Gray to Green with ICPR

by
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2023 FSA Annual Conference
Sanibel Harbour Marriott
Ft. Myers, Florida
June 14 – 16, 2023

STREAMLINE TECHNOLOGIES

Topics

- WQ Module Design Strategy
- Gray to Green – PK Avenue (Auburndale, FL)
  - ✓ Rain Garden / Bioswale
  - ✓ Pervious Parking with Underground Storage
  - ✓ Putting the Pieces Together
  - ✓ Cumulative Removal Efficiencies
  - ✓ Don’t Forget the Hydraulics
- Summary

WQ Module Design Strategy

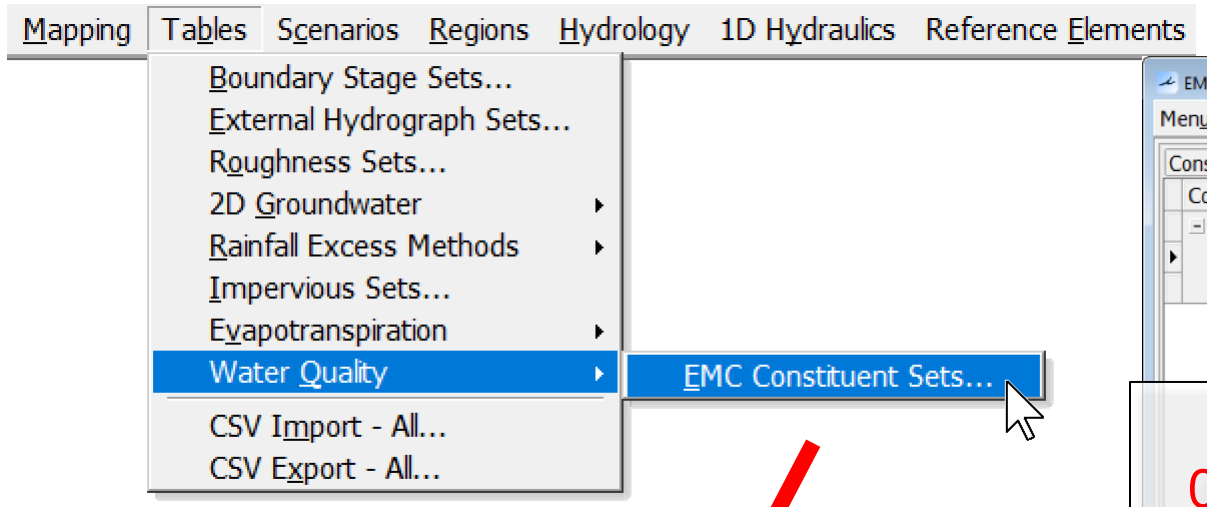
- Watershed Approach
- Water Quality Fully Integrated with H&H
  - ✓ Event Mean Concentrations Applied to Distributed Hydrology
  - ✓ Mass Balance at Nodes
  - ✓ Pollutants Transferred via Links
  - ✓ Removal Efficiencies can be Specified at any Basin, Node or Link
  - ✓ Percolation can be used to Remove Pollutants
- Continuous Simulations Required (*must have ICPR Expert*)
- Multiple Constituents Analyzed Simultaneously
- Initial, Irreducible & Boundary WQ Included

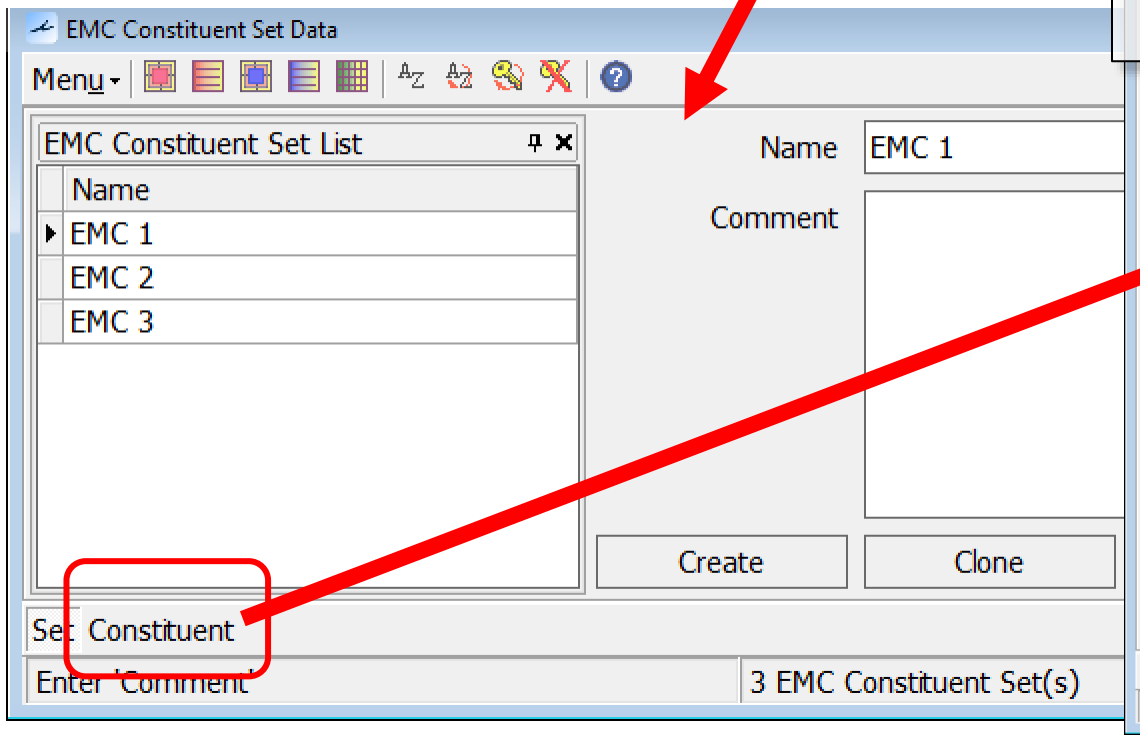
WQ Module Design Strategy

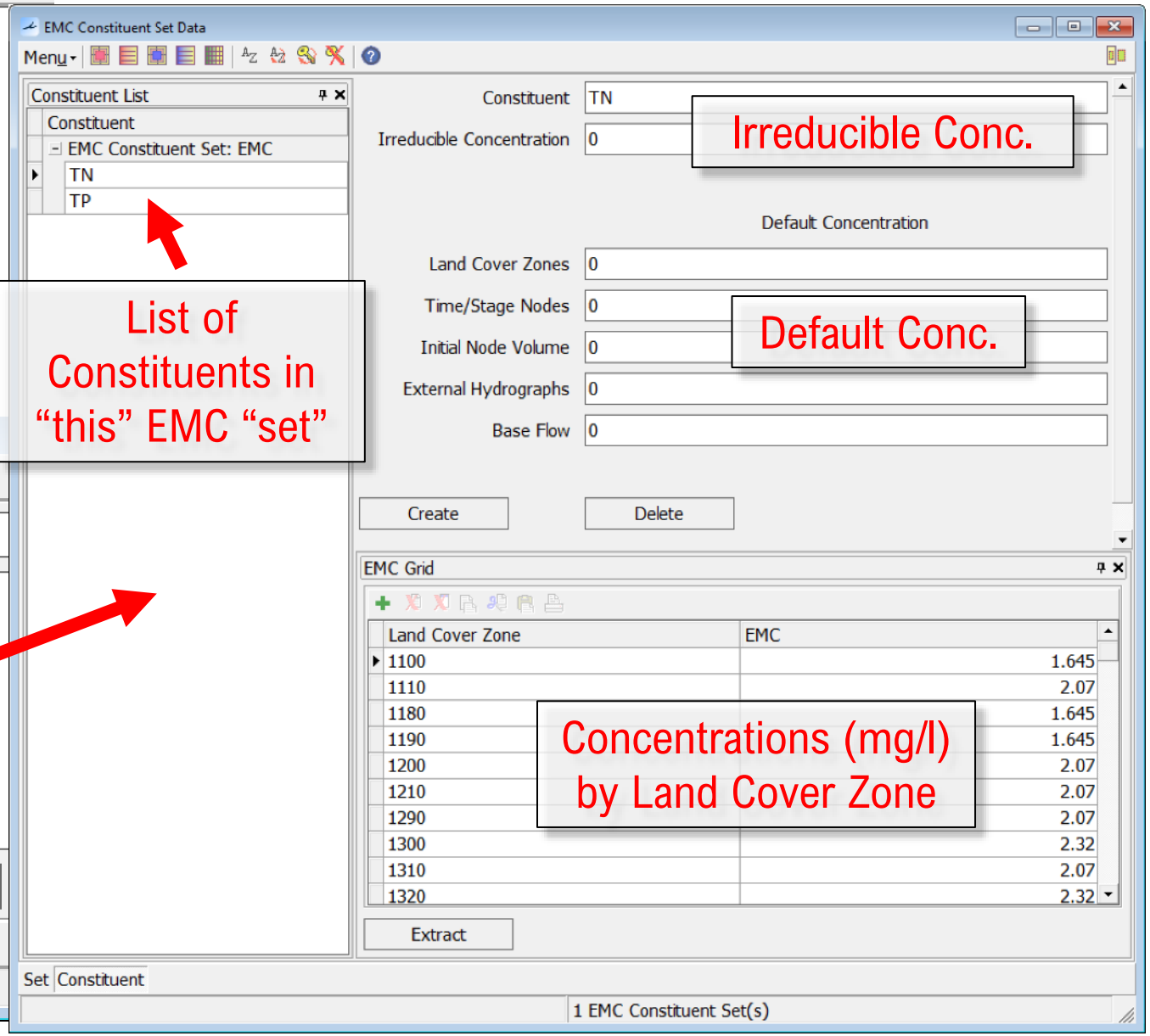
Physical processes associated with infiltration/percolation and evapotranspiration are modeled instead of relying on empirically based performance curves

ICPR Functionality	BMPs
Percolation & French Drain Links	Dry Retention, Exfiltration Trenches, Underground Storage, Treatment Swales, Pervious Pavement, Rain Gardens
Removal Efficiencies Specified at Nodes	Wet Detention Systems, Managed Aquatic Plant Systems (MAPS), User Defined BMPs
Removal Efficiencies Specified at Links	Upflow Filtration Systems, Biofiltration Systems with BAM, User Defined BMPs
Storage, Evapotranspiration & Irrigation	Vegetated Natural Buffer, Vegetated Filter Strip, Green Roof/Cistern Systems, Stormwater & Rainwater Harvesting, Interceptor Trees

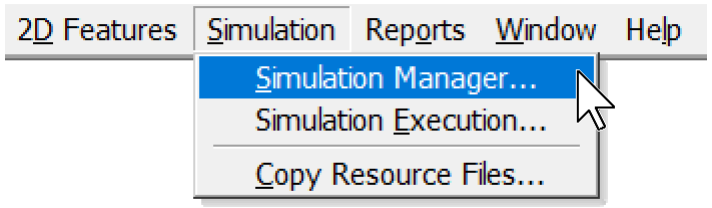
EMC LOOK-UP TABLE

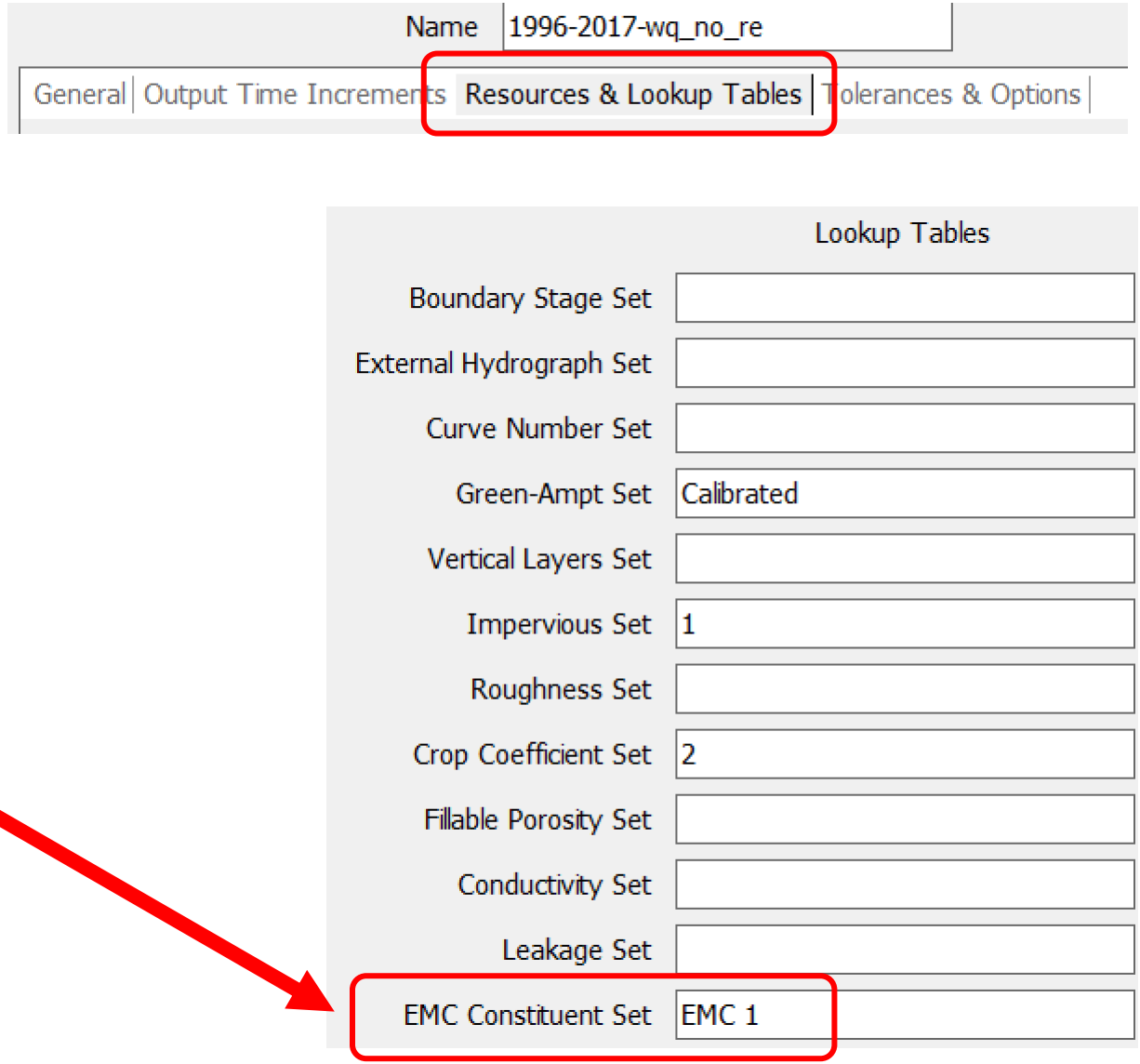






REFERENCING EMC LOOK-UP TABLE IN SIMULATION MANAGER





Water quality calculations are triggered by referencing an EMC look-up table in the Simulation Manager

Gray to Green – PK Avenue

City of Auburndale
INCORPORATED 1911

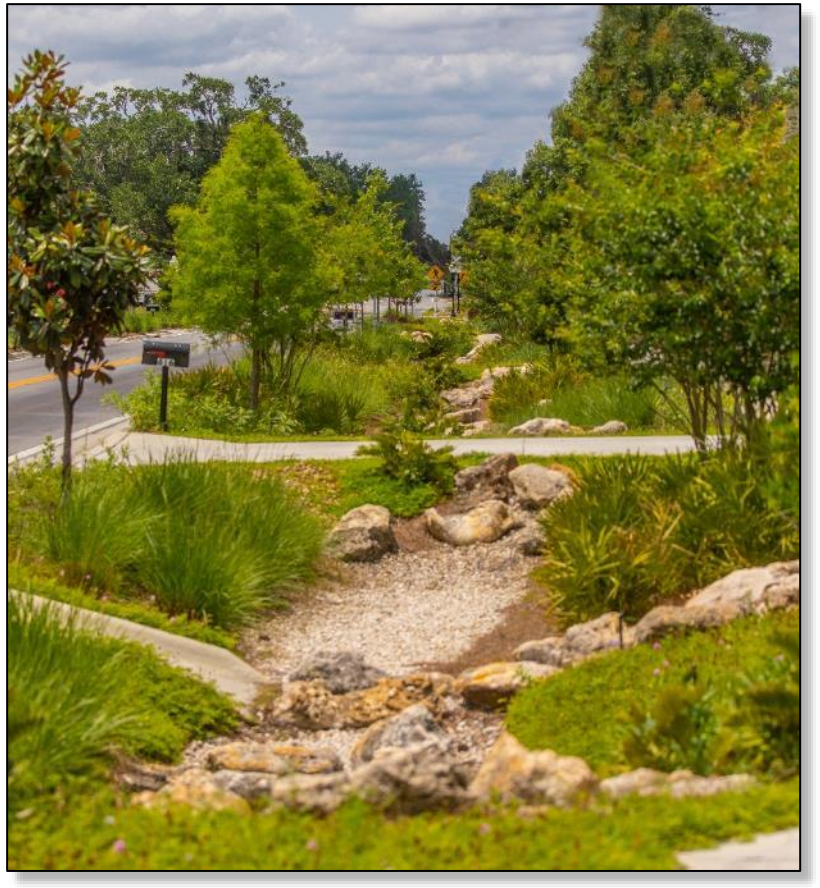
CHASTAIN SKILLMAN

Special thanks to:

Drew Morson, P.E.
Kevin Albrecht, P.E.

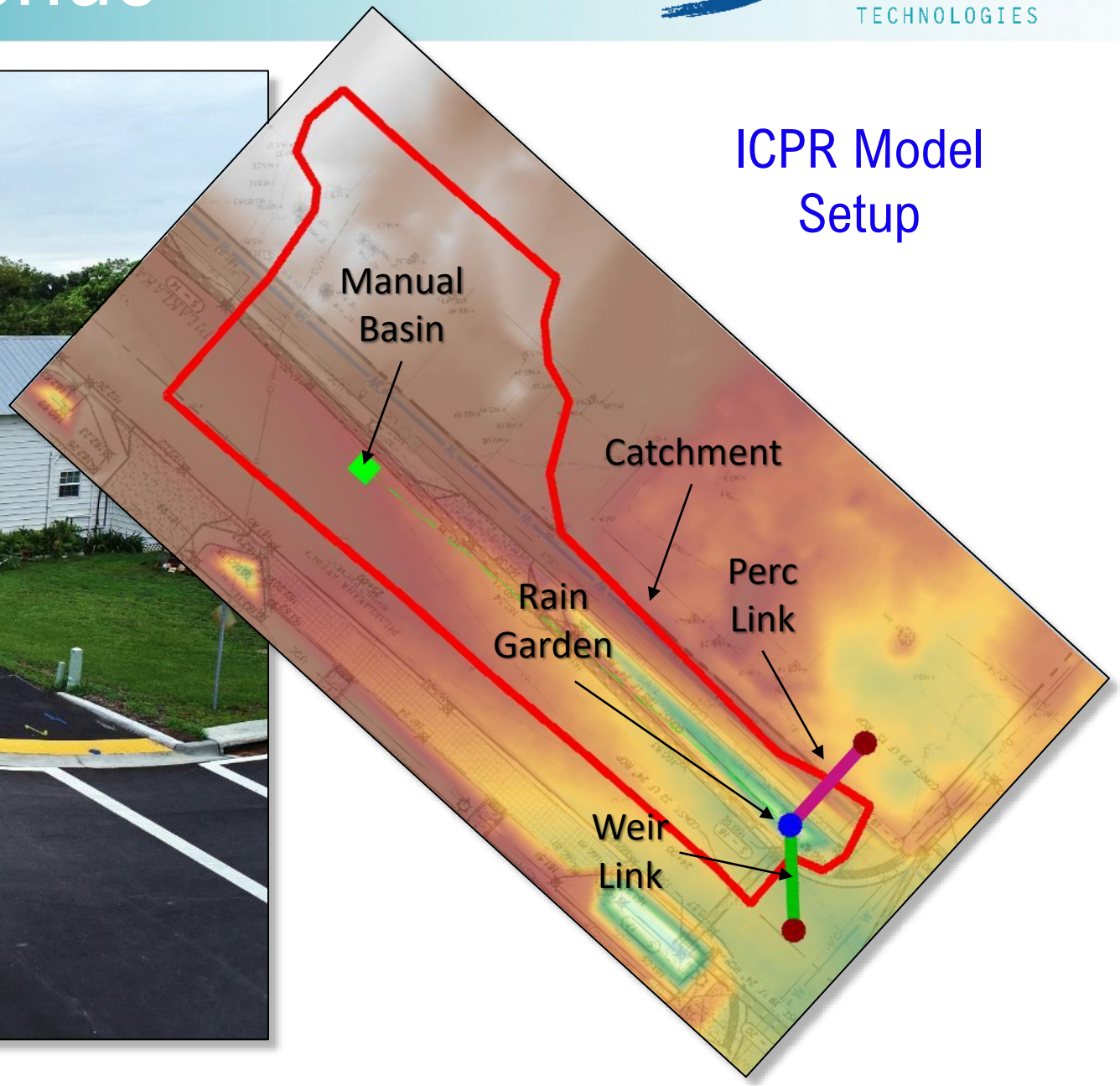
Note: The photographs and construction plans for PK Avenue are courtesy of Chastain Skillman.

Gray to Green – PK Avenue



Rain Garden / Bioswale Example

Gray to Green – PK Avenue



Gray to Green – PK Avenue

STREAMLINE TECHNOLOGIES

Manual Basin Data Form

Manual Basin Sub-Basin Edit

Area	Land Cover Zone	Soil Zone	Rainfall Name	Crop Coefficient Zone	Reference ET Station
0.084642	RESIDENTIAL M...	1425050	100837	GRASS	100837
0.14247	TRANSPORTATI...	1425050	100837	GRASS	100837
0.015748	RAIN GARDEN	1425050	100837	GRASS	100837

- ✓ Impervious % Table
- ✓ EMC Table
- ✓ Green-Ampt Table
- ✓ Rainfall Resource Files (NEXRAD)
- ✓ Crop Coef Table (ET)
- ✓ Reference ET Resource Files (USGS)

Total Area: 0.24286 ac (10,579 ft^2)

Gray to Green – PK Avenue

Node Data

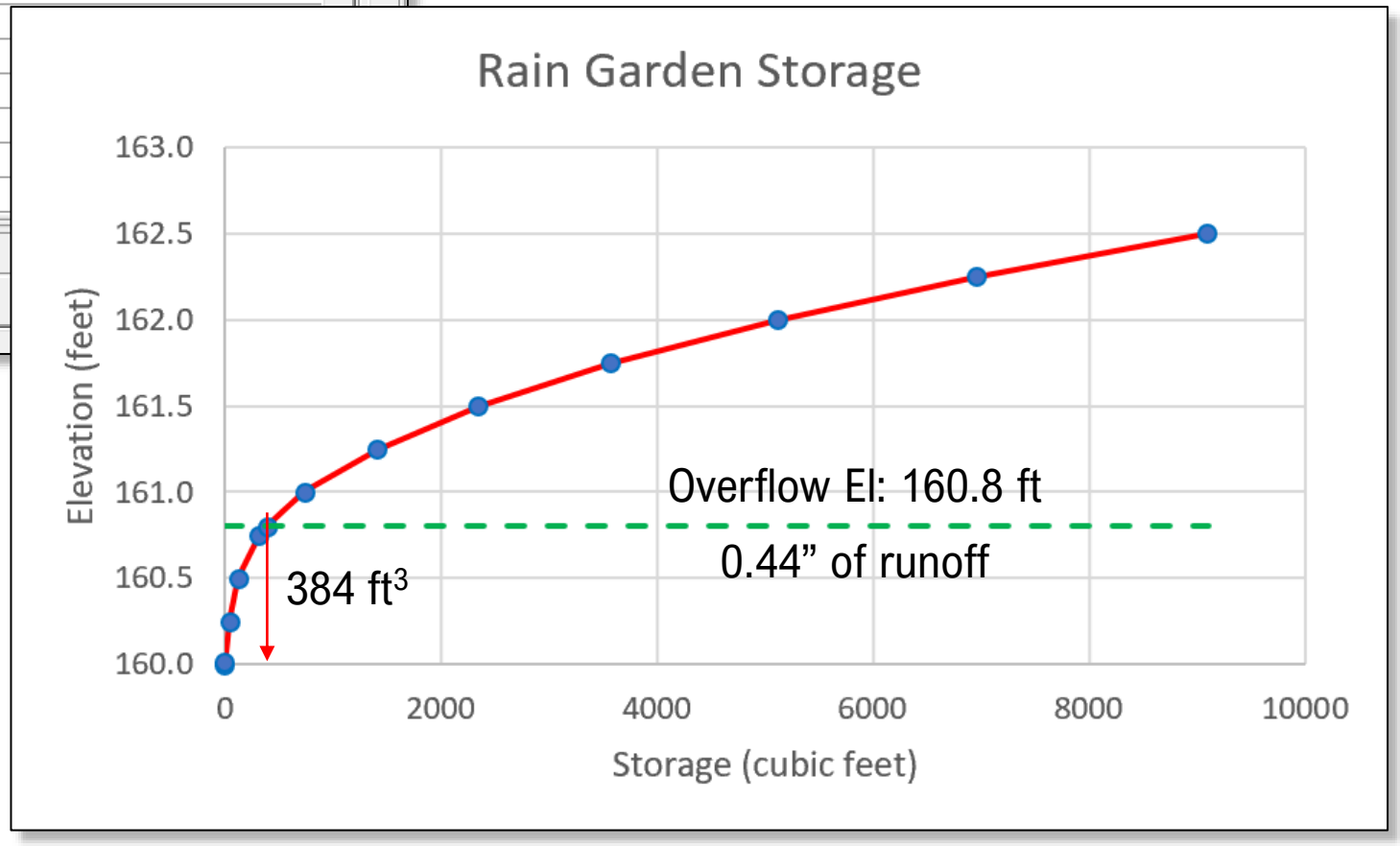
Name	20
Scenario	RAIN GARDEN EXAMPLE
Type	Stage/Area
Base Flow	0
Initial Stage	160
Warning Stage	160.8
Alert Stage	161.04
Comment	CLR: Stage-area based on merged surface. Initial stage based on stage/area low point. Warning at weir overflow, Alert at estimated roadway crown.

Node Point Edit

Stage	Area
160	0.0023
160.25	0.0047
160.5	
160.75	
161	
161.25	
161.5	
161.75	

Node External Hydrographs Grid

External Hy...



$$\text{Treatment Volume} = \frac{\text{Treatment Storage}}{\text{Basin Area}}$$

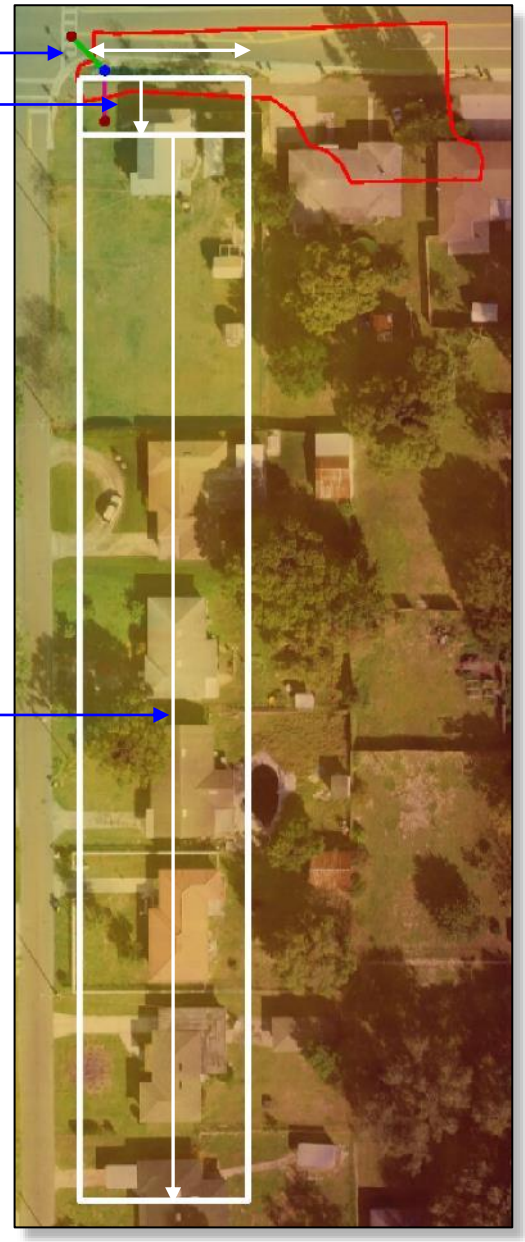
$$\left\{\frac{384\ ft^3}{10{,}579\ ft^2}\right\} \times 12\ in/ft = \underline{0.44\ in}$$

Gray to Green – PK Avenue

Percolation Link Data

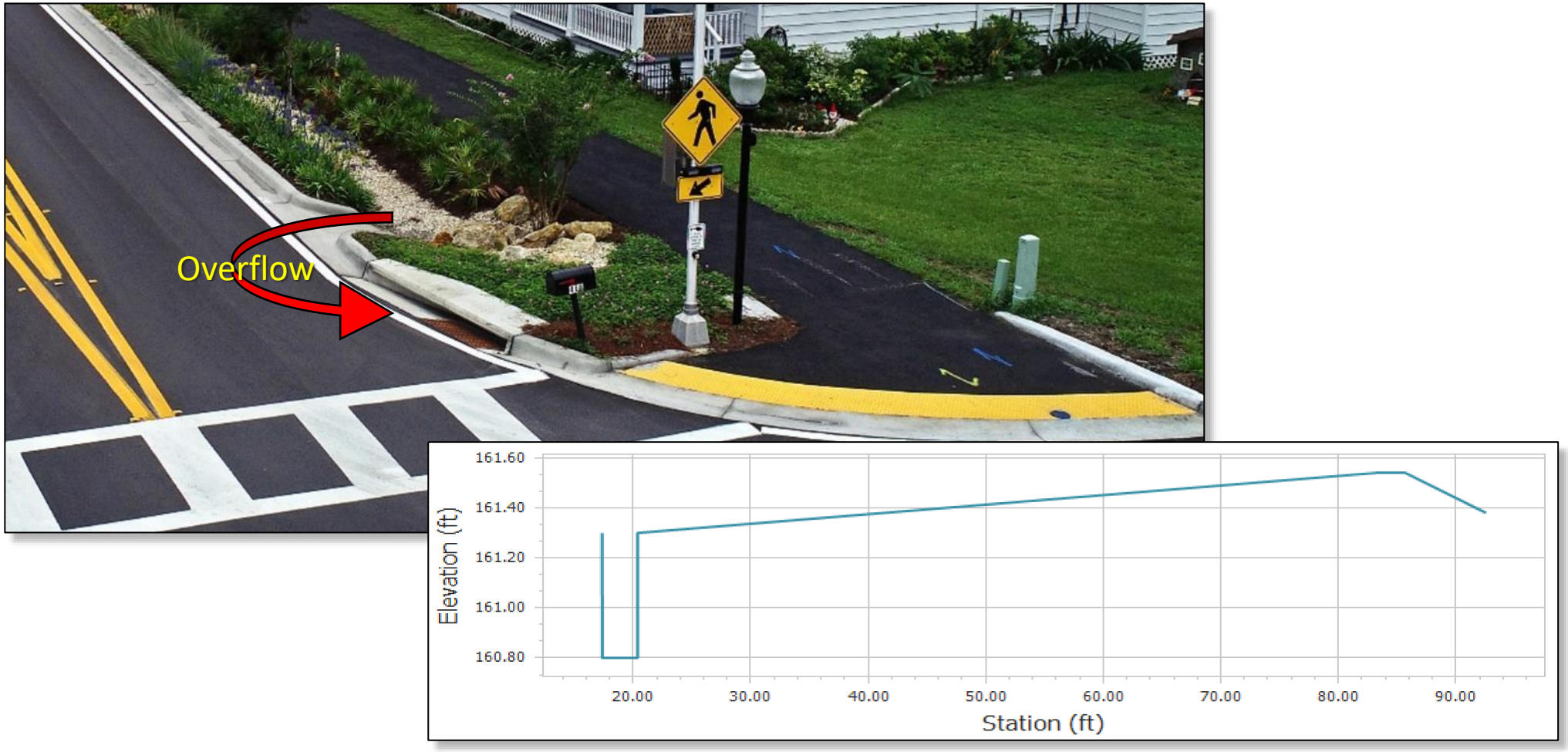
Name	20-PERC	Surface Area Option	Vary Based on Stage/Area ...
Scenario	RAIN GARDEN EXAMPLE		
From Node	20		
To Node	20-GW	Vertical Flow Termination	Horizontal Flow Algorithm
Link Count	1	Perimeter 1	92
Flow Direction	Both	Perimeter 2	92
Aquifer Base Elevation	98.2	Perimeter 3	92
Water Table Elevation	154.5	Distance P1 to P2	30
Annual Recharge Rate	0	Distance P2 to P3	570
Horizontal Conductivity	20	# of Cells P1 to P2	6
Vertical Conductivity	20	# of Cells P2 to P3	57
Fillable Porosity	0.2		
Layer Thickness	5.5		

from GeoTech Report



Gray to Green – PK Avenue

Weir Cross Section Data



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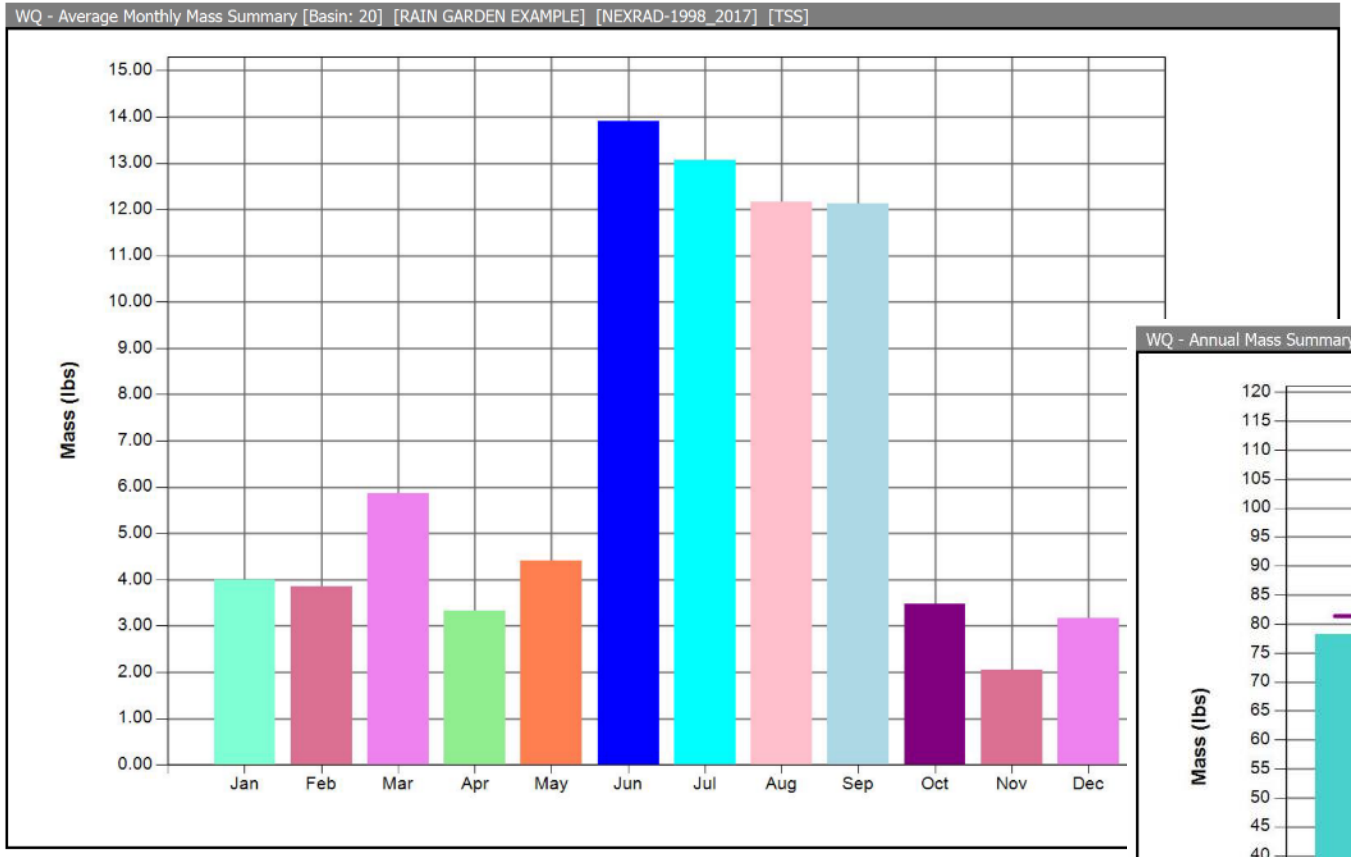
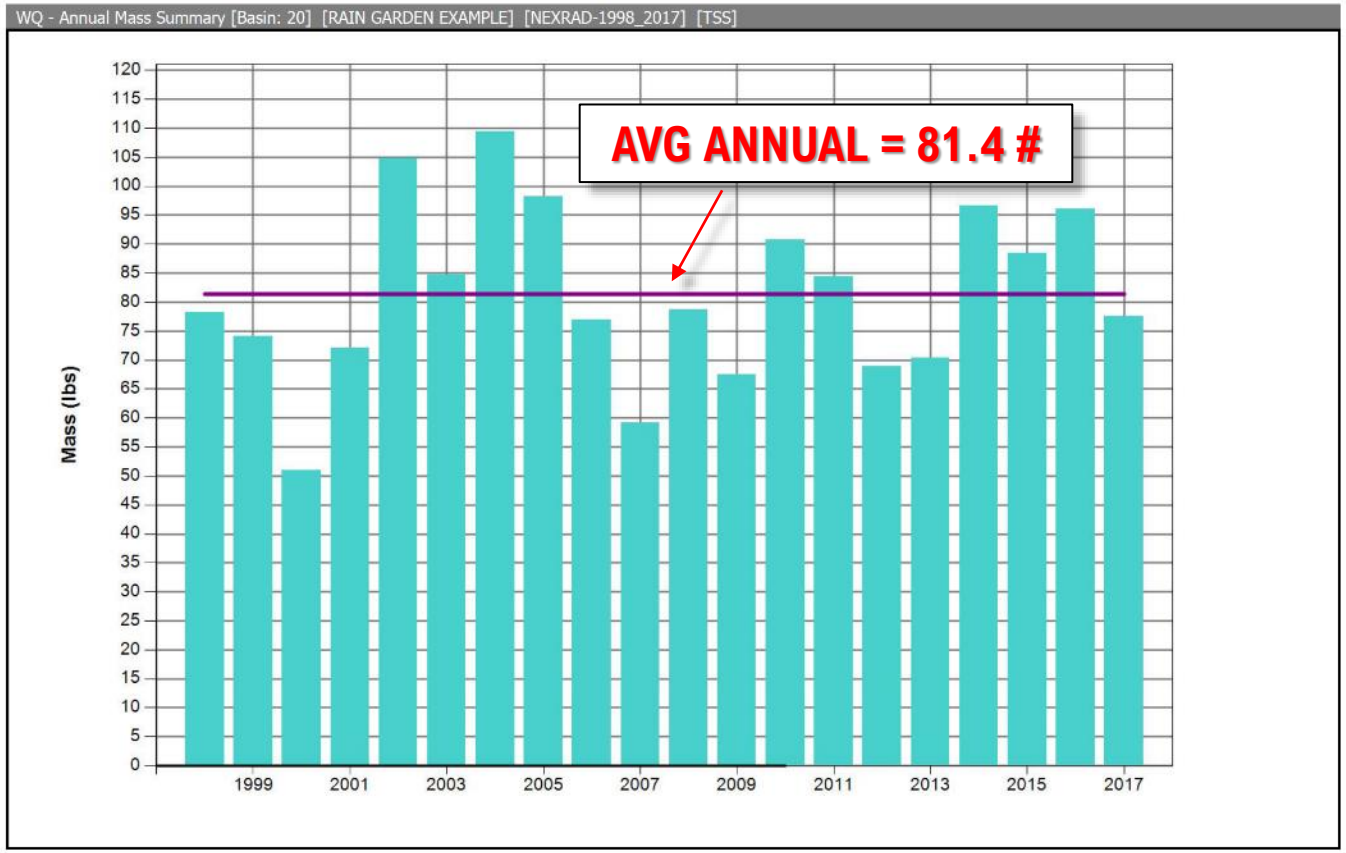


MONTHLY AVERAGES

TN = 3.14 # per year
TP = 0.44 # per year

ANNUAL TOTALS

TOTAL SUSPENDED SOLIDS (1998 – 2017 SIMULATION)



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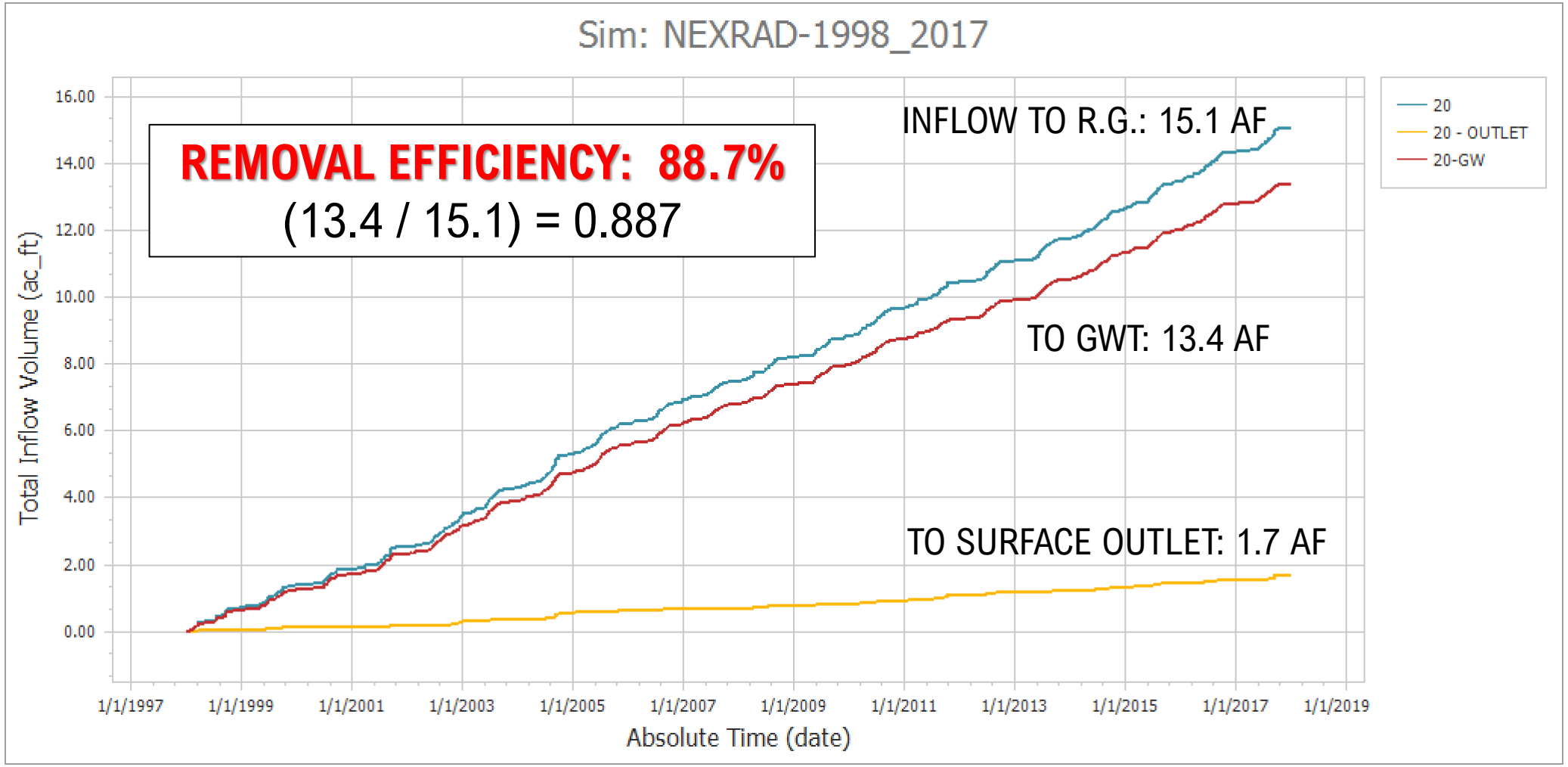

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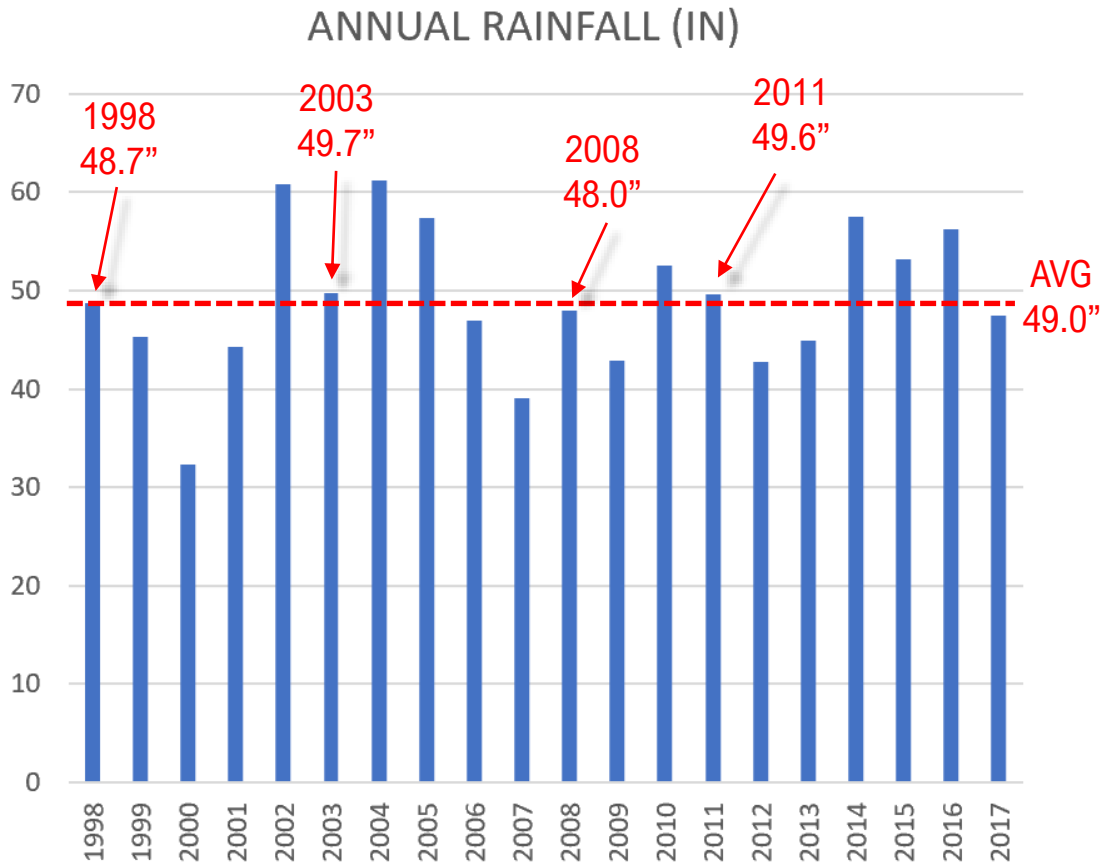
STREAMLINE TECHNOLOGIES

Can we use a typical year rather than a 20-year simulation?

Total Suspended Solids

Simulation Period	Annual TSS (#)	Removal Efficiency
1998 – 2017	81.41	88.7%
1998	78.20	89.3%
2003	76.98	92.3%
2008	73.23	86.0%
2011	78.91	88.1%



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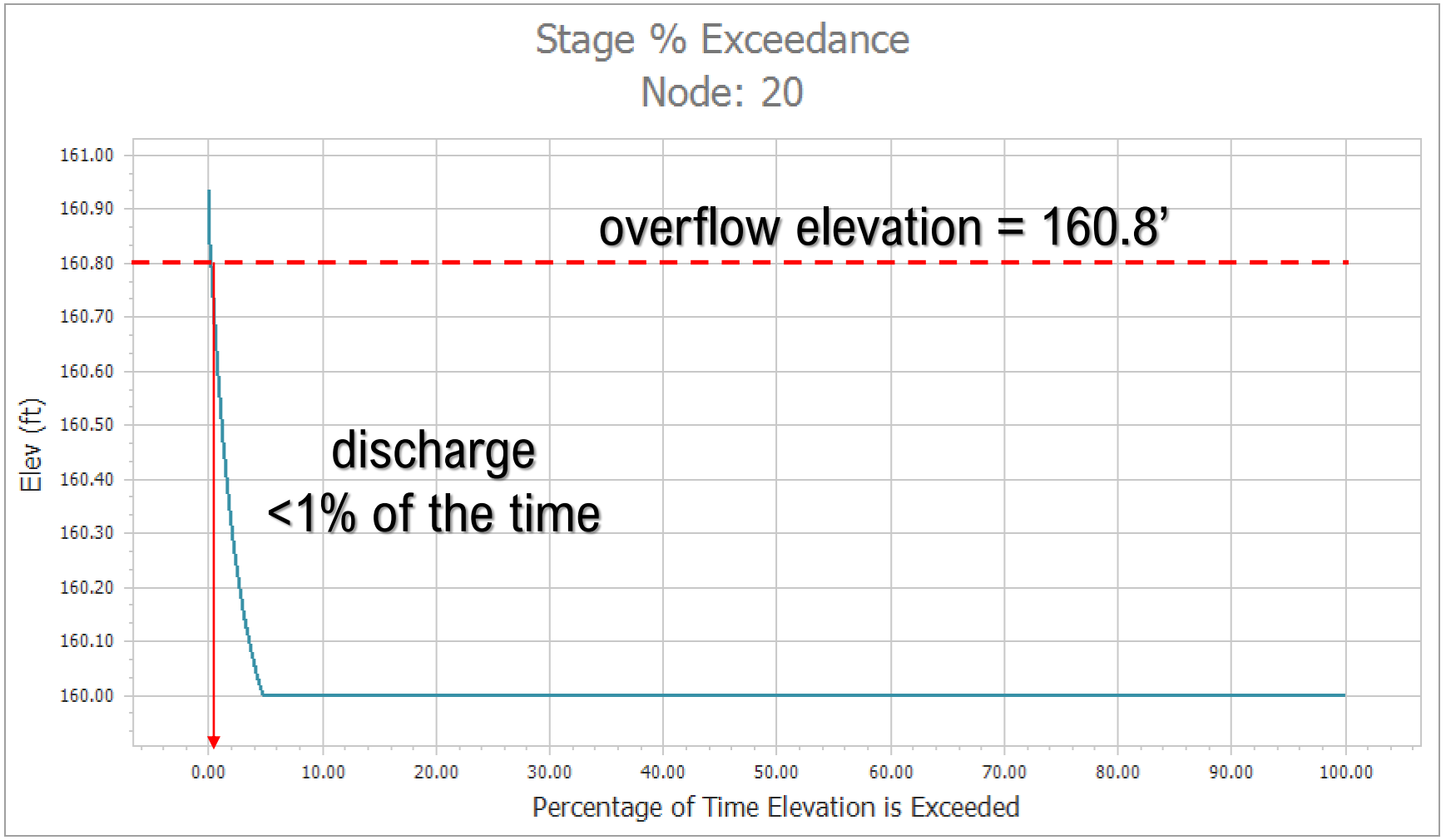
Exceedance Probability Chart



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Pervious Pavers & Underground Storage Example

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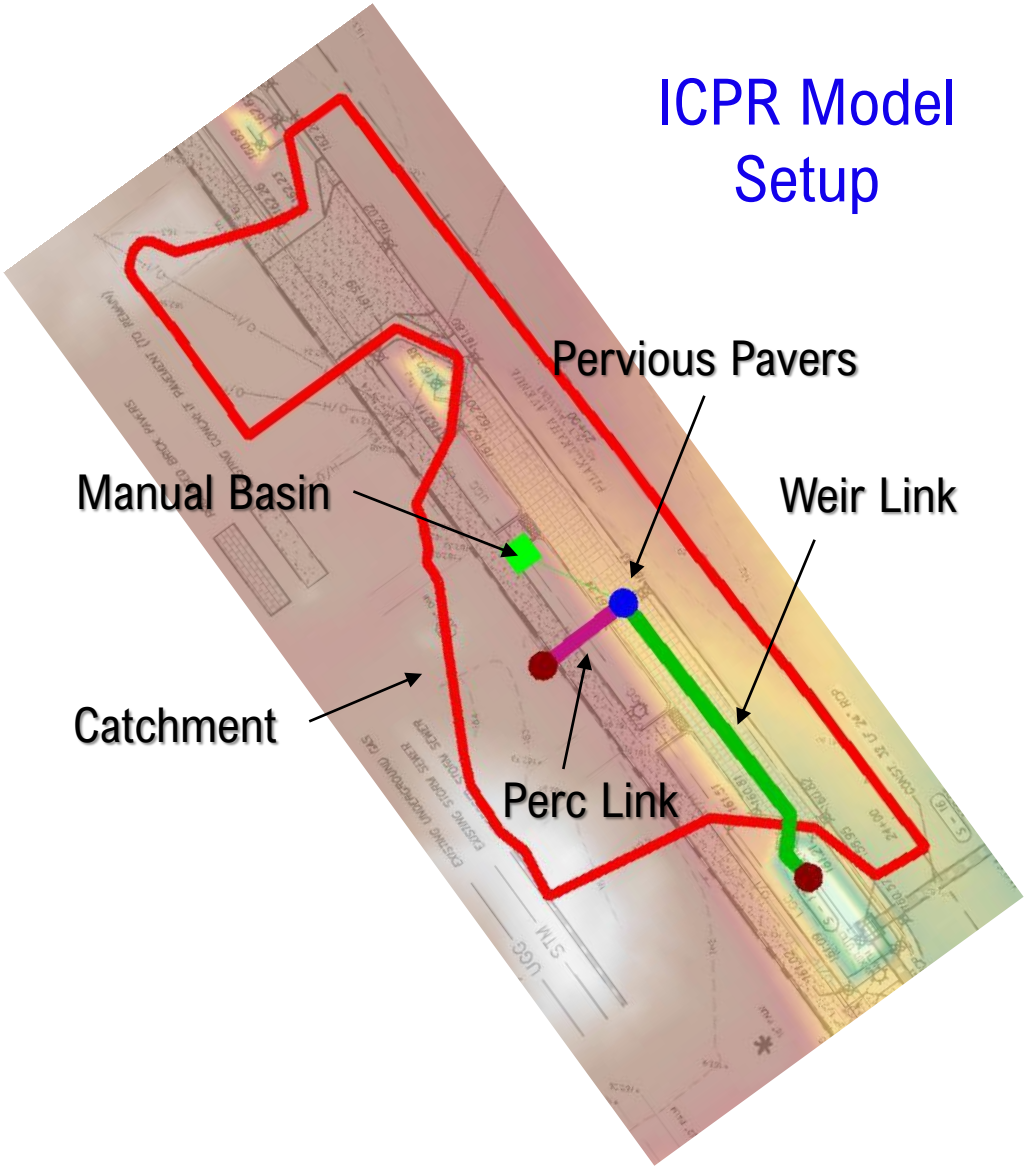

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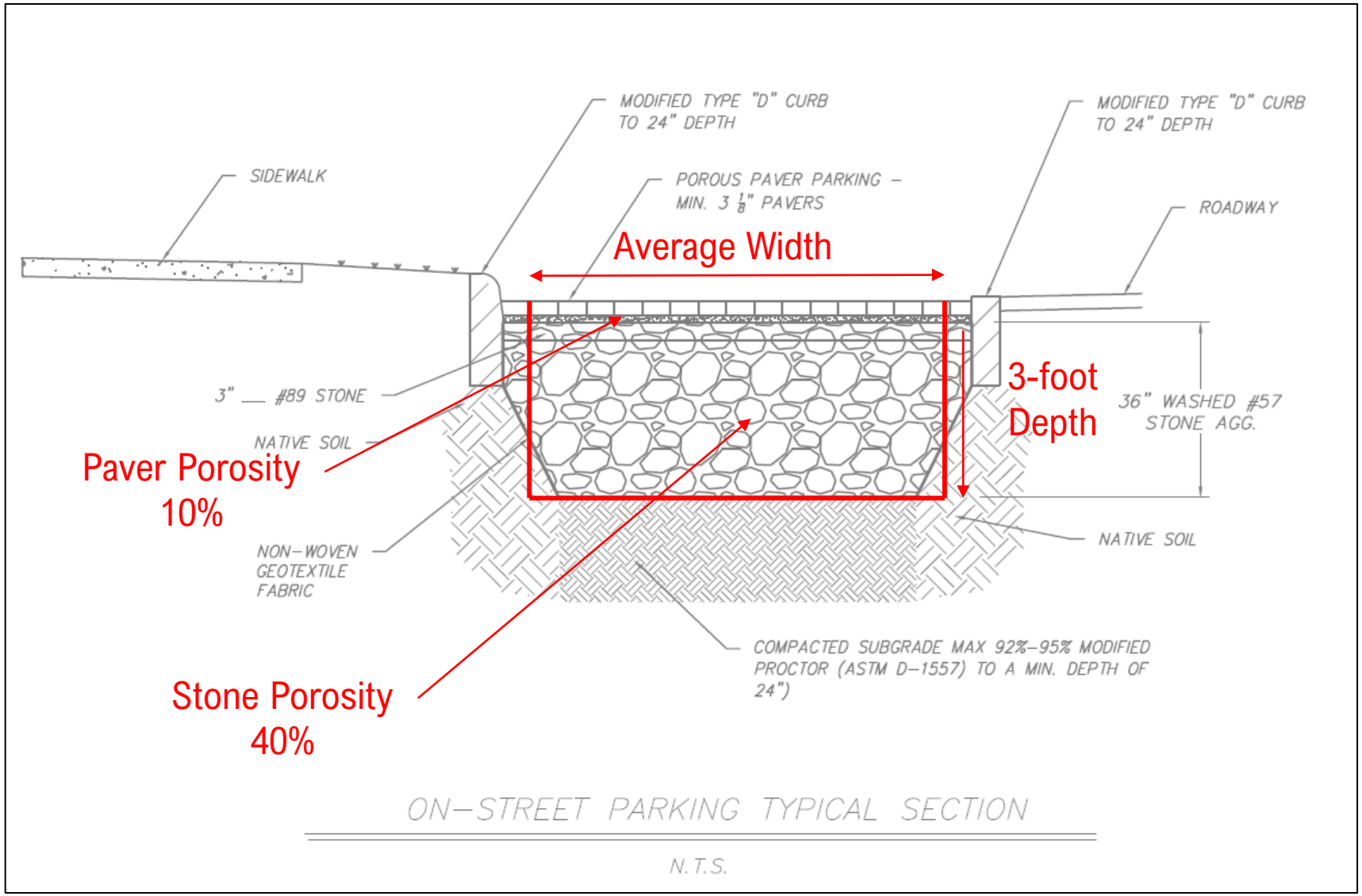


Gray to Green – PK Avenue

STREAMLINE TECHNOLOGIES

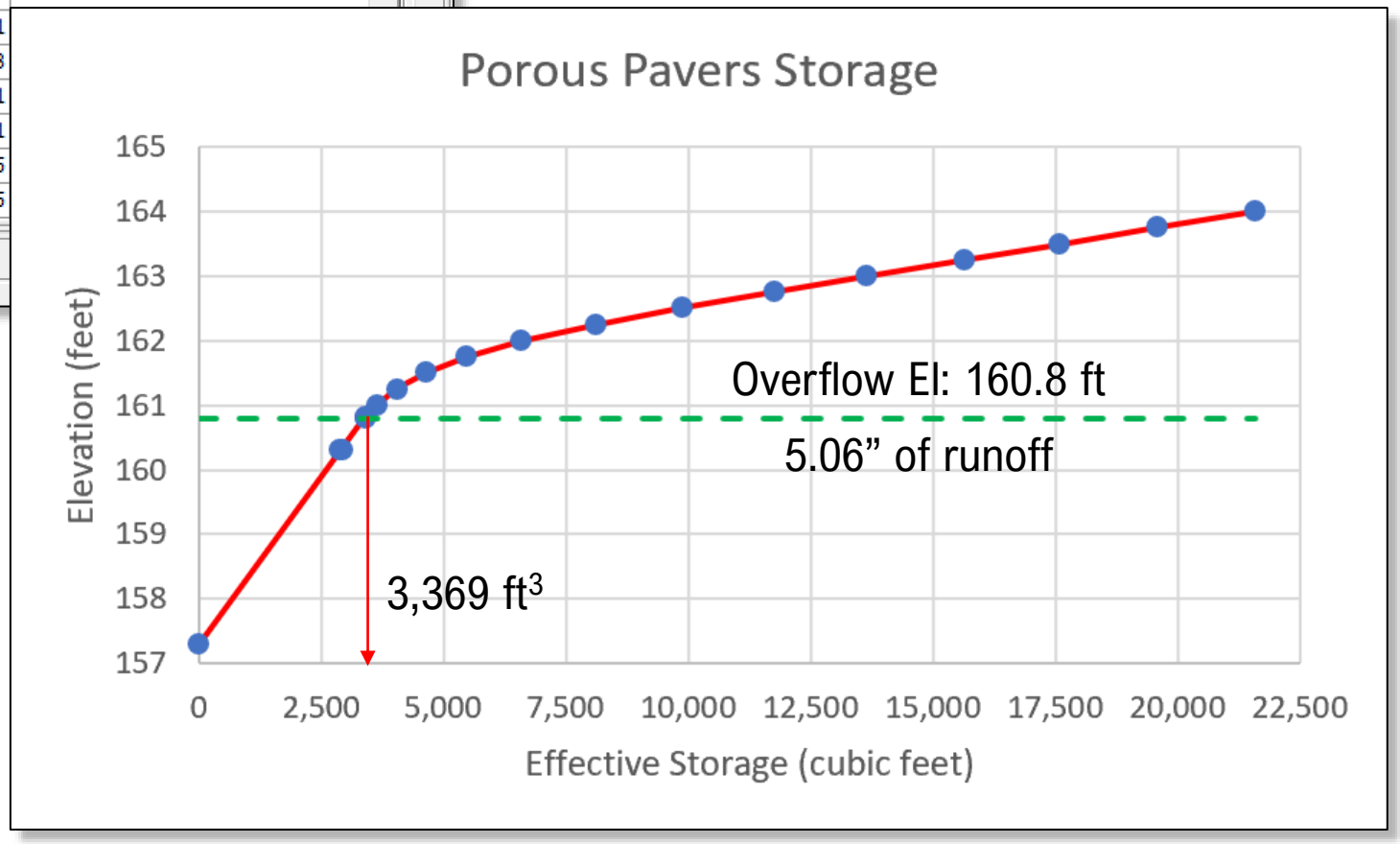
Name	19
Scenario	POROUS PAVERS EXAMPLE
Type	Stage/Area
Base Flow	0
Initial Stage	157.3
Warning Stage	160.81
Alert Stage	161.81
Comment	3-FT DEPTH OF COARSE GRAVEL WITH 40% POROSITY 0.5-FT THICK PAVERS AT

Node Point Edit

Stage	Area
157.3	0.0091
160.3	0.0091
160.31	
160.8	
160.81	
161	
161.25	
161.5	

Node External Hydrographs Grid

Node Data



Treatment Volume = $\frac{\text{Treatment Storage}}{\text{Basin Area}}$

$\left\{ \frac{3{,}369\ ft^3}{7{,}996\ ft^2} \right\}$ x 12 in/ft = 5.06 in

a lot of storage!!!

Gray to Green – PK Avenue

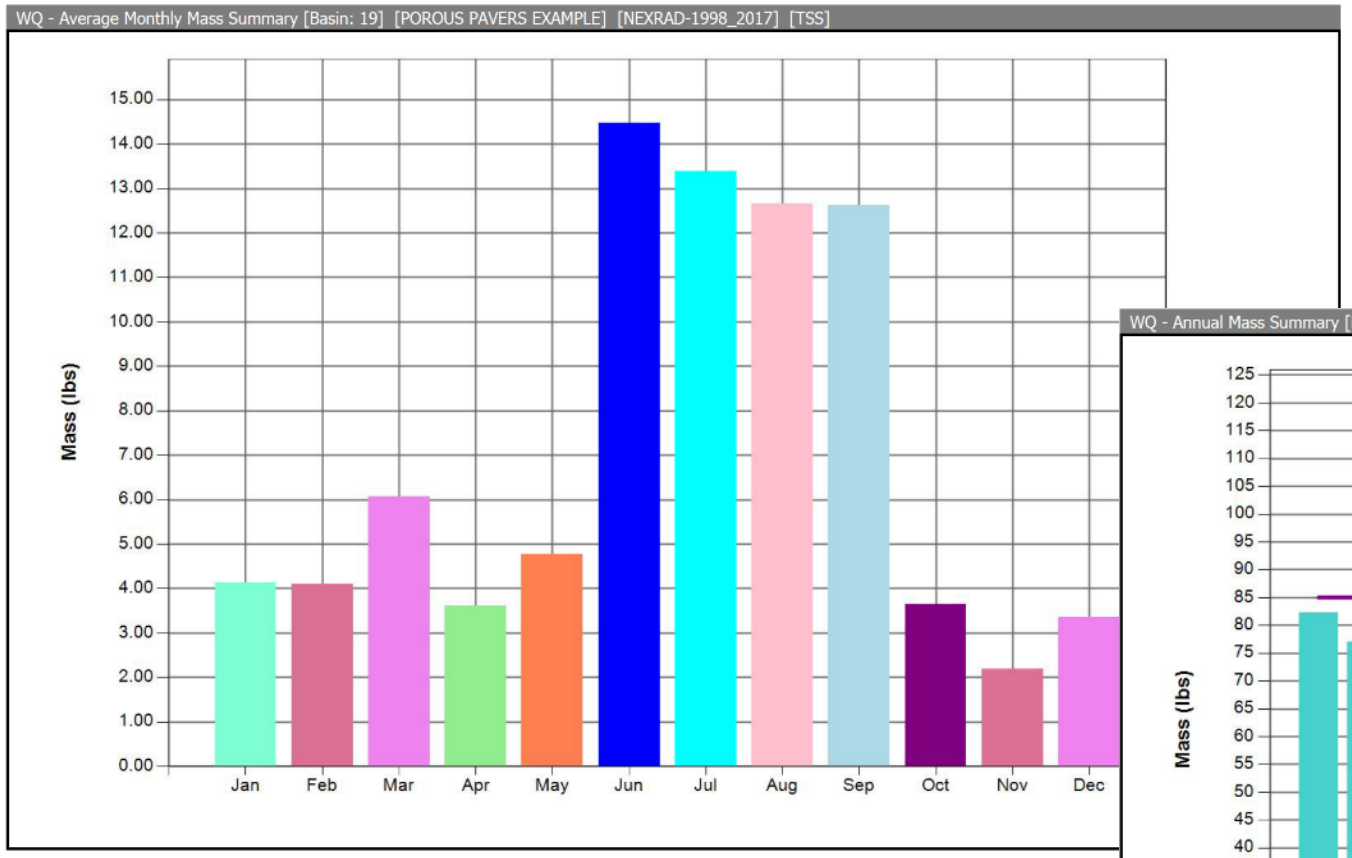
Percolation Link Data

Name	19-PERC	Surface Area Option	User Specified
Scenario	POROUS PAVERS EXAMPLE	Bottom Elevation	157.3
From Node	19	Surface Area	0.0221
To Node	19-GW	Vertical Flow Termination	Horizontal Flow Algorithm
Link Count	1	Perimeter 1	98
Flow Direction	Both	Perimeter 2	98
Aquifer Base Elevation	98.2	Perimeter 3	98
Water Table Elevation	154.3	Distance P1 to P2	30
Annual Recharge Rate	0	Distance P2 to P3	570
Horizontal Conductivity	20	# of Cells P1 to P2	6
Vertical Conductivity	20	# of Cells P2 to P3	57
Fillable Porosity	0.2		
Layer Thickness	3		

- ✓ "User Specified" option
- ✓ Elevation is at the bottom of the stone
- ✓ Surface area should not account for porosity of stone, it should be the area of the soil immediately below the stone

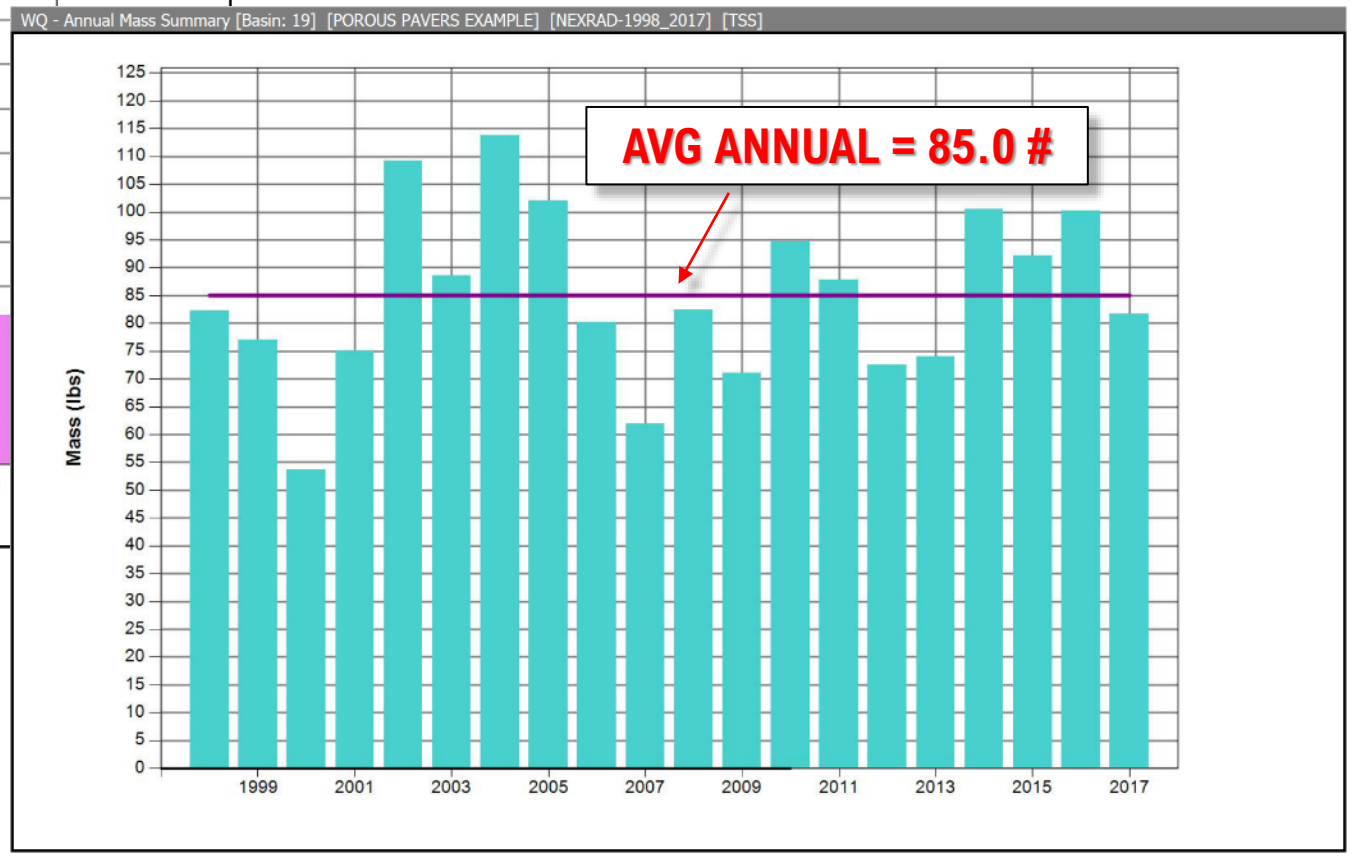
Gray to Green – PK Avenue

STREAMLINE TECHNOLOGIES



MONTHLY AVERAGES

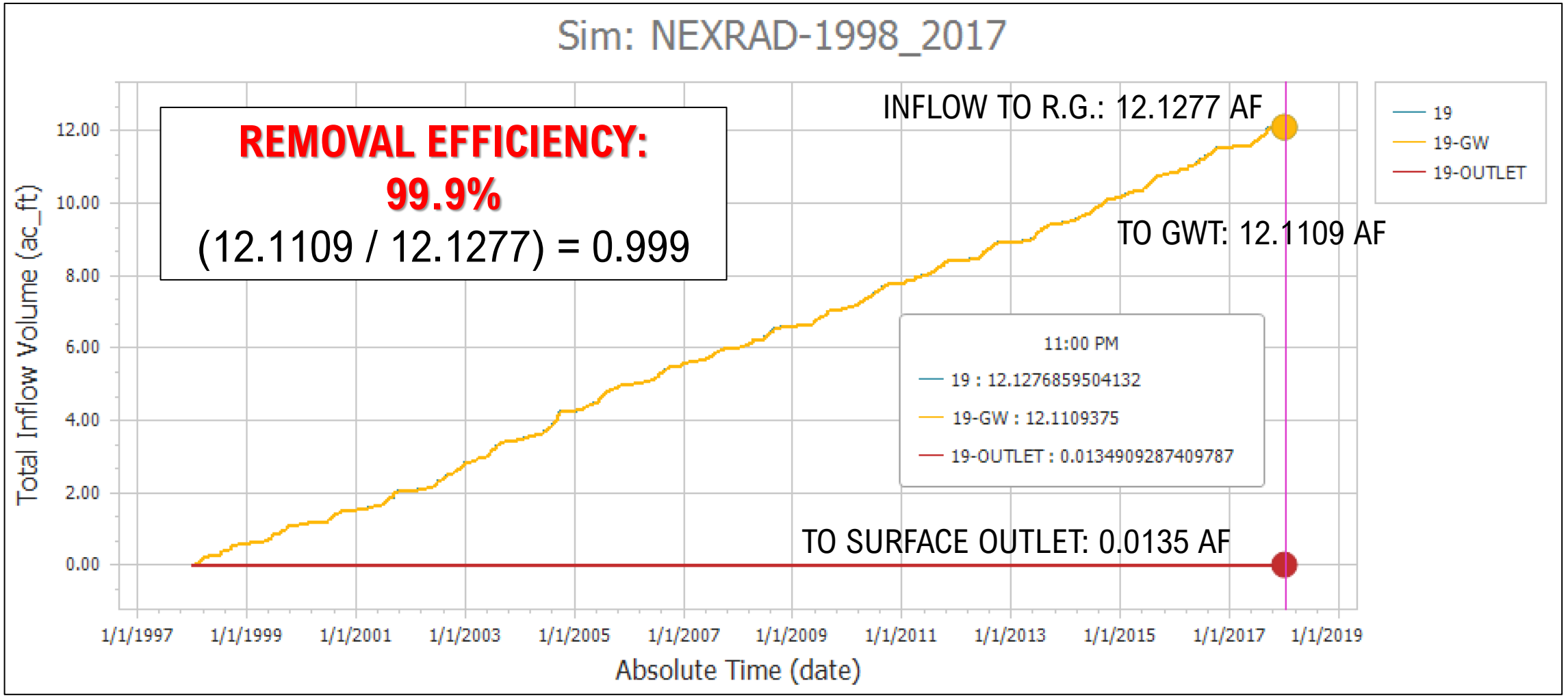
TOTAL SUSPENDED SOLIDS (1998 – 2017 SIMULATION)



TN = 2.85 # per year
TP = 0.39 # per year

ANNUAL TOTALS

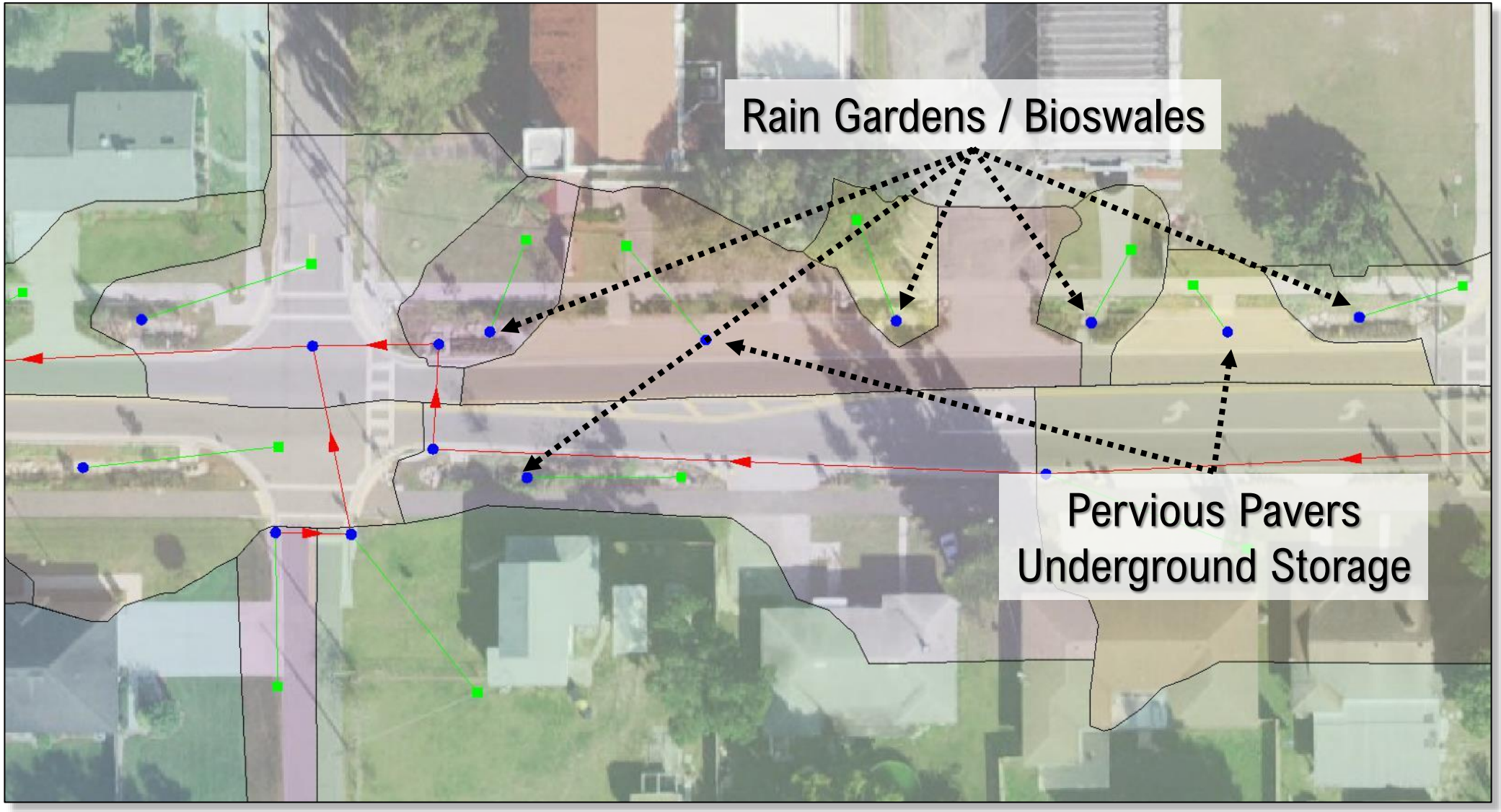
Gray to Green – PK Avenue



Gray to Green – PK Avenue

STREAMLINE TECHNOLOGIES

Putting the Pieces Together



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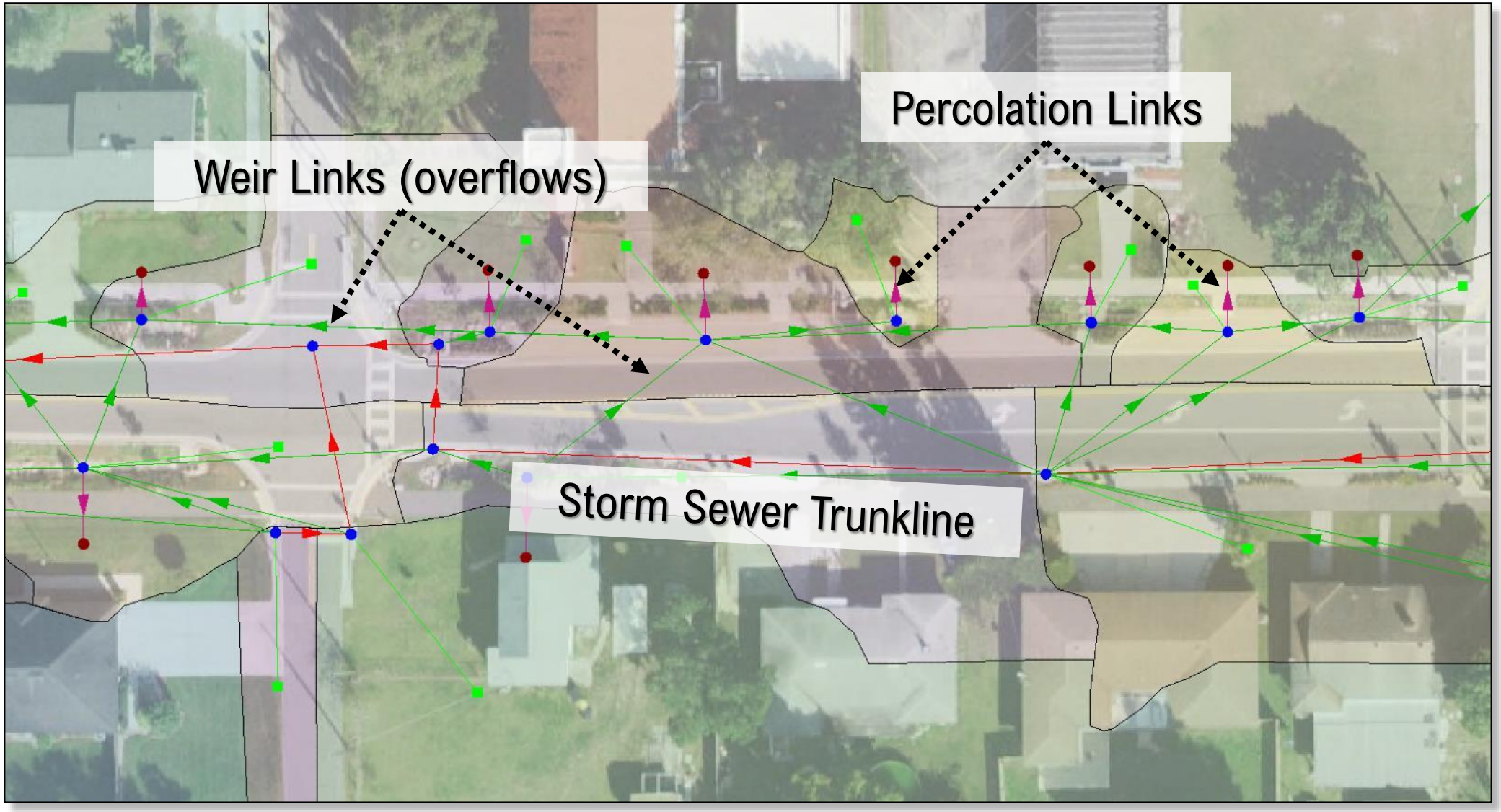
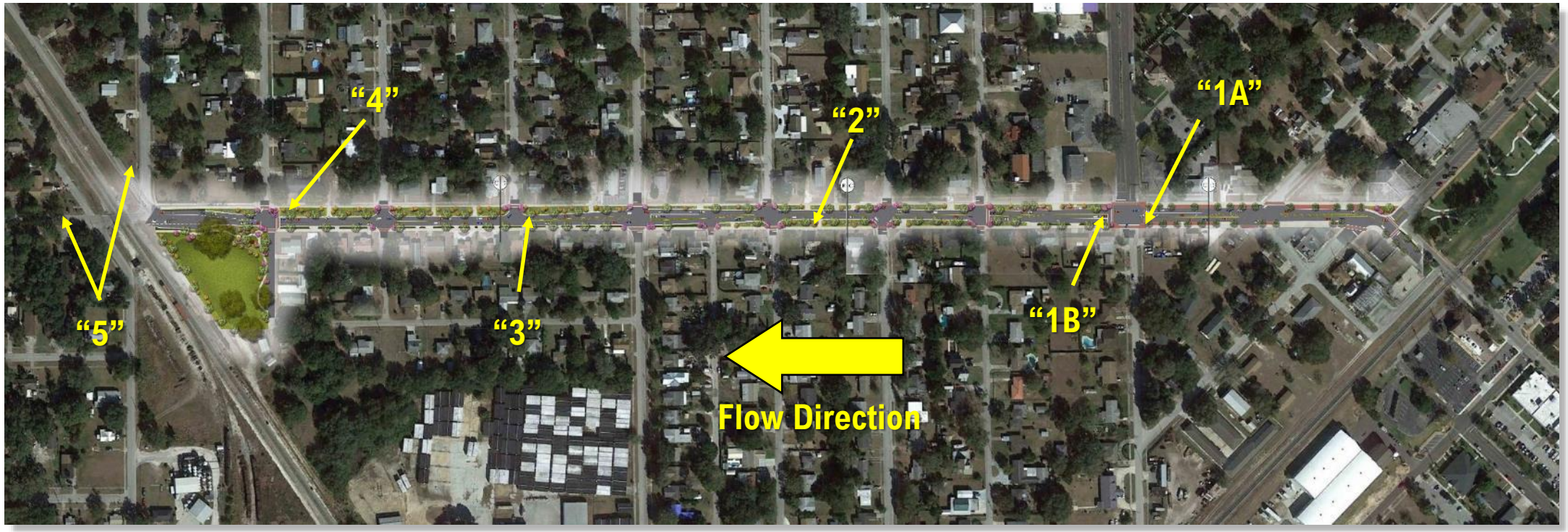
STREAMLINE TECHNOLOGIES

Putting the Pieces Together



Gray to Green – PK Avenue

Removal Efficiency Evaluation Locations



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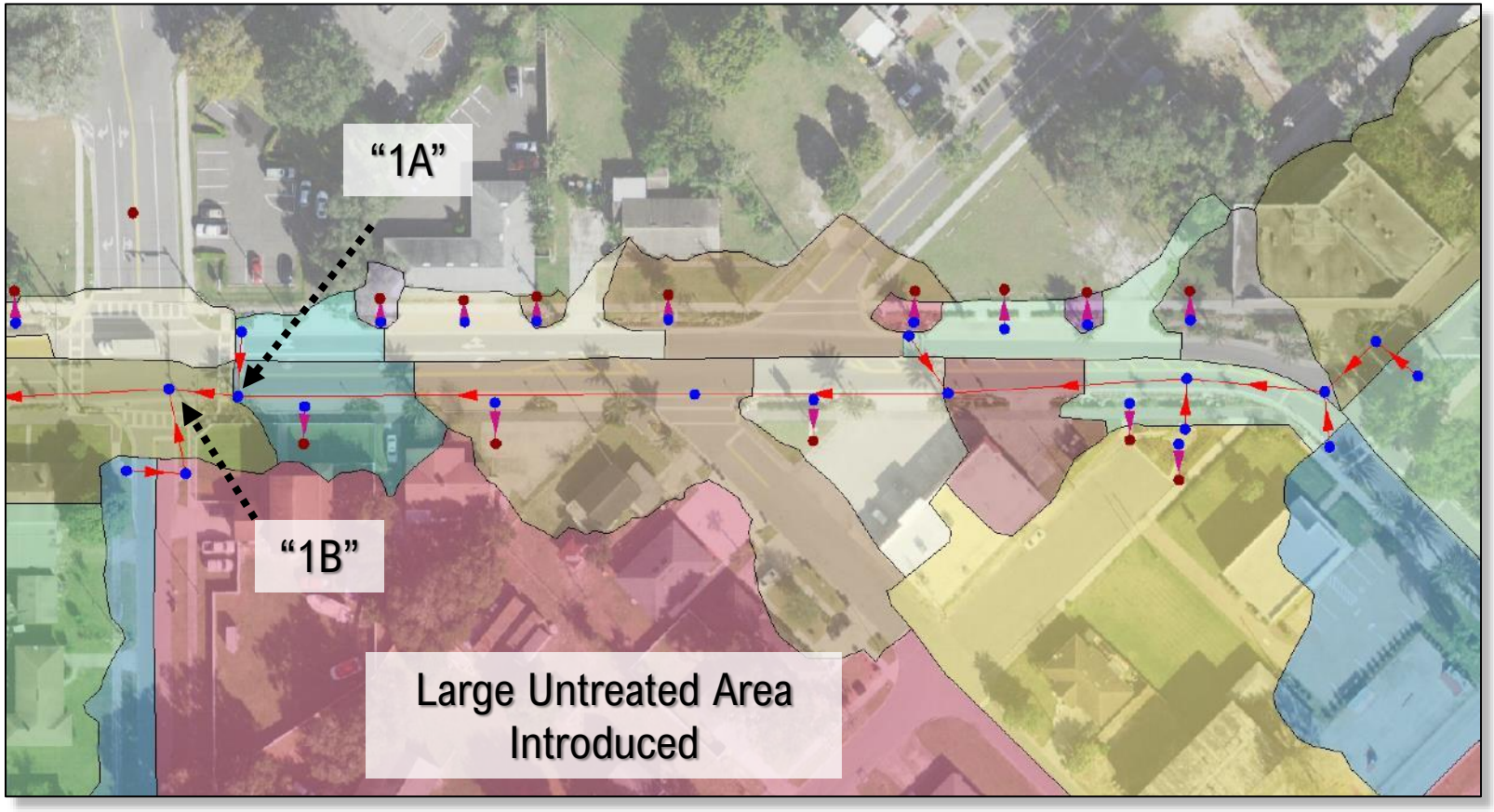
Location	Cumulative Runoff (AF)	Volume Arriving at Node (AF)	Removal Efficiency
1A	17.12	10.01	42%
1B	35.04	27.53	21%



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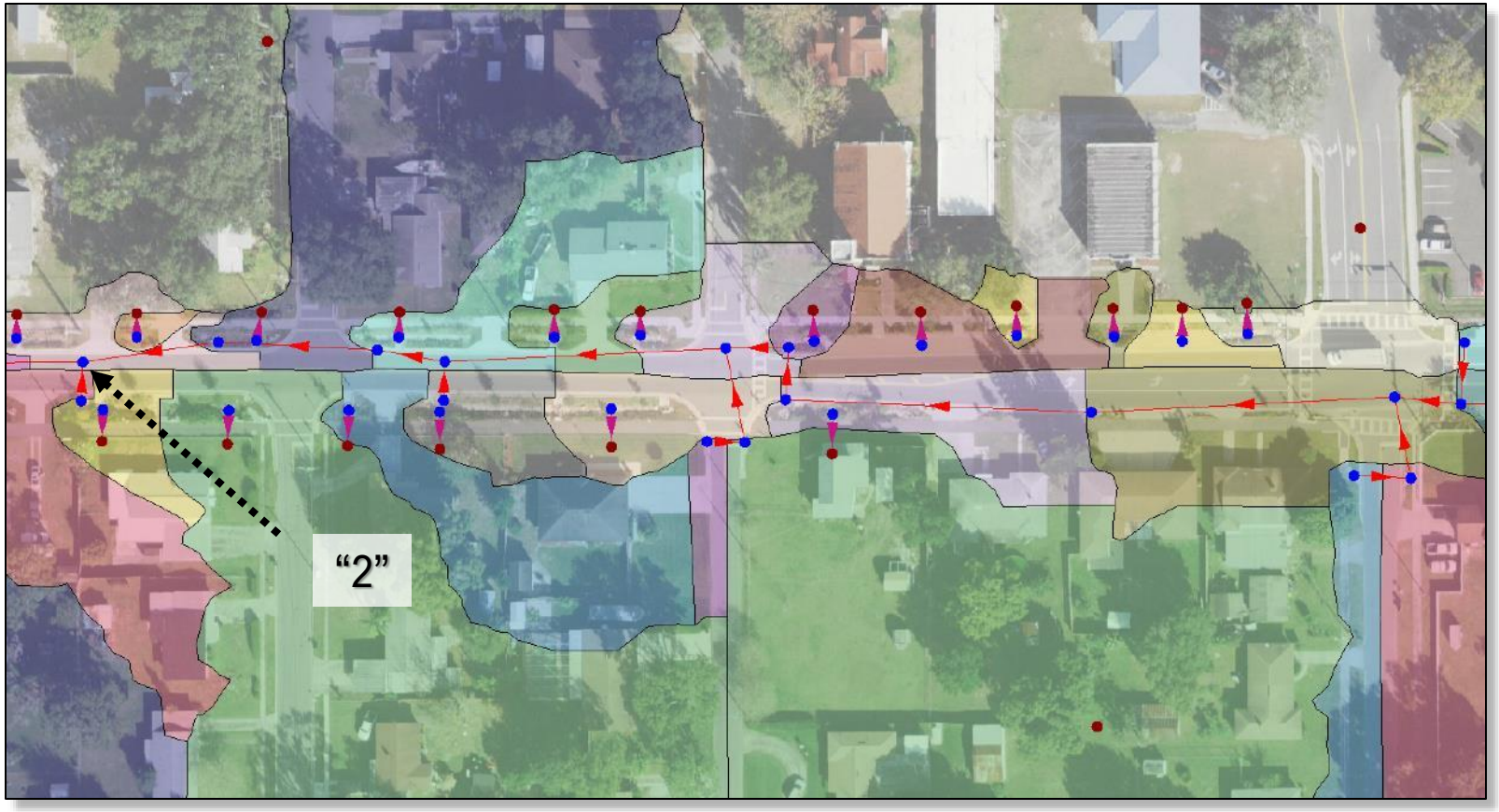
Location	Cumulative Runoff (AF)	Volume Arriving at Node (AF)	Removal Efficiency
2	73.87	51.28	31%



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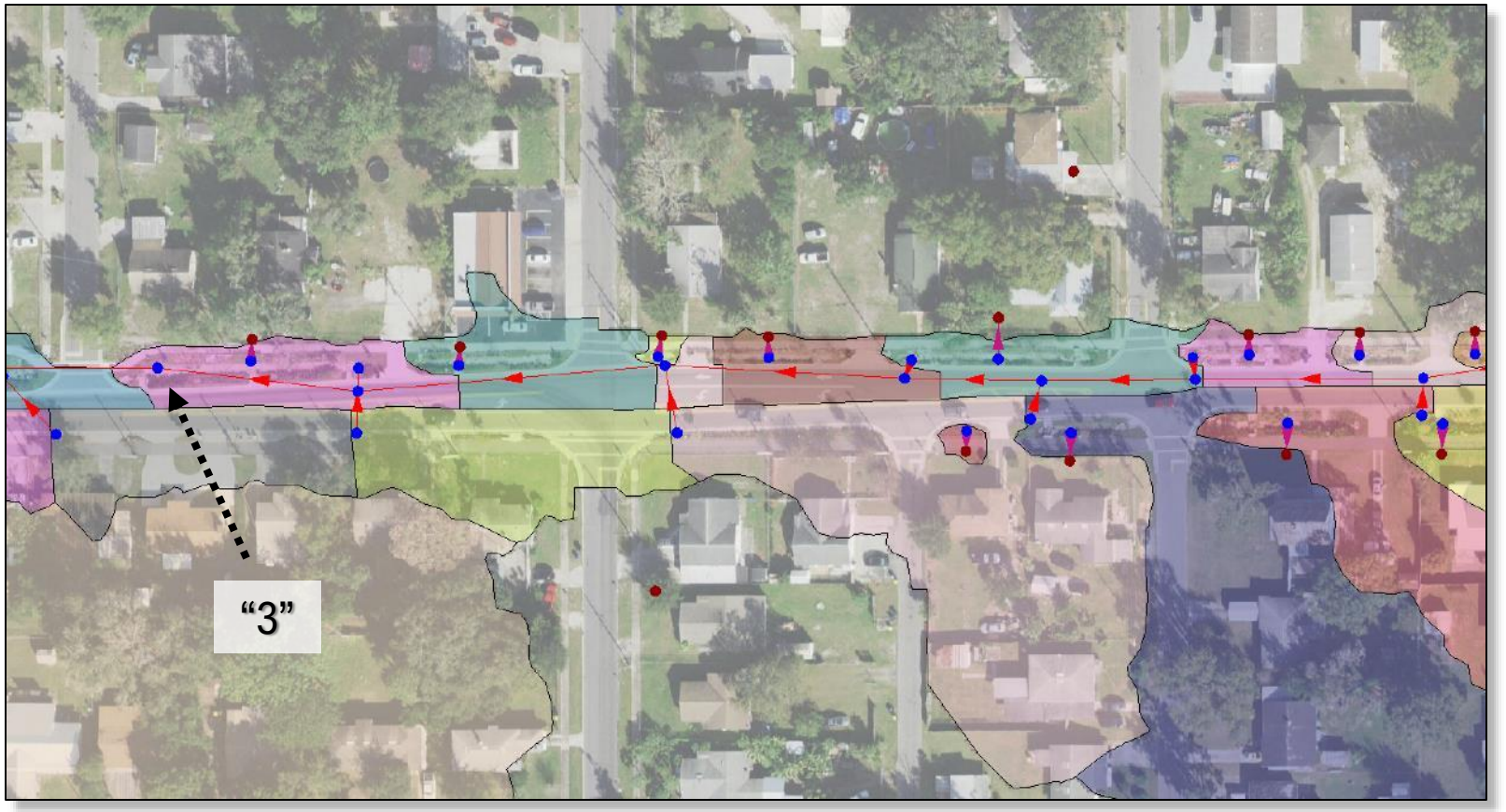
Location	Cumulative Runoff (AF)	Volume Arriving at Node (AF)	Removal Efficiency
3	87.28	61.45	30%



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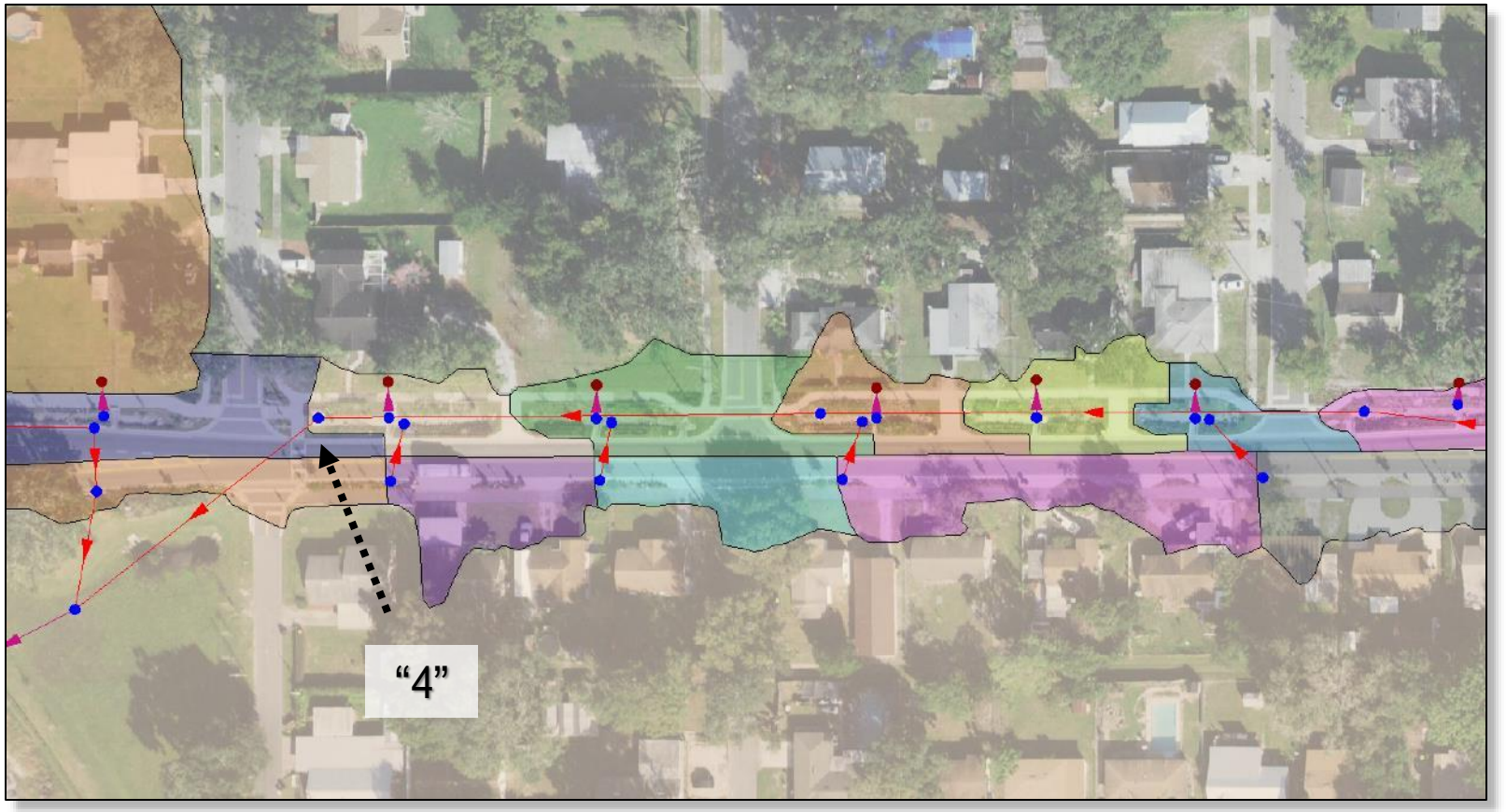
Location	Cumulative Runoff (AF)	Volume Arriving at Node (AF)	Removal Efficiency
4	93.17	62.72	33%



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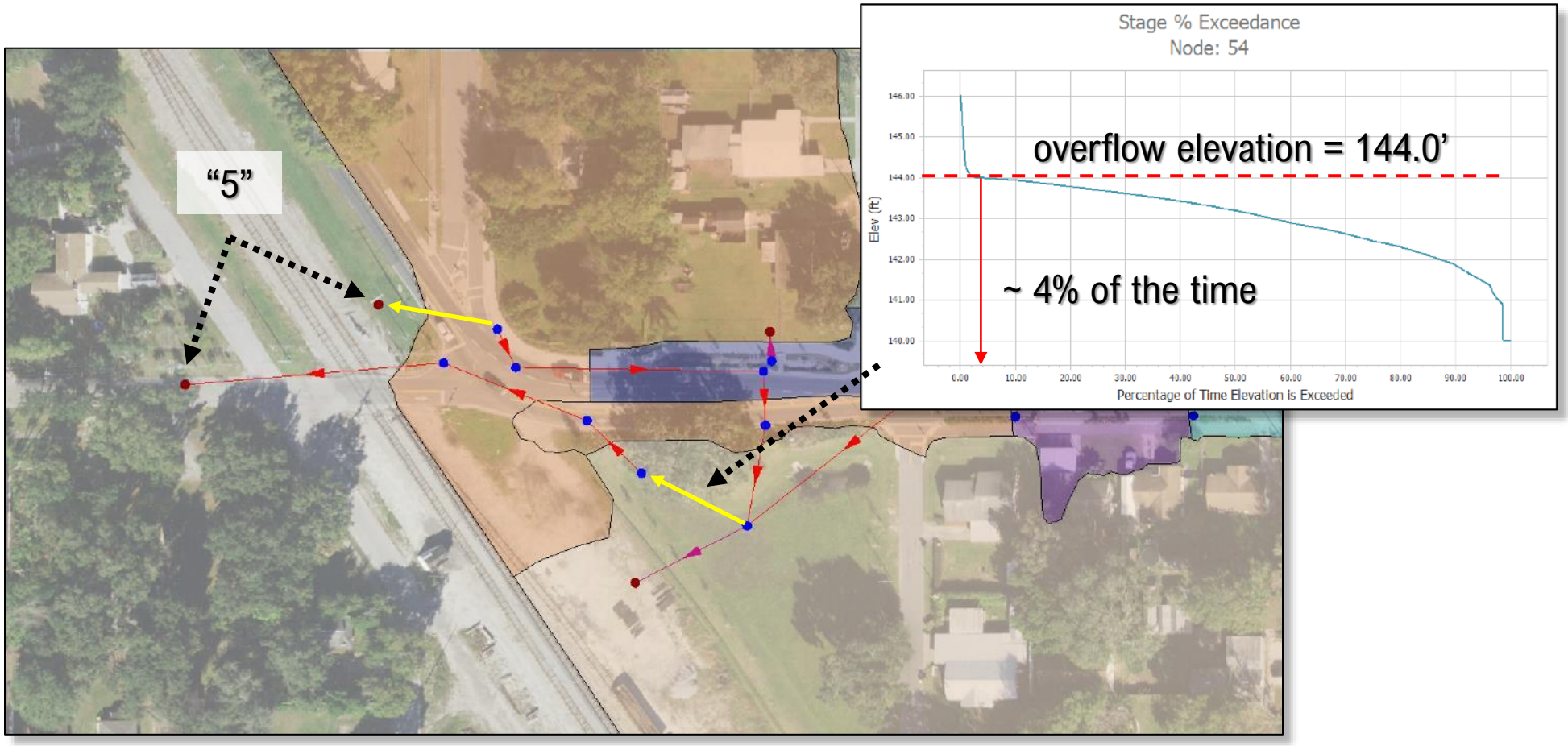
Location	Cumulative Runoff (AF)	Volume Arriving at Node (AF)	Removal Efficiency
5	161.60	106.81	34%



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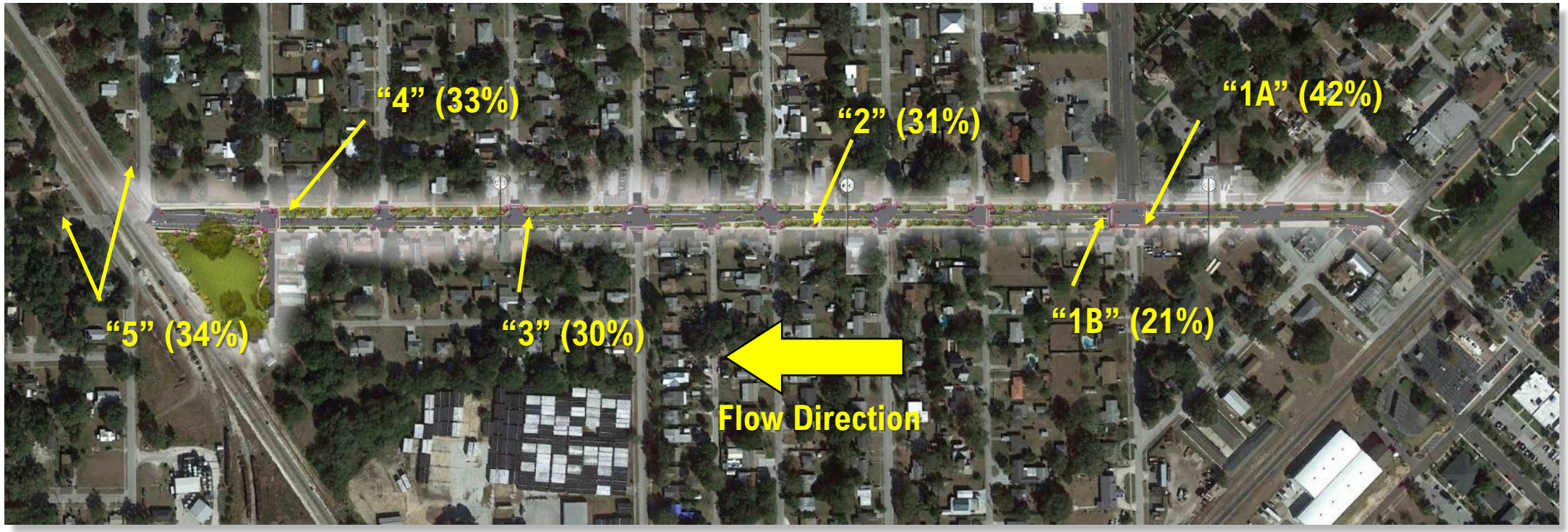
Cumulative Removal Efficiencies

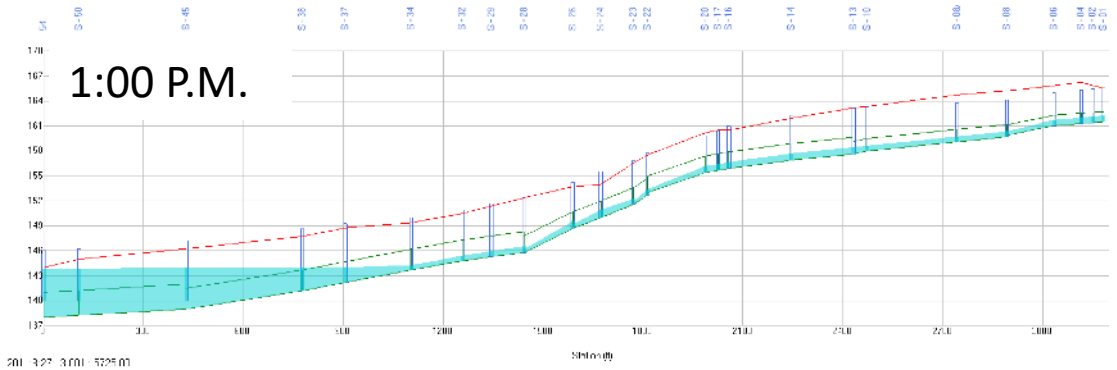


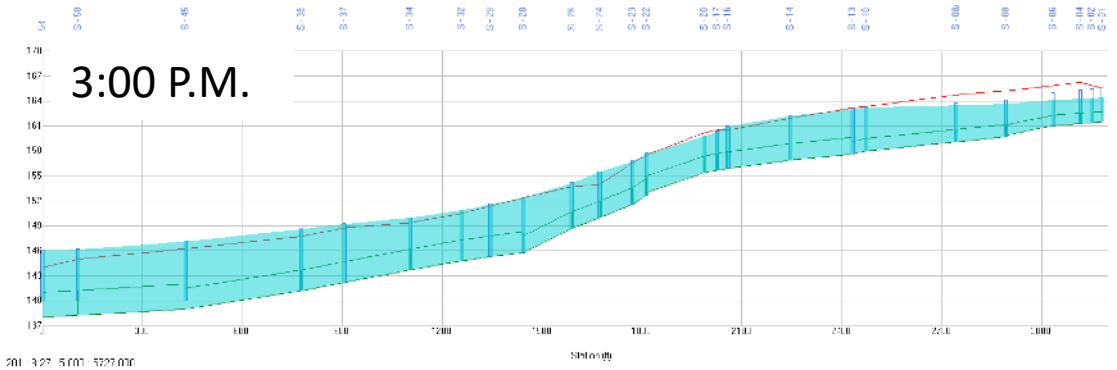
Gray to Green – PK Avenue

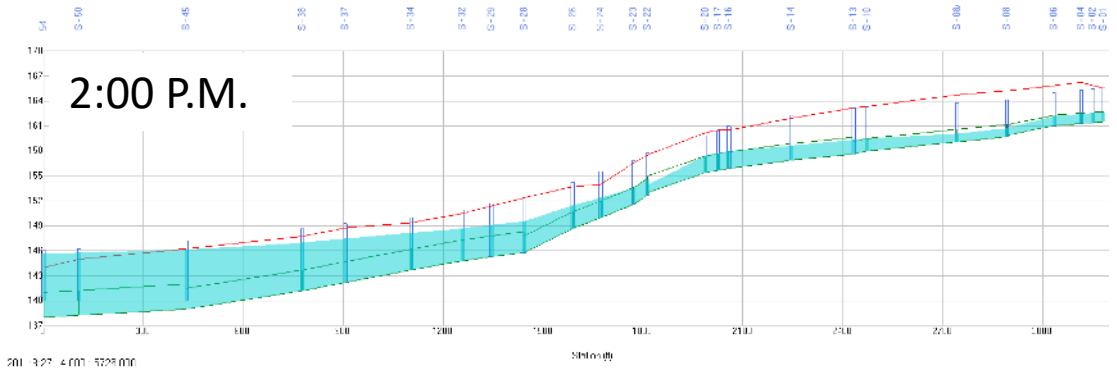
Let's Not Forget About the Hydraulics

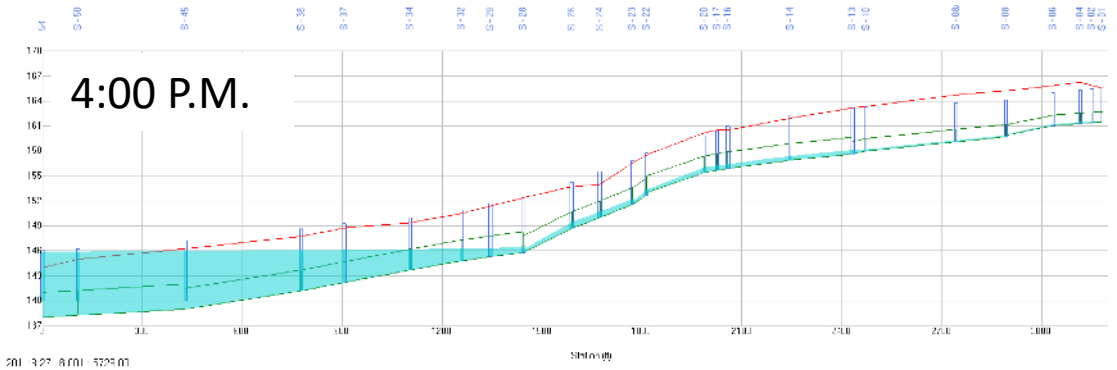
water surface profiles along storm sewer trunkline

Storm Date: September 27, 2011









Summary

- WQ Module Design Strategy
  - ✓ EMCs
  - ✓ Initial, Irreducible & Boundary Concentrations
  - ✓ Integrated WQ & Hydraulics
  - ✓ Perc & GW Mounding Included
  - ✓ Removal Efficiencies at Basins, Nodes & Links
- Gray to Green – PK Avenue (Auburndale, FL)
  - ✓ Rain Garden / Bioswale
    - 88.7% removal efficiency with 0.44” storage
  - ✓ Pervious Parking with Underground Storage
    - 99.9% removal efficiency with 5.04” storage
  - ✓ Putting the Pieces Together
    - 34.0% system-wide removal efficiency
  - ✓ System Hydraulics

Questions?

Gray to Green with ICPR

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STREAMLINE TECHNOLOGIES