Green Asset Management

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Watershed Protection Manager

Environmental Services & Sustainability

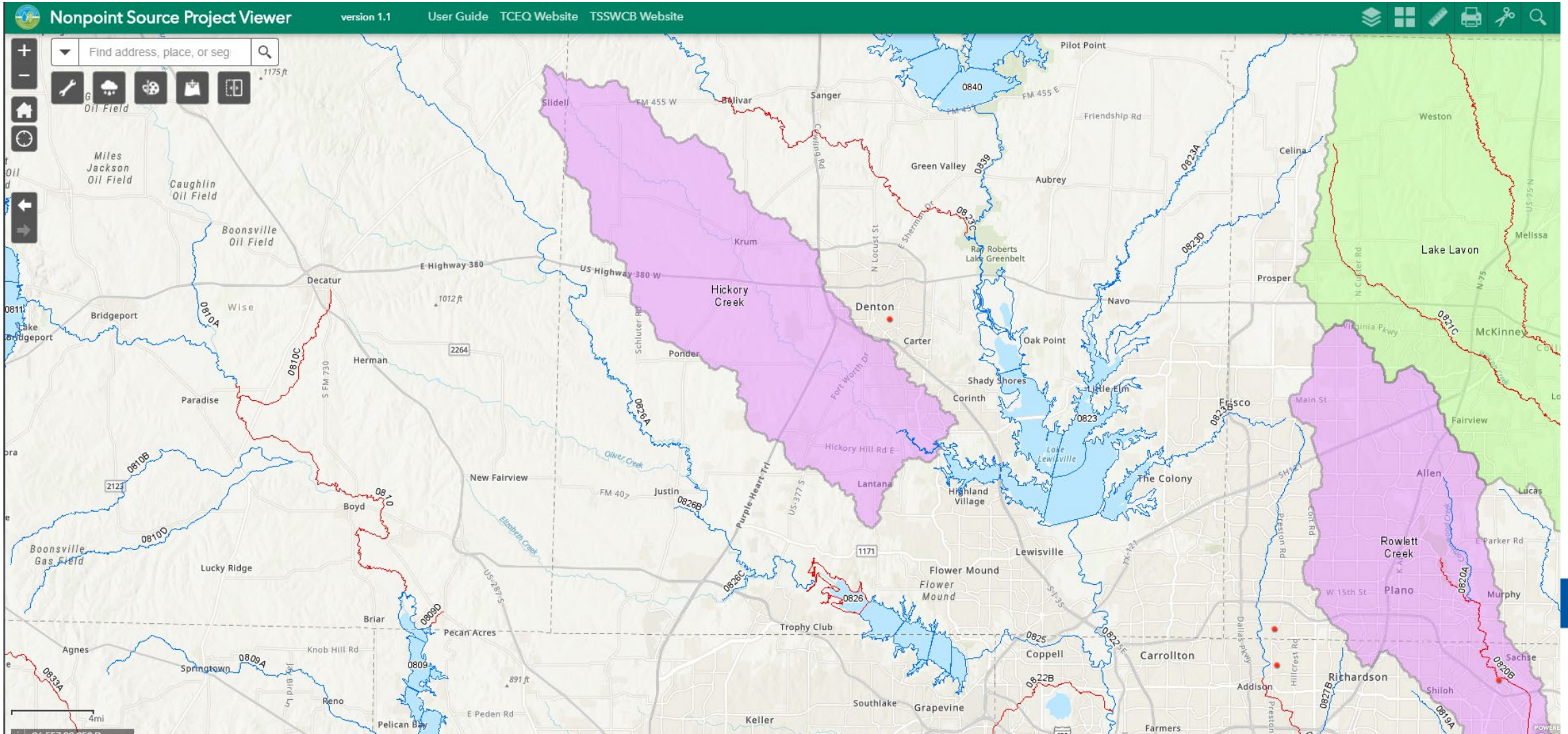
29 September 2023

MS4 Permit

Post Construction

- Inspections - Permittees who operate Level 4 small MS4s shall develop and implement an inspection program to ensure that all post construction stormwater control measures are operating correctly and are being maintained as required consistent with its applicable maintenance plan. For small MS4s with limited enforcement authority, this requirement applies to the structural controls owned and operated by the small MS4 or its contractors that perform these activities within the small MS4's regulated area.

Hickory Creek Watershed Protection Plan



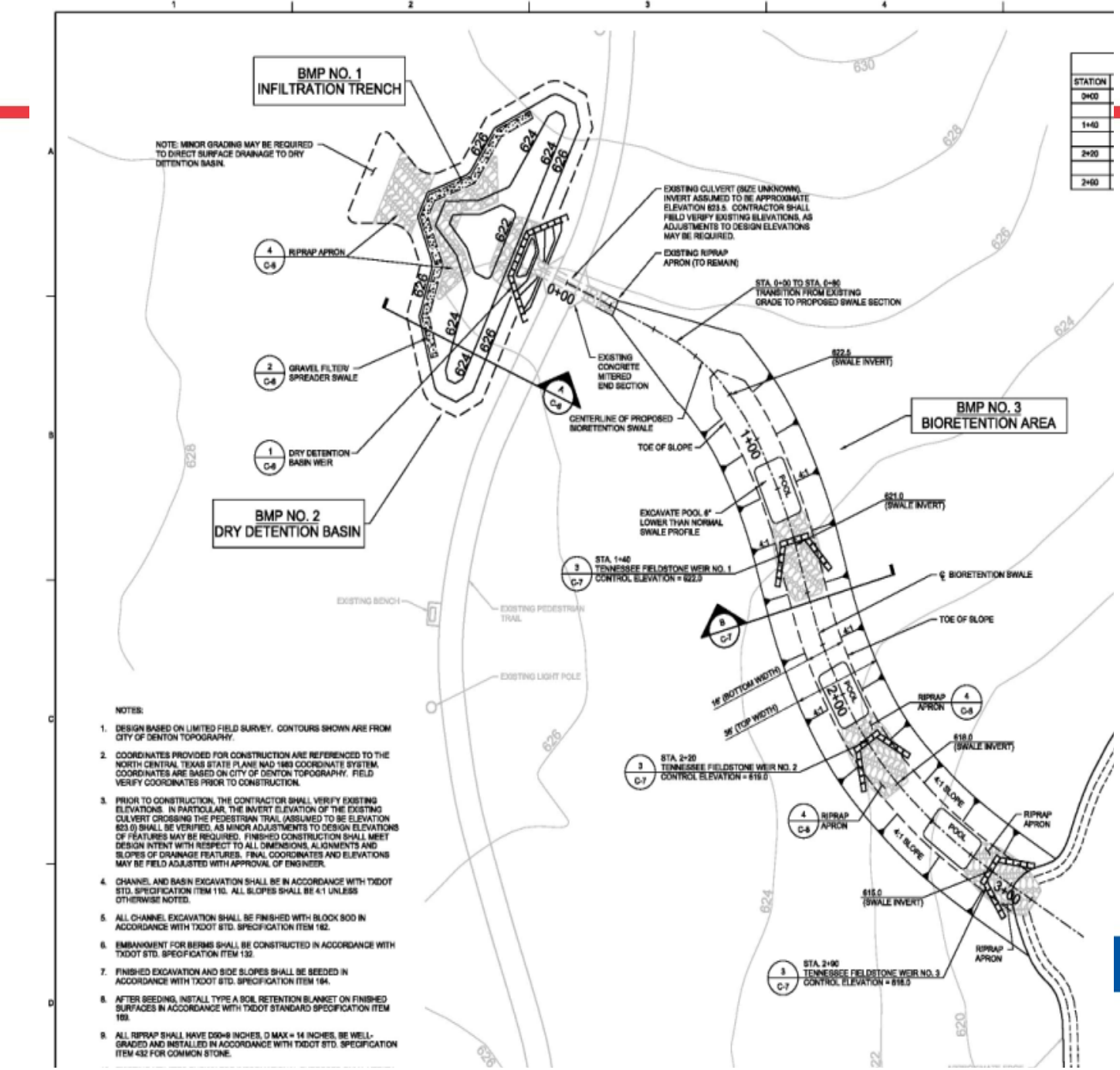
Post Construction
Best Management Practices

Benefits

- Improve water quality
- Reduce localized flooding
- Increase ecosystem services

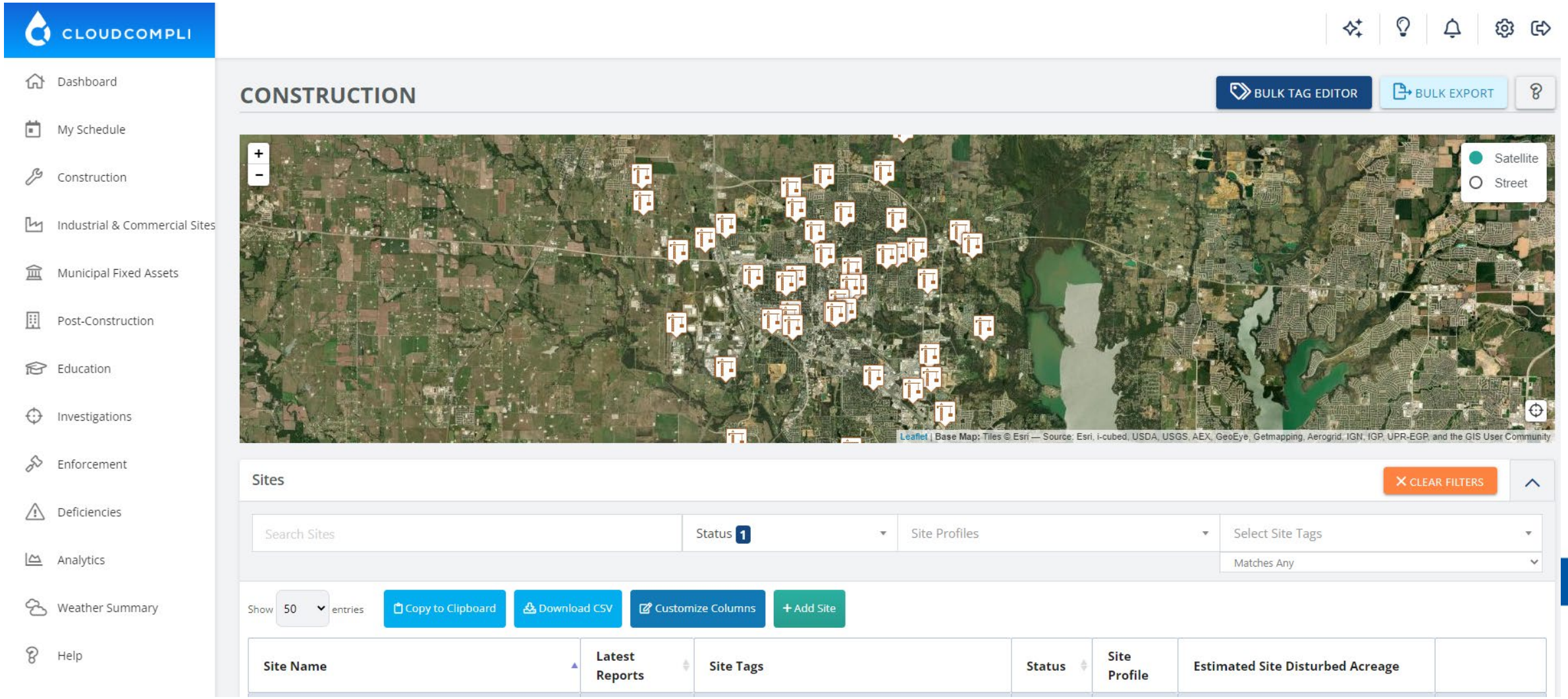
Project Focus

- Bioretention
- Rain Gardens
- Permeable Pavement

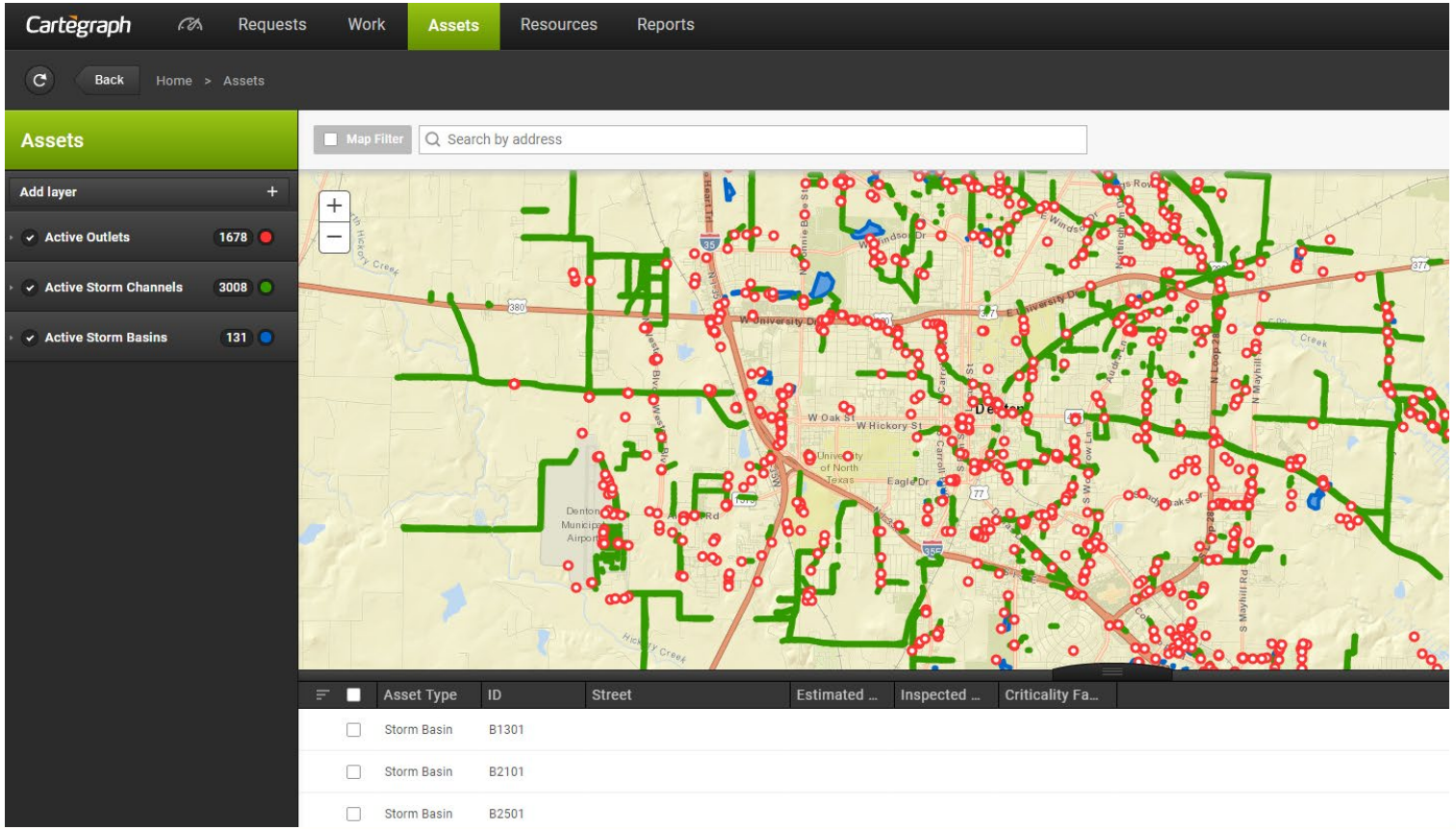

BMP NO. 1
INFILTRATION TRENCH
NOTE: MINOR GRADING MAY BE REQUIRED TO DIRECT SURFACE DRAINAGE TO DRY DETENTION BASIN.
4 C-8 RIPRAP APRON
2 C-8 GRAVEL FILTER/ SPREADER SWALE
1 C-8 DRY DETENTION BASIN WEIR
BMP NO. 2
DRY DETENTION BASIN
EXISTING CULVERT (SIZE UNKNOWN), INVERT ASSUMED TO BE APPROXIMATE ELEVATION 623.5. CONTRACTOR SHALL FIELD VERIFY EXISTING ELEVATIONS, AS ADJUSTMENTS TO DESIGN ELEVATIONS MAY BE REQUIRED.
EXISTING RIPRAP APRON (TO REMAIN)
STA. 0+00 TO STA. 0+90 TRANSITION FROM EXISTING GRADE TO PROPOSED SWALE SECTION
EXISTING CONCRETE MITERED END SECTION
CENTERLINE OF PROPOSED BIORETENTION SWALE
TOE OF SLOPE
622.5 (SWALE INVERT)
BMP NO. 3
BIORETENTION AREA
1+00
POOL
4:1
EXCAVATE POOL 6" LOWER THAN NORMAL SWALE PROFILE
621.0 (SWALE INVERT)
3 C-7 STA. 1+40 TENNESSEE FIELDSTONE WEIR NO. 1 CONTROL ELEVATION = 622.0
℄ BIORETENTION SWALE
TOE OF SLOPE
EXISTING BENCH
EXISTING PEDESTRIAN TRAIL
EXISTING LIGHT POLE
14' (BOTTOM WIDTH)
24' (TOP WIDTH)
2+00
RIPRAP APRON
618.0 (SWALE INVERT)
3 C-7 STA. 2+20 TENNESSEE FIELDSTONE WEIR NO. 2 CONTROL ELEVATION = 619.0
4:1 SLOPE
RIPRAP APRON
3+00
615.0 (SWALE INVERT)
RIPRAP APRON
3 C-7 STA. 2+90 TENNESSEE FIELDSTONE WEIR NO. 3 CONTROL ELEVATION = 616.0
STATION
0+00
1+40
2+20
2+90
NOTES:
1. DESIGN BASED ON LIMITED FIELD SURVEY. CONTOURS SHOWN ARE FROM CITY OF DENTON TOPOGRAPHY.
2. COORDINATES PROVIDED FOR CONSTRUCTION ARE REFERENCED TO THE NORTH CENTRAL TEXAS STATE PLANE NAD 1983 COORDINATE SYSTEM. COORDINATES ARE BASED ON CITY OF DENTON TOPOGRAPHY. FIELD VERIFY COORDINATES PRIOR TO CONSTRUCTION.
3. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL VERIFY EXISTING ELEVATIONS. IN PARTICULAR, THE INVERT ELEVATION OF THE EXISTING CULVERT CROSSING THE PEDESTRIAN TRAIL (ASSUMED TO BE ELEVATION 623.0) SHALL BE VERIFIED. AS MINOR ADJUSTMENTS TO DESIGN ELEVATIONS OF FEATURES MAY BE REQUIRED. FINISHED CONSTRUCTION SHALL MEET DESIGN INTENT WITH RESPECT TO ALL DIMENSIONS, ALIGNMENTS AND SLOPES OF DRAINAGE FEATURES. FINAL COORDINATES AND ELEVATIONS MAY BE FIELD ADJUSTED WITH APPROVAL OF ENGINEER.
4. CHANNEL AND BASIN EXCAVATION SHALL BE IN ACCORDANCE WITH TXDOT STD. SPECIFICATION ITEM 110. ALL SLOPES SHALL BE 4:1 UNLESS OTHERWISE NOTED.
5. ALL CHANNEL EXCAVATION SHALL BE FINISHED WITH BLOCK SOD IN ACCORDANCE WITH TXDOT STD. SPECIFICATION ITEM 162.
6. EMBANKMENT FOR BERMS SHALL BE CONSTRUCTED IN ACCORDANCE WITH TXDOT STD. SPECIFICATION ITEM 132.
7. FINISHED EXCAVATION AND SIDE SLOPES SHALL BE SEEDED IN ACCORDANCE WITH TXDOT STD. SPECIFICATION ITEM 164.
8. AFTER SEEDING, INSTALL TYPE A SOIL RETENTION BLANKET ON FINISHED SURFACES IN ACCORDANCE WITH TXDOT STANDARD SPECIFICATION ITEM 169.
9. ALL RIPRAP SHALL HAVE D50=9 INCHES, D MAX = 14 INCHES, BE WELL-GRADED AND INSTALLED IN ACCORDANCE WITH TXDOT STD. SPECIFICATION ITEM 432 FOR COMMON STONE.


SWEET CLOUD WAY
BMP NO. 4
RIPRAP PLUNGE
POOL AND OUTLET
PROTECTION
BMP NO.5 5A AND 5B
BIO-RETENTION AREAS
BMP NO. 5C
BIO-RETENTION
EXISTING
CULVERT
EXISTING
CULVERT
EXISTING
CULVERT
PLAYGROUND
PEDESTRIAN
TRAIL
554
552
550
548
546
544
542
540
538
536
SEE SHEET C-

Inspections



Asset Management



Questions?

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Environmental Services & Sustainability

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Green Asset Management

- Applying principles of asset management to GSI
- Developing tools to apply asset management to GSI
- Testing the methodology

EPA United States Environmental Protection Agency

Texas A&M AgriLife Extension

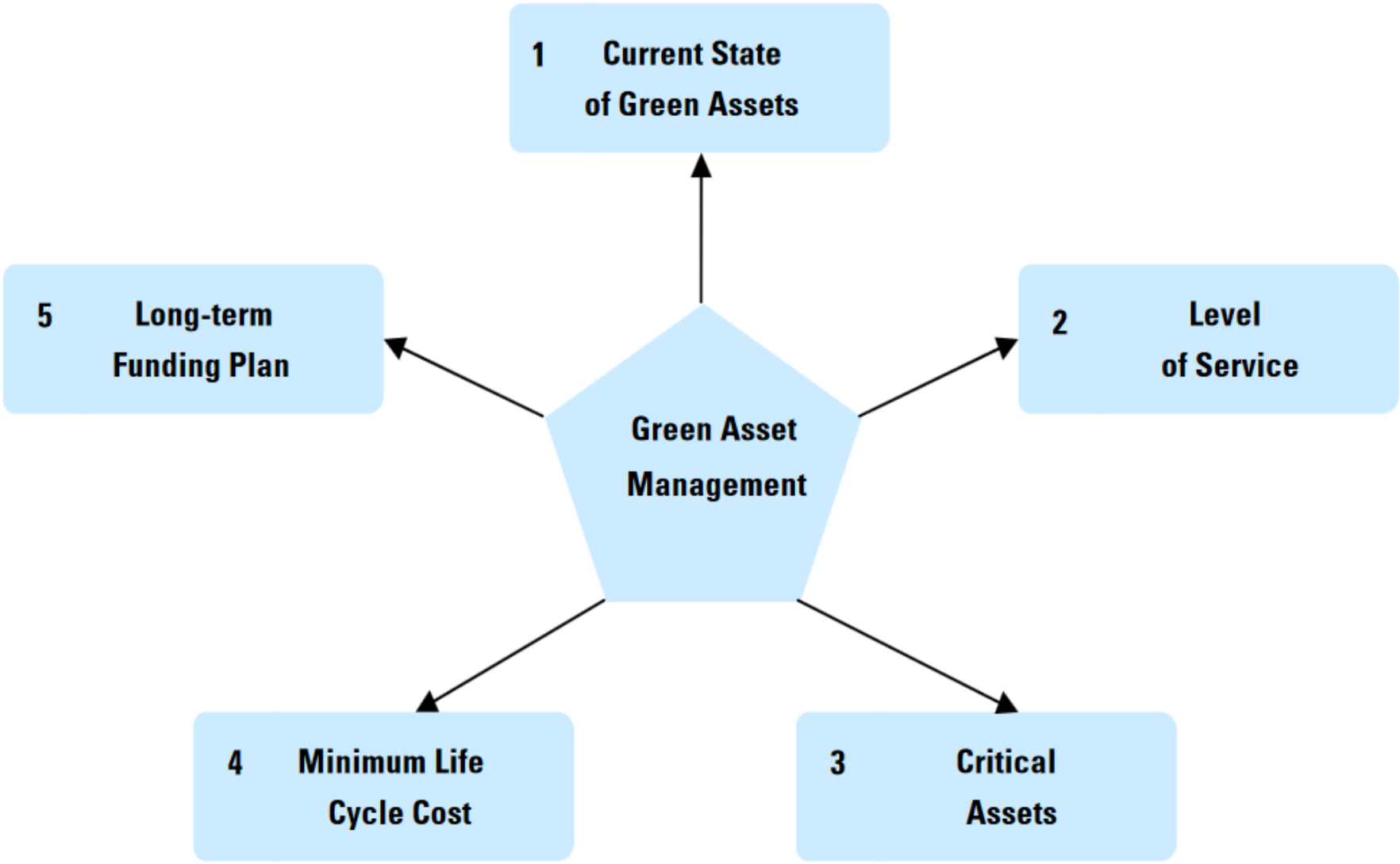
US Army Corps of Engineers

Southwest Environmental Finance Center

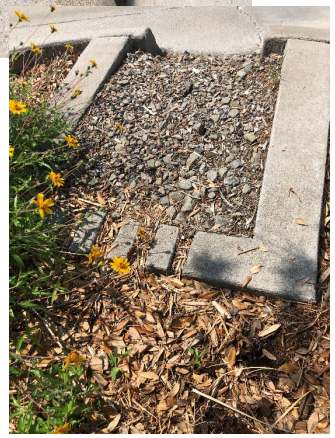
City of Denton

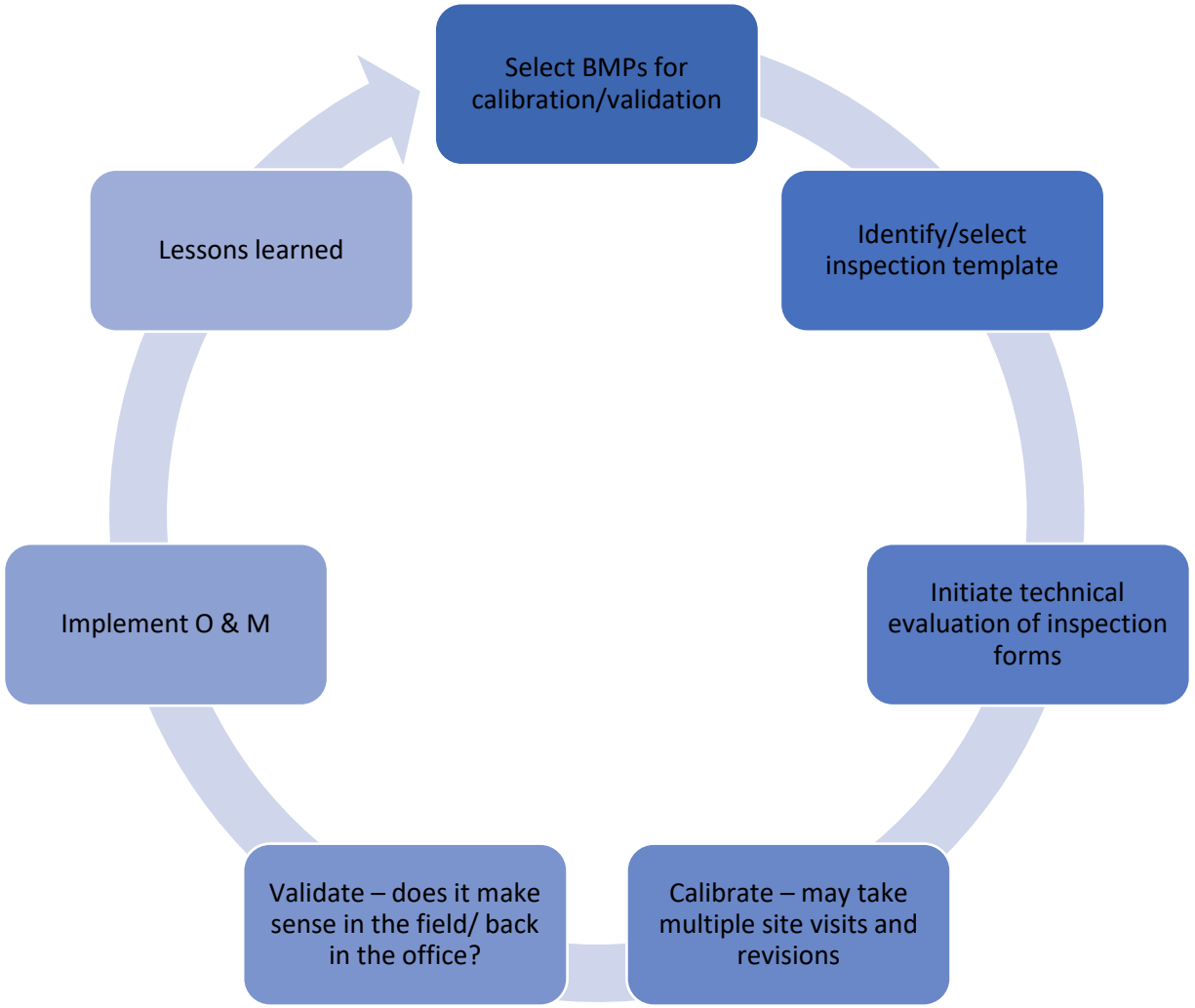
North Central Texas Council of Governments

The Five Core Components of Green Asset Management

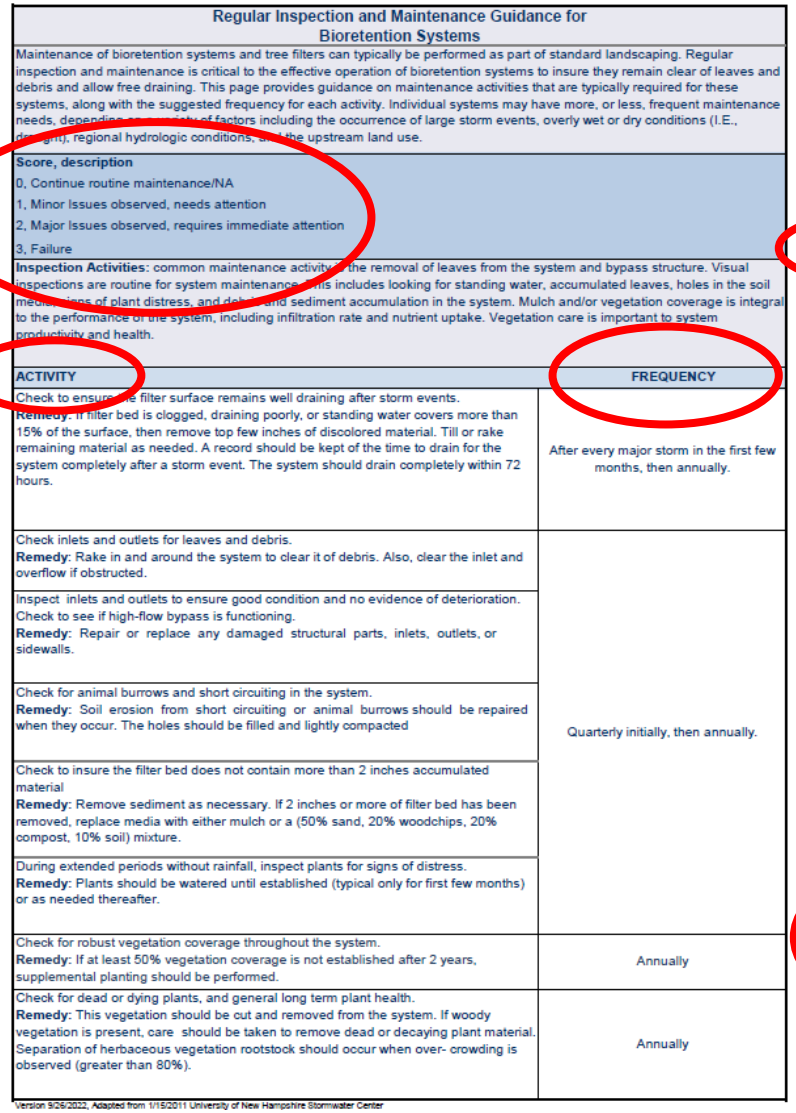


BMP Inspection Form Development Process





Bioretention systems



Regular Inspection and Maintenance Guidance for Bioretention Systems

Maintenance of bioretention systems and tree filters can typically be performed as part of standard landscaping. Regular inspection and maintenance is critical to the effective operation of bioretention systems to insure they remain clear of leaves and debris and allow free draining. This page provides guidance on maintenance activities that are typically required for these systems, along with the suggested frequency for each activity. Individual systems may have more, or less, frequent maintenance needs, depending on a variety of factors including the occurrence of large storm events, overly wet or dry conditions (I.E., drought), regional hydrologic conditions, and the upstream land use.

Score, description

0, Continue routine maintenance/NA

1, Minor Issues observed, needs attention

2, Major Issues observed, requires immediate attention

3, Failure

Inspection Activities: common maintenance activity is the removal of leaves from the system and bypass structure. Visual inspections are routine for system maintenance. This includes looking for standing water, accumulated leaves, holes in the soil media, signs of plant distress, and debris and sediment accumulation in the system. Mulch and/or vegetation coverage is integral to the performance of the system, including infiltration rate and nutrient uptake. Vegetation care is important to system productivity and health.

ACTIVITY	FREQUENCY
Check to ensure the filter surface remains well draining after storm events. **Remedy:** If filter bed is clogged, draining poorly, or standing water covers more than 15% of the surface, then remove top few inches of discolored material. Till or rake remaining material as needed. A record should be kept of the time to drain for the system completely after a storm event. The system should drain completely within 72 hours.	After every major storm in the first few months, then annually.
Check inlets and outlets for leaves and debris. **Remedy:** Rake in and around the system to clear it of debris. Also, clear the inlet and overflow if obstructed.	Quarterly initially, then annually.
Inspect inlets and outlets to ensure good condition and no evidence of deterioration. Check to see if high-flow bypass is functioning. **Remedy:** Repair or replace any damaged structural parts, inlets, outlets, or sidewalls.	
Check for animal burrows and short circuiting in the system. **Remedy:** Soil erosion from short circuiting or animal burrows should be repaired when they occur. The holes should be filled and lightly compacted	
Check to insure the filter bed does not contain more than 2 inches accumulated material **Remedy:** Remove sediment as necessary. If 2 inches or more of filter bed has been removed, replace media with either mulch or a (50% sand, 20% woodchips, 20% compost, 10% soil) mixture.	
During extended periods without rainfall, inspect plants for signs of distress. **Remedy:** Plants should be watered until established (typical only for first few months) or as needed thereafter.	
Check for robust vegetation coverage throughout the system. **Remedy:** If at least 50% vegetation coverage is not established after 2 years, supplemental planting should be performed.	Annually
Check for dead or dying plants, and general long term plant health. **Remedy:** This vegetation should be cut and removed from the system. If woody vegetation is present, care should be taken to remove dead or decaying plant material. Separation of herbaceous vegetation rootstock should occur when over- crowding is observed (greater than 80%).	Annually

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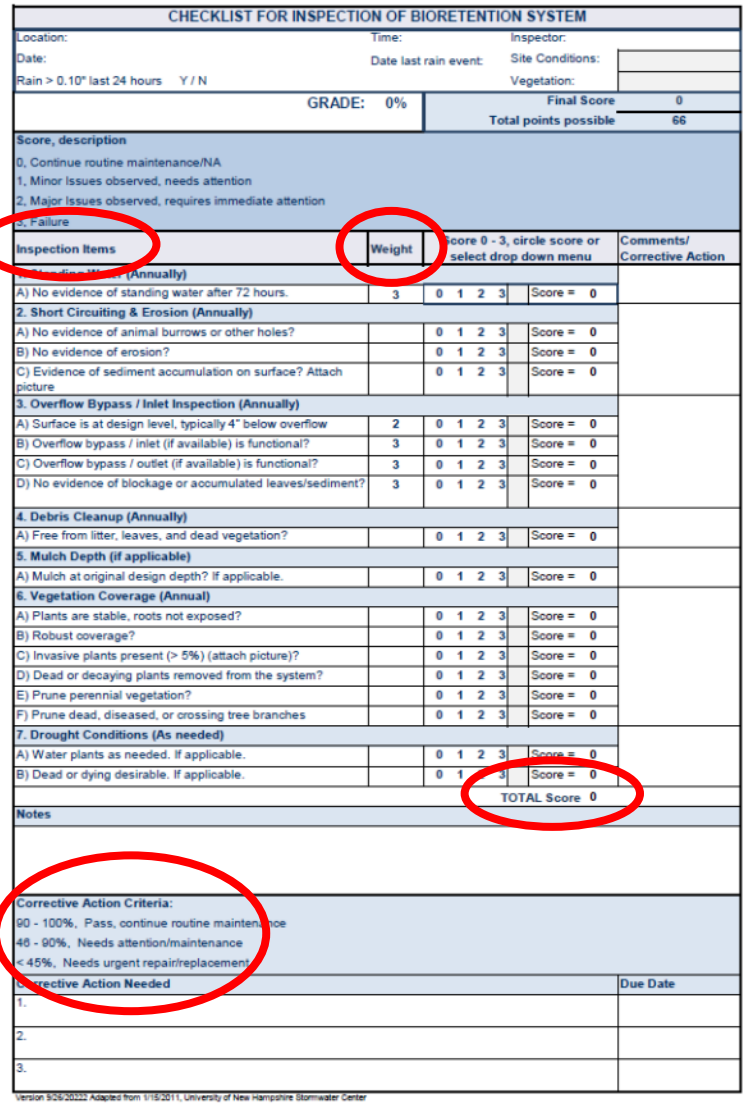

CHECKLIST FOR INSPECTION OF BIORETENTION SYSTEM

Location: Time: Inspector:

Date: Date last rain event: Site Conditions:

Rain > 0.10" last 24 hours Y / N Vegetation:

GRADE: 0% Final Score 0

Total points possible 66

Score, description

0, Continue routine maintenance/NA

1, Minor Issues observed, needs attention

2, Major Issues observed, requires immediate attention

3, Failure

Inspection Items	Weight	Score 0 - 3, circle score or select drop down menu	Comments/ Corrective Action
1. Standing Water (Annually)			
A) No evidence of standing water after 72 hours.	3	0 1 2 3 Score = 0	
2. Short Circuiting & Erosion (Annually)			
A) No evidence of animal burrows or other holes?		0 1 2 3 Score = 0	
B) No evidence of erosion?		0 1 2 3 Score = 0	
C) Evidence of sediment accumulation on surface? Attach picture		0 1 2 3 Score = 0	
3. Overflow Bypass / Inlet Inspection (Annually)			
A) Surface is at design level, typically 4" below overflow	2	0 1 2 3 Score = 0	
B) Overflow bypass / inlet (if available) is functional?	3	0 1 2 3 Score = 0	
C) Overflow bypass / outlet (if available) is functional?	3	0 1 2 3 Score = 0	
D) No evidence of blockage or accumulated leaves/sediment?	3	0 1 2 3 Score = 0	
4. Debris Cleanup (Annually)			
A) Free from litter, leaves, and dead vegetation?		0 1 2 3 Score = 0	
5. Mulch Depth (if applicable)			
A) Mulch at original design depth? If applicable.		0 1 2 3 Score = 0	
6. Vegetation Coverage (Annual)			
A) Plants are stable, roots not exposed?		0 1 2 3 Score = 0	
B) Robust coverage?		0 1 2 3 Score = 0	
C) Invasive plants present (> 5%) (attach picture)?		0 1 2 3 Score = 0	
D) Dead or decaying plants removed from the system?		0 1 2 3 Score = 0	
E) Prune perennial vegetation?		0 1 2 3 Score = 0	
F) Prune dead, diseased, or crossing tree branches		0 1 2 3 Score = 0	
7. Drought Conditions (As needed)			
A) Water plants as needed. If applicable.		0 1 2 3 Score = 0	
B) Dead or dying desirable. If applicable.		0 1 2 3 Score = 0	
		TOTAL Score 0	

Notes

Corrective Action Criteria:

90 - 100%, Pass, continue routine maintenance

46 - 90%, Needs attention/maintenance

< 45%, Needs urgent repair/replacement

Corrective Action Needed	Due Date
1.	
2.	
3.	

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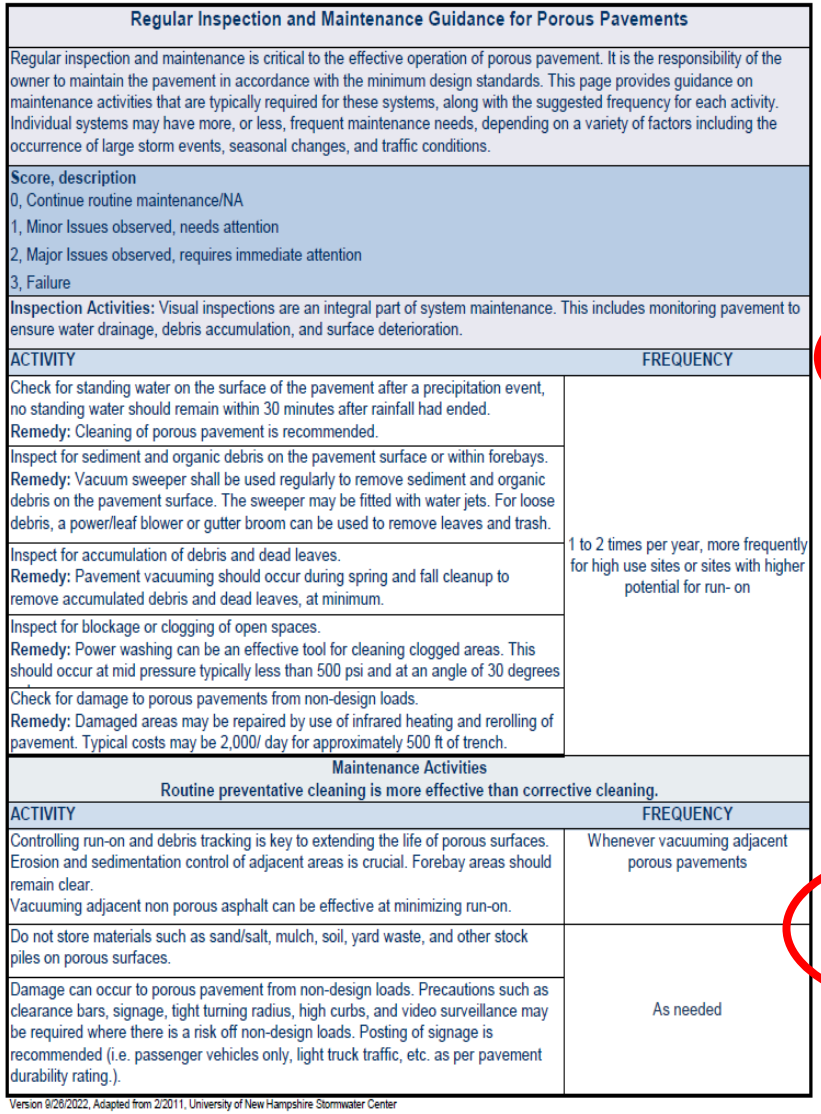
- Guidance
  - Scoring system
  - Activity
  - Frequency
- Checklist
  - Inspection items
  - Weight
  - Score
  - Comments/corrective action
  - Total Score

Porous Pavements



Regular Inspection and Maintenance Guidance for Porous Pavements

Regular inspection and maintenance is critical to the effective operation of porous pavement. It is the responsibility of the owner to maintain the pavement in accordance with the minimum design standards. This page provides guidance on maintenance activities that are typically required for these systems, along with the suggested frequency for each activity. Individual systems may have more, or less, frequent maintenance needs, depending on a variety of factors including the occurrence of large storm events, seasonal changes, and traffic conditions.

Score, description
0, Continue routine maintenance/NA
1, Minor Issues observed, needs attention
2, Major Issues observed, requires immediate attention
3, Failure

Inspection Activities: Visual inspections are an integral part of system maintenance. This includes monitoring pavement to ensure water drainage, debris accumulation, and surface deterioration.

ACTIVITY	FREQUENCY
Check for standing water on the surface of the pavement after a precipitation event, no standing water should remain within 30 minutes after rainfall had ended. **Remedy:** Cleaning of porous pavement is recommended.	1 to 2 times per year, more frequently for high use sites or sites with higher potential for run- on
Inspect for sediment and organic debris on the pavement surface or within forebays. **Remedy:** Vacuum sweeper shall be used regularly to remove sediment and organic debris on the pavement surface. The sweeper may be fitted with water jets. For loose debris, a power/leaf blower or gutter broom can be used to remove leaves and trash.	
Inspect for accumulation of debris and dead leaves. **Remedy:** Pavement vacuuming should occur during spring and fall cleanup to remove accumulated debris and dead leaves, at minimum.	
Inspect for blockage or clogging of open spaces. **Remedy:** Power washing can be an effective tool for cleaning clogged areas. This should occur at mid pressure typically less than 500 psi and at an angle of 30 degrees	
Check for damage to porous pavements from non-design loads. **Remedy:** Damaged areas may be repaired by use of infrared heating and rerolling of pavement. Typical costs may be 2,000/ day for approximately 500 ft of trench.	

Maintenance Activities
Routine preventative cleaning is more effective than corrective cleaning.

ACTIVITY	FREQUENCY
Controlling run-on and debris tracking is key to extending the life of porous surfaces. Erosion and sedimentation control of adjacent areas is crucial. Forebay areas should remain clear. Vacuuming adjacent non porous asphalt can be effective at minimizing run-on.	Whenever vacuuming adjacent porous pavements
Do not store materials such as sand/salt, mulch, soil, yard waste, and other stock piles on porous surfaces.	As needed
Damage can occur to porous pavement from non-design loads. Precautions such as clearance bars, signage, tight turning radius, high curbs, and video surveillance may be required where there is a risk off non-design loads. Posting of signage is recommended (i.e. passenger vehicles only, light truck traffic, etc. as per pavement durability rating.).	

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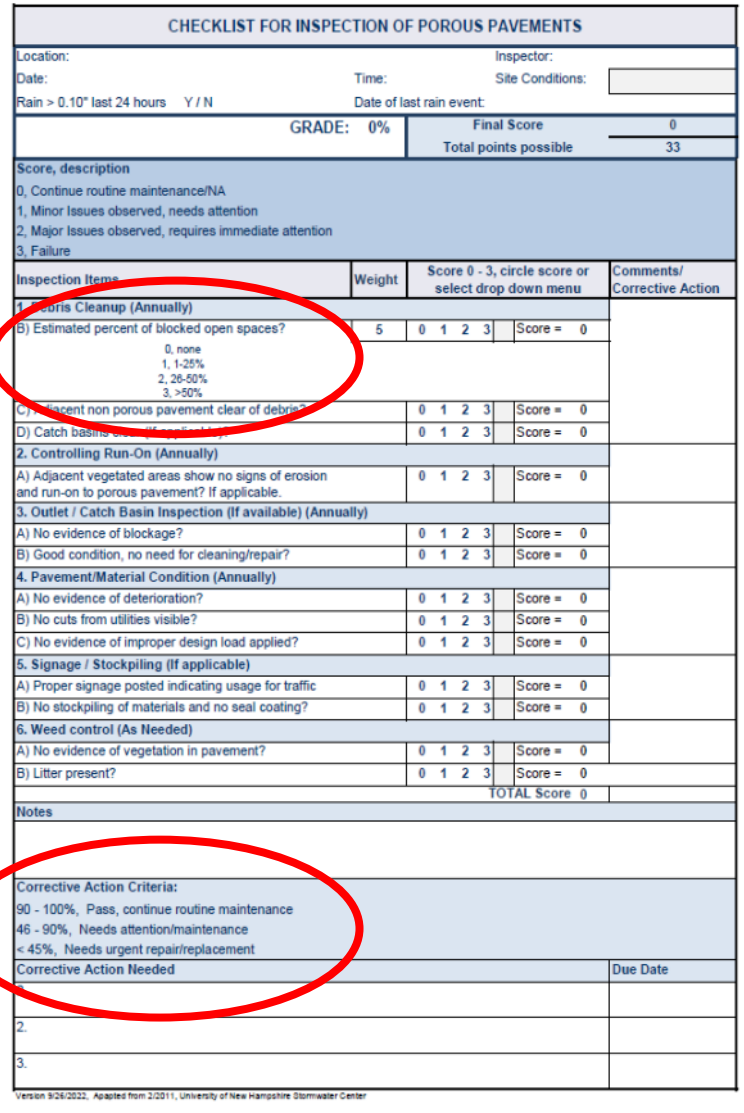


CHECKLIST FOR INSPECTION OF POROUS PAVEMENTS

Location: Inspector:
Date: Time: Site Conditions:
Rain > 0.10" last 24 hours Y / N Date of last rain event:

GRADE: 0% Final Score 0 / Total points possible 33

Score, description
0, Continue routine maintenance/NA
1, Minor Issues observed, needs attention
2, Major Issues observed, requires immediate attention
3, Failure

Inspection Items	Weight	Score 0 - 3, circle score or select drop down menu	Comments/ Corrective Action
1. Debris Cleanup (Annually)			
B) Estimated percent of blocked open spaces? 0, none 1, 1-25% 2, 26-50% 3, >50%	5	0 1 2 3 Score = 0	
C) Adjacent non porous pavement clear of debris?		0 1 2 3 Score = 0	
D) Catch basins clear (if applicable)?		0 1 2 3 Score = 0	
2. Controlling Run-On (Annually)			
A) Adjacent vegetated areas show no signs of erosion and run-on to porous pavement? If applicable.		0 1 2 3 Score = 0	
3. Outlet / Catch Basin Inspection (If available) (Annually)			
A) No evidence of blockage?		0 1 2 3 Score = 0	
B) Good condition, no need for cleaning/repair?		0 1 2 3 Score = 0	
4. Pavement/Material Condition (Annually)			
A) No evidence of deterioration?		0 1 2 3 Score = 0	
B) No cuts from utilities visible?		0 1 2 3 Score = 0	
C) No evidence of improper design load applied?		0 1 2 3 Score = 0	
5. Signage / Stockpiling (If applicable)			
A) Proper signage posted indicating usage for traffic		0 1 2 3 Score = 0	
B) No stockpiling of materials and no seal coating?		0 1 2 3 Score = 0	
6. Weed control (As Needed)			
A) No evidence of vegetation in pavement?		0 1 2 3 Score = 0	
B) Litter present?		0 1 2 3 Score = 0	
		TOTAL Score 0	

Notes

Corrective Action Criteria:
90 - 100%, Pass, continue routine maintenance
46 - 90%, Needs attention/maintenance
< 45%, Needs urgent repair/replacement

Corrective Action Needed	Due Date
1.	
2.	
3.	

Version 9/26/2022, Adapted from 2/2011, University of New Hampshire Stormwater Center

- Inspection Item Example
  - Estimated % of blocked open spaces
    - Scored 1 – 3
      - 0 = none
      - 1 = 1 - 25%,
      - 2 = 25 - 50%,
      - 3 = >50%,
- Corrective Action Criteria
  - 90 – 100% Pass
  - 46 – 90% Needs attention
  - < 45% Needs urgent repair or replacement

NSF AWARD NO. 2228731

Community-Science Partnership to Enhance Stormwater Adaptation under Climate Change

PI Dr. Wendy Jepson, Texas Water Resources Institute; Department of Geography, TAMU
Co-PIs: Dr. Lauren Fischer, Department of Public Administration, University of North Texas; Dr. Fouad Jaber, Department of Biological and Agricultural Engineering, Texas A&M University; Dr. Kelly Albus, Texas A&M AgriLife Extension

CIVIC INNOVATION CHALLENGE

Research disciplines: Urban Planning, Public Administration, Geography, Civil & Environmental Engineering; Biological & Agricultural Engineering

Project Challenge: How to ***overcome institutional barriers*** that limit large-scale and equitable implementation of blue-green infrastructure (BGI) to enhance stormwater adaptation under climate change

- Municipalities leave BGI **out of planning, budgets and maintenance plans** because they are considered landscapes not assets
- Communities benefit unequally and have diverse priorities and values that are **commonly left out of BGI planning and implementation.**

Vision for a Stage 2: *Small institutional innovation can lead to big change*

We seek to develop a set of innovative tools for **communities to engage in collaborative urban governance** to increase public acceptance of nature-based solutions and public investment.

- Monitor, analyze effectiveness of tool developed during the Stage 1 pilot
- Advance other needed tools for community-based BGI siting, priority setting, and planning (depending on CWSG)

Stage 1 Activities: Institutional innovation to increase public acceptance and public investment & maintenance in BGI

- Co-design, execute and assess a **pilot community-based green infrastructure asset management (C-GAM) tool**, which is modeled after other municipal asset management frameworks, to open new pathways for communities to directly participate in decision-making related to BGI installations across municipalities.
- **Community-Science Working Group** of research team and community BGI champions for change to guide C-GAM development and co-create Stage 2 Proposal

Piloting a Regional Vision

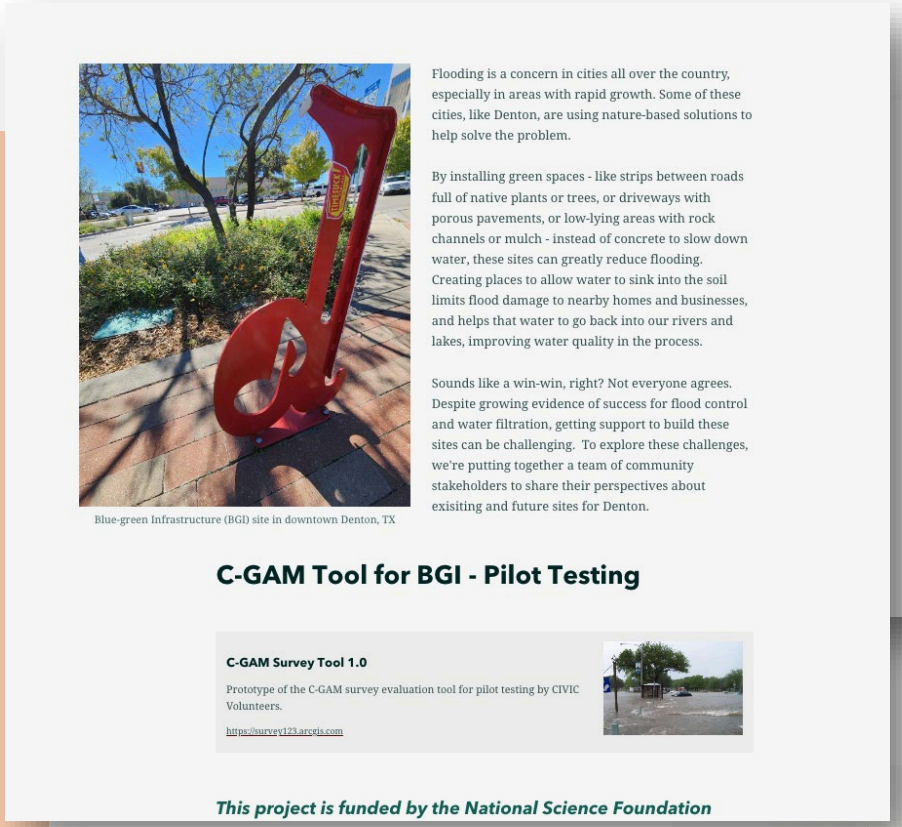
- Planning Phase: October 2022 – August 2023 Pilot Project in Denton.
- **Community Science Working Group**, representatives from the City of Denton and environmental and community groups, to advise project development
- Execute a series of **workshops for local stakeholders** to develop, refine, and evaluate the CGAM Tool for the city
- The project aims to reduce local stormwater flooding, establish new community connections, and **launch the tailored CGAM tool** for the City of Denton

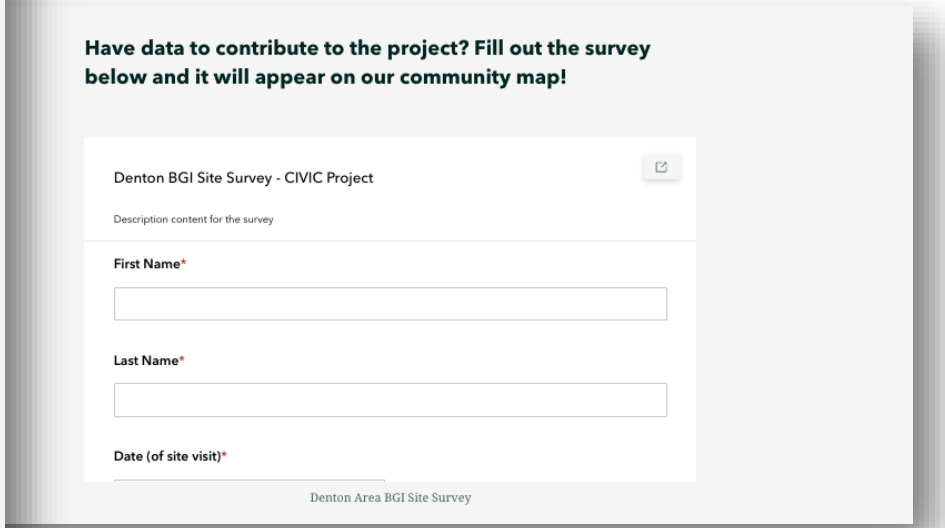
Community Green Asset Management Tool: A Pilot Project

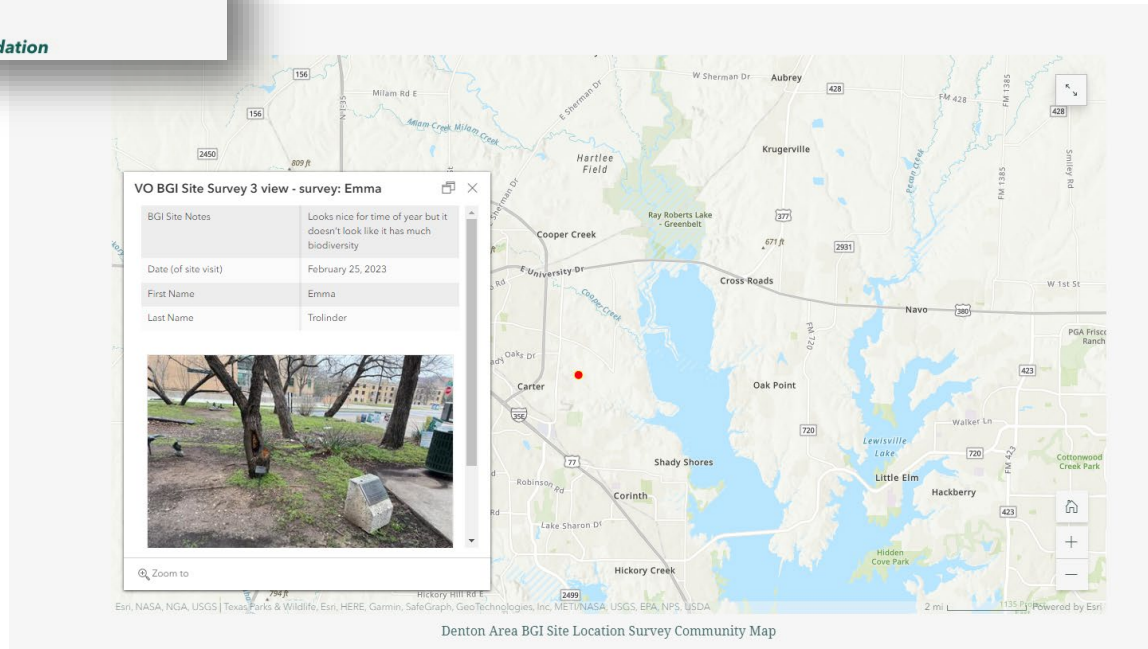
- We seek to address these challenges by incorporating community priorities into an **asset management framework for BGI**
- This approach manages **infrastructure assets** by minimizing costs of owning, operating, and maintaining them
- Develop and pilot a **Community Green Asset Management (CGAM) Tool** that reflects local concerns, priorities, and values associated with BGI

Hub Platform:
Interactive tools for co-development of data with local communities

- Citizen Science Projects
- Educational Modules
- Training Workshops
- Interactive Signage
- K-12 and Undergraduate classroom materials







Click on the Resource Library below to find online resources like literature, videos, educational activities and more!

Blue-Green Infrastructure Education Resource Library

Hub Platform:
Interactive tools for co-development of data with local communities

- Citizen Science Projects
- Educational Modules
- Training Workshops
- Interactive Signage
- K-12 and Undergraduate classroom materials

C-GAM Community Survey Tool

Site Characteristics
Plant Selection
Maintenance
Community Risks + Benefits
Level of Service
(Education, Social Connectivity)


North Texas
BGIN
Blue-Green Infrastructure Network