive management to make mid-course corrections to the composition, structure, and functional aspects to the detention ponds. Record these for use in future designs.
- 7.6 After 5-7 years, bare areas that are not freshly deposited soil from an erosion and/or sedimentation event, which are greater than 6-9 square feet and need an enhancement of conservative species, should be planted or seeded with rare wildflowers or other missing, under-represented, desirable plants to meet habitat goals. If species have equal coefficients of conservation (See Tables of Wildflower Species on Pages NAT APDX B-1 through B-3), choose showier species near human use areas or species that are known to attract more butterflies, birds, or desirable pollinators in more remote locations.
- 7.7 Choose well-rooted, disease-free and weed-free plant materials grown in a reputable nursery.
- 7.8 Use adaptive management to continue to tweak the detention pond ecosystems to achieve the habitat goals and objectives.

NAT Appendix B - Plant Materials for Use in Natural Areas and Detention Ponds

The following tables of plant materials represent plants appropriate for HPEC land restoration and should also be used in natural areas and detention ponds within Centerra. The list depicts appropriate species based on a variety of characteristics that should be considered in preparing planting plans for native areas and detention ponds.

Wildflower List						Sun/Shade			Soil Type						Soil Moisture																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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Wildflower List						Sun/Shade			Soil Type							Soil Moisture			Attracts		Attracts		Conservation					
Scientific Name	Common Name	Life Form	Flower Color	Blooming Season	Height (inches)	Shade	Partial	Sun	Clay	Loam	Loam	Loam	Sand	Gravel	Hydric	Mesic	Xeric	Butterflies	Birds	Conservation Coefficient*								
Copyright, Ark Ecological Services, Raymond H. Sperger, 303-985-4849																												
Wildflower List						Sun/Shade			Soil Type							Soil Moisture			Attracts		Attracts		Conservation					
Scientific Name	Common Name	Life Form	Flower Color	Blooming Season	Height (inches)	Shade	Partial	Sun	Clay	Loam	Loam	Loam	Sand	Gravel	Hydric	Mesic	Xeric	Butterflies	Birds	Conservation Coefficient*								
Copyright, Ark Ecological Services, Raymond H. Sperger, 303-985-4849																												
Copyright, Ark Ecological Services, Raymond H. Sperger, 303-985-4849																												



Shrub and Tree Species List for Detention Ponds, Drainages, and Other Natural Areas

The following tables of plant materials represent plants appropriate for HPEC land restoration and should also be used in natural areas and detention ponds within Centerra. The list depicts appropriate species based on a variety of characteristics that should be considered in preparing planting plans for native areas and detention ponds.

Common Name	Scientific Name	Growth Form	Height (feet)	Spread (feet)	Color	Bloom Seas	Water Sched.*	Light	Soil Type					Hardiness Zone
									Clay		Sandy			
									Clay Fine	Loam Moderately Fine	Loam Medium	Loam Moderately Course	Sand Course	

<u>Species for Uplands - North and east facing (Zones PS100, PT, R4, and U1</u>														
Fourwing Saltbush	<i>Atriplex canescens</i>	Medium Shrub	2-6	3-8	Gray foliage, conspicuous fruits	summer	1	sun to partial sh.	x	xx	xx	xx	xx	3
Rubber Rabbitbrush	<i>Chrysothamnus nauseosus</i>	Medium Shrub	4-6	4-6	silver green with yellow fl.	late su	1	full sun	xx	xx	xx	xx	xx	3-6
Three-leaved Sumac	<i>Rhus triobata</i>	Medium Shrub	3-6	4-8	Orange berries	summer	1	full sun		x	xx	xx	xx	3-6
Native Smooth Sumac	<i>Rhus glabra</i>	Medium Shrub	4-7	6-15	white flowers, red berries & fall foliage	spring	1-2	full sun to partial sh.		xx	xx	xx	x	3-9
Wood's Rose	<i>Rosa woodsii</i>	Medium Shrub	2-6	3-6	pink fl. & red hips	spring	2	sun to partial sh.		xx	xx	xx		2-6
White Snowberry^	<i>Symphoricarpos alba</i>	Small Shrub	2-4	4-6	white flowers & berries	spring	2	sun to shade		xx	xx	xx		3-6
Western Snowberry	<i>Symphoricarpos occidentalis</i>	Small Shrub	2-3	4-8	white flowers & berries	spring	2	sun to shade		xx	xx	xx		3-6
Netleaf Hackberry^	<i>Celtis reticulata</i>	Small Tree	10-15	8-12	inconspicuous flowers	spring	1	full sun to partial sh.		x	xx	xx	xx	4-6

<u>Species for Uplands - South and west facing (Zones PS100, PT, R4, and U1</u>														
Fourwing Saltbush	<i>Atriplex canescens</i>	Medium Shrub	2-6	3-8	Gray foliage, conspicuous fruits	summer	1	sun to partial sh.	x	xx	xx	xx	xx	3
Rubber Rabbitbrush	<i>Chrysothamnus nauseosus</i>	Medium Shrub	4-6	4-6	silver green with yellow fl.	late su	1	full sun	xx	xx	xx	xx	xx	3-6
Three-leaved Sumac	<i>Rhus triobata</i>	Medium Shrub	3-6	4-8	Orange berries	summer	1	full sun		x	xx	xx	xx	3-6
Desert False Indigo	<i>Amorpha canescens</i>	Small Shrub	1-2	1-2	gray foliage, pink flowers	summer	1	full sun	?	x	xx	xx	?	5
Dwarf Rabbitbrush	<i>Chrysothamnus nauseosus</i>	Small Shrub	1-2	1-2	silver green with yellow fl.	late su	1	full sun	xx	xx	xx	xx	xx	3-6
Winterfat	<i>Krascheninnikovia lanata</i>	Small Shrub	1-3	1-2	Silvery gray foilage, inconspicuous fl.	spring	1	full sun	xx	xx	xx	x		3-5
Yucca, Spanish Bayonet	<i>Yucca glauca</i>	Small Shrub	2-3	2-3	White flowers	J-J	1	full sun		x	xx	xx	xx	4-8

<u>Species for Moist, well-drained area (2.5 - 6 feet above high water line or 1 year storm) (Zones PS5, PS100, R4 & U1</u>														
Saskatoon Serviceberry^	<i>Amelanchier alnifolia</i>	Large Shrub	8-15	8-10	white fl & red berries	spring	2	sun or shade		x	xx	xx		3-5
Shiny-leaved Hawthorn^	<i>Crataegus erythropoda</i>	Large Shrub	10-20	8-15	white fl & red berries	spring	2-3	sun to partial sh.	x	xx	xx	xx	x	3-5
Wild Plum	<i>Prunus americana</i>	Large Shrub	12-15	15-20	white fl. & purple plums	spring	2	sun to partial sh.		x	xx	xx	xx	3-8
Western Chokecherry	<i>Padus virginiana var. melanocarpa</i>	Large Shrub	15-25	15-20	white fl. & purple berries	spring	2	sun or shade		xx	xx	xx	x	3-5
Western Sand Cherry	<i>Prunus besseyi</i>	Small Shrub	2-3	2-3	white flowers, purple black berries	spring	2-3	full sun to partial sh.		xx	xx	xx	xx	2-6
Cottonwood Trees	<i>Populus spp.</i>	Large Tree	50-60	50	reddish flowers, gold leaves in fall	spring	2-3	full sun	x	xx	xx	xx	xx	3-9
Netleaf Hackberry^	<i>Celtis reticulata</i>	Small Tree	10-15	8-12	inconspicuous flowers	spring	1	full sun to partial sh.		x	xx	xx	xx	4-6

<u>Species for subirrigated area (1 - 3 feet above high water line) (Zones upper PB4, PS2, Lower PS 5 on north side, upper R1, R2, & possible on R</u>														
Leadplant; False Indigo	<i>Amorpha fruticosa</i>	Medium Shrub	6-12	4-6 ft	purple flowers	summer	2-3	sun to partial sh.	xx	xx	xx	xx	xx	4-9
Redosier Dogwood	<i>Cornus sericea</i>	Medium Shrub	6-8	6-8	white flowers & berries	sp to su	3	sun or shade	xx	xx	xx	xx		2-7
Golden Currant	<i>Ribes aureum</i>	Medium Shrub	4-8	4-6	yellow fl., red fruits., red fall foliage	spring	2	full sun to partial sh.		xx	xx	xx		4-6
American Black Currant	<i>Ribes americanum</i>	Small Shrub	2-4	2-4	yellow fl., red fruits., red fall foliage	spring	3	full sun to partial sh.	?	xx	xx	xx	?	3-6
Peachleaf Willow	<i>Salix amygdloides</i>	Medium Tree	20-40	40	reddish flowers, gold leaves in fall	spring	2-3	full sun to partial sh.	x	x	xx	xx	xx	4-6

<u>Species for Wetland area (0 - 2 feet above high water line) (Zones W1, W2, W3, R1, and lower R2</u>														
Stapleaf Willow^	<i>Salix eryocephala</i> <i>var. ligulifolia</i>	Large Shrub	8-15	8-15	yellow catkins, red & yellow twigs	spring	3	full sun to partial sh.	xx	xx	xx	xx	xx	3-5
Whiplash Willow	<i>Salix lasiandra</i>	Large Shrub	15-25	10-15	yellow catkins	spring	3	full sun	xx	xx	xx	xx	xx	3-7
Sandbar Willow	<i>Salix exigua</i>	Medium Shrub	5-10	5-20	yellow catkins	spring	3	full sun to partial sh.	x	xx	xx	xx	xx	3-9
Bluestem Willow^	<i>Salix irrorata</i>	Medium Shrub	5-8	4-6	yellow catkins, bluish twigs	spring	3	full sun to partial sh.	x	xx	xx	xx	xx	3-5

*Shrub and Tree														
Watering Schedule 1			1st year	<i>Soak every 2 wks</i>		Watering Schedule 2			1st year	<i>Soak every week</i>				
			2nd year	<i>Soak every three weeks</i>					2nd year	<i>Soak every two weeks</i>				
			3rd year	<i>Soak once a month</i>					3rd year	<i>Soak every three to four weeks</i>				
			4th year	<i>Water during extended dry periods</i>										
			Watering Schedule 3			1st year	<i>Soak twice a week</i>							
						2nd year	<i>Soak once a week</i>							
						3rd year	<i>Soak every two weeks</i>							

^ Species on the margins of their range

*ZONES COORDINATE WITH CHARTS ON PAGES NAT APDX C-2 THROUGH C-7

Wetland and Subirrigated Tallgrass Prairie Species List

For Detention Ponds, Drainages, and Other Areas (See Graphic for Zone Layout)

<u>Common Name</u>	<u>Scientific Name</u>	<u>Wetl.</u> <u>Desiq.</u>	<u>Water</u> <u>Regime</u>	<u>Water</u> <u>Depth Preference</u>	<u>Growth</u> <u>Pattern</u>
<u>Community Type</u>	<u>Dimensions</u> (feet)	<u>Area</u> (Sq feet)	<u># of Plants</u>	<u>Density</u> 1/ 5 sq ft	
Species for Open Water (Standing or Slow Moving) (Zone PB1, also possible in parts of Zone PB2 and PB3)					
American Threesquare	<i>Schoenoplectus pungens</i>	obligate	H	0 to 6"	sod
Smallfruit Bulrush	<i>Scirpus microcarpus</i>	obligate	H to H+	0 to 3"	sod
Pale Bulrush	<i>Scirpus pallidus</i>	obligate	H to H+	0 to 3"	sod
Softstem Bulrush	<i>Schoenoplectus tabernaemontani</i>	obligate	H to H+	0 to 24"	sod
Hardstem Bulrush	<i>Schoenoplectus acutus</i>	obligate	H to H+	0 to 36"	sod
Giant Burreed*	<i>Sparganium eurycarpum</i>	obligate	H to H+	0 to 12"	sod
Broadleaf Arrowhead	<i>Sagittaria latifolia</i>	obligate	H	6 to 12"	sprout
Flooded Slopes (Zone PS2 and PB4)				1/sq ft to 1/two sq ft	
Clustered Field Sedge	<i>Carex praegracilis</i>	facw	H-	periodically flooded	sod
American Threesquare	<i>Schoenoplectus pungens</i>	obligate	H	0 to 6"	sod
Alkali Bulrush	<i>Bolboschoenus maritimus</i>	obligate	H to H+	0 to 6"	sod
Water Sedge	<i>Carex aquatilis</i>	obligate	H to H+	0 to 3"	bunch
Emory Sedge	<i>Carex emoryi</i>	obligate	H	seasonally flooded	sod
Nebraska Sedge	<i>Carex nebrascensis</i>	obligate	H	seasonally flooded	sod
Marsh Milkweed	<i>Asclepias incarnata</i>	obligate	H-	periodically flooded	sprout
Prairie Cordgrass	<i>Spartina pectinata</i>	facw	M+ to H-	seasonally flooded	sod
Flooded Flats (Zones PB2, PB3, W1, W2, and W3)				1/sq ft to 1/two sq ft	
Clustered Field Sedge	<i>Carex praegracilis</i>	facw	H-	periodically flooded	sod
Creeping Spikerush	<i>Eleocharis palustris</i>	obligate	H	0 to 3"	sod
American Mannagrass	<i>Glyceria grandis</i>	obligate	H	seasonally flooded	rhizomatous
Prairie Cordgrass	<i>Spartina pectinata</i>	facw	M+ to H-	seasonally flooded	sod
Emory Sedge	<i>Carex emoryi</i>	obligate	H	seasonally flooded	sod
Nebraska Sedge	<i>Carex nebrascensis</i>	obligate	H	seasonally flooded	sod
Nuttall Alkaligrass	<i>Puccinellia nuttalliana</i>	obligate	M+ to H-	seasoanlly flooded	sprout
Marsh Milkweed	<i>Asclepias incarnata</i>	obligate	H-	periodically flooded	sprout
Marsh Sunflower	<i>Helianthus nuttallii</i>	facw	M+	periodically flooded	sprout
Saturated Slopes (Zones PS2, possible lower PS5, W1, W2, W3, and R1)				1/sq ft to 1/two sq ft	
Bottlebrush Sedge	<i>Carex hystricicna</i>	obligate	H-	seasonally saturated	sod
Wolly Sedge	<i>Carex lanuginosa</i>	obligate	H-	seasonally flooded	sod
Slender Rush	<i>Juncus tenuis</i>	fac-facw	H	moist to saturated	bunch
Broom Sedge	<i>Carex scoparia</i>	facw	H	seasonally flooded	rhizomatous
Bebb's Sedge	<i>Carex bebbii</i>	obligate	H-	saturated soil	bunch
Colorado Rush	<i>Juncus confusus</i>	facw	H	moist - saturated	sod
Torrey's Rush	<i>Juncus torreyi</i>	facw-facw+	H	saturated soil	sod
Baltic Rush	<i>Juncus arcticus</i>	fac-obl	H- to H	moist - saturated	sod
American Mannagrass	<i>Glyceria grandis</i>	obligate	H	seasonally flooded	rhizomatous
Blue Vervain	<i>Verbena hastata</i>	facw	H-	moist - saturated	bunch
Marsh Sunflower	<i>Helianthus nuttallii</i>	facw	M+	periodically flooded	sprout
Saturated Flats (Zones PB2, PB3, and possibly PB4)				1/sq ft to 1/two sq ft	
Slender Rush	<i>Juncus tenuis</i>	fac-facw	H	moist to saturated	bunch
Fox Sedge	<i>Carex vulpinoidea</i>	obligate	H-	seasonally saturated	sod
Colorado Rush	<i>Juncus confusus</i>	facw	H	moist - saturated	sod
Torrey's Rush	<i>Juncus torreyi</i>	facw-facw+	H	saturated soil	sod
Bebb's Sedge	<i>Carex bebbii</i>	obligate	H-	saturated soil	bunch
Blue Vervain	<i>Verbena hastata</i>	facw	H-	moist - saturated	bunch
Rocky Mountain Iris	<i>Iris missouriensis</i>	obl-facw	M+ to H-	saturated	sprout
Marsh Skullcap	<i>Scutellaria galericulata</i>	facw	M+ to H-	moist - saturated	sprout
Agalinus	<i>Agalinus tenuifolia</i>	facw	M+ to H-	moist - saturated	sprout
Field Mint	<i>Mentha arvensis</i>	facw	M+	moist	sprout
Nuttall Alkaligrass	<i>Puccinellia nuttalliana</i>	obligate	M+ to H-	seasoanlly flooded	sprout
Inland Saltgrass	<i>Distichlis spicata</i>	facw	M+ to X	moist to xeric	rhizomatous
Prairie Cordgrass	<i>Spartina pectinata</i>	facw	M+ to H-	seasonally flooded	sod

<u>Common Name</u>	<u>Scientific Name</u>	<u>Wetl.</u> <u>Desiq.</u>	<u>Water</u> <u>Regime</u>	<u>Water</u> <u>Depth Preference</u>	<u>Growth</u> <u>Pattern</u>
<u>Community Type</u>	<u>Dimensions</u> (feet)	<u>Area</u> (Sq feet)	<u># of Plants</u>	<u>Density</u> 1/sq ft to 1/two sq ft	
Subirrigated Slopes (Zones upper PS2, PS5, Upper R1, R2, and lower R3)					
Switchgrass	<i>Panicum virgatus</i>	fac-facw	M- to M+	subirrigated	bunch
Yellow Indiangrass	<i>Sorghastrum nutans</i>	fac	M- to M+	subirrigated	bunchy sod
Big Bluestem	<i>Andropogon gerardii</i>	fac	M to M+	subirrigated	sod
Marsh Sunflower	<i>Helianthus nuttallii</i>	facw	M+	periodically flooded	sprout
Golden Banner	<i>Thermopsis divaricarpa</i>	upland	M	moist	rhizomatous
Prairie Coneflower	<i>Ratibida columnifera</i>	upland	X to X+	dry	sprout
Indian Blanket	<i>Gaillardia aristata</i>	upland	X+ to M	dry to moist	sprout

Subirrigated Flat (Upper R1, R2, and lower R3)				1/sq ft to 1/two sq ft	
Prairie Cordgrass	<i>Spartina pectinata</i>	facw	M+ to H-	seasonally flooded	sod
Switchgrass	<i>Panicum virgatus</i>	fac-facw	M- to M+	subirrigated	bunch
Yellow Indiangrass	<i>Sorghastrum nutans</i>	fac	M- to M+	subirrigated	bunchy sod
Big Bluestem	<i>Andropogon gerardii</i>	fac	M to M+	subirrigated	sod
Great Blue Lobelia	<i>Lobelia siphilitica</i>	obl-facw	M to M+	subirrigated	sprout
Rocky Mountain Iris	<i>Iris missouriensis</i>	obl-facw	M+ to H-	saturated	sprout
Joe Pye Weed	<i>Eupatorium maculatum</i>	fac	M to M+	subirrigated	sprout
Tulip Gentian*	<i>Eustoma grandiflorum</i>	fac	M to M+	subirrigated	sprout

obligate - obligate wetland: Estimated 99% probability of occurrence in wetlands.
facw - facultative wetland: Estimated 67%-99% probability of occurrence in wetlands.
fac - facultative: Equally occuring in wetlands and non-wetlands (34 - 66% probability).
upland - not found in wetland soils, but may be found above wetlands in upper subirrigated areas

X- = always xeric M- = periodically dry H- = periodically saturated
X = xeric M = mesic H = saturated
X+ = occassionally xeric M+ = moist H+ = standing water

***Colorado Natural Heritage Program State Conservation Ranks**
S1 -Critically Imperiled Tulip Gention*
S2 - Imperiled Giant Burreed
S3 - Vulnerable Likely Prairie Cordgrass

*ZONES COORDINATE WITH CHARTS ON PAGES NAT APDX C-2 THROUGH C-7



General List of Grasses and Grasslike Plants and Their Ecological Characteristics

Common Name	Scientific Name	Soil Type						Soil Moisture				Sun/Shade Tolerance			Growing Season	Height (feet)	Growth Form	
		Clay	Clay	Loam	Sandy	Sand	Gravel	Hydric	Mesic	Xeric	Shade	Partial	Sun					
		Fine	Moderatley Fine	Medium	Loam Moderatley Course	Course	Very Course											
Species for Upland Slopes (Zones PS100, PT, R4, and U1)																		
Little Bluestem	Schizachyrium scoparium	x	x	xx	xx	xx	xx		xx	xx	x			xx	xx	warm	1 to 4	bunchgrass
Side Oats Grama	Bouteloua curtipendula	x	xx	xx	xx	x	x			xx	xx	x		x	xx	warm	1 to 3	bunchy, sod forme
Blue Grama	Bouteloua gracilis	x	xx	xx	xx	x	x		x	xx	xx	xx			xx	warm	0.5 to 2	bunchgr., sod w/ r
Western Wheatgrass	Pascopyrum smithii	xx	xx	xx	x			x	xx	xx	x			x	xx	cool	1 to 3	sod forming
Green Needlegrass	Nassella viridula	xx	xx	xx	x	x			x	xx	xx	x		x	xx	cool	1.5 to 3.5	bunchgrass
Slender Wheatgrass	Elymus trachycaulus	x	xx	xx	xx				xx	xx	x			x	xx	cool	1.5 to 4	short-lived,bunchg
Buffalograss	Buchloe dactyloides	xx	xx	xx	xx	x	x		x	xx	xx	xx		x	xx	warm	0.2 to 0.5	sod forming
Bottlebrush Squirreltail	Elymus elymoides	x	xx	xx	xx	xx	xx		x	x	xx	xx			xx	cool	1 to 2	short-lived,bunchg
Sand Dropseed	Sporobolus cryptandrus		x	xx	xx	xx	xx			x	xx	xx		x	xx	warm	2 to 3	bunchgrass
Alkali Bluegrass	Poa juncifolia	x	xx	xx	xx	x	x		x	xx	xx	x	x	xx	xx	cool	0.5 to 1.5	bunchgrass
Sun Sedge	Carex inops ssp. heliophila																	
Species for Subirrigated Areas (Zones upper PB4, PS2, Lower PS 5 on north side, upper R1, R2, & possible on R3)																		
Big Bluestem	Andropogon gerardii	x	xx	xx	xx	xx	x		xx	xx	x			x	xx	warm	3 to 6	bunchy, sod forme
Switchgrass	Panicum virgatum	xx	xx	xx	xx	x	x		xx	xx	x				xx	warm	2 to 5	bunchgr., sod w/ r
Yellow Indiangrass	Sorghastrum nutans	xx	xx	xx	xx	xx	x	x	xx	xx	x	x		xx	xx	warm	3 to 6	bunchy, sod forme
Alkali Sacaton	Sporobolus airoides	x	xx	xx	xx	x			xx	xx	x			x	xx	warm	1 to 3	bunchgrass
Green Needlegrass	Nassella viridula	xx	xx	xx	x	x			x	xx	xx	x		x	xx	cool	1.5 to 3.5	bunchgrass
Western Wheatgrass	Pascopyrum smithii	xx	xx	xx	x			x	xx	xx	x			x	xx	cool	1 to 3	sod forming
Nuttall Alkaligrass	Puccinellia airoides	xx	xx	xx	x	x		x	xx	xx				x	xx	cool	1 to1.5	bunchgrass
Canada Wildrye	Elymus canadensis	xx	xx	xx	x			x	xx	xx	x		x	xx	xx	cool	2 to 4	short-lived,bunchg
Species for Wetland Areas (Zones PB1, PB2, BP3, PB4, PS2, and on W1, W2, W3, R1 and R2) (seeded)																		
Prairie Cordgrass	Spartina pectinata		xx	xx	xx	x		x	xx	x				xx	xx	warm	3.5 to 7	sod forming
Canada Wildrye	Elymus canadensis	x	xx	xx	xx	x		x	xx	xx	x		x	xx	xx	cool	2 to 4	short-lived,bunchg
Switchgrass	Panicum virgatum	xx	xx	xx	xx	x	x		xx	xx	x				xx	warm	2 to 5	bunchgr., sod w/ r
Inland Saltgrass	Distichlis spicata	xx	xx	xx	x			xx	xx	x				x	xx	warm	0.5 to1.5	sod forming
Fowl Bluegrass	Poa palustris		xx	xx	x			x	xx	x			x	xx	xx	cool	1 to1.5	bunchgrass
Nebraska Sedge	Carex nebrascensis	xx	xx	x				xx	x						xx	cool	1 to 2.5	sod forming
Woolly Sedge	Carex lanuginosa	x	xx	xx	xx			x	xx	x					xx	cool	1 to 3	sod forming
Creeping Spikerush	Eleocharis palustris	xx	xx	x				xx	x						xx	cool	0.5 to 2	sod forming
Torrey's Rush	Juncus torreyi	xx	xx	x				xx	xx	x					xx	cool	1 to 2.5	sod forming
Baltic Rush	Juncus balticus	xx	xx	x				xx	xx	x					xx	cool	0.5 to 2.5	sod forming

*ZONES COORDINATE WITH CHARTS ON PAGES NAT APDX C-2 THROUGH C-7

NAT Appendix C - Zoning and Decision Charts for Centerra

ZONING CHART 1 - Centerra Guideline Matrix

This guideline matrix provides a broad context for the appropriateness of various types of ecosystems and their attributes that can be created in Centerra. Centerra lands are divided up based on habitat patch size and the relationship of one patch to another, narrow and broad peninsulas of habitat, and narrow and broad habitat corridors (Column Headers). As development decisions are made, specific areas can be identified within these eight broader categories. An example of a **Small Patch Ecosystem** might be a neighborhood detention pond surrounded by the homes and other dwelling units in the neighborhood, whereas a **Large Patch Ecosystem** might be a regional detention facility covering several acres serving several neighborhoods or a larger part of the community. An example of a **Narrow Corridor Ecosystem** could be a small ephemeral stream drainage created to convey stormwater through a neighborhood, whereas a **Broad Corridor** may be needed to serve the larger community. **Peninsulas** of habitat could be **narrow or broad** but do not connect to open space lands on one end. Ecosystem attributes on the left side of the spreadsheet represent a continuum of aesthetics from open to dense vegetation, from shortgrass prairies to densely vegetated shrubby woodlands, a continuum of water regimes, and of options to buffer these ecosystems from the influences of the surrounding developed communities. Generally speaking, all of these lands are small when it comes to conserving wildlife habitat, thus limiting conservation to mostly songbirds, butterflies, some amphibians and reptiles, and plants (See NAT Appendix D for Landscape Functions).

To use the restoration decision matrix:

- 1. Determine the appropriate Centerra Areas Landscape Context and header for the project in consultation with the team environmental consultant or in discussions with HPEC personnel.
- 2. In the Centerra Guideline Matrix to the right, move down the column to find the appropriate planting types, depicted with XX.
- 3. Go to Charts 2A, 2B and 3 in the NAT Appendix C and NAT Appendix D to evaluate attributes of the ecosystem type to determine if the type meets project goals.
- 4. Select a desired habitat type.
- 5. Refer to Charts 4 and 5 in the NAT Appendix C for detention pond zones and specific ecosystems. Refer to Charts 6 and 7 in the NAT Appendix C for stream and channel conveyance zones and specific ecosystems and plant community types.
- 6. Select the specific plant communities, wildlife and habitat that you want to restore at your project site (i.e. Nebraska sedge, Herbaceous wetland, Tallgrass prairie, Shrubby woodland)
- 7. Refer to the Field Guide page depicted. Determine the seed mix from the Field Guide.
- 8. Use the descriptions and plant list from the Field Guide to determine the seed mixes, herbaceous plants and woody plants you want to restore at the project site.



Centerra Guideline Matrix

Ecosystem Types & Attributes	Centerra's Conservation Lands							
	Small Patch Ecosystem	String of Small Patches Ecosystem	Large Patch Ecosystem	String of Large Patches Ecosystem	Narrow Peninsula Ecosystem	Broad Peninsula Ecosystem	Narrow Corridor Ecosystem	Broad Corridor Ecosystem
General Aesthetics								
OPEN			X					XX
MIXED	X	X	XX	X	X	X	X	XX
DENSE	XX	XX	XX	XX	XX	XX	XX	XX
Plant Communities								
Shortgrass			X	X				X
Mixed grass	X	X	XX	XX	X	X	X	X
Tall grass prairie	XX	XX	XX	XX	XX	XX	XX	XX
Playa			X	XX		X		X
Herbaceous Wetland	X	X	X	XX	X	X	X	XX
Bulrush Marsh	XX	X	XX	X	XX	XX	XX	XX
Riparian Shrubland	XX	XX	XX	X	XX	XX	XX	X
Upland Shrubland	X	X	X	X	X	X	X	XX
Park-like Woodland	X	X	X	XX	X	X	X	XX
Shrubby Woodland	XX	XX	XX	XX	XX	XX	XX	XX
Water Relations								
No water	X	X	X	X	X			
Temporary Water	XX	XX	XX	XX	XX	XX	XX	XX
Long-term Temporary Water	XX	XX	XX	X	X	X	XX	XX
Permanent Water	XX	XX	XX				XX	XX
Ecosystem Buffer Protection								
Landscape Edge Protection	XX	XX	XX	X	XX	XX	XX	X
Type- Veg. Screening	XX	XX	XX	X	X	X	XX	XX
Type - Fencing/limit access	XX	X	X	XX	X	X	X	X
Light and Noise Protection	XX	XX	XX	XX	XX	XX	XX	XX

XX = Very appropriate and in large amounts
X = somewhat appropriate but in smaller amounts



Zoning Chart 2A - Quality rating of various ecosystems by landscape function focusing on aesthetics, water, and sediment.

	Herbaceous Wetland Wet Meadow and Playas w/ mudflats	Herbaceous Wetland - Bulrush Marsh	Riparian and Upland Shrubland	Park-like Woodland	Shrubby Woodland	Subirrigated Tallgrass Prairie	Short and Mid Grass Prairie
Topographic Position	Low (-0.5' - 2' + above AHW)	Low (-2' -2' + above AHW)	Moderately Low to High (0' - 4' + above AHW)	Moderately Low to Moderate (2' - 6' above AHW)	Moderately Low to Moderate (2' - 6' above AHW)	Moderately Low (1' - 4' + above AHW)	High (4' -8' + above AHW)
Tall Visual Screen	No	No	Limited to 15 feet	Good	Excellent	No	No
Low Visual Screen	Limited to 3 feet	Limited to 5-8 feet	Good	Fair to Good	Good to Excellent	Limited to 5 feet	No
Trail Visual Screen	Fair to Good depending on wetness	Good to Excellent depending on thickness	Good	Fair to Good	Good to Excellent	Fair to Good depend- ing on thickness	No
Viewshed	Excellent	Fair to Excellent	Fair to Good	Fair to Poor	Poor	Excellent to Good	Excellent
Viewshed Framing	Poor	Poor to Fair	Poor to Fair	Excellent to Poor	Excellent to Poor	Poor	Poor
Auditory Screen	No	No	Fair to Good	Fair to Good	Good to Excellent	No	No
Wind Moderator	No	Poor	Fair to Good	Good	Excellent	No	No
Temperature Moderator	No	No	Limited	Good	Good to Excellent	No	No
Water Quality Filter	Good to Excellent	Excellent	Good to Fair	Good to Excellent	Good to Excellent	Fair to Good	Fair
Flood Attenuation	Good to Excellent	Good to Excellent	Good to Fair	Good	Good	Good	Fair to Poor
Erosion Control	Good to Excellent	Good to Excellent	Good to Excellent	Good	Good to Excellent	Good	Fair to Good
Sediment Storage	Good to Excellent	Good to Excellent	Fair to Excellent	Good to Excellent	Good to Excellent	Fair to Good	Fair to Poor

AHW - Average High Waterline

Zoning Chart 2B - Quality rating of various ecosystems by landscape function primarily related to conservation of wildlife.

	Herbaceous Wetland - Wet Meadow and Playas w/ mudflats	Herbaceous Wetland - Bulrush Marsh	Riparian and Upland Shrubland	Park-like Woodland	Shrubby Woodland	Subirrigated Tallgrass Prairie	Short and Mid Grass Prairie
Topographic Position	Low (-0.5' - 2' + above AHW)	Low (-2' -2' + above AHW)	Moderately Low to High (0' - 4' + above AHW)	Moderately Low to Moderate (2' - 6' above AHW)	Moderately Low to Moderate (2' - 6' above AHW)	Moderately Low (1' - 4' + above AHW)	High (4' -8' + above AHW)
Wildlife Movement Corridor	Fair to Good	Poor to Fair	Good	Good	Good to Excellent	Good	Fair to Poor
Stepping Stone	Good	Excellent -existing	Good	Good	Good to Excellent	Good	Fair to Poor
Buffer	Good	Good to Excellent	Good to Excellent	Good to Excellent	Good to Excellent	Fair to Good	Fair to Poor
Wildlife Breeding	Good	Excellent -existing	Fair to Good	Fair to Good	Fair to Good	Good	Fair to Poor
Wildlife Feeding	Good to Excellent	Fair to Good (bulrushes)	Good to Excellent	Good	Good to Excellent	Good	Fair to Good
Wildlife Resting	Good	Fair to Good	Good to Excellent	Good	Good to Excellent	Good	Fair to Good
Migratory Stopover	Good to Excellent	Fair to Good	Good to Excellent	Good	Good to Excellent	Good	Fair

AHW - Average High Waterline

ZONING Chart 3 - Wildlife use by function for various ecosystems.

	Short and Mixed Grass Prairie	Herbaceous Wetland	Subirrigated Tallgrass Prairie	Herbaceous Wetland -Bulrush Marsh	Wetland and Upland Shrub Thicket	Park-like Woodland	Shrubby Woodland
Representation	Fair	Poor to Good	Poor	Excellent	Poor to Fair	Fair to Poor	Poor
Topographic Position	High (4' - 8' + above AHW)	Low (-0.5' - 2' + above AHW)	Moderately Low (1' - 4' + above AHW)	Low (-2' - 2' + above AHW)	Moderately Low to High (0' - 4' + above AHW)	Moderately Low to Moderate (2' - 6' above AHW)	Moderately Low to Moderate (2' - 6' above AHW)
Wildlife Movement Corridor	Small Mammals	Small Mammals	Up to Medium Mammals	Medium to Large Mammals	Medium to Large Mammals	Medium to Large Mammals	Medium to Large Mammals
Stepping Stone	Some grassland Song- birds on migration Butterflies	Waterfowl Many Shorebirds Some Songbirds Many Waders Some waterbirds Many Butterflies	Most Grassland Song- birds Some Raptors Many Butterflies	Some Songbirds Some Raptors Some Waders and Most Rails Few Butterflies	Many Songbirds Some Raptors	Many Raptors Many Songbirds Few Butterflies	Many Raptors Most Songbirds Some Butterflies
Buffer	Fair to Poor	Good	Fair to Good	Good to Excellent	Good to Excellent	Good to Excellent	Good to Excellent
Wildlife Breeding	Limited Waterfowl Limited Songbirds	Waterfowl Shorebirds Some Songbirds	Waterfowl Shorebirds Some Songbirds	Grebes Waterfowl Shorebirds Some Songbirds	Limited Waterfowl Many Songbirds	Limited Waterfowl Many Songbirds Raptors	Limited Waterfowl Many Songbirds Raptors
Wildlife Feeding	Limited Waterfowl Limited Songbirds Many Raptors Some Butterflies	Waterfowl Many Shorebirds Some Songbirds Many Waders Some waterbirds Many Butterflies	Most Grassland Song- birds Some Raptors Many Butterflies	Some Songbirds Some Raptors Some Waders and Most Rails Few Butterflies	Many Songbirds Some Raptors	Many Raptors Many Songbirds Few Butterflies	Many Raptors Most Songbirds Some Butterflies
Wildlife Resting	Limited Waterfowl Limited Songbird Many Raptors Some Butterflies	Waterfowl Many Shorebirds Some Songbirds Many Waders Some waterbirds Many Butterflies	Most Grassland Song- birds Some Raptors Many Butterflies	Some Songbirds Some Raptors Some Waders and Most Rails Few Butterflies	Many Songbirds Some Raptors	Many Raptors Many Songbirds Few Butterflies	Many Raptors Most Songbirds Some Butterflies
Migratory Stopover	Some Grassland Song- birds Some Raptors	Waterfowl Many Shorebirds Some Songbirds Many Waders	Most Grassland Song- birds Some Raptors	Some Songbirds Some Raptors Some Waders and Most Rails	Many Songbirds Some Raptors	Many Raptors Many Songbirds	Many Raptors Most Songbirds

AHW - Average High Waterline

DESIGN CHARTS 4 & 5

Centerra and HPEC Detention Pond Narrative

These charts show specific types of wetland and riparian ecosystems and their dominant plant communities that can be restored as habitat in detention ponds on Centerra and HPEC (High Plains Environmental Center) lands. These are existing ecosystems that have been described by a plant ecologist from the *Colorado Natural Heritage Field Guide to Wetland and Riparian Plant Associations of Colorado*. In Chart 4 the ecosystem zones in the left hand column correspond to the plan view and cross section drawings (on this sheet) of representative areas of a detention pond. The second column describes the relationship between topography and water relations for each zone designation, while the following columns describe the relationship between ecosystem zones, plant designations and communities. In Chart 5 (on page NAT APDX C-5) the ecosystem zones in the left hand column correspond to the plan view and cross section drawings (on this sheet) of representative areas of a detention pond. This is followed by the individual plant communities and the associated page number in the above mentioned field guide as well as restoration suitability and desirability of each of these plant communities in a particular zone. The table is broken up by major vegetative groups. Within each group the most water loving (wet) communities are on the top left and the most xeric (dry) communities are on the bottom right.

Additional plants for each community can be found in the NAT Appendix B

Chart 4 - Detention Pond Zones with hydrologic characteristics, soil moisture regimes, associated wetland plant designations, as well, as the general plant community that might be restored to pond bottom and pond slopes.

Zone Code	Hydrogeomorphology	Flood Return Interval*	Moisture Regime	Wetland Plant Designation	General Plant Community **
PB1	Pond Bottom Surface Water Frequent	0-0.10	H	obligate	Wetland Marsh
PB2	Pond Bottom Saturated	0.10 - 0.75	H to H-	obligate to facw	Herbaceous Wetland
PB3	Pond Bottom Periodically Saturated	0.75 to 1.0	H-	obligate to facw	Herbaceous Wetland
PB4	Pond Bottom Moist	1.0 to 2.0	M+	facw - fac	Herbaceous Wetland
PS2	Pond Slope up to 2 year flow	1.0 to 2.0	M+ to M	facw - fac	Shrubland or Woodland
PS5	Pond Slope from 2 to 5 year flow	2.0 to 5.0	M to M-	upl - facu	Shrubland, Woodland, or Grassland
PS100	Pond Slope from 5 to 100 year flow	5.0 to 100	M- to X+	upl - facu	Shrubland, Woodland, or Grassland
PT	Pond Top above slope	100+	X+ to X-	upl - facu	Grassland or Upland Shrubland

* Lower part of the range reflects when water will first flood this ecosystem while the upper end reflects when this community will be completely inundated

**Specific plant communities can be found on Page -----

Key:

- obligate** - obligate wetland: Estimated 99% probability of occurrence in wetlands.
- facw** - facultative wetland: Estimated 67% to 99% provability of occurrence in wetlands.
- fac** - facultative: Estimated 34% to 66% probability of occurrence in wetlands. Equally occurring in wetlands and non-wetlands.
- facu** - facultative upland: Estimated 1% - 33% probability of occurrence in wetlands, 67% to 99% probability of occurrence.
- upl** - upland: Not found in wetland soils, but may be found above wetlands in upper subirrigated areas.

- x-= always xeric

x = xeric

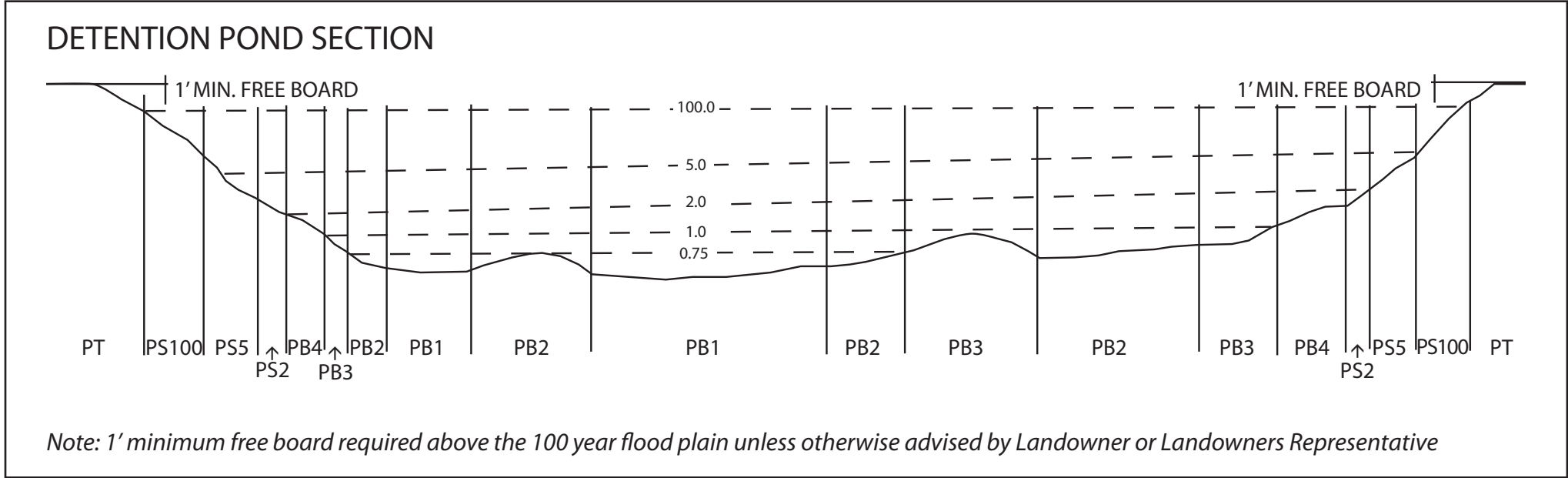
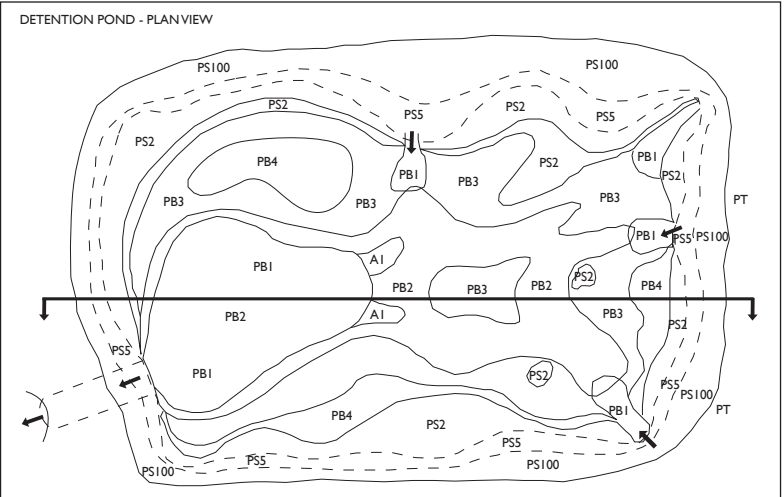
x+ = occasionally xeric
- M- = periodically dry

M = mesic

M+ = moist
- H- = periodically saturated

H = saturated

H+ = standing water



Design Chart 5 Detention Pond Ecosystems and Dominant Plant Communities - Existing Colorado Plant Communities that could be restored as habitat in detention ponds and surrounding slopes.

* Additional plants for each community can be found in the NAT Appendix B*

Ecosystems		Herbaceous Wetland						Riparian Shrubland						Upland Shrubland				
		Bulrush Marsh 416	Common Spikerush 376	Beggar Ticks 326	Nebraska Sedge 346 G4 S3	Woolly Sedge 350 G3 S3 (montane)	Prairie Chordgrass 426 G3? S3	Sandbar Willow 206	Strapleaf Willow* 222 G2G3 S2S3	River Hawthorn 288 G2Q S2	Chokecherry Plum 298 G4Q S2	Western Snowberry 310	Skunkbrush SBS G2 S2 (riparian)	Saltbush Winterfat SWS	Rabbitbrush RBS			
Field Guide Page**																		
Colorado Natural Heritage Program Ranking																		
Zone Code	Hydro-geomorphology																	
PB1	Pond Bottom Surface Water Frequent	xx	xx	xx	x													
PB2	Pond Bottom Saturated	xx	xx	xx	xx	xx	x		x	y								
PB3	Pond Bottom Periodically Saturated	xx	x	x	xx	xx	xx		xx	x								
PB4	Pond Bottom Moist	x	y	y	x	xx	xx		xx	xx	x	y	y					
PS2	Pond Slope up to 2 year flow	y			y	x	xx		xx	xx	x	x	x	y	x	x		
PS5	Pond Slope from 2 to 5 year flow					y	x		x	x	xx	xx	xx	xx	x	x		
PS100	Pond Slope from 5 to 100 year flow						y		y	y	x	xx	xx	xx	xx	xx		
PT	Pond Top above slope											x	x	x	xx	xx		
		Wet----->----->Mesic						Wet Mesic----->----->Dry Mesic									Dry Mesic----->Dry	
Ecosystems		Park-like Woodland					Shrubby Woodland						Prairie					
		P. Cottonwood PL Willow P. Chordgrass Sedge 160 G1 S1	P. Cottonwood Woolly Sedge 140 G2 S1	Peachleaf Willow 182	P. Cottonwood Switchgrass Little Bluestem 150 G2 S2	P. Cottonwood Western Wheatgrass 152 G2 S2 (in part)	P. Cottonwood Bluestem Willow 126	P. Cottonwood Peachleaf & Sandbar Willow 158 G4G3 S2	P. Cottonwood Chokecherry 154	P. Cottonwood Western Snowberry 168 G2G3 S2	P. Cottonwood Skunkbrush 156			Tallgrass Prairie 322 G2 S1S2	Midgrass Prairie MGP G3G4 S2	Shortgrass Prairie SGP		
Field Guide Page**																		
Colorado Natural Heritage Program Ranking																		
Zone Code	Hydro-geomorphology																	
PB1	Pond Bottom Surface Water Frequent																	
PB2	Pond Bottom Saturated	x	x	x			x		x					y				
PB3	Pond Bottom Periodically Saturated	xx	xx	xx	y	y	xx		xx					x				
PB4	Pond Bottom Moist	xx	xx	xx	xx	xx	xx		xx	y	y			xx				
PS2	Pond Slope up to 2 year flow	x	xx	xx	xx	xx	xx		x	x	xx	x		xx	y			
PS5	Pond Slope from 2 to 5 year flow	xx	y	x	xx	xx	x		xx	xx	xx	xx		xx	x	y		
PS100	Pond Slope from 5 to 100 year flow	x		y	xx	xx	y		x	xx	xx	xx		x	xx	x		
PT	Pond Top above slope	y			y	x			y	x	y	x		y	xx	xx		
		Wet----->----->Mesic						Wet Mesic----->----->Dry Mesic			Dry Mesic----->Dry							
Restoration Suitability and Desirability																		

* Each of these plant communities are found in Colorado and have been described by plant ecologists.
** [Field Guide to the Wetland and Riparian Plant Associations of Colorado](#) Colorado Natural Heritage Program, Colorado State University

ADDITIONAL PLANT COMMUNITIES - Most of these additional communities are found in the lower mountains or are found on the west slope, however all of these dominant species are found on the high plain (some are not the best adapted) although this exact plant community may not be found.
Other Woodlands - Plains Cottonwood/ Inland Saltgrass (142), Plains Cottonwood/Slenderwheatgrass (144) GU S2, Cottonwood Alkali Sacaton (162) (G3 S2)
Other Shrubby Woodlands - Cottonwood Red Osier Dogwood (114) G4 S3 (in part), Cottonwood River Birch (112), Cottonwood Alder (110),
Forests - Box Elder Red Osier Dogwood Forest (100), Box Elder Cottonwood Nettleaf Hackberry Forest (102), Box Elder Cottonwood Red Osier Dogwood Forest (104), Box Elder Chokecherry Forest (106)
Riparain Shrublands - Sandbar Willow Strapleaf Willow (208)
Herbaceous Wetlands - Clustered Field Sedge (352)G3G4 S2, American Mannagrass (389), Mountain Rush (or Baltic Rush) (396), Rice Cutgrass (402), Alkali Muhley (404), Cosmopolitan Bulrush (418) G4 S2, Common Threesquare (420) G3G4 S3, Alkali Sacaton (430), Giant Burreed (G4 S2)

- Colorado Natural Heritage Program Ranking:
- G1 - Globally Critically Imperiled

G2 - Globally Imperiled

G3 - Globally Vulnerable to Extinction

G4 - Globally Apparently Secure

G5 - Demonstrably Widespread, Abundant, and Secure
- S1 - State Critically Imperiled

S2 - State Imperiled

S3 - State Vulnerable to Exterpation

S4 - State Apparently Secure

S5 - Demonstrably Widespread, Abundant, and Secure

DESIGN CHARTS 6 & 7
Centerra and Stream Drainage Narrative

These charts depict the specific types of aquatic and riparian stream ecosystems and their dominant plant communities that can be restored as habitat along drainages and floodplains upstream of detention ponds on Centerra and HPEC lands. These are existing ecosystems that have been described by plant ecologists from the Colorado Natural Heritage Program in a book entitled *Field Guide to Wetland and Riparian Plant Associations of Colorado*. In Design Chart 6 the ecosystem zones in the left hand column correspond to the plan view and cross section drawings (on this sheet) of representative areas of a drainage system. The second column describes the relationship between the topography and water relations for each zone designation, while the remaining columns describe the relationship between ecosystem zones and plant designations and communities. In Chart 7 the ecosystem zones in the left hand column correspond to the plan view and cross section drawings (on this sheet) of representative areas of a drainage system. This is followed by the individual plant communities and the associated page number in the above mentioned field guide as well as restoration suitability and desirability of each of these plant communities in a particular zone. The table is broken up by major vegetative groups. Within each group the most water loving (wet) communities are on the top left and the most xeric (dry) communities are on the bottom right.

Additional plants for each community can be found in the NAT Appendix B

DESIGN CHART 6 - Aquatic and Riparian Stream Drainage Ecosystem Zones with hydrologic characteristics, soil moisture regimes, associated wetland plant designations as well as the general plant community that might be restored to stream drainages and associated floodplains.

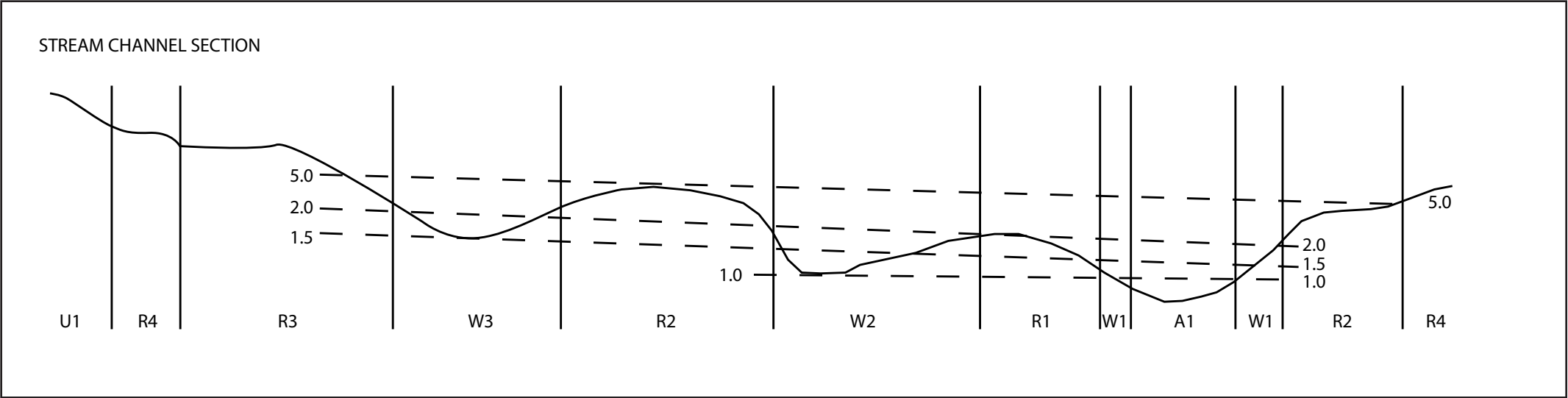
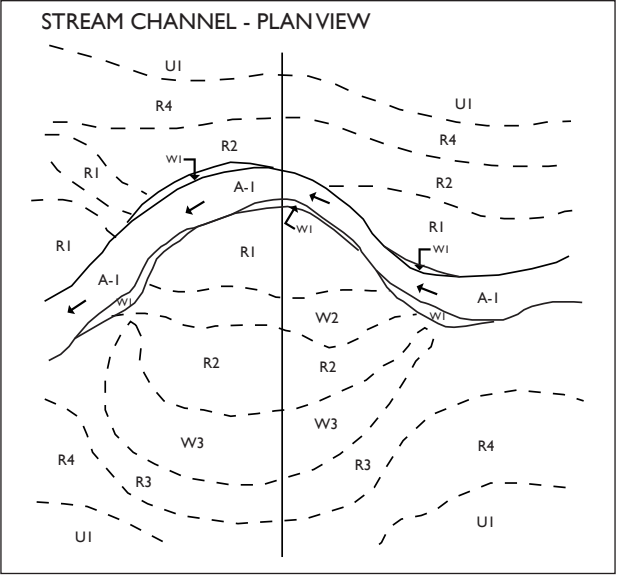
Zone Code	Hydrogeomorphology	Flood Return Interval*	Moisture Regime	Wetland Plant Designation	General Plant Community **
A1	Aquatic Main Channel	0-1.5	Aquatic to Wet	obligate	Wetland Marsh
W1	Main Channel Bank Wetland	1.0 - 2.0	Wet to Wet Mesic	obligate to facw	Herbaceous Wetland
W2	Secondary Channel Wetland	1.0 - 2.0	Wet to Mesic	obligate to facw	Herbaceous Wetland
W3	Old Meander Scroll Wetland	1.5 to 2.5	Wet to Mesic	obligate to fac	Herbaceous Wetland
R1	Active Riparian Point Bar	0.5 to 2.0	Wet to Mesic	obligate to fac	Shrubland or Woodland
R2	Middle Riparian Point Bar	2.0 to 5.0	Wet Mesic to Mesic	facw - fac	Shrubland, Woodland, or Grassland
R3	Oldest Riparian	4.0 to 10.0	Mesic	fac to facu	Shrubland, Woodland, or Grassland
R4	Riparian Floodplain Terrace	7.0 to 20.0	Mesic to Mesic Dry	upl - facu	Grassland or Upland Shrubland
U1	Upland Terrace	20.0 to 100.0	Mesic Dry to Dry	upl - facu	

* Lower part of the range reflects when water will first flood this ecosystem while the upper end reflects when this community will be completely inundated

**Specific plant communities can be found on Page LAN APDX C-7

Key:

- obligate** - obligate wetland: Estimated 99% probability of occurrence in wetlands.
- facw** - facultative wetland: Estimated 67% to 99% provability of occurrence in wetlands.
- fac** - facultative: Estimated 34% to 66% probability of occurrence in wetlands. Equally occurring in wetlands and non-wetlands.
- facu** - facultative upland: Estimated 1% - 33% probability of occurrence in wetlands, 67% to 99% probability of occurrence.
- upl** - upland: Not found in wetland soils, but may be found above wetlands in upper subirrigated areas.



Design Chart 7 Aquatic and Riparian Stream Drainage Ecosystems and Dominant Plant Communities - Existing Colorado Plant Communities that could be restored as habitat along drainage and floodplains upstream of detention ponds. * Additional plants for each community can be found in NAT Appendix B*

Ecosystems

Field Guide Page**

Colorado Natural Heritage Program Ranking

Zone Code

Hydrogeomorphology

A-1 Aquatic Main Channel

W1 Main Channel Bank Wetland

W2 Secondary Channel Wetland

W3 Old Meander Scroll Wetland

R1 Active Riparian Point Bar

R2 Middle Riparian Point Bar

R3 Oldest Riparian Point Bar

R4 Riparian Floodplain Terrace

U1 Upland Terrace

Plant Community*

Herbaceous Wetland

Bulrush Marsh

416

Nebraska Sedge

346

Woolly Sedge

350

Common Spikerush

376

Beggar Ticks

326

Prairie Chordgrass

426

G4 S3

G3 S3 (montane)

G3? S3

Wet----->

----->Mesi

Plant Community*

Riparian Shrubland

Sandbar Willow

206

Strapleaf Willow

222

River Hawthorn

288

Chokecherry Plum

298

Western Snowberry

310

G2G3 S2S3

G2Q S2

G4Q S2

G2 S2 (riparian)

Wet Mesic----->

----->Dry Mesic

Dry Mesic----->Dry

Plant Community*

Park-like Woodland

P. Cottonwood PL Willow

P. Cottonwood Woolly Sedge

160

G1 S1

Peachleaf Willow

182

P. Cottonwood Switchgrass

150

G2 S2

P. Cottonwood Western Wheatgrass

152

G2 S2 (in part)

P. Cottonwood Bluestem Willow

126

G1 S1

G2 S1

G2 S2

G2 S2 (in part)

G2 S2

Wet----->

----->Mesic

Wet Mesic----->

----->Dry Mesic

Dry Mesic----->Dry

Plant Community*

Shrubby Woodland

P. Cottonwood Peachleaf & Sandbar Willow

158

G4G3 S2

P. Cottonwood Chokecherry

154

P. Cottonwood Western Snowberry

168

G2G3 S2

P. Cottonwood Skunkbrush

156

G4G3 S2

G2G3 S2

G2 S1S2

G3G4 S2

Wet Mesic----->

----->Dry Mesic

Dry Mesic----->Dry

Plant Community*

Prairie

Tallgrass Prairie

322

G2 S1S2

Midgrass Prairie

G3G4 S2

Shortgrass Prairie

G2 S1S2

G3G4 S2

Wet Mesic----->

----->Dry

Restoration Suitability and Desirability

xx - highly suitable and desirable

x - suitable and desirable

y - marginal

* Each of these plant communities that are found in Colorado and have been described by plant ecologists.

** Field Guide to the Wetland and Riparian Plant Associations of Colorado, Colorado Natural Heritage Program, Colorado State University

ADDITIONAL PLANT COMMUNITIES - Most of these additional communities are found in the lower mountains or are found on the west slope, however all of these dominant species are found on the high plain: (some are not the best adapted) although this exact plant community may not be found

Other Woodlands - Plains Cottonwood/ Inland Slgrass (142), Plains Cottonwood/Slenderwheatgrass (144) GU S2, Cottonwood Alkali Sacaton (162) (G3 S

Other Shrubby Woodlands - Cottonwood Red Osier Dogwood (114) G4 S3 (in part), Cottonwood River Birch (112), Cottonwood Alder (110)

Forests - Box Elder Red Osier Dogwood Forest (100), Box Elder Cottonwood Netleaf Hackberry Forest (102), Box Elder Cottonwood Red Osier Dogwood Forest (104), Box Elder Chokeycherry Forest (11

Riparian Shrublands - Sandbar Willow Strapleaf Willow (208)

Herbaceous Wetlands - Clustered Field Sedge (352)G3G4 S2, American Mannagrass (389), Mountain Rush (or Baltic Rush) (396), Rice Cutgrass (402), Alkali Muhley (404), Cosmopolitan Bulrush (418) G4 S2, Common Threesquare (420) G3G4 S2, Alkali Sacaton (430), Giant Burreed (G4 S2)

Colorado Natural Heritage Program Ranking	
G1 - Globally Critically Imperiled	S1 - State Critically Imperiled
G2 - Globally Imperiled	S2 - State Imperiled
G3 - Globally Vulnerable to Extinction	S3 - State Vulnerable to Extirpation
G4 - Globally Apparently Secure	S4 - State Apparently Secure
G5 - Demonstrably Widespread, Abundant, and Secure	S5 - Demonstrably Widespread, Abundant, and Secure

NAT Appendix D - Landscape Functions

1. Aesthetic Qualities

- a) **Tall Visual Screen** – tall vegetation and berms that cannot be seen over or through (at least part of the year) to hide facilities or less visually appealing aspects of the landscape.
- b) **Low Visual Screen** – low but dense vegetation or berms that can be seen over, but not through, to hide facilities or less visually appealing aspects of the landscape.
- c) **Trail Screen** – a mixture of dense vegetation of various types and/or berms that help to make the trail appear as a more natural corridor, as well as to provide some or all of the other screening attributes.
- d) **Viewshed** – areas that provide unobstructed views of large, visually appealing landscape features, such as mountains, lakes, city lights, or even large cottonwood sentinel trees.
- e) **Viewshed Framing** – vegetation strategically located to frame desirable views, while possibly obstructing the views of undesirable landscape features.
- f) **Auditory Screen** – a mixture of dense vegetation and/or berms that help to dissipate noise.
- g) **Wind Moderator** – a mixture of dense vegetation and/or berms that help to dissipate wind.
- h) **Temperature Moderator** – a mixture of tall and possibly dense vegetation that help to shade the ground and provide a cooler environment for people and wildlife.

2. Water and Sediment Control

- a) **Water Quality Filter** – usually wetlands or riparian areas that remove nutrients, sediment, debris, and other pollutants from the water column through chemical, physical and biological processes.
- b) **Flood Attenuation** – areas that have the capacity to temporarily store water during small, moderate, or severe storms increasing the time it takes the water to reach the receiving body of water.
- c) **Erosion Control** – areas which have the ability to resist and adjust to wave action, shear stress caused by water, rills, gullies and other erosive forces.
- d) **Sediment Storage** – areas that have the ability to store sediment for a period of time but may release some of that sediment at a later time. These storage areas may also have plant communities that are designed to recover from being buried or that can recruit new plants on bare moist soils (e.g. pioneer plants like cottonwoods).

3. Wildlife and Plant Conservation

- a) **Movement Corridor** – an area generally linear in nature that tends to facilitate the daily or seasonal movement of wildlife from one location to another, as well as plant dispersal.
- b) **Stepping Stone** – an area generally isolated from surrounding habitat (a patch in an otherwise unsuitable matrix) that can provide some ability for species to move from one area to another via these islands of habitat. These areas can be especially valuable for birds, butterflies, wide ranging mammals, and can be a refuge for certain plant species.
- c) **Buffers** – areas that separate human landscape features from important wildlife habitat areas and/or sensitive plant species/communities. These areas reduce disturbance, excessive predation, and other negative edge effects (e.g. lights, noise, trash, pet intrusion).
- d) **Wildlife Breeding** – a mixture of food, cover, and landscape features in the right juxtaposition that tend to facilitate wildlife breeding by the conservation target species and possibly others.
- e) **Wildlife Feeding** – a mixture of food, cover and landscape features in the right juxtaposition that tend to facilitate feeding by the conservation target species.
- f) **Wildlife Resting** – a mixture of cover and landscape features in the right juxtaposition that tend to facilitate loafing areas for conservation target species.
- g) **Migratory Stopover** – a mixture of food, cover and landscape features in the right juxtaposition that tend to attract conservation target species and possibly others during migration. These areas are primarily used for resting and feeding of birds and butterflies.

- h) **Restoration** – Restore target ecosystem(s) that would represent a natural ecosystem which is supportable and sustainable in the long term. For the HPEC and Centerra this will be native plant communities that would occur from the base of the Rocky Mountains to the eastern edge of the state of Colorado and generally north of Denver. Restoring target ecosystems could include one or a combination of the following:

- 1. Restore the original ecosystem at the site.
- 2. Restore the ecosystem now best expressed by the flora and fauna of the site, particularly when a globally rare or endangered species is involved.
- 3. Restore the rarest or the otherwise highest priority ecosystem that is practical to restore at the site.
- 4. Restore a representative variety of the ecosystems at the site. Restore the largest possible example of a given ecosystem on the site.
- 5. Restore the highest priority and attainable mix of ecosystems in the quickest and easiest way.

4. Existing Well Represented Ecosystems that Do Not Need to be Restored

- a) **Open Water** – deeper water with limited submergent vegetation.
- b) **Shallow Water Wetland** – water less than 18” with submergent vegetation that can easily be accessed by dabbling ducks, waders, and some shorebirds.

5. Existing or Historically Under Represented Local Ecosystems that Need to be Restored

- a) **Herbaceous Wetlands - Playas with mudflats** – depressional wetlands (water collection basins) with a variety of emergent herbaceous vegetation usually surrounding areas of temporary shallow water or a temporary pond.
- b) **Herbaceous Wetlands - Wet Meadow** – often depressional wetlands or fringe wetlands. These areas are densely vegetated and dominated by wetland grasses, sedges, and rushes.
- c) **Herbaceous Wetlands - Bulrush Marsh** – fringe or depressional wetlands dominated by larger herbaceous vegetation, often very dense. They often surround, or are found on, the margins of deeper water areas.
- d) **Riparian Shrubland** – wetland areas or areas with high water tables that are dominated by willow species but may have other wetland and facultative wetland shrubs.
- e) **Upland Shrubland** – areas dominated by drought tolerant shrubs that are intermingled with grasses and wildflowers.
- f) **Park-like Woodland** – open woodlands (gallery forest) to a more closed forest dominated by one to three species of cottonwood tree with a few other tree species. These areas often have a grass dominated field layer and generally lack a diverse shrub component.
- g) **Shrubby Woodlands** – generally a more closed forest with some openings dominated by one to three species of cottonwood tree with a few other tree species. These areas have a diverse shrub component.
- h) **Tallgrass Prairie (Subirrigated)** – grassland areas with high water tables and a mixture of mostly warm season grasses. These areas are dominated by species taller than waist high and typically have a healthy component of native wildflowers.
- i) **Midgrass Prairie** – mixtures of warm and cool season grasses of medium stature with a healthy component of native wildflowers.
- j) **Shortgrass Prairie** – mixtures of warm and cool season grasses of short stature codominated by Blue Grama and Buffalograss with a healthy component of native wildflowers.

NAT Appendix E - Restoration Decision Charts for High Plains Environmental Center (HPEC)

CHART 1 - HPEC Guideline Matrix

This guideline matrix provides a broad context for the appropriateness of various types of ecosystems and their attributes that can be created on HPEC lands surrounding the reservoir. HPEC lands are divided up based on the Cedar Creek Buffer Zones of either 75 feet or 300+ feet (Column Headers). These Buffer Zones create narrow or broad corridors that encircle the two reservoirs. These corridors act as a hub that connects to incoming corridors from the surrounding matrix of developed lands. Many of the lands around the reservoirs will serve as regional detention facilities and many of the connecting corridors will convey storm water from the development into these regional detention basins. Ecosystem attributes on the left side of the spreadsheet represent a continuum of aesthetics from open to dense vegetation, from shortgrass prairies to densely vegetated shrubby woodlands, a continuum of water regimes, and of options to buffer these ecosystems from the influences of the surrounding developed communities. Generally speaking, all of these lands are small when it comes to conserving wildlife habitat, thus limiting their conservation potential to mostly songbirds, butterflies, some amphibians and reptiles, and plants. On HPEC lands, however, the reservoirs act to attract raptors, waterfowl, shorebirds, waders, and other water birds. Thus, the restoration decision matrix lands serve the important role of buffering the aquatic and adjacent wetland habitats from the influences of adjacent development.

To use the restoration decision matrix:

- 1. Determine the appropriate HPEC natural areas landscape context and header for the project in consultation with the team environmental consultant or in discussions with HPEC personnel.
- 2. In the High Plains Environmental Center guideline matrix below, move down the column to find appropriate planting types depicted with XX.
- 3. Go to Charts 2A, 2B and 3 in the NAT Appendix C and NAT Appendix D to evaluate attributes of ecosystem type to determine if the type meets project goals.
- 4. Select a desired habitat type.
- 5. Refer to Charts 4 and 5 in the NAT Appendix C for detention pond zones and specific ecosystems. Refer to Charts 6 and 7 in the NAT Appendix C for stream and channel conveyance zones and specific ecosystems and plant community types.
- 6. Select the specific plant communities, wildlife and habitat that you want to restore at your project site (i.e. Nebraska sedge, Herbaceous wetland, Tallgrass prairie, Shrubby woodland).
- 7. Refer to the Field Guide page depicted. Determine the seed mix from the Field Guide.
- 8. Use the descriptions and plant list from the Field Guide to determine the seed mixes, herbaceous plants and woody plants you want to restore at the project site.

HPEC Guideline Matrix

HPEC Conservation Lands

Ecosystem Types & Attributes	1 330' Equalizer SW & W	2 75' Houts SW & W	3 75' Houts W	4 300' Houts NW	5 75' Houts NE & E	6 300' Equalizer N	7 75' Equalizer NE	8 300' Equalizer W	9 75' Equalizer WSW	10 75' Equalizer SW	11 75' Equalizer S
General Aesthetics											
OPEN	X				XX	XX	XX	XX	XX	X	XX
MIXED	XX	X	X	X	X	X	X	X	X	XX	
DENSE	XX	XX	XX	XX						XX	
Plant Communities											
Shortgrass	X			X	X	X	XX	XX	XX	X	X
Mixed grass	XX	X	X	XX	X	X	X	X	X	XX	XX
Tallgrass	XX	XX	XX	XX	XX	XX	XX	XX	X	XX	X
Playa	XX			XX	XX	XX					
Herbaceous Wetland	XX	X	X	XX	XX	XX	XX	XX	X	XX	X
Bulrush Marsh	X	XX	XX	X	X	X	XX	X	XX	X	
Riparian Shrubland	XX	XX	XX	X	X	X	XX	XX	XX	XX	XX
Upland Shrubland	XX	X	X	X	X	XX	XX	X	X	XX	XX
Park-like Woodland	XX	X	X	XX	X	X	XX	X	XX	XX	X
Shrubby Woodland	XX	XX	XX	XX	X	X	X		XX	XX	
Water Relations											
No water	X	X		X	X	X	XX	X	XX	XX	XX
Temporary Water	XX	X	X	XX	XX	XX	X	XX	X	X	
Long-term Temporary Water	XX	XX	XX	X	X	X					
Permanent Water	XX		X							XX	
Ecosystem Buffer Protection											
Landscape Edge Protection	X	XX	XX	X	XX	X	XX	X	XX	XX	XX
Type- Veg. Screening	X	XX	XX	X	X	X	X	X	X	X	X
Type - Fencing/limit access	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
Light and Noise Protection	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

XX = Very appropriate and in large amounts
X = somewhat appropriate but in smaller amounts

HPEC Zone Map CHART

