3. RESTORATION DESIGN

Goals

The main goal of the Grand Trunk wetland restoration is to **recreate a seiche wetland with a direct hydrologic connection to Lake Michigan.** This wetland should provide ample habitat for fish spawning, while not compromising the site's ability to support amphibian species. It should also create an educational attraction within the city of Milwaukee, and ultimately serve as a model for how seiche restoration can and should take place within an urban ecosystem.

Constraints

As shown in the site analysis, native wetland soil throughout the site is buried beneath 10-15' of fill deposited over the past 150 years (Figure 2.27). Due to concerns that disposal of this contaminated fill off-site could make the project prohibitively expensive, the wetland excavation footprint was designed so that any excavated soil could be stored on-site beneath a clean cap.

Design Process

Early restoration drafts explored the minimum design interventions which could result in seiche wetland water fluctuations at the Bay View Wetland.

Two minimum scenarios, a small pond and a narrow stream corridor, were examined (Figure 3.2). In either of these scenarios the new waterbody would be excavated so that water from the Kinnickinnic River (controlled by Lake Michigan water levels) would be able to enter the site.

While these first two drafts would meet our goal of restoring a seiche wetland, they did not go far enough to create robust fish habitat or create a dramatic andscape feature that would draw attention to the restoration efforts.

A third draft of the seiche wetland restoration explored adding backwater wetlands to a main stream channel to create a more extensive footprint. The addition of backwaters would provide more variability in water level, which would promote vegetation establishment (and subsequently fish populations) despite water level variability. Ideal wetlands for fish spawning habitat have extensive shoreline where marsh plants can harbor young fish and the invertebrates that fish feed upon. These areas would also help make the rise and fall of the site's water levels more visible to visitors.

The wider channel and backwater wetlands of the third concept served all of our design goals, but the long stream channel which extended south into the site was still too small to meet the criteria of the team's design goals.

Recommended Design

The final recommended design expanded further on the idea of backwater wetlands and concentrated the seiche function on the northern portion of the restoration study area (Figure 3.3). The recommended concept creates the most robust seiche wetland of the explored options and limits the site's grading footprint.

The recommended wetland excavation is contained within the northern portion of the site to maximize the wetland's ecological benefit and aesthetic statement.

The Bay View Wetland Restoration includes a main channel lined with native marsh plantings. Native marsh plantings will be located on benches at multiple elevations below the average water line of Lake Michigan. These benches, coupled with islands of marsh vegetation and multiple shallow backwaters will ensure that fish habitat remains present on site despite predicted fluctuations in lake water levels due to seasonal variation and climate change.

Outside of the grading footprint, the Bay View

Concept Plan will seek to rehabilitate existing floodplain forest, upland grassland, wet meadow, and emergent marsh. The removal of invasive species and reestablishment of native plants in these areas will increase their viability as habitat for birds and other wildlife.

Limiting the grading footprint will be beneficial for existing wildlife at the project site because it will provide undisturbed refuge areas during the wetland's construction period. More trees and shrubs will be preserved in the southern portion of the site, to serve as a buffer between visitors and nearby industrial areas and provide a foundation for floodplain forest restoration.

The wetland footprint allows ample room for future development at the site's south west corner. Concepts for sustainable development will be explored in Chapter 4 (page 87).

The combination of unique habitats at the Bay View Wetland Site, combined with the urban framework of their surroundings, will create an ideal location for the public to engage with nature. Environmental education events hosted at the park could teach visitors about Milwaukee's diverse historical ecosystems.

Volunteer workers can engage in the on-going process of monitoring, maintaining, and improving a restored ecosystem. Even casual visitors to the site could experience a native prairie, floodplain forest, and multiple wetland ecosystems while simply strolling through the site and enjoying a respite from urban life.

Figure 3.1: An example of a coastal wetland in Lake County, IL

Draft 1: Small Pond

Draft 2: Narrow Stream

Draft 3: Long Channel

Draft 4: Channel + Backwaters

Figure 3.2: Drafts of the design for the Bay View Wetland.

- The seiche wetland consists of a main channel with backwater wetlands which serve as places to establish native wetland plants and harbor desirable fish species.
- Wet meadows, ponds, dunes, floodplain forest, and prairie will be restored. This diverse assemblage of ecosystems will be a benefit both for both people and wildlife.
- A sustainable development site will likely occur in the southwestern corner of the upland prairie. Ideas for the future of such a development can be found in Chapter 4 (page 87).

Figure 3.3: The recommended concept plan for the Bay View Wetland.

Soil Remedial Action Plan

The industrial history of the Bay View Wetland Restoration site has resulted in contamination with petroleum products and heavy metals, as described in the chapter 2 (page 30).

While soil testing confirmed that contaminants were present at the Bay View Wetland site, the data were not extensively collected in the areas where most of the excavation for the wetland will likely take place. The data is also ten years old and more filling due to the Marquette Interchange Project has occurred since extensive monitoring of soil conditions last took place at the property.

Any restoration plan for the Bay View Wetland will most likely have to address soil contamination through a remediation strategy. This strategy will need to be developed in cooperation with the Wisconsin DNR and will likely begin with further soil testing.

Restoration Project Assumptions

Due to the lack of robust soil data in the new wetland location at the Bay View Wetland site, the current conceptual plan is working under the conservative assumption that all soils deposited prior to the Marquette Interchange fill exceed regulatory standards for direct contact. Based on discussions between the Milwaukee Port Authority and the WI DOT, this project has also assumed that the clean fill deposited by the Marquette Interchange Project does not exceed regulatory standards for direct contact and can be used as part of a remediation strategy for the project site (Figure 3.4). These assumptions should be confirmed through further soil testing and analysis prior to the next design phase of the project.

Remediation Option 1: Cap Contaminated Fill On-Site

Given the assumption that all of the soil on-site that pre-dates the Marquette interchange fill is contaminated, moving all excavated soil off-site for disposal could be cost prohibitive. Therefore, option 1 keeps all contaminated soil on site and caps it with clean fill from the Marquette Interchange (Figure 3.5).

The WIDNR document "Guidance for Cover Systems as Soil Performance Remedies" (2007) states that "soil covers may be used to prevent direct contact exposure to contaminated soils. Generally, a 2-foot thickness of clean soil should be placed over the contaminated soil. Soil covers should be vegetated to prevent erosion and deterioration. Therefore, at least 6 inches of topsoil, with appropriate seeding or sod, to establish a good growth of grass should be placed on top of the clean soil. If topsoil is used, the consideration can be given to reducing the minimum thickness of the clean soil layer by the same amount as the topsoil layer thickness."

Other materials, such as mulch and gravel, can also be substitute for topsoil in the two foot clean soil profile. Pavement may also be substituted for clean soil.

The cover system should be designed so that it does not deteriorate due to erosion, natural forces such as freeze thaw cycles and settling, or human forces. It should also ensure that contamination does not migrate, either through comingling with groundwater or as a volatile vapor.

More information on cover systems can be found in the full WI DNR document PUB-RR-709. The final determination of an appropriate cover strategy will

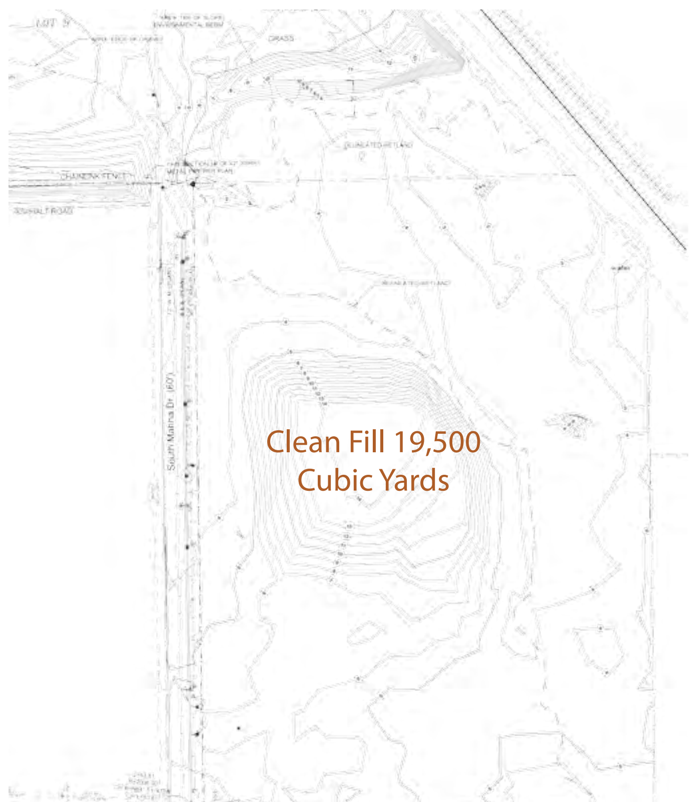


Figure 3.4: Approximately 19,500 cubic yards of fill was deposited during the Marquette Interchange Project.

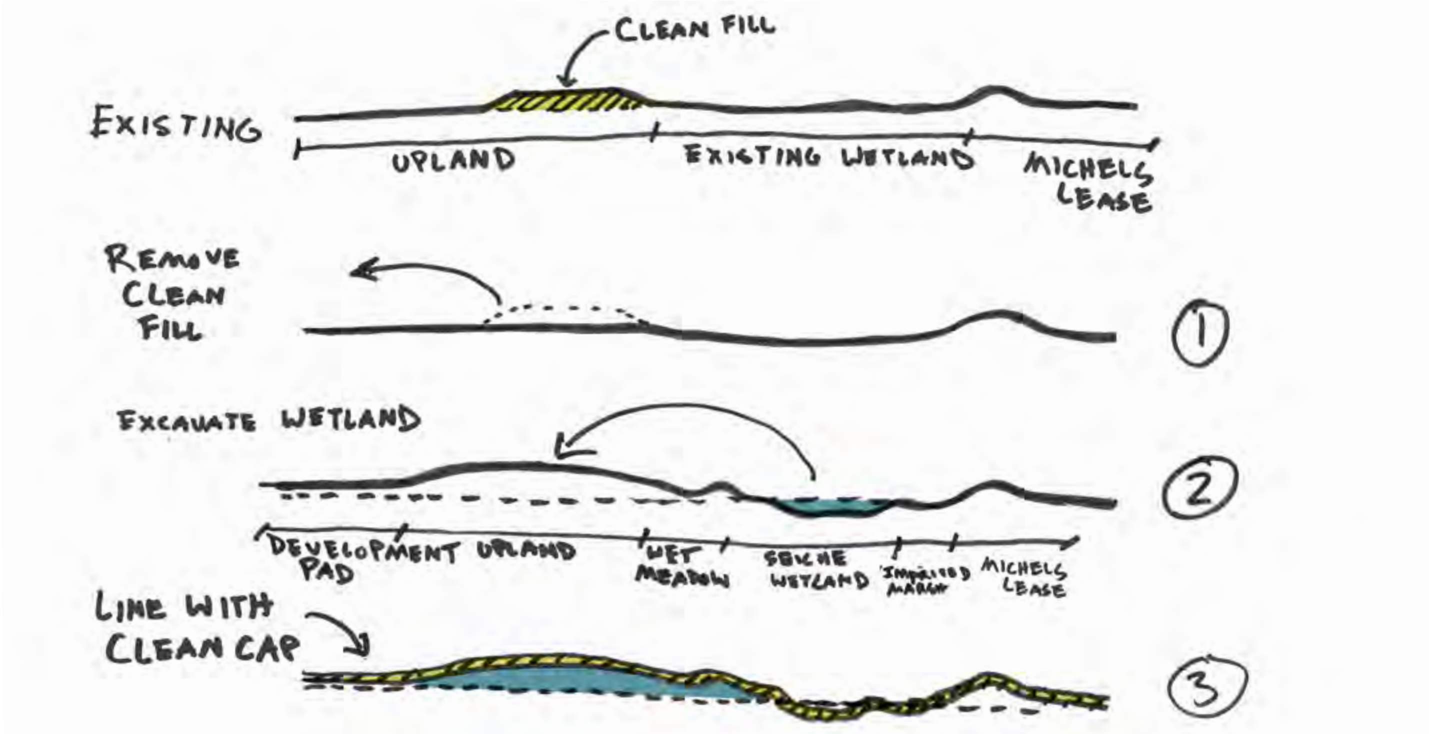


Figure 3.5: The presumed clean fill deposited during the Marquette Interchange Project will be removed from the site under this scenario. After the wetland is excavated the clean fill will be used to cap the site

need to be decided in conjunction with the WI DNR after more soil testing has been completed.

Step 1: Remove clean fill and store offsite

The clean fill from the Marquette Interchange should be staged for later use as a cap for the Bay View Wetland site's contaminated soils. The exact location for storage of the clean fill is yet to be determined. It is possible that soil could be stored on site as part of a staged grading project or on an adjacent property if an arrangement could be made with the property owner, to reduce transportation costs.

If contamination is present at the site where fill storage will occur, a geotextile liner should be used to line the interface between the existing ground surface and the clean fill. This will keep the fill from becoming contaminated during storage.

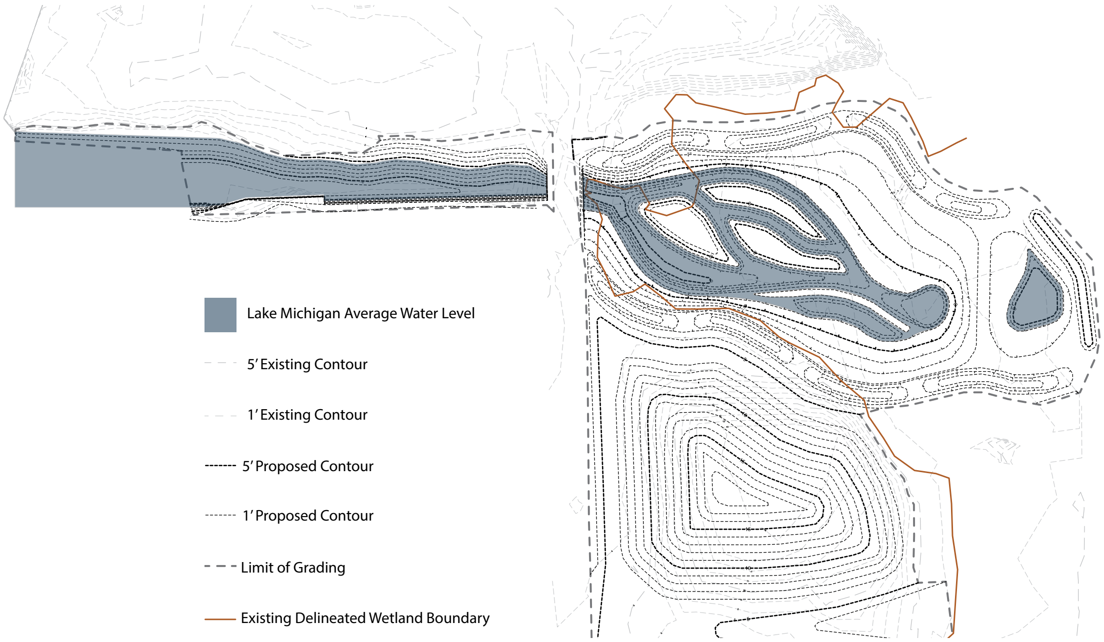
If the clean cap is stored off-site for longer than 2 months, a cover crop of winter wheat or similar annual grass should be planted to minimize erosion of the fill. The pile slopes should be a maximum of 3:1 to minimize erosion.

Step 2: Excavate contaminated soil

When the clean fill has been removed, grading of the seiche wetland can begin. Figure 3.6a shows the proposed finished wetland grade. This plan will excavate approximately 37,830 C.Y. of fill from low lying areas and use that soil to re-grade the site's upland (Figure 3.5). This number includes two feet of excavation below the finished grading plan. One foot of over-excavated depth will be used to accept the clean soil cap. On top of that, one foot of topsoil amended with compost, sand, and gravel will be brought in from off-site. The exact composition of the topsoil layer will be determined by the restoration zone (Figure 3.6b). The exact amount of over-excavation necessary will be determined by soil testing in the next phase of design. If some areas of soil are shown to have contamination at levels below direct contact standards these areas may only need to be over-excavated 1 foot to allow for topsoil deposition.

As part of the erosion control plan a temporary sedimentation basin should be graded three feet deep in the channel west of the culvert during this phase of design. Due to the largely flat slopes within the seiche wetland area, erosion from this phase of design should be minimal. The sedimentation basin will serve as a final treatment option for stormwater that does run off from the construction site by

A.



B.

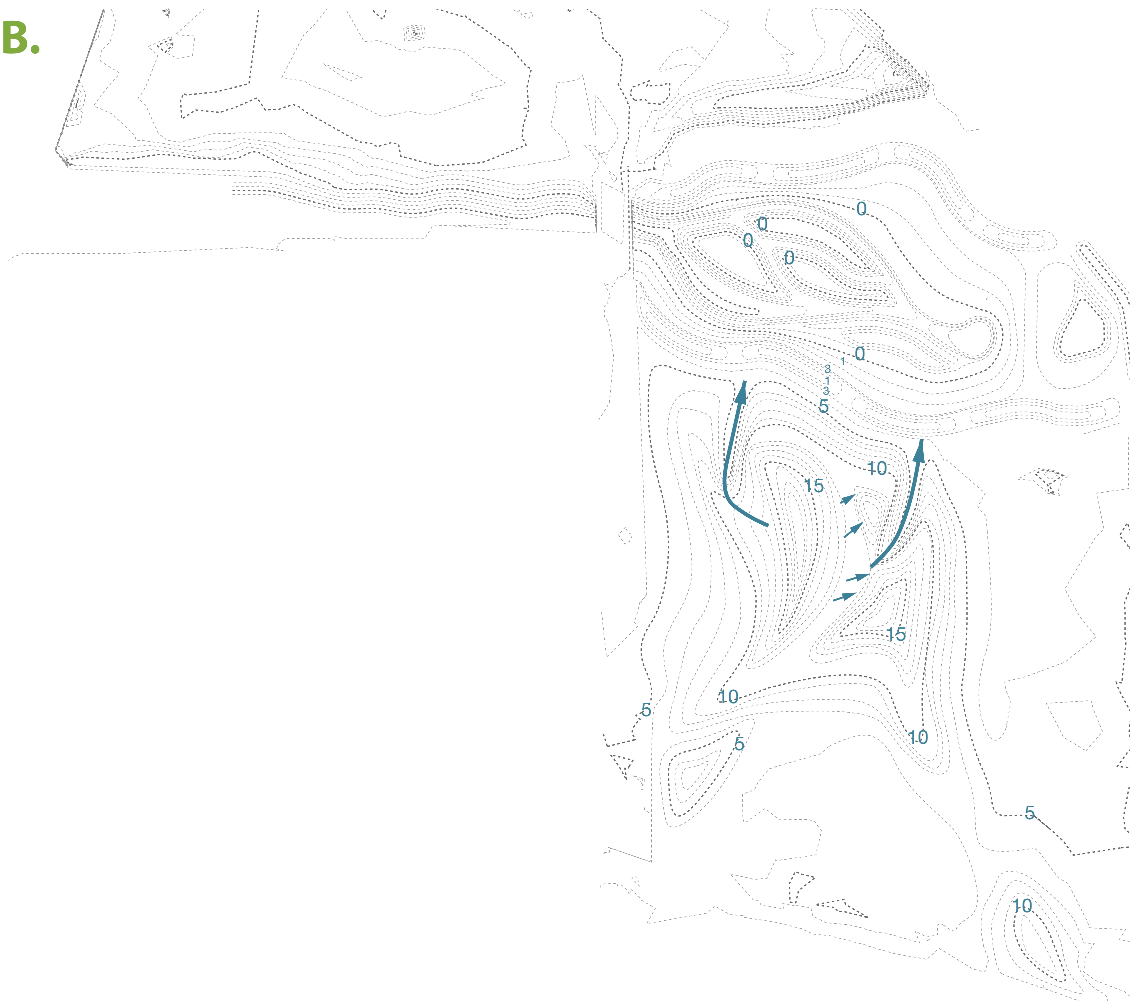
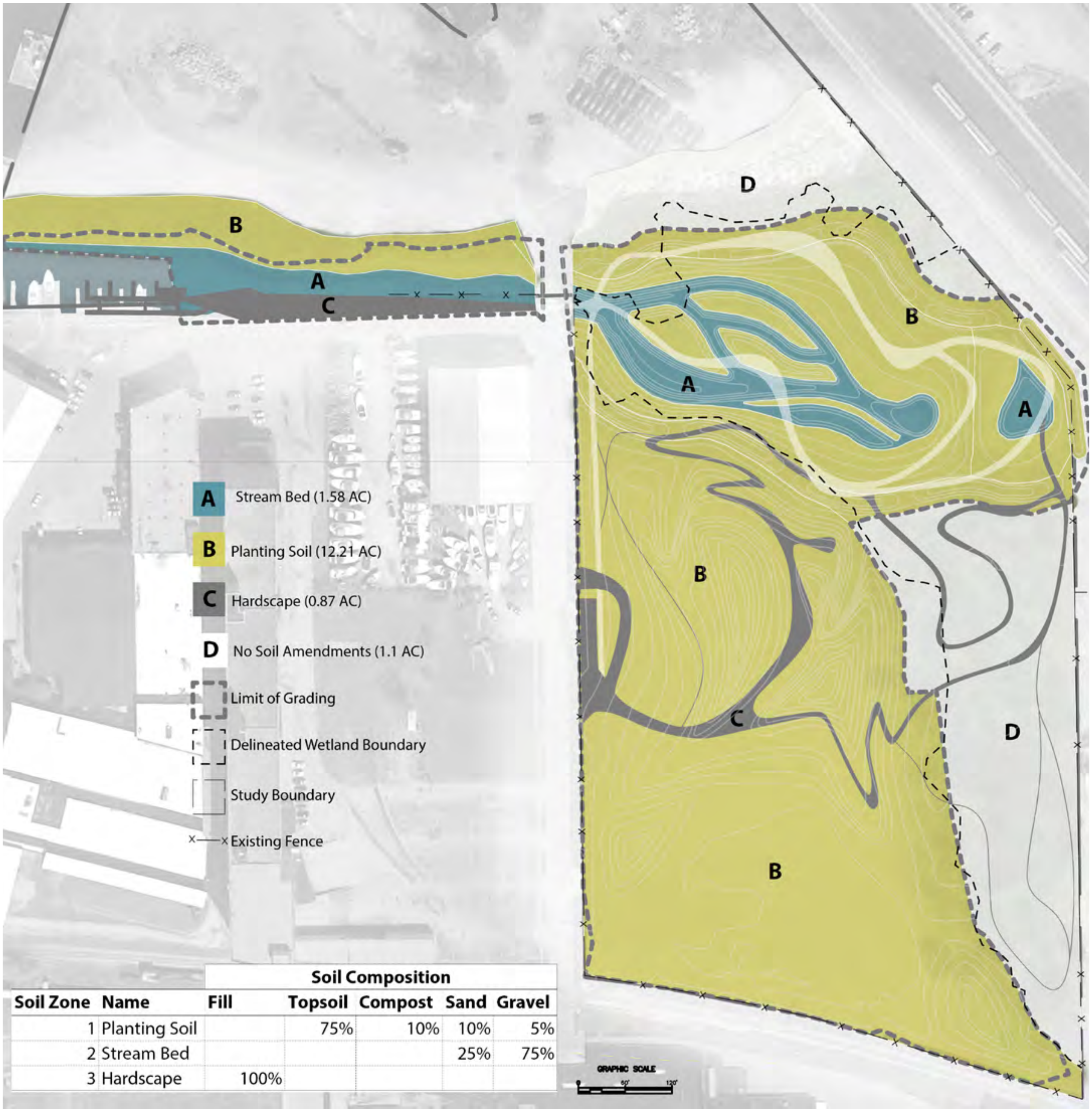


Figure 3.6a: The fill excavated in the creation of the seiche wetland can be deposited in the upland area of the site (A). This fill can be used to make topographic features which contribute to the site's aesthetic value and direct stormwater(B).

DRAFT January 2, 2014



		Soil Composition				
Soil Zone	Name	Fill	Topsoil	Compost	Sand	Gravel
1	Planting Soil		75%	10%	10%	5%
2	Stream Bed				25%	75%
3	Hardscape	100%				

Figure 3.6b: An example of possible remediation zones and soil compositions for the Bay View Wetland. Trail layout and lengths are based on Option C presented in Ch 4: Visitor Experience on page 74

allowing sediment and other contaminants to settle out of moving water before it comingles with the Kinnickinnic River. If deemed necessary in future phases of design, a dandy bag or similar product can be used to capture soil sediment before it has a chance to exit the construction area (Figure 3.7).

A complete erosion control plan would be prepared in the next phase of work.

Step 3: Grade the Upland Parkland

Excavated soil will be deposited in the upland zone at the Bay View Wetland site. Some of the soil will be used to raise the grade of the site at its southern end; the remainder will be mounded (as shown in Figure 3.6a) and used to create visual interest at the site. Once grading of the wetland areas is finished the upland area should be bounded by a silt fence to prohibit stormwater and sediment from running off into the finished wetland.

The soil should be graded to two feet below its finished grade. In most of the upland this will be accomplished by raising the grade using excavated fill from the wetland area.

If some areas of soil are shown to have contamination at levels below direct contact standards these areas may need to be raised to one foot below the finished elevation to allow for topsoil deposition. Areas that will be paved or covered with buildings in the final design do not need to be overexcavated below the finished grade; the impermeable surface created by the development will likely be sufficient to create a direct contact barrier between visitors and contaminated soil.

Step 4: Dredge and excavate the channel

The channel west of the culvert should be graded only after the eastern wetland portion of the site has reached its finished elevation so that the sedimentation basin can remain in place. Below the high water line, the channel will need to be dredged according to the finished grading plan. Spoils from this dredging will need to be taken off-site and disposed of in accordance with DNR Regulations (NR 347 and Chapter 30).

The channel slope should be re-graded to create a more gradual slope on which vegetation can be established. As in steps 2 and 3, the slope is expected to be over-excavated to allow for placement of a

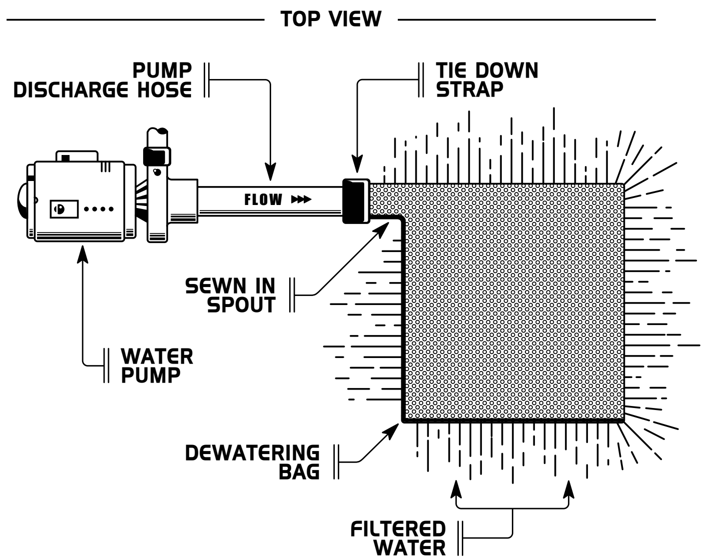


Figure 3.7: A product like the Dandy Dewatering Bag can be used to control sediment discharge when water is pumped from the wetland excavation site

clean liner (if necessary) and topsoil. The final depth of over-excavation necessary will be determined by soil testing. Excess excavated fill can be used as a portion of the upland grading plan.

The southern edge of the channel will likley not need to be over-excavated. This bank of the channel will be contained behind some form of retaining wall and capped with paving or boardwalk material as outlined starting on page 100.

Step 5: Contain Soil Outside of Grading Footprint

Some portions of the existing delineated wetland are outside of the proposed grading footprint for this project. If soil testing confirms that these areas exceed direct contact standards for contamination a final remediation plan for this area will be developed.

Remediation Option 2: Treat Contaminated Soils & Groundwater

Given the uncertainty surrounding soil contamination at the Bay View Wetland, it is not possible in this early phase of the project to outline a specific strategy for treatment of soil and groundwater contaminants.

An article published by the Journal of Environmental Management (Khan et. al. 2004) entitled "An overview and analysis of site remediation

Soil Treatment	Treatment Location		Contaminants Treated				Unit Cost
	On-Site	Off-Site	PCB	PAH	Metals	VOC's	
Soil Washing	*		*	*	*	*	$170 US/t
Soil Vapor Extraction	*					*	$20-50 US/t
Landfarming	*	*		*			$30-60 US/t
Soil Flushing	*			*	*	*	$20-250 US/t
Solidification/ stabilization	*	*			*		$ >110 US/t ex situ, $80 - 330 US cubic/ meter in situ
a. Asphalt batching	*	*		*			
b. Vitrification	*	*			*	*	
Thermal Desorption		*		*	*	*	$50-330 US t/m3
Biopiles	*	*				*	$130-260 US cubic/yard
Phytoremediation	*		*	*	*	*	$60,000 - 100,000 US /acre
Bioslurry System		*	*			*	$ 130 - 200 US cubic/meter
Bioventing	*					*	$30 - 90 US/t
Encapsulation	*		*	*	*	*	varies
Aeration	*					*	varies on volume of oil treated

Table 3.1: Soil treatment options and their associated unit costs (Khan et al. 2004)

Groundwater Treatment	Treatment Location		Contaminants Treated				Unit Cost
	On-Site	Off-Site	PCB	PAH	Metals	VOC's	
Air Sparging	*					*	$20-50 US cubic/yard
Groundwater pump and treat	*			*	*	*	varies
Passive/reactive treatment walls	*					*	cost data unavailable
Bioslurping	*						low cost
Ultraviolet-oxidation treatment	*		*	*		*	$10 - 50 US gallon/water
Biosparging	*			*			"cost-competitive"
Groundwater Circulation Wells	*			*		*	N/A
Horizontal Well Technology	*						$5,000 - 850,000 US per well
Natural Attenuation	*			*		*	Cost is primarily related to site evaluation and monitoring

Table 3.2: Groundwater treatment options and their associated unit costs (Khan et al. 2004)

technologies" offers a comprehensive overview of possible remediation strategies which have been employed successfully at other locations. This literature review gives a synopsis of multiple treatment techniques and provides a unit cost estimate for these techniques where possible.

The following descriptions of soil treatment techniques are based on the paper by Khan et. al (2004). The techniques described treat the highest number of types of contaminants and are highlighted in Table 3.1 and Table 3.2.

Soil washing uses liquid and mechanical processes to scrub soils. The liquid is usually water, but occasionally it is combined with solvents if warranted by the contamination issues at a site.

Soil washing works by separating fine soil particles (like clay and silt) from larger particles. Since hydrocarbons (aka PAHs) tend to bind to these particles, they are removed from the large-particle soil along with the fines.

Fines created as a result of this process would need to be treated using another method or safely disposed of.

Soil flushing works by 'flooding' contaminanted soils with a solution. This process moves the contaminants to an area where they can be removed. The flooding solution is passed through in-place soils via injection or infiltration.

Recovered groundwater and extraction fluid may need additional treatment in order to be safely released from the site. Activated carbon treatment, biodegradation, and pump-and-treat are commonly used in conjunction with flushing.

Phytoremediation uses plants to clean up contaminated soil and groundwater. Depending on the contaminants and plant species chosen plants either take up, accumulate, and/or degrade contaminants.

There are five basic types of phytoremediation.

- Rhyzofilitration takes contaminants into a plant's root system;
- Phytoextraction uptakes contaminants from soil into plant tissue;
- Phytotransformation degrades contaminants in soil and water through the plants' metabolic processes;
- Phytostimulation works when plant roots stimulate microbes in the soil to break down contaminants; and
- Phytostabilization uses plants to keep contaminants from migrating through the soil.

Encapsulation physically isolates contaminants using barriers such as low-permeability caps and cut-off walls. This is similar to the Option 1 cap and contain strategy, with the exception that water is not allowed to infiltrate the contaminated soil layer.

Groundwater pump and treat introduces extraction wells to a site at various locations. Water is pumped from the wells and contaminants are removed from the pumped water using other treatment techniques.

This method is commonly used to treat water in aquifers. Treated water is injected back into the aquifer it was pumped from or discharged into a surface water body.

Ultraviolet-oxidation treatment uses UV radiation and either peroxide or ozone (oxidants) to chemically break down contaminants in water.

An advantage of this method is that the chemicals used in treatment do not add to the system's pollutant levels. Once sufficiently explosed to the light and oxidation, the final product will be water, carbon dioxide, and an inorganic salt.

Restoration Action Plan

Native Plant Species

A list of plants native to Wisconsin will be developed in the next phase of design which specifies appropriate species for each ecosystem type. Ideally all specified plants should be sourced from within a 200-mile radius of the project site.

The tables on the following pages give examples of species typically found in the target restoration communities planned for the Bay View Wetland site.

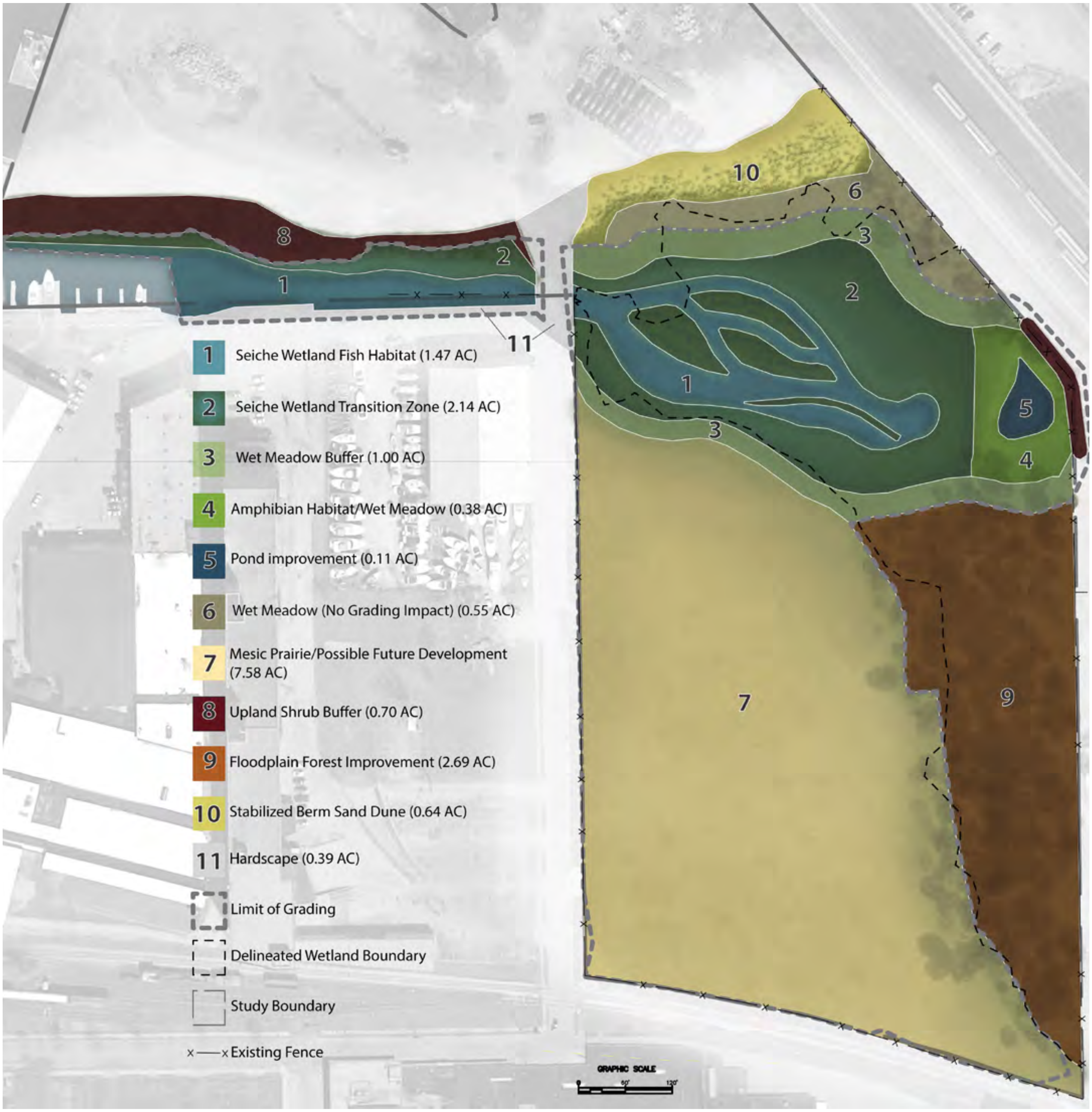


Figure 3.8: Restoration zones at the Bay View Wetland

Emergent marshes occur in lowland areas and at the edges of waterbodies. At the Bay View Wetland, emergent marshes will occur at the transition zone between the fish habitat and the seiche wetland transition zone (zones 1 & 2 on Figure 3.8). It will also occur at the edge of the pond improvement (zone 5).

Botanical Name	Common Name
Grasses, sedges, etc.	
Calamagrostis canadensis	Blue joint grass
Carex hystricina	Bottlebrush/Porcupine sedge
Juncus effusus	Common/soft rush
Carex stipata	Awl-fruited sedge
Scirpus validus	Great/soft stem bulrush
Scirpus cyperinus	Wool grass
Scirpus atrovirens	Dark green bulrush
Forbs	
Alisma subcordatum	Water plantain
Iris virginica shrevei	Wild blue iris
Pontederia cordata	Pickerelweed
Bidens cernua	Nodding bur marigold


Figure 3.9: Emergent Marsh


Figure 3.10: Wet Meadow

Wet meadows typically occur in low-lying areas and the space between shallow marshes and upland areas. These ecosystems usually have water within 6 inches of the soil surface. Zones 2-4 and 6 will likely be restored to wet meadow.

Botanical Name	Common Name
Grasses, sedges, etc.	
Andropogon gerardii	Big bluestem grass
Calamagrostis canadensis	Blue joint grass
Carex annectens	Small yellow fox sedge
Carex scoparia	Pointed broom sedge
Elymus virginicus	Virginia wild rye
Juncus dudleyi	Dudley's rush
Juncus effusus	Common/soft rush
Panicum virgatum	Switch grass
Scirpus atrovirens	Dark green bulrush
Spartina pectinata	Prairie cord grass
Forbs	
Angelica atropurpurea	Great angelica
Asclepias incarnata	Swamp/Marsh milkweed
Aster puniceus	Swamp aster
Boltonia asteroides	False aster
Coreopsis tripteris	Tall coreopsis
Desmodium canadense	Showy tick trefoil
Eupatorium perfoliatum	Common boneset
Helenium autumnale	Dogtooth daisy
Hypericum pyramidatum	Great st. John's wort
Liatris spicata	Marsh blazing star
Lycopus americanus	Water horehound/bugle weed
Mimulus ringens	Monkey flower
Penstemon calycosus	Smooth beard tongue
Polygonum spp	Smart weed
Ratibida pinnata	Yellow coneflower
Silphium perfoliatum	Cup plant
Solidago riddellii	Riddell's goldenrod
Verbena hastata	Blue vervain
Veronicastrum virginicum	Culver's root

Floodplain forests naturally occur along river corridors, where they are periodically inundated by high water.

At the Bay View wetland the primary source of water for the floodplain forest will be water from within the watershed as opposed to water from the Kinnickinnic River. Visits to the site suggest that the wetland will flood seasonally despite disconnection from the Kinnickinnic River. Floodplain forest will be restored in zone 9 (Figure 3.8).


Figure 3.11 Floodplain Forest
www.naturalheritage.state.pa.us

Botanical Name	Common Name
Grasses, sedges, etc.	
Bromus purgans	Hairy wood chess
Carex lupulina	Hop sedge
Carex sprengelii	Long-beaked sedge
Elymus virginicus	Virginia wild rye
Muhlenbergii mexicana	Leafy satin grass
Sphenopholis obtusa	Prairie wedge grass
Forbs	
Actinomeris alternifolia	Wingstem
Anemone canadensis	Meadow/Canada anemone
Aster lateriflorus	Calico aster
Boltonia asteroides	False aster
Campanula americana	Tall bellflower
Clematis virginiana	Virgin's bower
Eupatorium purpureum	Purple Joe pye weed
Hypericum pyramidatum	Great st. John's wort
Napaea dioica	Glad mallow
Penstemon calycosus	Smooth beard tongue
Rosa setigera	Illinois rose
Rudbeckia laciniata	Green-headed coneflower
Rudbeckia subtomentosa	Sweet black-eyed Susan
Zizia aurea	Golden alexanders
Shrubs	
Alnus rugosa	Speckled alder
Cornus racemosa	Gray dogwood
Cornus sericea	Red-twig dogwood
Hypericum kalmianum	St. John's wort
Viburnum lentago	Nannyberry
Viburnum prunifolium	Blackhaw viburnum
Trees	
Celtis occidentalis	Hackberry
Quercus bicolor	Swamp white oak
Quercus macrocarpa	Bur oak
Fraxinus americana	White ash
Juglans nigra	American walnut

The sand dune will be restored at the northern edge of the site in zone 10 (Figure 3.8). In nature, sand dunes are constantly changing landforms made of sand which is shaped by wind and water. These landforms are colonized by hardy grasses and forbs.

At the Bay View Wetland the sand dune will be in a fixed position between the Michel's lease on the site's northern half and the rest of the Bay View wetland. The following plants are examples of species which could help stabilize this area and mimic a natural sand dune.


Figure 3.12: Sand Dune

Botanical Name	Common Name
Grasses, sedges, etc.	
Ammophila breviligulata	Marram grass
Aristida oligantha	Needle grass
Bouteloua curtipendula	Side-oats grama
Carex bicknellii	Bicknell's/Prairie sedge
Schizachyrium scoparium	Little bluestem grass
Sorghastrum nutans	Indian grass
Forbs	
Allium cernuum	Nodding wild onion
Asclepias tuberosa	Butterfly milkweed
Aster azureus	Sky blue aster
Coreopsis palmata	Prairie coreopsis
Dalea purpurea	Purple prairie clover
Desmanthus illinoensis	Illinois sensitive plant
Echinacea pallida	Pale purple coneflower
Heliopsis helianthoides	Ox-eye/false sunflower
Liatris aspera	Rough blazing star
Monarda punctata	Dotted/Horse mint
Oenothera biennis	Common evening primrose
Potentilla arguta	Prairie cinquefoil
Ratibida pinnata	Yellow coneflower
Rudbeckia hirta	Black-eyed Susan
Silphium terebinthinaceum	Prairie dock
Solidago nemoralis	Old-field goldenrod
Tradescantia ohiensis	Common spiderwort
Verbena stricta	Hoary vervain
Shrubs	
Juniperus horizontalis	Prostrate juniper
Arctostaphylos uva-ursi	Kinnikinnick bearberry
Prunus pumila	Sand cherry

Mesic prairies are native grasslands that commonly occur on loamy soils. They retain more moisture than dry prairies and can thrive in full or partial sun.

Depending on the final design, zone 7 (Figure 3.8) may resemble a savanna rather than a true grassland. Savannas are essentially grasslands with scattered trees. Grasses are still the dominant plant cover in these environments.

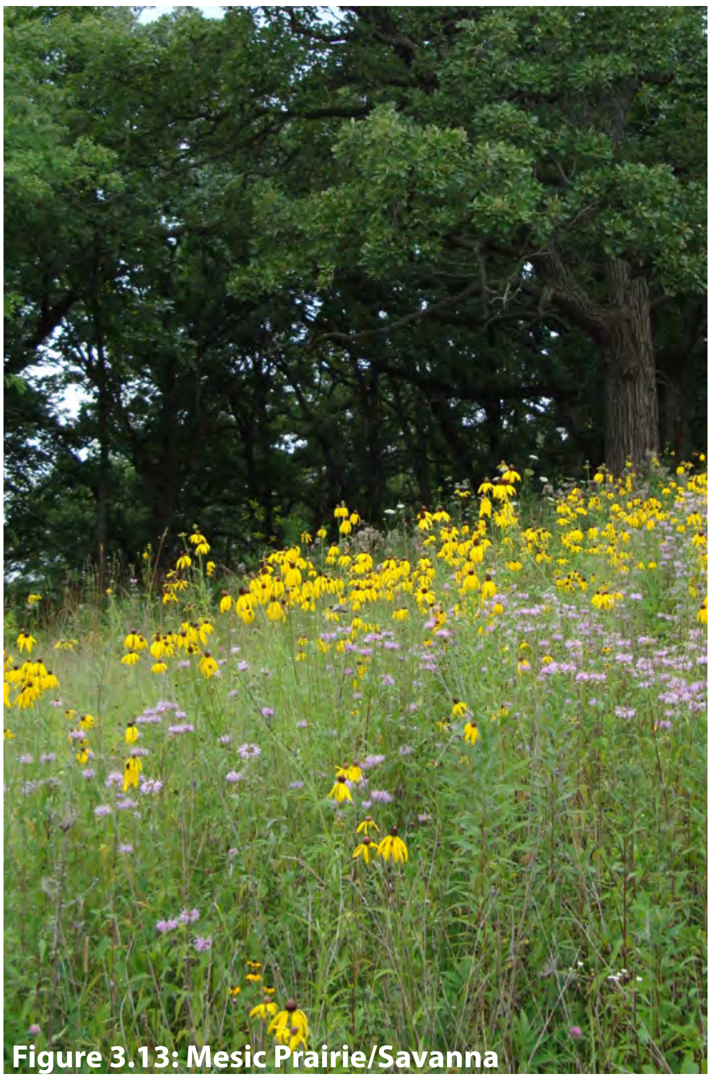


Figure 3.13: Mesic Prairie/Savanna

Botanical Name	Common Name
Grasses, sedges, etc.	
Andropogon gerardii	Big bluestem grass
Bromus purgans	Hairy wood chess
Elymus canadensis	Canada wild rye
Elymus hystrix	Bottlebrush grass
Schizachyrium scoparium	Little bluestem grass
Sorghastrum nutans	Indian grass
Bouteloua curtipendula	Side oats grama
Forbs	
Allium cernuum	Nodding wild onion
Anemone virginiana	Tall/Virginia anemone
Aster laevis	Smooth blue aster
Coreopsis tripteris	Tall coreopsis
Desmodium illinoense	Illinois tick trefoil
Dodecatheon meadia	Shooting star
Eupatorium purpureum	Purple Joe pye weed
Monarda fistulosa	Wild bergamot
Napaea dioica	Glad mallow
Penstemon calycosus	Smooth beard tongue
Polygonatum biflorum	Solomon's seal
Ratibida pinnata	Yellow coneflower
Rudbeckia hirta	Black-eyed Susan
Rudbeckia triloba	Brown-eyed Susan
Solidago rigida	Stiff goldenrod
Tradescantia ohiensis	Common spiderwort
Verbena stricta	Hoary vervain
Shrubs	
Aronia melanocarpa	Black chokeberry
Ceoanthus americanus	New Jersey tea
Corylus americana	Hazelnut
Rosa carolina	Pasture rose
Trees	
Carya ovata	Shagbark hickory
Crateagus crusgali	Hawthorn
Prunus americana	American plum
Quercus alba	White oak
Quercus bicolor	Swamp white oak
Quercus macrocarpa	Bur oak

Remove Invasive Species

The following are standard methods used to remove invasive species found at the Bay View Wetland site. Removal of invasive species is a critical step to ensure the success of new restoration plantings.

- Invasive wetland plants in areas with standing water or saturated soils should be treated with a 5% solution of Glyphosate (N-(phosphonomethyl) glycine) in a form approved for aquatic applications such as Rodeo or equivalent with added non-ionic surfactant. Two to three applications of glyphosate will likely be needed to sufficiently eradicate phragmites from areas where it is well established. Invasive wetland plants at the Bay View Wetland site are listed below:

Latin Name	Common Name
Dipsacus sylvestris	Common Teasel
Phalaris arundinacea	Reed Canary Grass
Poa pratensis	Kentucky Blue Grass
Typha angustifolia	Narrow-Leaved Cattail

Figure 3.14: Common Reed (*Phragmites*) at the Bay View Wetland site

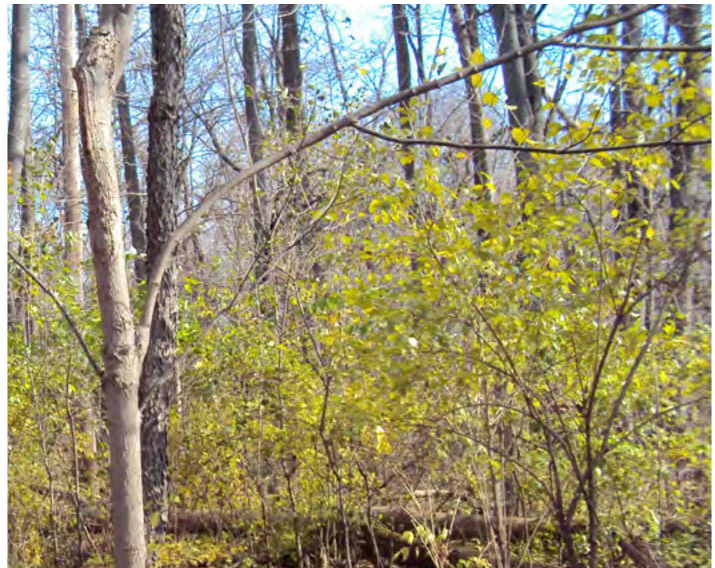


Figure 3.15: Common Buckthorn (*Rhamnus cathartica*)

- Invasive and Undesirable Trees and Shrubs
Buckthorn (*Rhamnus cathartica*) is an invasive shrub typically found in wooded areas. Large stands of buckthorn reduce biodiversity by creating too much shade on the forest floor for desirable native plant species to establish.

Buckthorn trees and shrubs should be removed by cutting with hand tools such as chain saws, clearing saws, bow saws, and loppers. Herbicide should be immediately applied to the cut stumps following the removal of the plant with wick, foam, or backpack applicators fitted with an appropriate nozzle to minimize drift. The herbicide will be suspended in basal oil with an applicable tracer dye as specified on the herbicide label. The herbicide will be applied to the entire cut stump surface, but it does not need to be applied to the sides of the stump. Herbicide will be applied to each stump or stem on multiple-stemmed or stumped plants.

This technique can also be used for native trees and shrubs in undesirable locations. For example, Eastern Cottonwood (*Populus deltoides*) and Box Elder (*Acer negundo*) are native trees. Eastern cottonwood saplings were observed in areas which will be restored to wet meadow. Left unchecked cottonwood could shade out desirable plants in this ecosystem, and should therefore be removed from these areas. Box elder, another weedy tree species, was observed in the floodplain forest restoration area. While a native species, box elder has a tendency to reproduce quickly and take over a forest understory where fire or other disturbance is no longer present. Therefore, this species should be removed to make room for more desirable trees and understory plants (See page 49 for suggestions).

- Invasive herbaceous plants in areas without standing water or saturated soils invasive plants (like garlic mustard) can be treated with a 3% solution of Glyposate (N-(phosphonomethyl) glycine), trade name Roundup, or equivalent. After an initial application the site should be reexamined after 14 days to evaluate resprout and new growth of undesired species. It is expected that a second and third application (also 14 days later) will be needed to reduce invasive species to manageable populations.

Latin Name	Common Name
Achillea millefolium	Yarrow
Alliaria petiolata	Garlic Mustard
Centaurea maculosa	Spotted Knapweed
Cichorium intybus	Chicory
Cirsium arvense	Field Thistle
Cirsium vulgare	Bull Thistle
Daucus carota	Queen Anne's Lace
Helianthus annuus	Garden Sunflower
Melilotus alba	White Sweet Clover
Pastinaca sativa	Wild Parsnip
Rumex crispus	Curly Dock


Figure 3.15: Garlic Mustard (*Alliaria petiolata*)

General Planting & Seeding Guidelines

- Minimize risks to workers due to direct contact with contaminated soil
  Laborers who are responsible for implementing the Bay View master plan should wear appropriate personal protective equipment to minimize their exposure to soil where pollutant levels exceed direct contact standards.

- General Seeding Guidelines
  All seed must be free from insects and disease.

  Seeding is recommended in early spring as soon as the soil is free of frost and in a workable condition (No later than June 1st). If spring seeding is not feasible a late fall dormant seeding (conducted after November 1st) is also possible, but not after the soil has been covered with snow or is frozen.

  The soil surface where seeding occurs should be lightly tilled. Grasses should be seeded at 75-100 lbs/acre; forbs should be seeded at 30-50 lbs/acre.

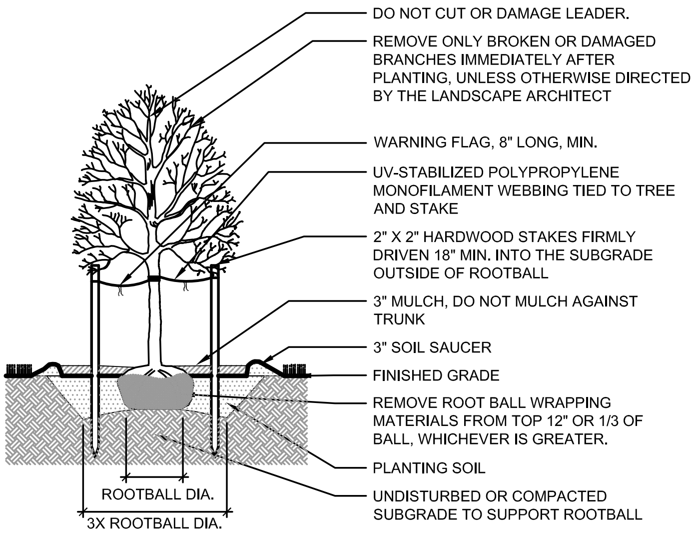
  All seed should be installed with a rangeland type grain drill or no-till planter. Areas of the site that are wet or steep may need to be hand-broadcast.

  After broadcasting the seed should be compressed into the soil with a cultipacker or equivalent type roller. Any seeded areas should be straw mulched at a rate of 2,000 lbs/acre immediately following seeding.

- General Plant Plug Guidelines
  All plant materials must be inspected to make sure they are healthy, vigorous, and free from insects and disease.

- General Tree Guidelines
  Nursery-grown trees and shrubs must have healthy root systems developed by transplanting or root pruning. The plants should be well-shaped, true to shape, fully branched, healthy, vigorous, and free from insects and disease. The plants should lack defects such as knots, sun scald, injuries, abrasions, and disfigurement.

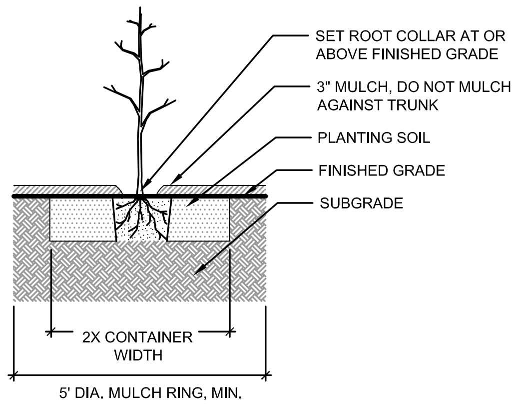
  Set container-grown stock plumb and in the center of pits or trenchs with the top of the root ball flush with adjacent finished grades. Containers should



NOTES:

1. STAKE TREES ONLY WHEN CONDITIONS REQUIRE ADDITIONAL STABILIZATION, AS DESCRIBED IN SPECIFICATIONS.
2. EXCAVATE TREE PIT AND SCARIFY EDGES TO ASSIST ROOT DEVELOPMENT.
3. SET TOP OF ROOT BALL 2 - 3" ABOVE FINISH GRADE. DO NOT BACKFILL OVER TOP OF BALL.
4. REMOVE ROOT BALL WRAPPING MATERIALS (BURLAP, TWINE, WIRE BASKET, ETC) AFTER TREE IS SET IN PLACE. REMOVE SYNTHETIC WRAPPING COMPLETELY.
5. LEAVE MONOFILAMENT WEBBING SLIGHTLY SLACK TO ALLOW TREE TO SWAY IN THE WIND.

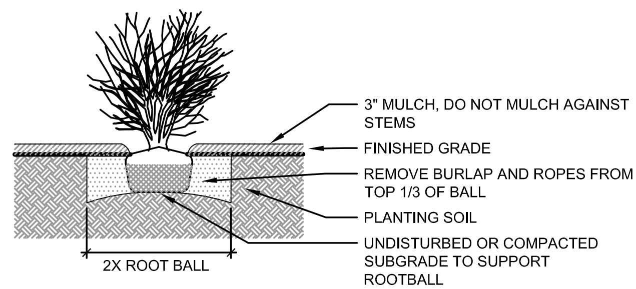
Deciduous Tree Planting



NOTES:

1. REMOVE CONTAINER BEFORE PLANTING.
2. SCARIFY EDGES OF TREE PIT.

Tree Sapling Planting



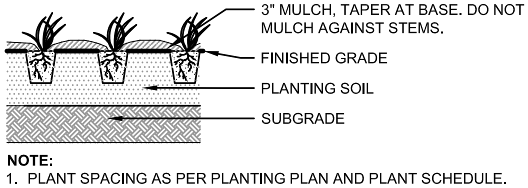
NOTES:

1. REMOVE ROOT BALL CONTAINER. SET TOP OF BALL 3" ABOVE FINISHED GRADE.
2. FOR B&B SHRUBS, REMOVE ROOT BALL WRAPPING MATERIALS (BURLAP, TWINE, WIRE BASKET, ETC) AFTER SHRUB IS SET IN PLACE. REMOVE SYNTHETIC WRAPPING COMPLETELY.
3. SCARIFY EDGES OF PLANTING PIT.

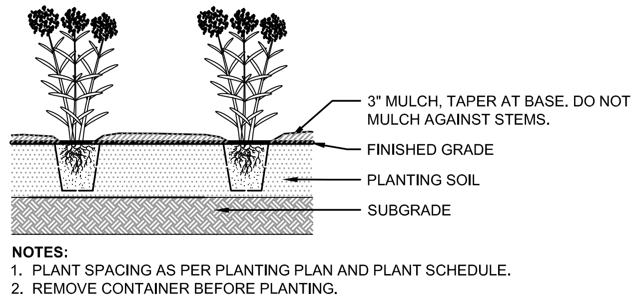
Shrub Planting

Figure 3.16a

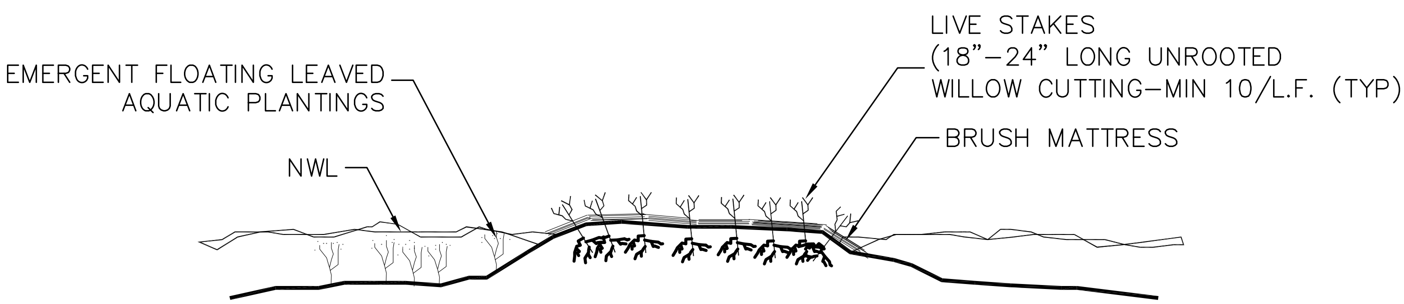
Top: Typical details for tree and shrub plantings.
Bottom: A successfully executed tree installation.



Herbaceous Plug Planting



Perennial Planting



Emergent Plants and Live Stakes

Figure 3.16b:

Top: Typical details for herbaceous plants and live stakes (a low-cost shrub installation method utilized in restoration projects).
Bottom: Successfully installed emergent plants

be cut away to an appropriate depth or removed entirely. Place planting soil mix (with appropriate mycorrhizae inoculants or other soil additives as needed) around the root ball in layers, tamping to settle the mix and eliminate voids and air pockets. When the pit is approximately one-half back filled, water thoroughly before placing the remainder of backfill. Repeat watering until no more water is absorbed. Trees should be watered again after placing and tamping the final layer of planting soil mix.

Apply 2-inch average thickness of organic mulch extending 12-inches beyond edge of planting pit or trench. Do not place mulch within 3 inches of the trunk or stems.

Management Schedule

A typical management schedule for the establishment of new vegetation is listed below. The schedule indicates in which quarter of a year work should be conducted by highlighting the quarter with bracket symbols (Ex. 12[3]4 , work proposed should be conducted in the third quarter of a calendar year or between the months July, August, and September). See Appendix 2: Maintenance and Monitoring for more management recommendations.

Figure 3.17: Erosion control mats installed next to a new emergent planting

		Year 1	Year 2	Year 3	Year 4	Year 5
1.	Weed Management and Site Inspection	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4
Assess site conditions, identify threats, ie: Phragmites, buckthorn, garlic mustard. Recommend mowing where necessary and/or design herbicide application plan.						
2.	Mowing.	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2][3]4	1[2][3]4
Conducted twice annually for weed control.						
3.	Herbicide Management	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]	[1][2][3][4]
Wick or spray application to non-native invasions, phragmites and garlic mustard, woody invasives such as buckthorn.						
4.	Additional Management Techniques	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4	1[2] [3]4
[ ] Indicates the quarter of the year when activities may occur						

Sand Dune Establishment

The existing "sand dune" at the Bay View Wetland site is the result of a spoilpile of sandy fill deposited by Michels Corporation at the border between their lease area and the delineated wetland. Because sandy soils are very susceptible to erosion, this dune should be stabilized with native vegetation to prevent its erosion into nearby marsh areas.

Restoring a dune at this site creates an unique ecosystem which, though once common along Lake Michigan, is now rare in the Milwaukee area.

Temporary erosion control will be critical for the establishment of native plants in the dune area. Sand fences and erosion control fences should be used to slow and trap eroding sand. Sand fences are made of wood slats with a width roughly equal to their spacing, supported by 3" poles or 2 x 4" posts.

The wooden slats are often held together with wire. The fences function similar to snow fences in that sand accumulates around the base of the fence. Once vegetation is established sand fences can be removed.

Dune planting should begin low on the face of the dune at the highest density in order to trap sand that might fall down the dune face. The dune should be planted with a mix of herbaceous and woody species adapted to the low nutrient and fast draining dunal conditions (Rogers and Nash, 2003).

Few invasive species were noted on the dunes. Hand pulling of undesired species should be sufficient for removal of invasive or undesired species.

Protect Wildlife

A review of endangered resources (ERs) near the Bay View Wetland was conducted in 2013. The purpose of this review was to ensure that possible risks to ERs at the Bay View Wetland were identified early in the master planning process. When the Bay View Wetland moves forward into planning for construction a formal ER Review will be conducted in cooperation with the Wisconsin DNR.

Prairie crayfish has been recorded within the vicinity of the project area and suitable habitat may be impacted by this project. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields in prairies. To avoid take of this species, one of the following options should be implemented:

- Alter the project to avoid take. Methods that can be used to avoid take may include time of year restrictions, avoidance of habitat, or exclusion fencing.
- Conduct surveys at the site to determine species presence/absence. If the Prairie crayfish is not found on site, there will be no project restrictions related to the Prairie crayfish. However, if surveys are conducted and Prairie crayfish are recorded on site, all impacts to the species must be avoided; if impacts cannot be avoided an incidental take permit/authorization should be applied for. Survey results should be submitted to the Endangered Resources Review Program.

Butler's gartersnake is known to be present on site. This species inhabits open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation such as reed canary grass.

To avoid take, activities likely to impact this species should take place during its non-active period of Late November – Early March. Snake exclusion fencing should be installed in the construction area. The spring deadline for installing snake exclusion fencing is March 12th. See fencing protocols for detailed information (WIDNR 2009). To the maximum extent possible, herbiciding should occur during the snake's dormant period (Nov. 6- March 15).

Figure 3.18: An example of snake fencing
www.reptilefencingco.co.uk

Seaside Spurge and Marsh Blazing Star have been recorded within the vicinity of the project area and suitable habitat will be impacted by this project. To avoid take of these species and because these plants are listed on public land one of the following options should be implemented:

- Alter the project to avoid take of the species. Avoidance measures would include time of year restrictions, including construction during plants' dormant periods (mid-November through mid-March). The current project timeline is similar to these avoidance dates.
- Conduct plant surveys at the site to determine species presence/absence. If Seaside Spurge and

Figure 3.19: If peregrine falcons are present at the Bay View Wetland construction from April through May should be avoided
www4.uwm.edu/letsci/biologicalsciences/falcon/

Marsh Blazing Star are not found on site, there will be no project restrictions related to this/ these species. However, if surveys are conducted and Seaside Spurge and Marsh Blazing Star are recorded on site, all impacts to the species must be avoided.

The Peregrine Falcon has been recorded in the vicinity of the project site and could be present in suitable habitat areas of the site. These birds are protected by Wisconsin's endangered species laws, and the birds and their nests and eggs are also protected under the federal Migratory Bird Treaty Act (MBTA). To avoid impacts to these listed species, the project should follow one of the two options below:

- Assume the birds are present on the site, and avoid all disturbances to the project site from early April - late July. If the project can avoid disturbing areas of suitable habitat for these species during this time period, there will not be any further project restrictions related to these species. If the project cannot completely avoid all areas of suitable habitat or take of the species an application for an Incidental Take Permit Authorization can be completed.
- Not assume the birds are present on the site and have a qualified biologist conduct surveys to determine if they are present (the biologist and survey protocols must be sent to the WIDNR Endangered and Rare Species Review Program for approval prior to the initiation of surveys). If the Peregrine Falcon is not found on the site as a result of the surveys, there will not be any project restrictions related to these species. If surveys are conducted and the Peregrine Falcon is recorded, protocols to avoid suitable habitat during spring and early summer should be followed as outlined above. Survey results should be submitted to the Endangered Resources Review Program.

The American eel, Greater Redhorse, Striped Shiner, and Longear Sunfish are known to occur within the area and based on the habitat description of the site, they are likely to occur here. There are two options regarding this species and impacts that may occur during the project:

- Assume that the American eel, Greater Redhorse, Striped Shiner, and Longear Sunfish are present and avoid impacts to the species by conducting work outside of spawning periods. American eel spawns in the ocean, so its spawning activity will not be affected by project construction. Greater Redhorse (spawns May or June), Striped Shiner (spawns late May - June), and Longear Sunfish (spawns late May - mid July, sporadic to Aug) may benefit from conducting work on portions of the Grand Trunk site outside of spawning periods.
- Do not assume the American eel, Greater Redhorse, Striped Shiner, and Longear Sunfish are present. Surveys by a qualified biologist will need to be conducted to determine if the species is present. If the American eel, Greater Redhorse, Striped Shiner, and Longear Sunfish are not

Figure 3.20: Evidence of rare fish activity at the site, like these longear sunfish burrows, would mean construction must occur outside of nesting periods
http://fawnriverrestoration.org/the-projec[...]-river-sightings/

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found on site, there will not be any restrictions related to this species for this project. If surveys are conducted and the American eel, Greater Redhorse, Striped Shiner, and Longear Sunfish are recorded, then work must be conducted outside of the spawning period (see bullet 1). Survey results should be submitted to the Endangered Resources Review Program.

Actions we recommend to help conserve Wisconsin's rare species and high-quality natural communities:

- A Migratory Bird Concentration Site is within the vicinity of the project. Migratory birds are protected under the Migratory Bird Treaty Act. Migratory bird concentration sites are important resting and feeding areas for birds as they fly between their breeding and wintering grounds. These areas also can be locations where large numbers of migrating birds often become concentrated due to prevailing winds and/or water barriers. Sites are used by many different species, both rare and non-rare. The WIDNR ER Review program is a resource which can be utilized to reduce potential risks to migratory birds.
- The project site is located near Lake Michigan and the Kinnickinnic, Milwaukee, and Menonomee River Basins. It is strongly recommended that erosion and runoff prevention measures be implemented during the course of the project. Please note that erosion control netting (also known as erosion control blankets, erosion mats or erosion mesh netting) used to prevent erosion during the establishment of vegetation can have detrimental effects on local snake and other wildlife populations. Plastic netting without independent movement of strands can easily entrap snakes moving through the area, leading to dehydration, desiccation, and eventually mortality. Netting that contains biodegradable thread with the "leno" or "gauze" weave (contains strands that are able to move independently) appears to have the least impact on snakes and should be used in areas adjacent to or near any waterbody.

Fish Passage

Much like people, fish have difficulty sustaining the high velocity swimming speed required to swim upstream in fast moving water. Northern pike, the key species of interest for this project, have difficulty swimming through shallow flowing water greater than 2 fps and up slopes greater than 2%. Unlike Chinook salmon and other salmonids capable of leaping up to 8-feet beyond abrupt barriers, Northern pike do not exhibit any leaping behavior.

The watershed upstream of the estuary and culvert is relatively small and intermittent such that fish, other aquatic life and wildlife would not be expected to encounter high and sustained volumes and velocities through a reasonably sized culvert. Rather than being driven by stormwater the hydrology of the Bay View wetland will be dictated by the ebb and flow of Lake Michigan water levels. Lake water levels will fluctuate regularly due to seiche effects, and

Figure 3.21: Northern pike need habitat with shallow slopes and low-velocity flows
upload.wikimedia.org

could fall as much as 2.4 feet by 2030 due to climate change(page 18). Therefore, the biggest potential impediment to fish passage at this site is insufficient water level rather than high stream velocity (Wawrzyn, 2013).

Numeric Guidelines

Water depth in the culvert should be a minimum of six inches to allow fish passage. The finished stream bed grade at the culvert is four feet below the current average Lake Michigan water level. This should allow ample depth for fish passage, even in the event that lake levels fall due to climate change.

The top of the culvert should be 3 feet above the average water depth to prevent the culvert from

Figure 3.22: An example of a perched culvert, which does not allow fish passage

becoming fully submerged and causing flow to become pressurized. This may require raising the grade of the road 1 foot to create sufficient depth for the road subbase (approximately 2 ft).

A bottomless culvert is preferable to traditional circular or box culverts. The bottomless design allows the stream channel to continue unimpeded through the culvert, making it easier for fish, other vertebrates such as reptiles and amphibians, and invertebrates to pass through. It also helps prevent erosion at the downstream end of the culvert. Excessive scour at the culvert mouth due to high velocity flows in traditional culverts can cause the stream channel to erode until its bottom elevation is below the bottom lip of the culvert, making it impossible for fish to swim through.

If a bottomless culvert is not possible, the culvert bottom should be buried at least 6 inches or 10-20% of the culvert depth below the stream bed,

Figure 3.23: An open bottom culvert or bridge with a stone facade would allow fish passage and be an aesthetic ammenity

www.deviantart.com

whichever is greater. If the 10 feet of recommended culvert width is not feasible with a single circular or box culvert, multiple culverts of smaller size can be used. For example, two 5 ft pipe culverts could be buried 10" below the stream bed to achieve a total width of 10 feet.

Construction of the new culvert should occur outside of typical fish migration and spawning times. In Southern Wisconsin, most fish spawn between March and June. Construction should be completed by mid-September to allow time for seeds to germinate and stabilize soils. Bare soil should not be allowed to persist into the winter months which can cause severe erosion issues and negatively impacting water quality and fish health.

Further information about the design of culverts for fish passage can be found in the document "Fish Friendly Culverts: Proper Design, Installation and Maintenance Can Protect both Roadways and Fish." (UWM Extension in cooperation with the WI DNR).

Bridge Aesthetics

The culvert 'bridge' will be an important portion of visitors' first impressions of the site if they first encounter it by boat. It is important that the bridge façade signal the beginning of a new experience that is separate from the boat landing at skipper buds. While the culvert will not be a true bridge, its construction should mirror the aesthetic of a bridge as much as possible as opposed to a traditional concrete culvert. The bridge façade should be constructed of either brick or natural stone characteristic of the natural surroundings, material patterns of the region, and historical significance of the site. Railings on the top of the bridge will be required to insure visitor safety, but should be designed to contribute to the aesthetic goals of the bridge.

Access

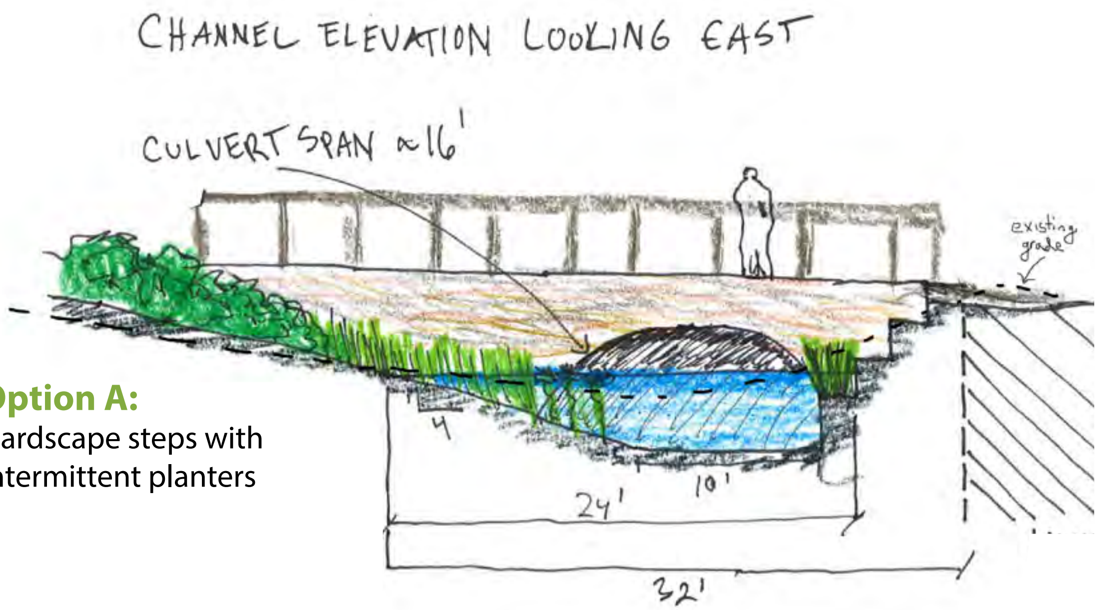
The bridge will need to provide access for pedestrians and vehicles. For this reason careful thought should be given to providing appropriate separation of uses. While it is expected that during times when large industrial equipment is crossing the bridge it will be closed to pedestrian access it is likely that light truck traffic from the Gillen operation and pedestrian traffic may occur on the bridge at the same time. Grade separation, speed control, and signage will all be required to ensure safe passage.

Channel South Bank Design Options

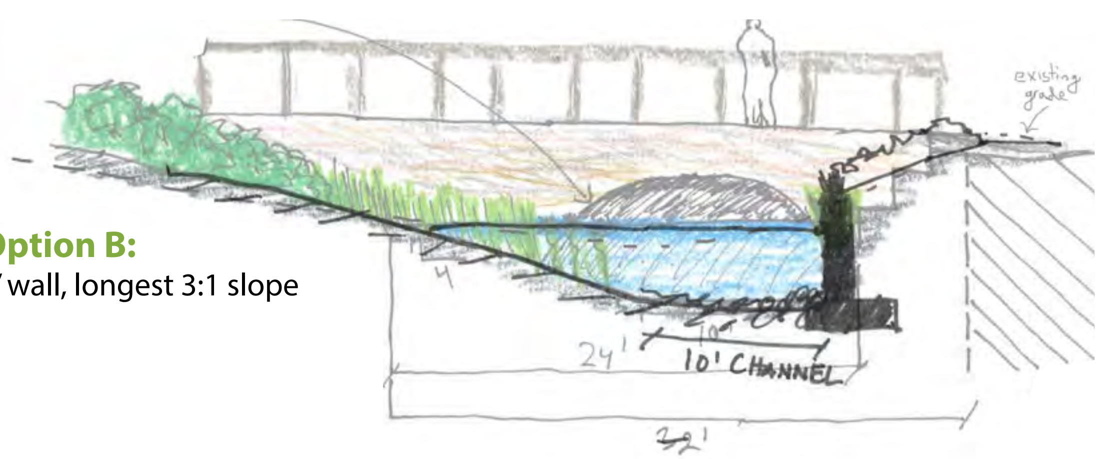
There is 9' of rise and 8' of run needed on the south bank between the south edge of the channel and the north edge of the proposed pedestrian access. The proposed access in this area is only expected to be 5' wide with the south edge adjacent to the limit of grading.

Option A has hardscaped steps to allow water access which would be planted intermittently to soften the edge.

Option B shows the dimensions if a single retaining wall beneath a 3:1 slope is used to stabilize the southern bank. This option would require a 6 foot retaining wall at the channel's southern edge . This option reduces overall fish habitat in the channel.



Option A:
Hardscape steps with intermittent planters



Option B:
6' wall, longest 3:1 slope

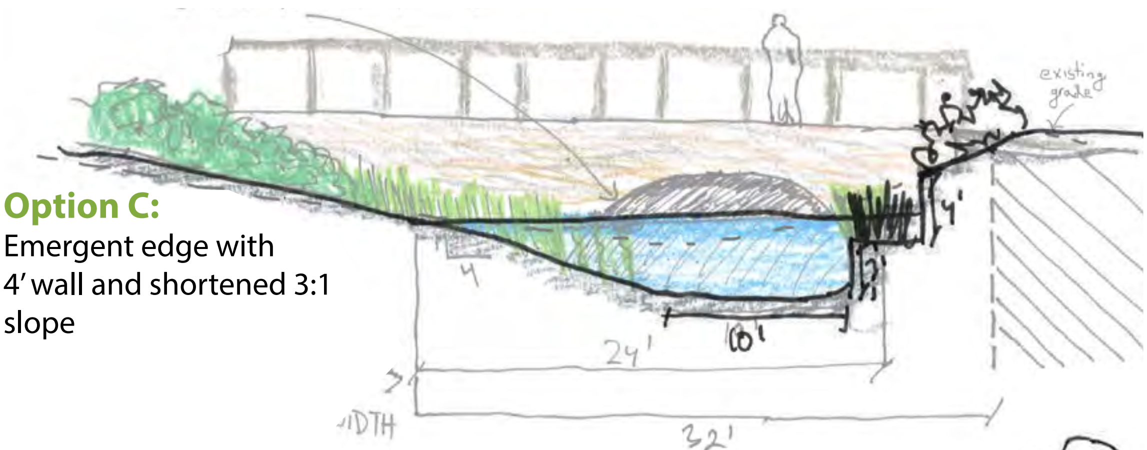
Figure 3.24 (Pages 61 & 62): Early design explorations of options for the south bank of the channel at the Bay View Wetland that flows between the fish passage culvert and the Kinnickinnic River. These concepts will be further refined in the next phase of design.

Option C shows an alternative design which shortens the 3:1 sloping bank in favor of creating an emergent wetland edge at the base of the southern slope. This option does not sacrifice shoreline fish habitat. It also reduces potential safety hazards by shortening the maximum retaining wall height.

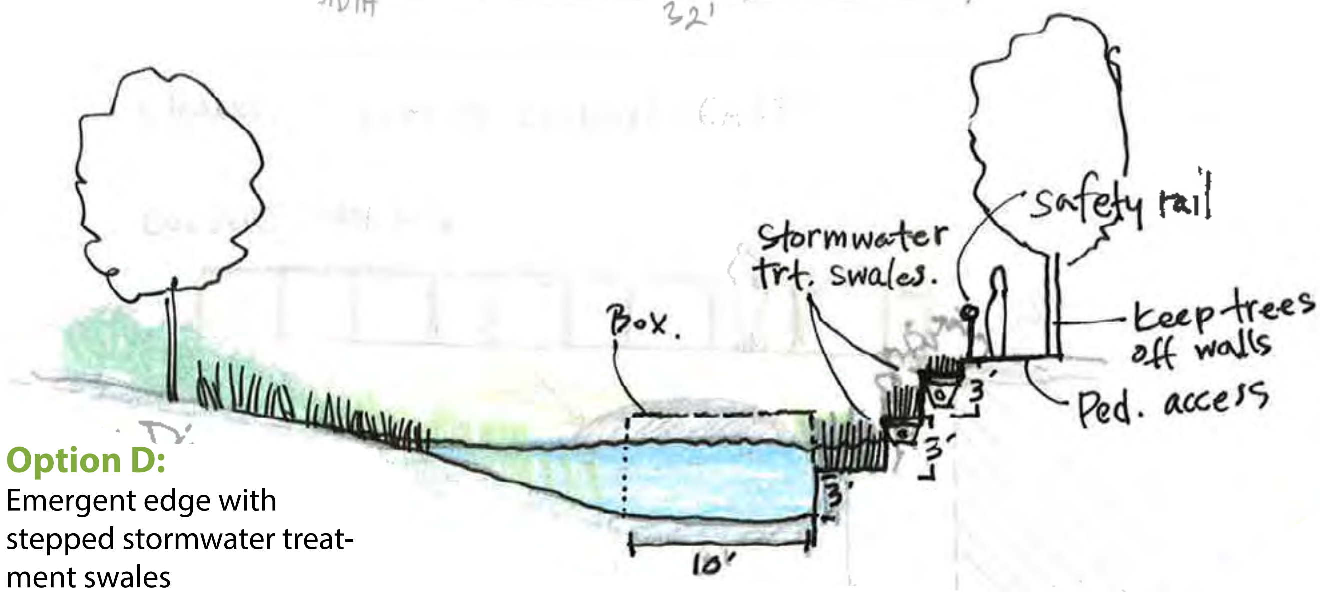
Option D is a revisioning of earlier stepped concepts for the southern edge. Whereas previously the steps were hardscape with intermittent planters, in option D the hardscape has been replaced with stormwater treatment swales that would accept water from the trail and plaza area. This option also extends the emergent wetland edge to three feet and reduces safety hazards due to high retaining walls.

All of the options for the southern edge would require a safety rail and could utilize trees as illustrated in option D.

Recommended: Option D would create a planted bank, reduce safety hazards due to high retaining walls, provide fish habitat, and add stormwater treatment functionality to the channel's southern edge.



Option C:
Emergent edge with 4' wall and shortened 3:1 slope



Option D:
Emergent edge with stepped stormwater treatment swales

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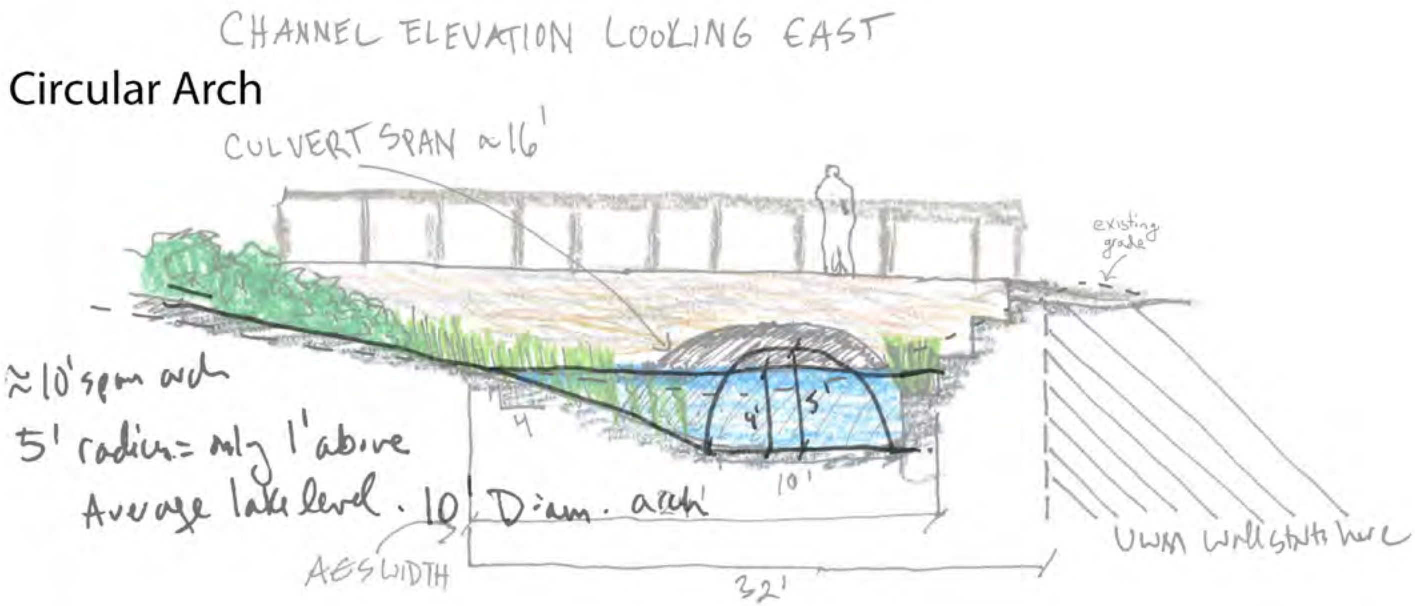
Bridge/Culvert Design Options

A ten foot span would allow ample room for fish passage when the new culvert is installed at the Bay View Wetland.

An arching culvert with a ten foot span will have a radius of five feet. Given that the channel will likely be four feet deep on average, this does not provide enough clearance between the top of the span and the top of the water to account for fluctuations in water level.

Recommended: A box culvert with a ten foot span, seven foot height and an open bottom. This option will allow sufficent room for water levels to fluctuate beneath the bridge span.

Circular Arch



Box

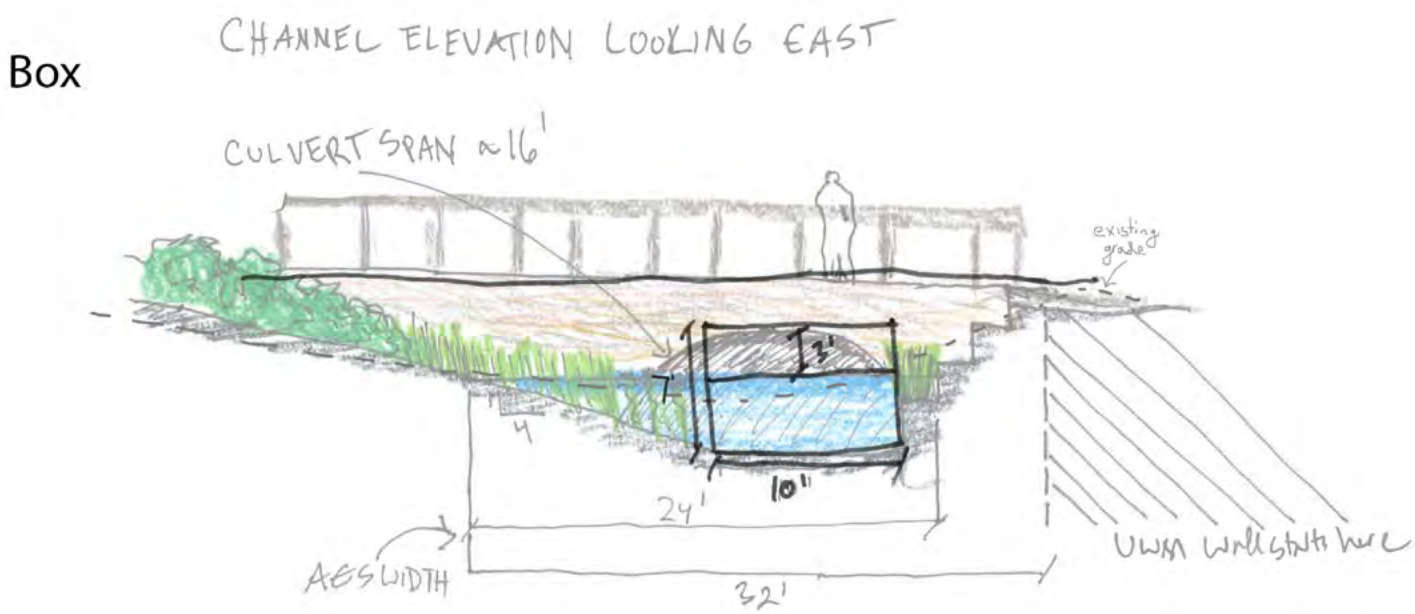


Figure 3.25: Early design explorations of dimensions for the culvert at the Bay View Wetland. These concepts will be further refined in the next phase of design.

Project Evaluation

Description of Scientific Merit

Once established, the Bay View Wetland will be the only known coastal seiche wetland restored in Milwaukee. It will also contain six other distinct ecosystems native to Milwaukee: a riparian shrubland, wet meadow, seepage pond, floodplain forest, sand dune, and mesic prairie. The diversity of ecosystems proposed within a relatively small project area (17.65 AC) gives the Bay View Wetland the opportunity to be a flagship site for the study of restoration science in Milwaukee.

Restoration at the Bay View Wetland will have to overcome significant challenges to achieve a high quality restoration. Safeguards will be in place at all steps of the restoration process to help the project surmount these pitfalls. If successful these methods can be employed at other urban sites which face similar challenges.

Figure 3.26: The industrial context at the Bay View Wetland makes it a good testing ground for best practices in urban ecosystem restoration

Control Invasive Species and Establish Native Vegetation

Invasive species are pervasive at the Bay View Wetland site. The Common Reed (*Phragmites australis*) is particularly extensive, providing nearly 100% cover in some site locations. Other invasive species at the site include:

Latin Name	Common Name
Achillea millefolium	Yarrow
Alliaria petiolata	Garlic Mustard
Centaurea maculosa	Spotted Knapweed
Cichorium intybus	Chicory
Cirsium arvense	Field Thistle
Cirsium vulgare	Bull Thistle
Daucus carota	Queen Anne's Lace
Dipsacus sylvestris	Common Teasel
Melilotus alba	White Sweet Clover
Pastinaca sativa	Wild Parsnip
Phalaris arundinacea	Reed Canary Grass
Poa pratensis	Kentucky Blue Grass
Rhamnus cathartica	Common Buckthorn
Rumex crispus	Curly Dock
Typha angustifolia	Narrow-Leaved Cattail

The maintenance plan outlined in Appendix 2 of the Bay View Wetland Master Plan offers adaptive maintenance plans for five to ten years of care for the restoration site. This plan will control invasive species populations so that native plants have a chance to establish at the site.

Numeric goals for minimum percent cover of native species and maximum cover of invasive species will be determined in the next phase of design. The following is an example of a goal structure for vegetative cover that could be employed at the Bay View Wetland:

- Two full growing seasons after provisional acceptance the seeded areas will meet or exceed 95% plant cover. 20% of planted species should be found at the site. In addition, non-native and/or invasive native species shall collectively not comprise greater than 30% relative cover in each community.
- If after two full seasons the seeded areas are not meeting this criteria a remedial action plan should be developed to address failed seeding areas.

Return of Native Fauna

The Bay View Wetland anticipates providing habitat not only for northern pike and other fish, but also for a host of other wildlife such as frogs, snakes, and birds.

The master plan for the wetland recommends that habitat and wildlife monitoring protocols be instituted at the site to determine whether wildlife does in fact recolonize the site. To prevent harm to wildlife which are currently located at the site the southern half of the site's forested wetland and a fifty foot wide swath of wet meadow will remain un-graded. This will ensure that wildlife have a refuge at the site, even during the construction of the restoration.

Construction activities will be timed so as not to coincide with wildlife breeding schedules as described in the restoration action plan. Appropriate exclusion fencing will also be utilized to minimize harm that could befall wildlife when construction occurs.

One of the largest potential impediments to establishing a fish population at the Bay View Wetland is falling lake levels due to climate change (page 18). Within the next 30 years some models predict that Lake Michigan could fall over two feet.

To ensure that fish are able to inhabit the site despite falling water levels, wetland benches and long shallow slopes will be graded at the edges of the wetland. This will ensure that wetland vegetation can establish at the edge of the waterbody regardless of its longterm levels.

Figure 3.27: Existing debris at the future Bay View Wetland site

The planned average depth of water at the Bay View Wetland once it is constructed is three to four feet. Even if water levels fall another two to three feet in the next thirty to fifty years, sufficient water depth will be available for fish to pass freely into the Bay View Wetland.

Pollution

Pollution of the Bay View Wetland is a potential concern. This pollution could be introduced when the seiche effect brings debris into the site from the Kinnickinnic River. To counteract this effect volunteer events could be hosted to pick up trash at the wetland. The University of Milwaukee and the Milwaukee Riverkeepers are both examples of the types of organizations which have been involved in the Bay View Wetland's planning who would have the capacity to organize such events.

The industrial context of the site's watershed, contaminated soils, and anticipated development on a portion of the site itself could cause unwanted stormwater runoff into the seiche wetland if not properly planned for. To counteract these effects the seiche wetland will be protected by the following fale-safes:

- Soil contamination on-site will be treated or contained by a Remedial Action Plan
- The wetland will be surrounded by shallow swales within the wet meadow designed to slow and infiltrate any stormwater that makes its way through the site before it has a chance to enter the seiche wetland.
- The mesic prairie and floodplain forest planned for the southern portion of the site will have very low rates of runoff. Most of the industrial areas adjacent to the Bay View Wetland do not drain onto the property.
- The flow of stormwater from industrial areas that do drain to the Bay View Wetland will be controlled by dense shrub plantings and/or berms on the site's northern edge.
- Future development at the site will be controlled by covenants which ensure that it treats and infiltrates any stormwater runoff within the development footprint.