2-DAY SWMM TRAINING WORKSHOP

SWMM Training Plancheck Module

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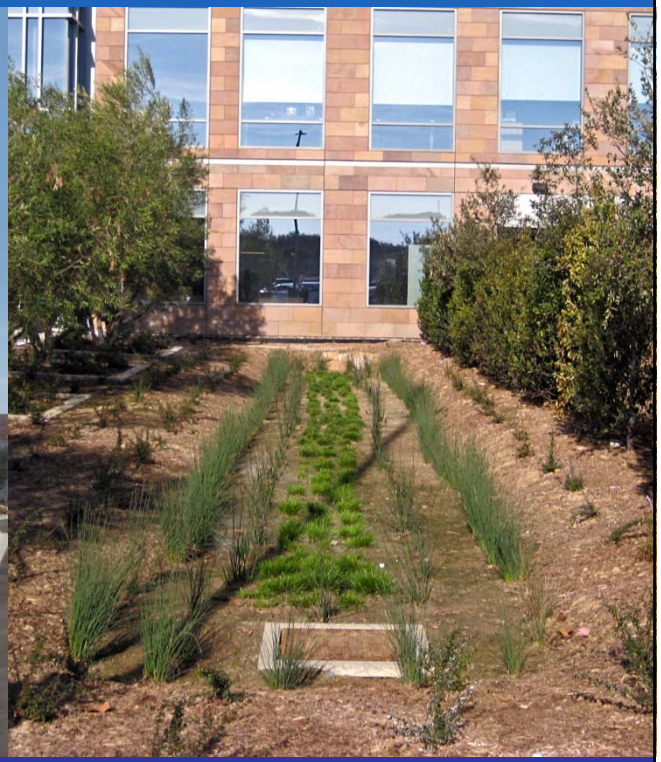


June 25, 2015

PLANCHECK ELEMENTS

- Model Input / Setup
- Model Output / Results
- Post-Processing Results
- Special Modeling Techniques
- Big Picture Project Review

PLANCHECK ELEMENTS

Model Input / Setup
Rainfall and Evaporation
Drainage Area and POC
Subcatchment Characteristics
Model Routing
Structural BMPs

Model Output
Rainfall Amount
Runoff Volume
Stage in Structural BMPs

Post-Processing / Results
Flow Frequency
Flow Duration
Drawdown Time for Structural BMPs

Other
Special Modeling Circumstances
Overall Land Planning
Cross Check with Flood Control

RAINFALL

- 19 Rainfall Records for San Diego
  - Available on Project Clean Water
  - All are approved for use
  - Select the most appropriate gauge (see HMP Chapter 4.3 or BMP Design Manual Appendix G.1)
  - Do not scale the rainfall
- Model the entire record in both pre- and post-condition models

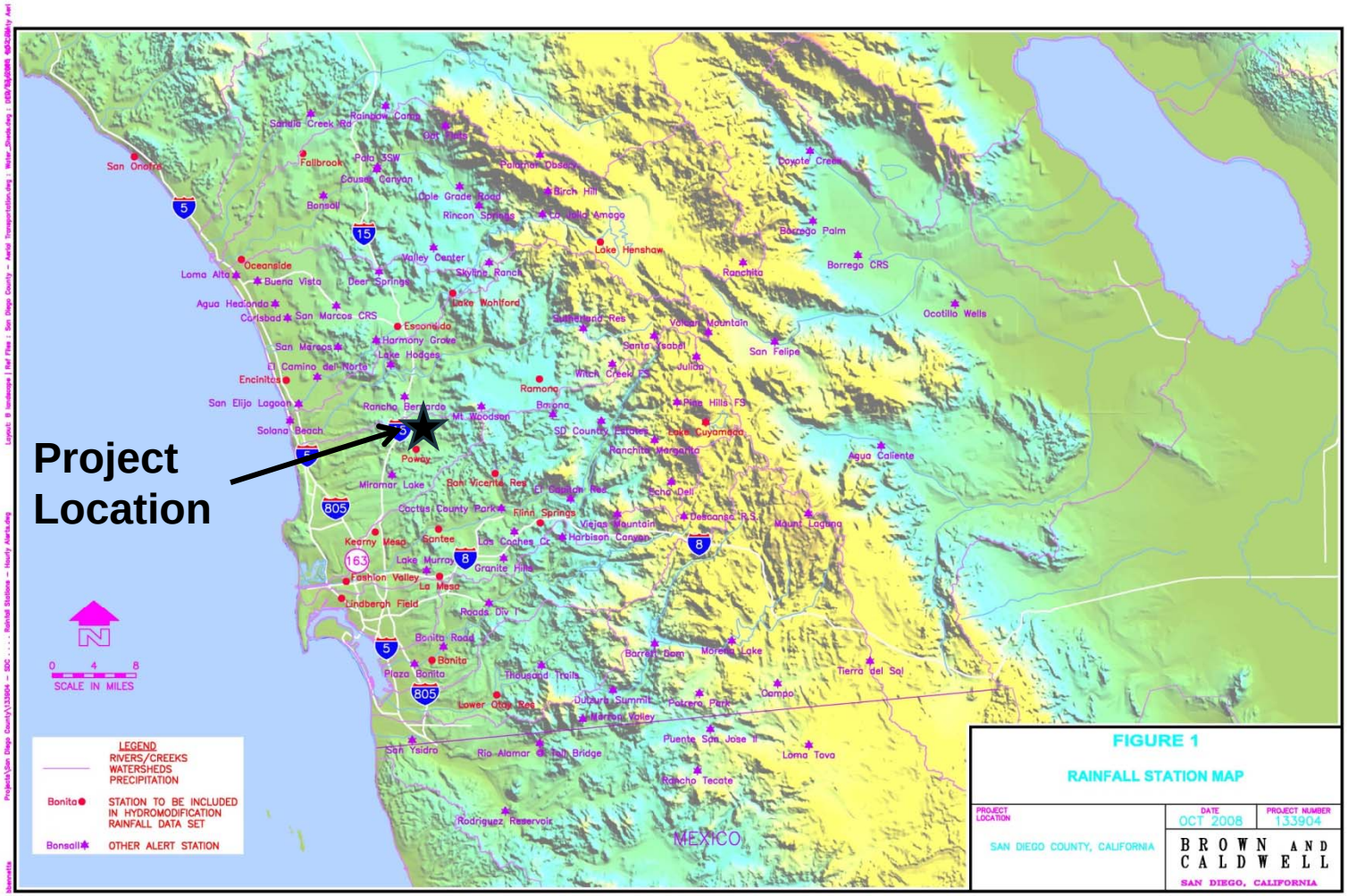
RAINFALL

- Plancheck Checklist for Rainfall:
  - ❑ Appropriate rain gauge for the project site
  - ❑ Total rainfall found by model matches original rain gauge total
  - ❑ Same amount of rainfall in pre- and post- condition models

RAINFALL

- Submittal checklist for rainfall:
  - ❑ Narrative identifies the intended rain gauge
  - ❑ Project location marked on rain gauge map
  - ❑ Supporting backup if selected rain gauge is not the closest gauge (e.g., copy of PZN map, comparison of site elevation to gauge elevation, as applicable)
  - ❑ Model output reports
  - ❑ Rainfall record file (electronic file)

RAINFALL


Project Location
FIGURE 1
RAINFALL STATION MAP
PROJECT LOCATION
SAN DIEGO COUNTY, CALIFORNIA
DATE
OCT 2008
PROJECT NUMBER
133904
BROWN AND CALDWELL
SAN DIEGO, CALIFORNIA
LEGEND
RIVERS/CREEKS
WATERSHEDS
PRECIPITATION
Bonita STATION TO BE INCLUDED IN HYDROMODIFICATION RAINFALL DATA SET
Bonsall OTHER ALERT STATION
SCALE IN MILES
MEXICO

RAINFALL

Status Report

Bookmarks

- Analysis Options
- Continuity Errors
- Runoff Results

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------

SWMM Training - Example Project - Pre-project Condition
June 23-26, 2015

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ YES
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... NO
  Water Quality .......... NO
Infiltration Method ...... GREEN_AMPT
Starting Date ............ OCT-04-1962 15:00:00
Ending Date .............. MAY-23-2008 15:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00


**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......        61.866       558.190
Evaporation Loss .........         2.400        21.655
Infiltration Loss ........        49.525       446.840
Surface Runoff ...........        11.135       100.463
Final Surface Storage ....         0.000         0.000
Continuity Error (%) .....        -1.929
```

Simulation start and end dates

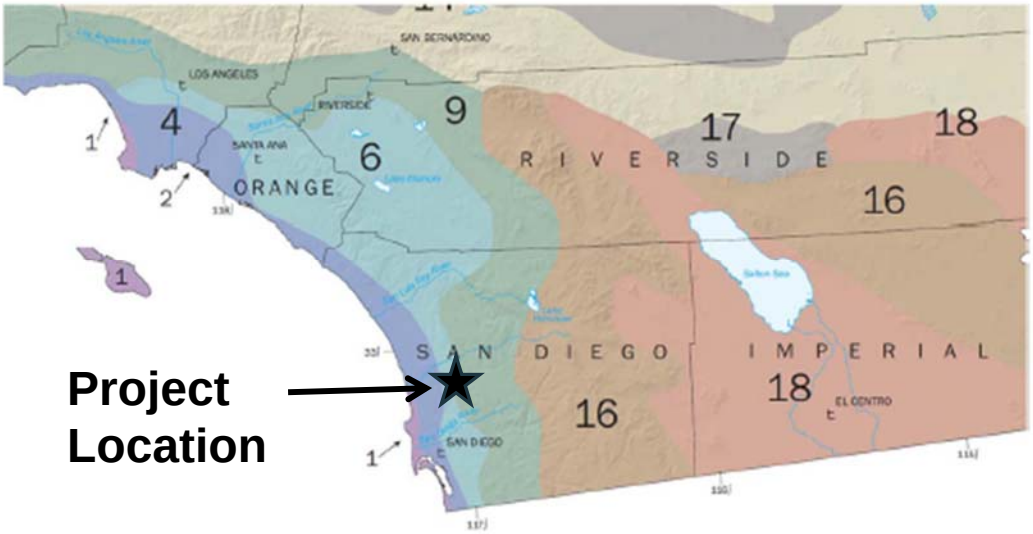
Total rainfall

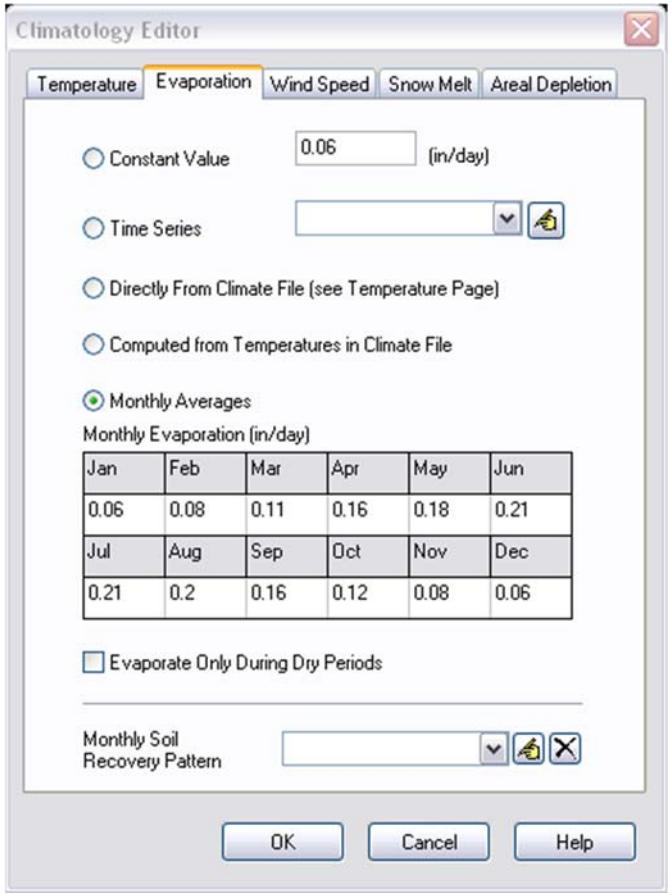
EVAPORATION/ EVAPOTRANSPIRATION

- Evapotranspiration input provided in Appendix G of BMP Design Manual
  - Source: CIMIS
  - Monthly rates linked to map
- Use the correct units (inches per day)

EVAPORATION/ EVAPOTRANSPIRATION

- Plancheck Checklist for Evaporation/ Evapotranspiration:
  - ❑ Appropriate ETo Zone selected
  - ❑ Data entered in inches per day





DRAINAGE AREA AND POC

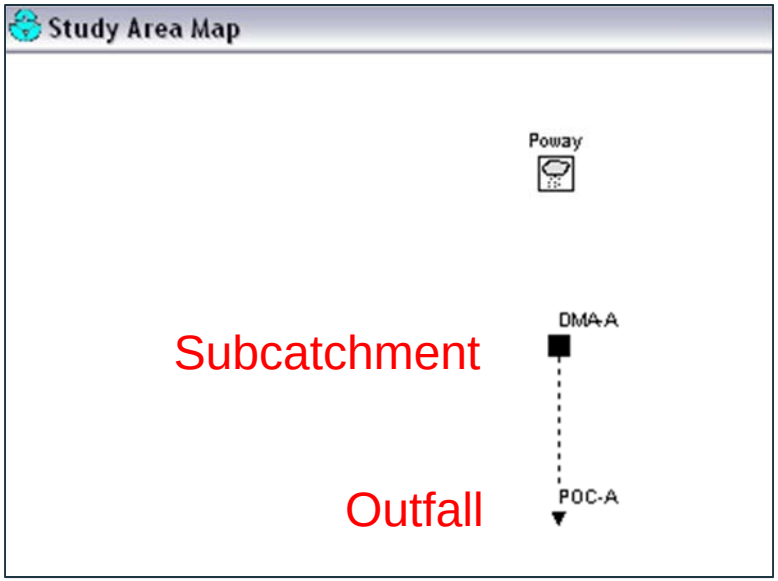
- POC required at each outfall
  - Every place that project runoff meets a susceptible channel
  - Could be onsite or offsite
  - <u>Mitigation required before discharge to natural systems</u>

DRAINAGE AREA AND POC

- All project impervious area must be accounted for in the model
- Diversion is extremely difficult to mitigate and should be avoided
- Offsite area draining through project mitigation features:
  - Natural area: not ok - avoid/ minimize this
  - Developed/ impervious area: maybe ok

DRAINAGE AREA AND POC

- SWMM elements for drainage area and POC
  - Subcatchment element defines drainage area and characteristics
  - POC is an outfall element



Subcatchment DMA-A

Property	Value
Name	DMA-A
X-Coordinate	3000.000
Y-Coordinate	7000.000
Description	

Outfall POC-A

Property	Value
Name	POC-A
X-Coordinate	3000.000
Y-Coordinate	6000.000
Description	

DRAINAGE AREA AND POC

- Plancheck Checklist for Drainage Area and POC:
  - ❑ Where will runoff from the project site meet a natural system? Do the POC(s) demonstrate outfall-level compliance?
  - ❑ Verify project watershed and subbasin boundaries shown on map, check for offsite areas and diversion areas
  - ❑ Tally of area for pre- and post- condition: is all of the area within the project watershed boundary entered into the model?

DRAINAGE AREA AND POC

- Plancheck Checklist for Drainage Area and POC:
  - Diversion areas:
    - Was the diversion approved in the flood control study?
    - If there is diversion, does the project provide mitigation to the appropriate level (i.e., if proposing to discharge runoff from 6 acres at a location with existing drainage area of 5 acres, is the mitigation feature designed to match 5 acres)?
  - Offsite areas draining through project mitigation features*:
    - Could this have been avoided?
    - Will this clog the structural BMP with sediment? What design measures are included to facilitate maintenance?

  *Option to request supplemental analysis of onsite area only

DRAINAGE AREA AND POC

- Submittal Checklist for Drainage Area and POC
  - ❑ Narrative description of project drainage area and POC(s), with special circumstances (e.g., diversion or offsite area) identified and justification provided if applicable
  - ❑ Pre- and Post- Condition Drainage Exhibits
  - ❑ Tabular Summary of pre- and post- area (acres) to be entered into the model

DRAINAGE AREA AND POC

- Submittal Checklist for Drainage Exhibits
  - ❑ Drainage boundaries and drainage area annotation – subcatchment name and area (acres)
  - ❑ Topography – legible, extend enough outside the watershed boundary to enable checking the boundary
  - ❑ Underlying hydrologic soil group
  - ❑ Flow paths
  - ❑ Show POC(s)
  - ❑ Show the natural channel(s) that will be protected – if the natural channel(s) are offsite and far away, an inset or separate exhibit should be provided
  - ❑ Show project features: grading, impervious areas, drainage network, mitigation features (include details)

SUBCATCHMENT CHARACTERISTICS

- Rainfall lands on a subcatchment and either:
  - remains in depression storage to be infiltrated or evaporated, or
  - runs off
- Subcatchment characteristics entered in the subcatchment element
- Guidance for subcatchment parameters has been compiled into the Model BMP Design Manual Appendix G

SUBCATCHMENT CHARACTERISTICS

Subcatchment DMA-A

Property	Value
Name	DMA-A
X-Coordinate	3000.000
Y-Coordinate	7000.000
Description	
Tag	
Rain Gage	Poway
Outlet	POC-A
Area	1.33
Width	245
% Slope	3
% Imperv	0
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	OUTLET
Percent Routed	100
Infiltration	GREEN_AMPT ...
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

Infiltration parameters (click to edit)

- SWMM subcatchment element
  - This is where information is entered that defines the characteristics of the drainage area(s)
  - Note some items lead to additional information (e.g., infiltration editor)

Infiltration Editor

Infiltration Method: GREEN_AMPT

Property	Value
Suction Head	9
Conductivity	0.025
Initial Deficit	0.33

Soil capillary suction head (inches or mm)

OK Cancel Help

SUBCATCHMENT CHARACTERISTICS

- Plancheck Checklist for Subcatchment Characteristics
  - ❑ Review each subcatchment input and compare to project drainage exhibit and/or tabular summary

Subcatchment DMA-A

Property	Value
Name	DMA-A
X-Coordinate	3000.000
Y-Coordinate	7000.000
Description	
Tag	
Rain Gage	Poway
Outlet	POC-A
Area	1.33
Width	245
% Slope	3
% Imperv	0

SUBCATCHMENT CHARACTERISTICS

These parameters are project-specific – compare to maps and drainage exhibits

Subcatchment DMA-A

Property	Value
Name	DMA-A
X-Coordinate	3000.000
Y-Coordinate	7000.000
Description	
Tag	
Rain Gage	Poway
Outlet	POC-A
Area	1.33
Width	245
% Slope	3
% Imperv	0
N-Imperv	0.012
N-Perv	0.05
Dstore-Imperv	0.05
Dstore-Perv	0.1
%Zero-Imperv	25
Subarea Routing	OUTLET
Percent Routed	100
Infiltration	GREEN_AMPT ...
Groundwater	NO
Snow Pack	
LID Controls	0
Land Uses	0
Initial Buildup	NONE
Curb Length	0

Infiltration parameters (click to edit)

Ranges for these parameters are provided in the BMP Design Manual

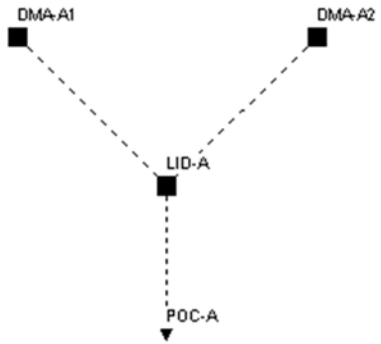
SUBCATCHMENT CHARACTERISTICS

- Submittal Checklist for Subcatchment Characteristics
  - ❑ Narrative description of pre- and post- condition of drainage area including identification of underlying hydrologic soil group(s), general discussion of slopes, features, land cover, impervious areas
  - ❑ Backup for underlying soil
  - ❑ Pre- and post- drainage exhibits
  - ❑ Tabular summary of subcatchment input parameters

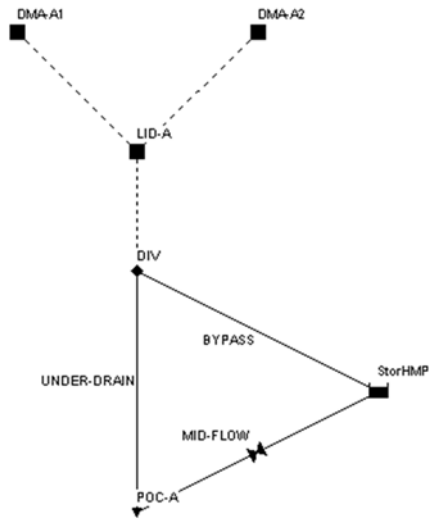
MODEL ROUTING

- Model routing network represents how runoff gets from landing on the subcatchment to arriving at the POC

Example pre-project condition:
A subcatchment drains to a POC



Example mitigated condition 1:
Two subcatchments drain to a third subcatchment with a bio-retention cell, then ultimately discharges to the POC



Example mitigated condition 2:
Two subcatchments drain to a third subcatchment with a bio-retention cell that has a mid-flow orifice in the surface ponding area, then ultimately discharges to the POC

MODEL ROUTING

- Plancheck Checklist for Model Routing
  - ❑ Check all connections from subcatchment through POC
  - ❑ Are all subcatchments ultimately connected to a POC?
  - ❑ Does the network reflect the flow paths and features shown on the drainage exhibits?

MODEL ROUTING

- Submittal Checklist for Model Routing
  - ❑ Narrative description of model network
  - ❑ Pre- and Post- Drainage Exhibits
  - ❑ Screen capture of model
  - ❑ SWMM electronic file

STRUCTURAL BMPS

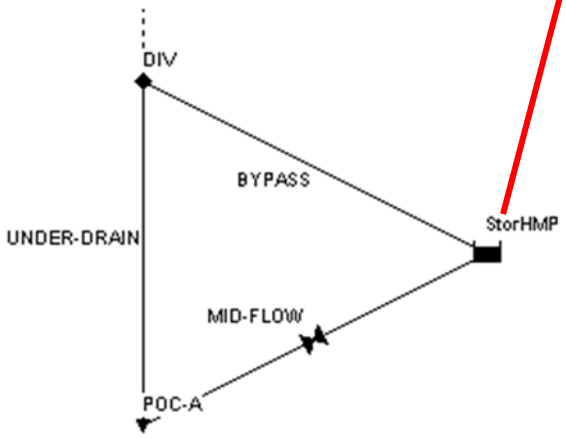
- Structural BMPs for hydromodification management provide storage volume and outflow control
- Model elements typically used to represent structural BMPs:
  - Storage unit element combined with one or more links (e.g., orifice, weir, outlet)
  - LID element (e.g., “bio-retention cell”)
  - Combination of LID and storage

STRUCTURAL BMPS

- Plancheck Checklist for Structural BMPs
  - ❑ Compare plans/ details to model elements
  - ❑ Storage unit volume in model matches volume available on plans
  - ❑ Outlet structure or outlet rating curve in model matches outlet structure on plans
  - ❑ Rating curve hydraulic calculations if “outlet” element used
  - ❑ Area of LID in subcatchment LID control editor
  - ❑ LID components in LID control editor

STRUCTURAL BMPS

- Planchecking a Storage Unit



Storage Unit StorHMP

Property	Value
Name	StorHMP
X-Coordinate	5000.000
Y-Coordinate	4000.000
Description	
Tag	
Inflows	NO
Treatment	NO
Invert El.	0
Max. Depth	1.5
Initial Depth	0
Ponded Area	0
Evap. Factor	1
Infiltration	NO
Storage Curve	TABULAR
Functional Curve	
Coefficient	1000
Exponent	0
Constant	0
Tabular Curve	
Curve Name	StorageCurve

Name of storage curve to use (after specifing a curve, you can double-click to edit it)

Storage Curve Editor

Curve Name: StorageCurve

Description

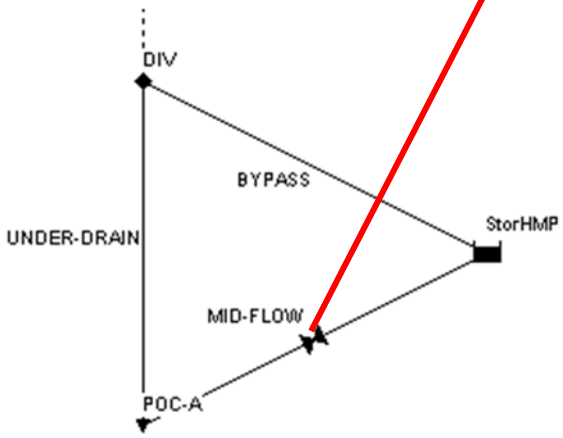
	Depth (ft)	Area (ft2)
1	0	1941
2	0.5	2345
3	1.5	3230
4		
5		
6		
7		
8		
9		

View... Load... Save... OK Cancel Help

Compare storage to plans

STRUCTURAL BMPS

- Planchecking a Storage Unit



Outlet MID-FLOW

Property	Value
Name	MID-FLOW
Inlet Node	StorHMP
Outlet Node	POC-A
Description	
Tag	
Inlet Offset	0
Flap Gate	NO
Rating Curve	TABULAR/DEPTH
Functional Curve	
Coefficient	10.0
Exponent	0.5
Tabular Curve	
Curve Name	RatingCurve

Name of rating curve that relates outflow to either depth or head (after specifing a curve, you can double-click to edit

Rating Curve Editor

Curve Name: RatingCurve

Description

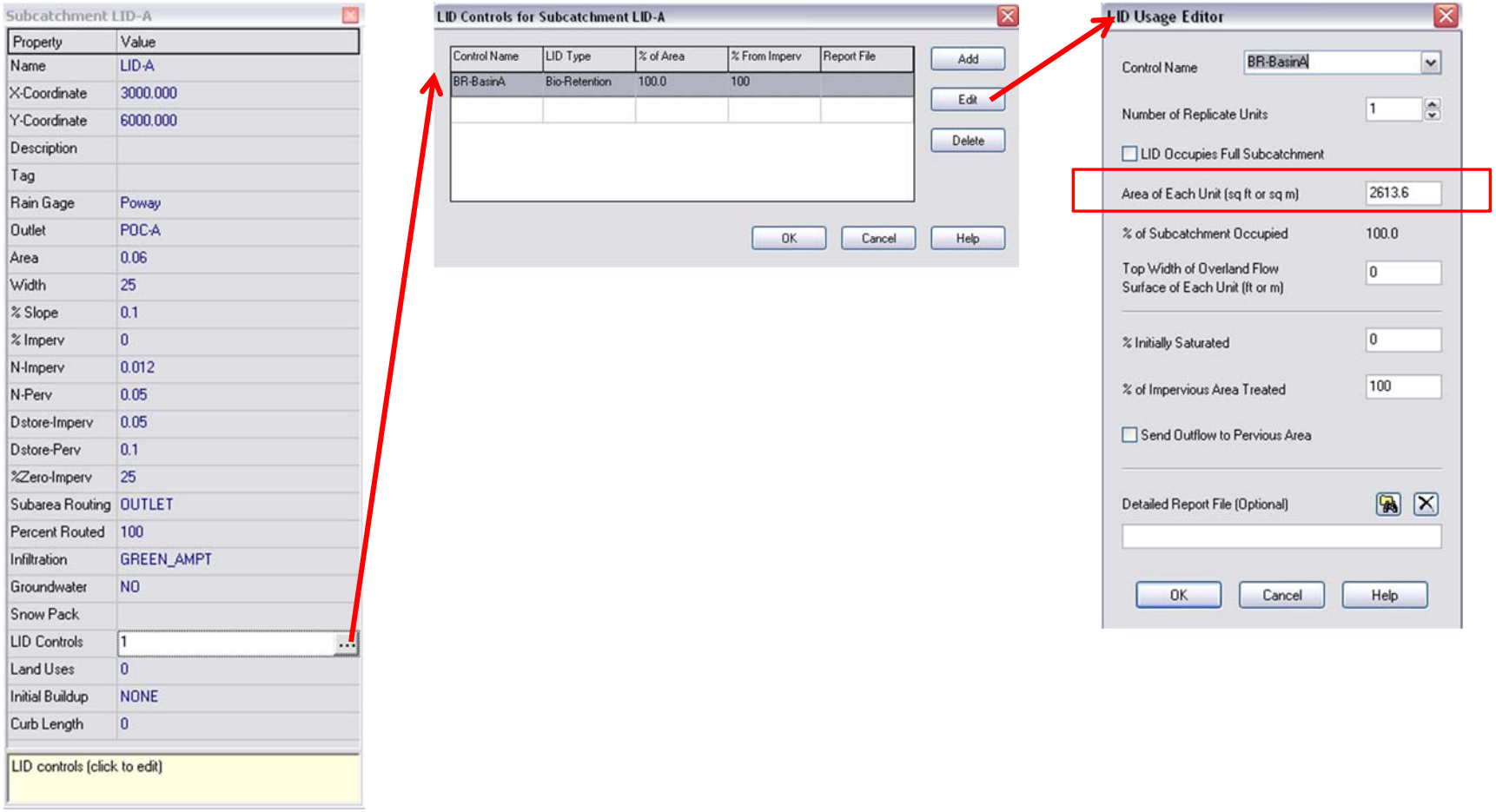
	Head (ft)	Outflow (CFS)
1	0	0
2	0.083	0
3	0.167	0.025
4	0.25	0.034
5	0.333	0.041
6	0.417	0.047
7	0.5	0.053
8	0.583	0.723
9	0.667	1.946

View... Load... Save... OK Cancel Help

Compare rating curve to backup provided in report, compare to actual outlet shown on plans

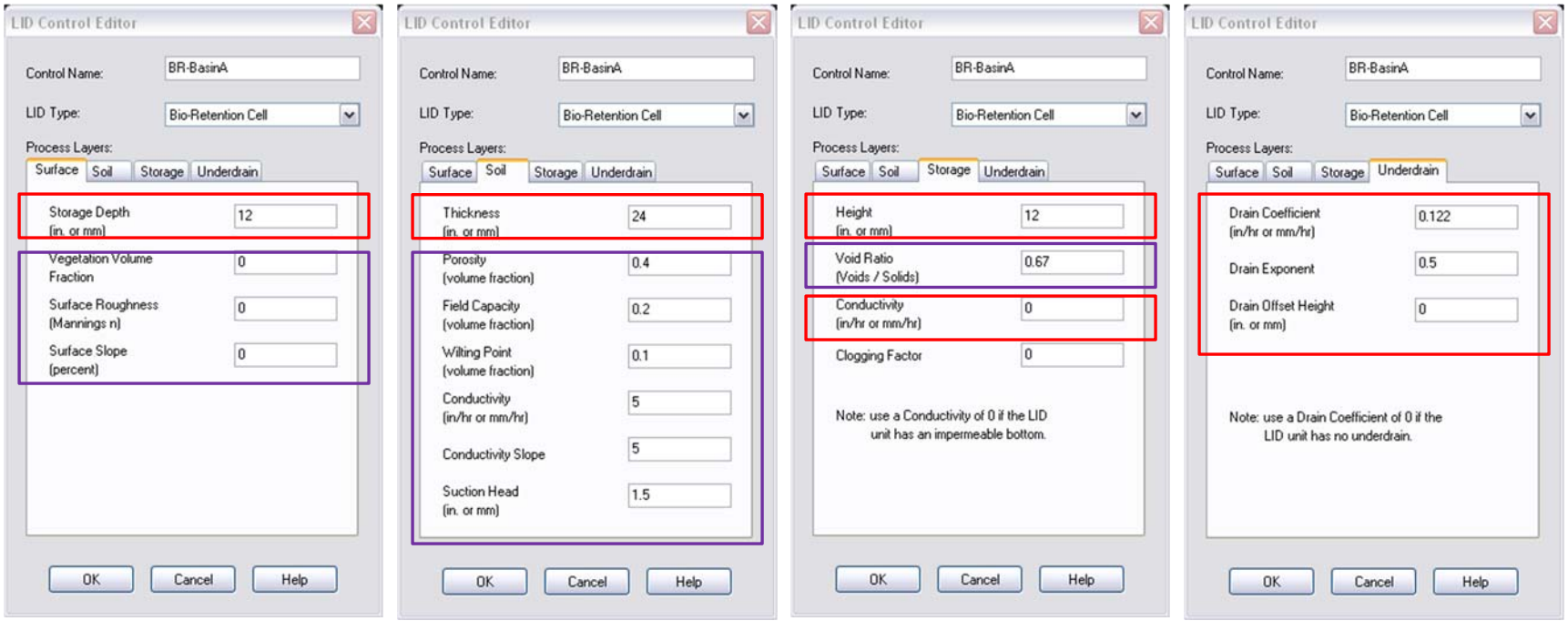
STRUCTURAL BMPS

- Planchecking a Bio-Retention Cell



STRUCTURAL BMPS

- Planchecking a Bio-Retention Cell



These parameters are project-specific – compare to plans

Ranges for these parameters are provided in the BMP Design Manual

STRUCTURAL BMPS

- Submittal Checklist for Structural BMPs
  - ❑ Narrative description of the intended structural BMP
  - ❑ Tabular summary of structural BMP input
  - ❑ SWMM electronic file
  - ❑ Plans/ detail for the structural BMP

MODEL OUTPUT / RESULTS

- Interpreting the continuous simulation model
  - Input 306,810 hours of hourly rainfall
  - Output 306,810 hours of hourly flow
  - How to review 306,810 hours of hourly flow?

MODEL OUTPUT / RESULTS

- Pre-screen model summary output
- Review flow frequency
- Review flow duration
- Check drawdown times in mitigation features

MODEL SUMMARY OUTPUT

- Plancheck Checklist for Model Summary Output
  - ❑ Total rainfall found by model matches original rain gauge total
  - ❑ Same amount of rainfall in pre- and post- condition models
  - ❑ Evaporation, infiltration, and surface runoff
  - ❑ Maximum stage occurring in mitigation features does not exceed data provided

RAINFALL

Status Report

Bookmarks

- Analysis Options
- Continuity Errors
- Runoff Results

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.022)
--------------------------------------------------------------

SWMM Training - Example Project - Pre-project Condition
June 23-26, 2015

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Antecedent Dry Days ...... 0.0
Report Time Step ......... 01:00:00
Wet Time Step ............ 00:15:00
Dry Time Step ............ 04:00:00


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Infiltration Loss ........        49.525       446.840
Surface Runoff ...........        11.135       100.463
Final Surface Storage ....         0.000         0.000
Continuity Error (%) .....        -1.929
```

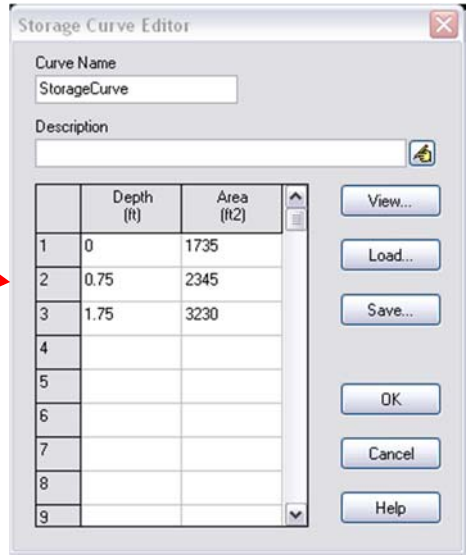
Total Rainfall,
Evaporation Loss,
Infiltration Loss,
Surface Runoff

MODEL SUMMARY OUTPUT

- Checking maximum stage in a storage unit:
  - Maximum HGL should not exceed the data provided

```
******************
Node Depth Summary
******************

-----------------------------------------------------------------------
                              Average  Maximum  Maximum  Time of Max
                                Depth    Depth      HGL   Occurrence
Node                 Type        Feet     Feet     Feet  days hr:min
-----------------------------------------------------------------------
POC-A                OUTFALL     0.01     0.33     0.33    74  18:31
DIV                  DIVIDER     0.01     0.33     0.33    74  17:14
StorHMP              STORAGE     0.01     0.85     0.85  6348  09:17
```



FLOW FREQUENCY AND DURATION

- The range of flows to control is from a fraction of pre- Q2 to pre- Q10
- HMP and BMP Design Manual are flexible about methods for:
  - Plotting position for frequency calculations (e.g., Weibull, Cunnane)
  - Determining unique runoff events

FLOW FREQUENCY AND DURATION

- Check pre- flow frequency analysis first – this determines pre- Q2 and pre- Q10
- Determine fraction of pre- Q2 to control
- Check post- flow frequency analysis
- Then check duration analysis

FLOW FREQUENCY AND DURATION

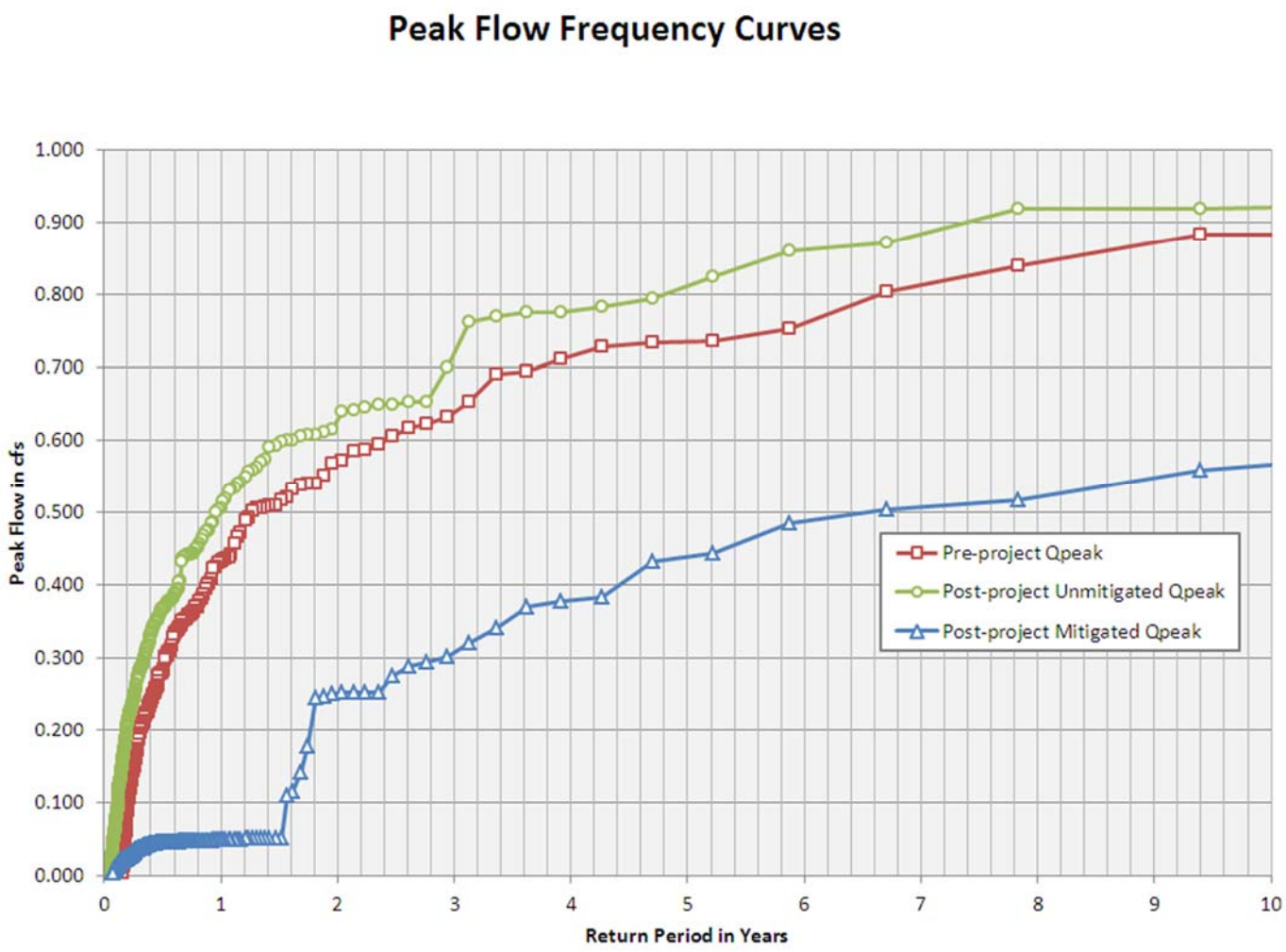
Pre-project Flow Frequency - Long-term Simulation

SWMM Training - Example Project - Pre-project Condition
Statistics - Node POC-A Total Inflow

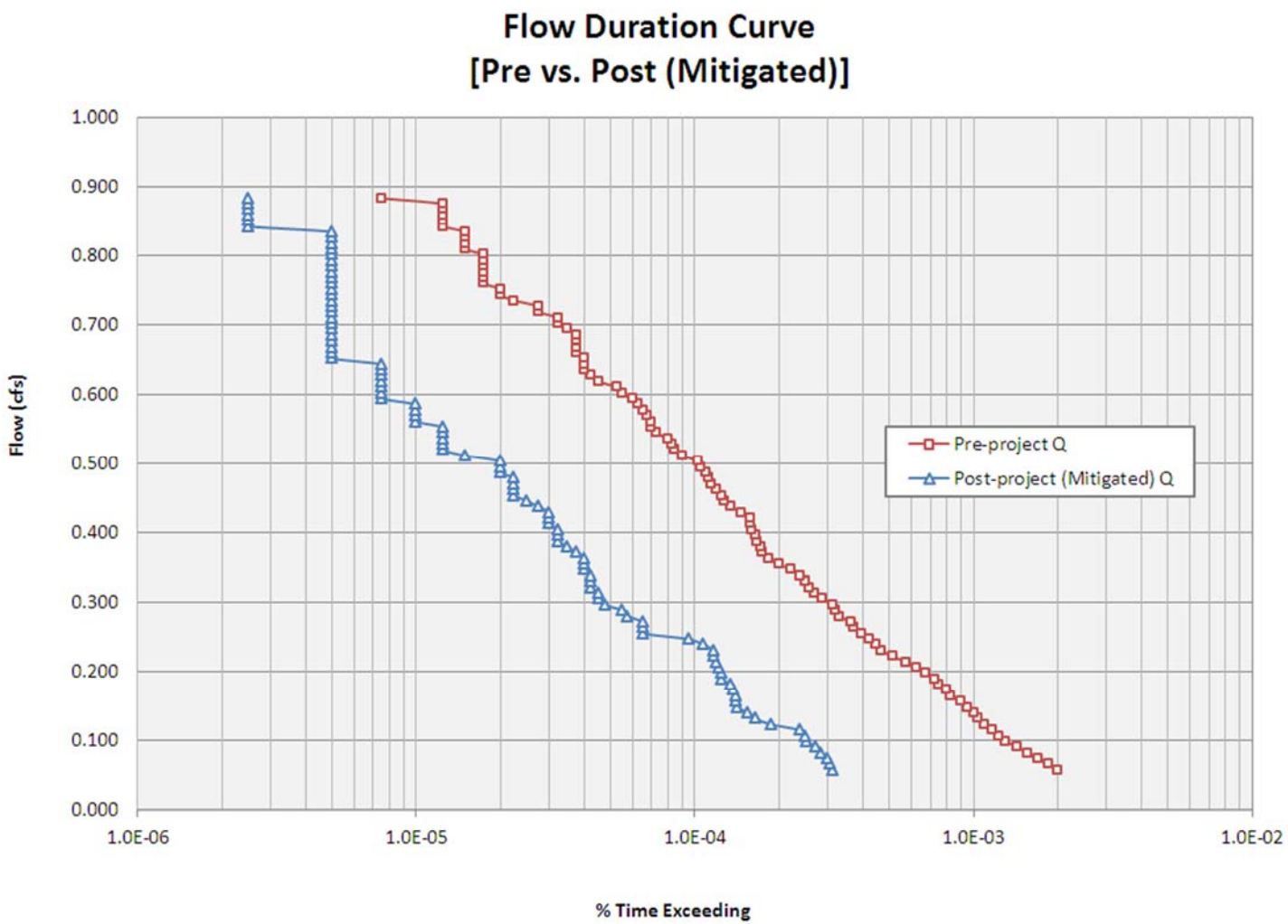
Rank	Start Date	Event Duration (hours)	Event Peak (CFS)	Exceedance Frequency (percent)	Return Period (years)
1	3/24/1983	11	1.019	0.34	47
2	2/18/1980	77	1.014	0.68	23.5
3	1/25/1995	11	0.908	1.02	15.67
4	1/9/1978	29	0.883	1.37	11.75
5	3/17/1982	21	0.883	1.71	9.4
6	12/28/2004	19	0.839	2.05	7.83
7	11/5/1987	2	0.804	2.39	6.71
8	2/8/1998	16	0.752	2.73	5.88
9	12/28/1978	37	0.735	3.07	5.22
10	11/29/1982	22	0.733	3.41	4.7
11	2/3/1998	7	0.727	3.75	4.27
12	12/18/1978	3	0.71	4.1	3.92
13	11/12/1976	2	0.693	4.44	3.62
14	2/28/1970	3	0.691	4.78	3.36
15	2/14/1998	5	0.652	5.12	3.13
16	1/6/1974	33	0.631	5.46	2.94
17	3/1/1983	42	0.623	5.8	2.76
18	2/8/1983	5	0.617	6.14	2.61
19	1/5/1979	21	0.605	6.48	2.47
20	1/28/1980	45	0.594	6.83	2.35
21	12/9/1965	29	0.587	7.17	2.24
22	1/9/2005	22	0.585	7.51	2.14
23	3/17/1983	29	0.571	7.85	2.04
24	11/16/1972	22	0.568	8.19	1.96
25	2/27/2001	10	0.55	8.53	1.88

10-year Q:	0.883	cfs
5-year Q:	0.734	cfs
2-year Q:	0.570	cfs
Lower Flow Threshold:	10%	
0.1xQ2 (Pre):	0.057	cfs

FLOW FREQUENCY AND DURATION



FLOW FREQUENCY AND DURATION



FLOW FREQUENCY AND DURATION

- Plancheck Checklist for Flow Frequency and Duration Results
  - Frequency calculations - compare tabular results or curves, post- mitigated flow less than pre- for the appropriate range (fraction pre- Q2 to pre- Q10)
  - Duration calculations - compare tabular results or curves, post- durations less than pre- within the appropriate range

FLOW FREQUENCY AND DURATION

- Submittal Checklist for Flow Frequency and Duration Results
  - ❑ Narrative identification of channel susceptibility and fraction of Q2 to control
  - ❑ Channel screening report (a.k.a geomorphic assessment) if 0.3Q2 or 0.5Q2 is used
  - ❑ Frequency calculations - tabular results and curves
  - ❑ Duration calculations - tabular results and curves

DRAWDOWN TIME

- The maximum recommended drawdown time for structural BMPs is 96 hours – this applies to:
  - Detention basins
  - Underground storage vaults
  - Above-ground storage portion of LID facilities
- HMP and BMP Design Manual are flexible about methods to calculate drawdown time
- Maximum depth must be based on the elevation of the overflow outlet

DRAWDOWN TIME

- Plancheck Checklist for Drawdown Time
  - ❑ Appropriate maximum depth and volume have been evaluated
  - ❑ Outflow calculation is based on the appropriate element or combination of elements controlling the flow
  - ❑ Drawdown time 96 hours or less

SPECIAL MODELING CIRCUMSTANCES

- Computer model does not have an off-the shelf element available for every structural BMP that we design
- Plancheck is project-specific – the applicant must provide information describing the model to the reviewer

SPECIAL MODELING CIRCUMSTANCES

- Submittal Checklist
  - Narrative description of intent – describe the structural BMP and the model elements selected to represent the BMP
  - Provide illustrations
  - Provide backup calculations

LUMPED MODELS

- 10 apartment buildings will drain to 10 biofiltration devices that collectively will meet performance criteria at one POC
- For the model, the engineer has lumped all of the drainage area into one subcatchment draining to one biofiltration device
- The total volume required for the biofiltration device is then distributed across the plans
- How to check this?

LUMPED MODELS

- Plancheck Checklist for Lumped Models
  - Both the volume <u>and</u> the maximum allowable outflow must be distributed
  - Multiple distributed outflow controls (e.g., 10 orifice openings) must collectively not exceed the 1 control in the lumped model
  - A structural BMP can only control runoff that is actually delivered into it, therefore the distributed volumes must be appropriate to the individual drainage areas

LUMPED MODELS

- Submittal Checklist for Lumped Models
  - ❑ Provide calculations showing the collective outflow from distributed flow controls
  - ❑ Provide calculations showing how the volume was distributed

OVERALL LAND PLANNING

- General land planning check
  - Floodplain limits
  - Streams / environmental limits
  - Sediment sources
  - Maintenance access
  - Flood control

TOOLS FOR PLANCHECK

- HMP, BMP Design Manual, SWMM User's Manual
- GIS Datasets
  - Aerial photo
  - USGS maps
  - National Flood Hazard Layer
  - Soils map
  - Parcels