Stormwater Management/Bioswale Design

A Forest Preserve District of Cook County/Illinois Tollway Cooperative Solution

Huff&Huff
incorporated

Today's Challenge:

- *Implement Stormwater BMPs for linear projects, i.e. roads and streets*

Ownership of U.S. Highways, 2002

Organization	% of Total Miles
State Highway Agencies	19.5
County	44.7
Town/City	31.0
Other	1.7
Federal Agency	3.0
Total	100

BMP Examples

- *Infiltration Trenches*
- *Infiltration Basins*
- *Bioswales*
- *Grass Filter*

Infiltration Trenches

Infiltration Basin

Grass Lined Swale

What is a bioswale ?
How is it different from a ditch?

Ditches

- Collect and transport water away from site as quickly as possible.

Bioswale is different by design and function

- *Transport water at reduced velocity*
- *Designed to reduce pollutants*
  - *Infiltration*
  - *Biological conversion*
  - *Vegetative uptake*
  - *Natural flocculation*

Bioswale Benefits

- Improved vegetation – native vs. exotic
- Enhanced water quality through infiltration
- Reduced Runoff Velocity
- Aesthetics

Examples of Bioswales

- *Illinois Tollway – 294 North - Proposed*
- *Prairie Parkway - Proposed*
- *Miller Brewing Milwaukee - Existing*

I-294 Bioswales - Illinois Tollway

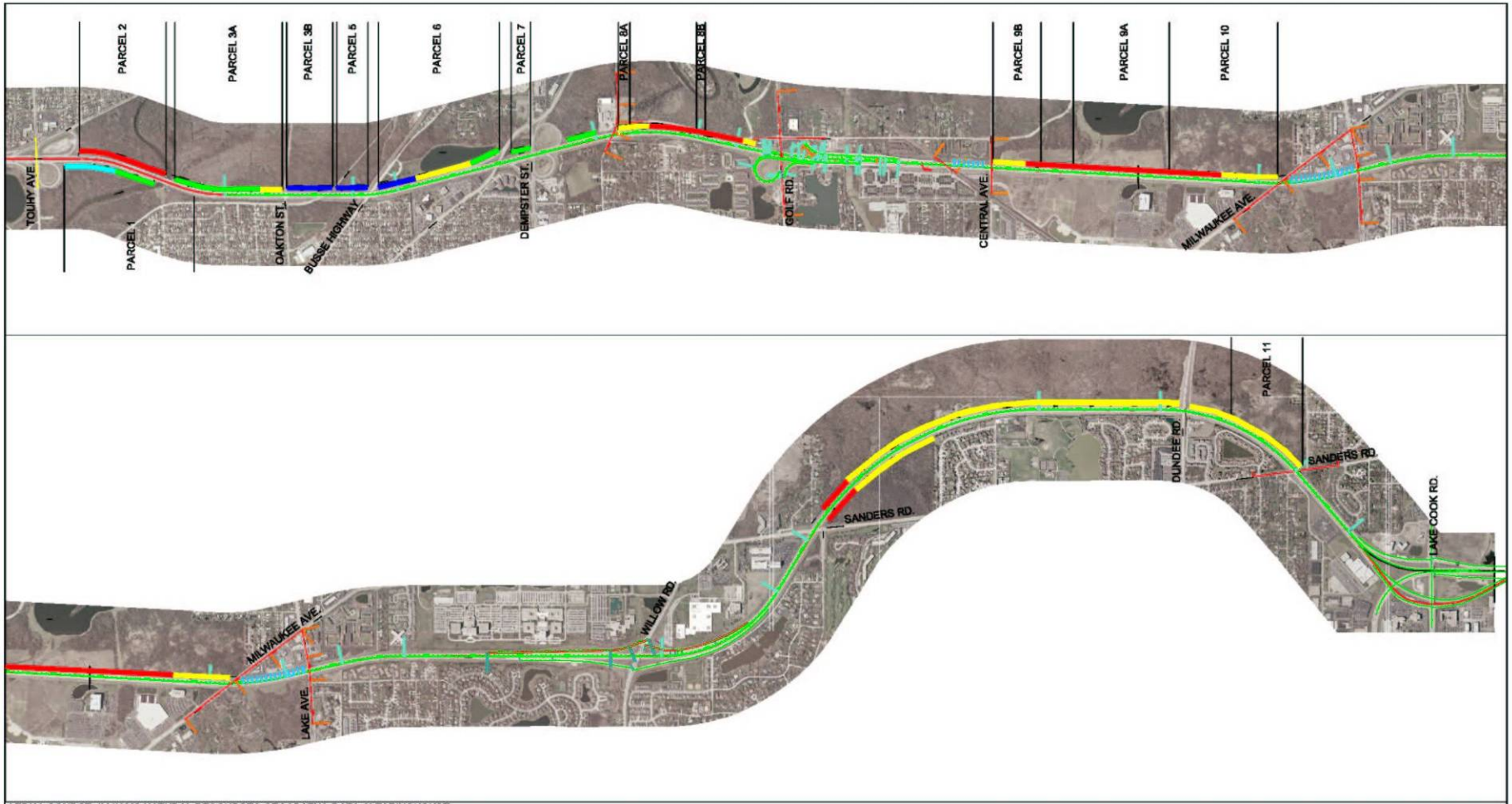
Stakeholders

- -Illinois Tollway
- -Forest Preserve District of Cook County (FPDCC)
- -Friends of the Forest Preserve
- -Openlands Project
- -Friends of the Parks
- -Cook County Board
- -USACOE
- -US Fish & Wildlife Service
- -Illinois Department of Natural Resources
- -Illinois Natural History Survey

I-294 Bioswales - Illinois Tollway

Stormwater runoff issues

- Roadway Pollutants
- FPDCC Concerns of Roadway Runoff -directly onto their sites.
- IDNR – Water Quality Concerns for Streams
- Reduce Runoff
- Vegetative Diversity



AERIAL SOURCE: ILLINOIS NATURAL RESOURCES GEOSPATIAL DATA CLEARINGHOUSE

N

2000' 0 2000'

- FOREST PRESERVE LIMIT
- BIOSWALE TYPE A
- BIOSWALE TYPE B
- BIOSWALE TYPE C
- BIOSWALE TYPE D
- BIOSWALE TYPE E
- BIOSWALE TYPE F

BIOSWALE CONCEPT
FOREST PRESERVE DISTRICT
OF COOK COUNTY

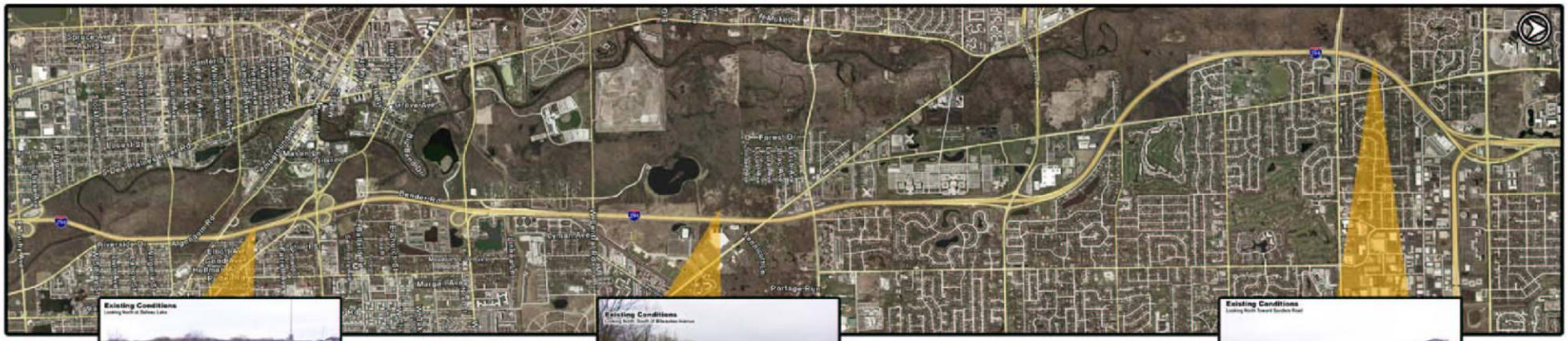
Illinois Tollway
Open Roads for a Faster Future

I-294 Bioswales - Illinois Tollway

Site Visit

I-294 Bioswales - Illinois Tollway

Site Visit



Illinois Tollway
Open Roads for a Faster Future

Hoff & Huff

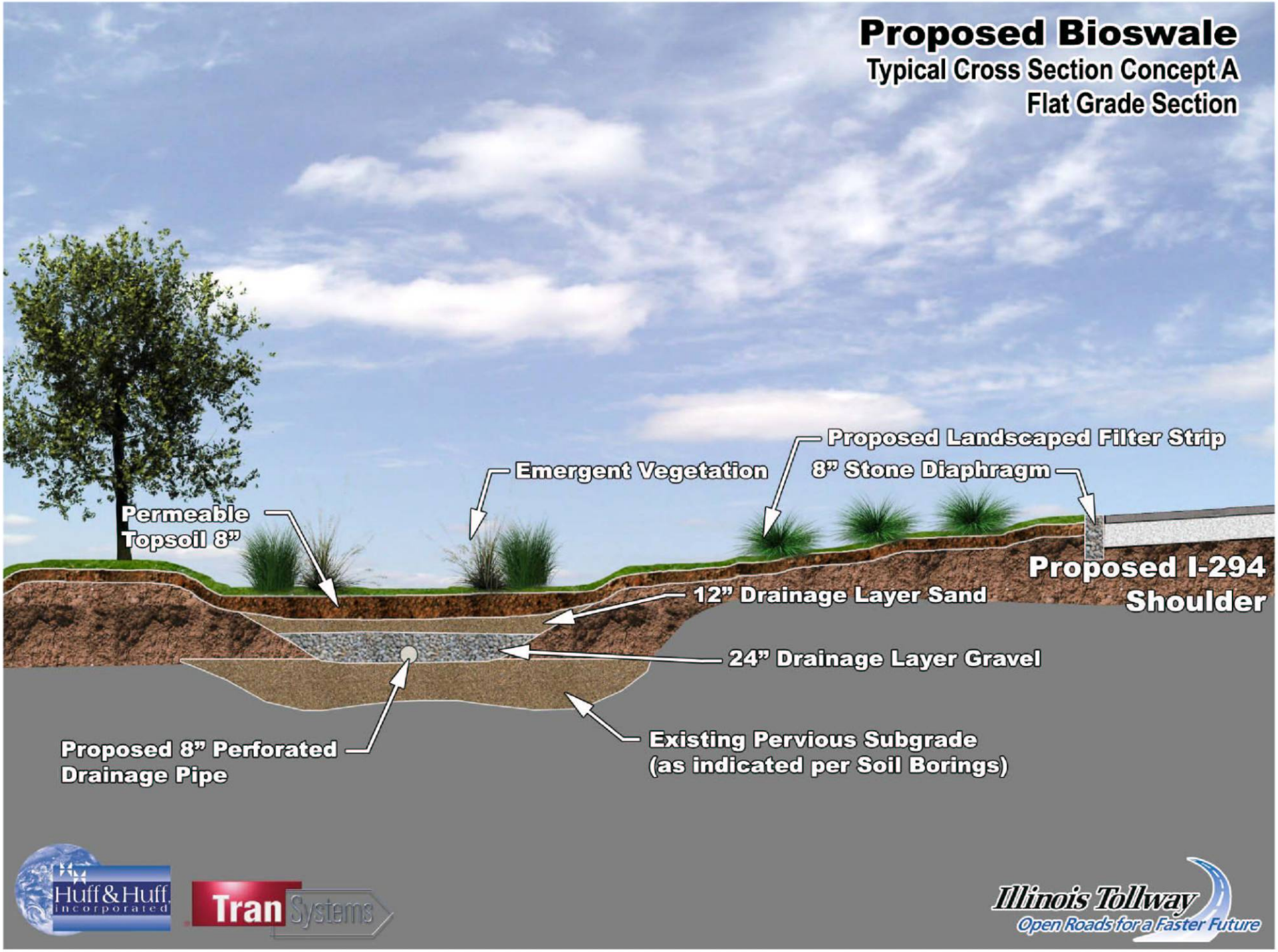
TranSystems

Forest Preserve District of Cook County - Bioswale Concept

May 2007
Conceptual - For Discussion Purposes Only

Bioswale Summary

Concept	Length, ft
A	6,100
B	3,600
C	3,950
D	4,450
E	6,600
F	1,350
G	1,400
H	3,550
Total	31,000


Proposed Bioswale
Typical Cross Section Concept A
Flat Grade Section
Proposed Landscaped Filter Strip
8" Stone Diaphragm
Emergent Vegetation
Permeable
Topsoil 8"
Proposed I-294
Shoulder
12" Drainage Layer Sand
24" Drainage Layer Gravel
Proposed 8" Perforated
Drainage Pipe
Existing Pervious Subgrade
(as indicated per Soil Borings)
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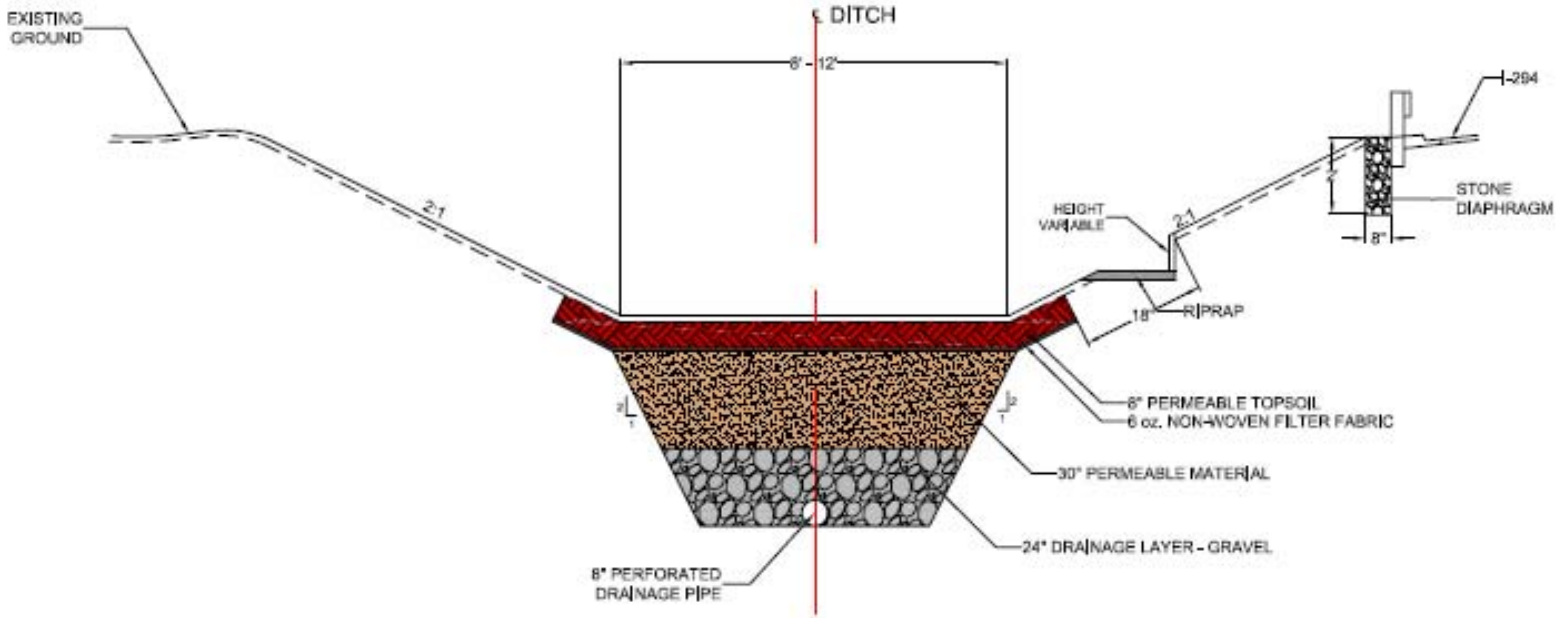
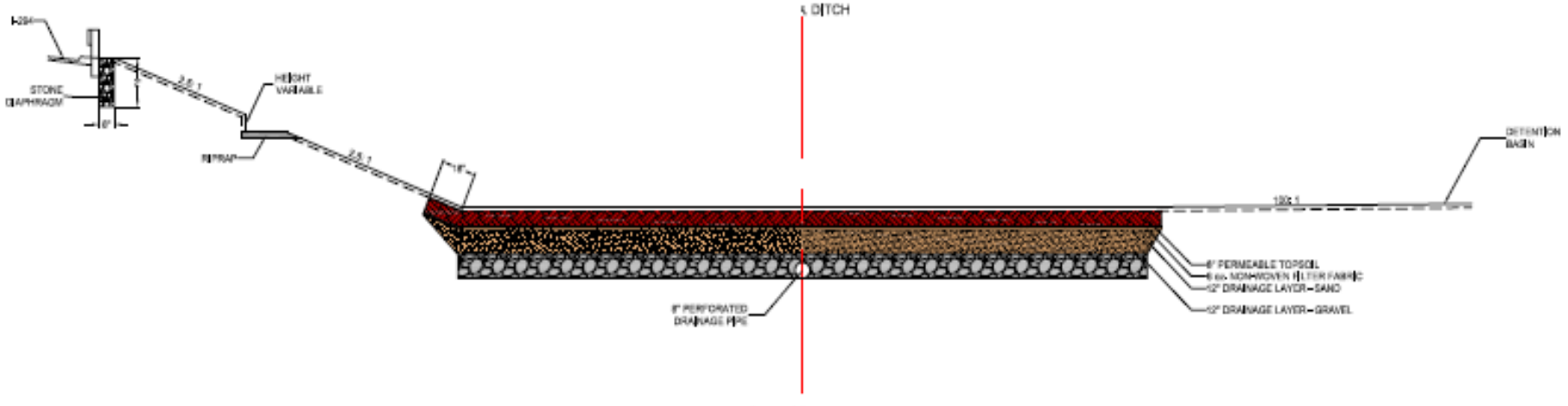
Illinois Tollway
Open Roads for a Faster Future



TYPICAL BIOSWALE - TYPE C
RETAINING DITCH GRADE SECTION
LEFT OFFSET
NOT TO SCALE



TYPICAL BIOSWALE - TYPE D
SHALLOW SWALE NEAR DES PLAINES RIVER & DETENTION POND
RIGHT OFFSET
NOT TO SCALE

Plant List

Bioswales

Species	Salinity tolerance	Siltation Tolerance	Notes
Agropyron elongatum	High	No data	
Alisma subcordatum	Moderate	High	
Aster lanceolatus	Moderate	High	
Bidens cernua	Low to moderate	Moderate to high	
Bidens frondosa	Moderate to high	High	
			* species currently being engineered for extreme salt tolerance
*Bouteloua hirsuta**	High	No data	
Carex stipata	Low to moderate	Moderate	
Carex vulpinoidea	Low to moderate	Moderate	
Eleocharis obtusa	Low to moderate	Low	
Elymus canadensis	Moderate	No data	
Elytrigia smithii	High	No data	
Helianthus grosseserratus	Moderate	Moderate	
Panicum virgatum	Moderate	Low to moderate	
Schizachyrium scoparium	High	No data	
Scirpus acutus	Moderate to high	Low to moderate	
Scirpus americanus	High	Low to moderate	
Scirpus fluvatilis	Low to moderate	High	
Scirpus tabernaemontani	Low to moderate	Moderate	
Spartina pectinata	Low to moderate	Moderate	
Verbena hastata	Moderate to high	Moderate to high	

Other species of note

Eleocharis erythropoda
Solidago sempervirens
Juncus effusus

Trees and Shrubs

Acer saccharinum	Low	
Acer pseudoplatanus	Low	
Celtis occidentalis	Moderate	Low to moderate
Cephalanthus occidentalis	Moderate to high	Moderate
Salix amygdaloides	Moderate	Low to moderate
Salix discolor	Moderate	Low to moderate

Slope vegetation/Filter strip
Tollway Salt Tolerant Seed Mix
Alta Fescue
Fults Pucinnellia Distans
Scaldis Hard Fescue
Dawson Red Fescue
Perennial Ryegrass

Maintenance of Bioswales

- Tollway responsible for perpetual maintenance
- Monitoring data used to develop annual report
- IGA with Forest Preserve District of Cook County
  - Annual review first 10 years
  - Bi-annual review after 10 years
  - Ensure plan is effective and compatible with adjacent natural resources

- Maintenance may include: burning, spraying, mowing cycles, mowing methods, seeding, clearing, species management, etc.

Bioswale Monitoring

- *The Tollway retained Illinois State Geological Survey and the University of Illinois to monitor bioswales.*
- *The Tollway is coordinating with the FPDCC to evaluate data and modify the BMP as necessary.*
- *Baseline (2007/08) monitoring is occurring for groundwater (three monitoring wells) and surface water (two bioswale concept points).*

Bioswale Performance Criteria

How to Assess Performance of Bioswale ?

Pollutant removal ?

Vegetation ?

Site Inspection ?

Table 1

Average values for constituents of highway runoff (Barret, et al., 1994).

Constituent	***Concentration (mg/L)***
SOLIDS	
Total	*437 – 1147*
Suspended	*45 – 798*
Volatile, suspended	*4.3 – 79*
Volatile, total	*57 – 242*
METALS	
Zinc	*0.056 – 0.929*
Cadmium	*0.0 – 0.04*
Nickel	*0.053*
Copper	*0.022 – 7.033*
Iron	*2.429 – 10.3*
Lead	*0.073 – 1.78*
Chromium	*0.00 – 0.04*
Magnesium	*1.062*
Mercury	*3.22*
NUTRIENTS	
Nitrate and Nitrate Nitrogen	*0.15 – 1.636*
Total Kjeldahl Nitrogen	*0.335 – 55.0*
Total Phosphorus	*0.113 – 0.998*
MISCELLANEOUS	
Chemical Oxygen Demand	*14.7 – 272*
Biological Oxygen Demand (5 day)	*12.7 – 37*
Oil and Grease	*2.7 – 27*

Pollutant Removal Efficiencies

California Stormwater Quality Association

Evaluation of 10 projects (1981-2002)

- Grassed channel (conventional) and wet/dry swales

Effective in removing:

- Total suspended solids
- Metals
- Oil and grease
- Organics

Effectiveness depends on maintenance

- Plant material
- Swale structure/integrity

TYPICAL POLLUTANT EFFICIENCIES OF BIOSWALES
(200 ft in length)

Parameter	Per Cent Removal
Total Suspended Solids	83 to 92
Turbidity	65
Lead	67
Copper	46
Total Phosphorus	29 to 80
Total Zinc	63
Oil & Grease	75
Nitrate	39 to 89

Source: State of Oregon DEQ

Alternatives to Pollutant Monitoring

1) *Sediment Sampling*
2) *Biological Sampling*
3) *Visual Inspections*

Vegetation Performance Standards

- *Performance standards*
- *The following species should not be the five most dominant plant species in the overall vegetative cover:*

- Teasel
- Purple loosestrife
- Non-native thistle
- Sweet clover
- Crown vetch
- Wild parsnip
- Garlic mustard
- Ragweed
- Kentucky bluegrass
- Buckthorn
- Sandbar willow
- Honeysuckle
- Multiflora rose
- Box elder
- Reed canary grass
- Common reed

Vegetation Performance Standards

- Acceptable species native to the region and not invasive as identified in the Native Plant Guide shall provide at least two-thirds of the coverage.
- The goals for permanent species planted in seed form:
  - 25 per cent in the second growing season surviving
  - 50 per cent in the third growing season surviving
  - long term goal would be to sustain 50 per cent of the permanent species.
- The goals for species planted as plugs, root stock, and tubers will be:
  - 50 per cent of the individuals planted surviving
  - 50 per cent of the species planted would survive the first growing season
  - all subsequent growing seasons, 50 per cent of the planted plugs, root stock, and tubers species will persist in the second growing season.

Vegetation Monitoring

- Vegetation sampling will occur at each bioswale during the prescribed monitoring period:
  - sampling will be conducted in one-meter square quadrats
  - focus of the vegetation component sampling will be on overall plant density
  - achieve at least 90% or better coverage density in the quadrats
- During the first two years of operation, the site will be inspected monthly with the exception of winter primarily to assess the vegetative component of the bioswales.
- To minimize weedy growth, high mowing of the vegetation will occur. After two years it is anticipated that the desired plant community will be established.

Vegetation Maintenance

- Sections that do not meet the performance standards will be re-seeded.
- Areas that were planted with plugs or tubers will have additional plugs or tubers installed when performance standards are not met.
- When invasive herbaceous plants are observed in the bioswale in exceedance of the performance standards they will be herbicided.
- Mowing will occur only in the first two years while the desired plant community becomes established.

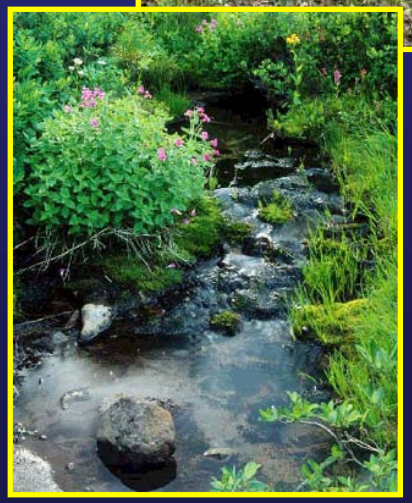
Vegetation Maintenance

- If soil pH falls below 6, lime will be spread to raise the soil pH.
- After the establishment of the native plant community in the bioswale, periodic burning will be conducted on a three year cycle to reduce the spread of invasive species.
  - Burning will be limited to the native plant community.
  - The roadway embankment, planted with Tollway salt tolerant species, will not be burned due to this community's lack of tolerance of fire.
  - Prescribed burning will be conducted by a certified contractor under certain conditions to prevent visibility issues on the highway and to prevent spread into the forested community adjacent to the bioswale.

Visual Inspections

- *Sediment Accumulation*
- *Debris Removal*
- *Ponding of Water in Swales*
- *Slope Stability*
- *Areas of Erosion*
- *Vegetative Density & Cover*

Presentations to Stakeholders



Concerns –

- Vegetation
- Maintenance
  - Controlled burns for vegetation
  - Clean outs/sediment traps
- Monitoring – Illinois Natural History Survey
- Pollutant Removal Efficiencies
- Tollway Commitments

Current Monitoring Efforts

- I-294 under construction
- Tollway secured Illinois State Geological Survey
- Four sites with pre-construction monitoring equipment
- ISGS downloads data every two weeks

Current Monitoring Efforts

Current Monitoring Efforts

Contract Plans and Constructability Issues

- Designers are currently developing contract plans for the bioswales.
- The Tollway continues to coordinate with the Forest Preserve staff, to review modifications from the concept plans.
- The bioswales are scheduled to be constructed in 2010, after mainline construction is completed.
- Bioswales will replace the temporary sediment/erosion control measures that the Tollway contractors have in place currently.
- Bioswale design is not meant to handle the sediment loads that are typical for an active construction site.

Contract Plans and Constructability Issues

- Due to delays in the bioswale/FPDCC agreement, the Tollway designers for the mainline proceeded with roadway contract plans that incorporated stormsewer for some bioswale sections.
- High embankment with steep slopes requires guardrails and stormsewers are preferred stormwater conveyance for steep sections.
- Bioswale contract plans will account for stormsewers. Outlets will discharge to bioswales. Scour protection at outfalls.
- Removal of furrow or pretreatment features on slope in stormsewer sections.


Proposed Bioswale
Typical Cross Section Concept B
Steep Grade Section
Proposed I-294
G-3 Gutter
2:1
Emergent Vegetation
Proposed Inlet
with Outfall
Permeable
Topsoil 8”
12” Drainage Layer Sand
24” Drainage Layer Gravel
Proposed 8” Perforated
Drainage Pipe
Existing Pervious Subgrade
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Contract Plans and Constructability Issues

- Drainage concerns of adjacent wetlands near Portwine Road. Plans must prevent continued draining of wetlands.
- Limited areas of more porous subsurface materials than anticipated – more heavy clays.
- More areas have existing high water table. As a result, underdrains not proposed for certain sections. Bioswales will act more as raingardens in these sections.
- Underdrains will not work for the areas near Des Plaines River.
- Meeting in January with FPDCC to obtain comments on modifications.

Conclusion

- *Bioswales Provide Benefits:*

- *Remove pollutants in stormwater*
- *Enhance ecology of drainage system*
- *Enhance water infiltration*

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