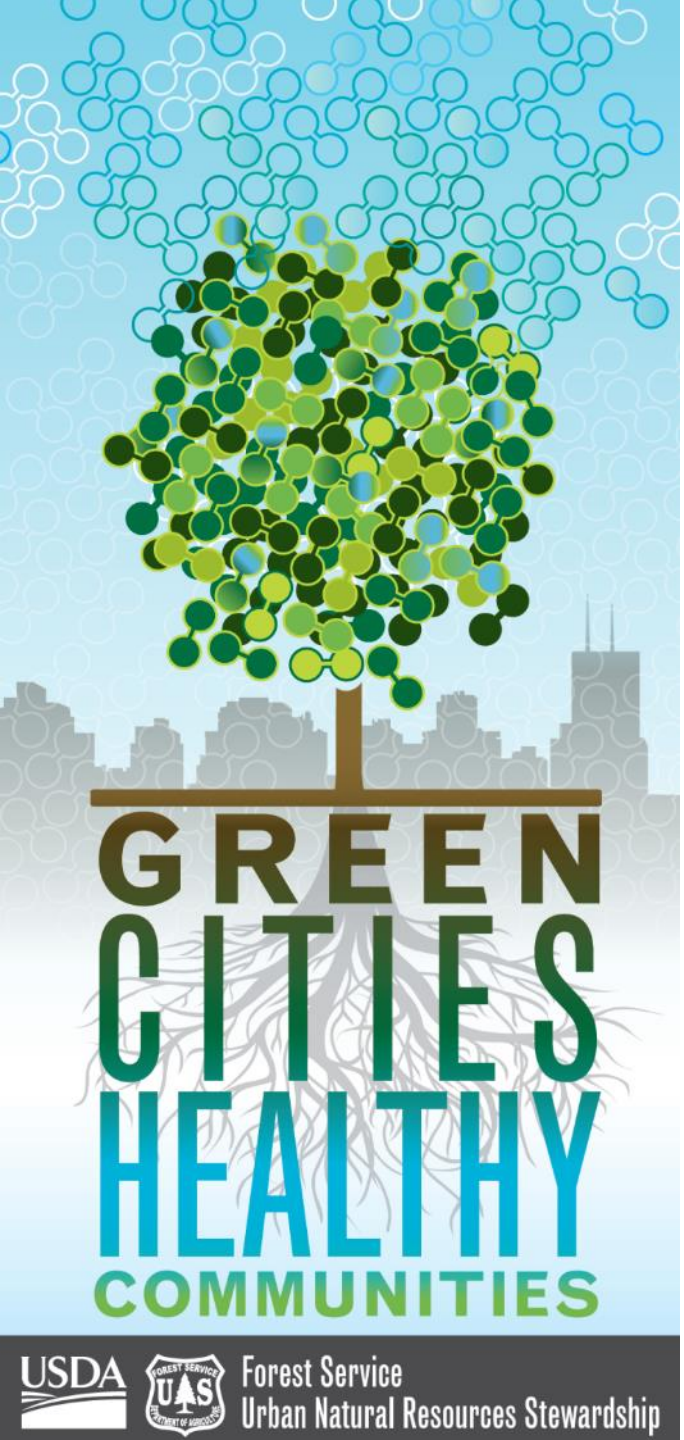


USDA Forest Service

URBAN FOREST CONNECTIONS

webinar series

Second Wednesdays | 1:00 – 2:15 pm ET

www.fs.fed.us/research/urban-webinars

USDA is an equal opportunity provider and employer.

Integrating Trees into Stormwater Management Design and Policy

Chris Kaeff

Regulatory Reporting and Wet Weather Manager

SD1

ckaeff@sd1.org

Craig Frye

Environmental Coordinator

SD1

cfrye@sd1.org

Laurence Wiseman

Principal

CenterLine Strategy LLC

ldwiseman@gmail.com

Terraced Reforestation

Sanitation District No.1 of Northern Kentucky

Chris Kaeff, GISP – Regulatory Reporting and Wet Weather Manager

Craig Frye – Environmental Coordinator

SD1 Timeline

- **1906 – City of Covington builds Willow Run sewer**
- **1946** – SD1 established by Kentucky Department of Health
- **1948** – Federal Water Pollution Control Act
- **1954** – SD1 builds first treatment plant in NKY in Bromley
- **1972** – Clean Water Act (CWA)
- **1979** – SD1 builds Dry Creek Wastewater Treatment Plant in Villa Hills, providing secondary treatment for first time
- **1995** – SD1 assumes ownership of sanitary sewers in most NKY jurisdictions
- **2003** – Fiscal Courts of three counties decide to create storm water utility
- **2007** – Consent Decree with USEPA, Kentucky Energy & Environment Cabinet, and SD1 approved by Federal Judge
- **2008** – SD1 builds Eastern Regional Water Reclamation Facility in Alexandria
- **2009** – SD1 begins assuming ownership of storm water infrastructure for most NKY jurisdictions
- **2011 – Construction of Terraced Reforestation**
- **2012** – SD1 builds Western Regional Water Reclamation Facility, in west Boone County
- **2014** – Integrated Watershed Plans for NKY technically approved by regulators
- **2017** – Renegotiation of the terms of Consent Decree based on affordability

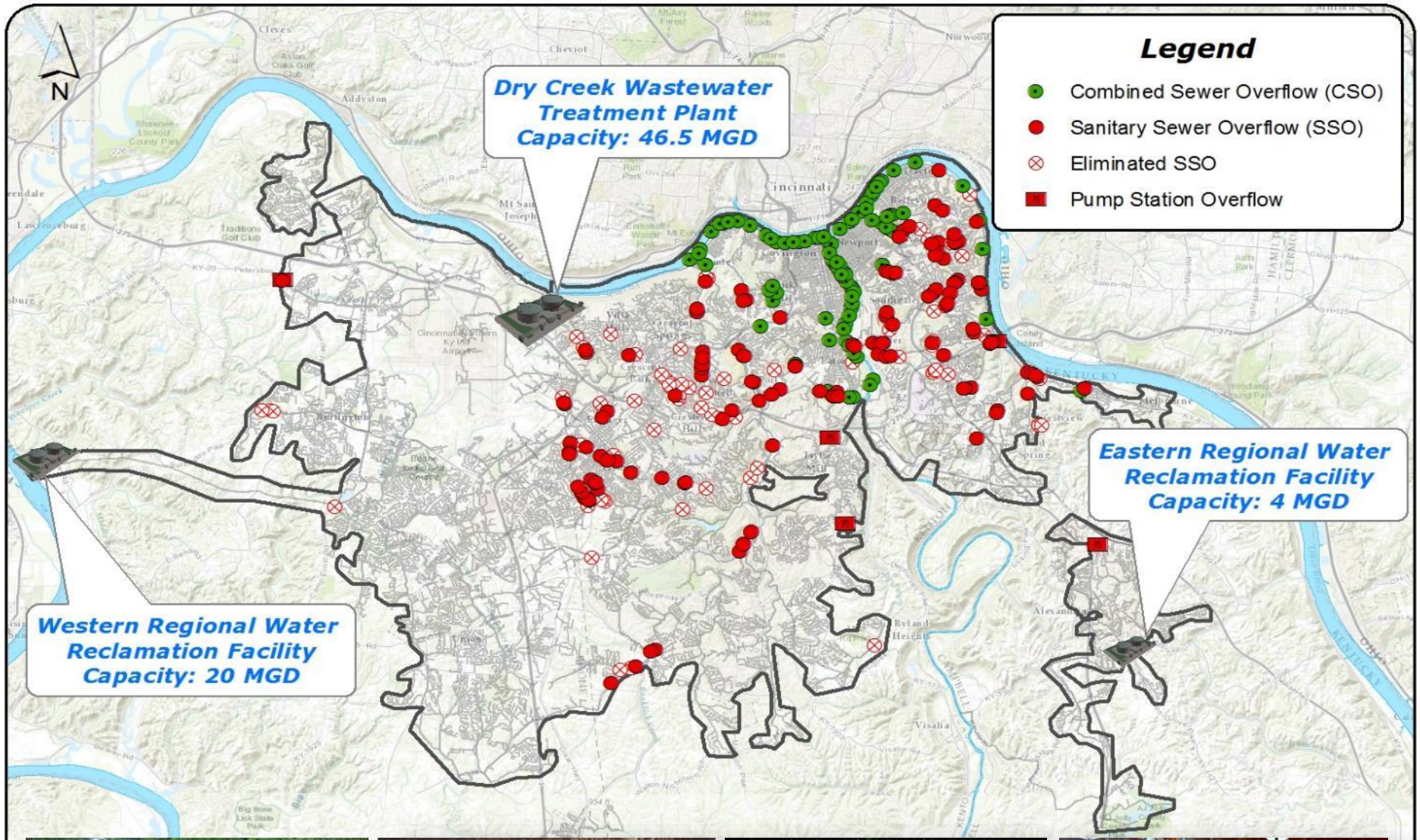
SD1 Infrastructure

- SD1 Sanitary Infrastructure
  - 1,610 miles of sanitary sewer pipes
  - 123 wastewater pumping stations
  - 6 small wastewater treatment plants
  - 3 major wastewater treatment plants

- SD1 Storm Water Infrastructure
  - 440 miles of storm pipe
  - 32,000 storm sewer structures
  - 15 flood pump stations
  - 78 flood gate structures

Primary Challenges

- Combined Sewer Overflows
  - 96 CSO Locations
  - 1.7 Billion Gallons Annually
  - Reduce by 85% per Consent Decree
- Sanitary Sewer Overflows
  - 139 Recurring SSO Locations
  - 149 Million Gallons Annually
  - Eliminate all per Consent Decree
- Storm Water Runoff (MS4 & NPS)
  - Hydromodification
  - Flooding
- Impaired Waters
  - Primary Pollutants of Concern (Bacteria, Solids & Nutrients)


N
Legend
Combined Sewer Overflow (CSO)
Sanitary Sewer Overflow (SSO)
Eliminated SSO
Pump Station Overflow
Dry Creek Wastewater Treatment Plant Capacity: 46.5 MGD
Eastern Regional Water Reclamation Facility Capacity: 4 MGD
Western Regional Water Reclamation Facility Capacity: 20 MGD

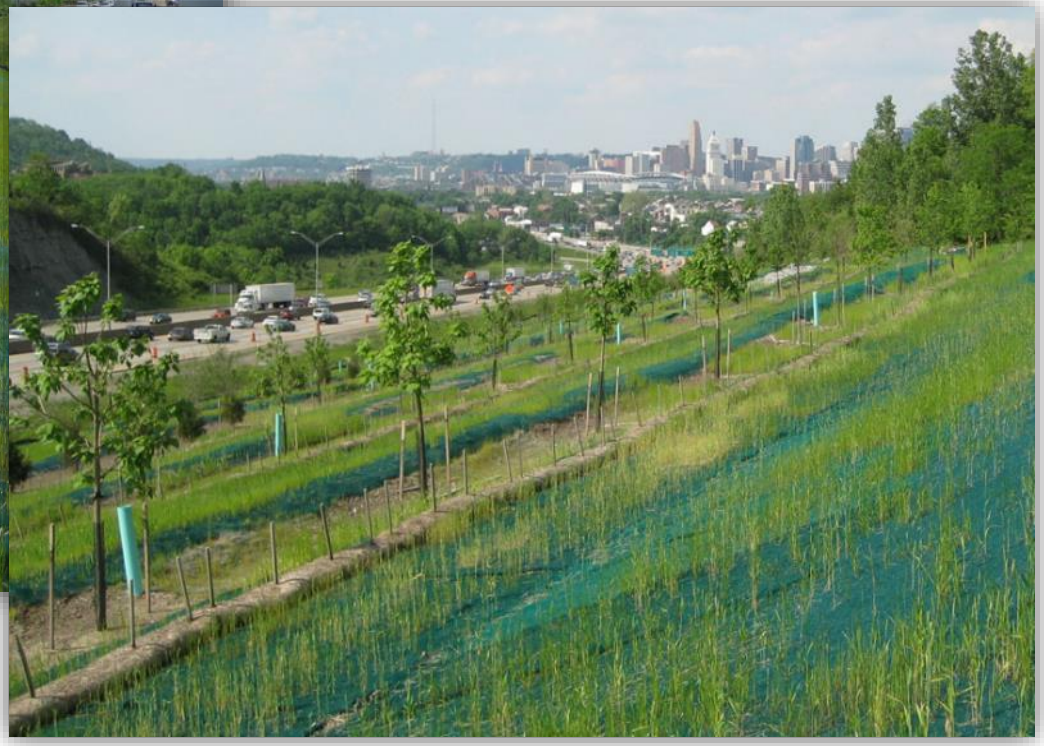
Watershed Based Approach

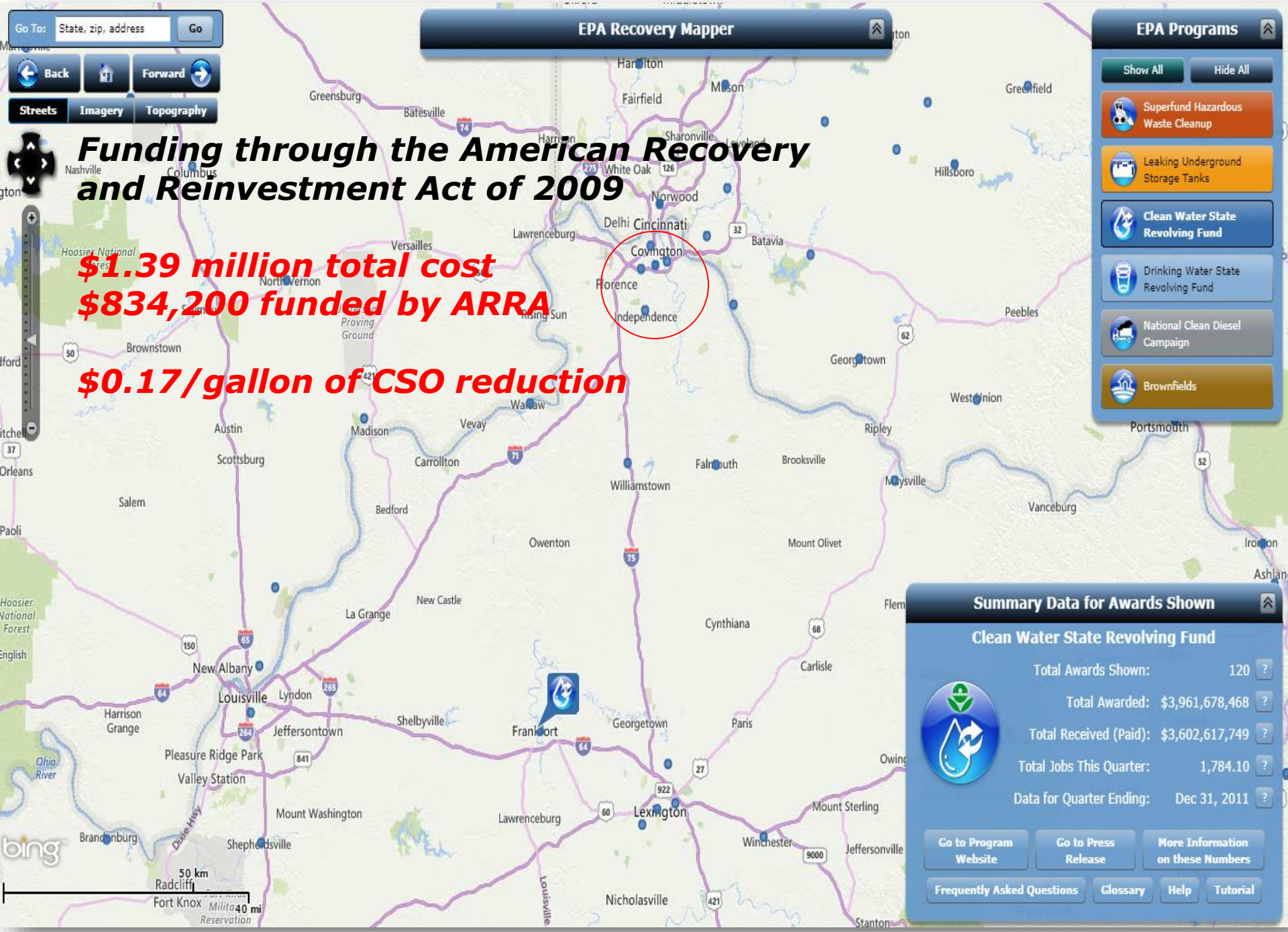
- Integrate green/gray/watershed controls to improve water quality
- Establish priorities based on regional objectives
- Address overflows in context with other sources of pollution
- Utilize 5-year planning cycles to identify affordable solutions that are targeted towards highest priorities

Terraced Reforestation on I71-75 “Cut in the Hill”

Terraced Reforestation
Interstate 71/75 Right-of-Way

Terraced Reforestation
Interstate 71/75 Right-of-Way



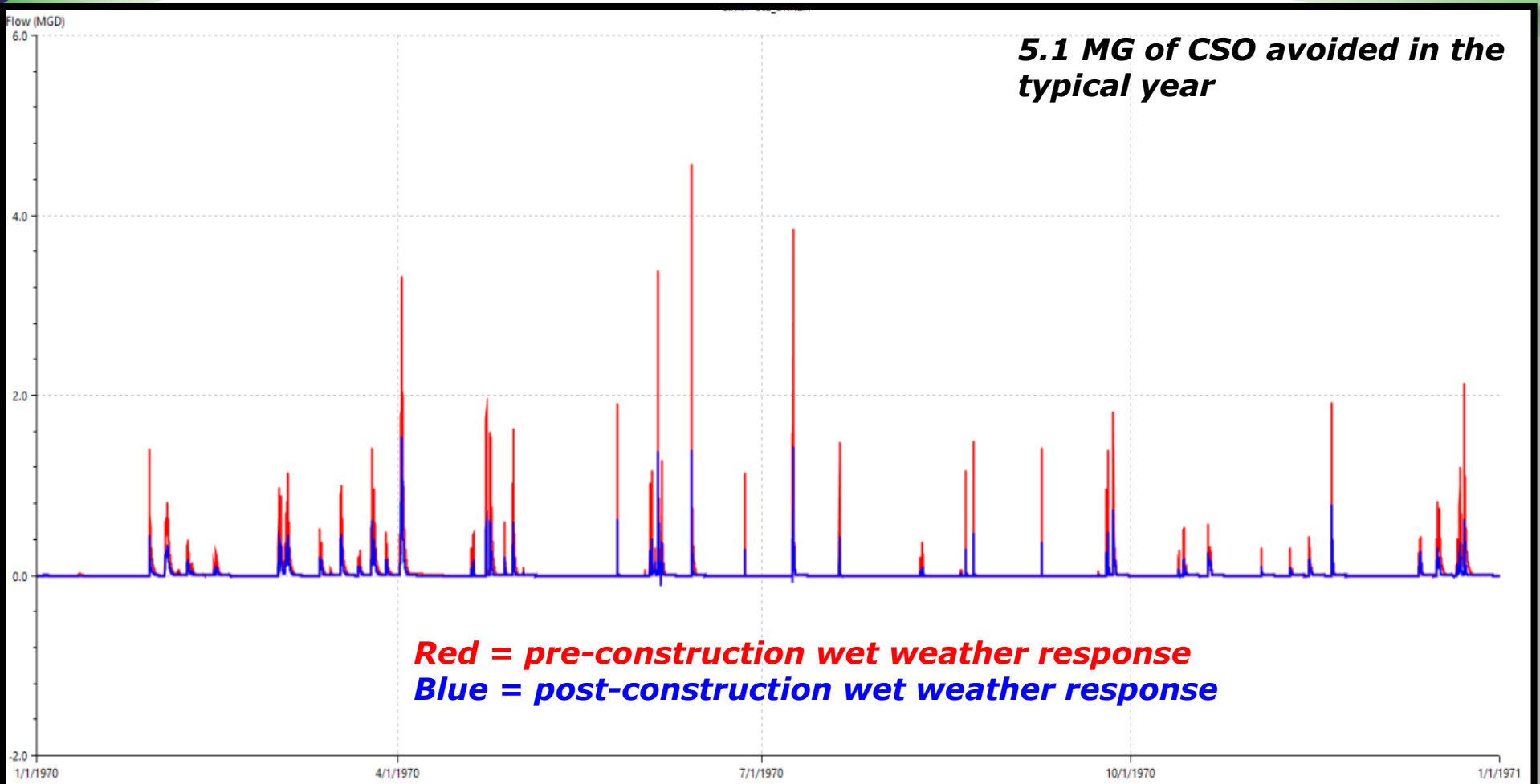


Funding through the American Recovery and Reinvestment Act of 2009

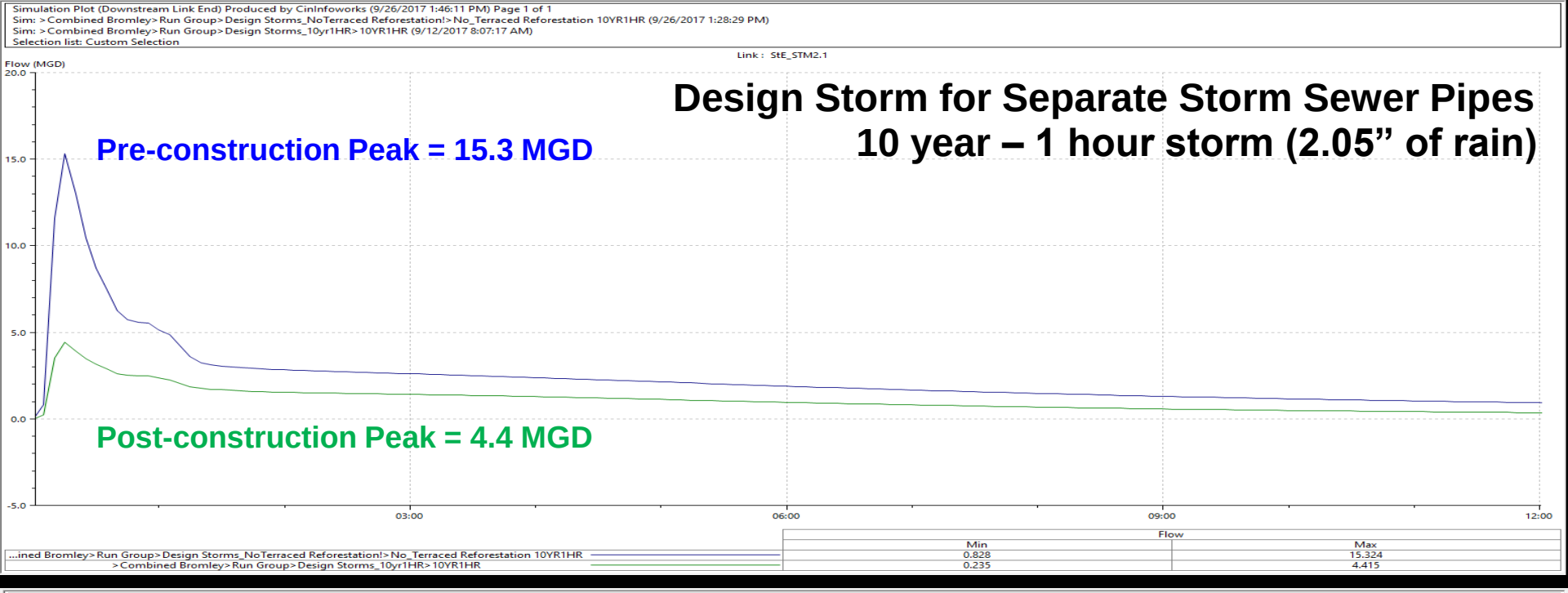
$1.39 million total cost
$834,200 funded by ARRA

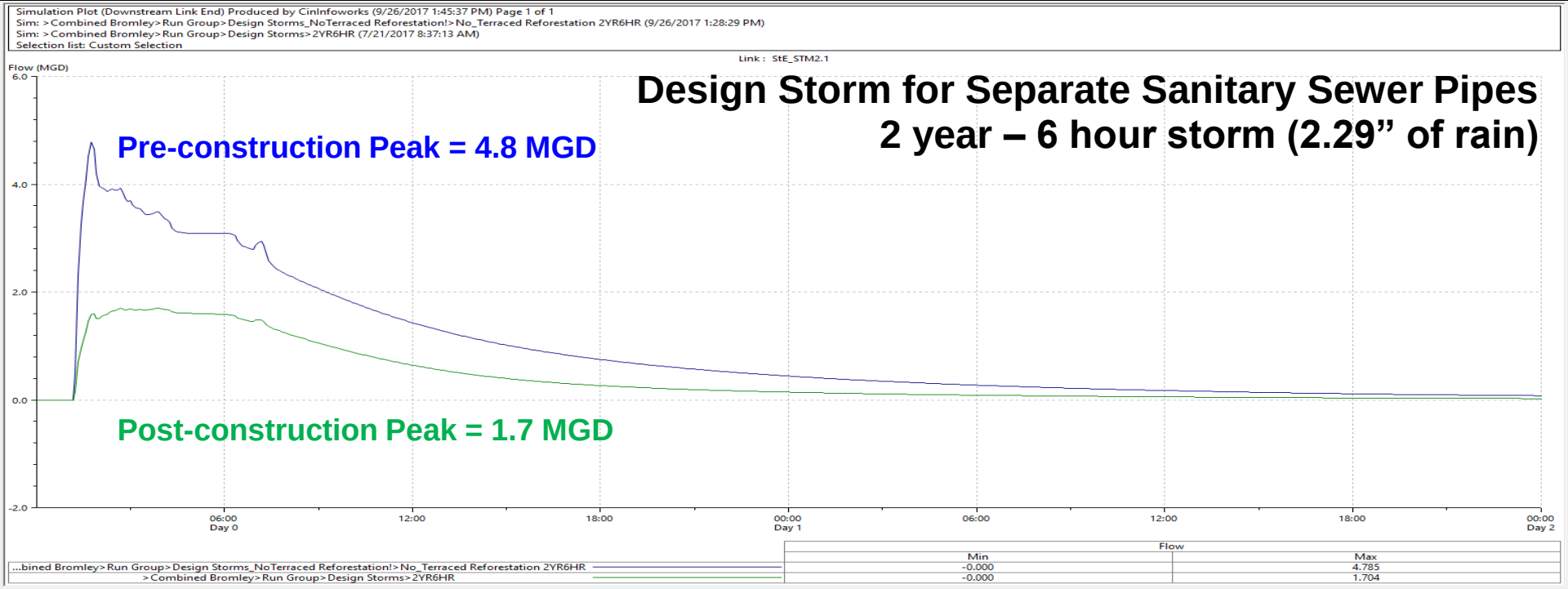
$0.17/gallon of CSO reduction

Typical Year Rate of Runoff Entering Combined Sewer System



	Flow	
	Min	Max
No Terraced Reforestation	-0.000	4.570
With Terraced Reforesation	-0.000	1.546


Simulation Plot (Downstream Link End) Produced by CinInfoworks (9/26/2017 1:46:11 PM) Page 1 of 1
Sim: >Combined Bromley>Run Group>Design Storms_NoTerraced Reforestation!>No_Terraced Reforestation 10YR1HR (9/26/2017 1:28:29 PM)
Sim: >Combined Bromley>Run Group>Design Storms_10yr1HR>10YR1HR (9/12/2017 8:07:17 AM)
Selection list: Custom Selection
Link : StE_STM2.1
Flow (MGD)
Design Storm for Separate Storm Sewer Pipes
10 year – 1 hour storm (2.05" of rain)
Pre-construction Peak = 15.3 MGD
Post-construction Peak = 4.4 MGD
20.0
15.0
10.0
5.0
0.0
-5.0
03:00
06:00
09:00
12:00
Flow
Min
Max
...ined Bromley>Run Group>Design Storms_NoTerraced Reforestation!>No_Terraced Reforestation 10YR1HR
0.828
15.324
>Combined Bromley>Run Group>Design Storms_10yr1HR>10YR1HR
0.235
4.415


Simulation Plot (Downstream Link End) Produced by CinInfoworks (9/26/2017 1:45:37 PM) Page 1 of 1
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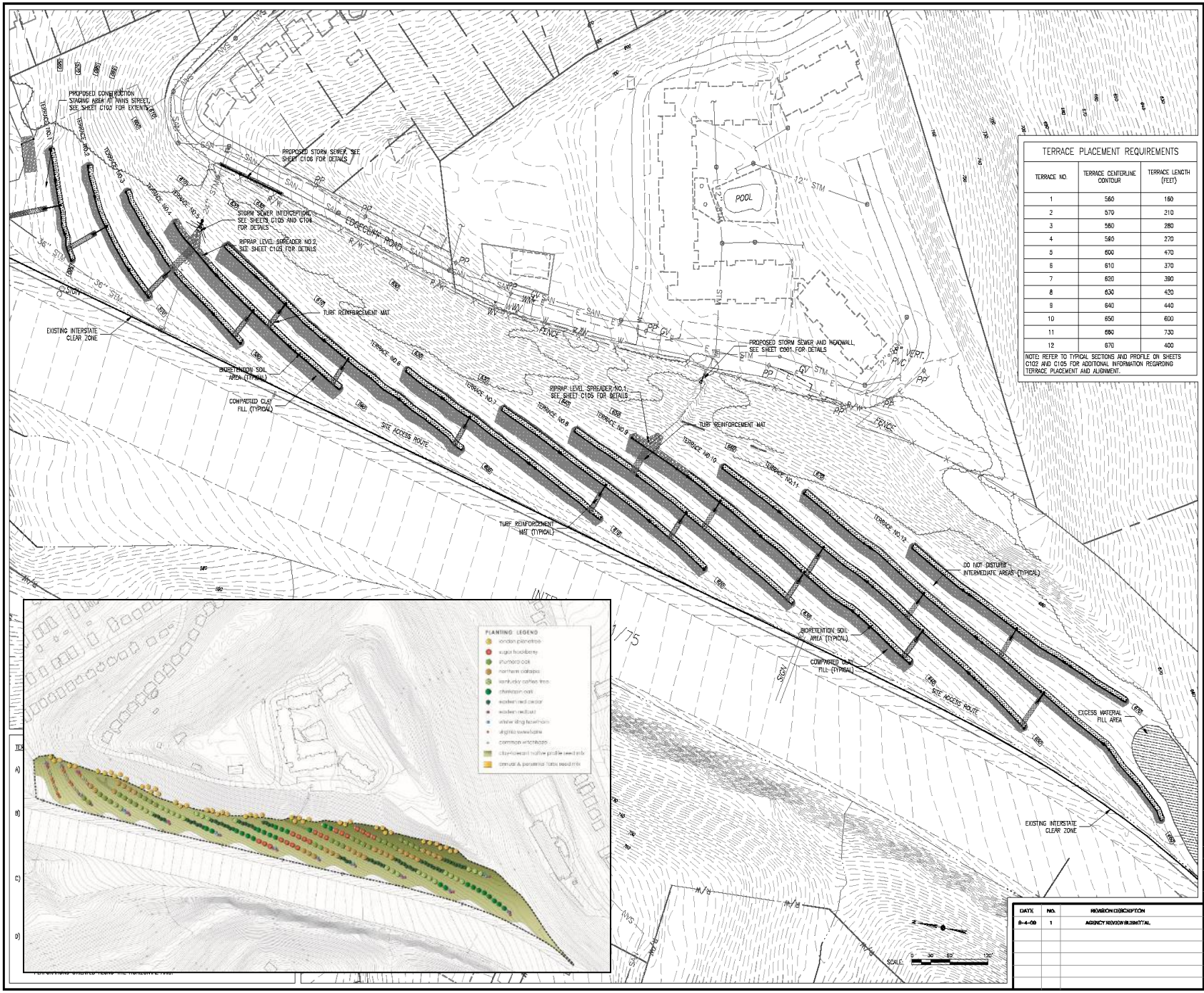
Sim: >Combined Bromley>Run Group>Design Storms>2YR6HR (7/21/2017 8:37:13 AM)
Selection list: Custom Selection
Link : StE_STM2.1
Flow (MGD)
Design Storm for Separate Sanitary Sewer Pipes
2 year – 6 hour storm (2.29" of rain)
Pre-construction Peak = 4.8 MGD
Post-construction Peak = 1.7 MGD
6.0
4.0
2.0
0.0
-2.0
06:00
Day 0
12:00
18:00
00:00
Day 1
06:00
12:00
18:00
00:00
Day 2
Flow
Min
Max
...bined Bromley>Run Group>Design Storms_NoTerraced Reforestation!>No_Terraced Reforestation 2YR6HR
-0.000
4.785
>Combined Bromley>Run Group>Design Storms>2YR6HR
-0.000
1.704

Construction of Willow Run Sewer in 1906

WILLOW RUN SEWER BUILT IN 1906-1906 EXTENDING FROM
PIKE ST. NEAR BULLOCK TO NEAR 16TH ST.,
CONTRACTOR C. BEHLE, INSPECTOR FOR THE CITY OF COV.
CONRAD SCHMIDT

N
500 MG of CSO per year
Willow Run Sewershed
878 acres of existing urban tree canopy
8 acres added with Terraced Reforestation
Terraced Reforestation
5.1 MG CSO Reduction



TERRACE PLACEMENT REQUIREMENTS

TERRACE NO.	TERRACE CENTERLINE CONTOUR	TERRACE LENGTH (FEET)
1	560	160
2	570	210
3	580	280
4	590	270
5	600	470
6	610	370
7	620	390
8	630	420
9	640	440
10	650	600
11	660	730
12	670	400

NOTE: REFER TO TYPICAL SECTIONS AND PROFILE ON SHEETS C102 AND C105 FOR ADDITIONAL INFORMATION REGARDING TERRACE PLACEMENT AND ALIGNMENT.

DATE	NO.	REVISION DESCRIPTION
9-4-09	1	AGENCY REVIEW SUBMITTAL

SEAL

PRIME CONSULTANT/ENGINEER
Riegler Engineering, LLC
Civil Engineering and Land Surveying
10260 Crescent Drive
Independence, KY 41051
P. 859.371.2800
F. 859.371.2810

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Sanitation District No. 1
1045 Eaton Drive
Fort Wright, KY 41017
P. 513.578.7450

CONSULTANT
STRAND ASSOCIATES, INC.
ENGINEERS
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Cincinnati, OH 45202
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LANDSCAPE ARCHITECT
Human Nature
990 St. Paul Place
Cincinnati, OH 45206
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F. 513.281.2243

GEOTECHNICAL ENGINEER
THELEN ASSOCIATES, INC.
Geotechnical • Testing Engineers
1396 Cox Avenue
Erlanger, KY 41018
P. 859.746.9400
F. 859.746.9405

TERRACED REFORESTATION OF INTERSTATE RIGHT-OF-WAY COVINGTON, KENTUCKY

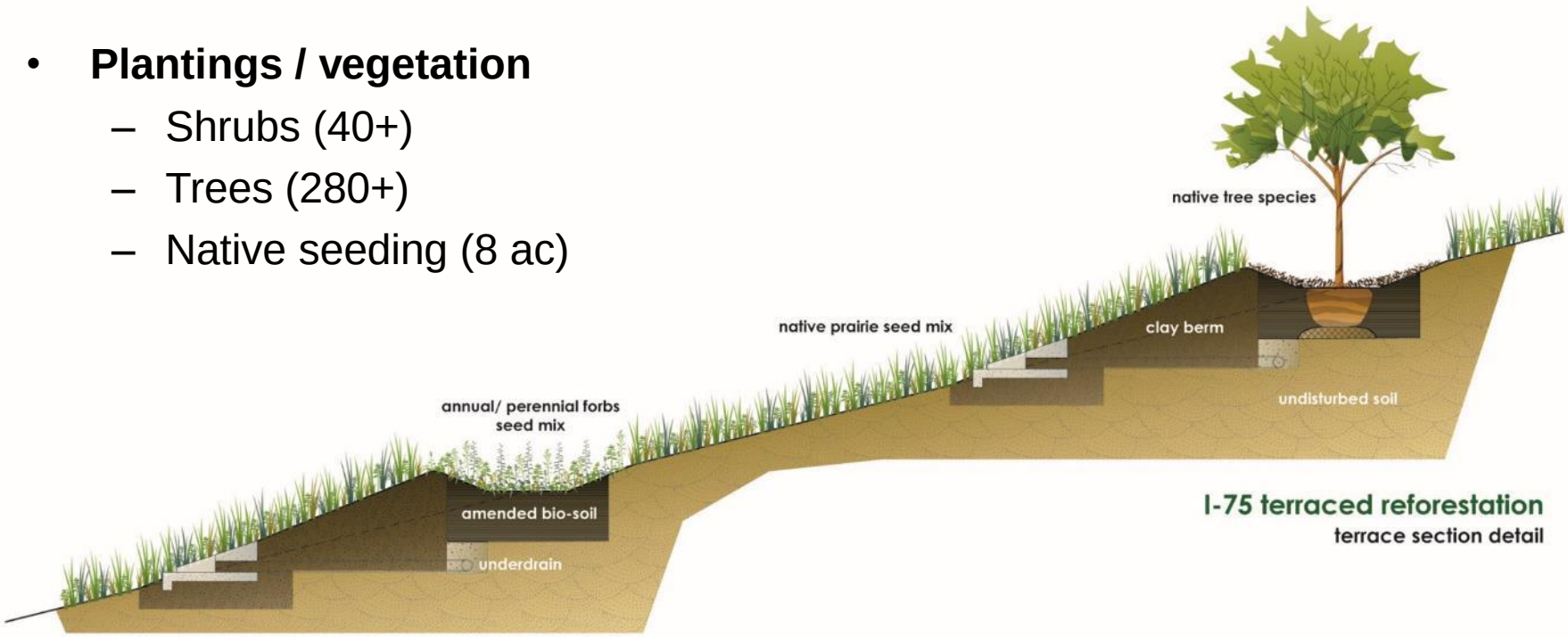
DATE: AUGUST 31, 2009
DESIGNED BY: CJR
CHECKED BY: MAW

09021
PROJECT No.

TERRACED REFORESTATION PLAN

SHEET NO.
C101

- **Bioretention**
  - 12 Linear cells, 4,900 ft total
  - Soil mix (3,800 cys)
  - Underdrain system
- **Plantings / vegetation**
  - Shrubs (40+)
  - Trees (280+)
  - Native seeding (8 ac)
- **Erosion / sediment control**
  - Erosion control blanket (3,900 sys)
  - Straw wattle (4,700 ft)



GENERAL NOTES

1. BASE INFORMATION PROVIDED BY RIEGLER ENGINEERING, LLC, 10136 TEUBEN DRIVE, INDEPENDENCE, KY 41051. 859.371.6665

2. CONTRACTOR SHALL LOCATE ALL UTILITIES, STRUCTURES, PAVEMENT AND VEGETATION TO REMAIN, AND TAKE THE NECESSARY PRECAUTIONS FOR THEIR PROTECTION DURING CONSTRUCTION. UTILITIES SHOWN ON PLANS ARE APPROXIMATE AND ONLY UTILITIES ON RECORD. FIELD LOCATE ALL UTILITIES. CONTRACTOR IS RESPONSIBLE FOR ALL UTILITIES. ANY FIELD ADJUSTMENTS REQUIRED SHALL BE REVIEWED BY THE LANDSCAPE ARCHITECT PRIOR TO IMPLEMENTATION.

3. CONTRACTOR SHALL BE RESPONSIBLE FOR MEETING ALL APPLICABLE FEDERAL, STATE AND LOCAL CODES, LAWS, ORDINANCES, RULES AND REGULATIONS DURING THE COURSE OF THIS PROJECT, INCLUDING BUT NOT LIMITED TO OSHA REQUIREMENTS FOR PUBLIC AND WORKER SAFETY. SITE SHOULD BE KEPT IN A SAFE MANNER THAT WOULD NOT JEOPARDIZE THE GENERAL PUBLIC SAFETY.

4. CONTRACTOR SHALL COORDINATE WITH THE WORK OF OTHER TRADES TO INSURE PROPER AND TIMELY EXECUTION OF THE WORK.

5. CONTRACTOR TO SECURE ENTIRE WORK AREA BY FENCING. TREE PROTECTION FENCING CAN BE UTILIZED . ANY GAPS TO BE FILLED WITH ADDITIONAL FENCING. CONTRACTOR TO MAINTAIN A SECURE SITE UNTIL SUCH TIME PROJECT IS COMPLETE AND TURNED OVER TO OWNER.

6. THE SITE DISTURBANCE LIMITS AS INDICATED ON THE PLANS ARE CONSIDERED THE MAXIMUM AREA THAT THE CONTRACTOR CAN DISTURB DURING CONSTRUCTION. THIS INCLUDES ALL GRADING, EQUIPMENT ACCESS, MATERIAL STORAGE, ETC. CONTRACTOR IS TO VERIFY THAT DISTURBANCE LIMITS IS ADEQUATE FOR CONSTRUCTION PRIOR TO BEGINNING WORK. NOTIFY LANDSCAPE ARCHITECT AT THE ONSET OF THE PROJECT IF LIMITS NEED TO BE ADJUSTED. STORAGE OF FILL, TOOLS, OR MACHINERY UNDER THE DRIPLINE OF TREES IS NOT PERMITTED.

7. CONTRACTOR IS RESPONSIBLE FOR REMOVING TREES AS INDICATED ON PLAN IN A SAFE MANNER WITHOUT DAMAGE TO PROPERTY AND SURROUNDING TREES. FOLLOW ALL SAFETY REGULATIONS! SAFETY OF PUBLIC AND WORKERS IS TO BE PRIMARY CONSIDERATION IN THE WORK. REMOVED TREES SHALL BE CHIPPED FOR USE AS EROSION CONTROL MULCH. REMOVE STUMPS AND ROOT BALLS.

8. REFERENCE TO LANDSCAPE ARCHITECT REFERS TO OWNER'S REPRESENTATIVE OR LANDSCAPE ARCHITECT.

9. SEE CIVIL ENGINEER DRAWINGS FOR SEDIMENT & EROSION CONTROL PLAN.

10. SEE CIVIL ENGINEER DRAWINGS FOR BERMONS LAYOUT.

11. SEE CIVIL ENGINEERS PLANS FOR SITE ACCESS AND CONTROLS.

PLANTING LEGEND

KEY	LANDSCAPE ITEM
	SUGAR HACKBERRY
	NORTHERN CATALPA
	SHUMARD OAK
	KENTUCKY COFFEE TREE
	CHINKAPIN OAK
	EASTERN RED CEDAR
	LONDON PLANETREE
	EASTERN REDBUD
	WINTER KING HAWTHORN
	COMMON WITCHHAZEL
	VIRGINIA SWEETSPIRE
	TOE OF SLOPE
	LIMITS OF DISTURBANCE MAINTENANCE

GRAPHIC SCALE
0 10 20 40
(IN FEET)
1 INCH = 20 FT.

DATE	NO.	REVISION DESCRIPTION
8/4/09	1	AGENCY REVIEW SUBMITTAL

PRIME CONSULTANT/ENGINEER
Riegler ENGINEERING LLC
CIVIL ENGINEERING AND LAND SURVEYING
10136 TEUBEN DRIVE
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F 859.371.8710

PROJECT COORDINATOR
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615 ELSINORE PL. #320
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LANDSCAPE ARCHITECT
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HELLER & ASSOCIATES, INC.
Geotechnical • Testing Engineers
1398 Cox Avenue
ERLANGER, KY 41018
P. 859.746.9400
F. 859.746.9405

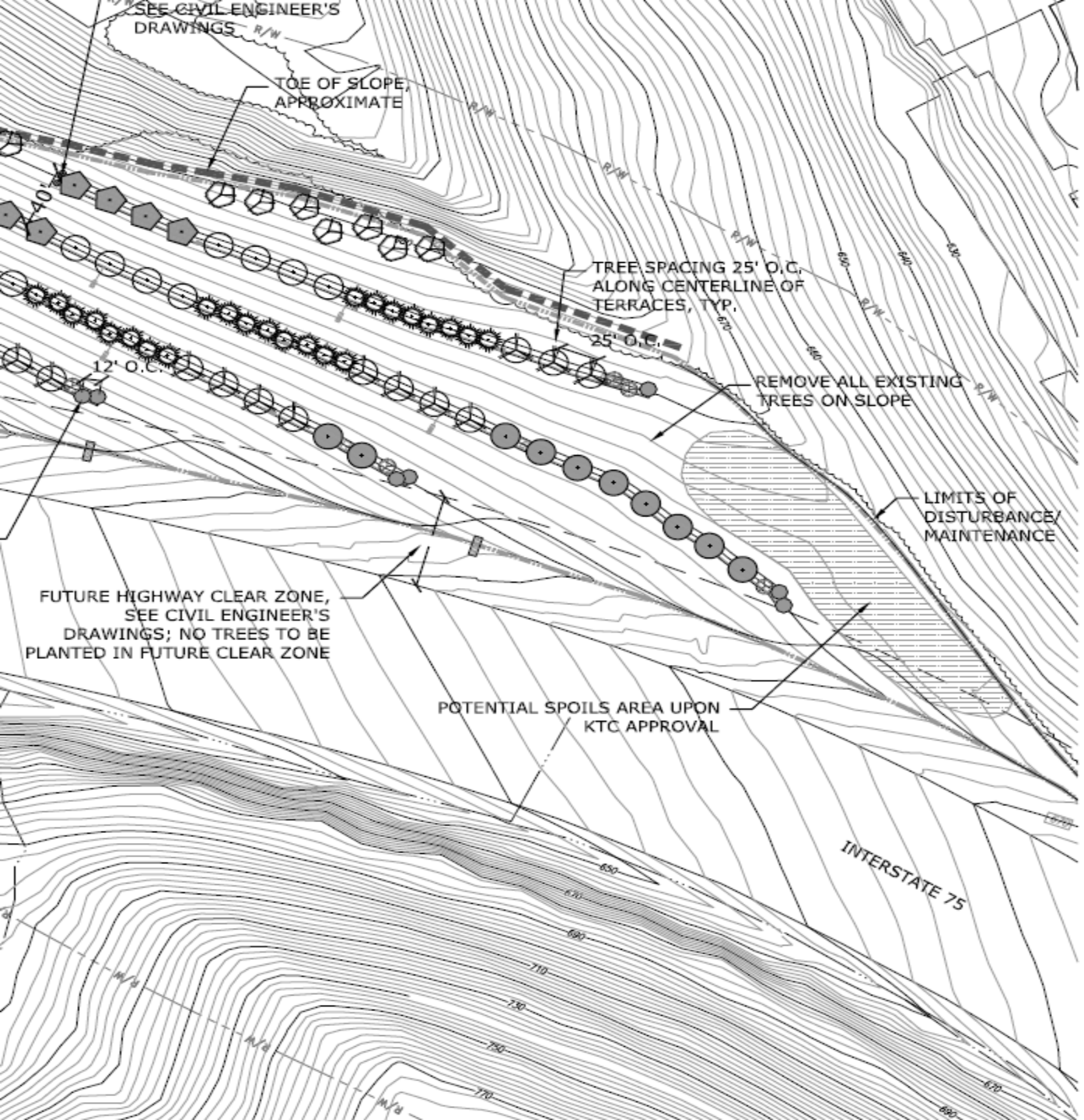
TERRACED REFORESTATION OF INTERSTATE RIGHT-OF-WAY COVINGTON, KENTUCKY

DATE: AUGUST 31, 2009
DESIGNED BY: GW
CHECKED BY: GW

20908
PROJECT No.

PLANTING PLAN

SHEET NO.
L100



PLANTING LEGEND

KEY	LANDSCAPE ITEM
	SUGAR HACKBERRY
	NORTHERN CATALPA
	SHUMARD OAK
	KENTUCKY COFFEE TREE
	CHINKAPIN OAK
	EASTERN RED CEDAR
	LONDON PLANETREE
	EASTERN REDBUD
	WINTER KING HAWTHORN
	COMMON WITCHHAZEL
	VIRGINIA SWEETSPIRE
	TOE-OF-SLOPE
	LIMITS OF DISTURBANCE/ MAINTENANCE

01.06.2011 11:07

05.25.2011 12:19

H 15

H 15

Storm BMP Site - Terraced Reforestation

Facility ID	51	Site Name	Terraced Reforestation	Active Site	☑
Permit Number		Permit Approval	/ / ... / /	Site Record No	68
Status	1 Operational	Acceptance Date	/ /		

Attributes | Contacts | Communications | BMP Assets | Asset Inspections | Asset Tests | Asset Violations/Enforcements | WO/PM/Req | Status Tracking | Custom | Comments

General Location	Located on the East side of the I75 Cut in the Hill			N.O.T Approved	/ /
Subdivision	0 NA			...	/ /
Receiving Stream	0 Combined Sanitary System			Maintenance Agreement	/ /
Parcel	NA	City	62 Covington	...	/ /
...		County	1 Kenton	...	/ /
...		Land Use	3 Transportation and Utilities	...	/ /
Maint Responsibility	SD1	GrIPP	2 No	Final Inspection	/ /
Approved By		Owner	7 State	...	/ /
Deed Book		Watershed	12 Ohio River North	Recorded Date	/ /
Page		In-Line / Off-Line	0 Off-line	...	/ /
...		Storm Water Credit	1 NA	...	/ /
...		Area	418822.2	...	/ /
...		Drainage Area		Water Quality Monitoring ☐	/ /
...		...		Flow Monitoring ☐	/ /
...		...		...	/ /
Zip Code	41011	...		...	/ /
Site ID		...			

Record 1 of 1 | View Mode | Ready...

Lucity 16.0 - client001 - [Storm BMP Site - SD1 Inspected - SD1 Owned/Maintained Sites]

System General Environmental Sewer Storm Transportation Water Electric Gas Trees/Parks Fleet Plant/Equip Facility Refuse/Recycling Work Inventory View Window Help

Facility ID	51	Site Name	Terraced Reforestation	Actively Inspected	☑
Permit Number		...	/ /	... / /	Site Record No 68
Status	1 Operational	...	/ /		

Attributes | Contacts | Communications | BMP Assets | Asset Inspections | Asset Tests | Asset Violations/Enforcements | WO/PM/Req | Status Tracking | Custom | Comments

Inspection Date	...	BMP Asset Number	Type Text	Inspector Text	Inspection Type Text	...	...
08/19/2012		009.24.8005	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8006	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8007	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8008	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8010	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8011	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8012	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8013	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8014	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8016	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
08/19/2012		009.24.8017	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
09/19/2012		009.24.8009	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
11/15/2012		009.24.8009	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
11/15/2012		009.24.8010	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
11/15/2012		009.24.8011	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
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11/15/2012		009.24.8016	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
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11/15/2012		009.24.8007	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
11/15/2012		009.24.8006	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
11/15/2012		009.24.8005	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
11/15/2012		009.24.8017	Biofiltration Swale	Craig Frye	WO Inspection - Post Construct		
02/18/2013		009.24.8017	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
02/18/2013		009.24.8005	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
02/18/2013		009.24.8006	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
02/18/2013		009.24.8007	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
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05/08/2013		009.24.8009	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
05/08/2013		009.24.8010	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
05/08/2013		009.24.8011	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		
05/08/2013		009.24.8014	Biofiltration Swale	Jason Burlage	WO Inspection - Post Construct		

Record 49 of 72 | View Mode | Ready...

Storm BMP Asset Inspections - Unnamed Filter Set

BMP Asset Number	009.24.8013	Type	3 Biofiltration Swale	Latest Inspection	☑
Inspector	0 Student Assistant	Inspection Date	03/18/2015 : AM	Inspector Name Text	Enderle
Inspection Type	1 WO Inspection	...	/ /	...	
Overall Cond	2 Good	...			

Inspection Checklist | Custom | Custom 2 | Notices / Violations / Corrections | Comments

No	Checklist Item	Pass Text	Note
1	Swale is free of organic/inorganic debris and trash	Yes	
2	No standing water is present 48 hours after rain event	Yes	
3	Plants are established and healthy	No	One dead and fallen tree needs to be removed
4	Sparse vegitation shall not result in bare patches of greater...	Yes	
5	Weeding has been preformed preventing nuisance weed t...	Yes	
6	No evidence of erosion/rills greater than 2 inches in size	Yes	
7	If present, riprap and/or check dams are intact	Yes	
8	No blockages or sediment build-up on inlets, outlets, and c...	Yes	
9	Cleanouts are free of debris and blockages	No	Could not find the cleanout for this terrace
10	Sediment depth shall not exceed 2 inches in any spot	Yes	
11	Sediment accumulation, regardless of depth, shall not cove...	Yes	
12	No erosion or under-cutting of inlet/outlet structures	Yes	
13			

Record 1 of 1 | View Mode | Ready...

07.15.2011 14:25

Budweiser
BUD LIGHT

Red +
White —
Amazon