

# The Prince George's County BMP Module

## A Project Description

Workshop: BMP Placement Project

Fairfax, VA

September 6, 2004

*Presented by:*

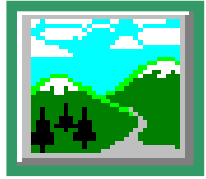
**Tetra Tech, Inc.**  
10306 Eaton Place  
Suite 340  
Fairfax, VA 22030

**University of Virginia**  
Charlottesville  
Virginia 22903

# Outline: BMP Evaluation Method

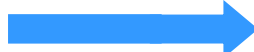
- Watershed Runoff Simulation (HSPF)
- BMP Placement (Module Interface)
- BMP Simulation (Algorithms)
  - Storage/Detention
  - Open Channel
  - Soil Layer Influence
- BMP Module Sensitivity and Application
- USEPA/ASCE National BMP Database

# BMP Evaluation Method

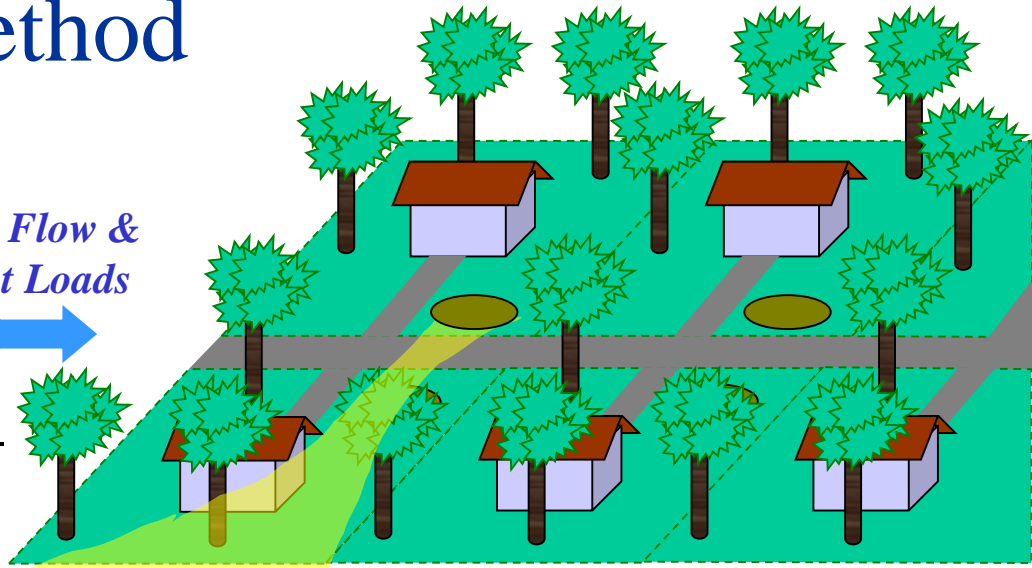


**HSPF LAND  
SIMULATION**

*Existing Flow &  
Pollutant Loads*



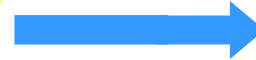
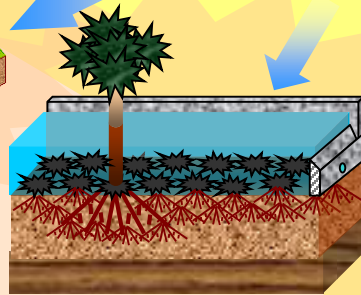
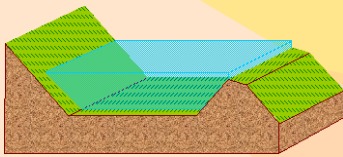
– *Unit-Area Output by Landuse* –



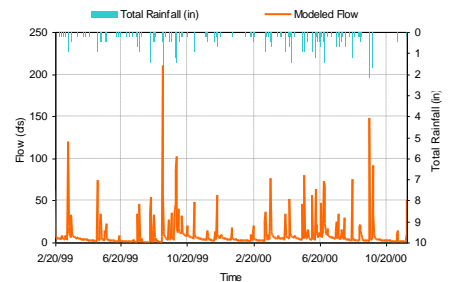
**SITE-LEVEL LAND/BMP ROUTING**

**BMP MODULES**

*Simulated  
Surface Runoff*

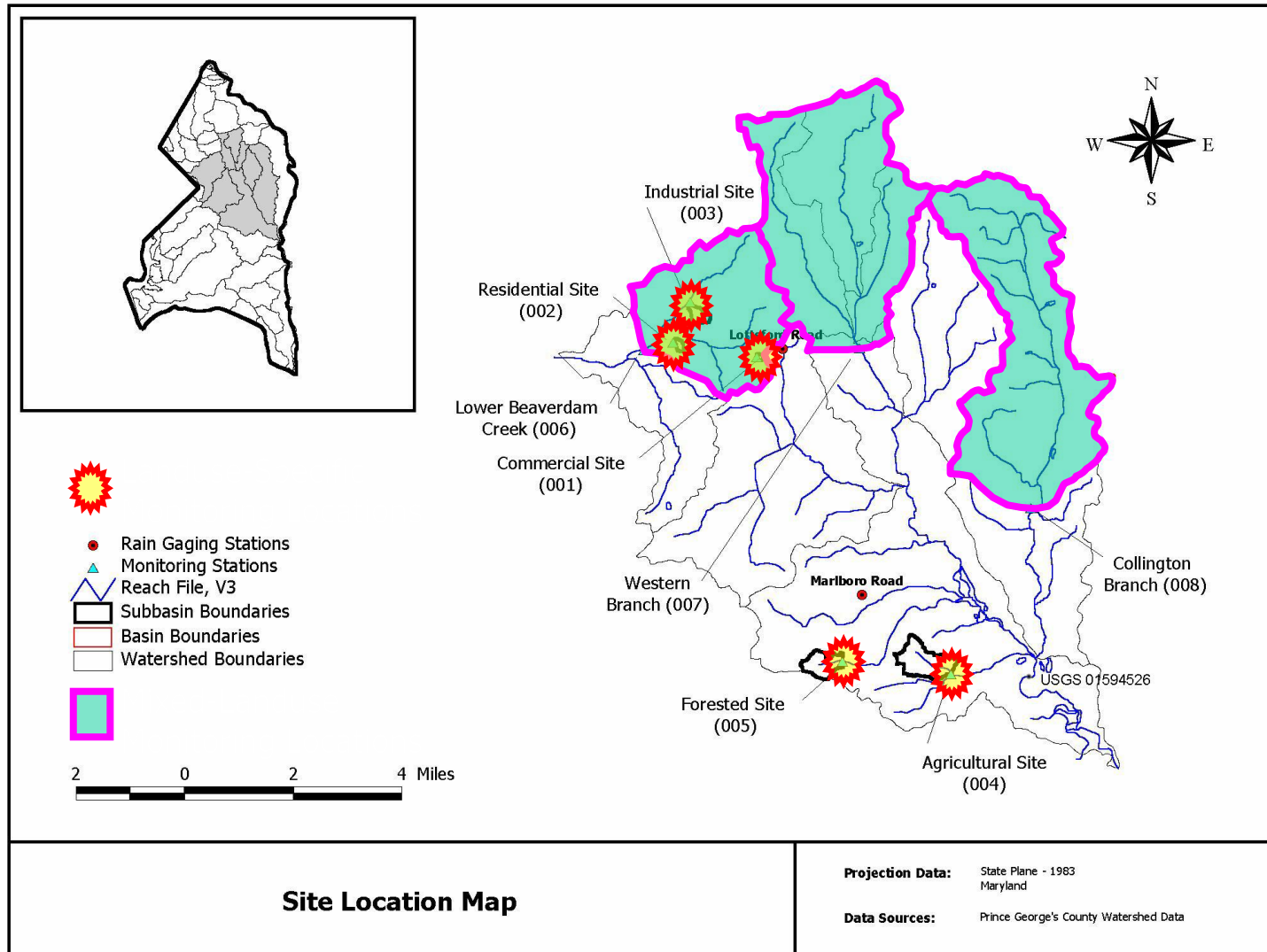


**BMP DESIGN**  
– *Site Level Design* –



*Simulated Flow/Water Quality Improvement  
Cost/Benefit Assessment of LID design*

# HSPF Landuse Representation



Prince George's County BMP Evaluation Module -

File Edit View Help

Land Use Types:

- Forest
- Agricultural
- Commercial\_Pervious
- Commercial\_Impervious
- Industrial\_Pervious
- Industrial\_Impervious
- Low\_Density\_Res\_Pervious
- Low\_Density\_Res\_Impervious
- Med\_Density\_Res\_Pervious
- Med\_Density\_Res\_Impervious
- High\_Density\_Res\_Pervious
- High\_Density\_Res\_Impervious

**Landuse Menu**

BMP Types:

- 1 Buffer\_Zone
- 2 Bioretention\_Basin
- 3 Dry\_Well
- 4 Filter\_Strip
- 5 Level\_Spreader
- 6 Grassed\_Swale
- 7 Rain\_Barrels
- 8 Cistern
- 9 Infiltration\_Trench

**BMP Menu**

0.170 0.330 0.170 0.330

2\_1 6\_2

1

2

3

*click-and-drag*

*edit attributes*

*connect objects*

# The Interface

Ready NUM

# BMP Physical Processes

- Possible storage processes include:
  - Evapotranspiration
  - Infiltration
  - Orifice outflow
  - Weir-controlled overflow spillway
  - Underdrain outflow
  - Bottom slope influence
  - Bottom roughness influence
  - General loss or decay of pollutant  
(Due to settling, plant-uptake, volatilization, etc)
  - Pollutant filtration through soil medium (Underdrain outflow)
- Depending on the design and type of the BMP, any combination of processes may occur during simulation

# BMP Class A: Storage/Detention

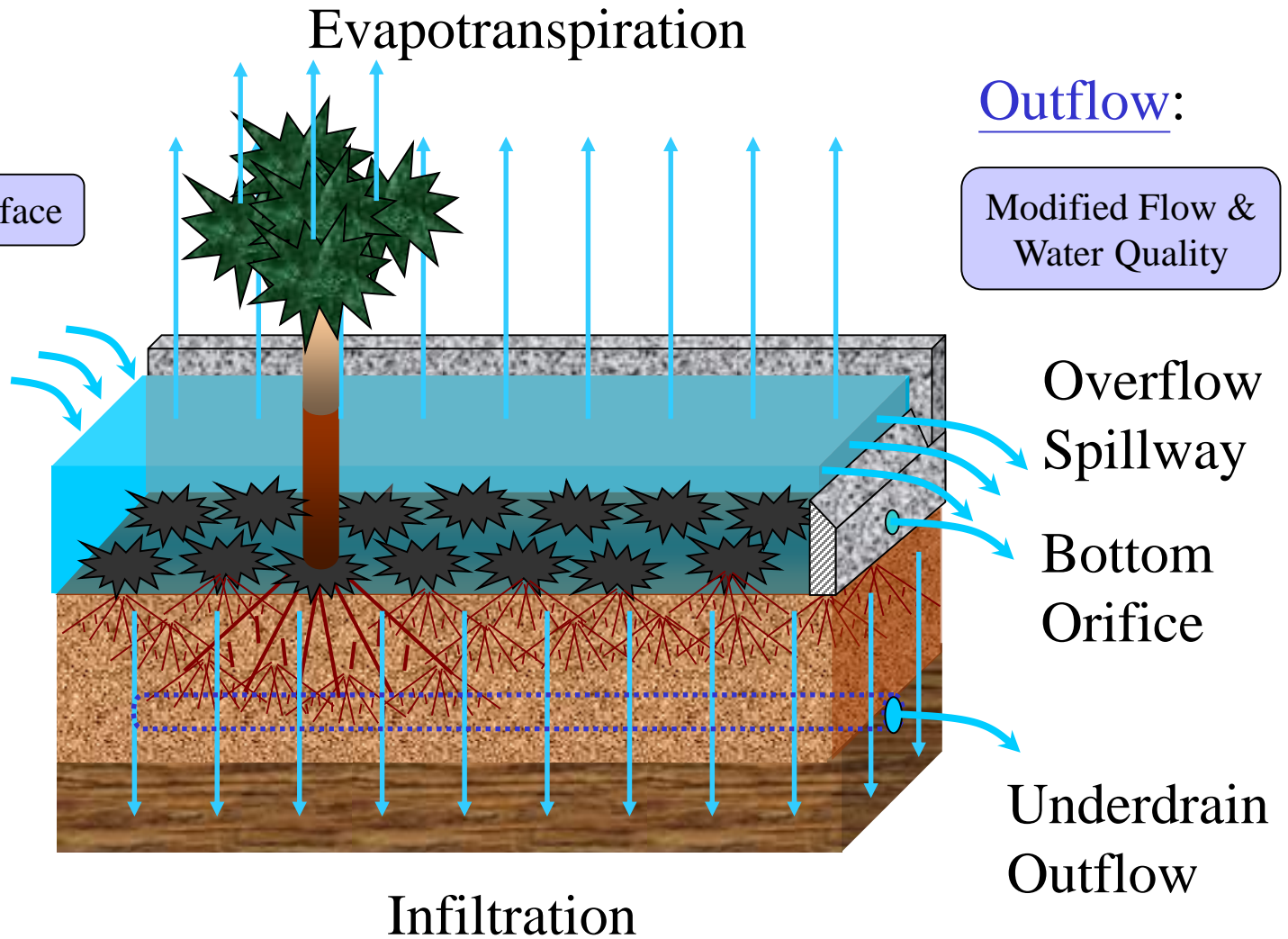
Inflow:

From Land Surface

Outflow:

Modified Flow & Water Quality

Storage



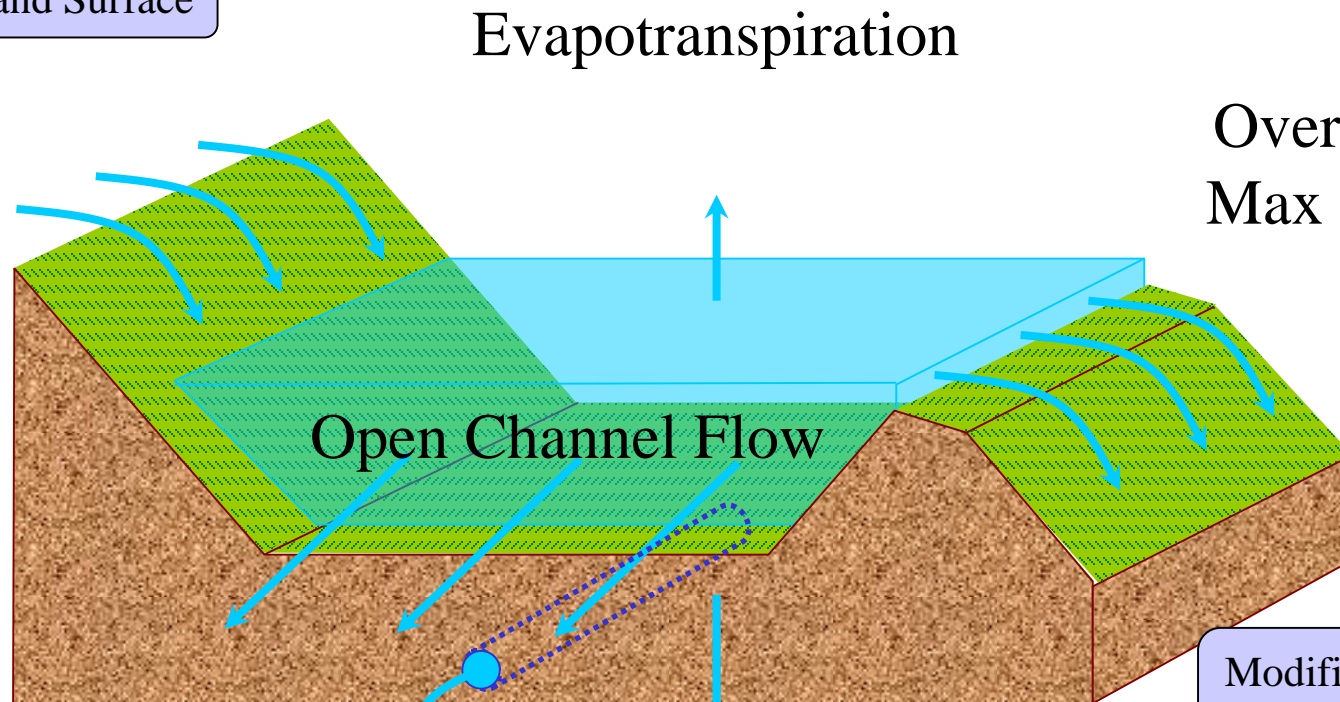
# BMP Class B: Open Channel

Inflow:

From Land Surface

Outflow:

Overflow at  
Max Design  
Depth



Open Channel Flow

Evapotranspiration

Underdrain Outflow

Infiltration

Modified Flow &  
Water Quality



**Premise:** Soil moisture storage, surface-connected porosity, and the effect of root paths are the dominant factors influencing infiltration capacity.

$$f = GI A S_a^{1.4} + f_c$$

- GI* Growth Index of plants in percent maturity – Can be varied over time to represent seasonal changes (0.1-1.0)
- A* Infiltration capacity of available storage, representing storage-connected porosity and density of plant roots. Empirical value based on type of vegetative cover and condition (in/h/in<sup>1.4</sup>)

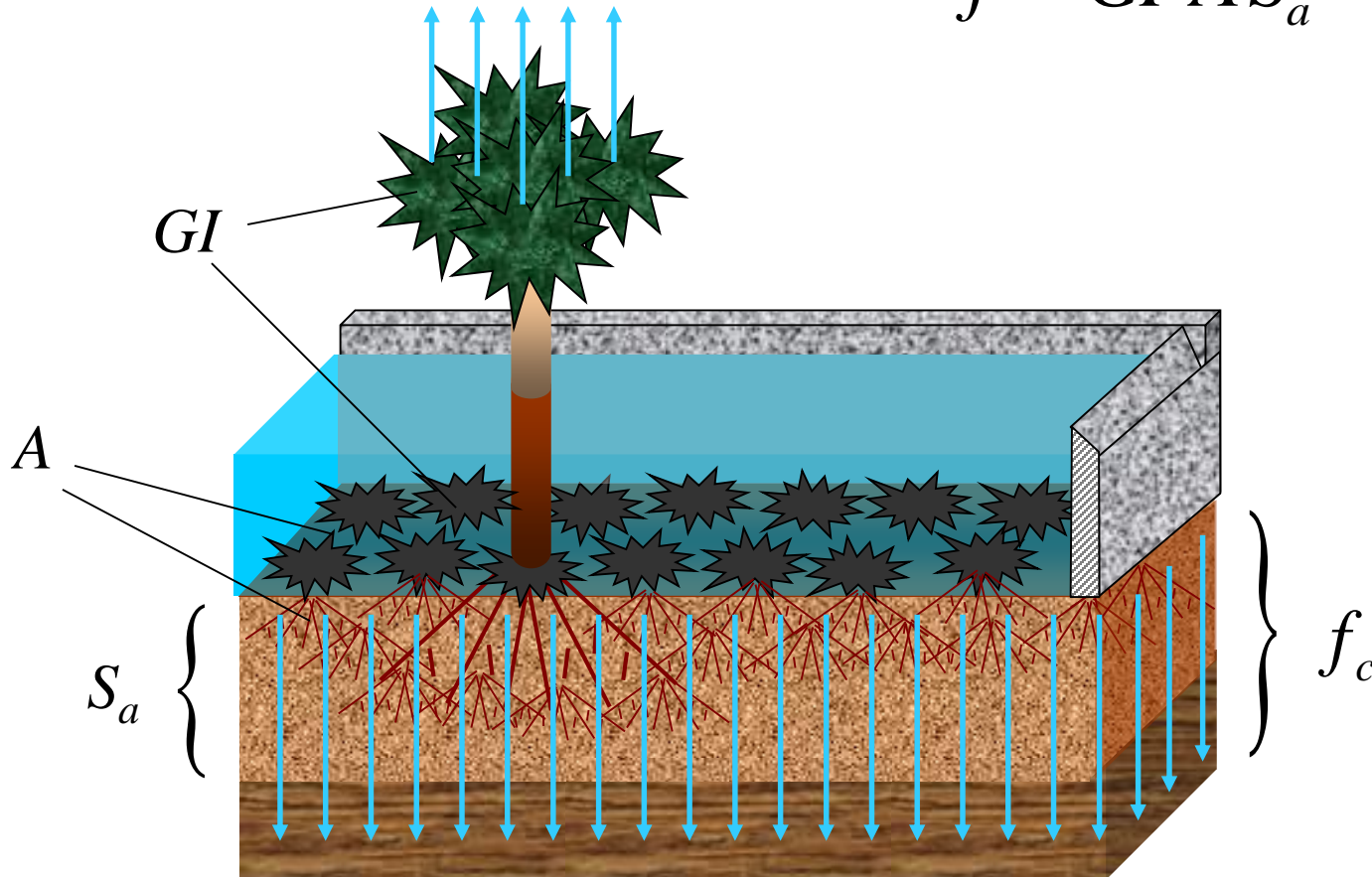
**Premise:** Soil moisture storage, surface-connected porosity, and the effect of root paths are the dominant factors influencing infiltration capacity.

$$f = GI A S_a^{1.4} + f_c$$

$S_a$  Available storage in the surface layer. Maximum storage capacity depends on BMP size and soil depth (in)

$f_c$  Constant infiltration rate when infiltration rate curve reaches asymptote; steady infiltration rate. Related to Hydrologic Soil group (in/h)

$$f = GI AS_a^{1.4} + f_c$$





# Underdrain Water Quality

## Percent Removal

veg. parameter

$$(A) \text{Mass}_{\text{out}} = \text{Mass}_{\text{in}} \times PCTREM$$

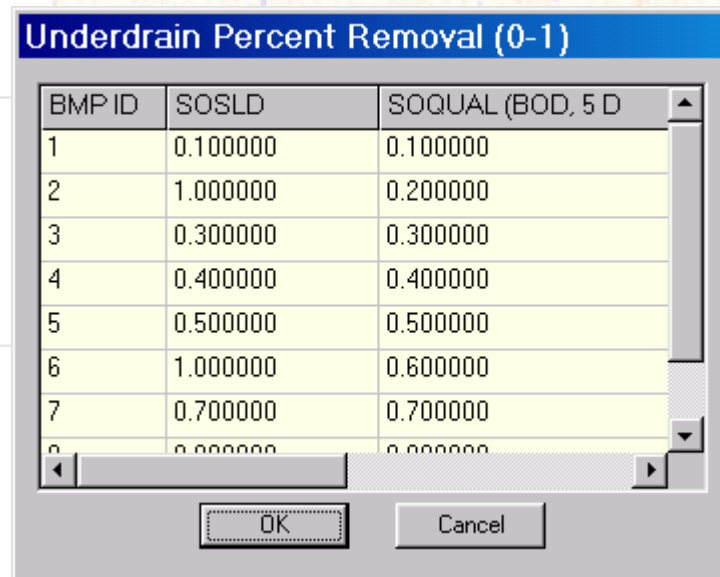
soil porosity

$$\text{Mass}_{\text{in}} = \text{Surface conc} * \text{underdrain flow}$$

Underdrain percent removal is a function of the soil media

soil f c

void fraction



| BMP ID | SOSLD    | SOQUAL (BOD, 5 D) |
|--------|----------|-------------------|
| 1      | 0.100000 | 0.100000          |
| 2      | 1.000000 | 0.200000          |
| 3      | 0.300000 | 0.300000          |
| 4      | 0.400000 | 0.400000          |
| 5      | 0.500000 | 0.500000          |
| 6      | 1.000000 | 0.600000          |
| 7      | 0.700000 | 0.700000          |
| 8      | 0.800000 | 0.800000          |



# General Water Quality

## First Order Decay Representation

$$\text{Mass}_2 = \text{Mass}_1 \times e^{-k t}$$

Pollutant Removal is  
a function of the  
detention time

**BMP Retention Loss Rates (1/day)**

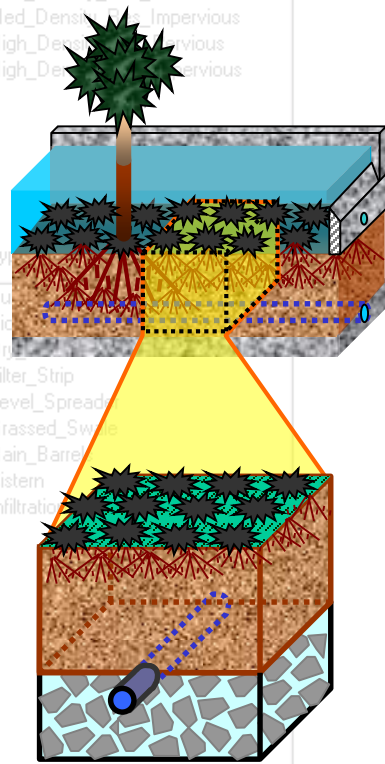
| BMP ID | SOSLD    | SOQUAL (BOD, 5 D) |
|--------|----------|-------------------|
| 1      | 0.510800 | 1.204000          |
| 2      | 0.287700 | 0.356700          |
| 3      | 2.302600 | 1.204000          |
| 4      | 1.204000 | 1.204000          |
| 5      | 0.693100 | 0.356700          |
| 6      | 0.693100 | 0.223100          |
| 7      | 0.105400 | 0.223100          |
| 8      | 0.105400 | 0.223100          |

OK Cancel

# BMP Module Emulates Observed Condition

- Land Use Types:
- Forest
  - Agricultural
  - Commercial\_Pervious
  - Commercial\_Impervious
  - Industrial
  - Industrial\_Impervious
  - Low\_Density\_Res\_Impervious
  - Med\_Density\_Res\_Pervious
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  - High\_Density\_Res\_Pervious
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Bioretention basin  
with underdrain pipe

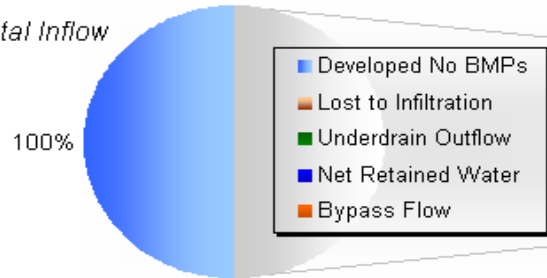


Ready

| Summary      | Rainfall (in) | Water Budget (in) |                      |                    |                    |             | Runoff        |
|--------------|---------------|-------------------|----------------------|--------------------|--------------------|-------------|---------------|
|              |               | Developed No BMPs | Lost to Infiltration | Underdrain Outflow | Net Retained Water | Bypass Flow | Pre-Developed |
| Total Weekly | 3.0500        | 0.6709            | 0.2985               | 0.0618             | 0.0421             | 0.2684      | 0.2123        |
| Max Hourly   | 0.3200        | 0.1216            | 0.0175               | 0.0005             | Not Applicable     | 0.0211      | 0.1029        |

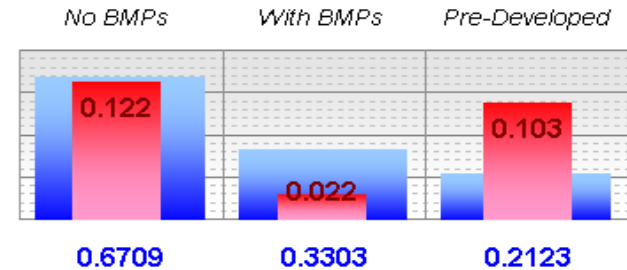
### Water Budget for the Week

Total Inflow



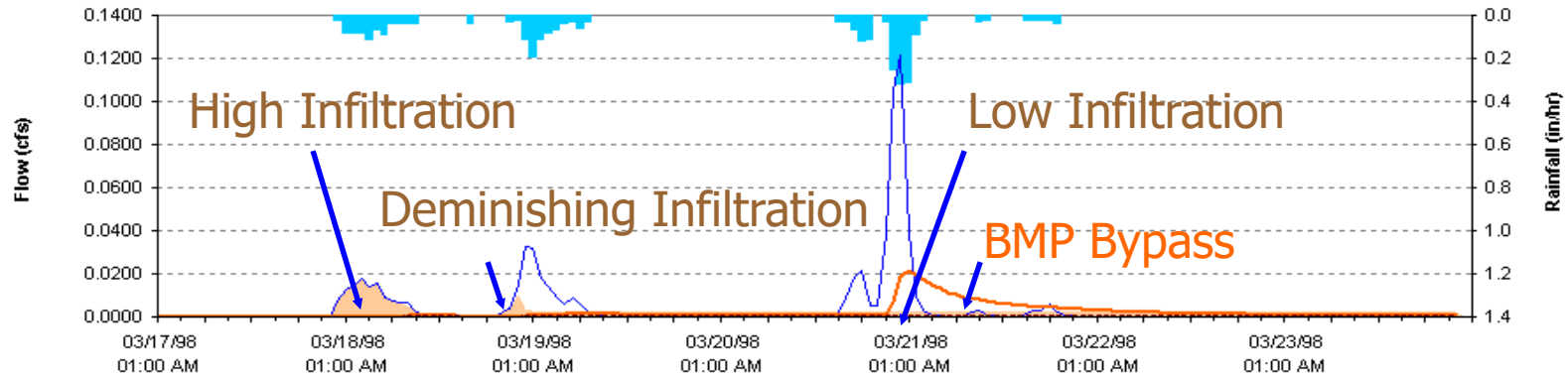
### BMP Outflow Distribution

Peak Flow (cfs) Stormwater Volume (in)



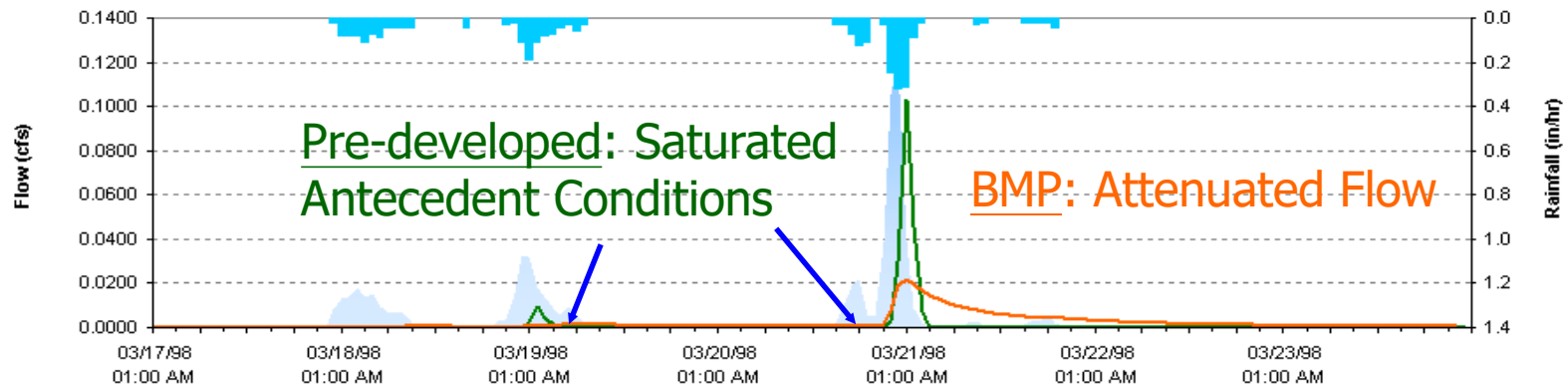
### Water Balance

Total Infiltration Rainfall (in/hr) Developed No BMPs Total Outflow Underdrain Outflow

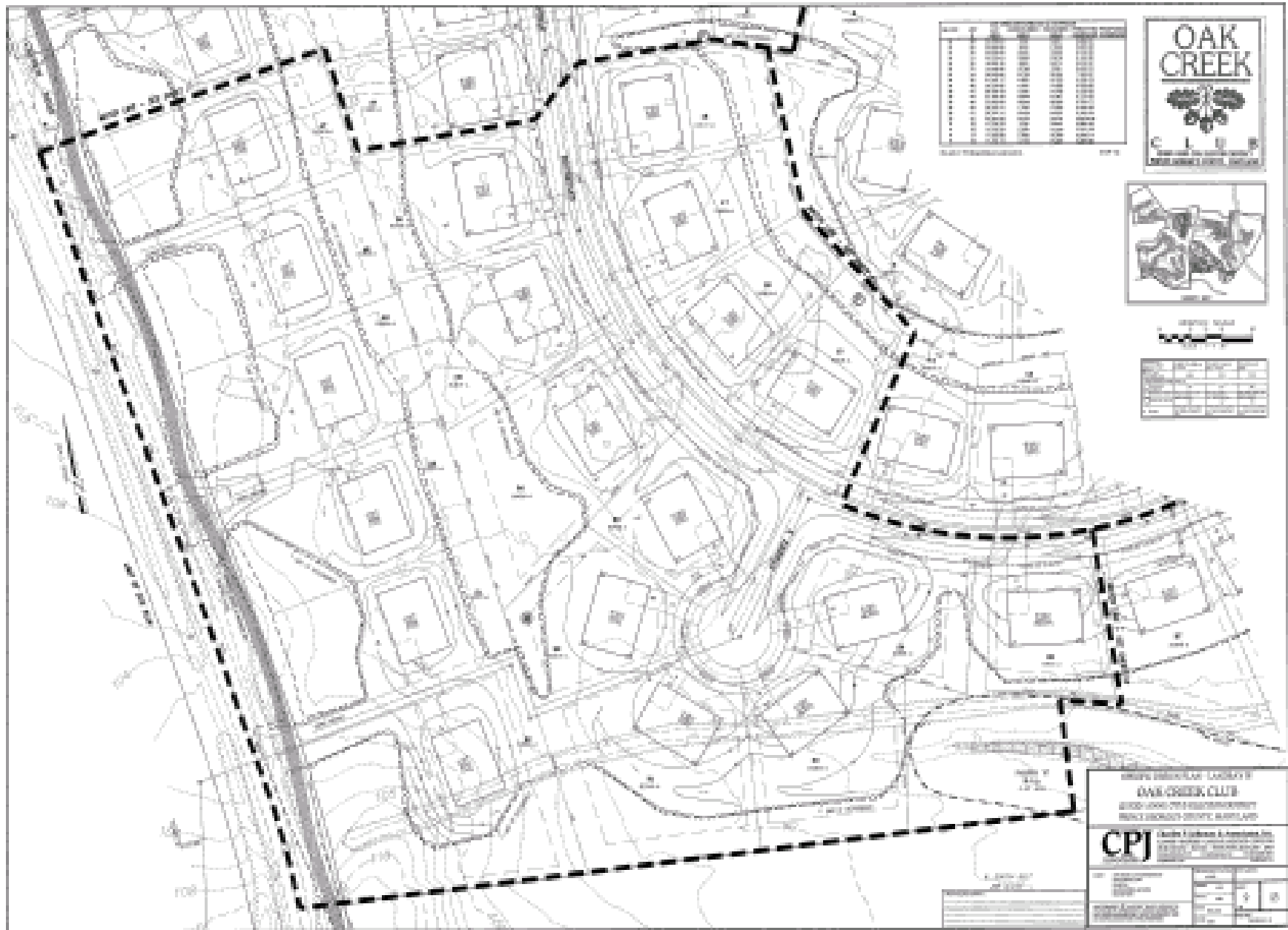


### Total Flow Hydrographs

Developed No BMPs Rainfall (in/hr) Pre-Developed Total Outflow







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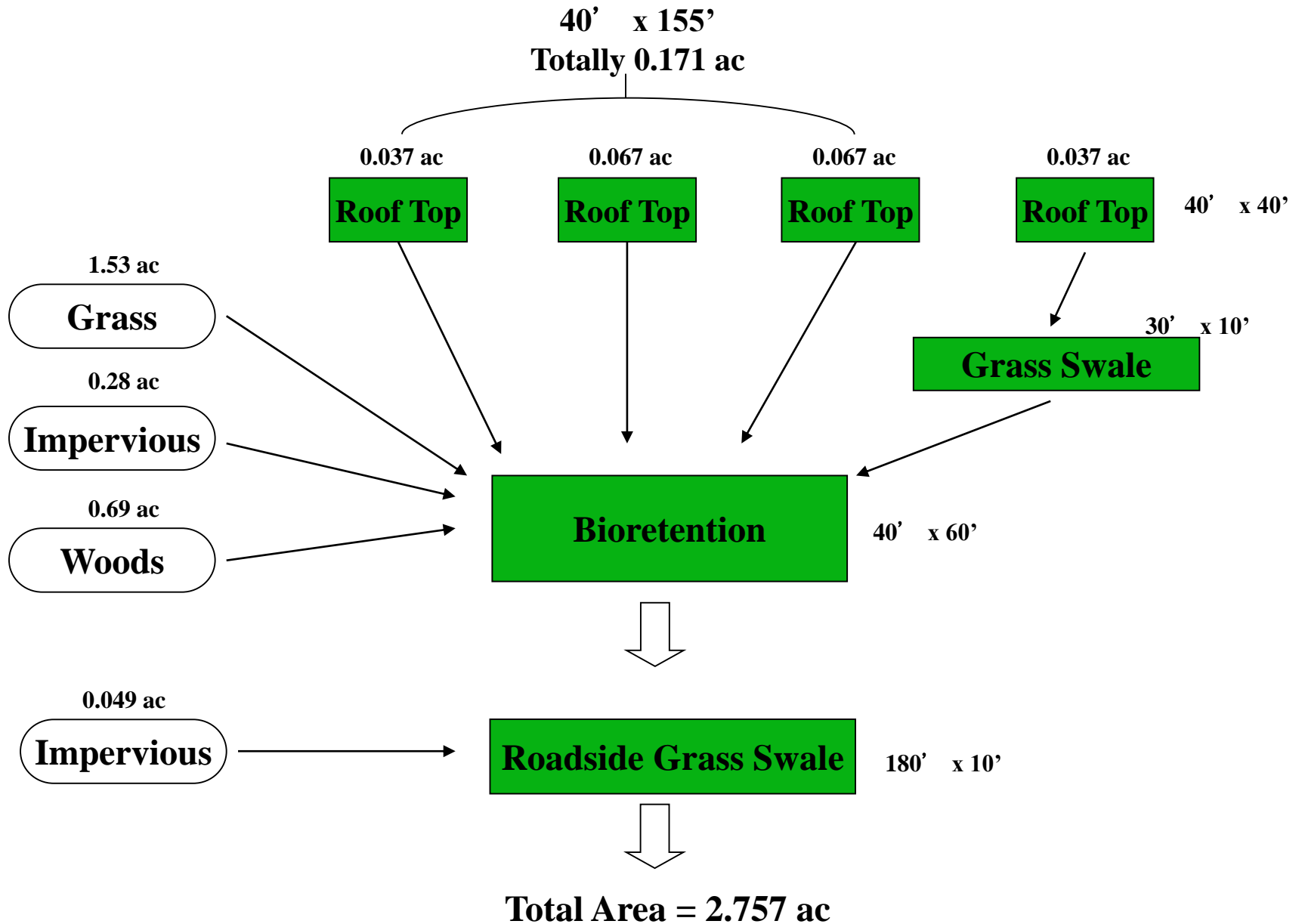
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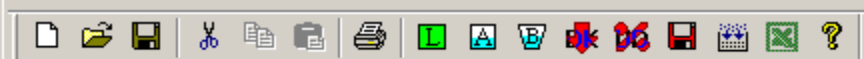
100% DESIGN/CONTRACT DOCUMENTS  
**OAK CREEK CLUB**  
 4500 LAKOTA DRIVE, SUITE 200  
 WEST HONOLULU, HAWAII 96817

**CPJ** CIVIL ENGINEERING & ARCHITECTURE  
 1000 KALANOAUA AVENUE, SUITE 100  
 HONOLULU, HAWAII 96813

DATE: 10/15/10  
 SCALE: AS SHOWN  
 SHEET NO. 10 OF 10

# Oak Creek Club Development





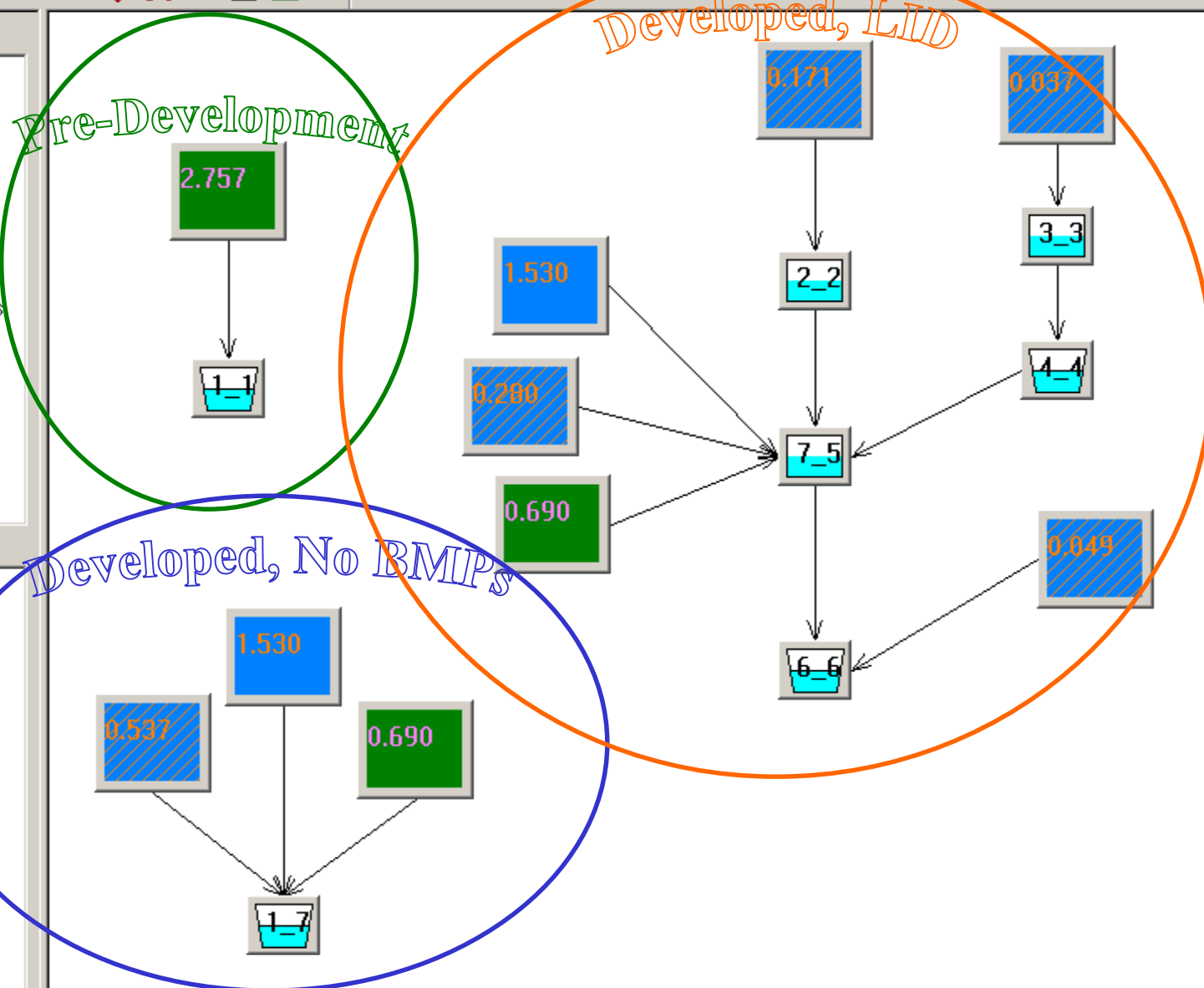
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  - Med\_Density\_Res\_Pervious
  - Med\_Density\_Res\_Impervious
  - High\_Density\_Res\_Pervious
  - High\_Density\_Res\_Impervious

- BMP Types:
- 1 dummy\_swale
  - 2 rooftop\_.171
  - 3 roof\_top\_.037
  - 4 grass\_swale\_2
  - 5 Level\_Spreader
  - 6 Grassed\_Swale
  - 7 bioretention
  - 8 Cistern
  - 9 Infiltration\_Trench

Pre-Development

Developed, No BMPs

Developed, LID



|                      | Existing Condition | Proposed Condition W/O BMPs | Proposed Condition with BMPs |
|----------------------|--------------------|-----------------------------|------------------------------|
| Flow (CF/year)       | 20,590             | 89,203                      | 8,498                        |
| Nutrients (lbs/year) | 5.68               | 13.52                       | 0.60                         |
| Zinc (lbs/year)      | 0.17               | 1.08                        | 0.01                         |
| Sediment (tons/year) | 0.35               | 0.90                        | 0.04                         |

