TECHNICAL NOTE

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WETLAND TOPOGRAPHIC DESIGN AND SEDIMENT REMOVAL
Biologist and Engineer

The purpose of this technical note is to transmit wetland topography guidance. This technical note does not contain all of the detailed information planners need to consider when planning and designing wetland restoration, enhancement, and/or creation projects. Users must keep in mind the wetland complex ratios (e.g., temporary and/or seasonal to semi-permanent) in order to provide sustainable and quality wetland landscapes in the Prairie Pothole Region. For further planning guidance, please consult the “Wetland Restoration Planning and Evaluation for Wildlife Habitat” worksheet found in Biology Technical Note No. 17. For wetland seeding guidance, please consult Biology Technical Note No. 16.

Sediment removal is often times a critical component to sustainable wetland restoration. The construction of micro- and macrotopographic features can be used to restore and enhance wetlands and to provide wetland features that did not previously exist. Wetland plant communities, and the wildlife species that use them, benefit from utilizing the natural variability found in wetlands.

WHAT IS MICRO- AND MACROTOPOGRAPHY?

Undisturbed natural wetland systems typically contain a complex of vegetative habitats. These “complexes” owe their existence to varying hydroperiods, the period of time during which a wetland is covered by, or saturated with, water. Hydroperiods are, in turn, greatly influenced by topographic relief, soil permeability, climate, and weather. Topographic variation ranges from relatively shallow areas (microtopography) to deeper wetland habitats (macrotopography) and may include upland characteristics.

When restoring wetlands that exhibit uniform topography, returning the hydrology alone (through removing drainage tile or plugging drainage ditches) will often not result in establishing the diversity of wetland habitats that previously existed prior to disturbance. Restoring or creating micro- and macrotopography increases the diversity of hydroperiods and results in a more complex wetland vegetative community, and consequently, a more diverse assemblage of wildlife species.

For the purposes of this document, microtopographic features are those features with less than six inches of water depth. Microtopographic features are either depressional in nature (e.g. pit-mound topography) or relatively flat in nature (e.g., small ridges in a flat field back water into shallow pooled areas. Microtopography can often be seen in fields where shallow “sheet” water stands for short durations after a rain.

For the purposes of this document, macrotopographic features are depressional in nature and have landscape positions that occur both in floodplains and on terraces. Macrotopographic features can range from approximately 0.1 acre to 5.0 acres in size and up to 30 inches deep. Variability in shape is common in these features. Some occur as simple circles, others as complex amoeba-like shapes, and still others as meandering linear features. The “upland” components that often occur in macrotopographic features consist primarily of mounds (circular or elliptical) and ridges (linear), and typically do not exceed 30 inches in height.
WHY IS MICRO- AND MACROTOPOGRAPHY IMPORTANT?

**Food:** In the spring, shallow, ephemeral wetlands warm up before larger, deeper bodies of water. The warmer waters produce significant amounts of protein-rich invertebrates; including snails, worms, fairy shrimp, midge larvae, spiders, backswimmers, diving beetles, dragonflies, and damselflies that make up an essential component of wetland food webs. These species provide important seasonal forage for shorebirds, waterfowl, nonmigratory birds, and other wildlife. Organic debris (such as leaves, plant stems, and decaying woody material, along with roots and tubers from aquatic vegetation) act as additional food sources, and provide substrates for the species described above. Consider designing wetlands that have a large portion of shallow area (less than 18 inches) where macroinvertebrate production is a priority.

**Habitat:** The undulating landscape features created by the use of micro- and macrotopography diversify available wetland habitat. Swales, oxbows, potholes, pit-mound, and other features provide varying hydroperiods from short-term ponding to seasonal and semi-permanent water conditions. Wetlands with multiple hydroperiods can support a variety of aquatic habitat types; including scrub-shrub, submergent, emergent, and floating-leaf communities (e.g., duckweed). A diverse wetland plant community benefits numerous species of wildlife including many fur-bearing mammals, waterfowl, shorebirds, wading birds, amphibians, and reptiles.

The addition of low-level mounds or ridges can greatly increase the biological diversity of restoration sites when combined with basins or pits. Variations in habitat mound design can provide escape areas, den sites, nesting opportunities, and plant diversity, as well as, visual breaks within the wetland complex. See Habitat Mounds for further design guidance.

**PLANNING**

When developing micro- and macrotopographic features, assessment of the site prior to the restoration is critical. What would the site have looked like historically (i.e., prior to drainage or cropping)? What other habitats (prairie, shrubland, etc.,) would the site have included? Historic photographs and aerial photography, topographic maps, and local remnant wetlands can be used to determine the appropriate features to include in the wetland project. Planners will need to evaluate proposed action to determine if the activity will impact other wetlands in the complex.

**Soils:** It is important for the planner to identify those portions of the site which have hydric soils or soils that will most likely respond to micro- and macrotopographic development. Look for soils that have low permeability, a restrictive under-lying layer, or high water tables. The Web Soil Survey can provide site-specific soils information, but there is also no substitute for a thorough onsite soils investigation.

Construction of micro- and macrotopography should be used with caution on sites with soils that are hydric only because of flooding events. These soils may not be appropriate if well-drained and not very frequently flooded. Floodplain sites along certain fluvial (river) systems fall into this category. Since these soils are well-drained, water remains in the basins only as long as the river elevations are high. Once the river levels fall, the basins go dry. In these cases, it is unlikely that the habitat needs of the target species will be met and it may be difficult to justify the expense of creating micro- and macrotopographic features.

If excess wetland sediment may be a concern, then assess and quantify the average wetland sediment depths using a grid system with a soil probe. The A-horizon shall not be removed. Create the basin or pit micro- and macrotopographic features with the removed sediment (mound) or in sediment removal areas (pit).

**Succession and Long-term Management:** Plant succession in wetlands is a natural process that can result in significant habitat changes over time. Common successional changes include the development of aquatic macrophytes (such as cattails), and, in some cases, encroachment of wetlands by trees and shrubs (especially willow). Such changes can alter the wildlife species composition of
wetlands over time by selecting for species that favor or can tolerate later successional stages. As a result, wetland diversity may be reduced as early successional species are lost. Historically, natural disturbance regimes have included wild fires, floods, tornados, drought, and beaver. Due to the ever increasing human-dominated landscape, many of these disturbances no longer function on a large scale. As a result, it may be necessary to mimic these conditions through the use of such methods as prescribed burning, diskng, mowing, herbicide application, and water draw-downs. Disturbance regimes/methods need not be applied to the entire wetland complex or all wetland sites as long as the disturbance is applied somewhere within the complex at different time intervals.

CONFIGURATIONS

**Basins or Pits:** There are no fixed or rigid configurations that micro- and macrotopographic features must have to provide wildlife habitat. However, basins or pits that are irregular in shape will increase edge and provide additional cover for waterfowl and other wildlife utilizing the site. Some common shapes include those that mimick potholes, oxbows, and river meanders (see below).

Planners should choose shapes that are common to the landscapes found in the area or should choose designs that maximize wildlife habitat. Designs with multiple lobes, for example, can provide visually-isolated basins or pits which will benefit species such as puddle ducks. See Table 2 on design guidance for specific wildlife guilds.

Basin or pit construction should result in side and bottom slopes with rough surfaces and a ragged shoreline to promote a variety of micro-habitats (see picture on right).

Basin or pit depth will have a significant effect on habitat qualities including the vegetative community and how long into the season water will remain. Shallow areas, for example, tend to vegetate quickly, while deeper areas may remain as open water. Basin or pit depth should reflect the needs of the wildlife guild. Multiple depths increase habitat diversity. Designs also need to take into consideration the soil drainage qualities of the site. Basins or pits form ephemeral wetlands that can hold water from only a few weeks (temporary) to several months (seasonal) during the year. Consider constructing deeper basins or pits where soils are in dryer drainage classes. Below are suggested configurations for basins or pits of varying depths.

<table>
<thead>
<tr>
<th>Depth Needed</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>One (1) depth</td>
<td>one depth composes 100% of the area</td>
</tr>
<tr>
<td>Two (2) depths</td>
<td>each depth composes 50% of the area</td>
</tr>
<tr>
<td>Three (3) depths</td>
<td>deepest depth = 20% of the area, middle depth = 30%, shallowest depth = 50%</td>
</tr>
</tbody>
</table>

**AERIAL VIEW**

**CROSS-SECTION**
**Habitat Mounds:** Fill material that is excavated from the micro- and macrotopographic basins or pits can be used to create upland habitat conditions (Figure 1). By varying the height, shape, and location of mounds, a diversity of vegetative communities can be developed. Consider the following recommendations when designing habitat mounds.

- As much as possible, mounds should mimic the natural landscape. For example, if the site is located on the interior of a river oxbow, ridge and swale design may be appropriate (Figure 2). When possible, place mounds in such a way as to increase meander distance across the wetland.

- Mounds should be seeded with herbaceous vegetation as soon after construction as feasible. This will reduce the erosion potential and limit invasion of aggressive plant species.

- In situations where geese are a nuisance, at least 30 feet should exist between the habitat mound and any water surface. The area between the mound and the water should then be planted with a vegetative barrier such as warm season grasses (taller species) or shrubs. This barrier will reduce the attractiveness of the mound as a nesting site.

- Side slopes should have a minimum slope of 6:1 where wave action is a concern, and to reduce visual impact.

- Where wetland sites have a designed water level, varying the elevation of mounds will produce different vegetative communities. For maximum diversity, design the mounds so that approximately one-third are six (6) inches to one (1) foot below, one-third are six (6) inches to one (1) foot above, and one-third are at the expected water elevation.

- Where restoration sites do not have a designed water level, such as in floodplains, habitat mounds can be used to direct water flow during flood conditions (Figure 3). Mounds can range from six (6) inches to two (2) feet above average ground level, depending upon the flow impact desired.

**Sheet Water:** The creation of linear habitat mounds on gently sloping sites can be an efficient means of providing shallow, “sheet water” habitat (Figure 4). The excavated material from a macrotopographic basin is used to form a low, meandering ridge on the down slope side of the basin or pit. Typical heights for the mound range from one (1) foot to two (2) feet. By using the spoil in a creative manner, the total shallow water on a project site can be substantially increased. The impounded sheet water provides seasonal or ephemeral water for shallow feeders while the excavated basins provide longer hydro-period wetland habitats. This method can also be utilized where wetland meadow conditions are desired.

**Connecting Ditches:** Ditches of varying depths and widths can be constructed to provide habitat connectivity and escape routes from predators (Figure 5). However, in situations where amphibians are the primary species of concern, the connecting of ditches should be limited because access routes for predatory fish are created, particularly if connected to deeper, more permanent pools.

**Creative Borrowing:** Borrow areas for dikes or embankments can be incorporated into the development of micro- and macrotopographic features. Potholes, swales, meanders, and other shallow water habitats can serve as borrow areas for needed fill. Specific configurations should be
based on the habitat requirements of the wildlife guild. For example, equipment operators can randomly fill scrapers across the entire wetland instead of taking it all from one area, leaving shallow, single-trip borrow sites that are used for foraging by migrating shorebirds. Borrow areas can also be used to provide additional hydroperiod diversity in wetland complexes.

Table 2: Micro- and Macrotopography Design Guidance (In addition, follow Biology Technical Number 15, Appendixes B and C).

<table>
<thead>
<tr>
<th>Wildlife Guild</th>
<th>Excavated Depth (inches)</th>
<th>Size (acres)</th>
<th>Basin Side Slopes</th>
<th>Density (% of area restored)</th>
<th>Hydrology (minimum)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Wetland Wildlife</td>
<td>6 - 30</td>
<td>0.5 – 1.5</td>
<td>Between 8:1 and 20:1</td>
<td>10 -15%</td>
<td>July 15</td>
<td>Create variety in size &amp; depth</td>
</tr>
<tr>
<td>Amphibians</td>
<td>0 - 8</td>
<td>0.1 – 3.0</td>
<td>20:1 or flatter</td>
<td>30 – 50%</td>
<td>July 15</td>
<td>Must remain fish-free</td>
</tr>
<tr>
<td>Aquatic Snakes &amp; Turtles</td>
<td>0 – 10</td>
<td>0.1 – 3.0</td>
<td>20:1 or flatter</td>
<td>30 – 50%</td>
<td>July 15</td>
<td>Sandy sites preferred for nesting turtles</td>
</tr>
<tr>
<td></td>
<td>10 – 20</td>
<td>0.1 – 3.0</td>
<td>8:1</td>
<td></td>
<td>Permanent</td>
<td></td>
</tr>
<tr>
<td>Wading Birds (bitterns, egrets, herons)</td>
<td>3 – 24</td>
<td>0.5 – 3.0</td>
<td>20:1 or flatter</td>
<td>30 – 50%</td>
<td>Permanent</td>
<td>Create areas of saturation only</td>
</tr>
<tr>
<td>Shorebirds</td>
<td>0 - 10</td>
<td>0.5 – 3.0</td>
<td>20:1 or flatter</td>
<td>Up to 100%</td>
<td>June 15: spring migration</td>
<td></td>
</tr>
<tr>
<td>Waterfowl Feeding areas (50%)</td>
<td>6 – 18</td>
<td>0.5 – 3.0</td>
<td>8:1 or flatter</td>
<td>10 -15%</td>
<td>May 30: spring migration July 15: breeding</td>
<td></td>
</tr>
<tr>
<td>Waterfowl Loaing areas (50%)</td>
<td>18 – 30</td>
<td>1.0 – 3.0</td>
<td>8:1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES


