PROMOTING PHYTOREMEDIATION DESIGN TECHNIQUES AND PUBLIC EDUCATIONAL OPPORTUNITIES FOR THE TWIN CITIES ARMY AMMUNITION PLANT (ARDEN HILLS, MINNESOTA)
THIS PROJECT IS DEDICATED TO MY MOTHER. BORN TO LOVE. RAISED WITH LOVE. FOREVER LOVED.

THANK YOU FOR EVERYTHING
FAMILY
OVERWHELMING LOVE FOR THE GREAT OUTDOORS
TCAAP
TWIN CITIES ARMY AMMUNITION PLANT
THE TCAAP WAS A PRODUCT OF THE GOVERNMENT-OWNED, CONTRACTOR-OPERATED (GOCO) WAR MATERIALS PRODUCTION PROGRAM ESTABLISHED BY THE WAR DEPARTMENT DURING WWII

- 1 of 6 GOCO PLANTS MAKING WEAPONS
- OPERATED BY FEDERAL CARTRIDGE CORP.
- .30, .50, .45 CALIBER AMMUNITION
SUPERFUND SITE:

- Polluted locations requiring a long-term response to clean up of hazardous material contaminations.
- Designated under the (CERCLA) or Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
- 1322 Superfund sites
SITE SIZE: 2,382 ACRES
WHAT HAS BEEN HAPPENING ON SITE?
HOW DO I DESIGN A PARK WHERE THE PUBLIC CAN HAVE AN EDUCATIONAL EXPERIENCE AS WELL AS BE SAFE FROM TOXINS LEFT IN THE AREA?
1 | IMPROVE SOIL/WATER QUALITY
2 | PROMOTING HUMAN INTERACTION

- LOW-IMPACT DEVELOPMENT
- GREEN INFRASTRUCTURE
- ENVIRONMENTAL SITE DESIGN
- STORM WATER TREATMENT
- AQUATIC BUFFERS
- EROSION CONTROL
THESIS SITE LOCATION:
ARDEN HILLS, MINNESOTA

TWIN CITIES ARMY AMMUNITION PLANT BOARDER
(T.C.A.A.P.)
TOTAL POPULATION WITHIN 20MILE RADIUS
2,765,723
OR
50.52%
OF MN POPULATION
NETWORK SYSTEMS

RICE CREEK
NORTH TRAIL
SYSTEM

GREEN SYSTEM:
GREEN ZONES
CONNECTED
BY WATER SYSTEMS

RICE CREEK

TWIN CITIES ARMY
AMMUNITION
PLANT BOARDER
(T.C.A.A.P.)
GATE VALVES: PROVIDES FLEXIBILITY IN DEPTH CONTROL

AQUATIC BENCH: 02

LOW MARSH: 03

EXTENDED DETENTION WETLAND ZONE: 04

MICRO-POOL: ADDITIONAL SEDIMENTATION: 05

FORE-BAY: ALLOWS FOR SEDIMENTATION: 06

CONCRETE SPILLWAY: WATER DEPTH CONTROL ASSISTANCE: 07

WATER LEVEL CONTROL

RISER IN EMBANKMENT: WATER LEVEL CONTROL: 10

WETLAND OUTLINE: 11

MAXIMUM EXTENDED DETENTION LIMIT: 08

HIGH MARSH: 09

SYSTEM FLOW

WATER FLOW

SEDIMENTATION SYSTEM FLOW
WETLAND SPECIFICATIONS

- **Hydraulic Loading Rate:** 0.02 Inflow/m²/day, 48,000 gallons/day
- **Total Suspended Solids:** 18 grams Inflow/m²/day
- **Organic Loading Rate:** 5.0 grams BOD⁵ Inflow/m²/day
- **Hydraulic Retention Time:** 2.83 days
- **Velocity of Output Flow Rate:** 0.19 m/second
RHIZOFILTRATION:
Filtering water through a mass of roots to remove toxic substances or excess nutrients. The pollutants remain absorbed in or adsorbed to the roots.

PHYTOREMEDIATION TYPES

PHYTOVOLATILIZATION:
Removal of substances from soil or water with release into the air, sometimes as a result of phytotransformation to more volatile and/or less polluting substances.

PHYTODEGRADATION:
Chemical modification of environmental substances as a direct result of plant metabolism, often resulting in their inactivation, degradation, or immobilization.

PHYTOEXTRACTION:
Uptake and concentration of substances from the environment into the plant biomass.

PHYTOSTIMULATION:
Enhancement of soil microbial activity for the degradation of contaminants, typically by organisms that associate with roots.

PHYTOSTABILIZATION:
Reducing the mobility of substances in the environment, for example, by limiting the leaching of substances from the soil.

PHYTODEGRADATION:
CHEMICAL MODIFICATION OF ENVIRONMENTAL SUBSTANCES AS A DIRECT RESULT OF PLANT METABOLISM, OFTEN RESULTING IN THEIR INACTIVATION, DEGRADATION, OR IMMOLIZATION.
POPLAR
- TRICHLORETHYLENE
- CARBON TETRACHLORIDE
- CADMIUM

BIRCH
- SELENIUM
- ZINC
- MERCURY

CEDAR
- COPPER
- LEAD
- CAESIUM 137

PINE/SPRUCE
- TRICHLORETHYLENE
- NICKEL
- CADMIUM

MAPLE
- POTASSIUM
- MAGNESIUM
- ZINC

GRASSES
- LEAD
- NITROGEN
- CADMIUM
GLASS WINDOW PANELS
Creating views of the wetland-based park setting while bringing in natural light.

EDUCATIONAL CENTER
Host activities centered around water quality, pyroremediation, and human interaction.

PRIMARY GATHERING ZONE
Main entrance gathering zone will allow people to begin their journey throughout the park.

WAREHOUSE/RESEARCH
Large storage and research center for pyroremediation purposes.

CONCRETE PLANTING BEDS
Elevated sections of the plaza will be concrete-based utilizing the planting palette from elevation.

RE-PURPOSED CONCRETE PLAZA
Using sustainable practices by utilizing old building footprints to supply concrete from proposed plaza planting entrance.

BUILDING CONCEPTS
**ELEVATED DECK:**
Allows for a higher view shed which overlooks the plaza, Rice Creek North Trail, and the wetland system.

**PHYTOSTIMULATION:**
Enhancement of soil microbial activity for the degradation of contaminants, typically by organisms that associate with roots.

**RAISED PLANTER:**
Creates a barrier from the Rice Creek North Trail but allows for a gathering space behind it.

**PHYTOEXTRACTION:**
Uptake and concentration of substances from the environment into the plant biomass.

**PHYTODEGRADATION:**
Chemical modification of environmental substances as a direct result of plant metabolism, often resulting in their inactivation, degradation, or immobilization.

**RCNT CHANNEL:**
The existing trail that runs north to south through the site creates linear views and spaces for users.

**VISITOR CENTER**
1 | VISITOR CENTER
2 | RESEARCH/WAREHOUSE
3 | WETLAND PLANTINGS
4 | MAPLE PLANTINGS
5 | POPLAR PLANTINGS
6 | BIRCH PLANTINGS
7 | PINE/SPRUCE PLANTINGS
8 | PRAIRIE PLANTINGS
9 | GREEN OPEN-SPACE

**FORMED CONCRETE**
FCO | D04

**REFURBISHED TIMBER**
RTO | D03

**REFLECTIVE GLASS**
RFO | D01

**PRESSED CONCRETE**
PCO | D02

**GREY BIRCH**
BXO | P04

**EASTERN WHITE PINE**
PSO | P01

**BALSAM FIR**
PSO | P02

**SCOTS PINE**
PSO | P04

**NORWAY SPRUCE**
PSO | P07
PIECE/SPRUCE PLANTINGS

OPEN LAWN (GREEN SPACE)

ENCLOSED TRANSITION

TRANSITION SPACE BRINGS PEOPLE FROM THE BUILT TO NATURAL DESIGN ZONES

LAYERED PLANTINGS BASED ON ELEVATIONS

ADJACENT PLANTING RAAP SYSTEM

CONNECTION TO EXISTING RCNT SYSTEM

SMOKE RIDGE

SMO | D06

PRESSED CONCRETE

PCO | D02

SHOPTREX HARDWOOD

ADA COMPLIANT RAMP SYSTEM

EROSION CONTROL

KAYAK LAUNCH

KAYAK STORAGE

PINE/SAPRE PLANETINGS

01

02
SITE CIRCULATION

CONNECTED VEHICLE LOOP ALLOWS FOR SMOOTH CIRCULATION OF VEHICLE AND PEDS

(HIGHWAY 3) ONLY ENTRANCE TO SITE LOCATION

STAFF PARKING

PRIMARY PARK ZONES

EXISTING RCNT SYSTEM RUNS NORTH TO SOUTH THROUGH SITE LOCATION

CREATE LINEAR CHANNEL OF VEGETATION AND HARD-SCAPE MATERIALS

LINEAR DESIGN ALLOWS FOR EASIER MOVEMENT THROUGH SITE

MULTIPLE PATH TYPES ALLOWS FOR VARIED SITE VIEWS

DIFFERENT PATH TYPES ALLOW FOR SLOPE TRANSITION DOWN FROM BUILDINGS TO WETLAND

ELEVATED PLANTING BEDS CREATES PERSONAL SPACES THAT ARE CONNECTED

ENTRY SIGN

LINEAR CHANNEL

ENCLOSED SPACES

STAFF PARKING

CONNECTED VEHICLE LOOP ALLOWS FOR SMOOTH CIRCULATION OF VEHICLE AND PEDS
PINE/SPRUCE LAYER  
ELEVATION (890' - 895')

POPLAR LAYER  
ELEVATION (883' - 885')

BIRCH LAYER  
ELEVATION (885' - 888')

ADA COMPLIMENT  
FLAT SURFACE FOR EASY ACCESS AND SMOOTH CIRCULATION

STAGGERED DESIGN  
ALLOWS VISITORS TO MOVE THROUGH EACH VEGETATION LAYER AND ELEVATION

STONE PATH  
ALTERNATE PATH SYSTEM ALLOWS FOR VARIETY OF CIRCULATION OPTIONS

PERSONAL SPACE  
SMALLER ENCLOSED VEGETATION ZONES ALLOW FOR MORE PERSONAL ZONES

STAGGERED DESIGN  
ALLOWS VISITORS TO MOVE THROUGH EACH VEGETATION LAYER AND ELEVATION

STONE PATH  
ALTERNATE PATH SYSTEM ALLOWS FOR VARIETY OF CIRCULATION OPTIONS
**Rhizofiltration:** Filtering water through a mass of roots to remove toxic substances or excess nutrients. The pollutants remain absorbed in or adsorbed to the roots.

**Phytostabilization:** Reducing the mobility of substances in the environment, for example by limiting the leaching of substances from the soil.

**Phytovolatilization:** Removal of substances from soil or water with release into the air, sometimes as a result of phyto-transformation to more volatile and/or less polluting substances.

**Wetland Lookout:** Overlooks the first of 3 fore-bays along the wetland system, this gives a view from 12ft over the water height.

**Natural Path:** The secondary path systems are soft-scape based allowing the user to experience the site at grade.

**Control Station:** This building functions as the gate station for the wetland but also is a part of the research building located near the entrance.

**Primary Trail:**
1. Control Station
2. Boardwalk System
3. Wetland Lookout
4. Wetland Fore-Bay
5. Secondary Path
6. Rice Creek
7. Wetland Plantings
8. Creek Bank Stabilization
9. Poplar Plantings
Maples Layer Elevation (895' - 905')

Pine/Spruce Layer Elevation (895' - 905')

Pyto Zone Elevation (906')

South Lookout
Elevated platform allows site viewers to experience the site at all levels from ground to the sky.

Concrete Wall
Creates space in front and on top of wall utilizing the steep elevation changes.

Boardwalk System
Using re-purposed wooden railway ties provides a walking surface for the trail systems.

Concrete Wall
Provides open space for ground level visitors and opens up view sheds for elevated platform above.

Prairie Stay Plantings
Provides open space for ground level visitors and opens up view sheds for elevated platform above.

Pine/Spruce Layer Elevation (895' - 905')

Rock Sculptures
This area provides a space for rock sculptures but also allows for actual climbing upon rocks.

Formal Plantings
Each vegetation layer will have a formal planting zone to show off what the layer vegetation is like.

Lookout 880

Lookout 880

Lookout 900

Lookout 900

Lookout 910

Lookout 910

Lookout 915

Lookout 915

Lookout 925

Lookout 925

Lookout 930

Lookout 930

Lookout 935

Lookout 935

Lookout 940

Lookout 940

Lookout 945

Lookout 945

Lookout 950

Lookout 950

Concept
HOW DO I DESIGN A PARK WHERE THE PUBLIC CAN HAVE AN EDUCATIONAL EXPERIENCE AS WELL AS BE SAFE FROM TOXINS LEFT IN THE AREA?

- WETLAND SEDIMENTATION
- IMPROVING SOIL/WATER QUALITY [GOAL 1]
- PHYTOREMEDIATION TECHNIQUES
  - PLANTING ELEVATIONS [GOAL 2]
- BENEFIT TO ARDEN HILLS
- BALANCE TO ECOLOGY