



CUY-90-14.90

PID 77332/85531

APPENDIX ST-02

**Green Bulkhead Reference Information
(Reference Document)**

State of Ohio
Department of Transportation
Jolene M. Molitoris, Director

**Innerbelt Bridge
Construction Contract Group 1 (CCG1)**

FROM



Cuyahoga River Remedial Action Plan &
Cuyahoga – American Heritage River Initiative



Appendix E: Design Criteria for Navigation Channel Fish Habitat Areas

Based on initial meetings with fisheries biologists and RAP stakeholders, below is a list of design elements to be considered in the evaluation of the potential effectiveness of a constructed fish habitat area.

1. No, or limited, protrusions into the water body; construction should be designed to be behind the line of the bulkhead.
2. Located along bank and constructed so that physical structures would:
 - a. Not gather and accumulate passing floating debris.
 - b. Have the ability to avoid damage from ice scour.
 - c. Have the ability to absorb or dissipate propeller wash, especially bow and stern thrusters, without damage.
3. Easily accessible –in and out- (at least theoretically) by swimming fish. Minimum opening through a solid bulkhead of at least: 4 ft.
4. Optimal minimum linear length of at least 25ft. along shore to provide reasonable accessibility to swimming fish – smaller sized structures will provide some benefit, larger ones will provide more benefit.
5. Vertical dimension of any opening cut through a solid bulkhead to be 6 ft. below water surface, and
 - a. Tall enough to provide water access, to accommodate projected fluctuations in water level
 - b. To be of certain size and spacing to exclude adult carp, if possible.
6. A minimum surface area of at least: 300 sq. ft. to support adequate vegetation to function as a fish refuge (smaller areas will provide some benefit, larger areas will provide more benefit).
7. Soil depth of 12 - 24" to provide an adequate root zone for habitat plants.
8. Variable habitat depths:
 - a. Ranging in depth from 12" to 24" for larval fish, Minimum Bottom Surface Plane (mbsp) 100 sq. ft.
 - b. Deeper habitat from 12" to 72" for predator fish, (mbsp of 200 sq. Ft) with some bottom structure,
 - c. Provide these depths as lake levels fluctuate (suggests a sloped bottom structure)
9. Adequate underwater riverside bottom and slope stabilization to keep the structure from:
 - a. Being destabilized by boat wakes or prop wash.
 - b. Slumping into the river channel (suggests proper slope gradient and/ or rock stabilized ledges.
10. Provides plants and structures to benefit habitat for birds and other terrestrial life.
11. Emphasis on design that replicates, to the extent possible, natural habitat with native aquatic plants should be utilized in all projects.
12. Minimal on-going maintenance requirements, (i.e. set it and forget it)
13. Accessible for maintenance, if needed.
14. Located, where possible, in conjunction with related green space / trail elements from the lower river and flats area.

Habitat for Hard Places

In the Cuyahoga River

~

Conference on Urban Habitat Restoration

22-23 January 2009

James White

Executive Director

Cuyahoga River Remedial Action Plan

The Historic Cuyahoga River

- 112 miles long
- Drains 812 sq. miles thru 91 local governments in 6 counties
- Centerpiece of Cuyahoga Valley National Park
- 1.2 million people- unchanged since the 1970s
- Enters Lake Erie in center of Cleveland - shipping and industrial Center



Catalyst for the Clean Water Movement

- **1969-** Infamous Fire
2009 is 40th Anniversary
- **1972-** Clean Water Act & USEPA
- **1973-** Ohio EPA
- **1985-** IJC defines 42 Areas of Concern of RAPs- BUIs emphasize Water Quality
- **1986-** Formation of RAPs as Community Driven efforts



Related Actions

- **1988-** CRCPO Organized as 501(c)3 to support Cuyahoga RAP (fragile funding model)
- **1998- American Heritage River Presidential Designation**
 - Rediscover, Respect, Revitalize Ohio's American Heritage River
 - Links Environment - Economy – Heritage
 - One of 14 rivers- National support network

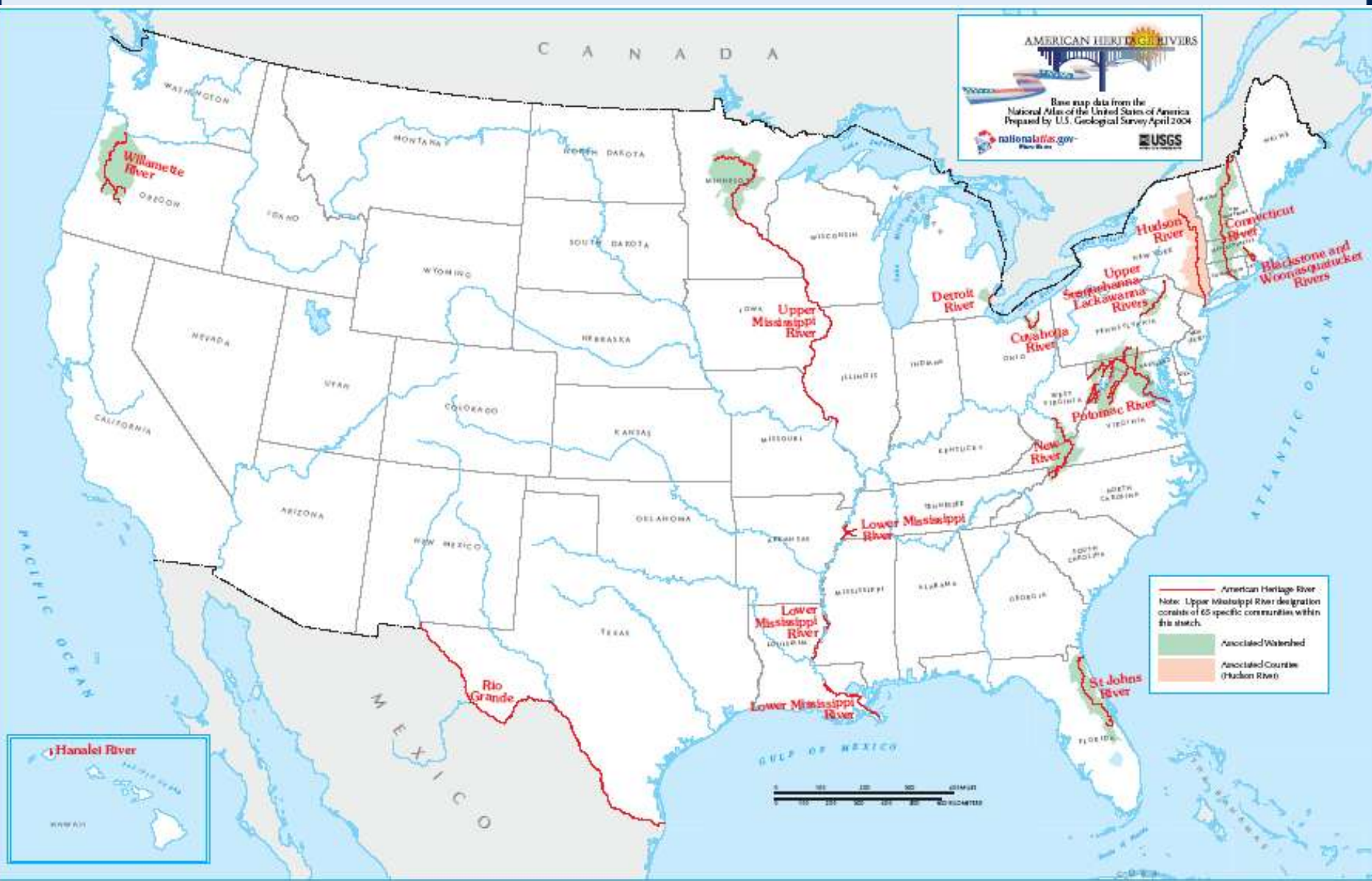
American Heritage Rivers



AMERICAN HERITAGE RIVERS

Base map data from the National Atlas of the United States of America Prepared by U.S. Geological Survey April 2004

nationalatlas.gov



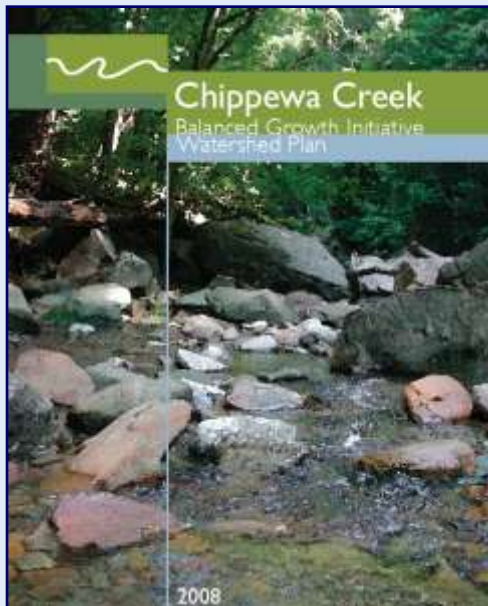
Related Actions



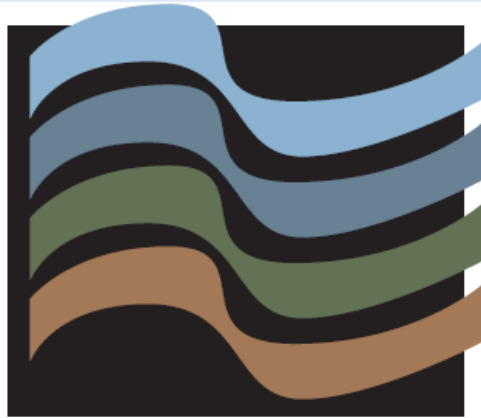
- **2006 Great Lakes Regional Collaborative**
 - New plan to focus Federal efforts-
reemphasizes importance of AOCs & RAPs

CRCPO Branding

- To be perceived as:
 - **Friendly, Knowledgeable & Supportive**
 - **A Catalyst to Assemble Assets for Collaborative Problem Solving**



CLEERTEC



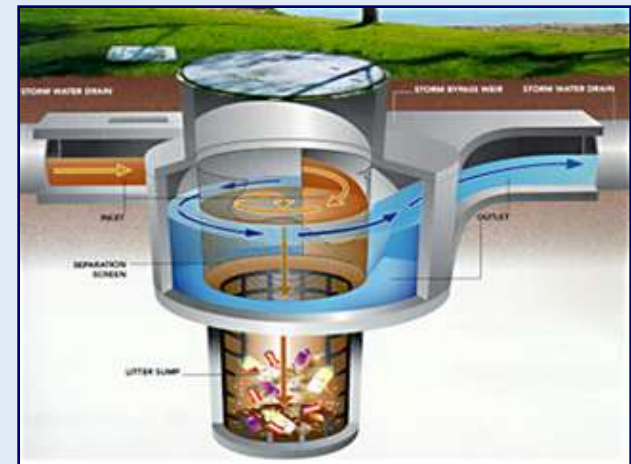
CLEERTEC

c u y a h o g a • l a k e e r i e
e n v i r o n m e n t a l r e s t o r a t i o n t e c h n o l o g y
e n t e r p r i s e • c e n t e r



CLEERTEC

- Place-based Business and Job Formation
- Focus on Environmental restoration &
- Emerging technology
- Focal point for Public-Private Partnerships for problem solving



Substantial projected new federal funding especially opportunities emerging from the Great Lakes Regional Collaborative for Great Lakes cleanup has the potential to provide capital and significant additional market demand for environmental restoration providers.



CLEERTEC a Local Resource



CLEERTEC is a Community Resource Tool

- Facilitate the conversion of promising ideas into
- Environmental remedial action,
- Regional business development and local jobs.



CLEERTEC Model

- **Develop a network** of interested & skilled collaborators.
- Identify and **merge Great Lakes Restoration priorities** as defined in the GLRC with technology driven ideas for environmental restoration
- **Help shape and integrate viable ideas into a problem solving-based business concept.**
- **Help secure regulatory support** for innovative restoration solutions



CLEERTEC Model (cont.)



- **Promote pilot projects** to help attract investment capital to the business concept for incubation
- **Add businesses and jobs** growth to the region
- **Reduce environmental impairments** to the river
- Increase **community support** for our “River of Recovery”



Ship Channel



- Gateway between Natural river and Lake Erie
- Lower 5.6 miles of River
- Outlet of the 812 square miles Cuyahoga River Watershed
- Contributes to the Area of Concern (AOC) Designation



Ship Channel

- Dredged to 23 feet from avg 6 foot natural
- Slow Flow: Low D.O. / Sediment Deposition
- 55,000 feet of armored shore of which 22,000 used for freight activity
- Armored shore line: Barren / No Shelter/ No Food for migrating Larval fish



Ship Channel

**Similar context to over 130 navigable
ports in Great Lakes**



Ship Channel

Problem- Armored Shoreline:

- Aging / Expensive to replace
- Need to preserve Maritime Commerce
- Replacement “as is” provides no environmental restoration benefit
- Inadequate replacement options



Ship Channel



IDEA-

High Performance Shoreline Management System

- Aka- **Green Bulkheads**

Provide micro-habitats to provide food and shelter for migrating larval fish as they move from natural river to the Lake.

Ship Channel



Solution-

Develop new alternative products for shoreline

- Provide land owners with viable options
- Integrate habitat needs- promote River Restoration culture
- Produce mitigation credits
- Provide new business and jobs

Ship Channel

System Design Issues-

Functionality: Survive contact with reality

- Ship traffic- freighter prop wash/ physical contact, freezing, debris, carp, geese
- Integrate plants and habitat with structural integrity of the bulkhead



Ship Channel

System Design Issues- Manufacturability

- Business and Job producer
- Develop a supply chain for needed plant products



Ship Channel



System Design Issues-

Install-ability

- Technically able to be economically and efficiently installed

Ship Channel

System Issues- Sustainability

- Adding habitat to highly artificial environment to provide connections between spawning grounds in upstream riffle beds with lake and lake-edge marshes
 - Probable need for ongoing level of management and service- Also a business / job incubator
- Funding Models to replace bulkheads generally- \$80 million needed.



Progress



Funded via a \$495,000 Federal (WRDA) Funds
and local match

- Design Development
- Prototype development and evaluations

More Evaluation sites and \$ will be needed.

Progress



Assembled team of partners with needed expertise:

- Larval Fish- Habitat needs and conditions for fish species
- Wetland/ Stream Plants / Soils- Functional benefit, Durability
- Stream restoration- Plant propagation
- Designers- Creative Idea resources
- Bulkhead Design- Knowledge of local site conditions
- Bulkhead Installation- Private Sector expertise
- Materials and Manufacturing process – Private Sector Expertise

Progress



Team of Partners (cont)

Community Partners:

-City / County / Port Authority/ COE/
OEPA- 401/ Land Owners / Developers /
River freight users

Progress



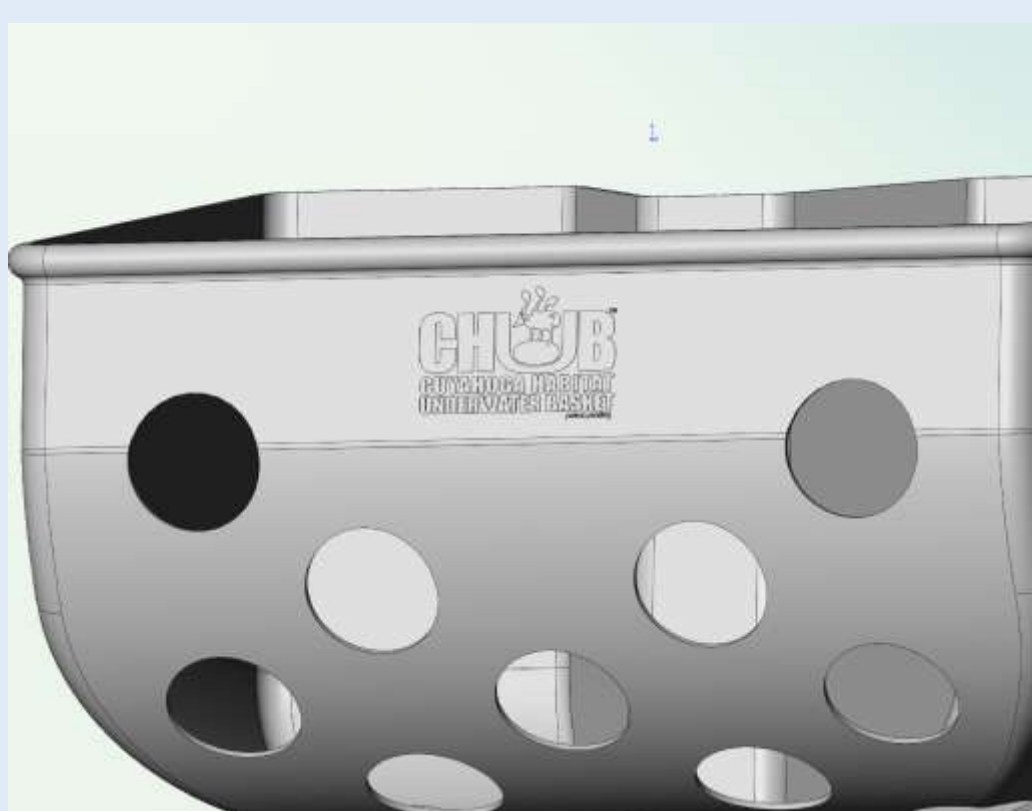
Three Alternates

- A- Add-on devices for existing SSP bulkhead not in imminent danger of replacement
 - **CHUBStm- Cuyahoga Underwater Habitat Baskets**

- B- Spot locations for areas of weakened wall sections
 - **Pocket Habitats** –installed behind the bulkhead

- C- Replacement wall configurations - Value of land versus cost of facility
 - **Tiered Wall**
 - Lower cost construction options require more land
 - Value of land versus Replacement Costs the big issue for intensive land users

CHUBs- Cuyahoga Habitat Underwater Baskets™



CHUBs



- Designed to fit in recesses of SSP Bulkheads
– protected from prop wash and debris flow
- Molded Rubber for flexibility and strength
(15% recycled content)
- Bottom holes promote root development in
nutrient rich water
- Hung by chains at various levels in the water
- Each basket holds a “Plant Pillow”



CHUBs are
manufactured
locally.





100

100

Plant Pillows

- Pillows are 16" X 12" round mesh net tubes
- Patented mesh bag secures plants & growing medium –
 - Discourages damage from carp and geese
- Custom blended soil/aggregate medium
 - Mimics natural stream bank soil conditions
- Plants are combinations of native emergent and submergent wetland species for diversity

Plant Pillows

- 70 lbs of soil/ stone mix in a mesh net pillow
- Each pillow holds 3-4 wetland plants –Emergent or Submergent varieties
- Each is all the same plant type- for ease of replacement if plant type fails



CHUB installation
Note the passing freighter





Next Steps

Build, Deploy & Evaluate....

CHUBs have been produced and currently hanging along several areas of navigation channel

A few sites have been evaluated for pocket habitat and/or tiered wall installation, site specific construction details are being finalized for 2009

Design team is establishing evaluation protocols to test for structural integrity, durability, plant growth and fish habitat



**A fish was found
within first 3 weeks
of installation!**



Plant Pillows

- Developing supply chain logistics –**
- Sprout / Propagate/ Mature / Deploy on site**
 - Including installation and maintenance logistics



Plant Logistics

How to Produce enough Plant Pillows:

Developed an Agreement with Cleveland Metroparks to use a portion of the O& E Canal for testing growth of plants in Plant pillows

- New use for old asset
- Linear/ Accessible wetland
- Control depth in water as plants mature

O & E Canal



Potential for Wide Application



- The Cuyahoga Navigation Channel shoreline is similar in context to over 130 navigable ports in Great Lakes
- Solutions developed here have widespread implications and market potential
- **More test sites needed in other Great Lakes Areas!**

Contact-

Jim White 440-317-0397

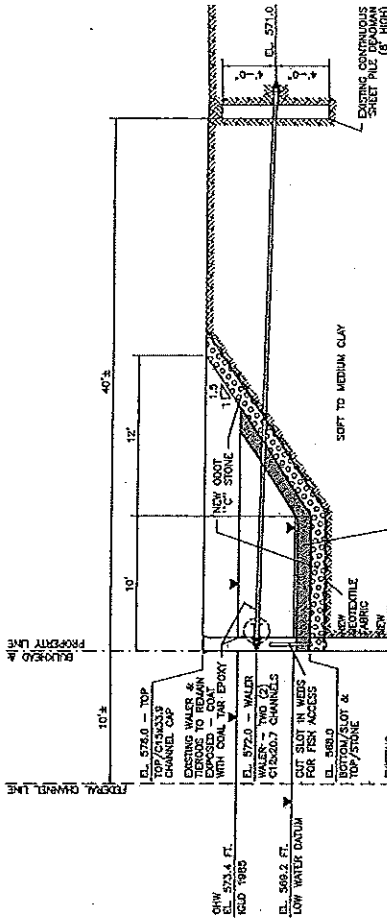
WhiteJ@CuyahogaRiverRAP.org

Website-

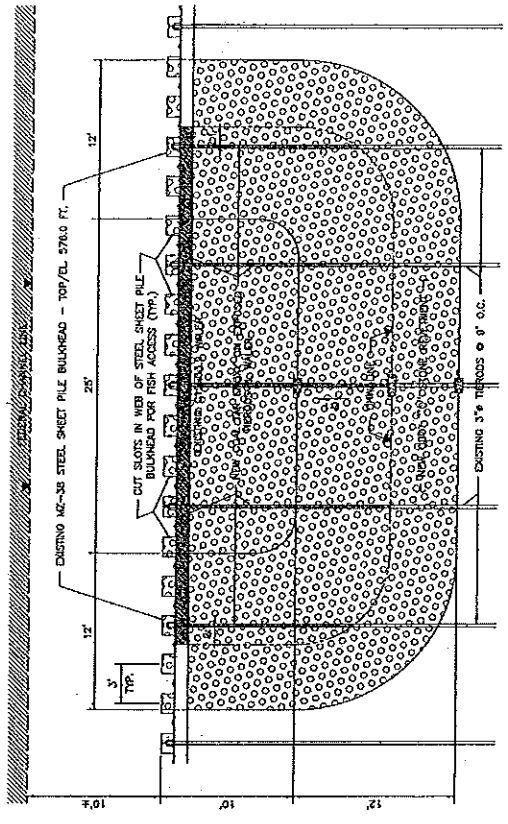
CRCPO.org

2009 Year of the River

- **Celebrate recovery** since the 1969 fire
- **Expand community awareness** of the need for on-going watershed Stewardship
- **Develop sustainable funding support**



BULKHEAD HABITAT - OPTION B
SCALE 1/4" = 1'



SITE PLAN - BULKHEAD HABITAT - OPTION B
SCALE 1/4" = 1'

PRELIMINARY

NOTES:

- 1) ALL ELEVATIONS ARE REFERRED TO OLD 1985, 0.0 UMG = 309.20 FT.

DATE: 11/15/85
DRAWN BY: [Name]
CHECKED BY: [Name]

NOTES:

SITE PLAN & SECTION - OPTION B
PROPOSED BULKHEAD HABITATS
ON THE CUYAHOGA RIVER
CLEVELAND, OHIO

MATRIX ENGINEERING INC.
1777 EAST 17TH AVE., SUITE 1107
CLEVELAND, OHIO 44114
PHONE: (216) 761-1000
FAX: (216) 761-1001

FROM

Submerged plants

Pondweeds: *Potamogeton* spp.

- Leafy pondweed *P. foliosus*
 Crisp pondweed *P. crispus* (Introduced) Grows to 5 ft depth
 Sago pondweed *P. pectinatus* Widely planted, has tubers.

Waterweeds or naiads: *Najas* spp.

- Bushy pondweed *N. flexilis* Can grow 20 ft long.
 Southern naiad *N. guadalupensis*

Other submerged plants

- Hornwort (Coontail) *Ceratophyllum demersum*
 Water milfoils both native and Asiatic
 Elodea

Emergents

- Softstem bulrush *Scirpus validus*
 3 square bulrush *Scirpus pungens*
 Water plantain *Alisma plantago-aquatica*
 Broad leaf arrowhead (Duck potato) *Sagittaria latifolia*
 Arrow arum *Peltandra virginica*
 Pickerel weed *Pantederia cordata*
 Giant burreed *Sparganium eurycarpum*

Grasses

- Manna grass *Glyceria striata*
 Cord grass *Spartina pectinata*
 Cut grass *Lersia oryzoides*

Problems

- Muskrats
 Geese
 Ducks
 Grass carp and other weed eating fish
 Strong currents
 ice

FROM

Grasses & Grass-Like Species

Allama subcordatum (*A. plantago-aquatica*)

Native

MUD PLANTAIN (WATER PLANTAIN)

Grows rapidly in early spring. Provides food for waterfowl and pheasants.

INDICATOR Herbaceous Biennial / OBL

HABITAT Marshes, streams and muddy shores. pH 5.0 to 7.0.

CHARACTERISTICS A single crown species that grows to 2 ft. tall. Blooms in midsummer. Small white flowers.

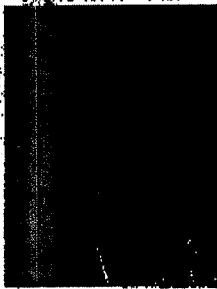
SEEDING RATE 1% to 10% in a mix.

ECOTYPE Pennsylvania

Glyceria striata

Native

BUNCHGRASS



Provides winter food for waterfowl, muskrats and deer.

INDICATOR Herbaceous Perennial / OBL

HABITAT Wet woods, swamps and bogs. pH 4.0 to 8.0. Shade-tolerant.

CHARACTERISTICS A cool season bunchgrass that spreads by short rhizomes and grows to 4 ft. tall. Blooms from June to September. Foliage has a reddish tint.

SEEDING RATE 1% to 10% in a mix.

ECOTYPE Pennsylvania; Canada

Eleocharis oryzoides

Native

BUNCHGRASS



Creates natural sediment traps. Provides food for ducks and a habitat for invertebrates, which waterfowl feed on.

INDICATOR Herbaceous Perennial / OBL

HABITAT Marshes, bogs or wet meadows. pH 5.1 to 8.3. Full sun.

CHARACTERISTICS A rhizomatous warm season species that grows to 3 ft. tall. Blooms from June to October.

SEEDING RATE 1% to 20% in a mix.

ECOTYPE Iowa; Pennsylvania

FROM

Grasses & Grass-Like Species

Native

Peltandra virginica

ARROW ARUM

Seeds stored wet. Provides food and cover for waterfowl.



INDICATOR Herbaceous Perennial / OBL
HABITAT Swamps, stream or lake edges and tidal marshes. pH 5.2 to 9.5. Partial shade tolerant.

CHARACTERISTICS A bunch type species that grows to 3 ft. tall. Blooms from May to June. Seed pods ripen in the fall and contain numerous large seeds.

SEEDING RATE 1 lb. per 1000 sq. ft.

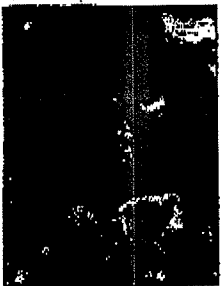
ECOTYPE Pennsylvania

Native

Pontederia cordata

PICKEREL WEED

Seeds stored wet. Seed provides food for wildlife.



INDICATOR Herbaceous Perennial / OBL
HABITAT Swampy edges of lakes, streams and along tidal shores. pH 6.0 to 8.0. Shade tolerant.

CHARACTERISTICS A very ornamental wetland bunchgrass that grows to 3 ft. tall. Blooms from July to September. Blue spiked panicles.

SEEDING RATE 1 lb. per 1000 sq. ft.

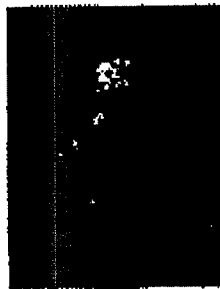
ECOTYPE Pennsylvania

Native

Sagittaria latifolia

DUCK POTATO (ARROWHEAD)

Tubers provide food for waterfowl, muskrats and beavers.



INDICATOR Herbaceous Perennial / OBL
HABITAT Swamps, wet shores and shallow water of ponds and streams. pH 4.7 to 8.6. Full sun.

CHARACTERISTICS An ornamental wetland species that produces large underground tubers and grows to 3 ft. tall. Blooms from July to August. Spikes of delicate white flowers.

SEEDING RATE 0.5% to 10% in a mix.

ECOTYPE Midwest; Pennsylvania

FROM

Grasses & Grass-Like Species

Native

Scirpus americanus (*S. pungens*)(*Schoenoplectus pungens*)

COMMON THREE SQUARE BULRUSH

Provides food and cover for waterfowl, muskrats and spawning grounds for bluegills and largemouth bass.

INDICATOR Herbaceous Perennial / FACW+

HABITAT Marshes, moist shores, riverbanks and mud flats. pH 3.7 to 7.5. Full sun.

CHARACTERISTICS A rhizomatous species that grows to 4 ft. tall. Blooms from June to September.

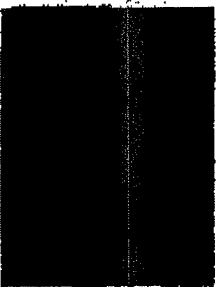
SEEDING RATE 0.5% to 10% in a mix.

ECOTYPE West

Native

Scirpus validus (*Schoenoplectus tabernaemontani*)

SOFT STEM BULRUSH



Provides food for waterfowl, muskrats and spawning grounds for fish.

INDICATOR Herbaceous Perennial / OBL

HABITAT Swamps, wet ditches, mud flats, lake and pond margins. pH 5.4 to 7.5. Full sun.

CHARACTERISTICS A rhizomatous species that grows to 10 ft. tall. Blooms from June to September. Red flowers.

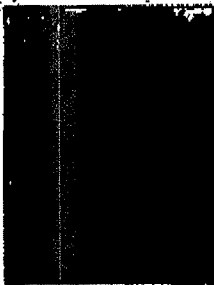
SEEDING RATE 0.5% to 10% in a mix.

ECOTYPE Midwest; Pennsylvania

Native

Sparganium eurycarpum

GIANT BUR REED



An emergent aquatic plant. Provides food and cover for waterfowl, pheasants, muskrats and beavers.

INDICATOR Herbaceous Perennial / OBL

HABITAT Bogs, swamps, lake margins, ditches and swampy meadows. pH 5.0 to 8.5. Partial shade tolerant.

CHARACTERISTICS A species that grows to 7 ft. tall. Blooms from July to August. Greenish brown flowers give way to large ball shaped seed heads.

SEEDING RATE 5% to 20% in a mix.

ECOTYPE Pennsylvania

Native

Spartina pectinata

PRAIRIE CORN GRASS



An aggressive sod forming grass whose root system provides erosion control. Provides food for waterfowl, songbirds and a habitat for muskrats.

INDICATOR Herbaceous Perennial / OBL / FACW

HABITAT Sandy shores and alluvial flats. pH 6.0 to 8.5. Full sun.

CHARACTERISTICS A warm season species that spreads by rhizomes and grows to 7 ft. tall. Blooms from July to August.

SEEDING RATE 8 lbs. per acre alone; 5% to 25% in a mix.