Green Stormwater Infrastructure at MnDOT
Land of 10,000 Lakes… Land of Sky Blue Waters

Introduction

Peter MacDonagh PLA, FASLA **MnDOT Green Infrastructure PM** **U of MN Adj Faculty**

DEPARTMENT OF TRANSPORTATION

mndot.gov/

What is Green Stormwater Infrastructure? Working Landscape
Slow It Down, Spread It Out, Soak It In…

Vegetation that serves a Transportation function

- Combinations of soil, plants, and engineered structures
- Uses natural processes to meet infrastructure needs
- Delivers environmental, economic, & social co-benefits

Chapter 12 of MnDOT Facility Design Guide: Infrastructure functions and added benefits

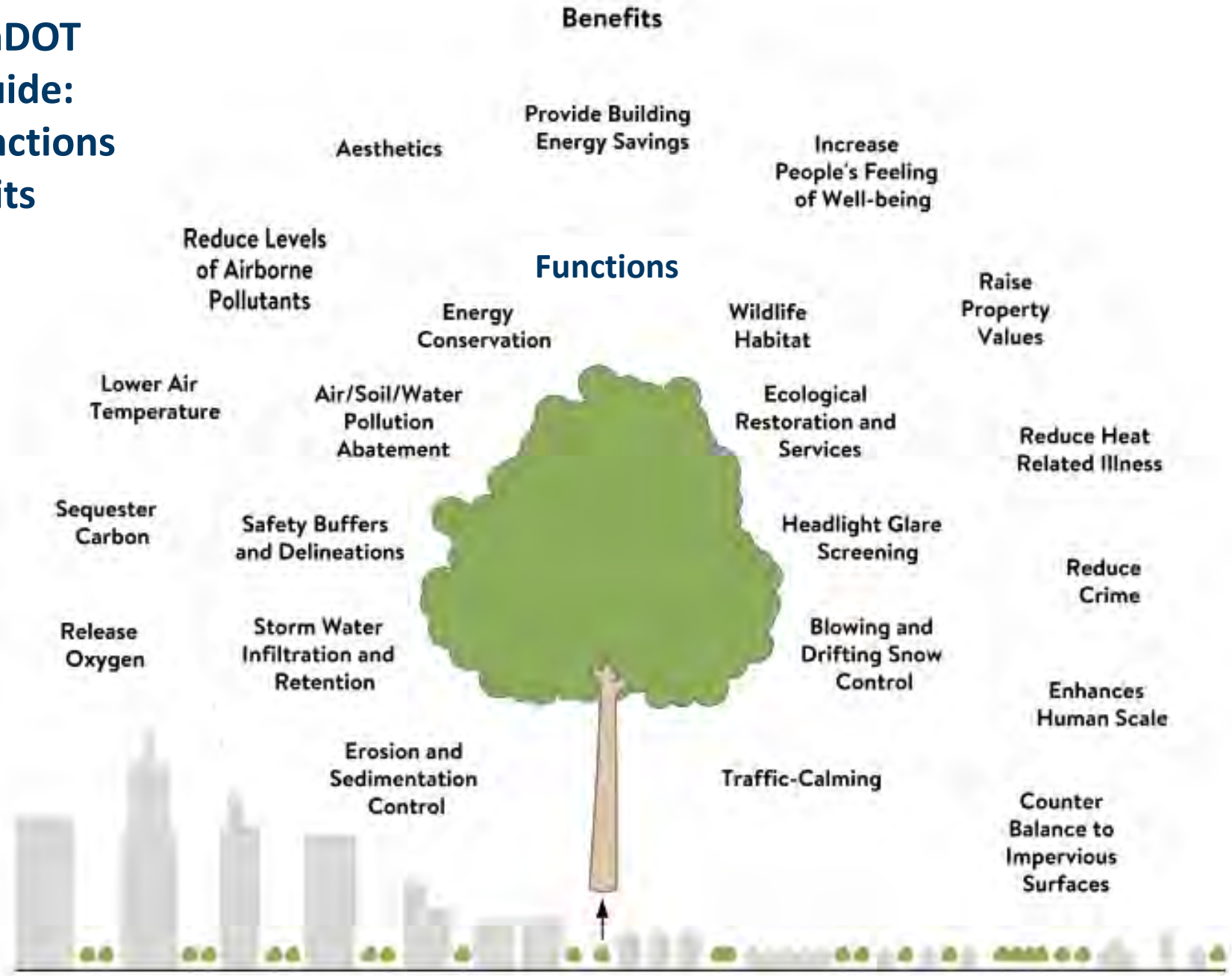
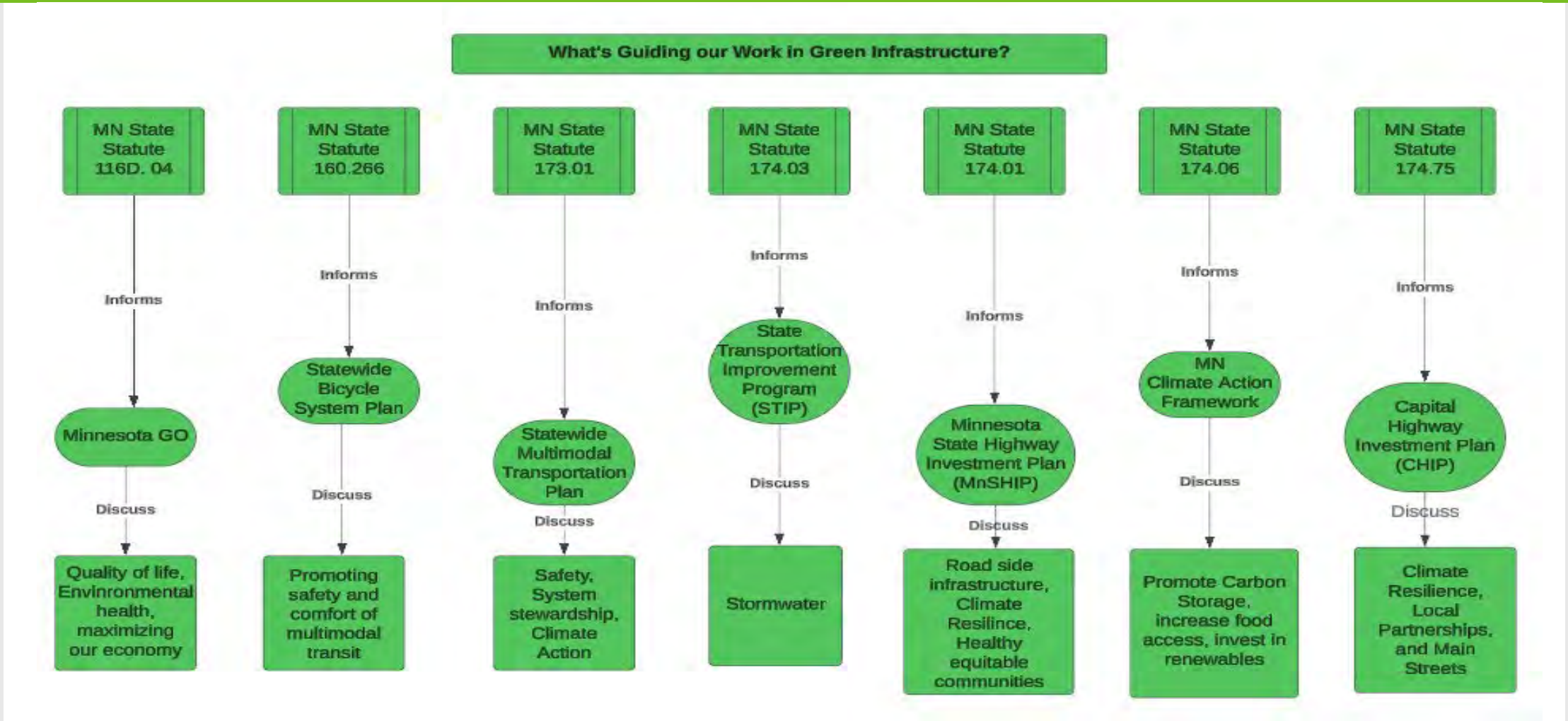


Illustration shows the engineering, environmental, social, and economic benefits of transportation landscape design.

Is MnDOT directed to invest in Green Infrastructure? Yes! Statutory & Policy Context



Transportation Statutes

§ 174.01, Subd. 2 – Transportation System Goals

§ 174.03 – Duties of the Commissioner of Transportation

§ 174.75 – Complete Streets

§ 160.266 – Bikeway Planning & Mississippi River Trail

- GI can help meet goals for:
  - safety, resilience, stormwater mgmt., & user appeal

Environmental Requirements

§ 116D.04 – Environmental Review (MEPA)

33 U.S.C. Clean Water Act

- § 1342 – NPDES Permits
- § 1344 - Section 404 Permits

General Permit 2004-0001 – MN Public Waters Work Permit

Executive Order 19-28– Pollinator Protection

- GI can help meet requirements:
  - Stormwater mgmt., stream restoration, habitat…

Plans & Policies

Statewide Multimodal Transportation Plan

Transportation Asset Mgmt Plan

MN Climate Action Framework

Strategic Highway Safety Plan

Complete Streets Policy

Pedestrian Plan & Bicycle Plan

Resilience Improvement Plan

Cost Participation Policy

- GI can help meet goals:
  - Safety, mobility, resilience, environmental protection

Environmental Requirements

- Stormwater Permits
- Watershed District Permits
- DNR Public Waters Permit
- USFWS Protected Species Requirements
- USCOE Stream Mitigation

Bioretention areas

Permeable pavements

Stormwater planter boxes

Vegetated riprap

Infiltration boulevards

Linear Green Infrastructure: It's the Law & MnDOT Has the Land

Roadside vegetation

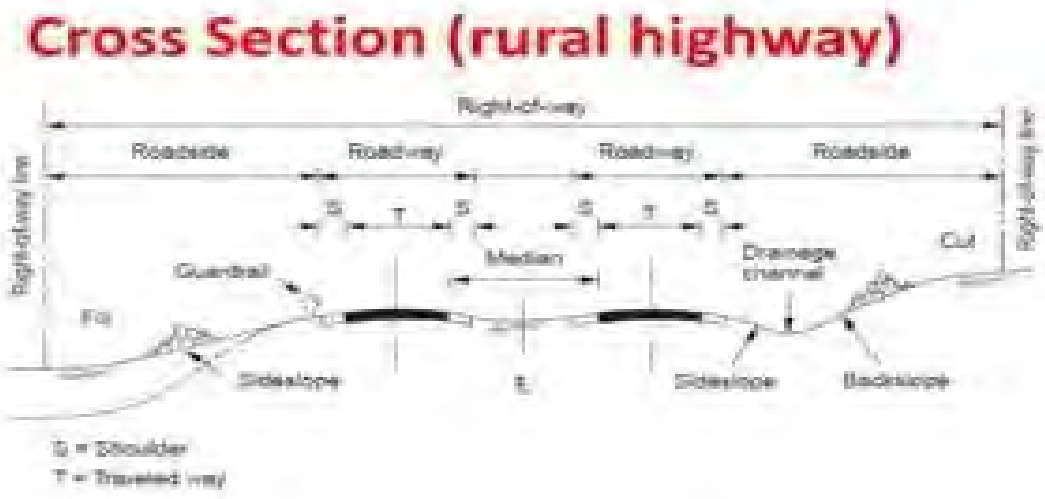
Stream stabilization

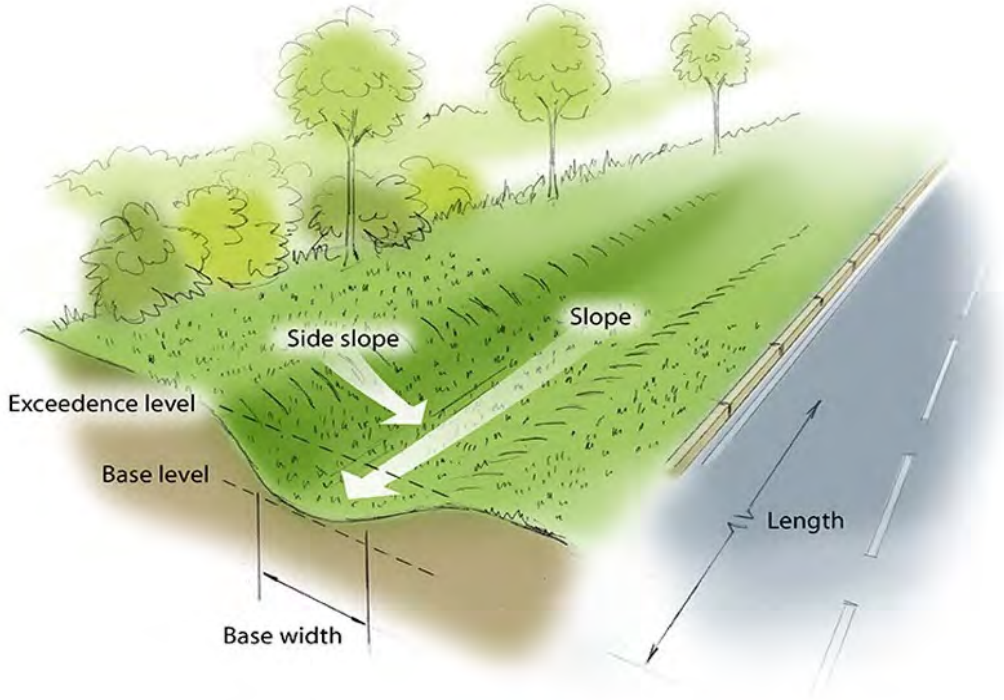
Landscape plantings

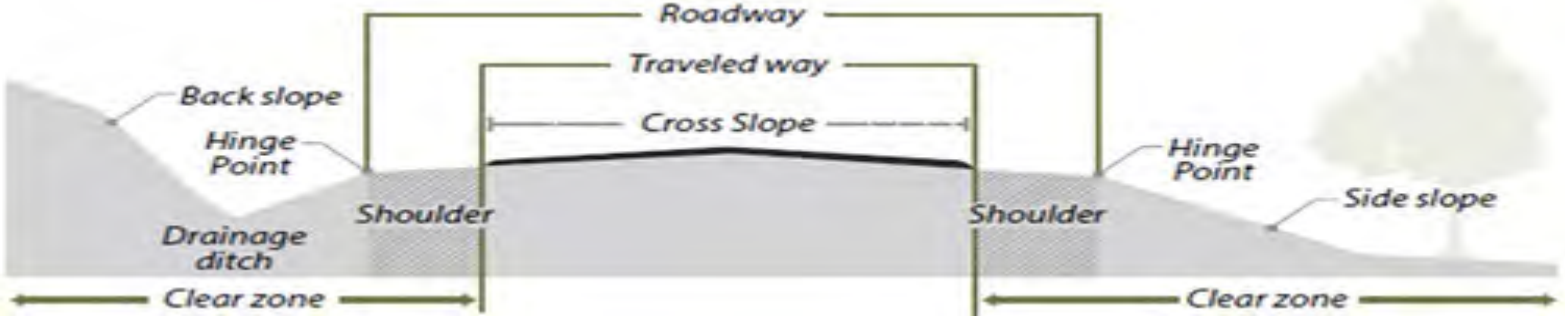
Green corridors

Living snow fences

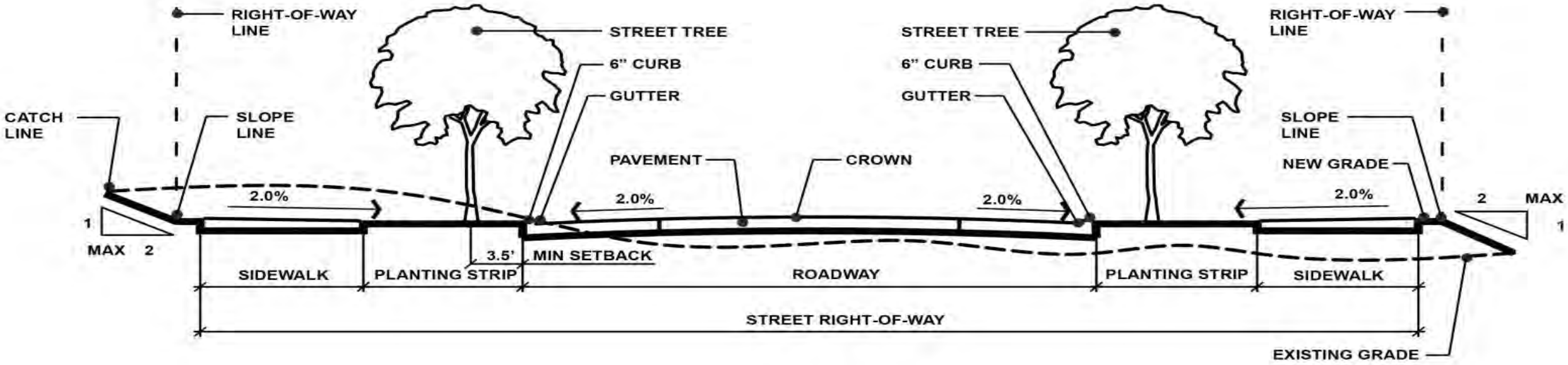
What & Where Can We Fit GSI/GI in Rural Linear ROW?







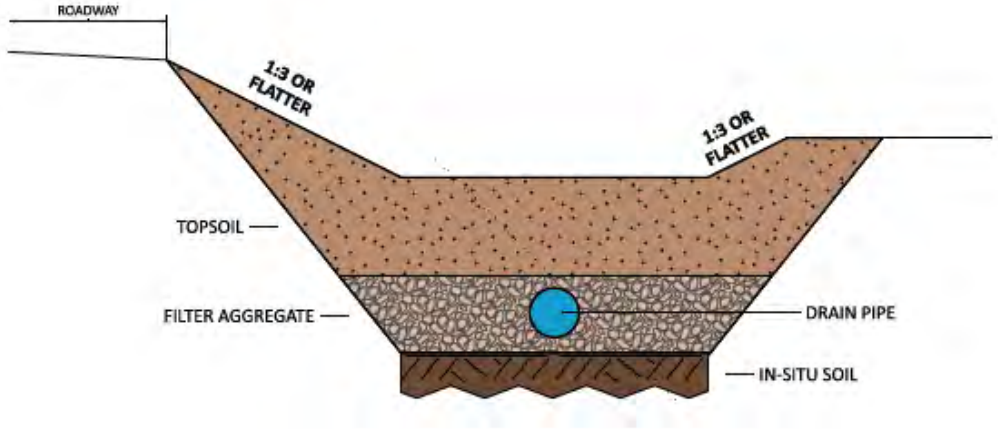
What & Where Can We Fit GSI/GI in Urban Linear ROW?

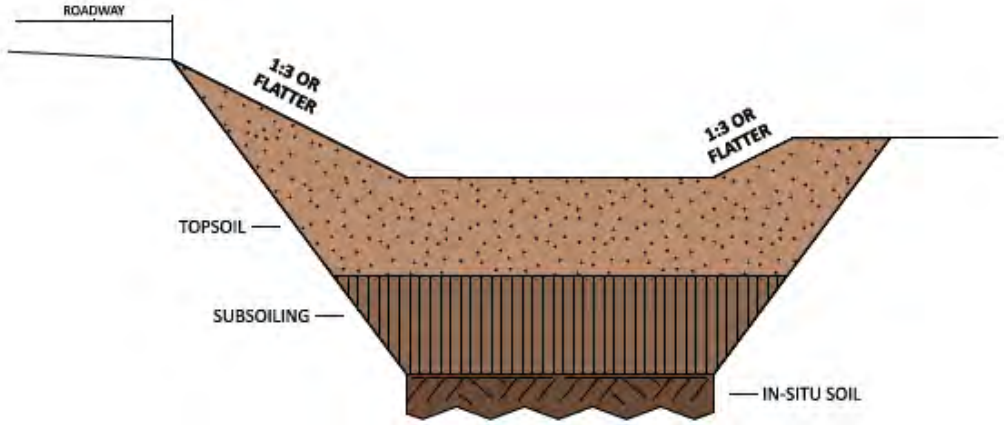


STANDARD DESIGN CROSS SECTION
NOT TO SCALE

Technical Advisory Committee Membership

Environmental Stewardship	Sustainability & Public Health	Transportation System Management	Land Management
Planning	Transit & Active Transportation	Design	Construction
Hydraulics	Project Management	Asset Management	Maintenance





GSI Tool Kits

Peter MacDonagh, PLA, GI PM - Office of Env Stewardship - Co-PM GSI MTK – Steve Gebauer PE

Young Env – Barr - Alliant

FACTSHEET EXAMPLE

Mini Forest

Photo from City of West Des Moines

Land Use: Urban or Rural

- Mini forests are areas 500 square feet to 1 acre of land that are planted densely with native vegetation to create habitat, improve biodiversity, and intercept stormwater. Vegetation includes trees, shrubs, and groundcovers.
- Mini forests are applicable for a variety of settings including creating a natural sound buffer to roadways.
- Urban forests have been shown to reduce air pollution, absorb particulate material, and lead to significant
- below-canopy air quality improvements.
- After becoming successfully established, mini forests require no watering or fertilizer applications and little to no long-term maintenance.

DEPARTMENT OF TRANSPORTATION

Green Stormwater Infrastructure Tool Kit —Practice Selection Fact Sheet

Suitability

Evaluate the suitability of the project site to accommodate the proposed best management practice (BMP). Mini forests should be located outside the clear zone of mainline trunk highways with posted speeds exceeding 55 mph.

Slope Stability/Erosion

Mini forests can be planted on sites with steep slopes depending on the vegetation choice. Once established, the plant roots will provide extra stability to the site.

Soil Compaction

Soil compaction will limit the ability of successful tree growth. Till and amend soil with organic matter for proper growth.

Groundwater Depth

Groundwater depth requirements vary based on tree species.

Presence of Karst

Mini forests can be used in active karst areas.

Contaminated Water or Soil

Areas may require removal of contaminated soil and redirection/pretreatment of contaminated water.

Wellhead Protection Areas

Mini forests can be used in wellhead protection areas.

Costs

Design Costs	◔
Construction Costs	◔
Operation & Maintenance Costs	◔

KEY= Describes unit cost per length/area/volume of BMP

◔ LOW ◑ MED ● HIGH

Practice Benefits

Stormwater Management

- ◔ Rate Control
- ◔ Volume Control
- ◑ Water Quality Improvement

Environmental

- ● Erosion Control
- ● Ecological Benefits
- ● Energy Savings
- ● Climate Resiliency
- ● Air Quality Improvement
- ● Heat Island Effect Reduction
- ● Noise Pollution Reduction
- ● Shade
- ● Aesthetic Value

Transportation

- ◑ Traffic Calming
- ● Active Transportation Comfort
- ● Multimodal Transportation
- ● Pedestrian Safety
- ◔ Vehicular Safety
- ● Safety Buffers
- ● Headlight Glare Screening
- ● Blowing and Drifting Snow Control

KEY= Describes the level of benefit

◔ LOW ◑ MED ● HIGH

LOW: Provides a single gray infrastructure benefit.
MED: Provides a blend of green and gray infrastructure benefits.
HIGH: Maximizes green infrastructure benefits.

Mini Forest

Siting Considerations

Soil Permeability
Mini forests are appropriate for any soil type, but trees may struggle to grow properly in the absence of loose soil with plenty of organic matter. Poor quality urban soils may require soil amendments or remediation for proper tree growth and establishment. Percent of organic matter in soil should be greater than 3.5% at a minimum and greater than 5% for optimal conditions.

Topography
Mini forests are adaptable to a range of topography, however flat or gentle slopes are ideal to provide good drainage and ease of maintenance. Steep slopes are prone to erosion and difficult to plant on but could be terraced to support trees.

Drainage Area Size
Not applicable.

Design Considerations

Sizing
There is no strict size limit, however the focus is on mimicking a natural ecosystem in a condensed area. Typically, the planting density ranges from 2 to 7 trees per square yard.

Pretreatment
No pretreatment is required.

Hydrology & Hydraulic/Water Quality Design
Sufficient supply of water will be required to sustain the desired vegetation within the mini forest. Trees can also transfer water to each other, increasing the climate resiliency of this practice.

Models for calculating stormwater management benefits include:

Hydrology and Hydraulics	Water Quality
• HydroCAD	• MIDS
• XPSWMM	• P8
• EPA SWMM	

Consider using the i-Tree tools developed by the USDA Forest Service for quantifying the environmental benefits of adding a mini forest.

Construction Considerations

- Stake the layout of the mini forest before beginning. Consider a diverse mix of trees, shrubs, and groundcover plants to create a layered mini ecosystem.

Constraints and Limitations

Space Limitations	• Mini forests can obstruct driver visibility when planted too close to intersections and along road curves. • Larger areas are preferred for maximum stormwater control and air quality benefits. • Mini forests should avoid future canopy conflicts with overhead utilities.
Regulatory Restrictions	• Vegetation management plans must account for health department codes regarding overgrown lots and safety concerns of the residents.
Common Causes of BMP Failure	• Poor plant selection or spacing. • Improper planting methods and neglecting water during establishment. • Poor soils (e.g., insufficient drainage and nutrients). • High road salt inputs can cause issues.

Inspections and Maintenance

- Frequent maintenance will be required for the first few years until desired, native trees and plants become established.
- Trimming and maintaining trees could pose a risk to workers and passing vehicles if access is too close to busy roads with high traffic volume.
- Maintain Clear Zone distances for all woody trunks or branches greater than 4-inches in diameter.

Short-Term Maintenance	Long-Term Maintenance
• Weed control. • Checking for ponding, erosion, or damage in areas where plants haven't established. • Replanting and replacement of dead plants. • Removal of trash/debris.	• Weed control. • Checking for healthy vegetation and addressing issues as needed. • Monitoring for infestations of invasive species.

Mini Forest Examples

The Miyawaki Method

Mini Forest – City of Paris, France

Additional Resources

- Urban Forest Company

Treatment Trains

Pair this practice with:
- Stormwater Ponds.
- Soil Bioengineering.

TOOLKIT EXAMPLE

CHAPTER 9
Mini Forests

Traditionally, MnDOT has sustained existing vegetation and installed new landscaping within its unpaved rights-of-way. Mini Forests, previously described as Mass Plantings by MnDOT, specified small woody stock, irregularly spaced to mimic natural densities of successional native tree and shrub groves, with an emphasis on trees. Successfully establishing and sustaining designed MnDOT Mass Plantings (Mini Forests) then and now, requires subsoiling to address compaction, incorporation of compost, and recreated forest floor duff, utilizing wood chip mulch. Trees formed the centers of these Mass Plantings with shrubs on the perimeter to achieve defined mown edges, and clear zone safety. In order to utilize Mini Forests for stormwater treatment, selecting locations where stormwater is already, or can be redirected into the forested area should be considered.

Chapter 9 Topics:

9A Designer Notes

9B Stormwater Treatment Credit

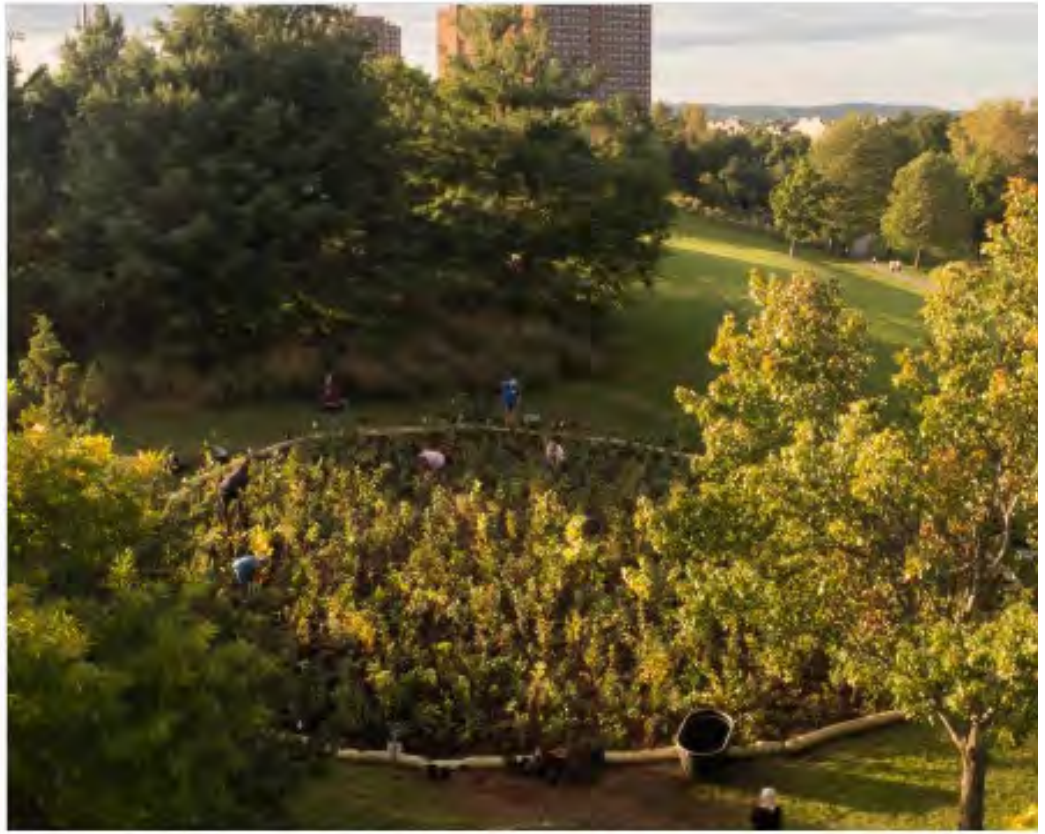
9C Specifications

9D Cost Estimating

9E Construction

9F Maintenance

- Benefits of Mini Forests
  - Slows down stormwater runoff
  - Spreads out to increase capture
  - Vegetation to soak up stormwater
  - Provides shade, habitat for wildlife, improved air quality, noise dampening, and better soil health.



Volunteers planting trees and shrubs in a new Mini Forest in Danehy Park, North Cambridge, Massachusetts. *Photo courtesy of sugiproject.com*

Exhibit 9-2

3 Years Post Planting Cambridge, MA

~3,000 square feet in area; less than 1/10th of an acre in size.

Photo courtesy of sugiproject.com

Exhibit 9-3

Inspection 3 years after planting Cambridge, MA

Note: Interpretive Sign and 8 to 10 foot tall Sumac in left foreground with 3 years of growth.

Photo courtesy of sugiproject.com

9.A.4 Design Elements

9.A.4.1 Vegetation

A—Vegetation planted on site must be native to the area. This is how Mini Forests become self-sustainable 2-3 year after planting. Native trees and woody vegetation are already accustomed to the soil properties and the rain amount needed to survive. Choose at least 5 different climax, tree species to plant, along with shrubs, pollinator plants, and other smaller native woody species. For the best results, have as many different native species planted as possible. This increases the biodiversity of the forest and will make it more resilient over time. Example target quantities of woody tree and shrub species per area are given in **Exhibit 9-4**.

Exhibit 9-4

Target Number of Tree and Shrub Species

Mini Forest Size (square feet)	Species
Less than 3,000	25
~ 5,000	35
~ 10,000	50
~20,000	65

9.A.4.2 Planting Density

A—The typical planting density for Mini Forests is 2-4 trees for every square yard. To put this into context, a Mini Forest that is ¼ an acre in area (21,780 square feet) will have about 5,000-10,000 trees that are initially planted. Some trees will die out, but this is to be expected. All of those plantings are still a crucial part of developing a Mini Forest.

B—In addition to trees, smaller plants like shrubs, pollinator plants, and other small woody species can be included in the Mini Forest. Plants that require more sunlight can be placed on the edges of the Mini Forest. These smaller plants don't have a set planting density, but are simply planted where they can fit. Mini Forest ratio of tree species to shrub species will vary from 4:1 to 8:1. Saturating the remaining area with seeding as well can help ensure successful plant establishment.

9.A.4.3 Soil

A—The soil must be loosened to improve moisture infiltration and root growth. Test the existing soil for tree growth suitability and amend existing soil to improve the quality. Soil compaction must be less than 200 psi; optimum rates are ~100 psi. Soil organic matter percentages should be 3.5% to 5%. Planting Soil Preparation with a spading machine as seen in MnDOT Standard Planting Details 2571.3D meets this criteria. Large quantities of compost can be worked into the soil to improve moisture uptake and provide nutrients. MnDOT Grade #2 Compost meets this criteria.

9.A.4.4 Mulch

A—Hardwood mulch is an important component because it provides the functions of a natural forest flow including preventing erosion, raindrop interception, suppressing weeds, retaining moisture, and enriching the soil. MnDOT Type #6 Mulch meets this criteria.

9.A.5 Plant Establishment Period

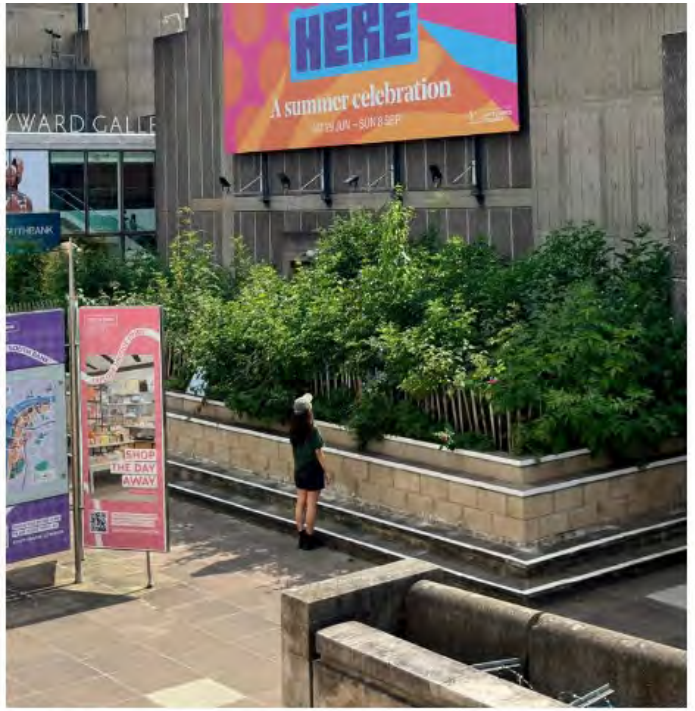
A—A - MnDOTs Landscape Project contracts for Certified Landscape Contractors include a Plant Establishment Period (PEP: Chapter 5) of two years after Initial Planting Operations (IPO: Chapter 4) are completed by the contractor. In many cases, this 2-year long PEP will meet the important establishment criteria for Mini Forests. In cases where additional maintenance of that specific Mini Forest is needed beyond the length of the standard 2-year PEP; then a defined scope, short-term Negotiated Maintenance Contract (NMC) can be entered into with the contractor to complete that specific landscape maintenance for that Mini Forest.

9B STORMWATER TREATMENT CREDIT

A—While stormwater treatment credits will vary greatly, there are some common benefits of Mini Forests that can be applied.

1. Stormwater Storage
   a. Stormwater that runs off from developed areas into the Mini Forests that is contained in the Mini Forest is stormwater volume control.
2. Infiltration
   a. Stormwater that infiltrated into the native soils is considered 100% treated.
3. Tree preservation/growth
   a. Some cities and counties provide benefits for preserving or planting trees.

Photos courtesy of Sugi Forest Project



Note that limited total soil volumes per each woody plant within raised planter will greatly reduce the ultimate mature heights of trees and shrubs in this Mini Forest.

9C SPECIFICATIONS

9.C.1 MnDOT Pay Items

A—Typical pay items used to develop Mini Forests include the following:

Exhibit 9-7

Soil Preparation

Item Number	Description	Unit
2574.505/00010	SUBSOILING	ACRE
2574.505/00020	SOIL BED PREPARATION	ACRE
2574.507/00110	COMPOST GRADE 2	CU YD

Exhibit 9-8

Plantings

Item Number	Description	Unit
2571.502/01012	CONIFEROUS TREE 12" HT SEEDLING	EACH
2571.502/06012	DECIDUOUS TREE 12" HT SEEDLING	EACH
2571.502/13012	ORNAMENTAL TREE 12" HT SEEDLING	EACH
2571.502/37002	DECIDUOUS SHRUB NO 2 CONT	EACH
2571.502/71030	PERENNIAL PLUGS	EACH
2571.502/72400	PERENNIAL 4" CONT	EACH
2571.502/73001	PERENNIAL NO 1 CONT	EACH

Exhibit 9-9

Erosion Control and Turf Establishment

Item Number	Description	Unit
2572.503/00020	TEMPORARY FENCE	LIN FT
2575.504/003XX	ROLLED EROSION PREVENTION CATEGORY 10-47 & 57	SQ YD
2575.507/00060	MULCH MATERIAL TYPE 6	CU YD

9D COST ESTIMATING

9.D.1 Planning Level Estimate

A—The planning level cost estimate below is useful at early stages of design when the details of the design have not been determined. It provides an approximation to determine if the GSI practice is suitable for the site and project.

B—Mini Forests cost about $60-90 per square foot to plant depending on the scale and vegetation used. There will be maintenance costs in the first two years for watering, weeding and inspections, but the forest are largely self-sustainable after 2-3 years, lowering long term maintenance costs.

9.D.2 Detailed Cost Estimate Example

A—This is an example showing the process for cost estimating a Mini Forest. Each project's design will vary from this example.

B—These are the design parameters for the site example:

1. Forest area of 1,000 square feet.
2. Subsoiling will be done to 18 inches to improve infiltration on site, incorporating compost.
3. A total of 340 tree seedlings will be planted to meet planting density goals of 2-4 trees per square yard.
4. After planting, apply 2 inches MnDOT Mulch Material Type 6.
5. Native seed mix shall be seeded in all areas without mulch to help slow the flow of runoff and increase biodiversity.
6. If slopes are disturbed during construction, additional erosion control measures may be required.

C—These are notes for the designer to consider when cost estimating Mini Forests.

1. When added as a retrofit or replacement to old stormwater practices, there needs to be special attention placed on any runoff or sediment discharge during construction.
2. The largest cost in implementing Mini Forests are the trees. When possible, plant the trees as seedlings instead of larger options to drastically reduce costs.
3. A variety of tree species should be included.

D—Below is the detailed cost estimate for this design. All costs listed are based off of the Average Bid Price, 2024.

Exhibit 9-11

Mini Forest Cost Calculations based on 2024 Average Bid Costs

Item	Pay Item	Quantity	Unit	Cost/Unit	Total Cost
Subsoiling	2574.505/00010	0.03	ACRE	$5,000.00	$150.00
Soil Bed Preparation	2574.505/00020	0.03	ACRE	$2,000.00	$60.00
Compost Grade 2	2574.507/00110	3	CU YD	$35.00	$105.00
Deciduous Tree 12" HT Seedling	2571.502/06012	100	EACH	$240.00	$24,000.00
Coniferous Tree 12" HT Seedling	2571.502/01012	100	EACH	$250.00	$25,000.00
Seed Southern Shortgrass Roadside	2575.608/25170	15	LB	$50.00	$750.00
Temporary Fence	2572.503/00020	130	LIN FT	$5.50	$715.00
Mulch Material Type 6	2575.507/00060	6	CU YD	$79.50	$477.00
Total Cost					$51,257.00

(1) All Costs based on Average Bid Price, 2024

9E CONSTRUCTION

9.E.1 Soils and Construction Notes

A—The following should be added to the Soils & Construction Notes in the plans:

1. STOCKPILING MATERIALS AND OPERATING HEAVY EQUIPMENT ARE PROHIBITED WITHIN Mini Forests.

Exhibit 9-12

Construction Inspection Checklist

Project: Location:

Inspection Item	Satisfactory?	Comments
1. Pre-Construction Meeting		
Date:		Inspector:
Discuss sequence of activities		
2. Pre-Construction		
Date:		Inspector:
Runoff diverted from site		
3. Vegetation and Erosion Control		
Date:		Inspector:
Topsoil composition and elevation to specifications		
Soil beds are free of weeds		
Erosion Control 8" fiber rolls established along perimeter		
Seeding/plantings installed per plans and specifications		
If planted, all plants and trees are in healthy condition		
Soil properly stabilized for permanent erosion control		
4. Final Inspection		
Date:		Inspector:
70% vegetative cover		
Pre-treatment operational		
Construction generated sediments removed		
Runoff diversion removed		

9F MAINTENANCE

9.F.1 Maintenance Overview

A—Mini Forest Maintenance Quick Facts

1. Mini Forests will need to be horticulturally maintained for the first 2-3 years while becoming established. Specific maintenance needs include:
   a. Weeding
   b. Watering
   c. Mulching
   d. Removing litter
   e. Material or vegetation replacement if needed
2. Weeding the forest for the first 2-3 years is required. Afterwards, the trees will create enough shade to reduce weeding. Invasive woody weeds (Buckthorn, Asian Honeysuckle) must continue to be controlled on a 2-3 year cycle.
3. Maintenance will be greatly reduced after the first 2-3 years.
4. Never remove the mulch or organic matter from the woodland floor, only amend with Type 6 Mulch to maintain 6 inch mulch depth.
5. Never cut or prune plants, except for a maintained border if required.
6. Approved MnDOT herbicides may be applied by a Minnesota Certified Applicator with wick or wiper or brush applicator on weeds within Mini Forest as needed.

9.F.2 Maintenance Inspection

A—Mini Forests require regular inspection and maintenance at first but will be largely self-sustainable 2-3 years after the initial planting. Schedule reactive maintenance when issues are identified to prevent damage. Pay particular attention to invasive woody weeds and watering issues during drought conditions. Inspection is recommended at the following intervals for the first 2-3 years:

1. Inspect every other month during the growing season (March, April, May, June, July, August, September, October).

Exhibit 9-13

Stormwater Facility Maintenance Inspection Form

Facility Type: _____ TAMS ID: _____

Construction End Date: _____ Roadway: _____

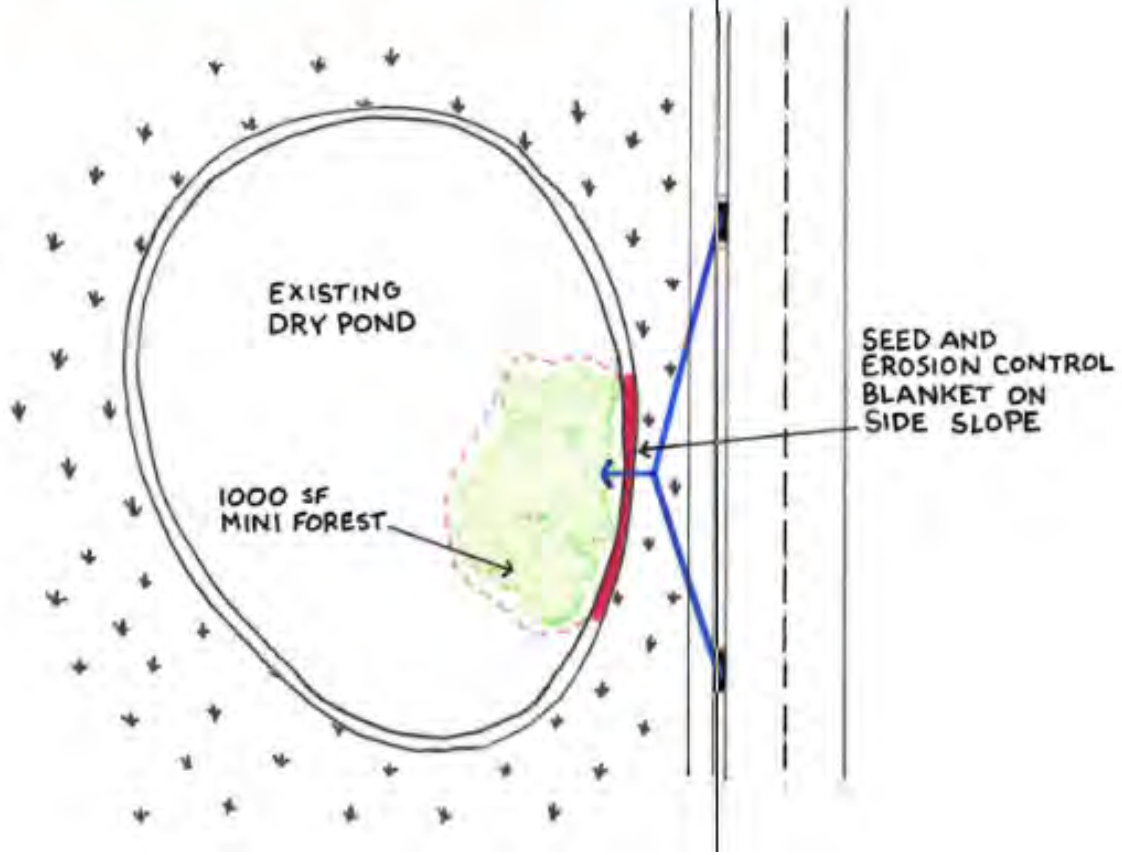
Inspection Date: _____ Reference Point: _____

Inspector Name: _____ Google Map URL: _____

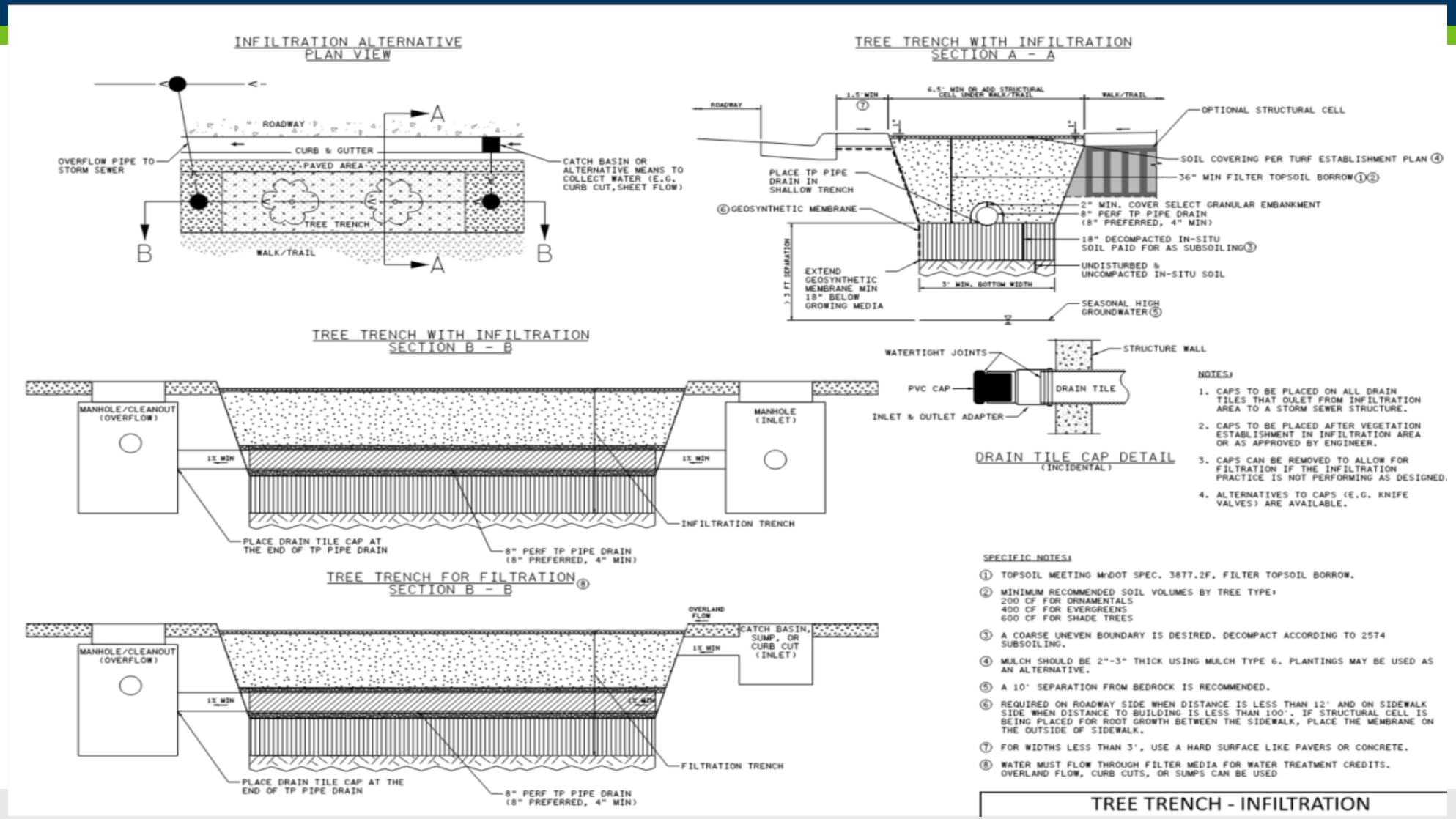
Inspection Activity	Yes	No	Comments	Maintenance Activity Code	Due Date for Maintenance
Is there erosion in the Mini Forest?					
Is there trash or debris?					
Are plants dead or diseased?					
Is there adequate mulch?					
Are there noxious weeds?					

Exhibit 9-10

Mini Forest Cost Estimate Example Sketch



Think of combining GSI Practices with existing BMPs or using GSI practices in series with each other.


INFILTRATION ALTERNATIVE
PLAN VIEW
ROADWAY
CURB & GUTTER
PAVED AREA
TREE TRENCH
WALK/TRAIL
OVERFLOW PIPE TO STORM SEWER
CATCH BASIN OR ALTERNATIVE MEANS TO COLLECT WATER (E.G. CURB CUT, SHEET FLOW)
A
B
TREE TRENCH WITH INFILTRATION
SECTION A - A
ROADWAY
1.5' MIN ⑦
6.5' MIN OR ADD STRUCTURAL CELL UNDER WALK/TRAIL
WALK/TRAIL
OPTIONAL STRUCTURAL CELL
SOIL COVERING PER TURF ESTABLISHMENT PLAN ④
36" MIN FILTER TOPSOIL BORROW①②
PLACE TP PIPE DRAIN IN SHALLOW TRENCH
⑥GEOSYNTHETIC MEMBRANE
2" MIN. COVER SELECT GRANULAR EMBANKMENT
8" PERF TP PIPE DRAIN
(8" PREFERRED, 4" MIN)
18" DECOMPACTED IN-SITU SOIL PAID FOR AS SUBSOILING③
UNDISTURBED & UNCOMPACTED IN-SITU SOIL
EXTEND GEOSYNTHETIC MEMBRANE MIN 18" BELOW GROWING MEDIA
≥3 FT SEPARATION
3' MIN. BOTTOM WIDTH
SEASONAL HIGH GROUNDWATER⑤
TREE TRENCH WITH INFILTRATION
SECTION B - B
MANHOLE/CLEANOUT (OVERFLOW)
MANHOLE (INLET)
1% MIN
INFILTRATION TRENCH
PLACE DRAIN TILE CAP AT THE END OF TP PIPE DRAIN
8" PERF TP PIPE DRAIN
(8" PREFERRED, 4" MIN)
TREE TRENCH FOR FILTRATION⑧
SECTION B - B
OVERLAND FLOW
CATCH BASIN, SUMP, OR CURB CUT (INLET)
MANHOLE/CLEANOUT (OVERFLOW)
1% MIN
FILTRATION TRENCH
PLACE DRAIN TILE CAP AT THE END OF TP PIPE DRAIN
8" PERF TP PIPE DRAIN
(8" PREFERRED, 4" MIN)
WATERTIGHT JOINTS
STRUCTURE WALL
PVC CAP
DRAIN TILE
INLET & OUTLET ADAPTER
DRAIN TILE CAP DETAIL
(INCIDENTAL)
NOTES:
1. CAPS TO BE PLACED ON ALL DRAIN TILES THAT OULET FROM INFILTRATION AREA TO A STORM SEWER STRUCTURE.
2. CAPS TO BE PLACED AFTER VEGETATION ESTABLISHMENT IN INFILTRATION AREA OR AS APPROVED BY ENGINEER.
3. CAPS CAN BE REMOVED TO ALLOW FOR FILTRATION IF THE INFILTRATION PRACTICE IS NOT PERFORMING AS DESIGNED.
4. ALTERNATIVES TO CAPS (E.G. KNIFE VALVES) ARE AVAILABLE.
SPECIFIC NOTES:
① TOPSOIL MEETING MnDOT SPEC. 3877.2F, FILTER TOPSOIL BORROW.
② MINIMUM RECOMMENDED SOIL VOLUMES BY TREE TYPE:
200 CF FOR ORNAMENTALS
400 CF FOR EVERGREENS
600 CF FOR SHADE TREES
③ A COARSE UNEVEN BOUNDARY IS DESIRED. DECOMPACT ACCORDING TO 2574 SUBSOILING.
④ MULCH SHOULD BE 2"-3" THICK USING MULCH TYPE 6. PLANTINGS MAY BE USED AS AN ALTERNATIVE.
⑤ A 10' SEPARATION FROM BEDROCK IS RECOMMENDED.
⑥ REQUIRED ON ROADWAY SIDE WHEN DISTANCE IS LESS THAN 12' AND ON SIDEWALK SIDE WHEN DISTANCE TO BUILDING IS LESS THAN 100'. IF STRUCTURAL CELL IS BEING PLACED FOR ROOT GROWTH BETWEEN THE SIDEWALK, PLACE THE MEMBRANE ON THE OUTSIDE OF SIDEWALK.
⑦ FOR WIDTHS LESS THAN 3', USE A HARD SURFACE LIKE PAVERS OR CONCRETE.
⑧ WATER MUST FLOW THROUGH FILTER MEDIA FOR WATER TREATMENT CREDITS. OVERLAND FLOW, CURB CUTS, OR SUMPS CAN BE USED
TREE TRENCH - INFILTRATION

Reminder on where GSI info is found

- https://www.dot.state.mn.us/environment/erosion/green-infrastructure.html

OR

- Google – MnDot Green Stormwater

Thank You!

Peter MacDonagh PLA (651) 391-0048

peter.macdonagh@state.mn.us

MnDOT Green Stormwater Infrastructure &

Green Infrastructure Work Group

RWMWD Clean Water Retrofit Program

DNR Monthly LGU Forum

June 17, 2026

Paige Ahlborg
Assistant Administrator

RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

RWMWD

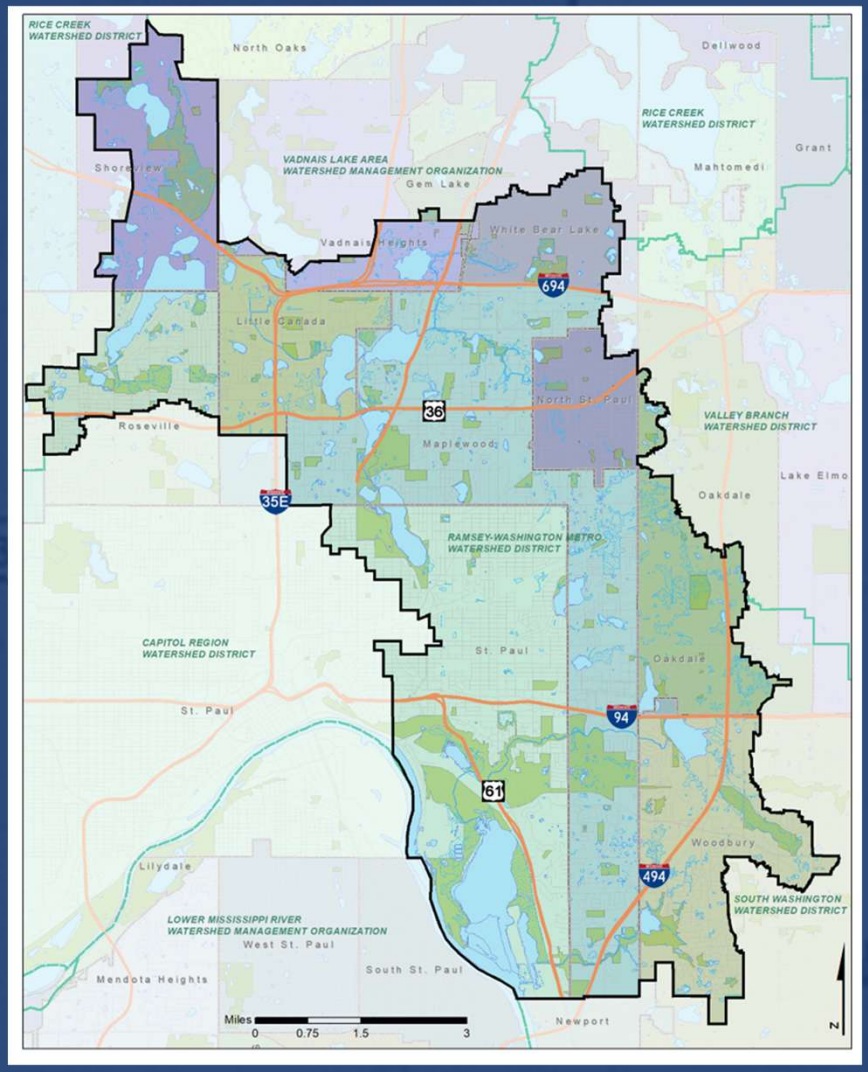
Includes parts of:

- Ramsey County
- Washington County

Includes all or parts of:

- St. Paul
- Woodbury
- Oakdale
- Landfall
- North St. Paul
- Maplewood
- Little Canada
- White Bear Lake
- Vadnais Heights
- Gem Lake
- Shoreview
- Roseville

- 65 square miles
- 20 lakes, 5 streams, hundreds of wetlands
- All drains to the Mississippi River



Our Priorities

Mitigate
Flood Risk

Quality
Surface Water

Healthy
Ecosystems

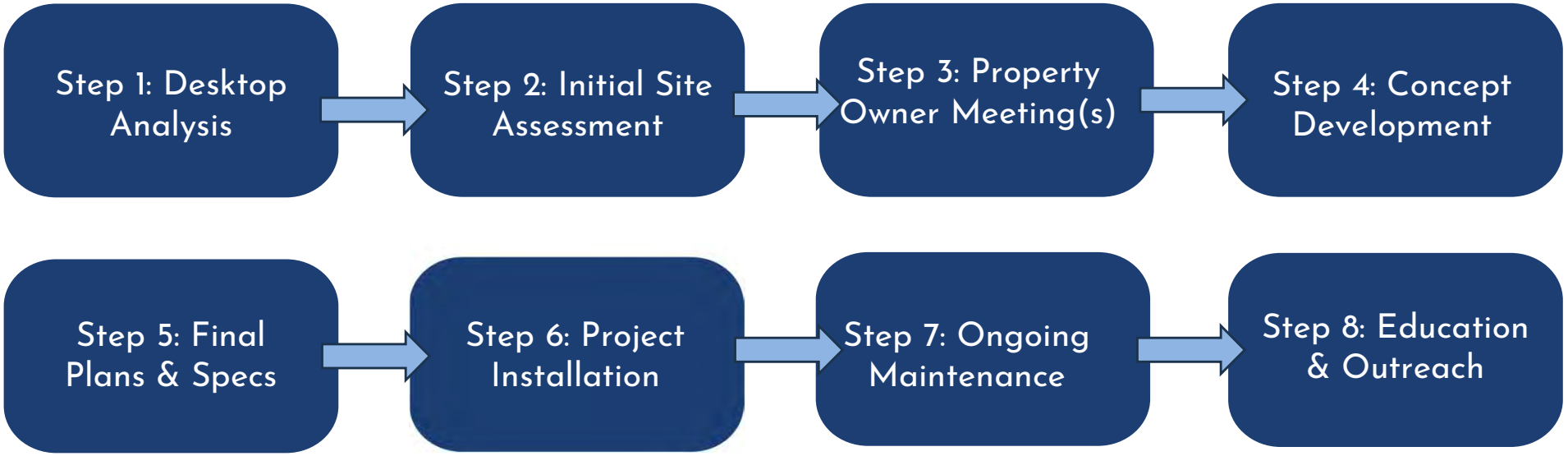
Community
Education and
Engagement

Clean Water Retrofit Program

- Seek out projects in underserved parts of RWMWD and/or priority drainage areas.
- District pays for **100%** cost of project
- Properties with high impervious surface coverage and no plans for future reconstruction
- 20-year maintenance agreements
- District pays for maintenance first 2 years post-construction

RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

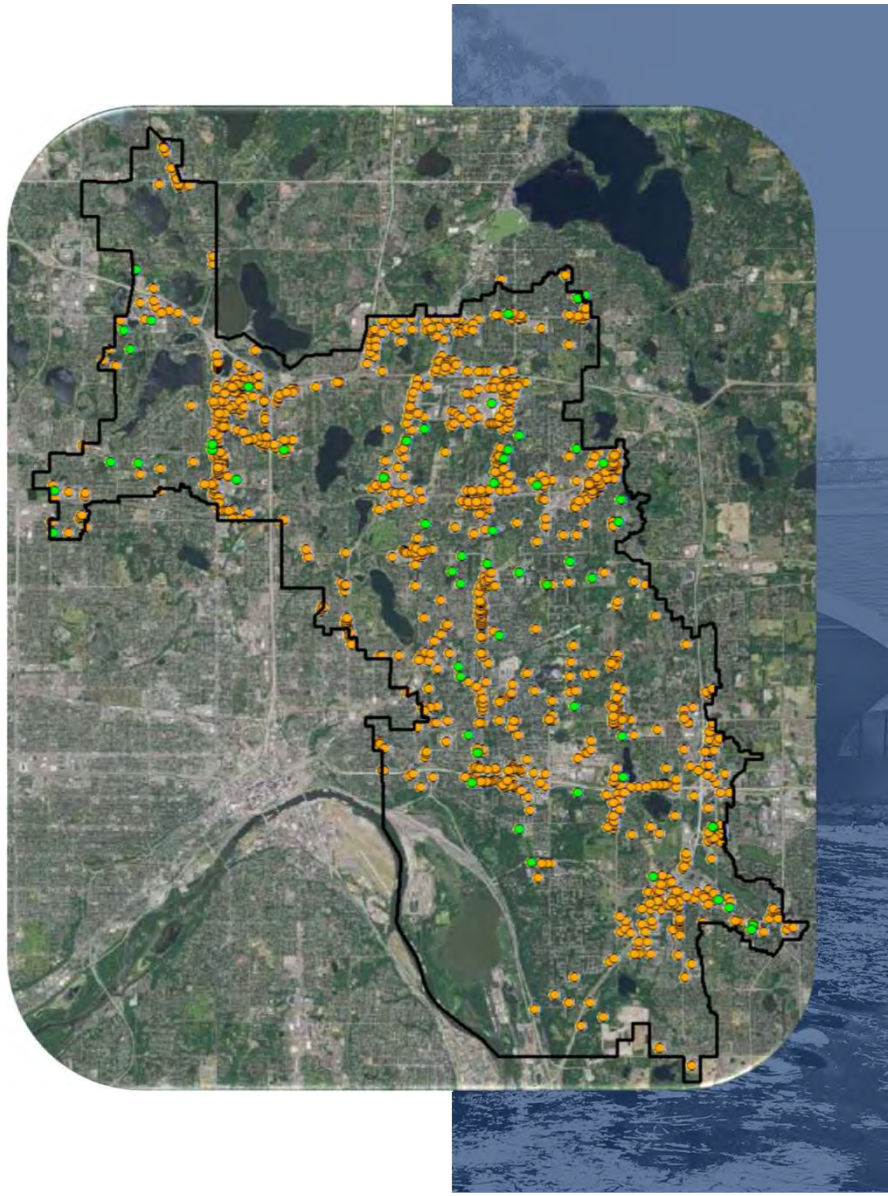
Retrofit Project Timeline



RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

Step 1: Desktop Analysis

- GIS Mapping
- Past Permit/Stewardship Grant Projects
- Social Vulnerability Index
- Flood Risk Potential
- Water Quality Impairment
- Natural Resources Protection



RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

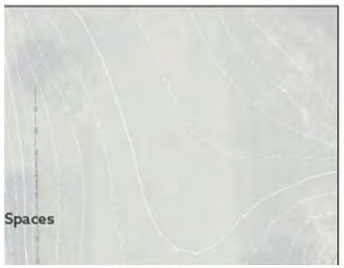
Step 2: Site Assessments

- Visit Top 10-15 Priority Sites
- Note visible drainage issues
- Existing green space
- Parking lot usage
- General site up-keep

Step 3: Meet with Property Owner(s)

- Any drainage concerns/observations
- Appetite for long-term maintenance
- Snow storage and other winter maintenance
- Willingness to remove parking stalls/asphalt
- Upcoming future projects

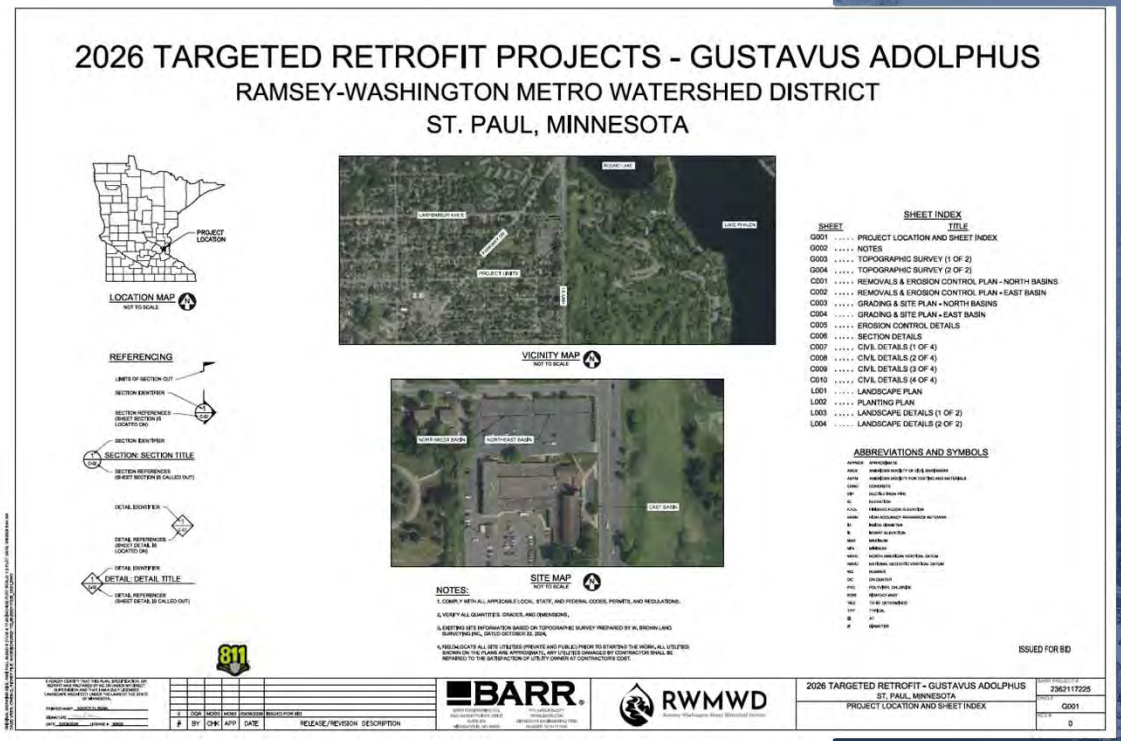
Step 4: Concept Development



	TP Retained (%)	TSS Retained (%)	TP Load Retained (lbs)	TSS Load Retained (lbs)
Northwest Basin	95%	95%	0.7	143
Northeast Basin	91%	91%	1.4	248
East Basin	98%	99%	0.6	103
		Total:	2.7	494

Step 5: Final Plans and Specs

Provide Operation and Maintenance Manuals up front



2026 TARGETED RETROFIT PROJECTS - GUSTAVUS ADOLPHUS

RAMSEY-WASHINGTON METRO WATERSHED DISTRICT

ST. PAUL, MINNESOTA

PROJECT LOCATION

LOCATION MAP

VICINITY MAP

SITE MAP

REFERENCING

SECTION: SECTION TITLE

DETAIL: DETAIL TITLE

SHEET INDEX

SHEET	TITLE
G001	PROJECT LOCATION AND SHEET INDEX
G002	NOTES
G003	TOPOGRAPHIC SURVEY (1 OF 2)
G004	TOPOGRAPHIC SURVEY (2 OF 2)
C001	REMOVALS & EROSION CONTROL PLAN - NORTH BASINS
C002	REMOVALS & EROSION CONTROL PLAN - EAST BASIN
C003	GRADING & SITE PLAN - NORTH BASINS
C004	GRADING & SITE PLAN - EAST BASIN
C005	EROSION CONTROL DETAILS
C006	SECTION DETAILS
C007	CIVIL DETAILS (1 OF 4)
C008	CIVIL DETAILS (2 OF 4)
C009	CIVIL DETAILS (3 OF 4)
C010	CIVIL DETAILS (4 OF 4)
L001	LANDSCAPE PLAN
L002	PLANTING PLAN
L003	LANDSCAPE DETAILS (1 OF 2)
L004	LANDSCAPE DETAILS (2 OF 2)

ABBREVIATIONS AND SYMBOLS

NOTES:

1. COMPLY WITH ALL APPLICABLE LOCAL, STATE, AND FEDERAL CODES, PERMITS, AND REGULATIONS.
2. VERIFY ALL QUANTITIES, GRADES, AND DIMENSIONS.
3. EXISTING SITE INFORMATION BASED ON TOPOGRAPHIC SURVEY PREPARED BY W. BROWN LAND SURVEYING INC., DATED OCTOBER 20, 2025.
4. RELOCATE ALL SITE UTILITIES (PRIVATE AND PUBLIC) PRIOR TO STARTING THE WORK. ALL UTILITIES SHOWN ON THE PLANS ARE APPROXIMATE, ANY UTILITIES DAMAGED BY CONTRACTOR SHALL BE REPAIRED TO THE SATISFACTION OF UTILITY OWNER AT CONTRACTORS COST.

ISSUED FOR BID

811

#	BY	CHK	APP	DATE	RELEASE/REVISION DESCRIPTION
1	DGR	MDR	MDR	20260206	ISSUED FOR BID

BARR

RWMWD

2026 TARGETED RETROFIT - GUSTAVUS ADOLPHUS
ST. PAUL, MINNESOTA
PROJECT LOCATION AND SHEET INDEX

236117225

G001

D

Step 6: Project Installation

Step 7: Ongoing Maintenance

First two years of maintenance subcontracted by RWMWD

Maintenance grants available

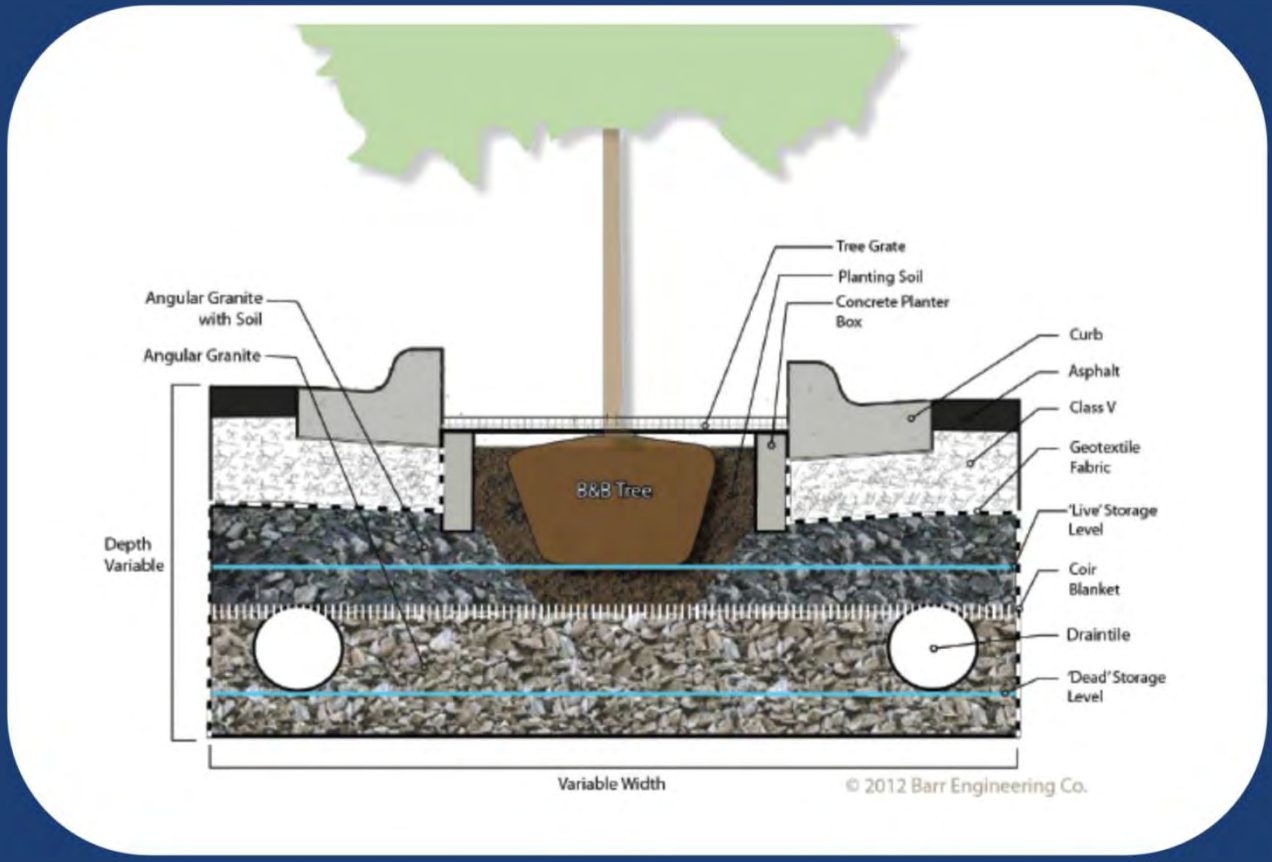
Ongoing routine inspections by RWMWD

Step 8: Education & Outreach

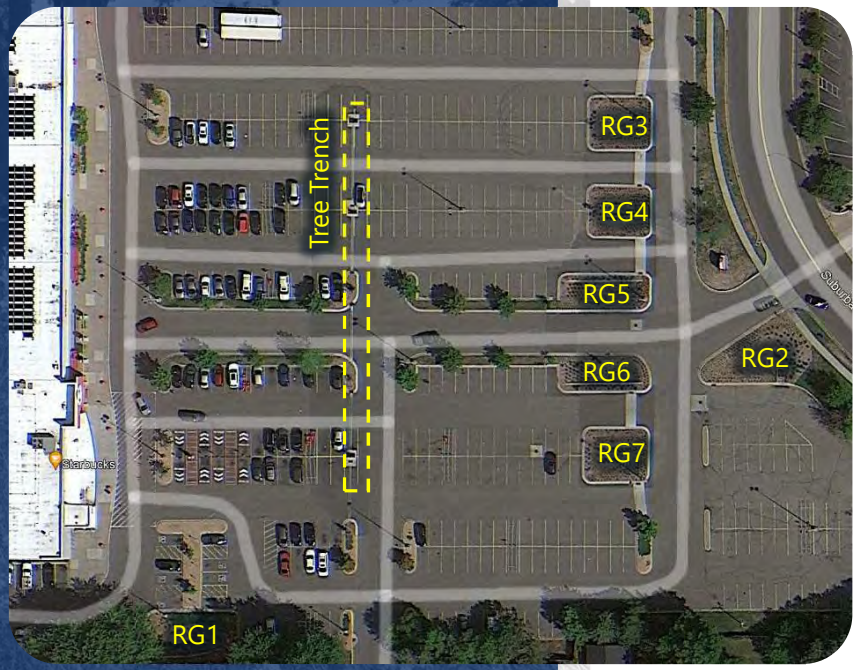
Partnership Highlight: RWMWD & Target Corp

Parking Lot Best Management Practices (BMPs)

Tree Trenches



EAST SAINT PAUL STORE



East St. Paul Target

Drains to Mississippi River

Best Management Practices Installed:

- 1 Large Tree Trench
- 2 Rain Gardens (Filtration Basins) with iron enhanced sand trenches in existing open green space
- 5 Rain Gardens (Filtration Basins) with iron enhanced sand trenches in existing parking spaces

RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

East St. Paul Target

- 36 parking spaces removed
  - Reduction in impervious area
  - Replaced with filtration basins
- Runoff captured from 3.2 acres of impervious pavement
  - 54% of site impervious pavement

RAMSEY-WASHINGTON
METRO WATERSHED DISTRICT

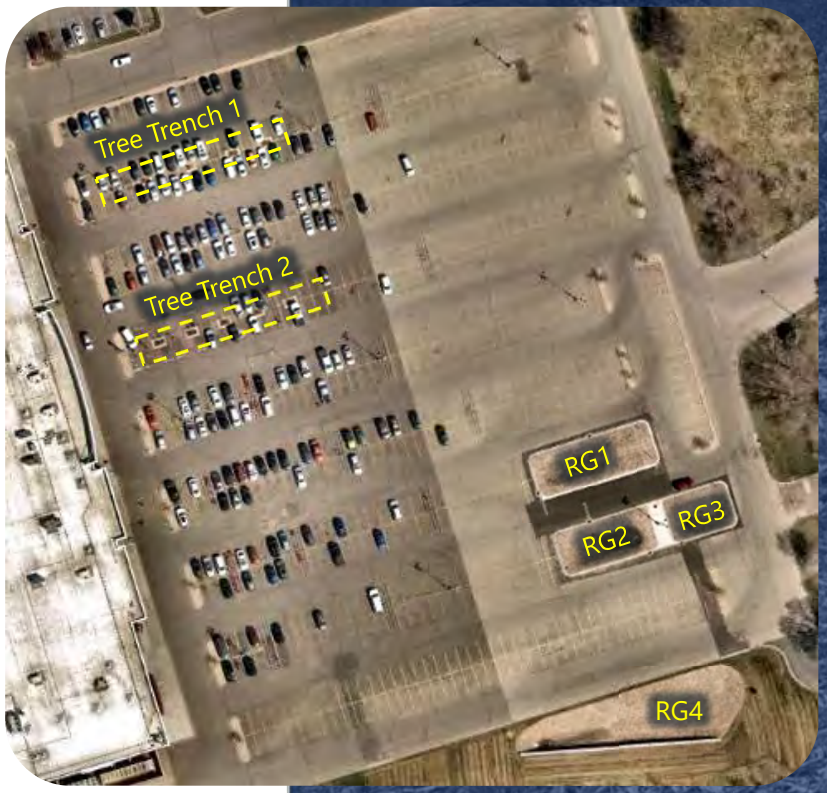
NORTH SAINT PAUL STORE

North St. Paul Target

Drains to Kohlman Lake

Best Management Practices Installed:

- 2 Large Tree Trenches
- 1 Rain Garden (Filtration Basin) with iron enhanced sand trenches in existing open green space
- 3 Rain Gardens (Filtration Basins) with iron enhanced sand trenches in existing parking spaces



North St. Paul Target

- 50 parking spaces removed
  - Reduction in impervious area
  - Replaced with filtration basins
- Runoff captured from 4.0 acres of impervious pavement
  - 36% of site impervious pavement

CLEAN WATER LAND & LEGACY AMENDMENT
YOUR Clean Water Fund AT WORK

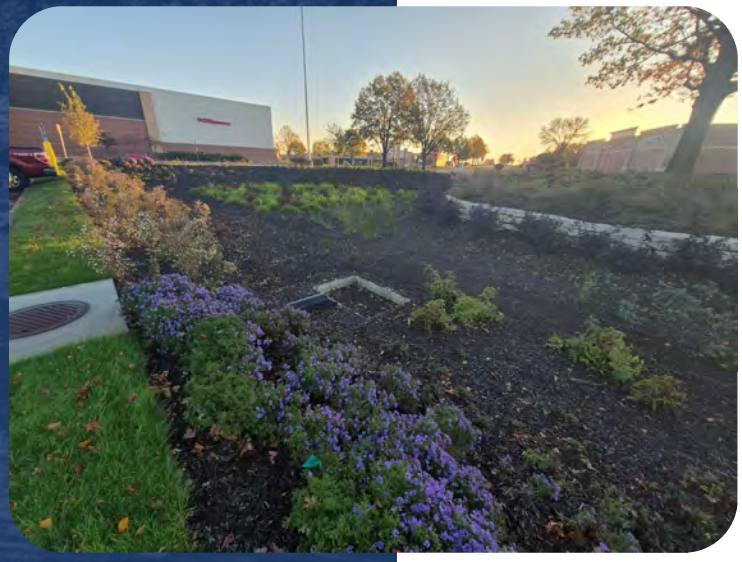
VALLEY CREEK PLAZA STORE

Valley Creek Plaza Target

Drains to Battle Creek Lake

Best Management Practices Installed:

- 1 Rain Garden (Filtration Basin) with iron enhanced sand trenches in existing open green space
- 1 Rain Garden (Filtration Basin) with iron enhanced sand trenches in existing parking spaces and open green space



Valley Creek Plaza Target

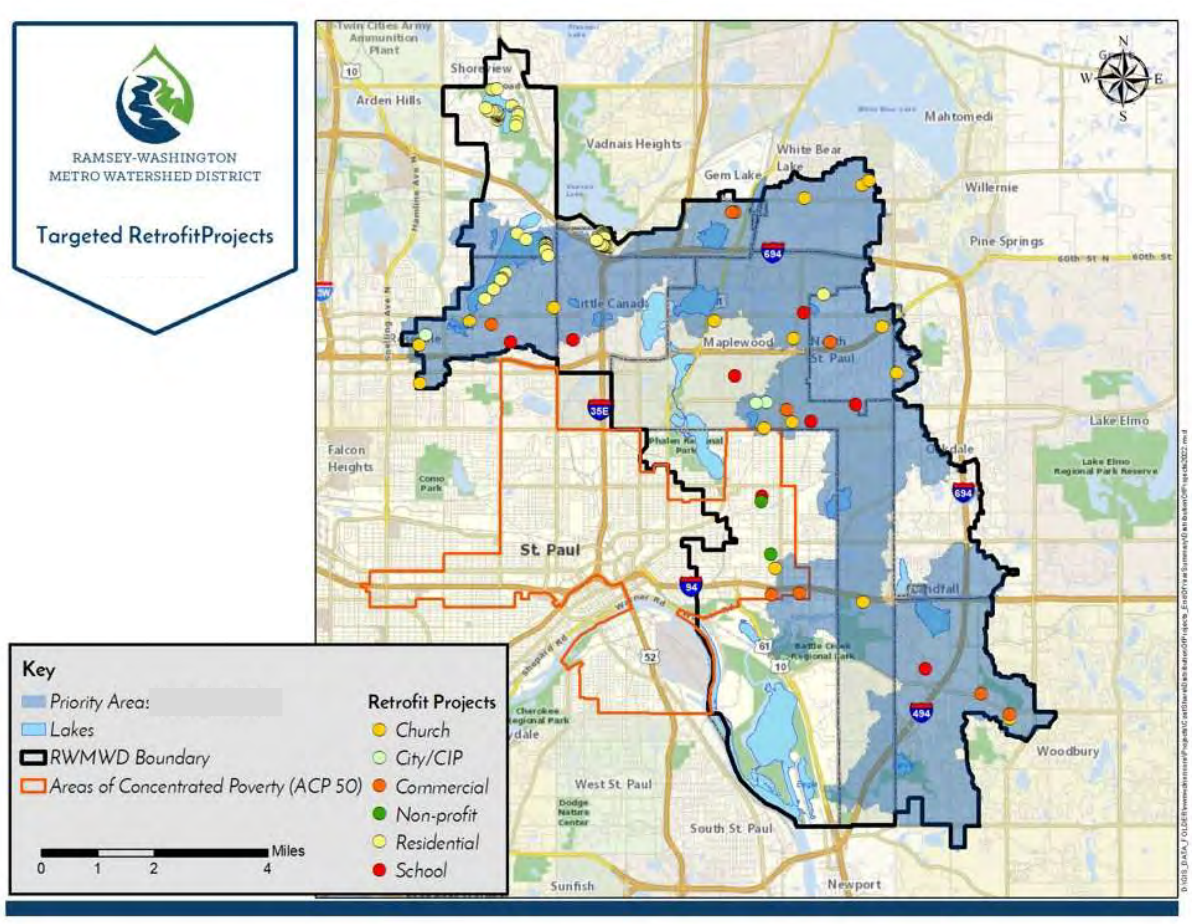
- 8 parking spaces removed
  - Reduction in impervious area
  - Replaced with filtration basins
- Runoff captured from 4.3 acres of impervious pavement
  - 59% of site impervious pavement

Estimated Average Annual Pollutant Removal

Pollutant	East St Paul	North St Paul	Valley Creek Plaza
Total Suspended Solids (lbs)	890	1,120	1,290
Total Phosphorus (lbs)	5	6	6.4
Runoff Volume (CF)	3,400	4,070	3,000
Parking Stalls Removed	36	50	8
Impervious Area Removed (SF)	5,832	8,100	1,296

Annual pollutant removals estimated using MIDs Calculator (Minnesota Stormwater Manual, MPCA)

How are we doing?



- Between 2014 and 2025: constructed 54 stormwater BMPs at 36 sites
  - 16 churches
  - 8 schools
  - 8 commercial sites
  - 4 parks/city owned sites
- $6.7 M in capital (District and CWF Grants)
- 293 lb TP removed annually
- 89,486 lb TSS removed annually
- 389,583 cu ft volume reduction

CLEAN WATER LAND & LEGACY AMENDMENT

YOUR Clean Water Fund AT WORK

Questions?

Paige.Ahlborg@rwmwd.org

651-792-7964