What we have learned about the Community Rain Garden on Spring Creek – three years later

As Presented at the
Lodi Parks Commission Meeting
March 23, 2010

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USGS
science for a changing world

WELCOME TO LODI COMMUNITY RAIN GARDEN
This rain garden is designed to collect stormwater run-off from our streets and roof tops. The garden helps remove pollutants as the run-off slowly seeps through the garden before entering Spring Creek.
A project brought to you by :
Lodi Park Commission
Friends of Scenic Lodi Valley
Wisconsin Department of Natural Resources
United States Geological Survey
University of Wisconsin
Wisconsin Department of Transportation

Presentation Outline

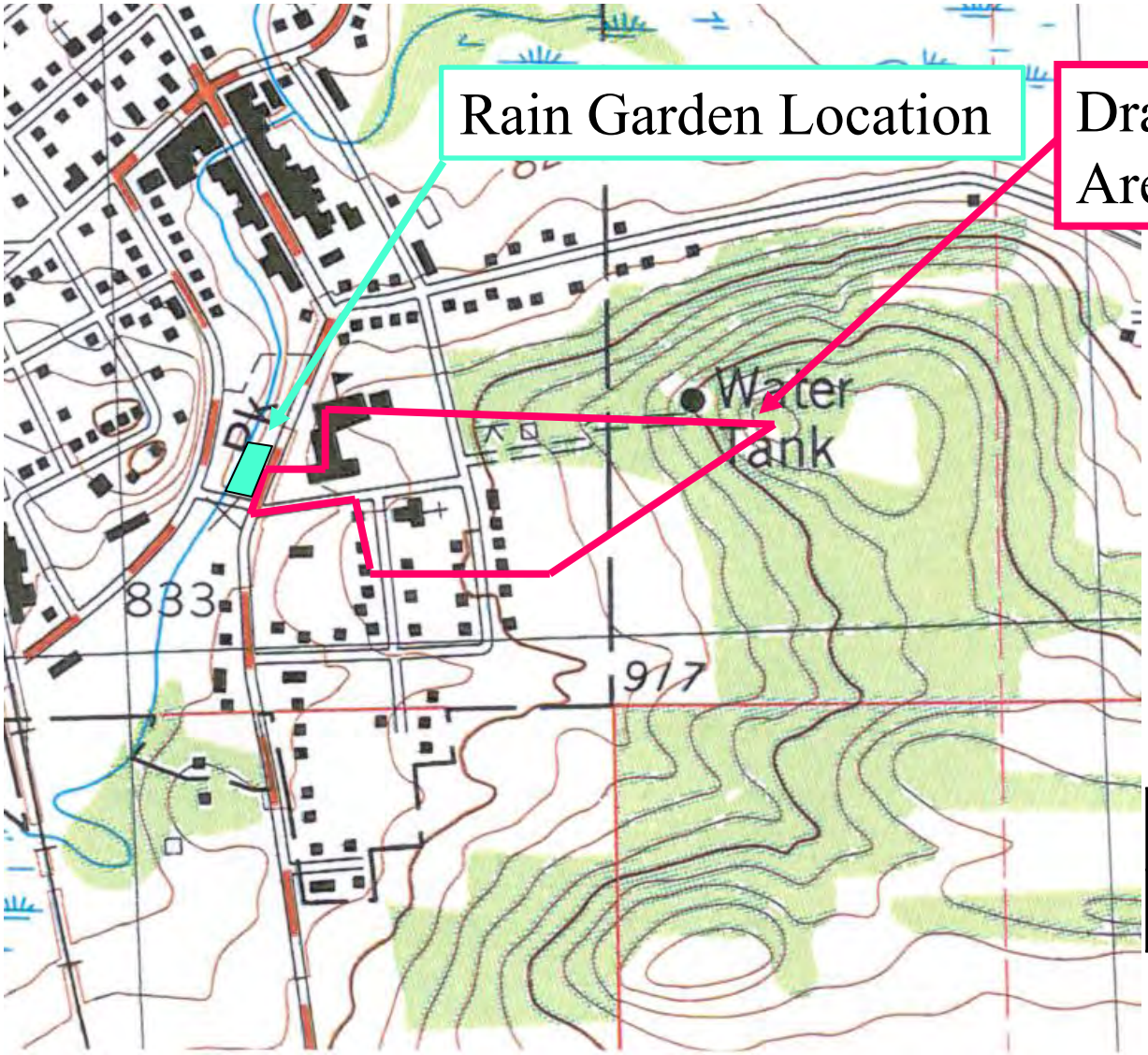
Overview of Rain Garden

- Rain garden location and watershed
- Rain garden design
- USGS project design

Data Analysis – Rain garden effect on:

- Storm volumes
- Peak flow
- Event duration
- Water temperature

Site Location



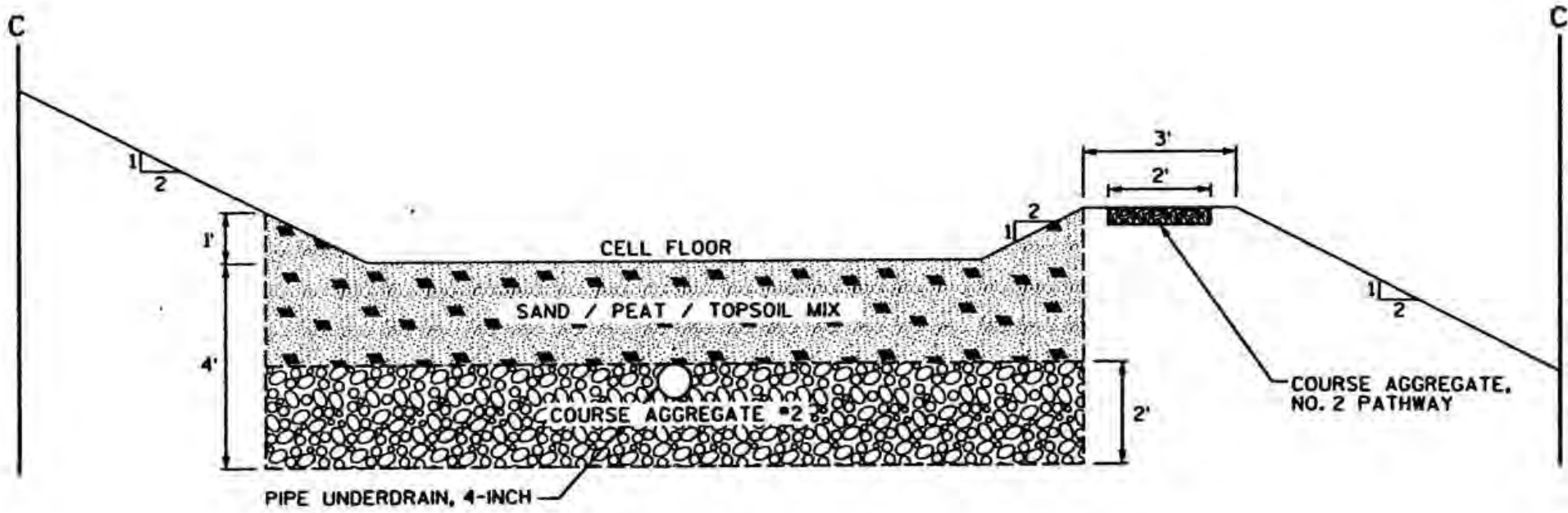
Land Use	Area (percent)
Forest	37%
Lawn/Ag	24%
Flat Roof	10%
Road	9%
Parking Lot	8%
Playground – Paved	4%
Sidewalk	4%
Gravel	3%
Pitched Roof	<1%

Pervious	61%
Impervious	39%

City of Lodi, Columbia County, WI

Rain Garden Site

Rain Garden Design



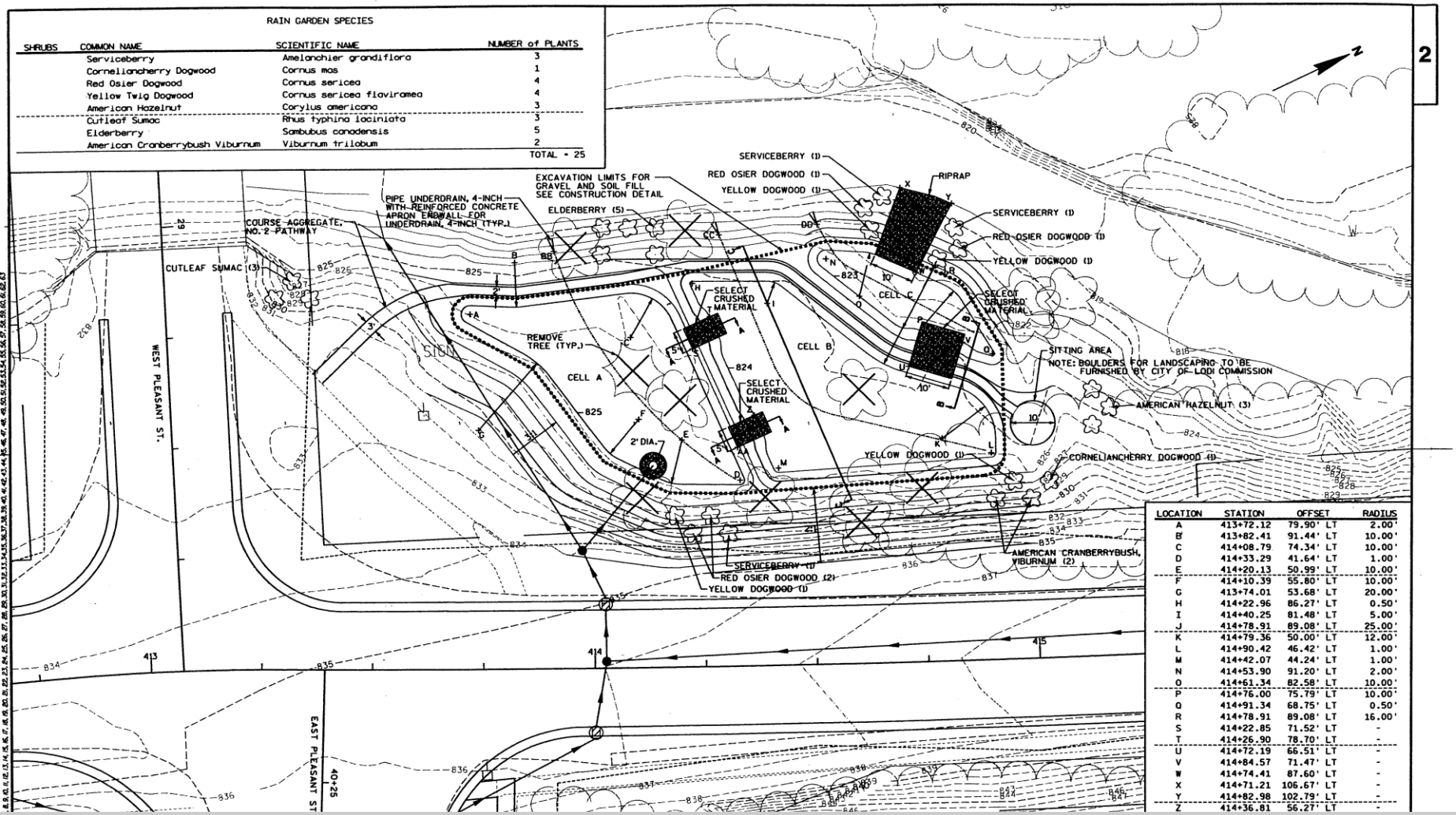
The rain garden is made up of 3 cells, an image of which is displayed on a later slide. This image represents the design details for one cell. The 4 inch under drain carries water to the creek after the water has moved through the topsoil and filled the course aggregate space. Once the cell fills with water it spills over into the next cell through the pathway shown on the right side of the image.

Rain Garden Construction:
Removal of native soil

Rain Garden Construction:
Coarse aggregate with perforated PVC tile under-drain

Rain Garden Construction:
Completed construction with spillways

Shrub Planting Plan & Detailed Grading Plan



LOCATION	STATION	OFFSET	RADIUS
A	413+72.12	79.90' LT	2.00'
B	413+82.41	91.44' LT	10.00'
C	414+08.79	74.34' LT	10.00'
D	414+33.29	41.64' LT	1.00'
E	414+20.13	50.99' LT	10.00'
F	414+10.39	55.80' LT	10.00'
G	413+74.01	53.68' LT	20.00'
H	414+22.96	86.27' LT	0.50'
I	414+40.25	81.48' LT	5.00'
J	414+78.91	89.08' LT	25.00'
K	414+79.36	50.00' LT	12.00'
L	414+90.42	46.42' LT	1.00'
M	414+42.07	44.24' LT	1.00'
N	414+53.90	91.20' LT	2.00'
O	414+61.34	82.58' LT	10.00'
P	414+76.00	75.79' LT	10.00'
Q	414+91.34	68.75' LT	0.50'
R	414+78.91	89.08' LT	16.00'
S	414+22.85	71.52' LT	-
T	414+26.90	78.70' LT	-
U	414+72.19	66.51' LT	-
V	414+84.57	71.47' LT	-
W	414+74.41	87.60' LT	-
X	414+71.21	106.67' LT	-
Y	414+82.98	102.79' LT	-
Z	414+36.81	56.27' LT	-

A detailed plan was developed for the placement of shrubs and surrounding landscape grading.

Rain Garden Species Plan – Cell A

School District Project to Plant Rain Garden

RAIN GARDEN: CELL A

RAIN GARDEN SPECIES

SYMBOL	COMMON NAME	SCIENTIFIC NAME	NUMBER of PLANTS * CELL A
FORBS			
A	Stiff Coreopsis	Coreopsis palmata	65
B	Butterflyweed	Asclepias tuberosa	68
C	New England Aster	Aster novae-angliae	59
D	White False Indigo	Baptisia lactea	46
E	Purple Prairie Clover	Dalea (Petalostemum) purpurea	77
F	Pale Purple Coneflower	Echinacea pallida	46
G	Rattlesnake Master	Eryngium yuccifolium	26
H	Western Sunflower	Helianthus occidentalis	69
I	Rough Blazingstar	Liatris aspera	71
J	Lupine	Lupinus perennis	48
K	Smooth Penstemon	Penstemon digitalis	66
L	Great Solomon's Seal	Polygonatum canaliculatum	53
M	Yellow Coneflower	Ratibida Pinnata	53
N	Compassplant	Silphium laciniatum	32
O	Cupplant	Silphium perfoliatum	37
P	Prairie Dock	Silphium terebinthinaceum	44
Q	Showy Goldenrod	Solidago speciosa	53
R	Spiderwort	Tradescantia ohiensis	66
S	Shootingstar	Dodecatheon meadia	14
GRASSES			
	Big Bluestem	Andropogon gerardi	11
	Sideoats Grama	Bouteloua curtipendula	26
	June Grass	Koeleria macrantha	68
?	Little Bluestem	Schizachyrium scoparium	61
*	Prairie Dropseed	Sporobolus heterolepis	60
SEDGES			
2	Tussock	Carex stricta	89
3	Bottlebrush	Carex comosa	63
		TOTALS =	1381

* ADDITIONAL QUANTITIES SHOWN ELSEWHERE IN PLAN

STATE PROJECT NUMBER: 5281-01-71 | HWY: STH 113 | COUNTY: COLUMBIA | RAIN GARDEN PLANTING DIAGRAM | SCALE, FEET 0 N/A | SHEET NO: | E

M	Yellow Coneflower	Ratibida Pinnata	53

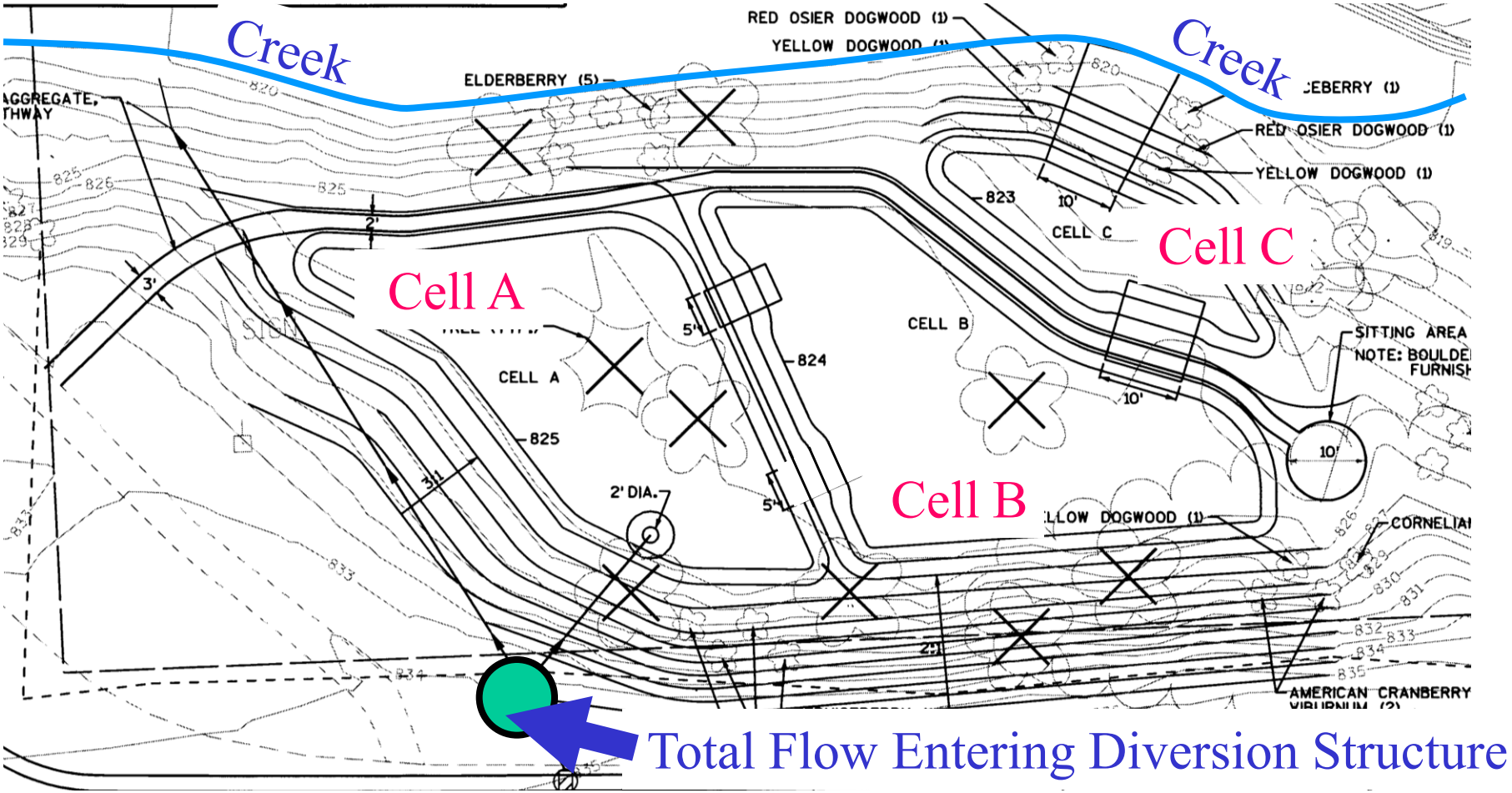
A detailed plan was also developed for plant species and placement for each cell.

Completed Rain Garden

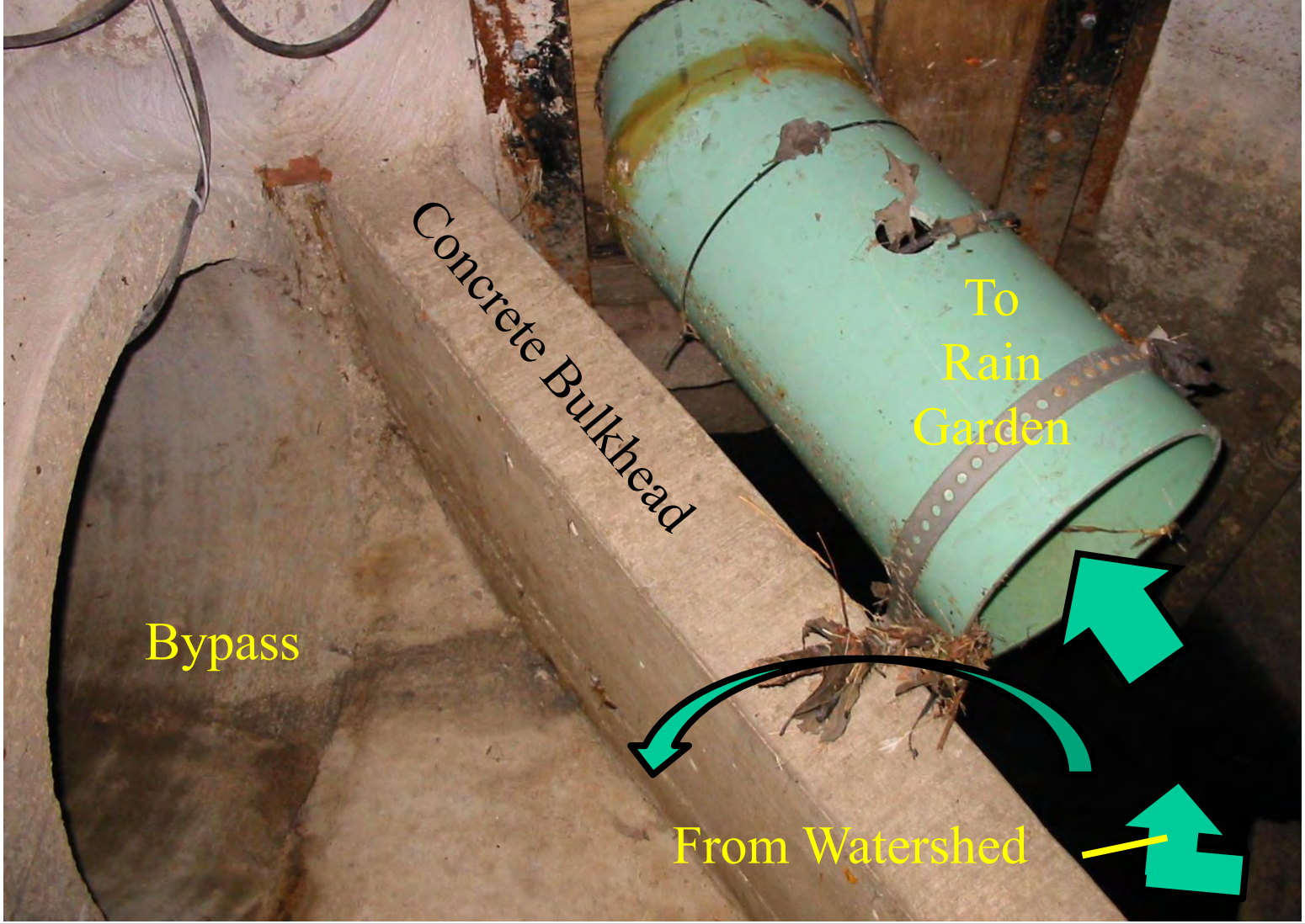
Three years after planting

USGS Study and Results

Monitoring Stations and Flow Path

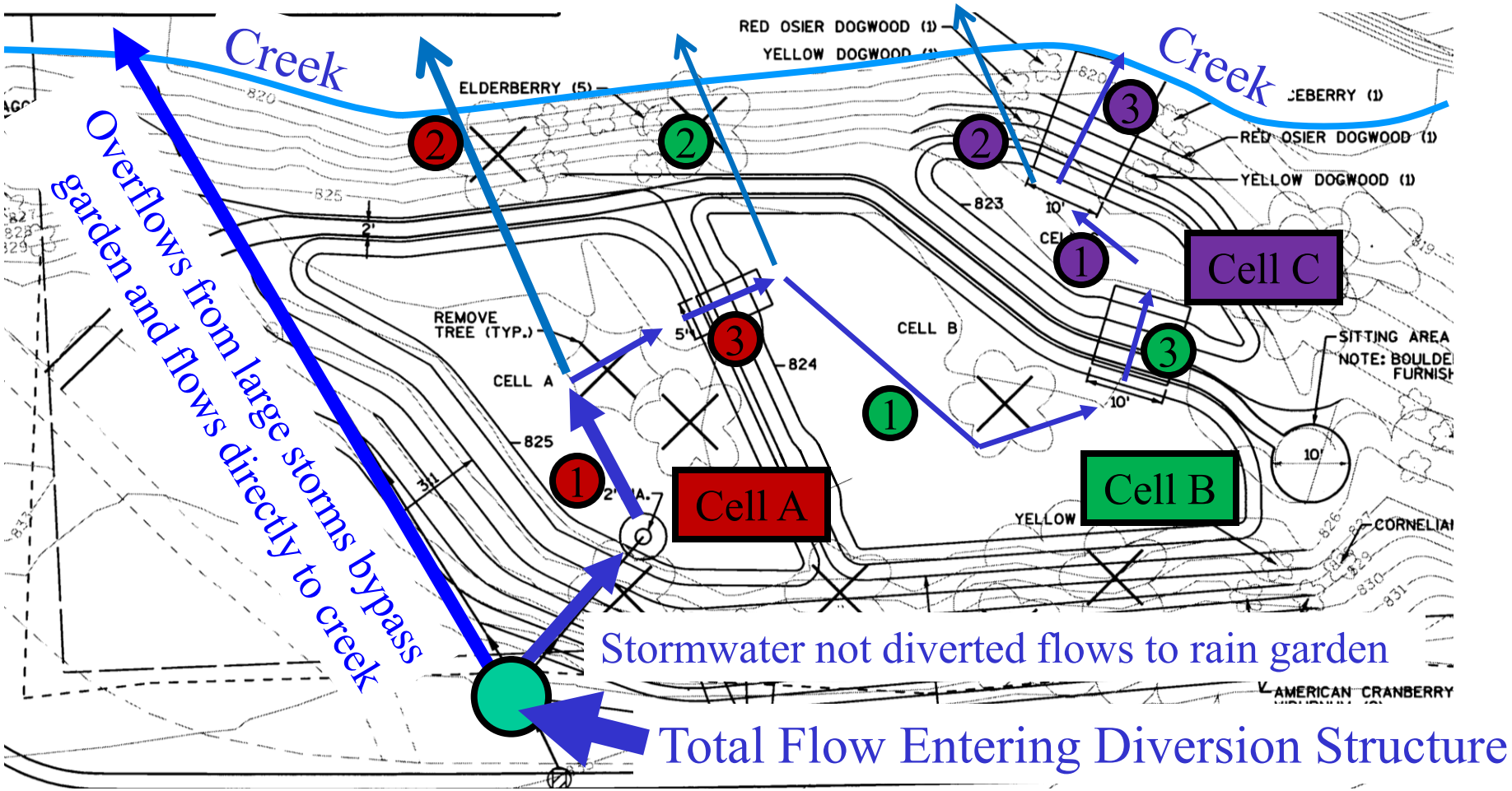


During a rainfall event, all of the water that runs off of the watershed enters storm sewer pipes which lead into a single manhole. In the manhole, there is a diversion structure which sends some water to the rain garden and excess water to a pipe which bypasses the garden (shown in next slide).



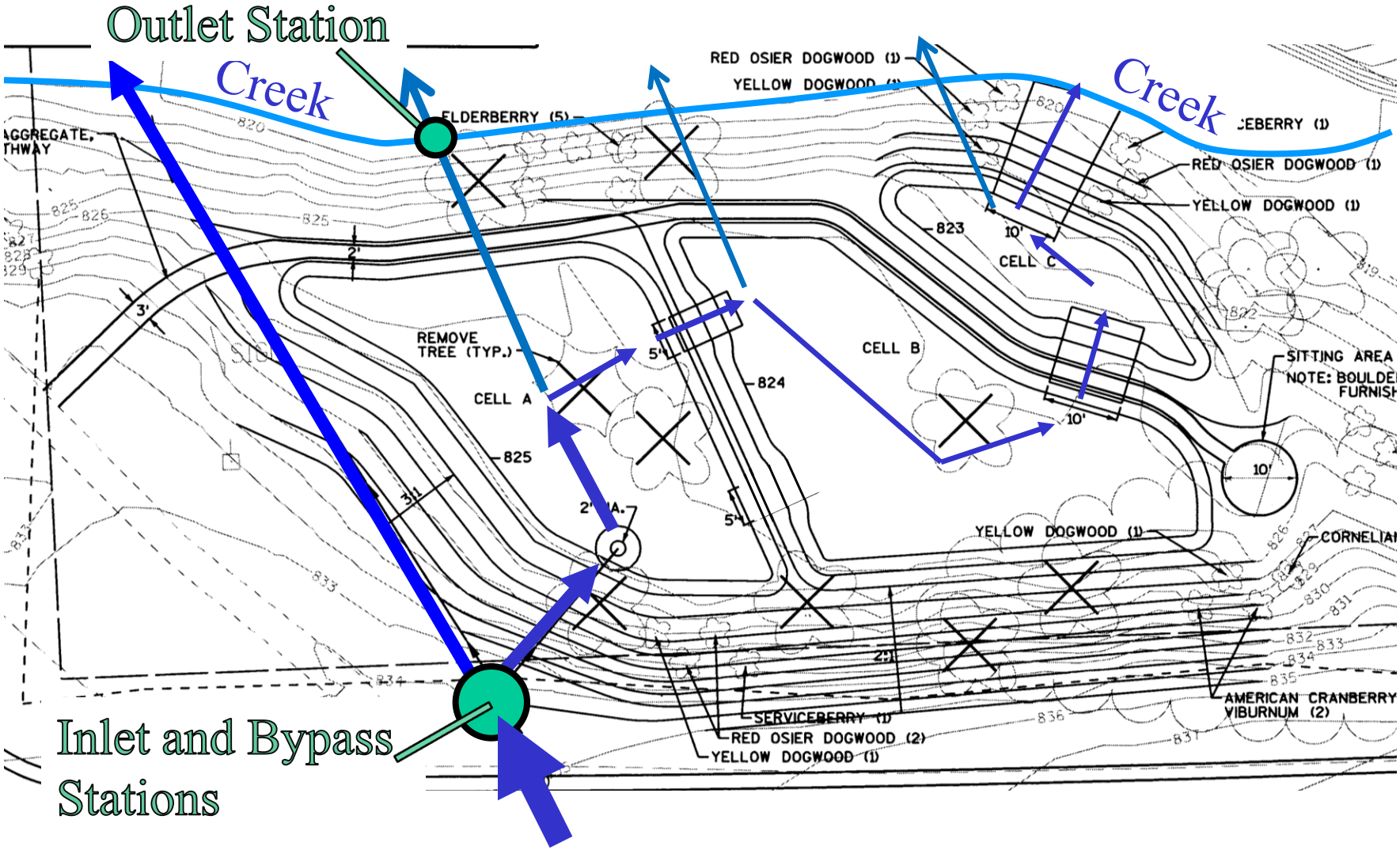
Stormwater enters the manhole through a submerged pipe approximately 4’ below a 1’ diameter pipe that leads to the rain garden. During a storm event, water rises to the level of this pipe and begins to flow to the rain garden. If water rises above the height of the concrete bulkhead, it spills over the wall and the excess water is discharged to the creek through the bypass pipe.

Rain Garden Flow Path



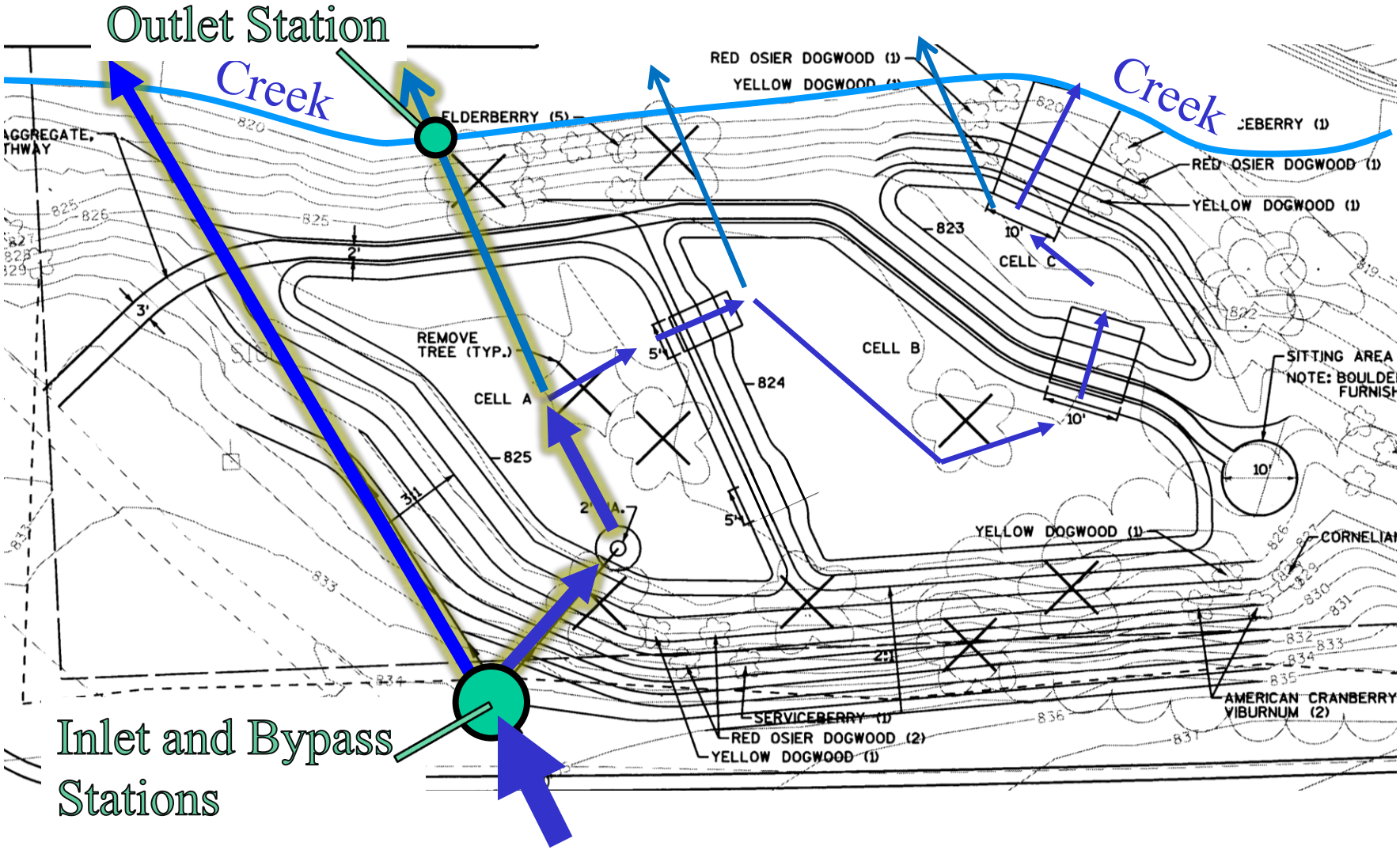
①Water flows into cell A, filling the coarse aggregate layer. ② Water infiltrates through the soil to the under-drain that discharges to the creek. ③Water fills cell A, reaches the level of the rock spillway and flows to cell B. This path sequentially repeats for cells B and C (cell C spillway empties to creek).

Monitoring Stations



Monitoring equipment was installed at 3 locations, at the Inlet to the rain garden, at the Bypass pipe, and at the Outlet from Cell A under-drain.

Monitoring Stations



The flow monitored by the USGS is highlighted in yellow. Any flow that traveled into Cells B or C were not monitored, nor were infiltration or evapotranspiration.

Location of the Inlet station equipment enclosure, raingage, and solar panel. The monitoring equipment is located beneath the enclosure in the manhole.

Location of the Outlet station equipment enclosure, flume, and solar panel.

Monitored Parameters

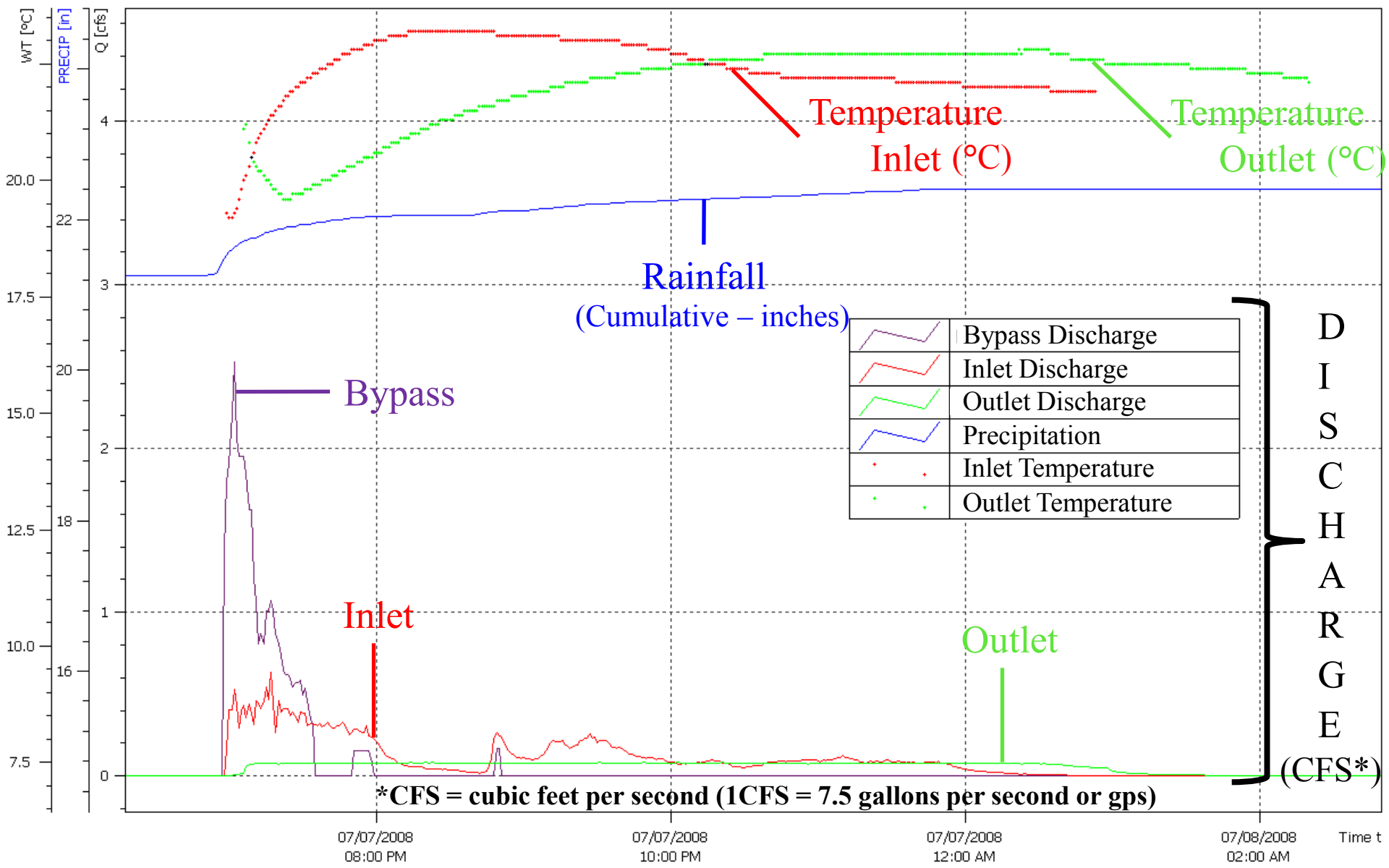
Discharge (flow rate)

Inlet, Bypass, and Outlet

Temperature

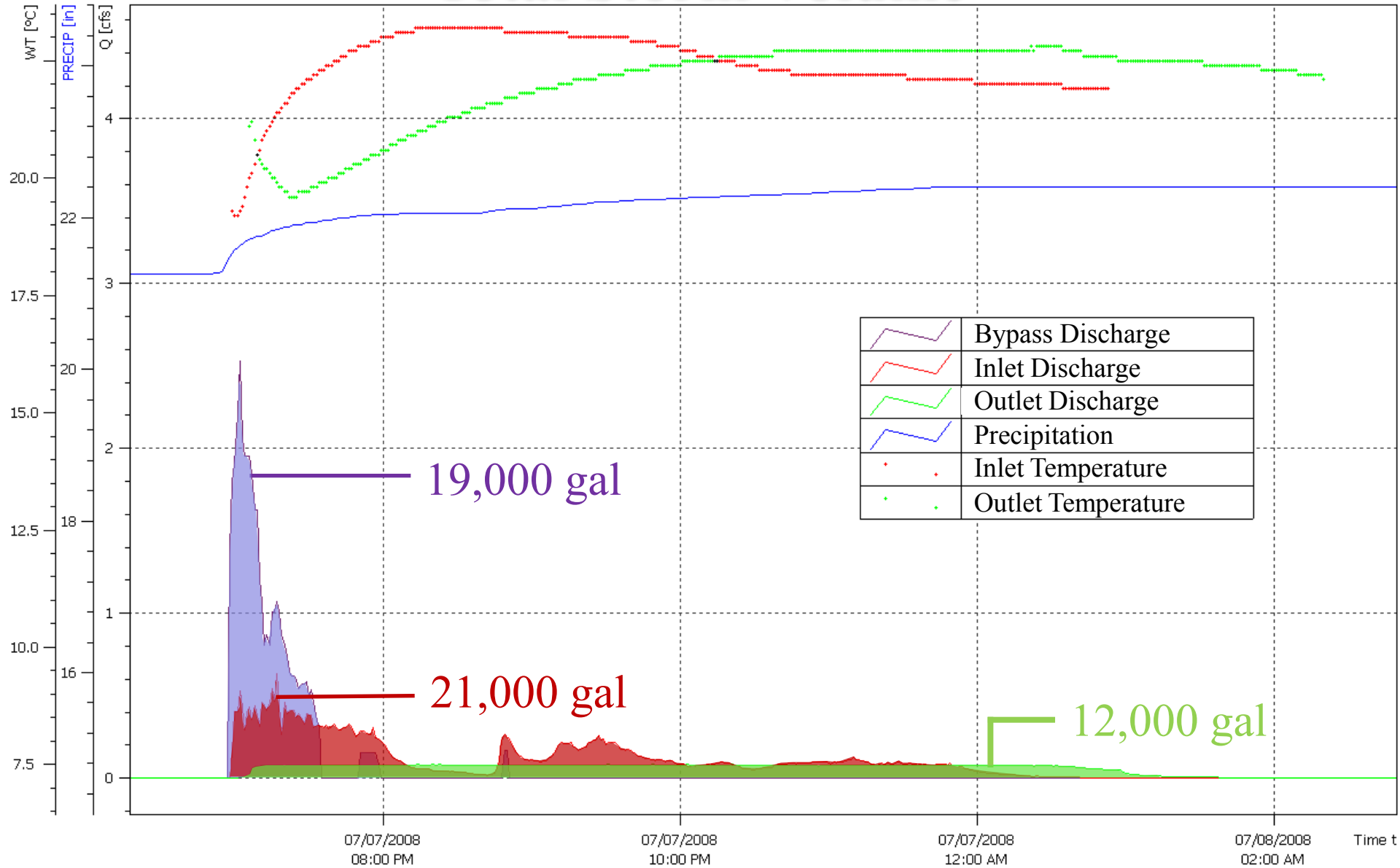
Inlet and Outlet

Precipitation



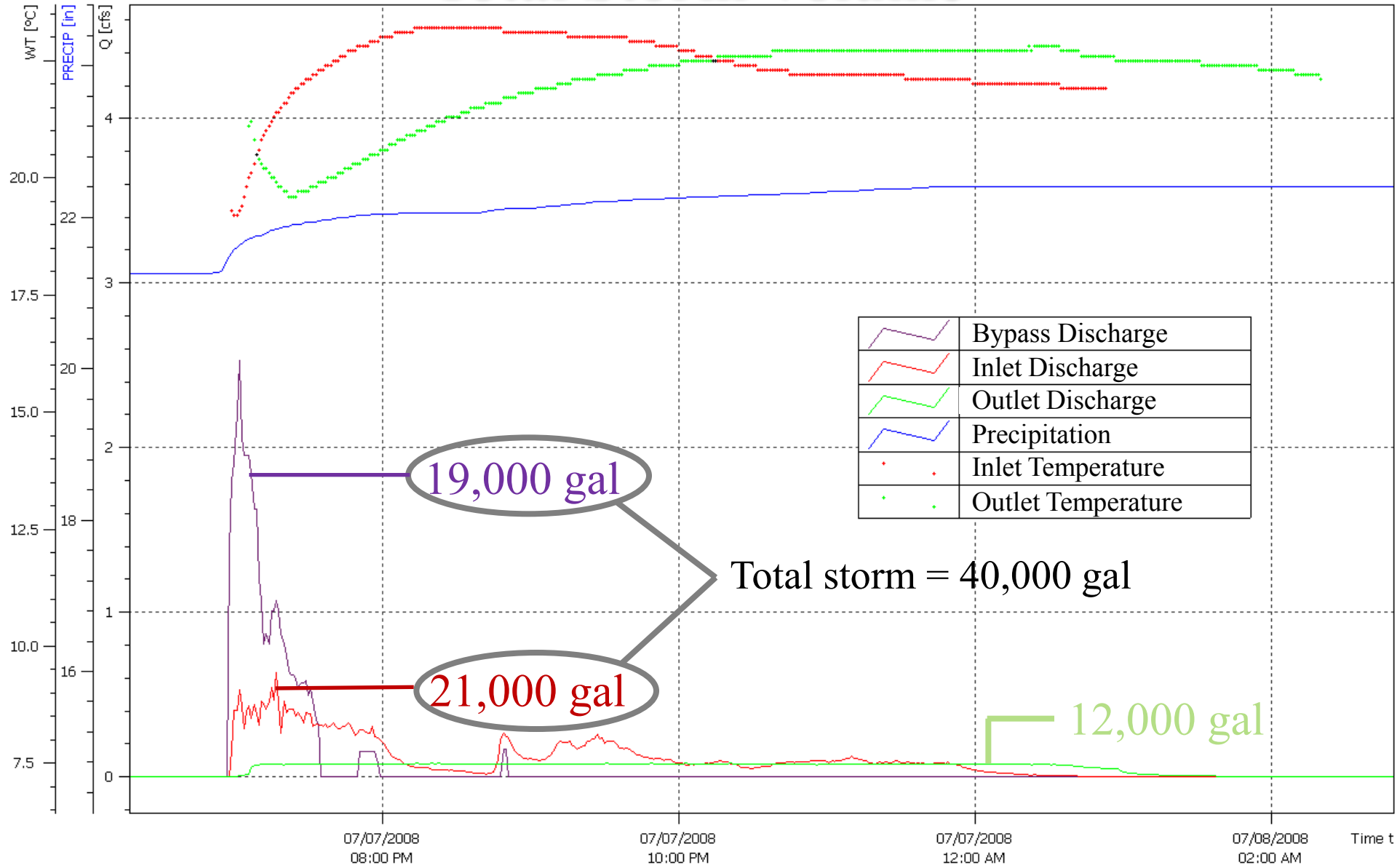
This is a time series plot of all of the monitored parameters during a rainfall event in July of 2008. The remainder of the slides will address the significance of these results and how the rain garden affects these parameters

Total Storm Volume



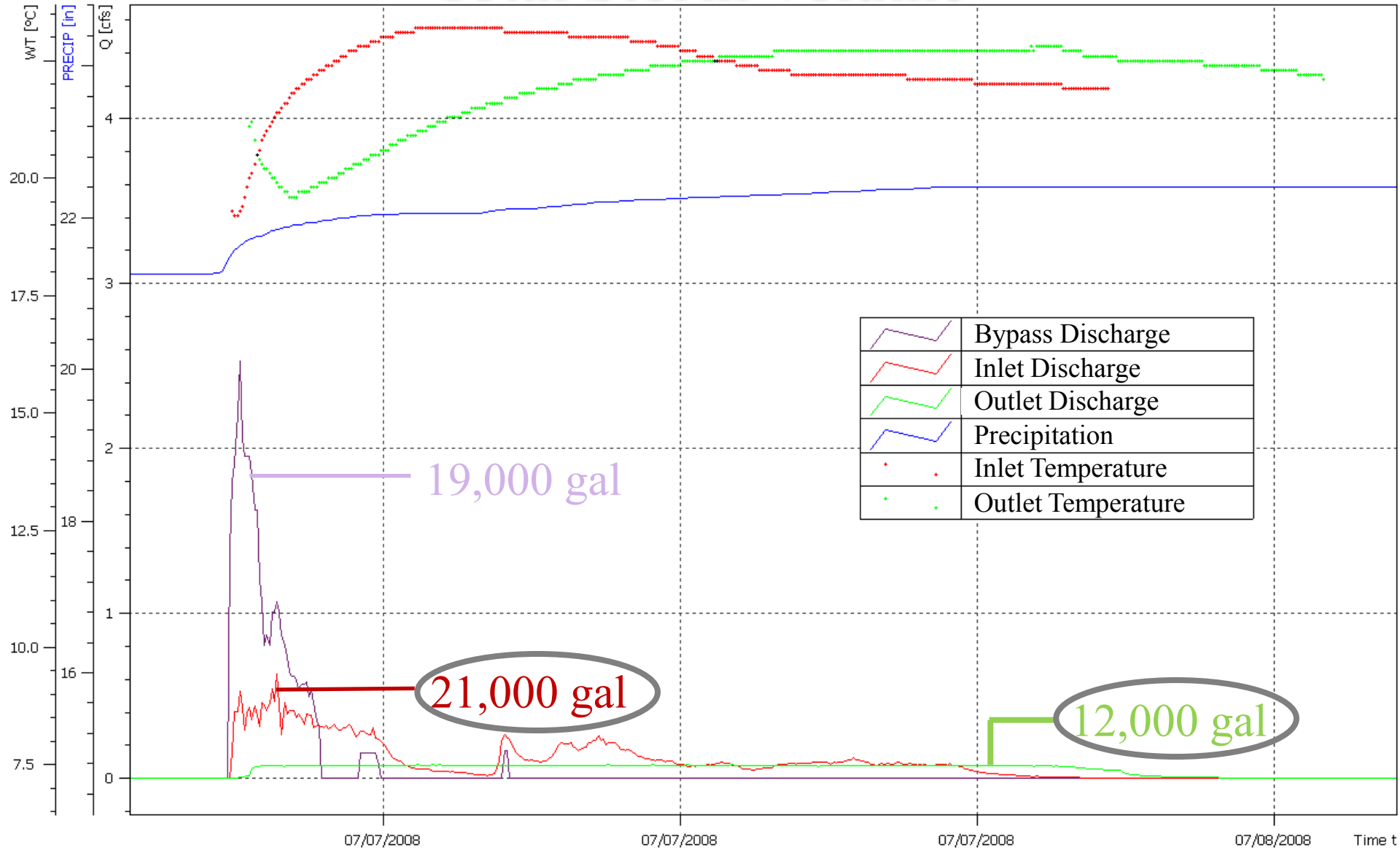
During this event, 19,000 gallons of water bypassed over the bulkhead, 21,000 gallons entered the garden, and 12,000 gallons exited cell A.

Total Storm Volume



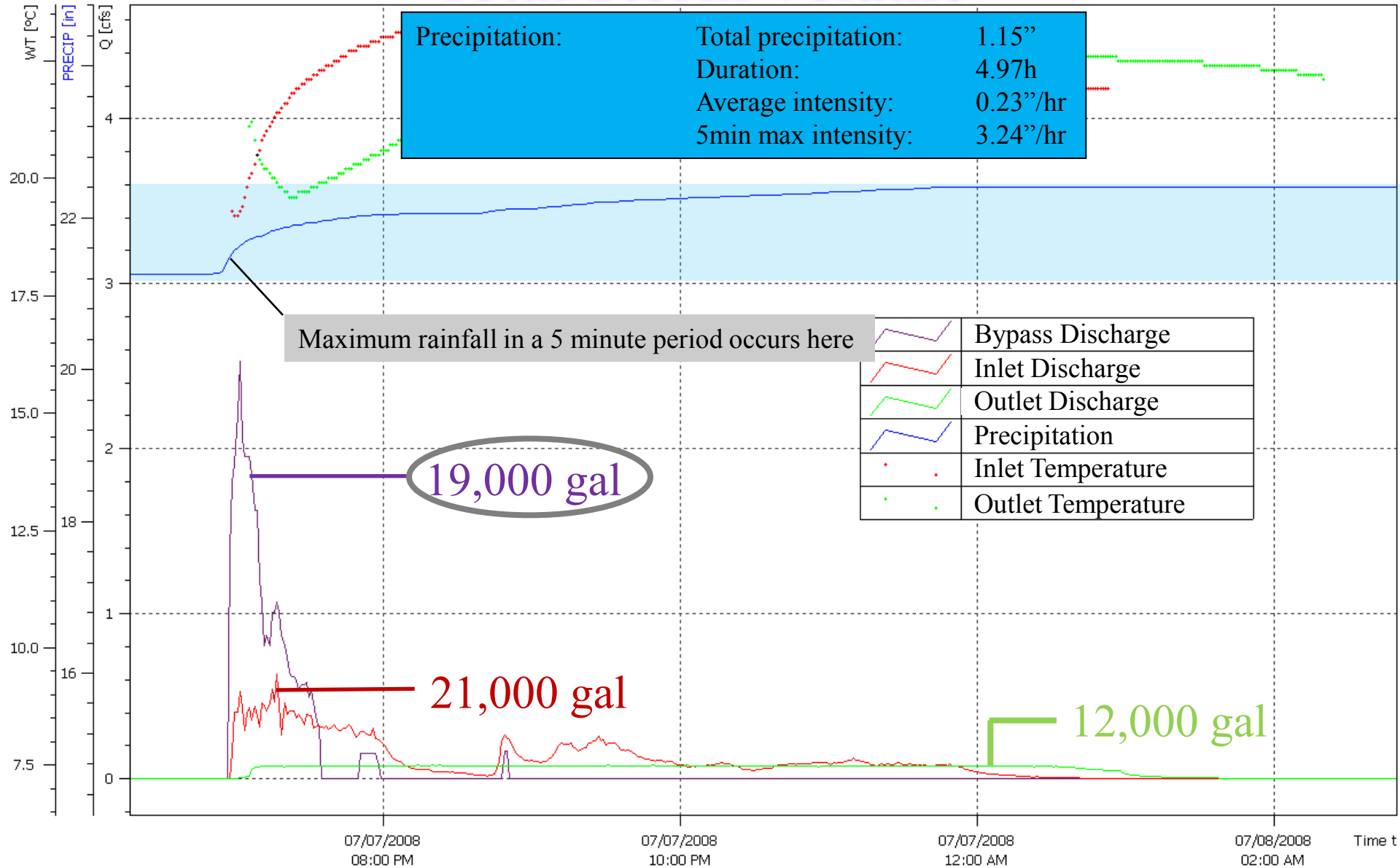
Slightly over half (53%) of the total storm runoff enters the garden.

Total Storm Volume



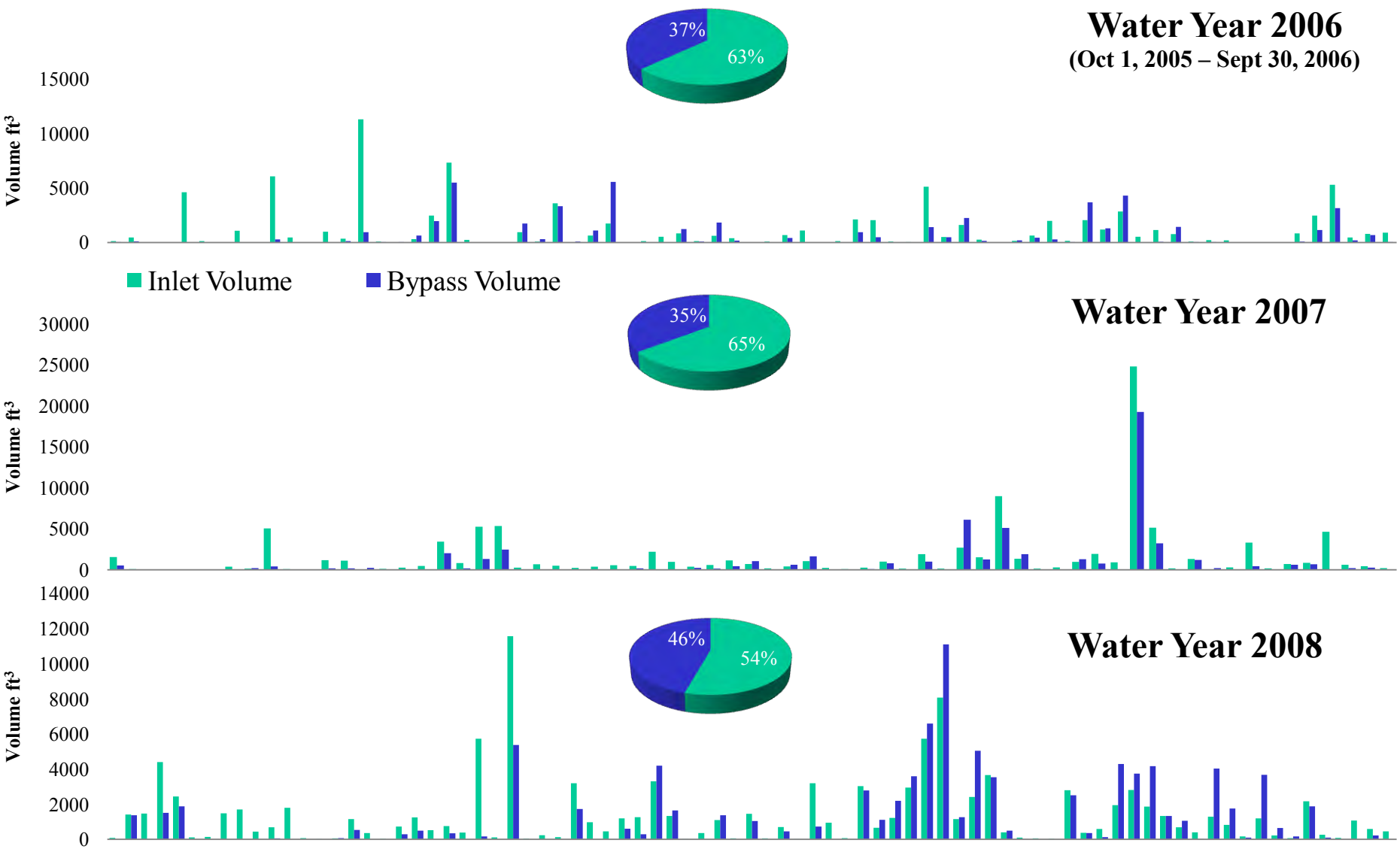
60% of what enters Cell A infiltrates the soil and exits through the under-drain. The remaining 9,000 gallons is either stored in the rain garden soil, infiltrates past the rain garden, or flows to the next cell(s). Although no monitoring equipment existed in Cells B and C, there was little evidence that water frequently exited cell C.

Total Storm Volume



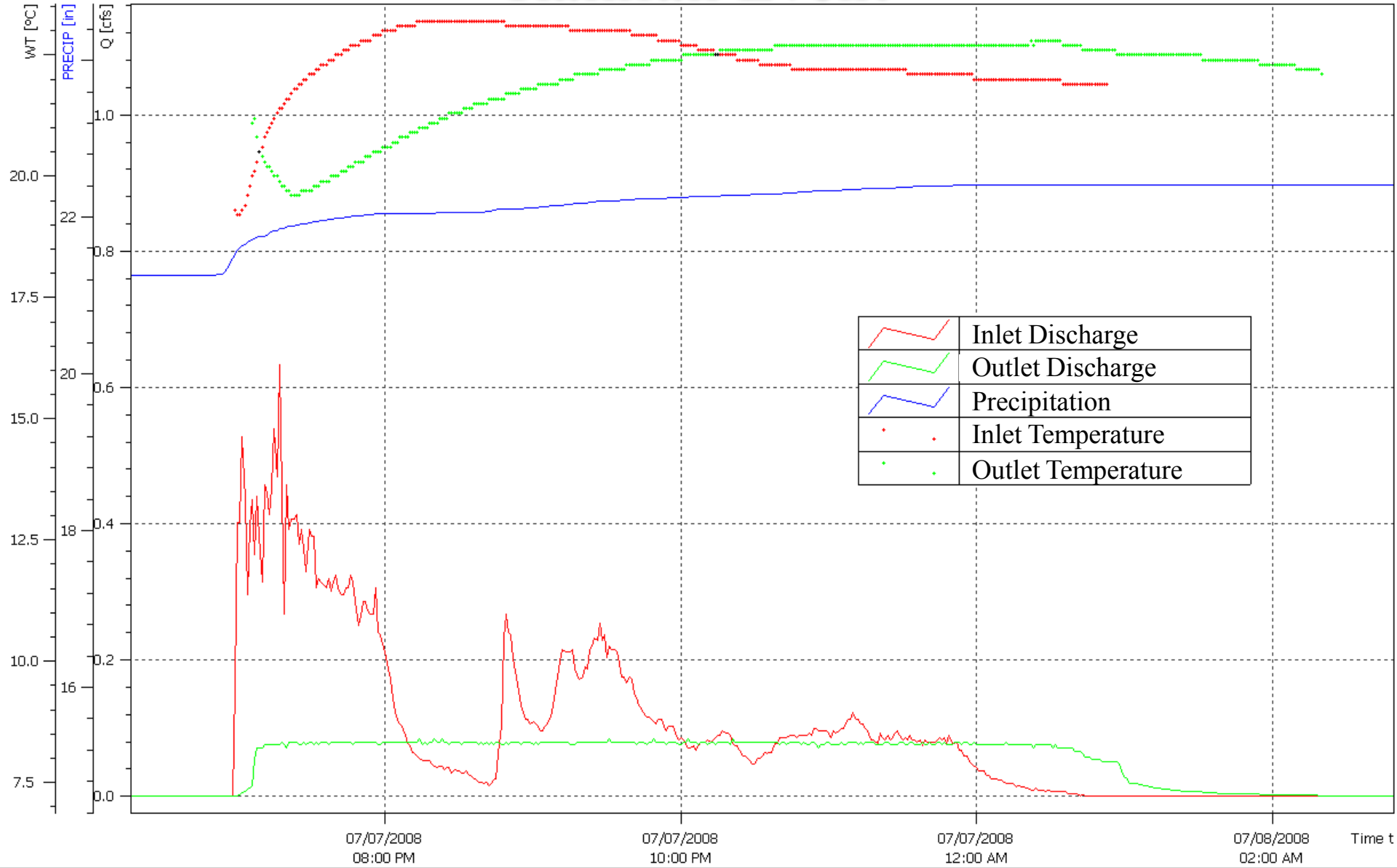
A large portion of the storm bypasses the garden due to heavy runoff from a high-intensity rain event. After the intensity lowers, the majority of runoff enters the garden.

Bypass Volumes by Storm and Year



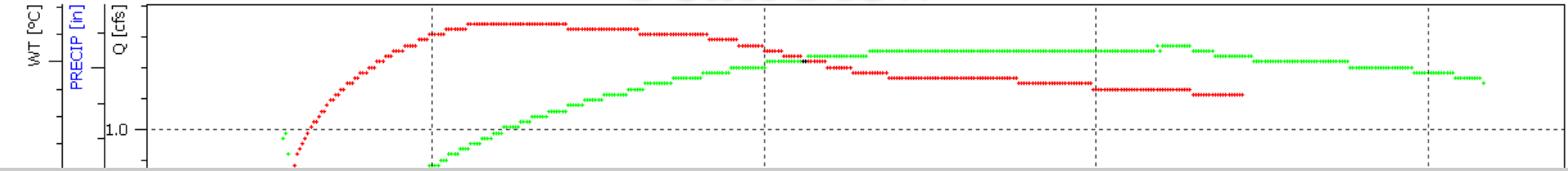
On average, 61% of all runoff enters the garden, showing that the garden is currently receiving the majority of the watershed runoff.

Rainfall Event

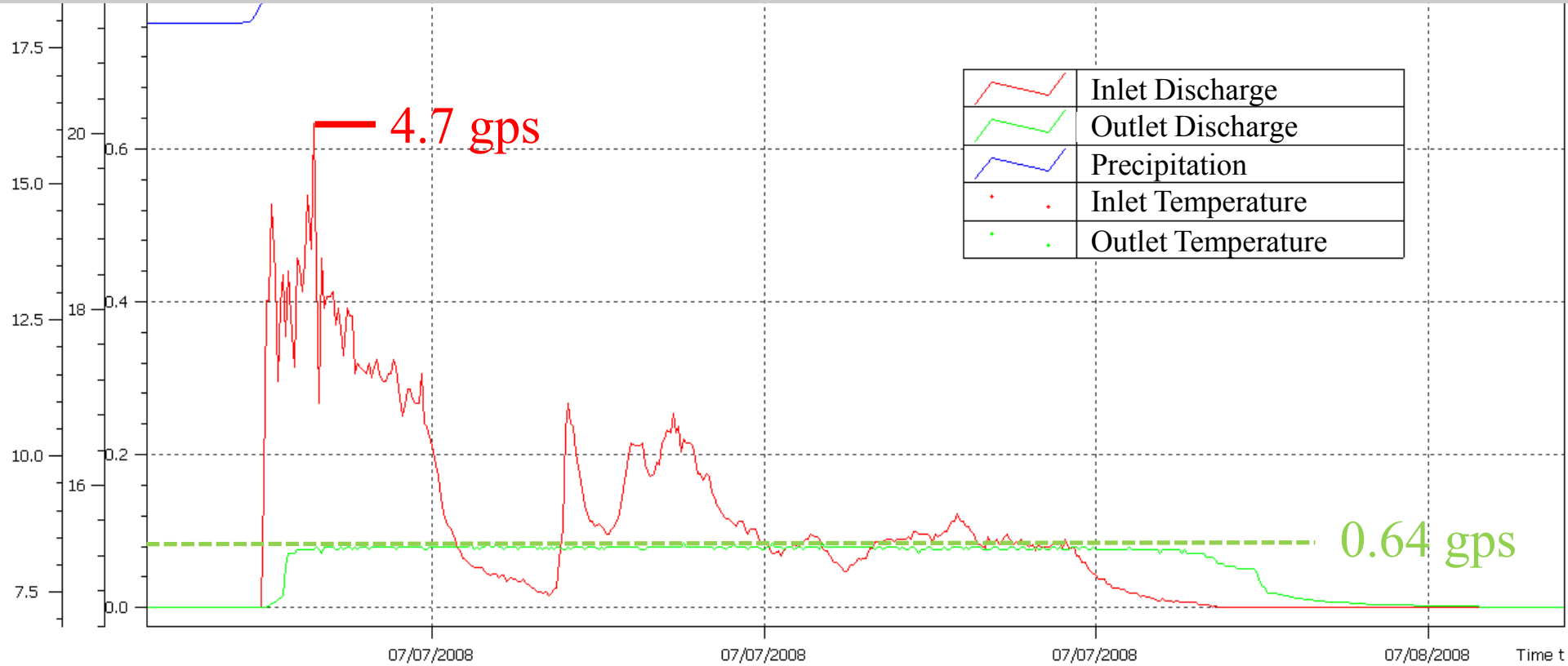


This is the same graph with the bypass discharge removed and the scales adjusted to better show the relationship between the Inlet and Outlet.

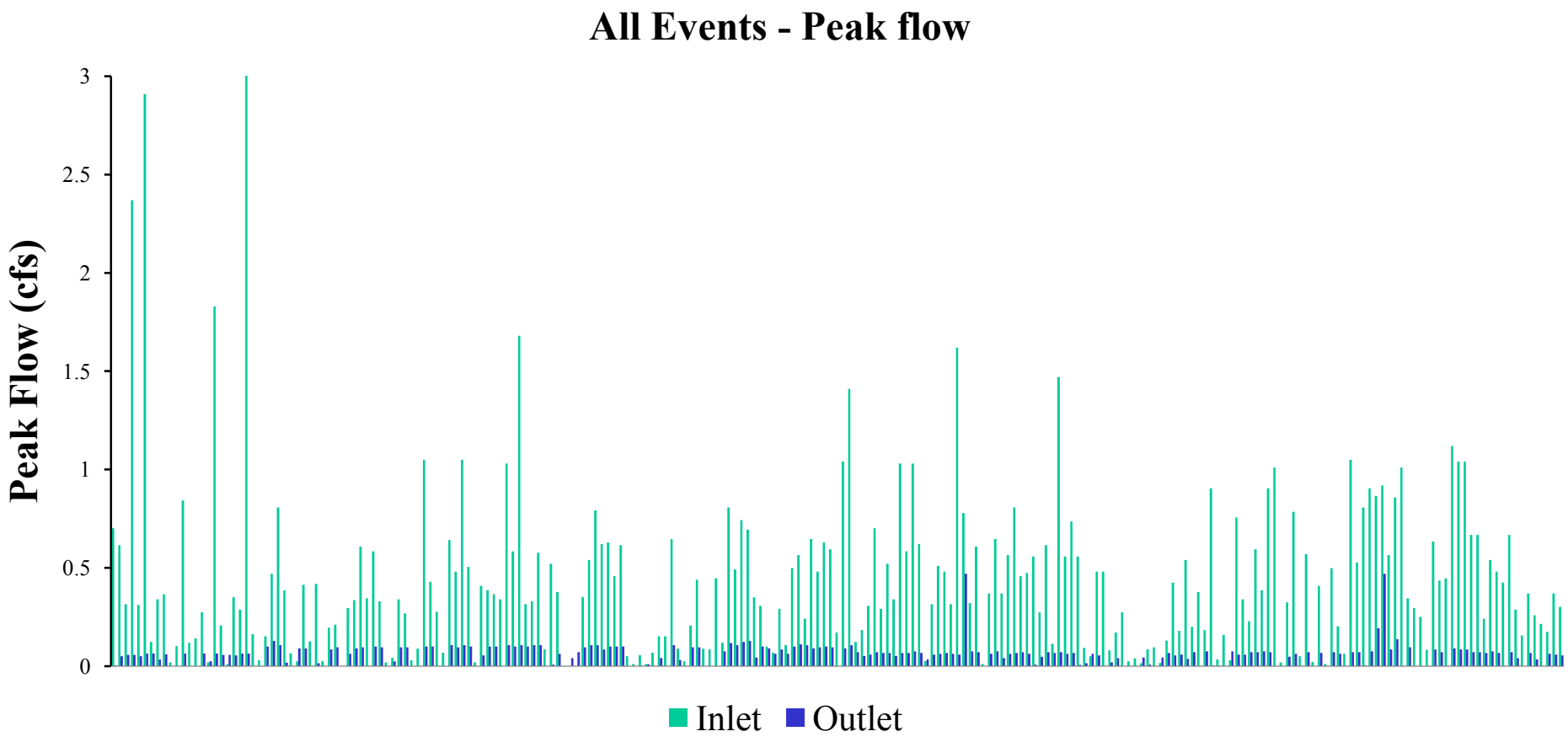
Peak Flow



The maximum discharge at the Inlet is 7.5 times higher than at the Outlet. This shows that the rain garden is effective at attenuating high flows*.



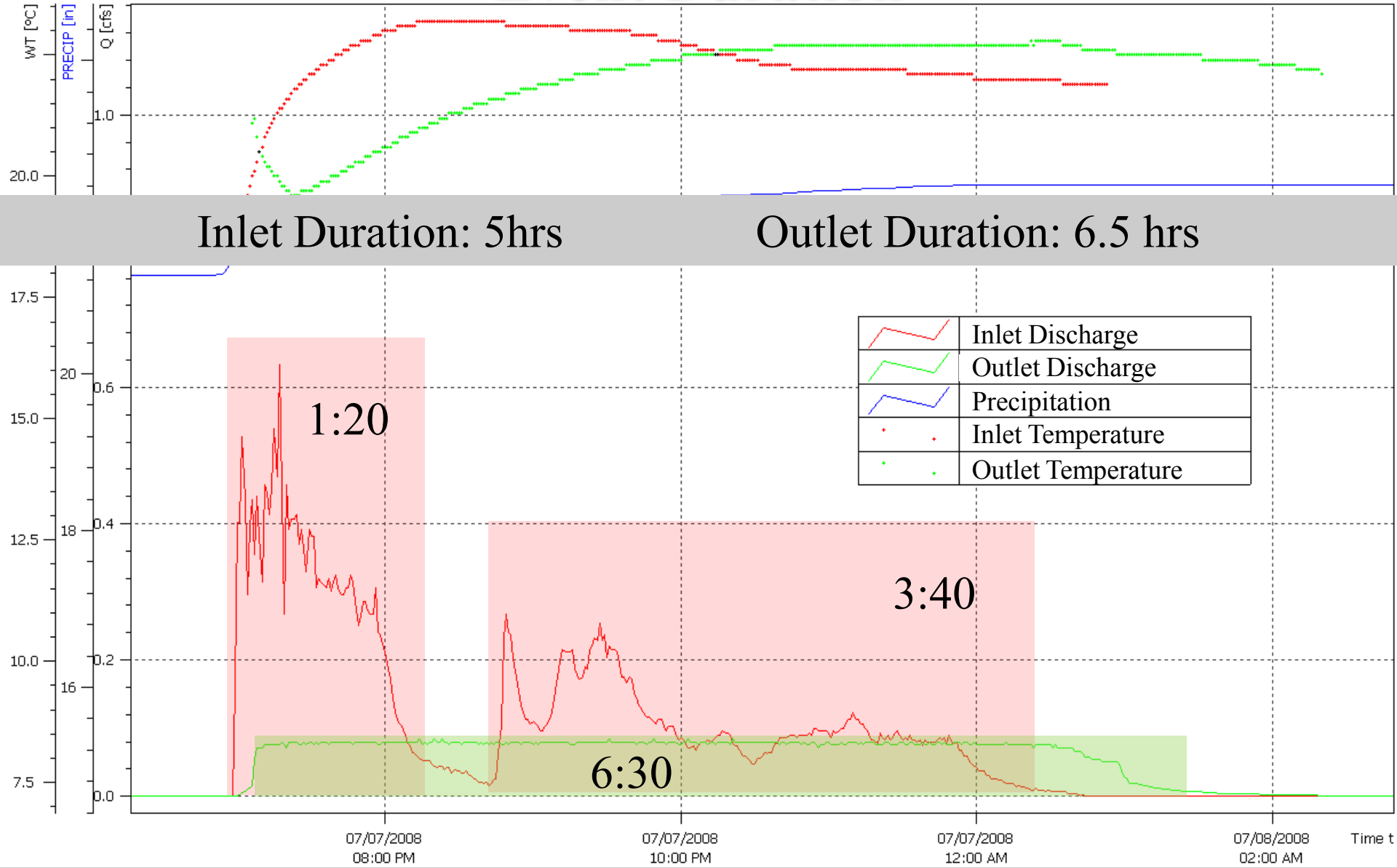
*flows into and out of cells B and C are not monitored, so the outlet discharge does not represent the total flow from the garden. However, each cell has the same size drain pipe, and there was no evidence that cell C overtopped except in creek flooding conditions.



All monitored storms showed this significant decrease in peak flow.

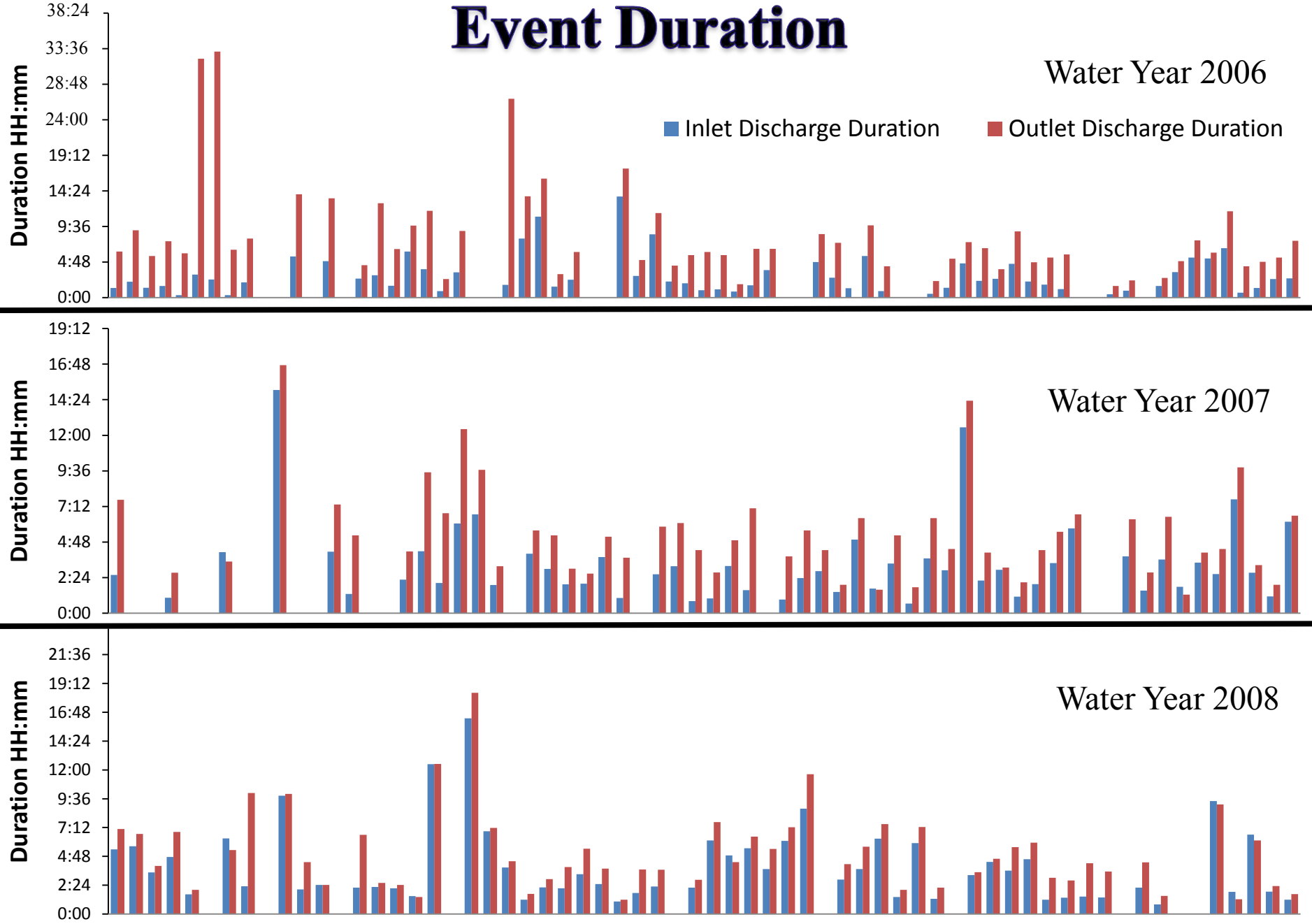
Note: Events where Outlet peak flow is disproportionately high represent flooding conditions where the creek stage rose above the stage monitoring instrumentation

Event Duration



The rain garden stretches out the duration of the storm, creating lower intensity events.

Event Duration



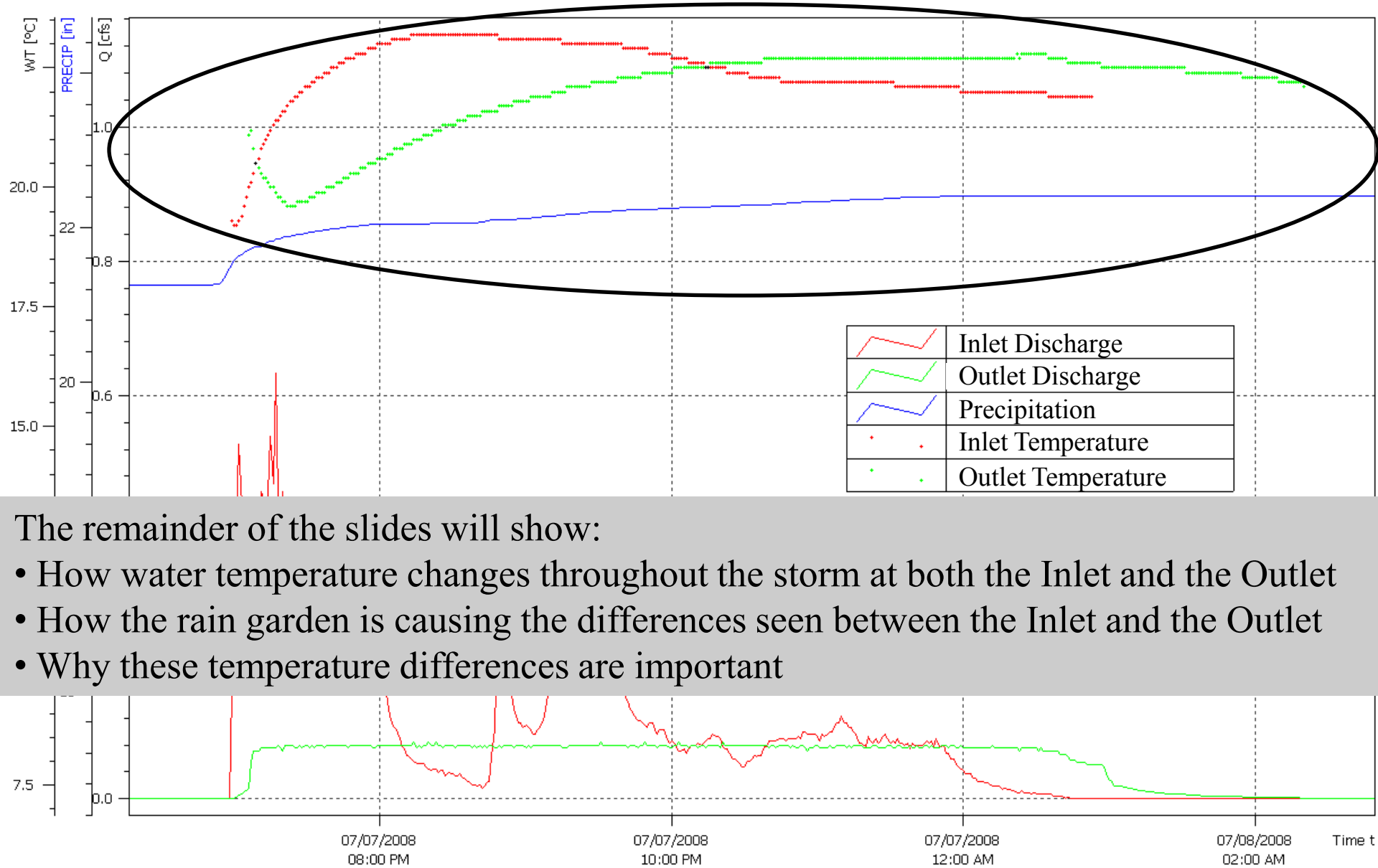
Nearly all monitored storms showed a lengthening of event duration.

Flow Duration Stats

Averaging Over all 299 Storms:

- Outlet begins to flow 22 minutes later than Inlet
- Outlet stops flowing 3 hours 14 minutes after the Inlet
- Outlet storm duration is 2 hours 53 minutes longer than Inlet duration

Temperature

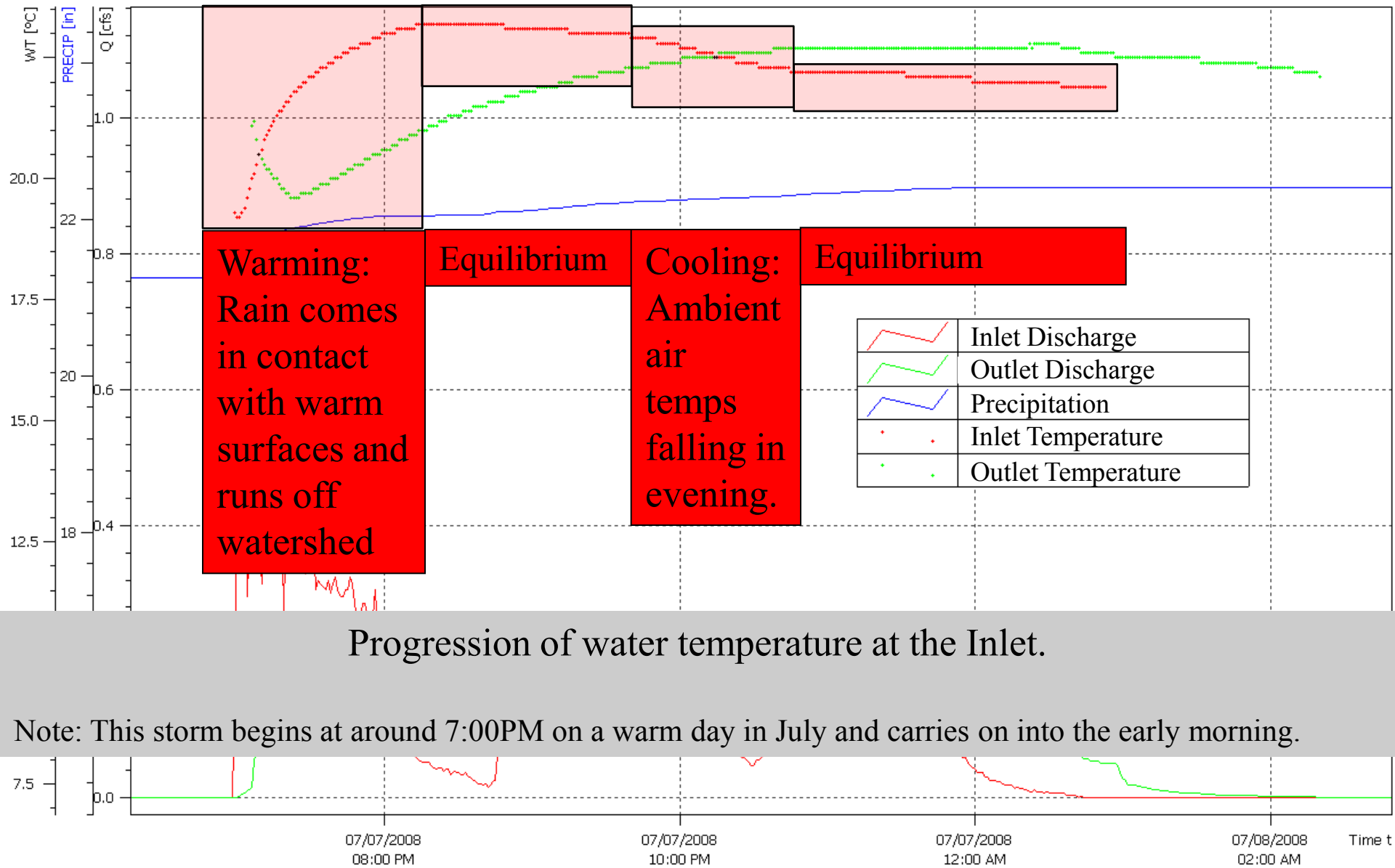


The remainder of the slides will show:

- How water temperature changes throughout the storm at both the Inlet and the Outlet
- How the rain garden is causing the differences seen between the Inlet and the Outlet
- Why these temperature differences are important

Temperature

Inlet

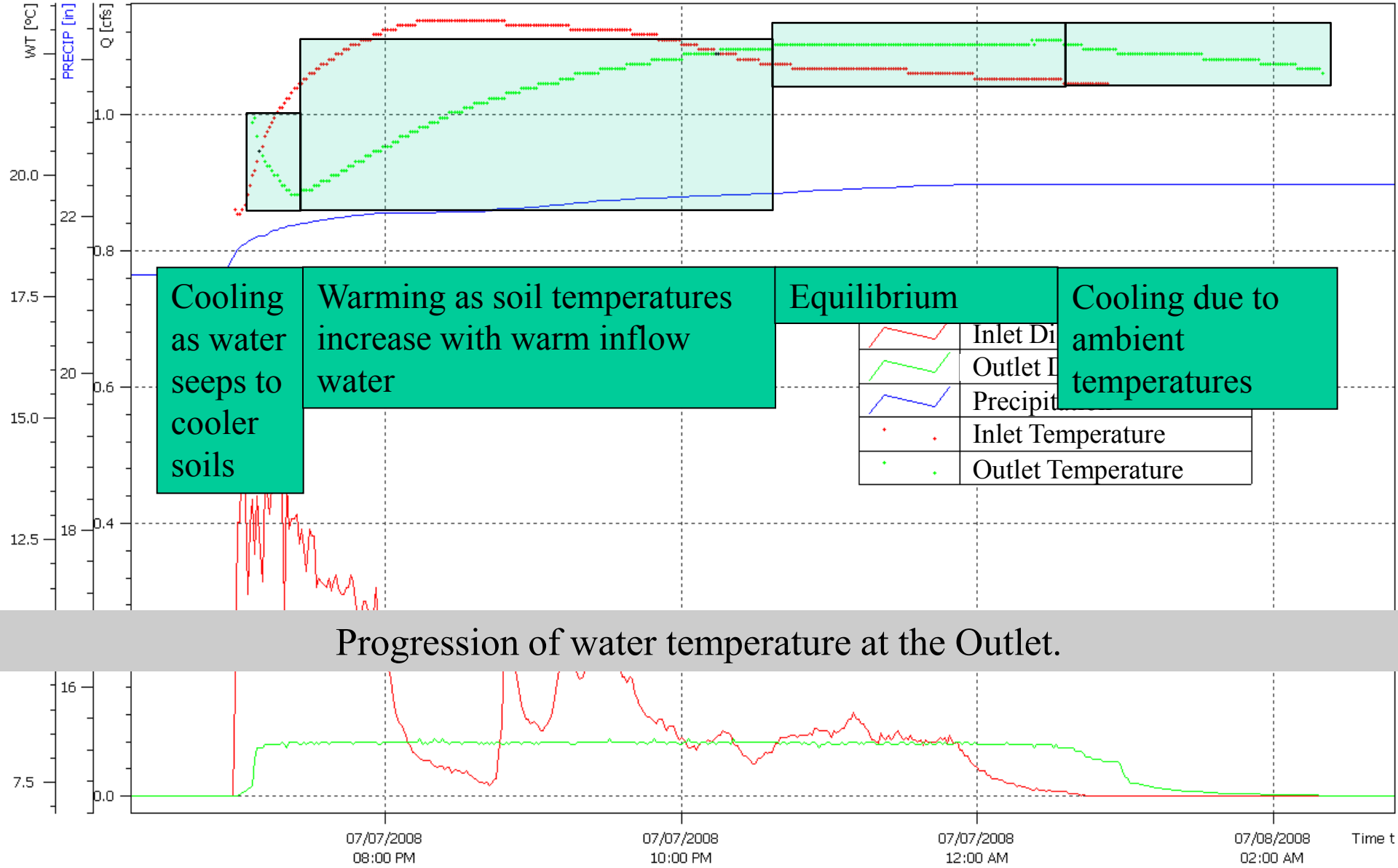


Progression of water temperature at the Inlet.

Note: This storm begins at around 7:00PM on a warm day in July and carries on into the early morning.

Temperature

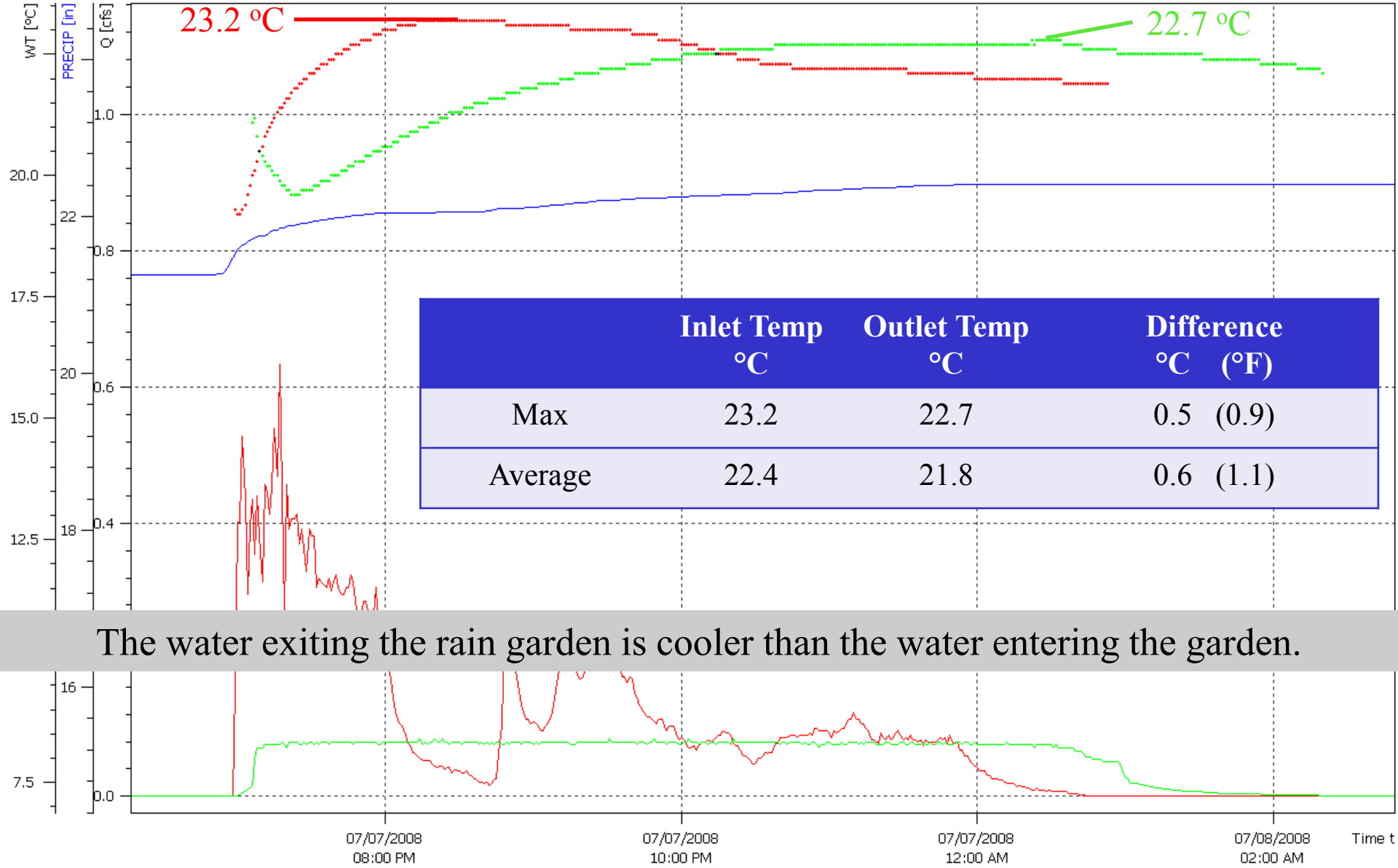
Outlet



Progression of water temperature at the Outlet.

Temperature

The Point Being…..



	Inlet Temp °C	Outlet Temp °C	Difference °C (°F)
Max	23.2	22.7	0.5 (0.9)
Average	22.4	21.8	0.6 (1.1)

The water exiting the rain garden is cooler than the water entering the garden.

Brown Trout Die 27°C

Rainbow Trout Die 25°C

Brook Trout Die 24°C

Thermal criteria for cold, cool and warm water streams in Wisconsin:

	Max Instantaneous Temp	Max Daily Mean Temp
Cold water Stream	< 25 °C	< 22 °C
Cool water Stream	25-28 °C	22-24 °C
Warm Water Stream	>28 °C	> 24 °C

Spring Creek is classified as a trout stream.
Small changes in water temperature mean big changes in fish habitat, especially around the 25°C mark.

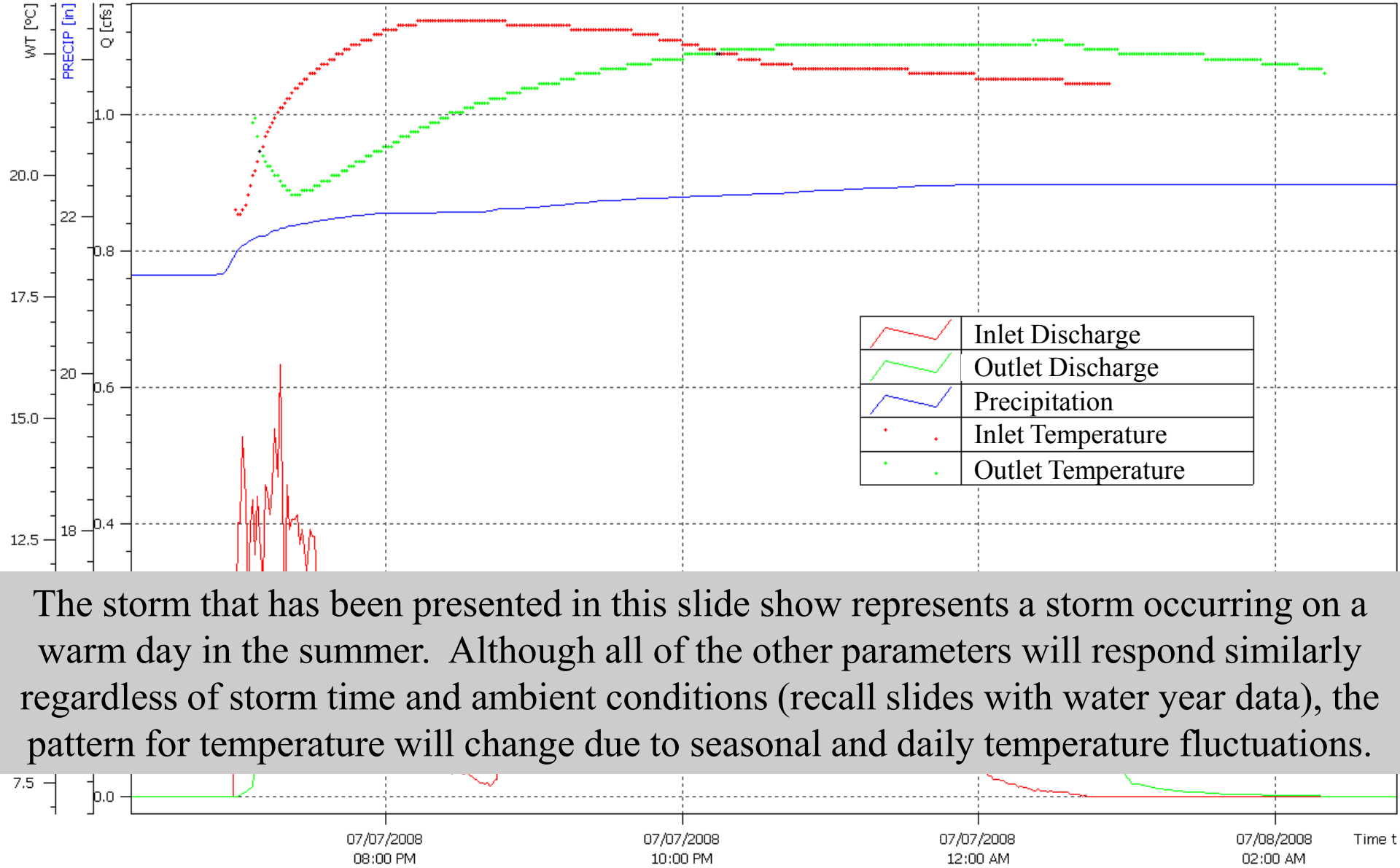
21-30°C
Optimal temperature range for bass, sunfish, catfish, minnows, darters, northern pike, dragonfly larva

10-20°C
Optimal temperature range for trout, sculpin, and larva of mayfly, stonefly, caddisfly

4.5-10°C
Optimal temperature range for brook and brown trout spawning

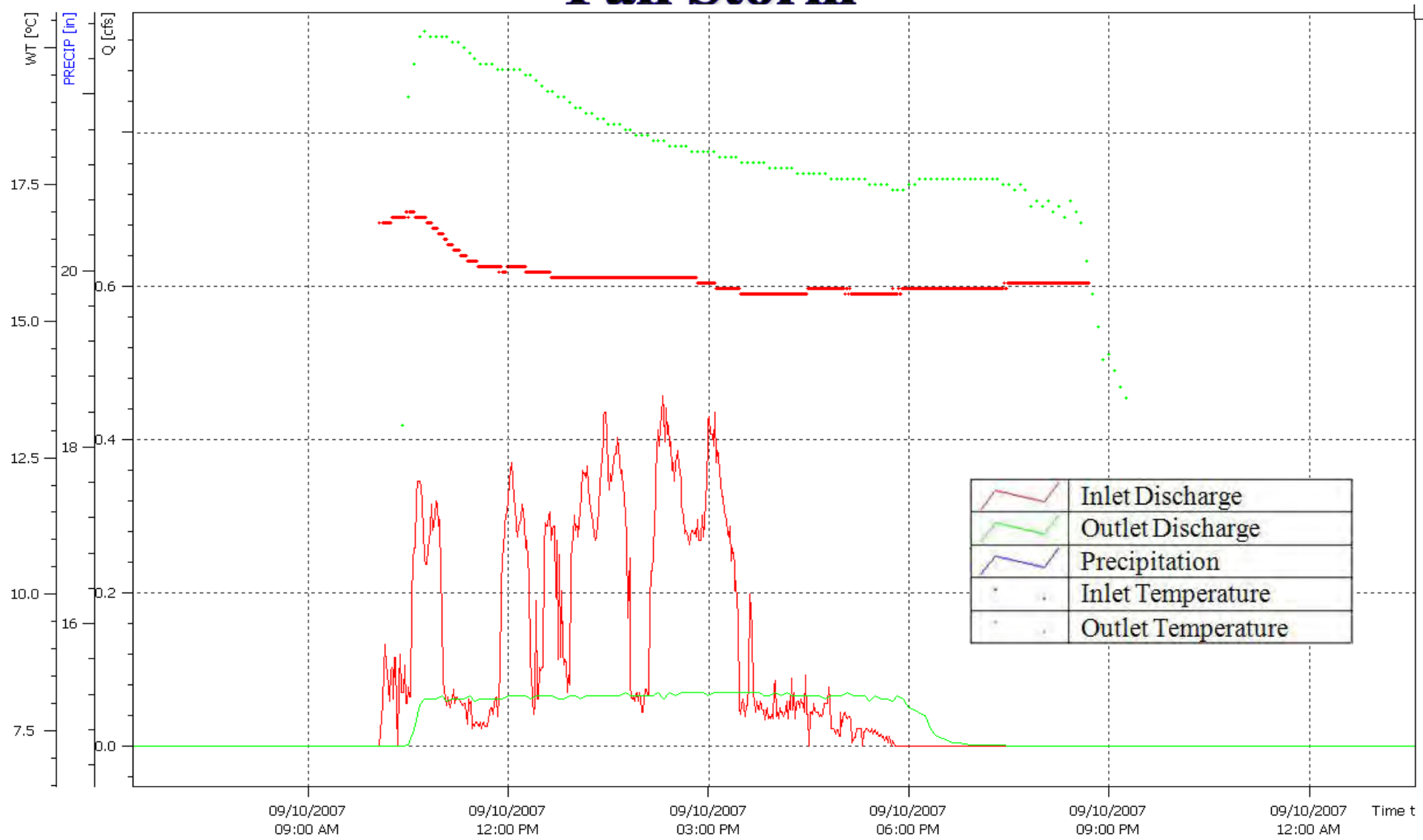
Information from:
Wisconsin Citizen-Based Stream Monitoring Report
Central Wisconsin Trout Unlimited
2006-2007 Level 2 Stream Monitoring Results
http://watermonitoring.uwex.edu/pdf/level2/reportCWTU.pdf

Summer Daytime Storm

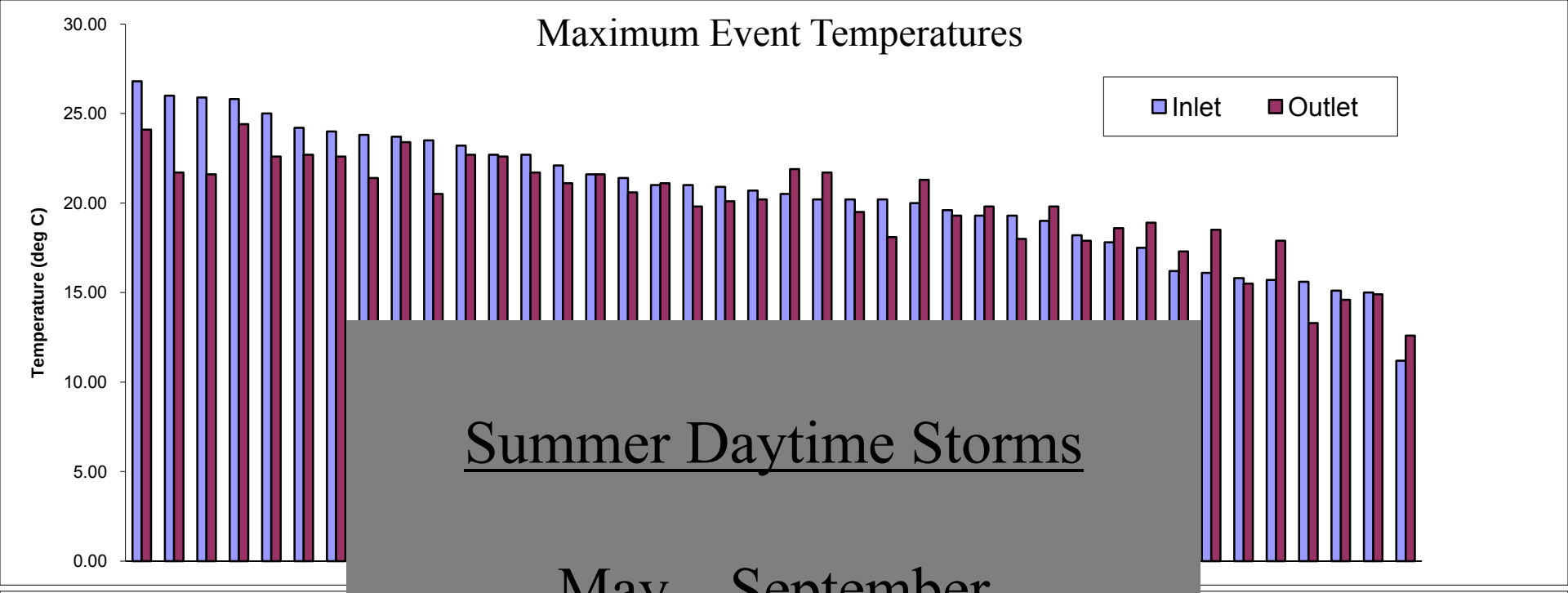


The storm that has been presented in this slide show represents a storm occurring on a warm day in the summer. Although all of the other parameters will respond similarly regardless of storm time and ambient conditions (recall slides with water year data), the pattern for temperature will change due to seasonal and daily temperature fluctuations.

Fall Storm

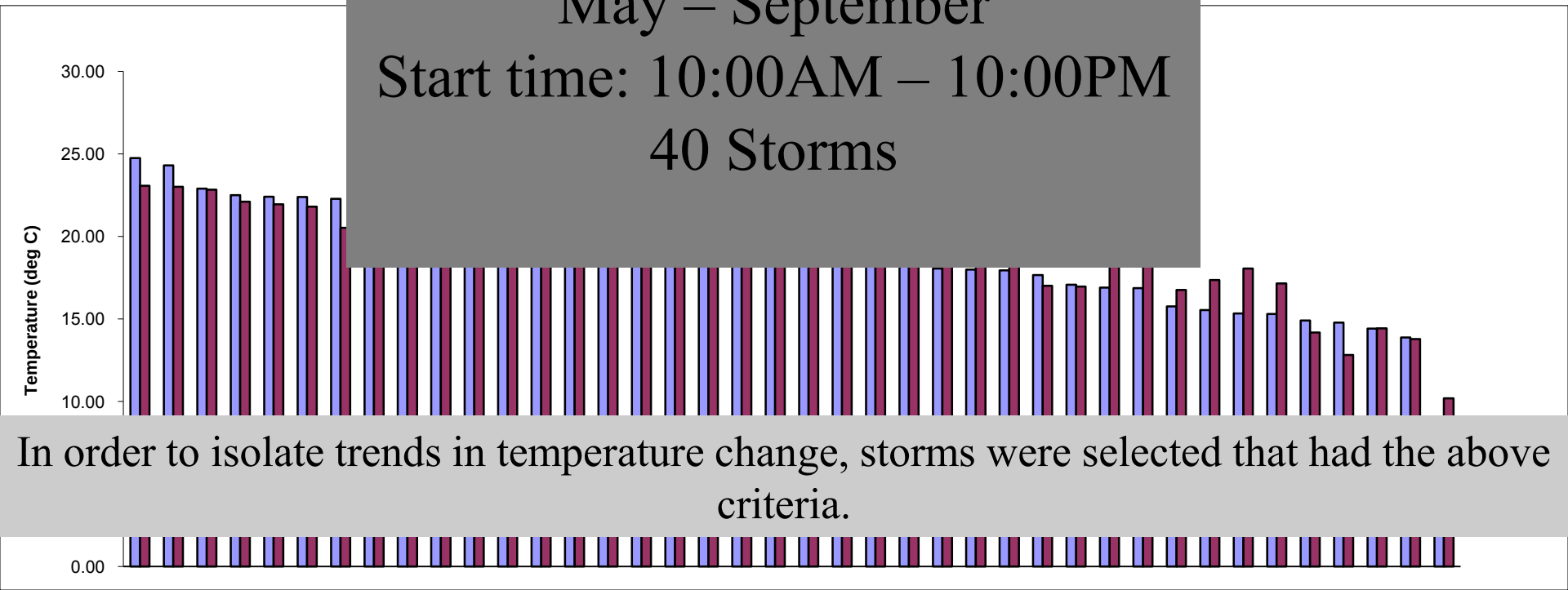


This storm occurs in the morning of a fall day. Although the outlet temperature is higher than the inlet throughout the storm, temperatures are not near critical habitat temperatures for trout (max Outlet temp is around 19.5 °C)

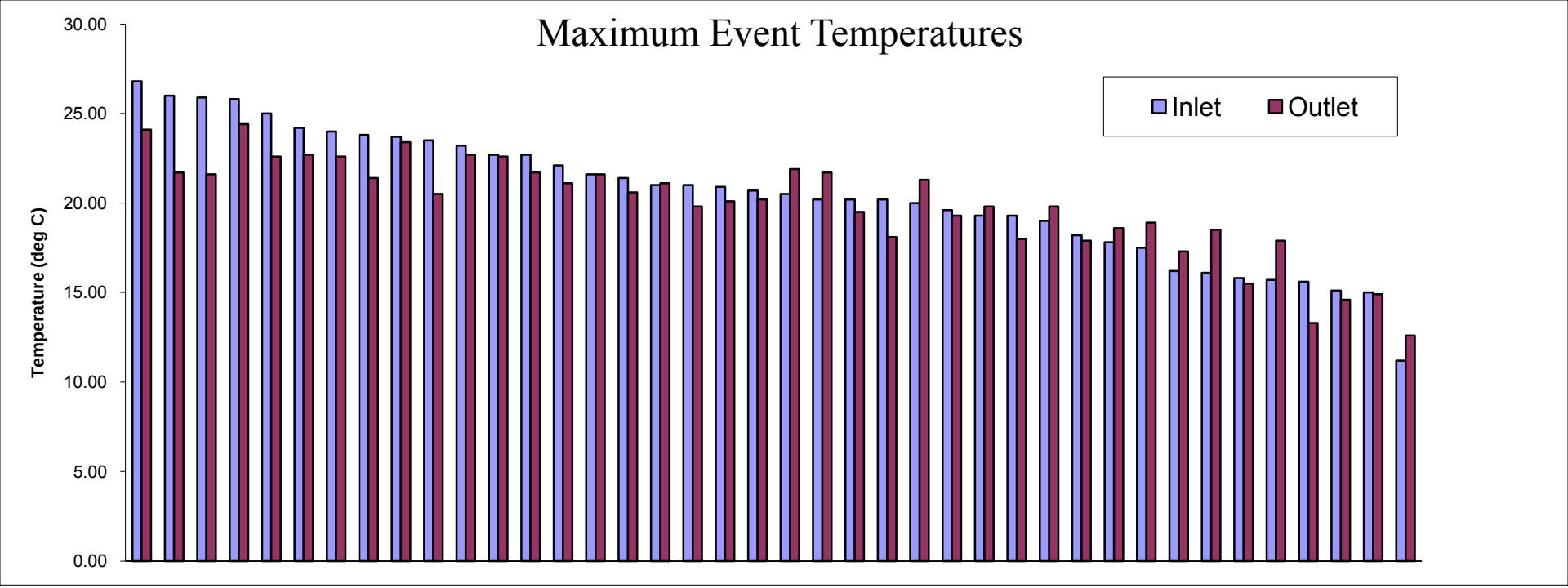


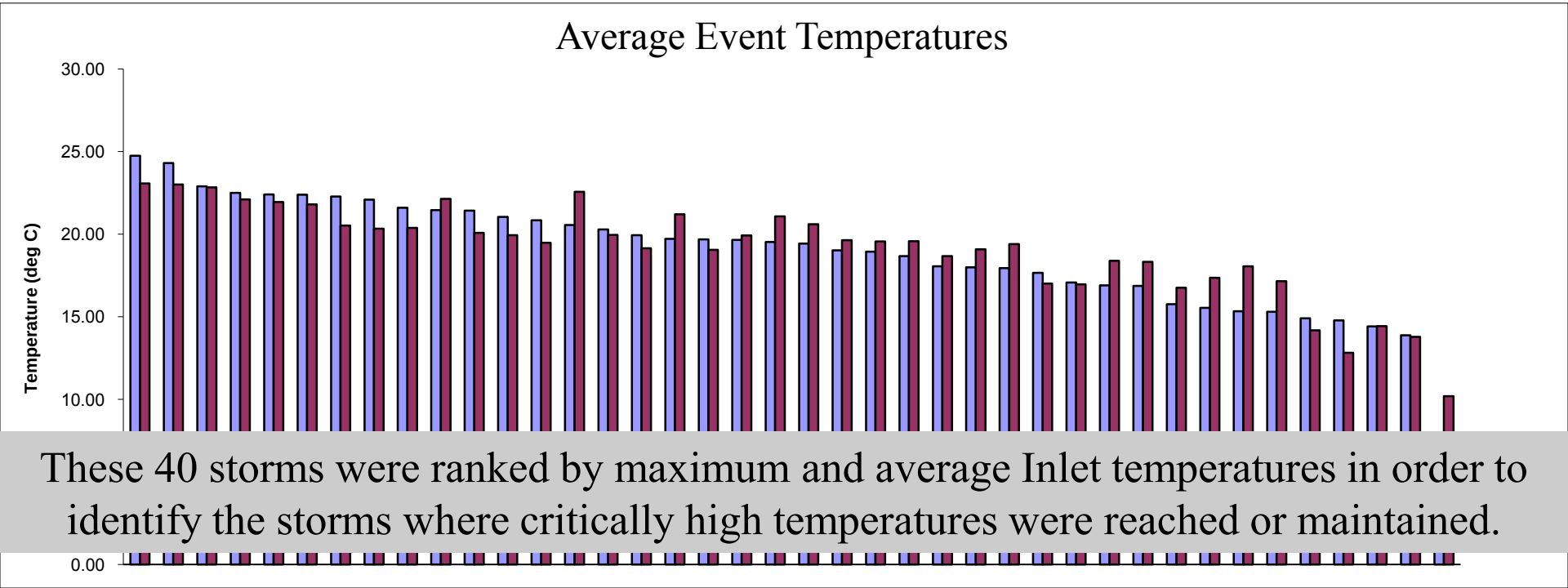
Summer Daytime Storms

May – September
Start time: 10:00AM – 10:00PM
40 Storms

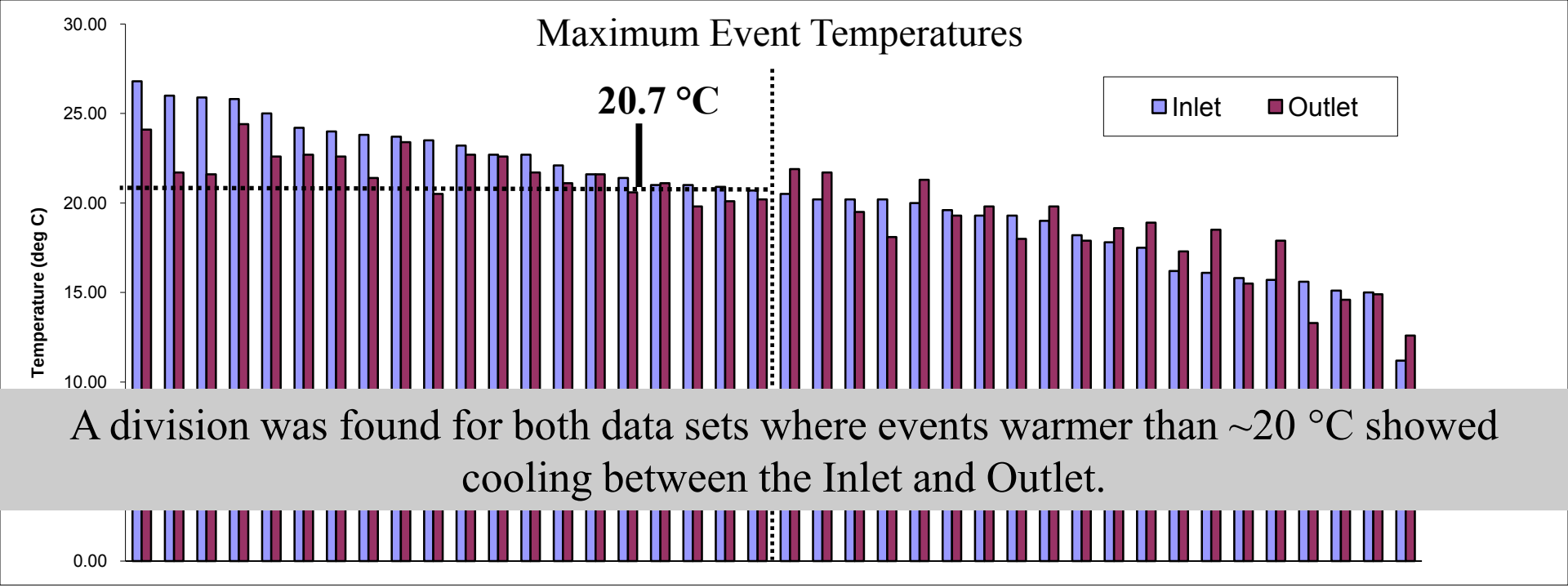


In order to isolate trends in temperature change, storms were selected that had the above criteria.

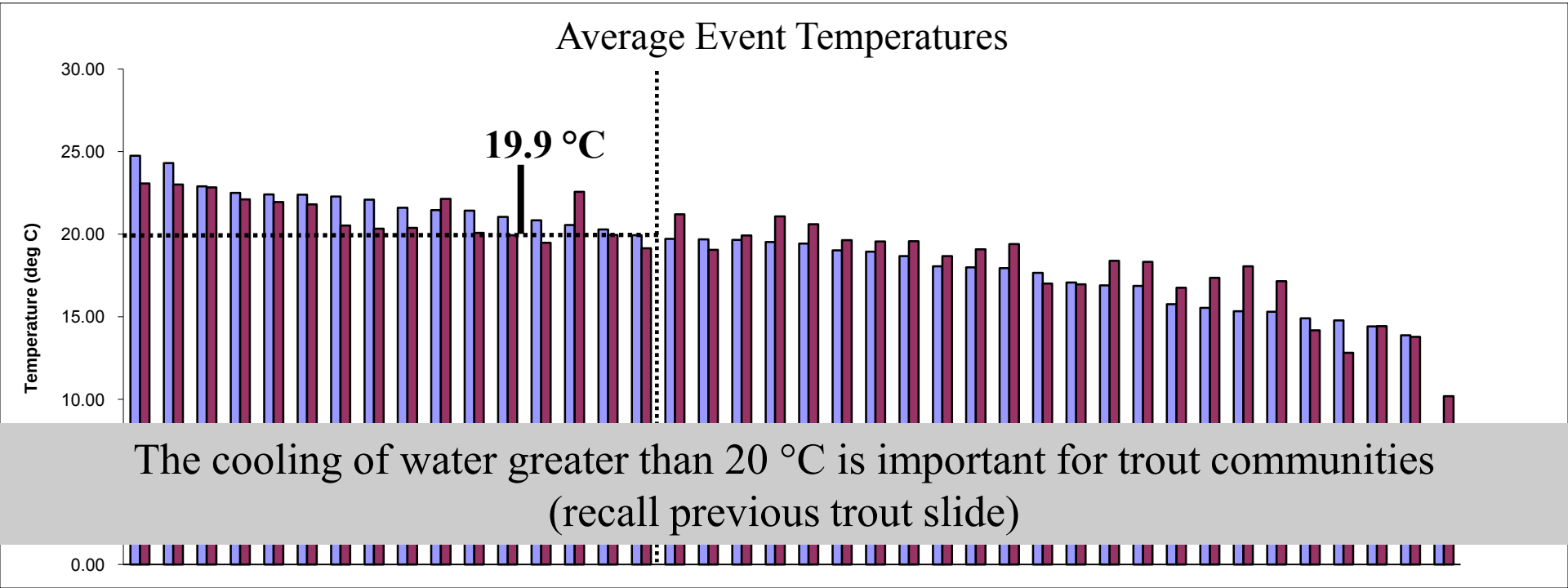




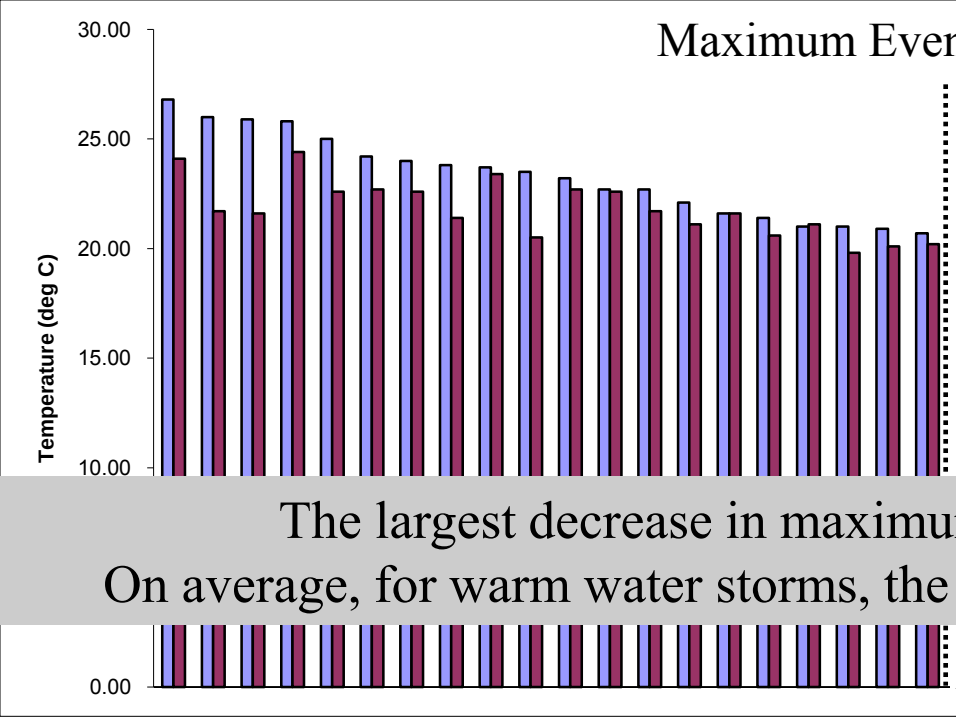
These 40 storms were ranked by maximum and average Inlet temperatures in order to identify the storms where critically high temperatures were reached or maintained.



A division was found for both data sets where events warmer than ~20 °C showed cooling between the Inlet and Outlet.



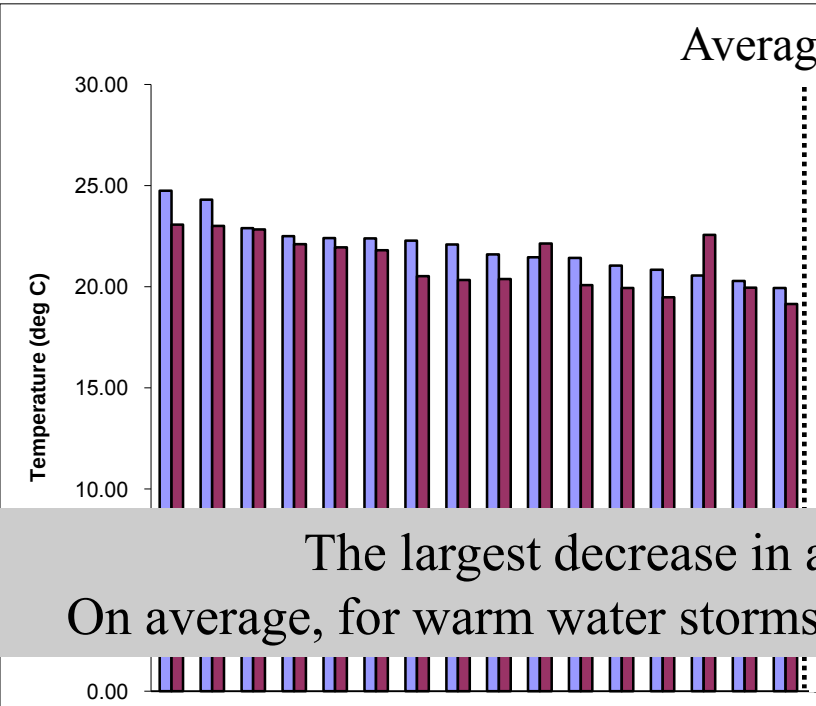
The cooling of water greater than 20 °C is important for trout communities (recall previous trout slide)



Max Difference	4.3 °C	(7.7 °F)
Average Difference	1.5 °C	(2.7 °F)

The largest decrease in maximum water temperature was 4.3 °C

On average, for warm water storms, the max temperature was reduced by 1.5 °C



Max Difference	1.8 °C	(3.2 °F)
Average Difference	0.7 °C	(1.3 °F)

The largest decrease in average water temperature was 1.8 °C

On average, for warm water storms, the average temperature was reduced by 0.7 °C

Conclusions

On average, 61% of all runoff is reaching the rain garden

Most of the water entering the rain garden is infiltrating quickly to the drain pipe and exiting the garden (at least 60% in our example)

Peak discharges are being attenuated

Events are being distributed over a longer period of time

Temperatures are being reduced for critically warm events