

# **ODOT Research**

# **Soil Amendment for Stormwater Volume Reduction**

ms consultants | USGS | 2019

## **Research Team**









### ms consultants, inc.

Principle-in-charge Principle investigator, interim and final reports Hydrologic analysis Construction plan production

### **United States Geological Survey (USGS)**

Co-principle investigator Flow monitoring Hydrologic analysis

**STONE Environmental** Soil amendment plans Report assistance

BUDS INC. General contracting services Soil amendment installation/construction

## **Project Overview**

### GOAL

Develop additional options for post-construction BMPs available to ODOT projects.

#### LOCATION **WORK PLAN** AND Site Identification 1) DESIGN Phase 1 Flow monitoring plans MANUAL 2) 8 months Soil amendment plans 3) Phase 2 Existing conditions flow monitoring 4) 15 months Install/construct soil amendments 5) Post-amendment flow monitoring 6) **VOLUME TWO** Phase 3 DRAINAGE DESIGN Analyze results 7) 23 months The OHIO DEPARTMENT of TRANSPORTATION Develop BMP design standards 8) Submit to Ohio EPA for comments and approval 9)

## Site Selection

### **SELECTION CRITERIA**

- 1) Grassed shoulders in ODOT right-of-way (similar to current vegetated filter strip BMP)
- 2) Appropriate length, width, and slope
- 3) Safe access for construction/maintenance crews
- 4) Minimize offsite drainage area
- 5) Distribute sites across Ohio's rainfall zones A, B, and C
- 6) Coordinate with schedules ODOT Projects

### **CONTROL SITES**

- 1) Added to provide more accurate results and analysis
- 2) Compare rainfall and runoff from one year to the next
- 3) Located adjacent to other monitoring sites







# **Field Visits**



# Center medians provided the best monitoring sites

- 1) Within ODOT R/W
- 2) Consistent length, width, and slope
- 3) Good protection
- 4) Easy to maintain
- 5) High percent of roadway sheet flow
- 6) No off-site drainage area
- 7) Minimal utility conflicts
- 8) Existing catch basins ideal for installing monitoring equipment

## **Selected Sites**



### **MATERIALS REVIEWED**

- 1) Compost
- 2) Sand
- 3) Gravel
- 4) Gypsum
- 5) Expanded Shale
- 6) Biochar
- 7) Crumb Rubber
- 8) Others



Soil Amendment

### **MATERIAL CRITERIA**

- 1) Improve infiltration, exfiltration, and evapotranspiration
- 2) Improve soil stability and resist erosion
- 3) Improve vegetation growth
- 4) Materials readily available in Ohio
- 5) Cost effective

## **Amendment Designs**

### **Selected Materials**

- 1) Compost
- 2) Sand
- 3) Expanded Shale

### **Amendment Designs**

- 1) Compost & Sand (4-inch)
- 2) Compost & Sand (6-inch)
- 3) Compost & Expanded Shale (4-inch)
- 4) Compost & Expanded Shale (6-inch)

FINAL RECOMMENDED SOIL AMENDMENT DESIGN										
Mix Design	Number of Sites	Incorporation Depth (in.)	Native Soil (%)	Compost (%)	Sand (%)	Expanded Shale (%)				
Α	2	4	54	29	17	0				
В	B 2		54	29	0	17				
С	3	6	54	29	17	0				
D	3	6	54	29	0	17				



## **Amendment Locations**

10



# Gage Installation March 12 - 30, 2018



# Gage Installation March 12 - 30, 2018



# Gage Installation March 12 - 30, 2018









### Gage Data - flumes

#### USGS Ohio Water Science ...

Available Parameters   □ All 2 Available Parameters for this site   ☑ 00060 Discharge   ☑ 00065 Gage height	Available Period 2018-03-16 2018-05-11 2018-03-16 2018-05-11	Output format Graph Graph w/ stats Graph w/o stats Graph w/ (up to 3) parms Table Tab-separated	Days (1) or Begin date 2018-04-03 End date
		○ Tab-separated	2018-04-04

#### Summary of all available data for this site Instantaneous-data availability statement

#### Discharge, cubic feet per second

Most recent instantaneous value: 0.00000 05-11-201

#### Gage height, feet

Most recent instantaneous value: -0.04 05-11-2018 09:02 EDT



#### USGS 400448082452500 Flume at SR 161 nr Beech Road nr New Albany OH



#### 17

**a** 

### Gage Data - rain

#### Precipitation, total, inches

Most recent instantaneous value: 0.00 05-11-2018 08:02 EDT



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1										
2					Input					
3										
4		Time Step	Rain	Q					Gap	Gap
5		(min)	Cuttoff	Cutoff					Ignore	Ignore
6		1	0	0					180	75
7										
8	#	Date Time	Rain	0	Cume	Cume	Rain	Q Above	Rain	O Index
9		Dute Time		2	Rain	Q	above	Cutoff	Index	QINCER
10	1	3/16/2018 10:55	0.00	0.00	0.00	0.00	0.00	0.00	0	0
11	2	3/16/2018 10:56	0.00	0.00	0.00	0.00	0.00	0.00	0	0
12	3	3/16/2018 10:57	0.00	0.00	0.00	0.00	0.00	0.00	0	0
13	4	3/16/2018 10:58	0.00	0.00	0.00	0.00	0.00	0.00	0	0
14	5	3/16/2018 10:59	0.00	0.00	0.00	0.00	0.00	0.00	0	0
15	6	3/16/2018 11:00	0.00	0.00	9.00	0.00	0.00	0.00	0	0

336356	336347	11/4/20 <u>18 23·41</u>	0.00	0.00	40.65	131319	0.00	0.00	0	0
336357	336348	11/4/2018 23:42	0.00	0.00	40.65	131319	0.00	0.00	0	0
336358	336349	11/4/2018 23:43	0.00	0.00	40.65	131319	0.00	0.00	0	0
336359	336350	11/4/2018 23:44	0.00	0.00	40.65	131319	0.00	0.00	0	0
336360	336351	11/4/2018 23:45	0.00	0.00	40.65	131319	0.00	0.00	0	0
336361	336352	11/4/2018 23:46	0.00	0.00	40.65	131319	0.00	0.00	0	0
336362	336353	11/4/2018 23:47	0.00	0.00	40.65	131319	0.00	0.00	0	0
336363	336354	11/4/2018 23:48	0.00	0.00	40.65	131319	0.00	0.00	0	0
336364	336355	11/4/2018 23:49	0.00	0.00	40.65	131319	0.00	0.00	0	0
336365	336356	11/4/2018 23:50	0.00	0.00	40.65	131319	0.00	0.00	0	0
336366	336357	11/4/2018 23:51	0.00	0.00	40.65	131319	0.00	0.00	0	0
336367	336358	11/4/2018 23:52	0.00	0.00	40.65	131319	0.00	0.00	0	0
336368	336359	11/4/2018 23:53	0.00	0.00	40.65	131319	0.00	0.00	0	0
336369	336360	11/4/2018 23:54	0.00	0.00	40.65	131319	0.00	0.00	0	0

## Annual Pre-BMP results

Period of record March - December 2018										
				Measured T	otals					
Site #	DA	Slope	Rain (in)	Rain (ft.^3)	Runoff (Ft.^3)		% Runoff			
1	2.05	2.0%	44.2	329,212	148,293		45%			
2	1.04	1.2%	46.3	174,641	79,448		45%			
C1	2.42	1.9%	45.0	395,571	110,692		28%			
3	0.50	2.3%	37.6	68,262	25,361		37%			
4	1.64	1.9%	41.9	249,618	52,857		21%			
5	1.88	1.0%	35.3	240,765	74,201		31%			
6	0.97	2.1%	37.2	131,126	12,580		10%			
C2	0.70	0.8%	36.2	91,908	5,208		6%			
7	1.89	2.5%	34.8	238,890	111,023		46%			
8	0.82	1.4%	31.0	92,394	6,568		7%			
9	0.82	1.1%	28.6	85,161	12,921		15%			
10	1.47	1.2%	28.3	151,225	32,636		22%			

## Annual Pre-BMP results

Period of record March - December 2018										
				Measured T	otals					
Site #	DA	# rain days	Rain (in)		% Runoff					
1	2.05	125	44.2	329,212	148,293		45%			
2	1.04	129	46.3	174,641	79,448		45%			
C1	2.42	130	45.0	395,571	110,692		28%			
3	0.50	115	37.6	68,262	25,361		37%			
4	1.64	146	41.9	249,618	52,857		21%			
5	1.88	121	35.3	240,765	74,201		31%			
6	0.97	152	37.2	131,126	12,580		10%			
C2	0.70	146	36.2	91,908	5,208		6%			
7	1.89	113	34.8	238,890	111,023		46%			
8	0.82	128	31.0	92,394	6,568		7%			
9	0.82	120	28.6	85,161	12,921		15%			
10	1.47	121	28.3	151,225	32,636		22%			









# An event begins .....

### The first 0.01 inch of rain is recorded

# An event ends .....

If there is no additional rain over the next 3 hours AND

If there is no recorded stage above 0.01 ft

## Event based BMP06

	Event						Rain	Max	Max			
#	Dur	Start	End	Dur	Rainfall	FT.^3	Intensity	1 Min	10 Min	Dur	Q	%Runoff
39	148	5/26/18 18:54	5/26/18 21:21	148	2.24	7887	0.0151	0.10	0.82	91	2986	37.9%
<mark>69</mark>	<mark>66</mark>	7/5/18 16:42	7/5/18 17:47	46	0.84	2958	0.0183	0.10	0.60	60	1247	42.2%
60	202	<mark>6/22/18 16:16</mark>	<mark>6/22/18 19:37</mark>	160	1.06	3732	0.0066	0.08	0.55	195	514	13.8%
105	887	9/24/18 13:01	9/25/18 3:47	887	1.56	5493	0.0018	0.04	0.21	<mark>6</mark> 31	576	10.5%
75	310	7/21/18 15:52	7/21/18 21:01	310	0.61	2148	0.0020	0.05	0.19	No Flow	NA	
100	3581	9/7/18 21:33	9/10/18 9:13	3581	3.15	11091	0.0009	0.03	0.18	3233	508	4.6%
36	325	5/21/18 21:49	5/22/18 3:13	325	0.99	3486	0.0030	0.02	0.18	200	166	4.8%
95	583	8/21/18 0:09	8/21/18 9:51	583	0.68	2394	0.0012	0.04	0.16	3	0	0.0%
12	1559	4/15/18 2:12	4/16/18 4:10	1559	2.74	9648	0.0018	0.03	0.15	1125	1824	18.9%
6	1366	4/3/18 3:46	4/4/18 2:31	1366	2.09	7359	0.0015	0.04	0.13	1123	1517	20.6%
50	305	<mark>6/10/18 23:3</mark> 3	6/11/18 4:37	305	0.67	2359	0.0022	0.02	0.11	131	421	17.8%
132	2271	10/31/18 10:11	11/2/18 0:01	2269	2.13	7500	0.0009	0.02	0.09	1315	1047	14.0%
2	1428	3/29/18 6:26	3/30/18 6:13	1367	0.80	2817	0.0006	0.01	0.04	1426	68	2.4%

# **Event Pre-BMP results**



# Hypothetical Event Pre vs Post results



# Pre-Post BMP Results comparison factors

- Drainage area size
- Drainage area slope
- Percentage of drainage area that is impervious
- Event total rainfall
- Event total rainfall intensity
- Event max 1-minute rainfall intensity
- Event max 10-minute rainfall intensity
- Event timeframe of maximum rainfall intensity
- Total rainfall in previous 24 hours
- Total rainfall in previous 48 hours

### **Construction Plans**











# **Next Steps**

- 1) Finish soil amendment installations
- 2) Post-amendment flow monitoring
- 3) Analyze results
- 4) Develop BMP design standards
- 5) Submit to Ohio EPA for comments and approval

# **QUESTIONS?**

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