



IMPLEMENTING VERNAL POOLS IN MID-ATLANTIC STREAM RESTORATION PROJECTS

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Overview

- About Vernal Pools
- Why Vernal Pools
- Project Background & Objectives
- Vernal Pool Design
- Monitoring Methods
- Macro-Invertebrate Sampling & Colonization
- Mosquitos
- Lessons Learned



What are Vernal Pools?

- Vernal pools are seasonal depressional wetlands
- Wet for variable periods of time and may be dry throughout the summer and fall
- May contain rare species because of unique conditions



Why Vernal Pools?

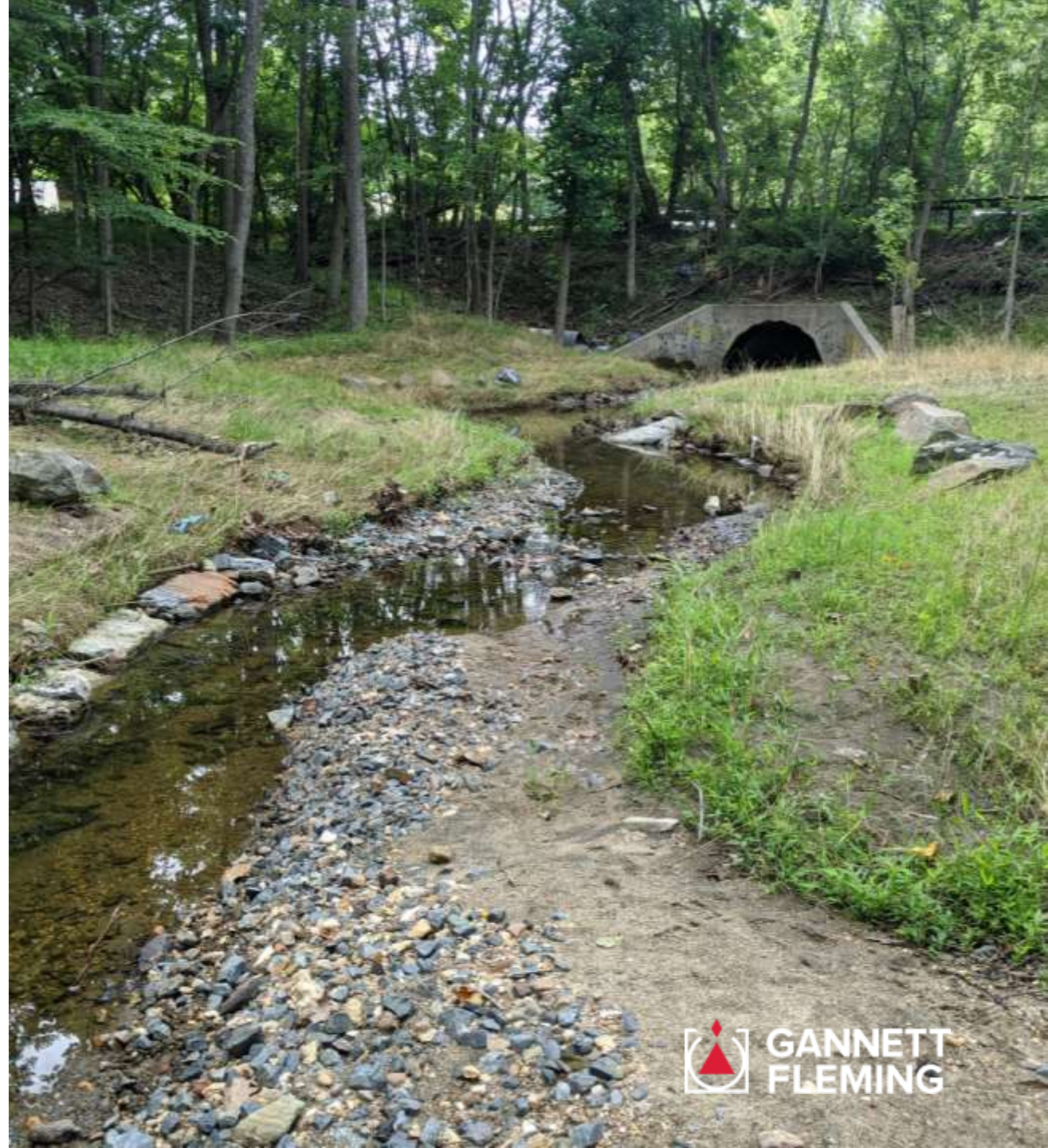
- Floodplain storage
- Added habitat and species diversity (both aquatic and terrestrial)
- Groundwater infiltration and hyporheic exchange
- Natural water treatment
- Cost effective wetland creation



Project Background and Objectives

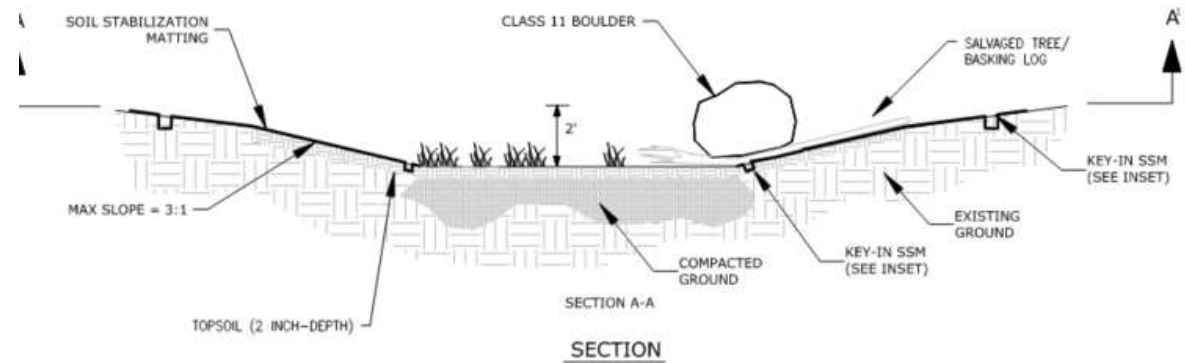
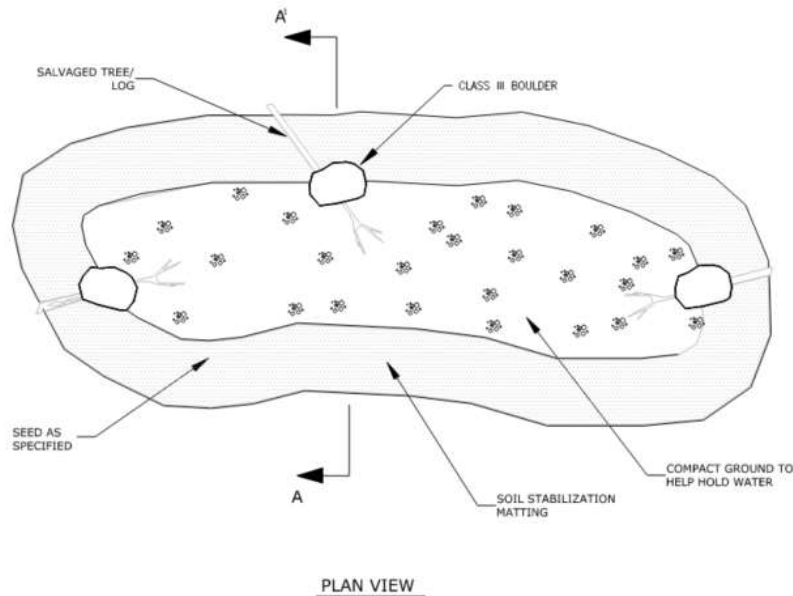
- **Cooper Branch – Baltimore County, MD**
 - Construction completed 2019
 - Confined urban stream valley
 - 3 reaches restored to B4 stream type
 - Monitored for 3 years per USACE Permit
 - 4 constructed vernal pools

- **Cedar Branch – Baltimore County, MD**
 - Construction completed 2020
 - Confined urban stream valley
 - 5 reaches restored to C4 & B4 stream types
 - Monitored for 3 years per USACE Permit
 - 6 constructed vernal pools



Vernal Pool Design

- Vernal pools excavated during demobilization of the haul road
- SSM, topsoil, seed, logs and boulders were added
- Assumed wetting from precipitation, overland flow, and overbank flow events
- Boulders and logs for aquatic and terrestrial habitat



VP VERNAL POOL
SCALE: NOT TO SCALE

Monitoring Methods

- Both projects monitored quarterly for 3 years for USACE permit requirements
- Maryland Biological Stream Survey (MBSS) Vernal Pool Habitat Assessment Form
- Baltimore County DEPS Conducted Macroinvertebrate Sampling in Vernal Pools
 - Cedar Branch 2016, May 2020 – April 2021
 - Cooper Branch July 2019 – April 2021



Design and Monitoring Observations

- Cedar Branch VP-6 never held water
- Cooper Branch VP-4 only held water during one visit
- Vernal pools received water through precipitation and overland flow
- MBSS Vernal Pool Datasheet



Cooper Branch VP-4 6/5/20



Snapping turtle and tadpoles in Cooper Branch vernal pool

MBSS Vernal Pool Data Sheets

- MBSS Vernal Pool Data Sheets used
- Primarily observational
- Recorded dimensions
- Water depth
- Visual observations of inhabitants
- Comments section for other notes



v. 2014 **MBSS VERNAL POOL DATA SHEET** Page **3** of **4**

SITE Watershed Code Segment Type Year Reviewer: First Second

Within Transect? (Y/N): Lat: Long:

Vernal Pool ID: **V P - 0 2**

Dimensions: **1 3** m X **3** m

Max Depth: **3 0** cm

Landscape Setting: **F** Upland or Floodplain

Fish Observed? (Y/N): **N**

Anostraca Observed? (Y/N): **N**

Predominant Surrounding Landuse:

Distance From Pool →

Species	Lifestage			Seen (Y/N)	Heard (Y/N)	# Ret.	# Photos Taken
	Adult	Larva	Egg				
Damselfly (Zygoptera)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	5	<input type="checkbox"/>
Snail (Gastropoda)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Green Frog (Lithobates clamitans)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	6	<input type="checkbox"/>
Mosquito (Culicidae)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
Spider (Araneae)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>

Number **PHOTODOCUMENTATION** Voucher (Y/N)

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COMMENTS: 1 ft standing water throughout, cattails, sedges, and abundant with life.

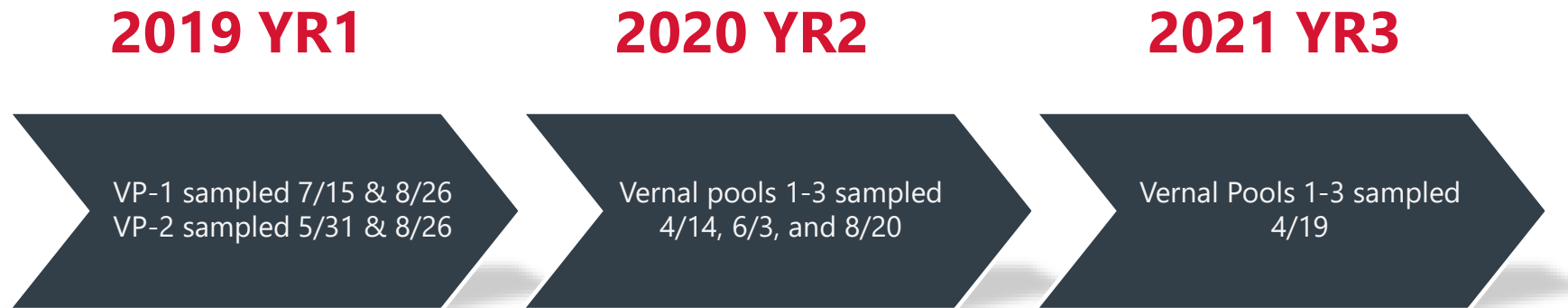
Macroinvertebrate Sampling Methods

- General Approach by Baltimore County Department of Environmental Protection and Sustainability (DEPS)
 - Sample post construction benthos in restored channel and vernal pools
 - Macroinvertebrates were sampled, preserved, and identified in the lab
 - External taxonomist verification of species ID
 - 10 sq. ft sampling areas were used beginning in 2020
 - Species ID, density, diversity, and behavior were considered
 - Do restored channels and riparian zones increase mosquito populations and carry disease to nearby residents?

Macroinvertebrate Sampling

Cooper Branch

- VP-3 was dry during 2019 sampling
- VP-4 only held water during 4/1/20 visit and was not sampled



Macroinvertebrate Results and Colonization

Cooper Branch

- Expect abundance and species diversity increase, then stabilize over time
- Colonization began < 2 months from construction in 2019
- In 2020, VP-1 had a population of *callibaetis* mayflies, a still/slow water species
- Predator species exist in significant numbers
- Midges, craneflies, true bugs, damselflies, dragonflies, snails, beetles, and worms were collected in all pools

Cooper VP-1	7/15/2019	8/26/2019	4/14/2020	6/3/2020	8/20/2020	4/19/2021
Total abundance	6	15	55	53	80	60
Abundance/sq.ft.	N/A	N/A	5.5	5.3	8.0	6.0
No. of distinct taxa	4	9	7	6	15	16
% Chironomidae	0	7	0	2	20	5
% Predator	33	40	27	8	21	33

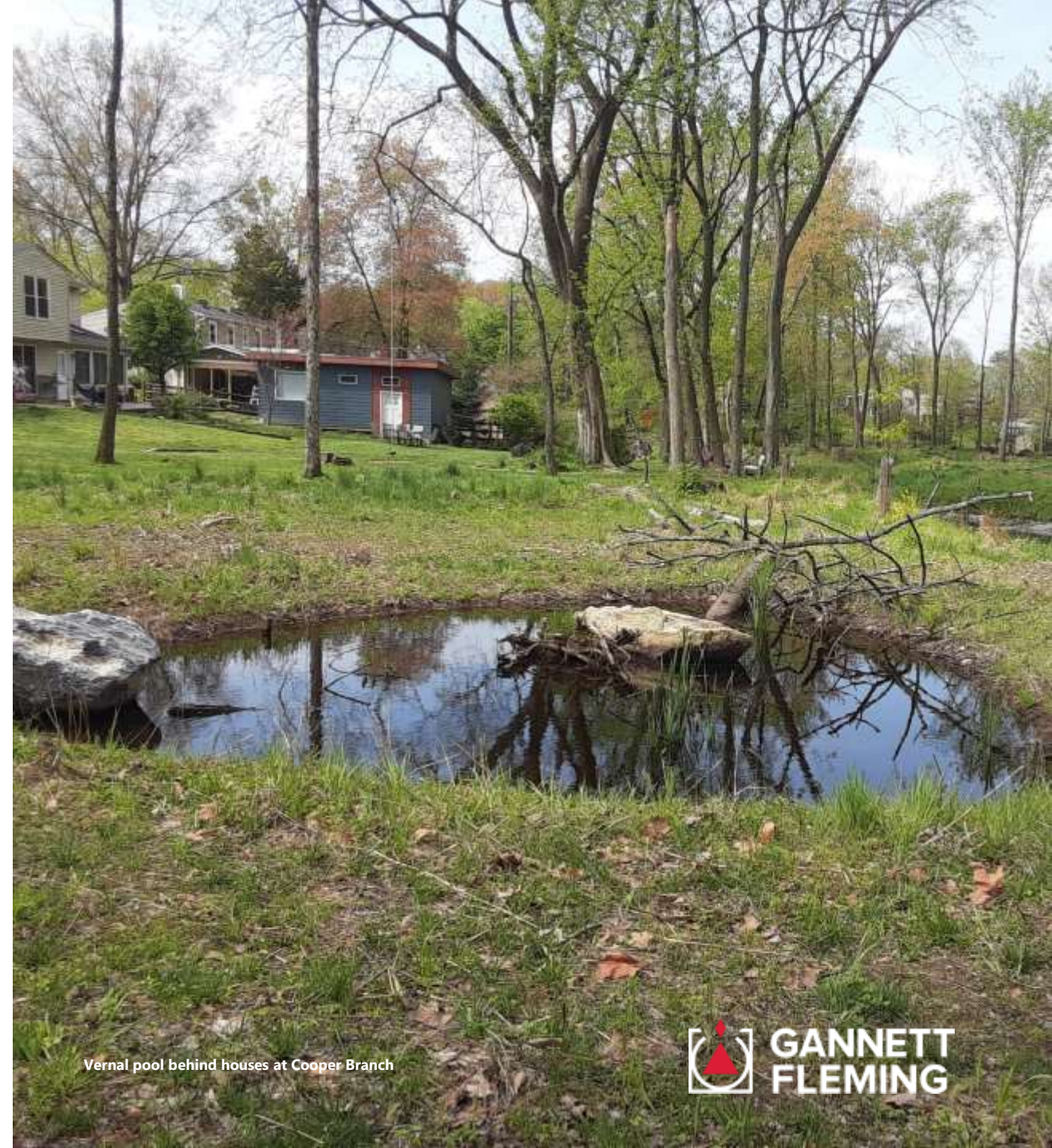
Cooper VP-2	5/31/2019	8/26/2019	4/14/2020	6/3/2020	8/20/2020	4/19/2021
Total abundance	1492	16	61	72	67	84
Abundance/sq.ft.	N/A	N/A	6.1	7.2	6.7	8.4
No. of distinct taxa	8	7	4	10	8	12
% Chironomidae	0	6	0	18	1	11
% Predator	0	38	13	21	7	24

Cooper VP-3	NO SAMPLE (DRY)	4/14/2020	6/3/2020	8/20/2020	4/19/2021
Total abundance		15	113	139	72
Abundance/sq.ft.		1.5	11.3	13.9	7.2
No. of distinct taxa		4	14	14	9
% Chironomidae		0	6	5	31
% Predator		13	12	14	14

Mosquitos

Cooper Branch

- Field observations noted far fewer mosquitos present in 2020 than 2019
- Invertebrate species diversity increased beginning in 2019
- Three container species were identified but comprised less than 10% of each subsample except the first sample (4/14/2020) in VP-3.
- *Cx. Territans* only feeds on amphibians and requires good water quality
- *Aedes albopictus* (Asian tiger mosquito), the most common urban pest, was absent in all samples.

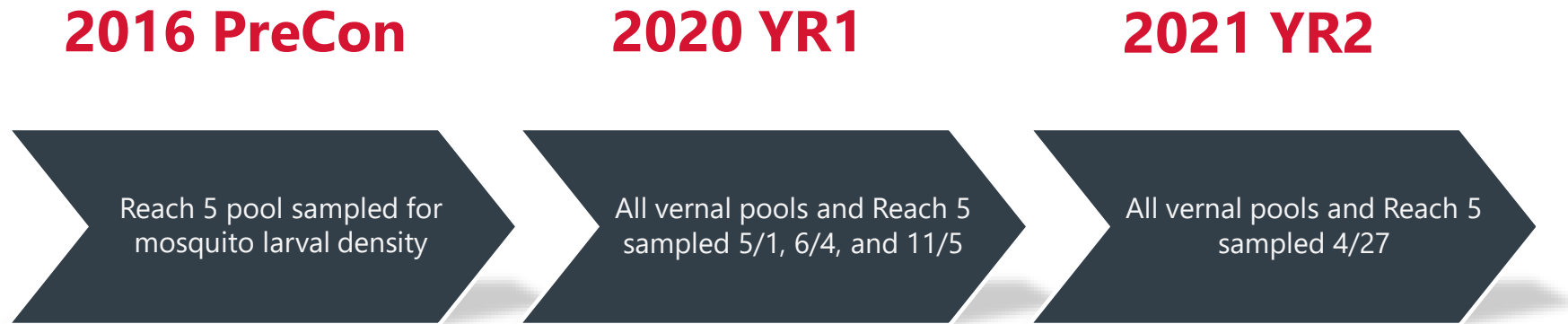


Vernal pool behind houses at Cooper Branch

Macroinvertebrate Sampling Results

Cedar Branch

- VP-6 never held water and was excluded from sampling



Macroinvertebrate Results and Colonization

Cedar Branch

Cedar VP-1	5/1/2020	6/4/2020	11/5/2020	4/27/2021
Total abundance	27	412	56	87
Abundance/sq.ft.	2.7	41.2	5.6	8.7
No. of distinct taxa	5	9	9	11
% Chironomidae	15	48	4	2
% Predator	0	0	46	29

Cedar VP-4	5/1/2020	DRY	11/5/2020	4/27/2021
Total abundance	9		11	29
Abundance/sq.ft.	0.9		1.1	2.9
No. of distinct taxa	4		6	6
% Chironomidae	56		0	14
% Predator	11		9	34

Cedar VP-2	5/1/2020	6/4/2020	11/5/2020	4/27/2021
Total abundance	186	1440	67	85
Abundance/sq.ft.	18.6	144	6.7	8.5
No. of distinct taxa	4	11	9	8
% Chironomidae	78	19	4	14
% Predator	1	0	9	8

Cedar VP-5	5/1/2020	NO SAMPLE (DRY)	4/27/2021
Total abundance	178		47
Abundance/sq.ft.	17.8		4.7
No. of distinct taxa	5		6
% Chironomidae	6		2
% Predator	0		0

Cedar VP-3	5/1/2020	DRY	11/5/2020	4/27/2021
Total abundance	14		2	84
Abundance/sq.ft.	1.4		0.2	8.4
No. of distinct taxa	3		2	2
% Chironomidae	0		0	2
% Predator	0		50	0

Cedar Reach 5	9/16/2016	5/1/2020	6/4/2020	11/5/2020	4/27/2021
Total abundance	254	36	418	11	87
Abundance/sq.ft.	6.0	3.6	41.8	1.1	8.7
No. of distinct taxa	4	4	7	6	9
% Chironomidae	0	92	69	9	46
% Predator	0	0	0	82	2

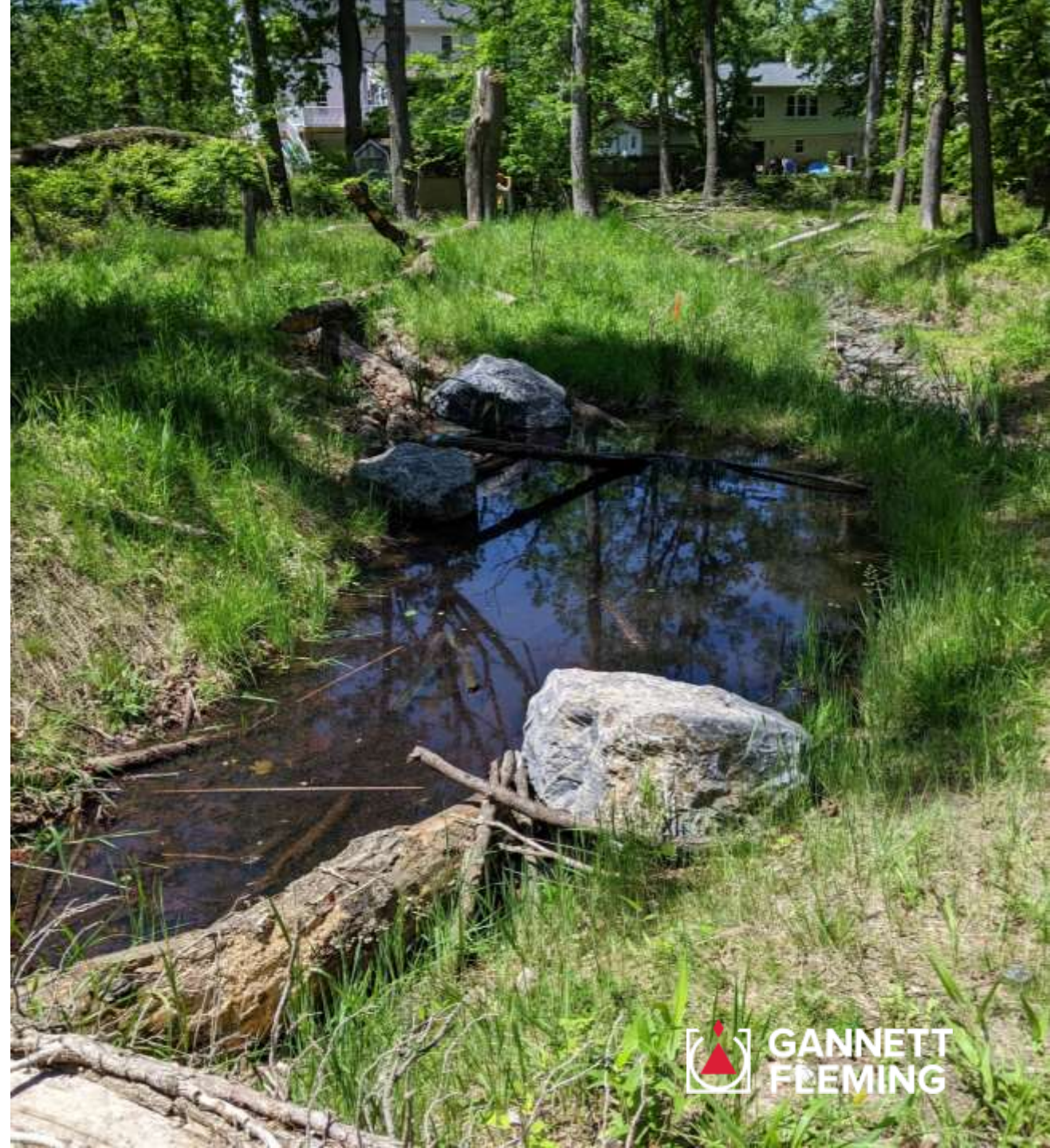
Macroinvertebrate Results and Colonization | Cedar Branch

- Chironomidae were initial colonizers
- Chironomidae tend to decrease as predators increase
- The vernal pool community was more diverse than the stream channel
- Consisted of mayflies, damselflies, dragonflies, non-biting midges, phantom midges, water beetles, snails, true bugs, moth flies, leeches, and worms
- Vernal pool samples differed from the stream channel and from each other
- VP-1 and VP-2 were most diverse, held water during all sampling events, and included mayfly populations



Mosquitos | Cedar Branch

- Construction of the Reach 5 channel reduced mosquito density by 2.0 individuals/sq. ft and changed the community
- Only *Cx. pipiens* was present before and after construction. Wide distribution and tolerance for water quality.
- The presence of species of *Anopheles* suggests water quality improvement in Reach 5, as at least one species (*A. punctipennis*) is reported to prefer clean water (WRBU, 2021a).
- Three container species were identified but varied in population between vernal pools.
- *Cx. Territans* only feeds on amphibians and requires good water quality
- *Aedes albopictus* (Asian tiger mosquito), the most common urban pest, was absent in all samples.



Lessons Learned

- New detail includes planting plugs and livestockes in vernal pools
- Boulders can be better positioned for habitat/basking
- Vernal pools colonize and naturalize quickly
- Vernal pool benthic communities diversified within the first year
- Low risk
 - Too much water becomes a wetland
 - Too little water is a dry depression
- Location, Location, Location
 - Needs sufficient drainage area for inundation
 - Cannot rely solely on flood flows



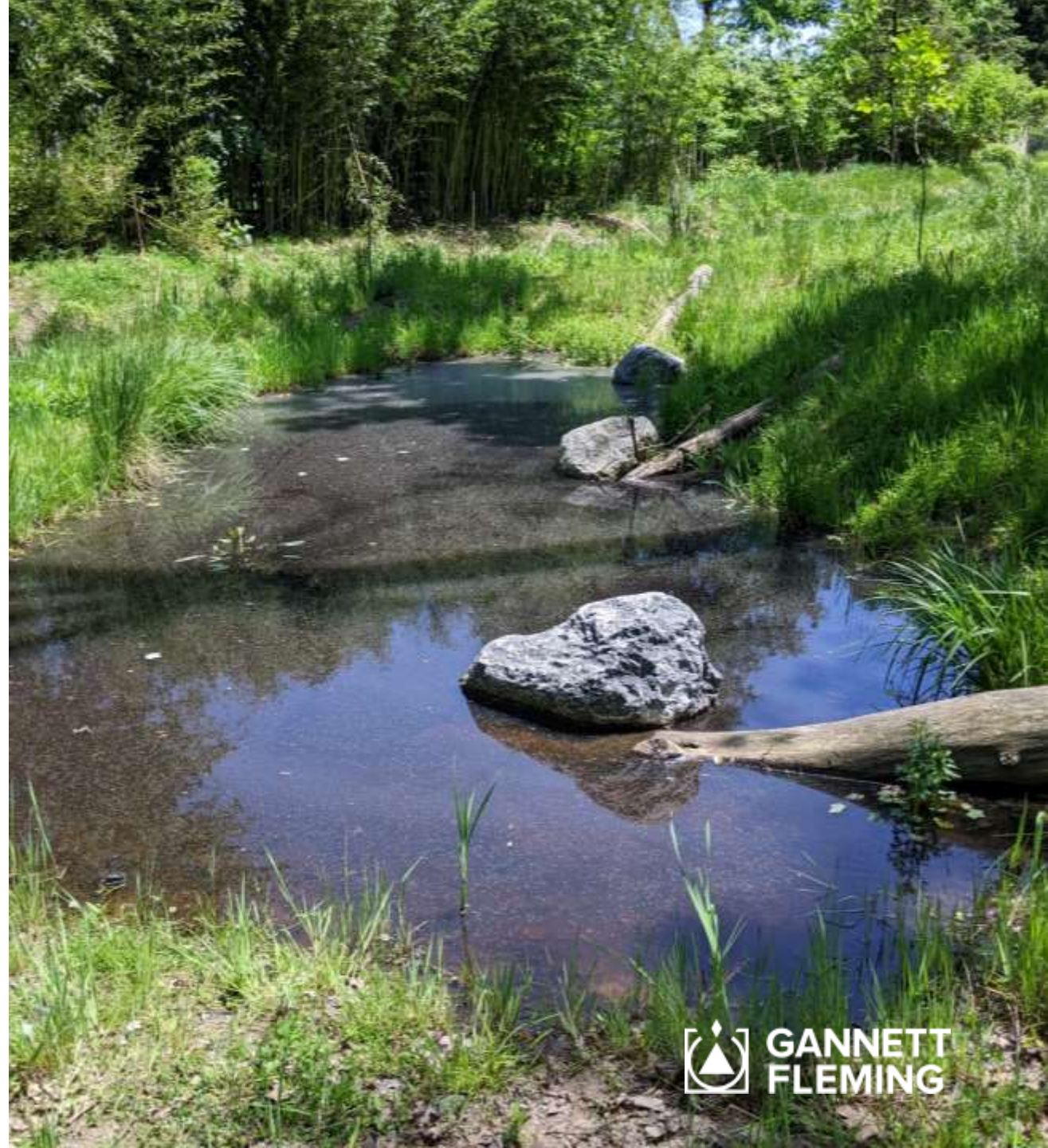
Cooper Branch vernal pool in winter



Cooper ranch vernal pool that never held water

Lessons Learned

- Can be difficult to visualize trends from monitoring due to wet/dry periods
- Increases habitat and species diversity within the stream valley
- Cost effective
- Mosquitos are present, including container mosquitos, but in limited numbers
- Asian tiger mosquito absent in all samples across both projects





THANK YOU!
