Utah State University

LECTURE #16

ANALYSIS OF ALTERNATIVES: MODELING SCENARIOS, BMPS, AND TMDLS

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ANALYSIS OF ALTERNATIVES

- Definition of alternatives
- Selection of constituents and numeric/ statistical measures
- Representation of alternatives
  - input changes
  - system configuration
  - parameter changes

Representation can be simple or complex

STEPS IN THE ANALYSIS OF ALTERNATIVES

1. **Define Appropriate Base Conditions**
2. **Define Basis and Measures for Comparison of Alternatives**
3. **Simulate Base Conditions**
4. **Define Alternatives**
5. **Define and Evaluate Model Changes (Input, Parameters, Representation) for Each Alternative**
6. **Perform Simulation Runs of Alternatives**
7. **Compare Model Results for Base and Alternatives**

MEASURES OF MODEL SCENARIO COMPARISONS

- Point-to-point paired data comparison
- Time and/or space integrated paired data comparison
- Frequency domain comparison

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ANALYSIS OF ALTERNATIVES - # 1

ANALYSIS OF ALTERNATIVES - 1

Alternative:	Point source waste treatment
Model Representation:	Changes in point source loads
Possible HSPF Input Changes:	Modify point load input files in WDM
	Modify MFACT in EXT SOURCES
	Use GENER option to calculate new point loads
	Point Source Manager in WinHSPF

ANALYSIS OF ALTERNATIVES - 2

Alternative:	Instream aeration
Model Representation:	Point load of oxygen to stream
Possible HSPF Input Changes:	Develop point load oxygen files in WDM, and input to stream reach
	Use GENER option to calculate new point load oxygen files
	Point Source Manager in WinHSPF

ANALYSIS OF ALTERNATIVES - # 2

ANALYSIS OF ALTERNATIVES - 3

Alternative:	**Land use changes**
Model Representation:	**Change areas for each PLS affected**
Possible HSPF Input Changes:	**Modify area factors in SCHEMATIC Block or NETWORK Block** **Land Use Editor in WinHSPF**

ANALYSIS OF ALTERNATIVES - 4

Alternative:	**Reservoir operations analysis**
Model Representation:	**Change in operating rule curves and/or outflows for existing reservoir**
Possible HSPF Input Changes:	**Modify FTABLES to reflect new operating procedures – Reach Editor in WinHSPF** **Modify time-varying outflow demand files in WDM -- WDMUtil** **Link to another reservoir model with MUTSIN/PLTGEN**

ANALYSIS OF ALTERNATIVES - # 3

ANALYSIS OF ALTERNATIVES - 5

Alternative:	**Reservoir site investigations**
Model Representation:	**Replace existing stream reach with a proposed reservoir**
Possible HSPF Input Changes:	**Modify OPN SEQUENCE, RCHRES, and/or SCHEMATIC blocks, as needed** **Modify/develop FTABLE for new reservoir** **Reach Editor in WinHSPF**

ANALYSIS OF ALTERNATIVES - 6

Alternative:	**Flow augmentation and/or diversions**
Model Representation:	**Modify inflows and/or outflows to/ from specific reaches**
Possible HSPF Input Changes:	**Add or modify time series files of flows or outflow demands through changes to NETWORK, RCHRES, and/or FTABLE blocks, as needed** **Reach Editor in WinHSPF**

ANALYSIS OF ALTERNATIVES - # 4

ANALYSIS OF ALTERNATIVES - 7

Alternative:	Rainfall/ET/air temp regime changes (precip augmentation, climate changes)
Model Representation:	Clearly define expected changes in appropriate met data input files
Possible HSPF Input Changes:	Modify input data files in WDM using MFACT in EXT SOURCES – Met Data Editor in WinHSPF
	Calculate new input files using GENER option
	Develop new input files – WDMUtil

ANALYSIS OF ALTERNATIVES - 8

Alternative:	Wasteload allocation
Model Representation:	Distribute allowable waste loadings for each constituent among existing/expected dischargers
Possible HSPF Input Changes:	Modify point loads input files and/or NPS loads by changes in file values, MFACT multipliers in EXT SOURCES,MASS-LINK Blocks, or BMP Module Point Load Editor and BMP Module in WinHSPF
	Will need to iterate simulation.

ANALYSIS OF ALTERNATIVES - # 5

ANALYSIS OF ALTERNATIVES - 9

Alternative: Stream channel modifications (e.g. channelization, levees)

Model Representation: Modify flow characteristics in specific stream reaches

Possible HSPF Input Changes: Modify RCHRES block and associated FTABLES to reflect changes

Reach Editor in WinHSPF

ANALYSIS OF ALTERNATIVES - 10

Alternative: Stormwater drainage and management

Model Representation: Define componets of proposed plan (e.g. storage/treatment, street sweeping)

Possible HSPF Input Changes:

Modify appropriate PERLND parameters

Modify RCHRES network for storage options (e.g. detention facilities)

Use GENER, MASS-LINK, or BMP Module to modify NPS loadings and/or outflows

Link with a separate urban storage/ treatment model using MUTSIN/PLTGEN

Reach Editor and BMP Module in WinHSPF

ANALYSIS OF ALTERNATIVES - # 6

ANALYSIS OF ALTERNATIVES - 11

Alternative:	**Urban and/or agricultural best management practices (BMPs)**
Model Representation:	**Define all components of each BMP and differences from base conditions**
Possible HSPF Input Changes:	**Modify appropriate PERLND and/or SPEC-ACTIONS parameters**
	Modify linkage of land and reach segments through MASS-LINK or BMP Module (BMP Efficiency Approach) -- BMP Module in WinHSPF

ANALYSIS OF ALTERNATIVES - 12

Alternative:	**Land/soil disruptions (e.g. construction, mining waste disposal, clear cutting)**
Model Representation:	**Define components resulting from specific type of disruption/disturbance**
Possible HSPF Input Changes:	**Modify appropriate PERLND parameters to represent 'disturbed' or changed condition**
	May require additional PLSs with adjusted parameters & corresponding changes throughout the UCI

CONNECTICUT WATERSHED MODEL STUDY

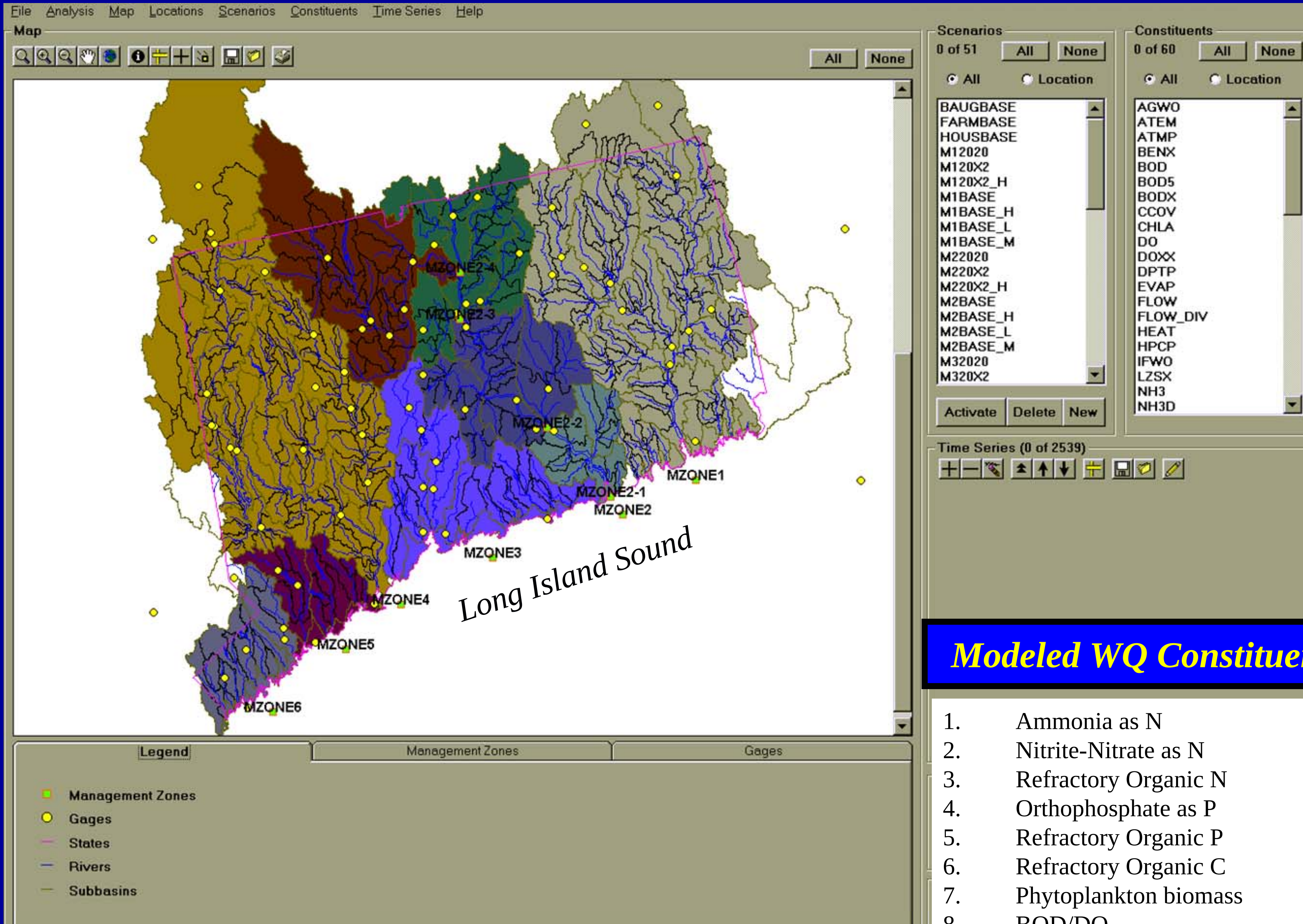
AND

EXAMPLE TMDL CALCULATIONS

STUDY OBJECTIVES

- Develop a watershed model as a framework for quantifying nutrient sources and loadings to LIS from Connecticut watersheds
- Evaluate the potential for nutrient load reduction from various BMP implementation levels under both current and future growth scenarios
- Provide a spreadsheet compilation of nutrient loads to LIS and modeled scenarios as a simplified planning tool

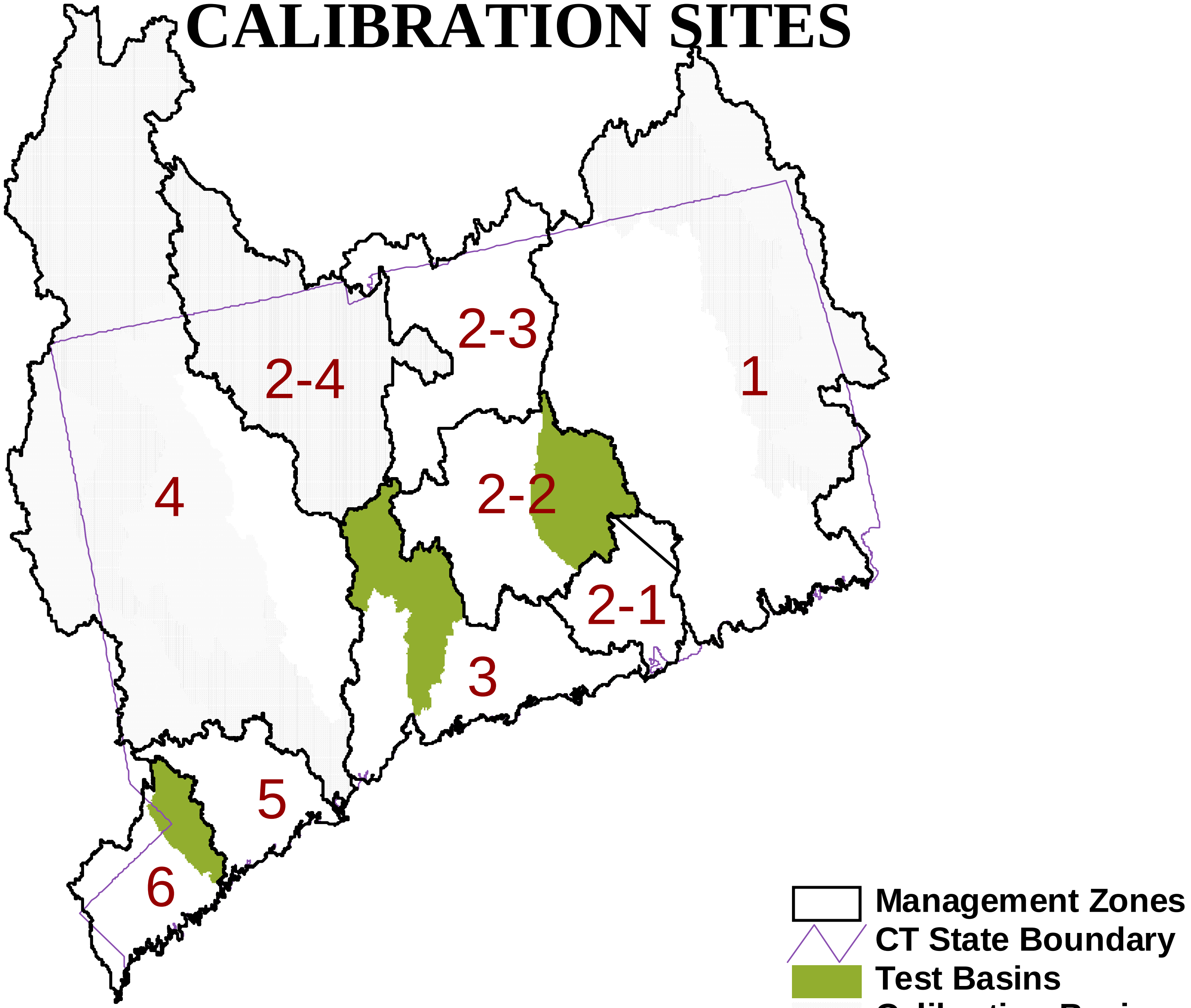
CTWM – HSPF WITHIN GENSCN



Modeled WQ Constituents

1. Ammonia as N
2. Nitrite-Nitrate as N
3. Refractory Organic N
4. Orthophosphate as P
5. Refractory Organic P
6. Refractory Organic C
7. Phytoplankton biomass
8. BOD/DO
9. Water Temperature

CTWM, NUTRIENT MANAGEMENT ZONES, AND CALIBRATION SITES

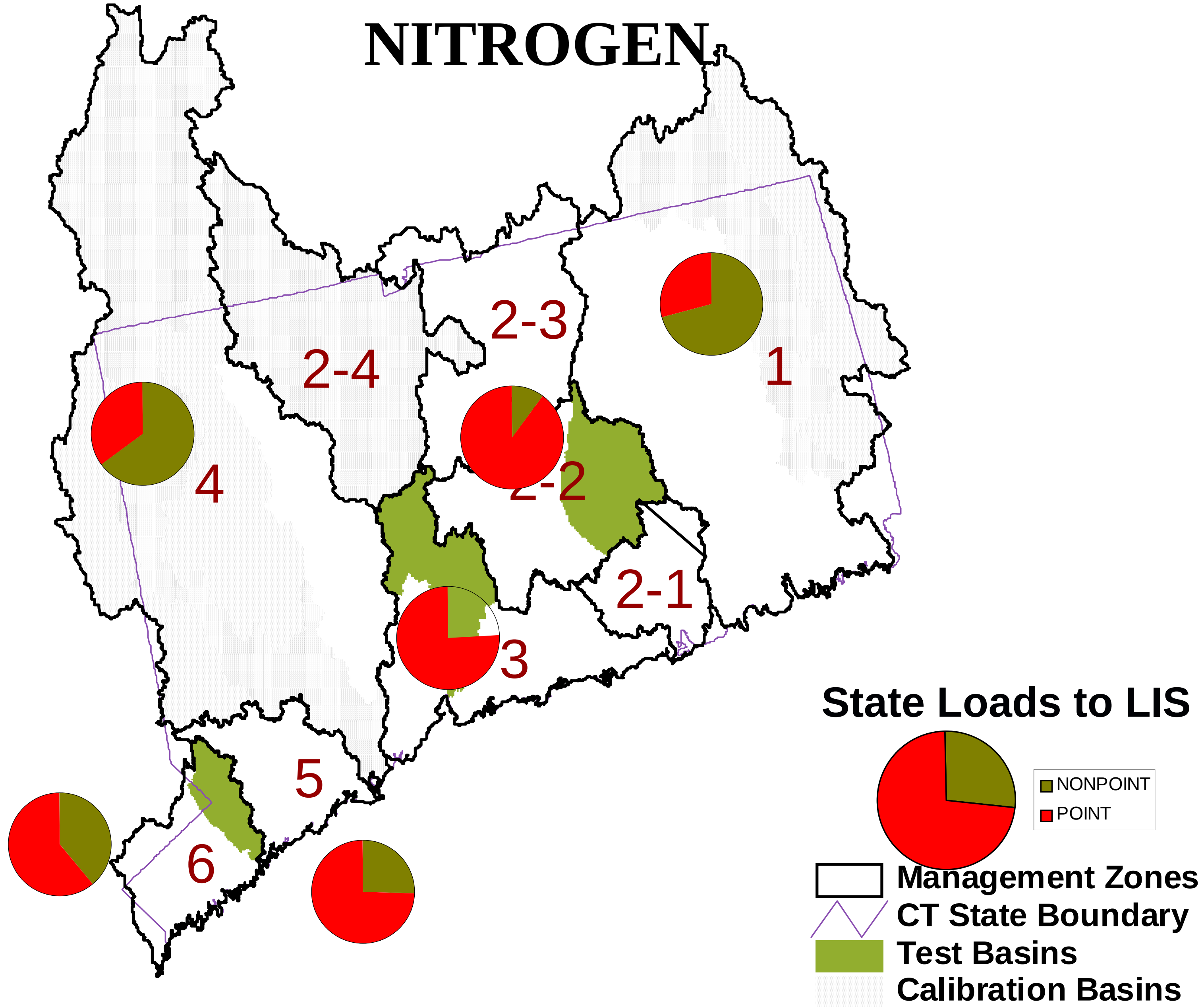


AVERAGE ANNUAL NUTRIENT LOADS (10^3 lbs / yr) DELIVERED TO LIS FOR EACH OF THE MANAGEMENT ZONES

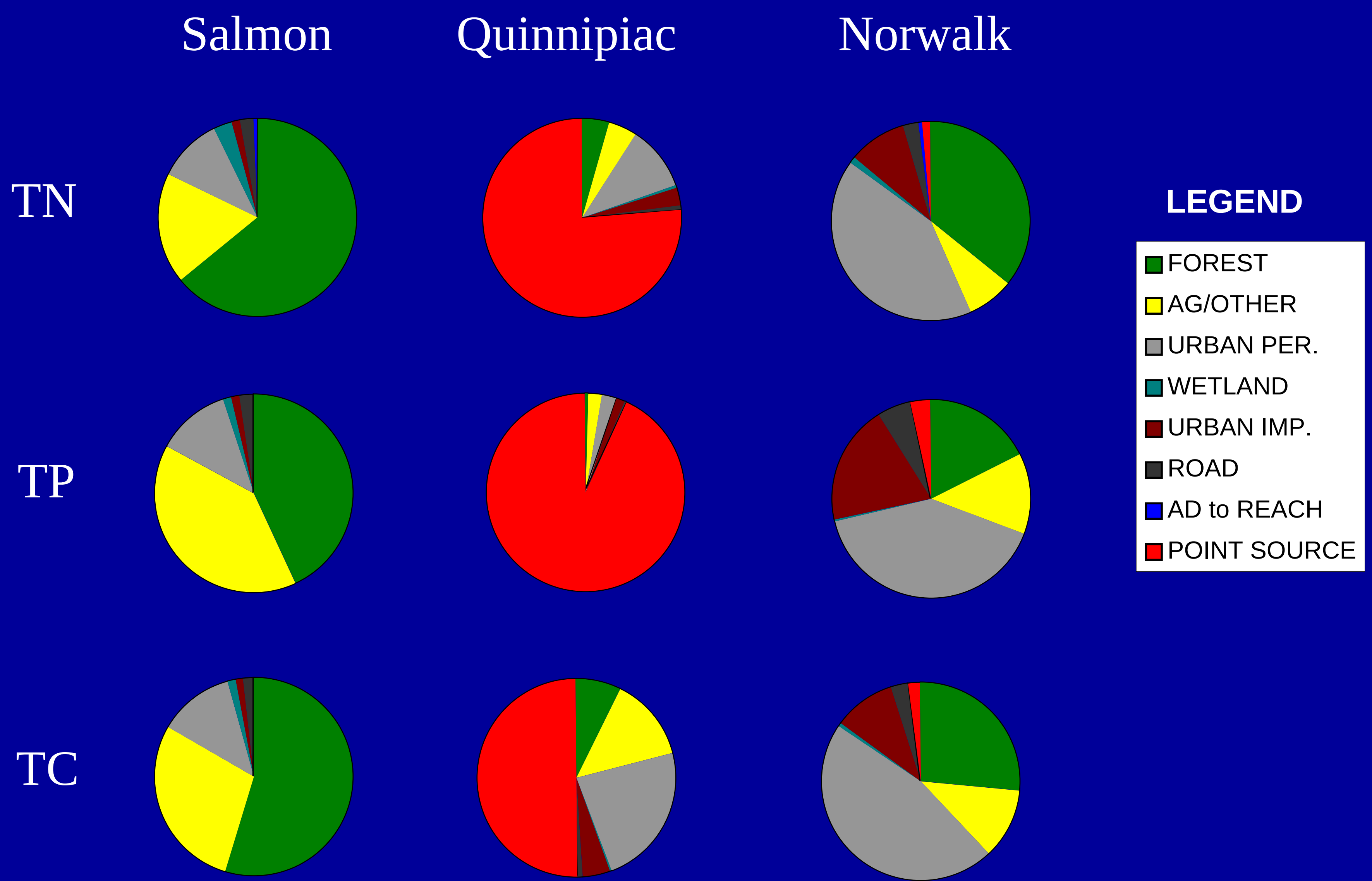
M-Zone	Total Nitrogen			Total Phosphorus			Total Organic Carbon		
	NPS	% of Total	Total	NPS	% of Total	Total	NPS	% of Total	Total
1	4,078	71%	5,757	209	38%	552	32,334	63%	51,669
2	3,043	10%	29,343	168	7%	2,505	17,173	17%	101,395
3	978	24%	4,052	54	14%	398	2,511	48%	5,184
4	3,929	65%	6,061	316	61%	521	13,824	90%	15,386
5	475	26%	1,855	25	13%	194	2,262	40%	5,724
6	629	39%	1,616	34	20%	169	3,141	54%	5,852
Total (10^3 lbs / yr)	13,132	27%	48,684	807	19%	4,338	71,245	38%	185,211
Total (tons / yr)	6,566	27%	24,342	404	19%	2,169	35,623	38%	92,606

Note: The totals for Management Zone 2 include the Fall-Line boundary condition loads for the Connecticut River at Thompsonville, while for Management Zone 4 they include the boundary condition for the Housatonic River at Ashley Falls, MA.

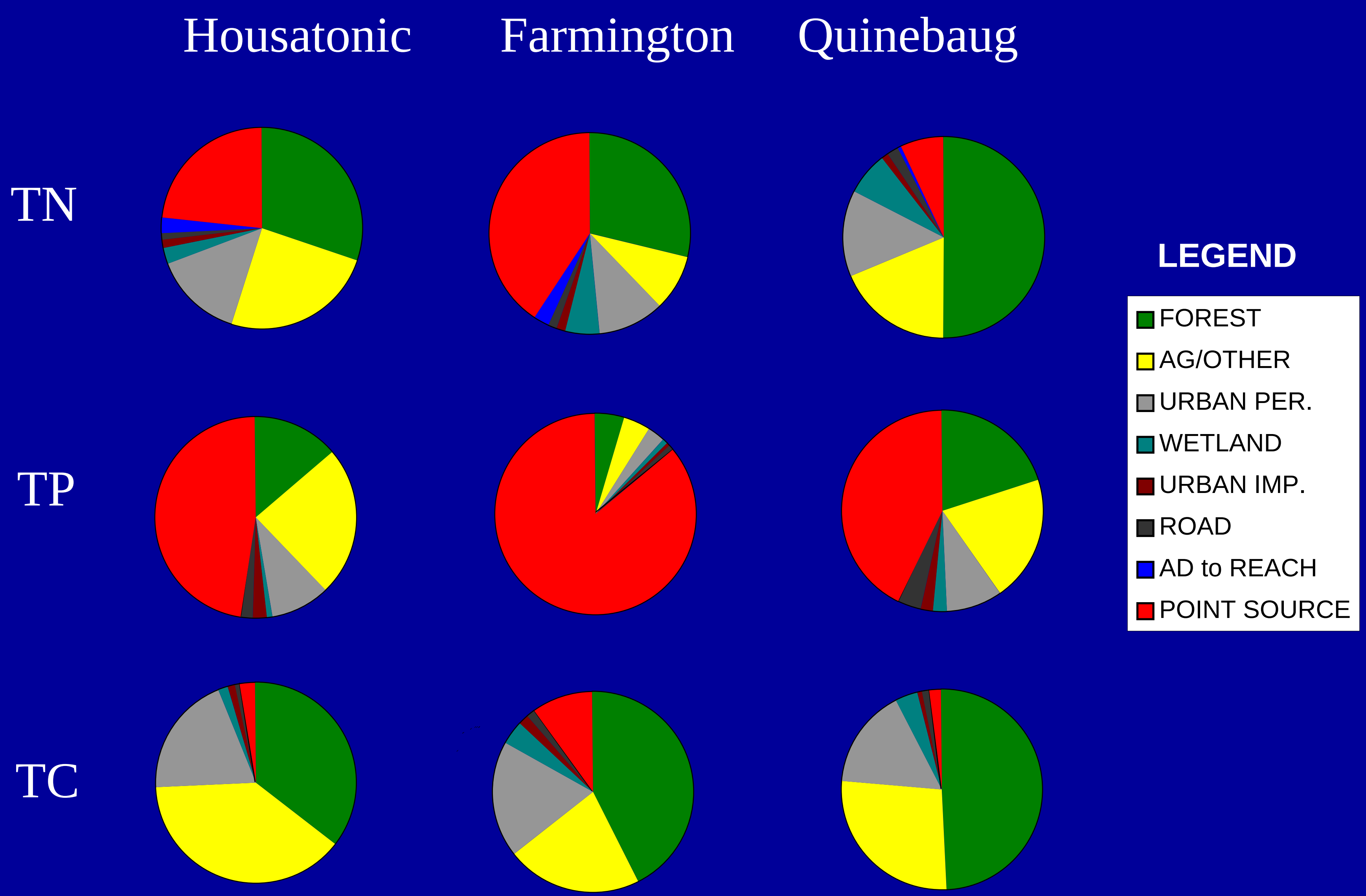
CTWM POINT VS. NONPOINT – TOTAL NITROGEN



PIE CHARTS FOR 3 TEST WATERSHEDS



PIE CHARTS FOR 3 CALIBRATION BASINS



CTWM SCENARIOS

- Base Conditions (1991-1995)
- 10% BMP Implementation
- 30% BMP Implementation
- 50% BMP Implementation
- 2020 Buildout
- Double (2X) 2020 Buildout
- Double (2X) 2020 Buildout plus 50% BMP Implementation

BMP MODULE

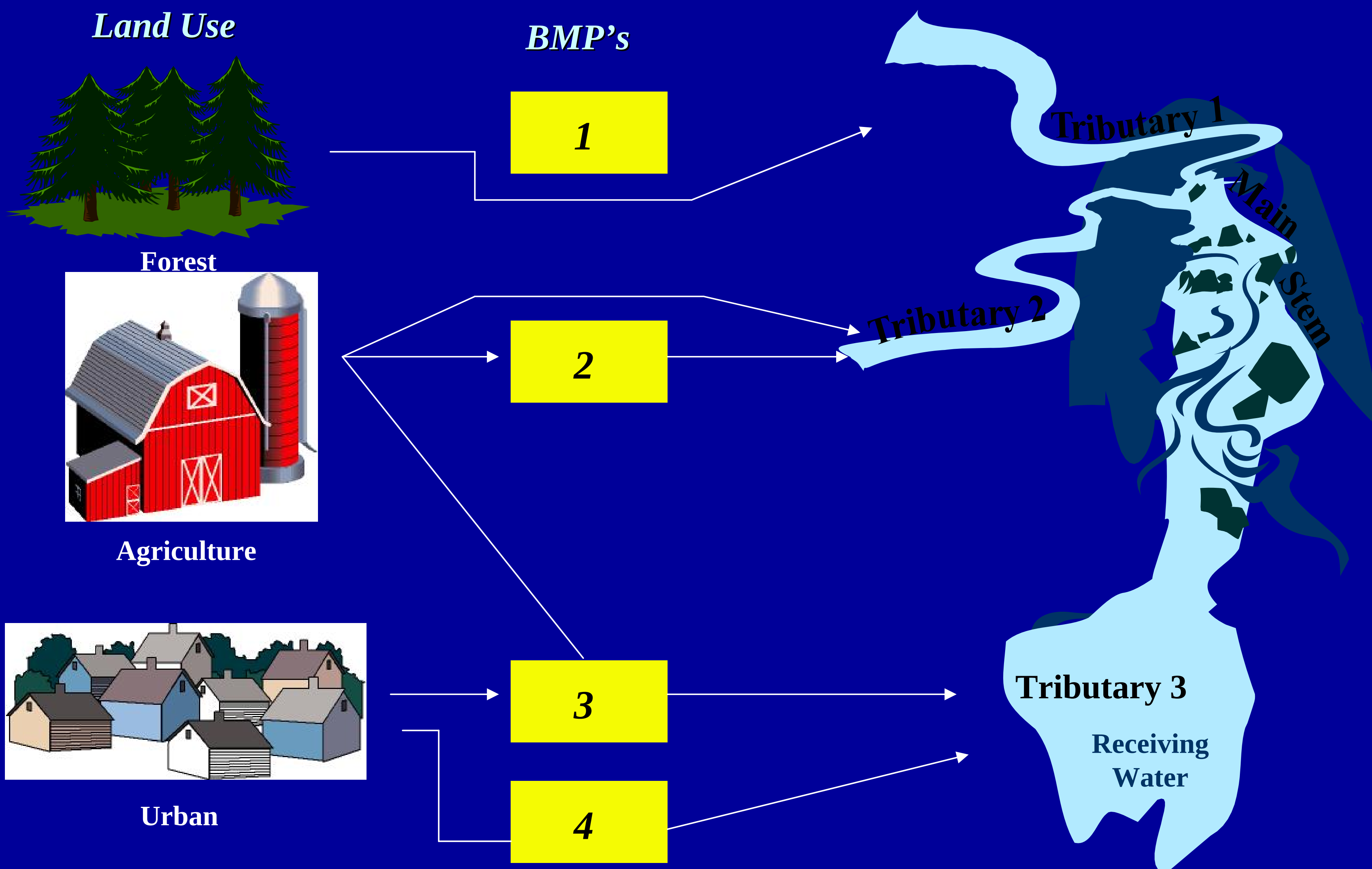
BMPs MODULE

- Built-in default parameter database with references
- Choice of using default numbers or user specified numbers
- Efficiency factors used for pollutant removal
- Removal efficiency input as constant or varying monthly
- Keeps track of pollutant removed

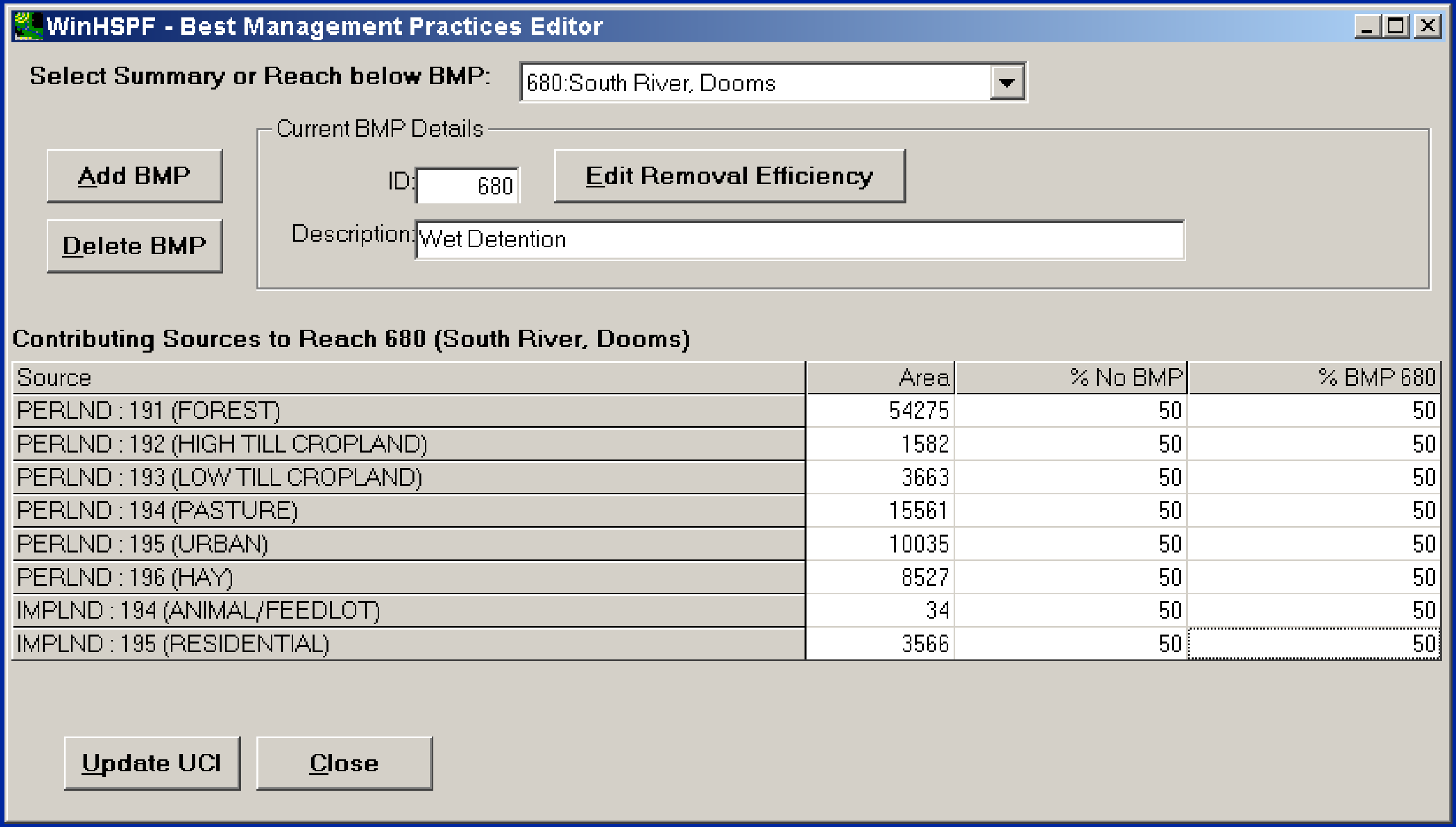
BMPs INCLUDED IN MODULE

- Changes in land use acreage's due to land use planning/management
- Wet detention pond
- Dry detention pond
- Vegetated swales and filter strips (various widths)
- Stream buffers (25 feet and 100 feet)
- User specified sediment and pollutant (nitrogen, phosphorous, BOD, fecal coliform, metals - copper, cadmium, and zinc) load reductions

HSPF BMP MODULE



SPECIFY BMP DETAILS



Source	Area	% No BMP	% BMP 680
PERLND : 191 (FOREST)	54275	50	50
PERLND : 192 (HIGH TILL CROPLAND)	1582	50	50
PERLND : 193 (LOW TILL CROPLAND)	3663	50	50
PERLND : 194 (PASTURE)	15561	50	50
PERLND : 195 (URBAN)	10035	50	50
PERLND : 196 (HAY)	8527	50	50
IMPLND : 194 (ANIMAL/FEEDLOT)	34	50	50
IMPLND : 195 (RESIDENTIAL)	3566	50	50

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SET BMP EFFICIENCY INFORMATION

WinHSPF - Best Management Practices Efficiency Editor

BMP Name: Wet Detention   BMP Operation # 680

Reference: Urban Drainage and Flood Control District - Denver, Colorado. Urban Storm Drainage Criteria Manual, Volume 3 - Best Management Practices, Stormwater Quality. September 1992.

Removal Fractions

Constituent	Fraction	DB Range	Reference
Sediment:Sand	0.	80%-90%	2
Sediment:Silt	0.	80%-90%	2
Sediment:Clay	0.	80%-90%	2
Fecal Coliforms:Solution	0.	50%-90%	9
Fecal Coliforms:Sand Assoc.	0.	50%-90%	9
Fecal Coliforms:Silt Assoc.	0.	50%-90%	9
Fecal Coliforms:Clay Assoc.	0.	50%-90%	9
BOD	0.	20%-40%	2
NO3:Solution	0.	30%-40%	2
TAM:Solution	0.	20%-30%	2
NO2:Solution	0.	30%-40%	2
PO4:Solution	0.	60%-70%	2
NH4:Sand Adsorbed	0.	20%-30%	2
NH4:Silt Adsorbed	0.	20%-30%	2
NH4:Clay Adsorbed	0.	20%-30%	2
PO4:Sand Adsorbed	0.	40%-50%	2
PO4:Silt Adsorbed	0.	40%-50%	2
PO4:Clay Adsorbed	0.	40%-50%	2
TDS	0.	20%-40%	2
Lead:Solution	0.	70%-80%	2

Update UCI   Close

CTWM SCENARIOS

- Base Conditions (1991-1995)
- 10% BMP Implementation
- 30% BMP Implementation
- 50% BMP Implementation
- 2020 Buildout
- Double (2X) 2020 Buildout
- Double (2X) 2020 Buildout plus 50% BMP Implementation

MODEL REPRESENTATION OF SCENARIOS

- Land use distributions for each model segment for the 2020 Buildout and 2X 2020 Buildout scenarios
- BMP removal efficiencies for urban and agricultural BMPs for all modeled constituents
- Model land use affected by the BMP implementation levels - 10%, 30%, 50%

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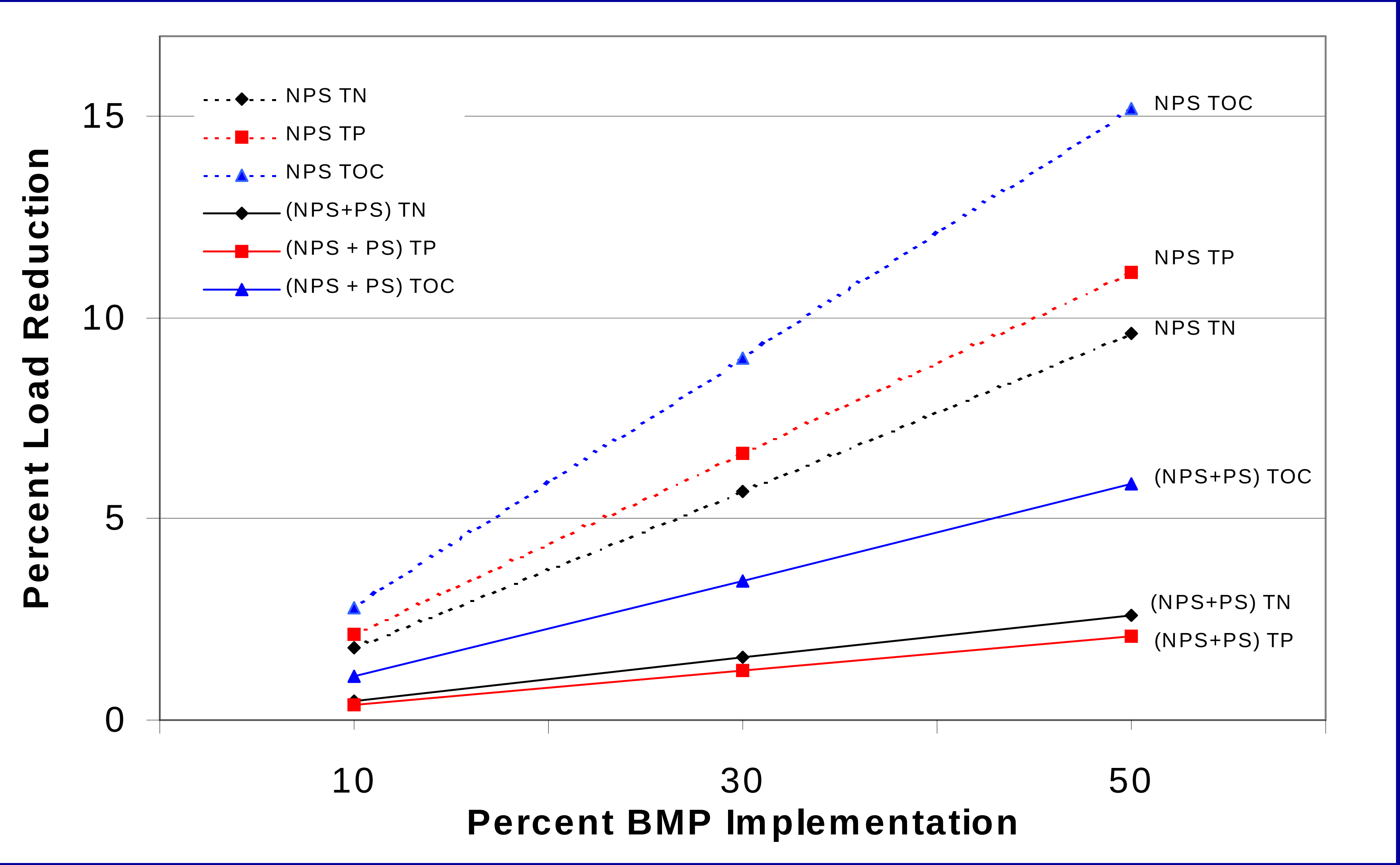
REMOVAL EFFICIENCY VALUES USED IN THE CTWM

Constituent	Removal Efficiency (%)
BODu	40%
NOx	35%
NH3	45%
PO4	50%
Organic N	55%
Organic P	55%
Organic C	55%

PERCENT CHANGE IN AVERAGE ANNUAL LOADS DELIVERED TO LIS FOR EACH OF THE CTWM SCENARIOS

Scenario	Total Nitrogen		Total Phosphorus		Total Organic Carbon	
	NPS	Total	NPS	Total	NPS	Total
10% BMP Implementation	-1.78	-0.48	-2.11	-0.39	-2.78	-1.07
30% BMP Implementation	-5.70	-1.54	-6.62	-1.23	-8.99	-3.46
50% BMP Implementation	-9.62	-2.59	-11.13	-2.07	-15.20	-5.85
2020 Buildout	1.38	0.37	1.38	0.26	1.72	0.66
Double 2(X) 2020 Buildout	2.56	0.69	2.53	0.47	3.09	1.19
Double 2(X) 2020 Buildout plus 50% BMP Implemetation	-7.90	-2.10	-9.40	-1.70	-13.40	-5.20

RELATIONSHIP BETWEEN PERCENT REDUCTION IN LOADS DELIVERED TO LIS AND PERCENT BMP IMPLEMENTATION ON URBAN AND AGRICULTURAL LAND



CTWM SUMMARY CONCLUSIONS

- **NPS reductions are relatively small, <15%, for all BMP scenarios. However, this is consistent with expectations. Larger reductions would require increased area treated, increased removal efficiencies, or extending BMPs to other land uses.**
- **Largest reductions are for TOC, TP, and TN, in that order. Order is due to assumed removal efficiencies, loading rates, delivery processes, and sources.**
- **Significant differences in NPS impacts among CT Management Zones.**
- **Urban buildout scenarios show an almost linear impact on NPS loading rates. Increases are small due to limited potential for buildout and relatively small state-wide urban fraction. Reasonable BMP implementation levels can offset growth impacts.**
- **CTWM and associated spreadsheet tool can be used for watershed and statewide planning-level assessments of BMPs and TMDL development.**

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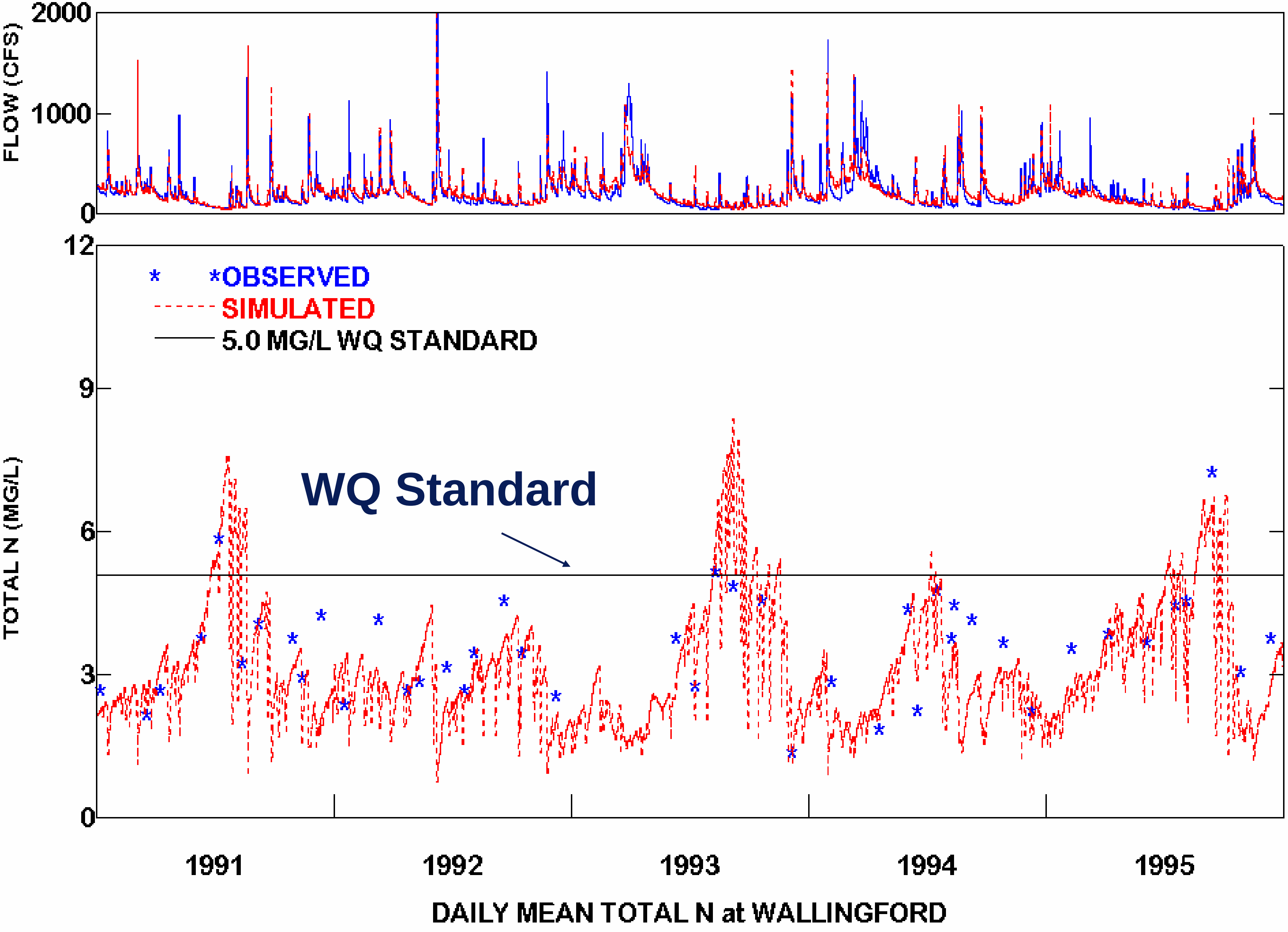
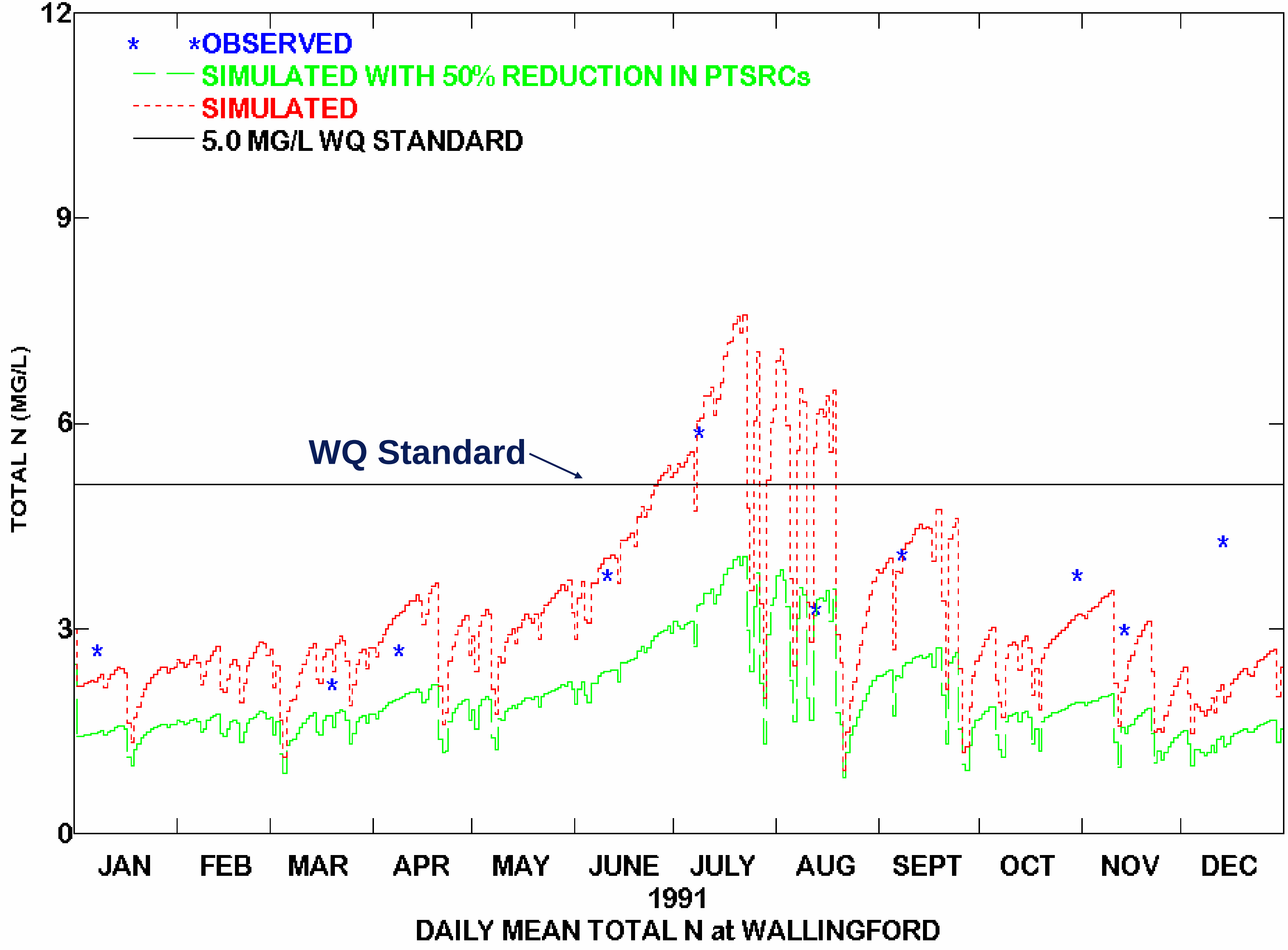
SAMPLE TMDL CALCULATION

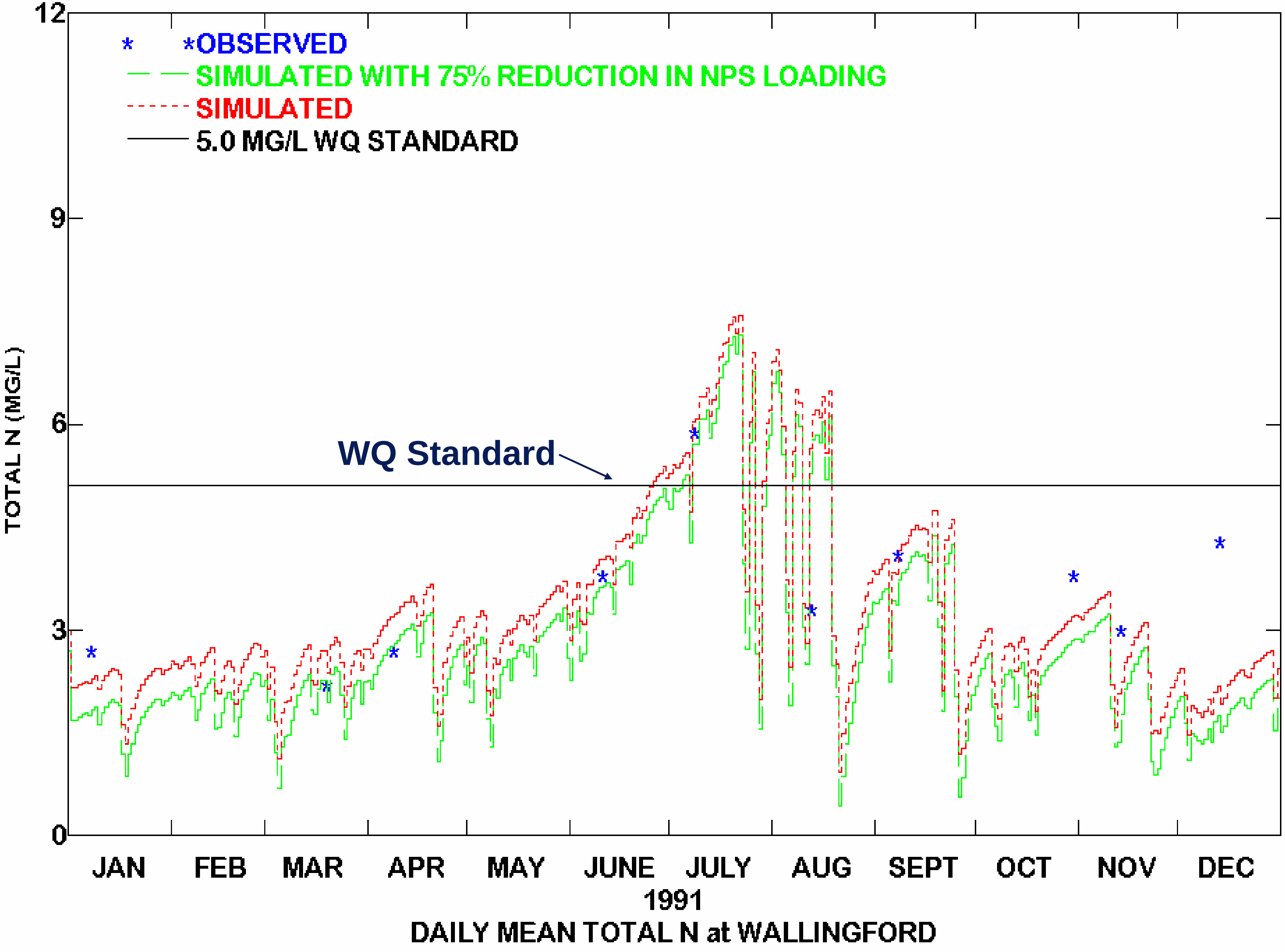
SAMPLE MODEL CALIBRATION RESULTS FOR TOTAL N



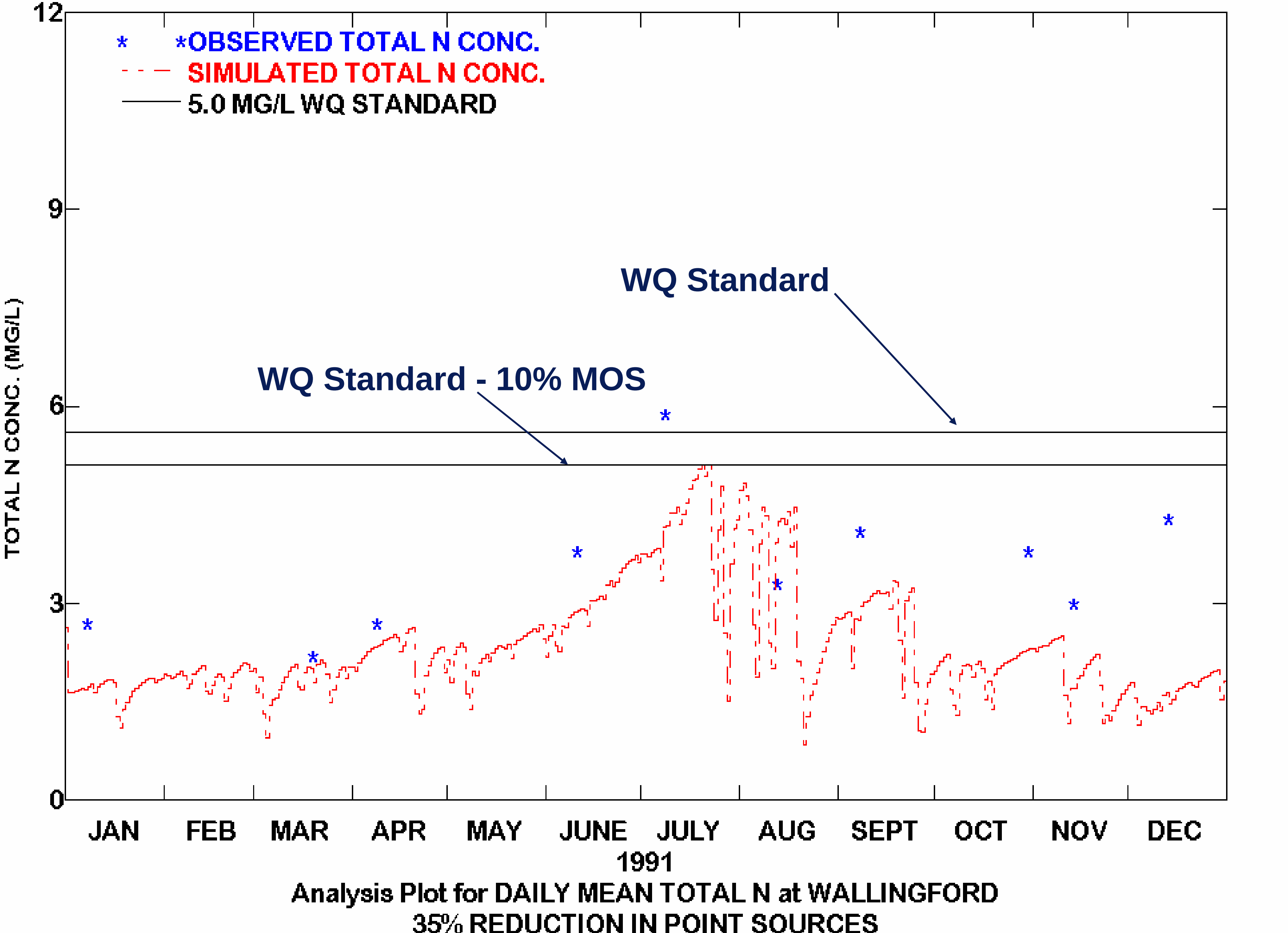
SAMPLE: IMPACTS OF POINT SOURCE REDUCTION



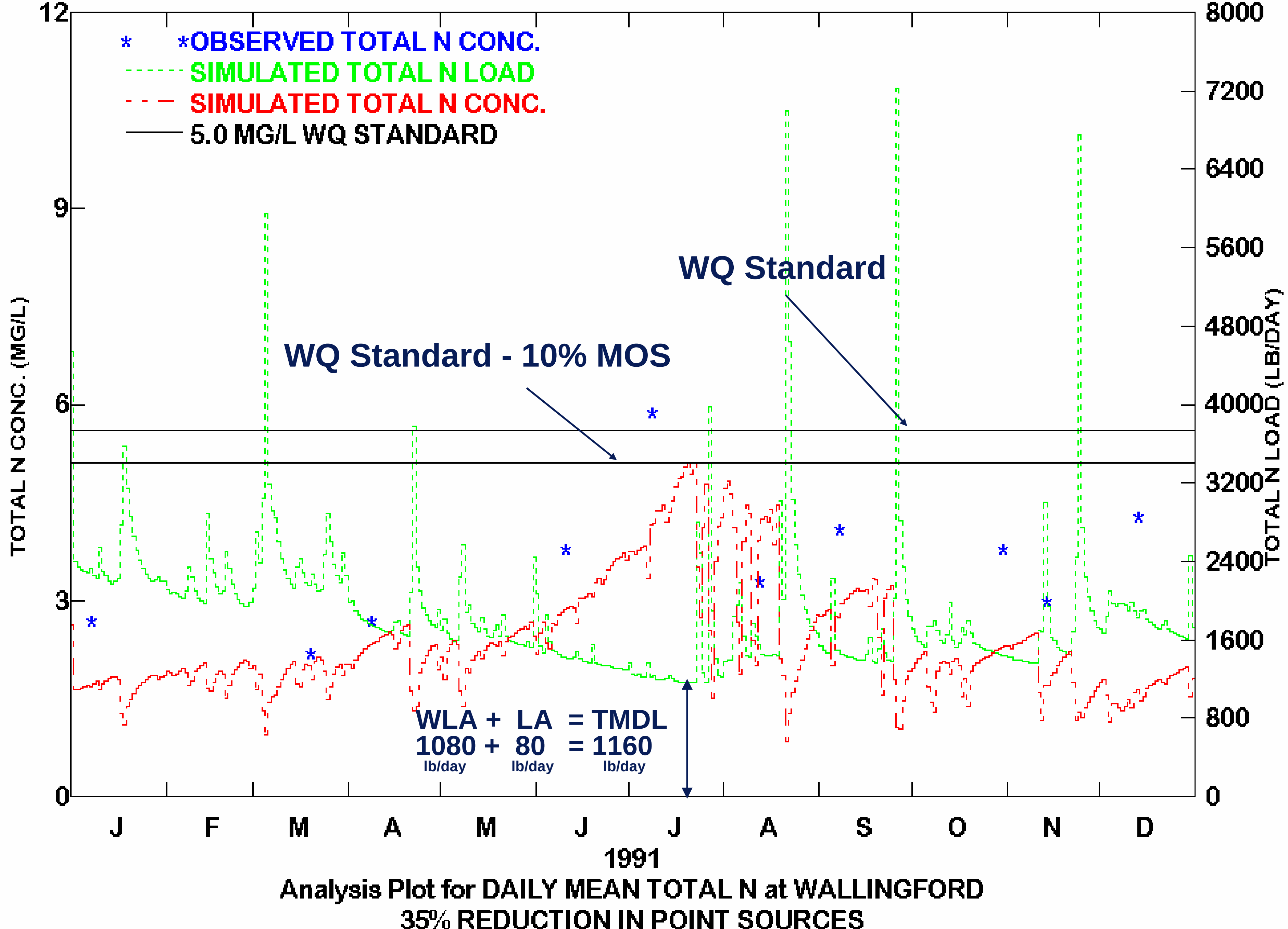
SAMPLE: IMPACTS OF NONPOINT SOURCE REDUCTION



SAMPLE TMDL DETERMINATION



SAMPLE TMDL DETERMINATION



HSPF APPLICATION TO THE ARROYO SIMI WATERSHED

VENTURA COUNTY, SOUTHERN CA

HSPF APPLICATION TO THE ARROYO SIMI WATERSHED VENTURA COUNTY, SOUTHERN CA

STUDY OBJECTIVES

- **Develop hydrologic model of watershed**
- **Assess potential urbanization impacts**
- **Assess impacts of detention on flows and flood peaks**
- **Provide tool for TMDLS, hydrograph modification, urban stream erosion assessment (ongoing efforts)**

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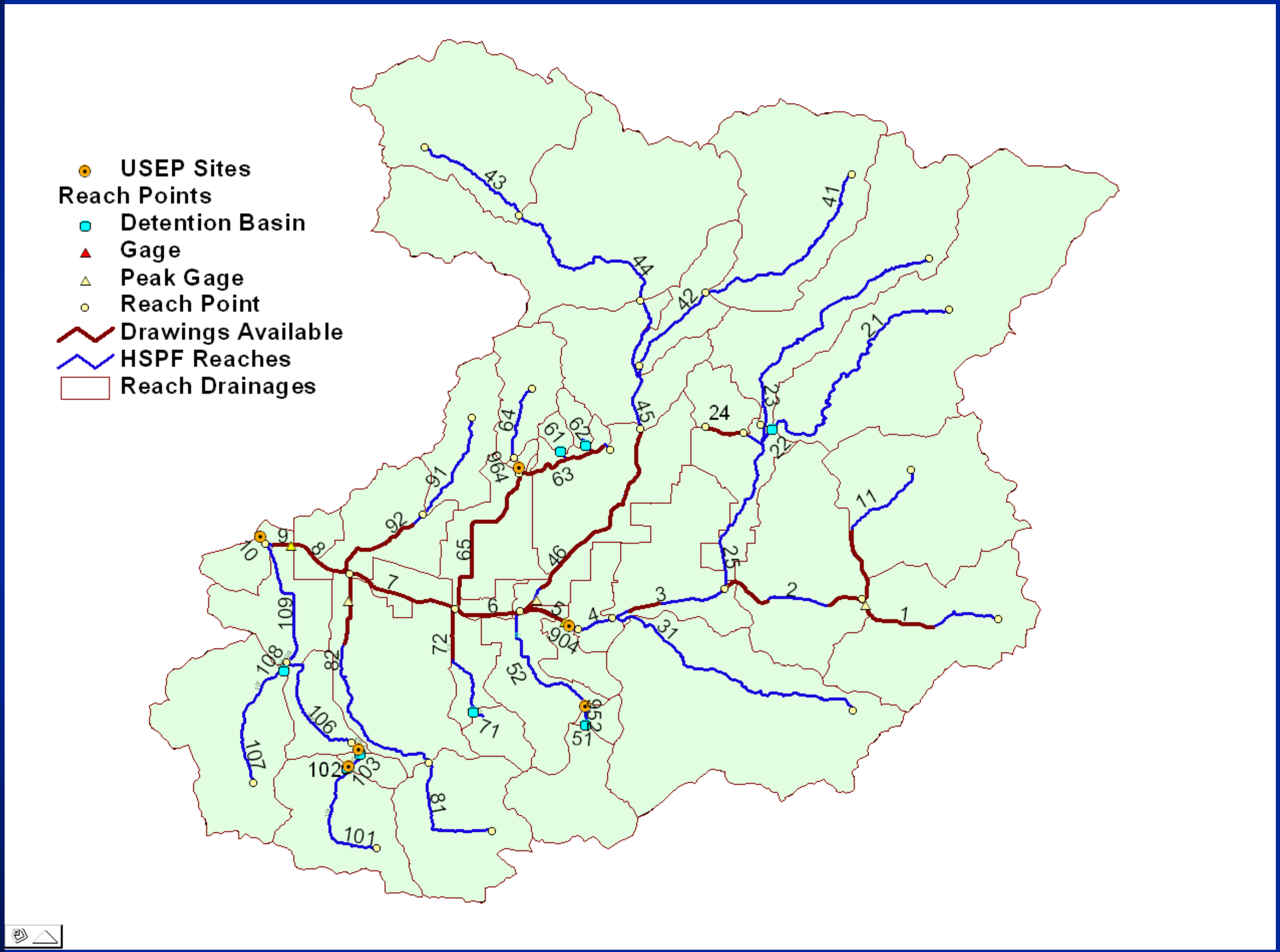
LOCATION OF ARROYO SIMI WATERSHED

REACH SEGMENTATION



SCENARIOS

- **Natural, Pre-development**
- **10% increase in urban fringe areas**
- **30% increase in urban fringe areas**
- **50% increase in urban fringe areas**
- **Detention Basins implemented with 50% increase in urban fringe areas**

NATURAL CONDITIONS

1. Removed all timeseries representing **groundwater pumping and dewatering**, which contributed to the mainstem below Royal.

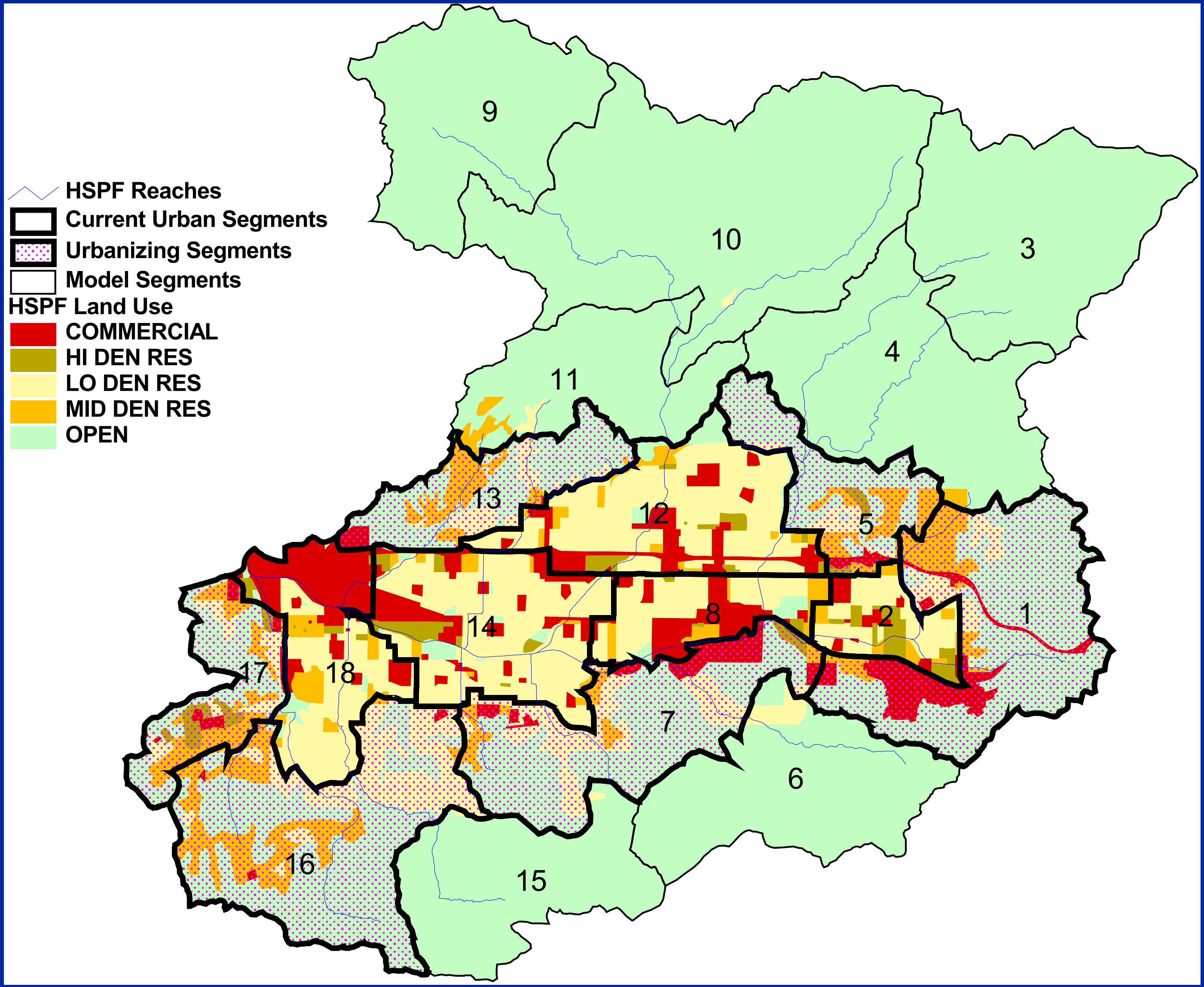
2. Removed all **irrigation inputs** for landscape watering.

3. Removed all **detention and debris basins** included within the Baseline setup, including Las Llagas, Runkle, Tapo 1 and 2, Erringer, and Sycamore. Oak Canyon basins were not constructed until after the calibration period, and therefore were not included in the Baseline model.

4. Eliminated any **impervious areas**, which were reassigned pervious land parameter values.

5. Assigned **model parameters** for the OPEN land use category to all the urban categories, except for physical characteristics such as slope, overland flow length, etc. which remained unchanged. This included parameters related to surface roughness, vegetal interception and ET, soil moisture storages (upper zone), and interflow.

LAND USE FOR BASELINE/CURRENT AND URBAN SEGMENT BOUNDARIES



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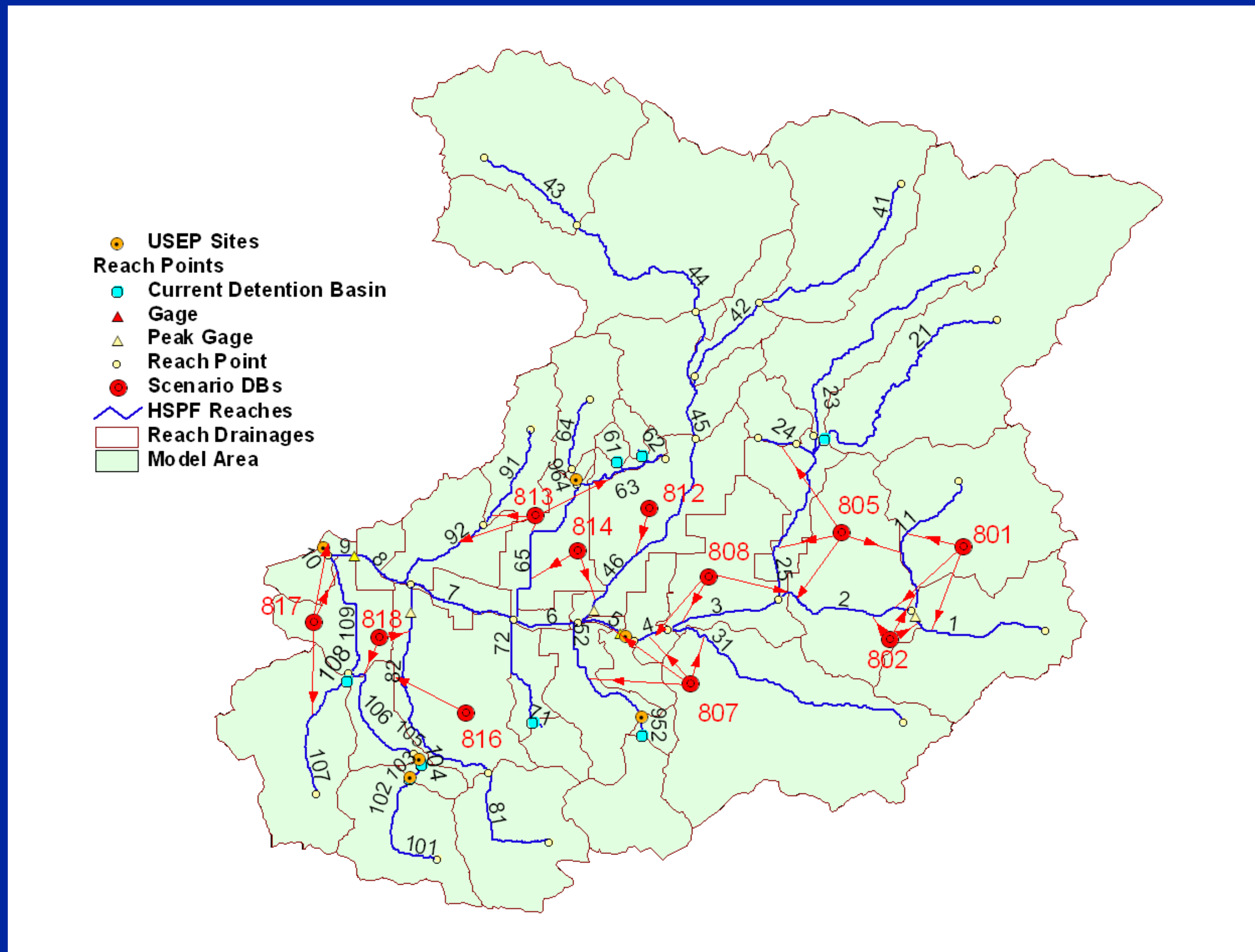
LAND USE FOR BASELINE AND URBANIZATION SCENARIOS

	Base Condition			10% Increase			30% Increase			50% Increase		
	Open	**Urban**	**Total**	**Open**	**Urban**	**Total**	**Open**	**Urban**	**Total**	**Open**	**Urban**	**Total**
Total Area (Acres)	34,898	15,094	50,179	34,313	15,866	50,179	33,143	17,036	50,179	31,972	18,206	50,179
% of Watershed	69.5%	**30.1%**	100.0%	68.4%	**31.6%**	100.0%	66.0%	**34.0%**	100.0%	63.7%	**36.3%**	100.0%
% EIA		**6.7%**			**7.0%**			**7.5%**			**7.9%**	

GENERALIZED LOCATIONS OF SCENARIO DETENTION BASINS



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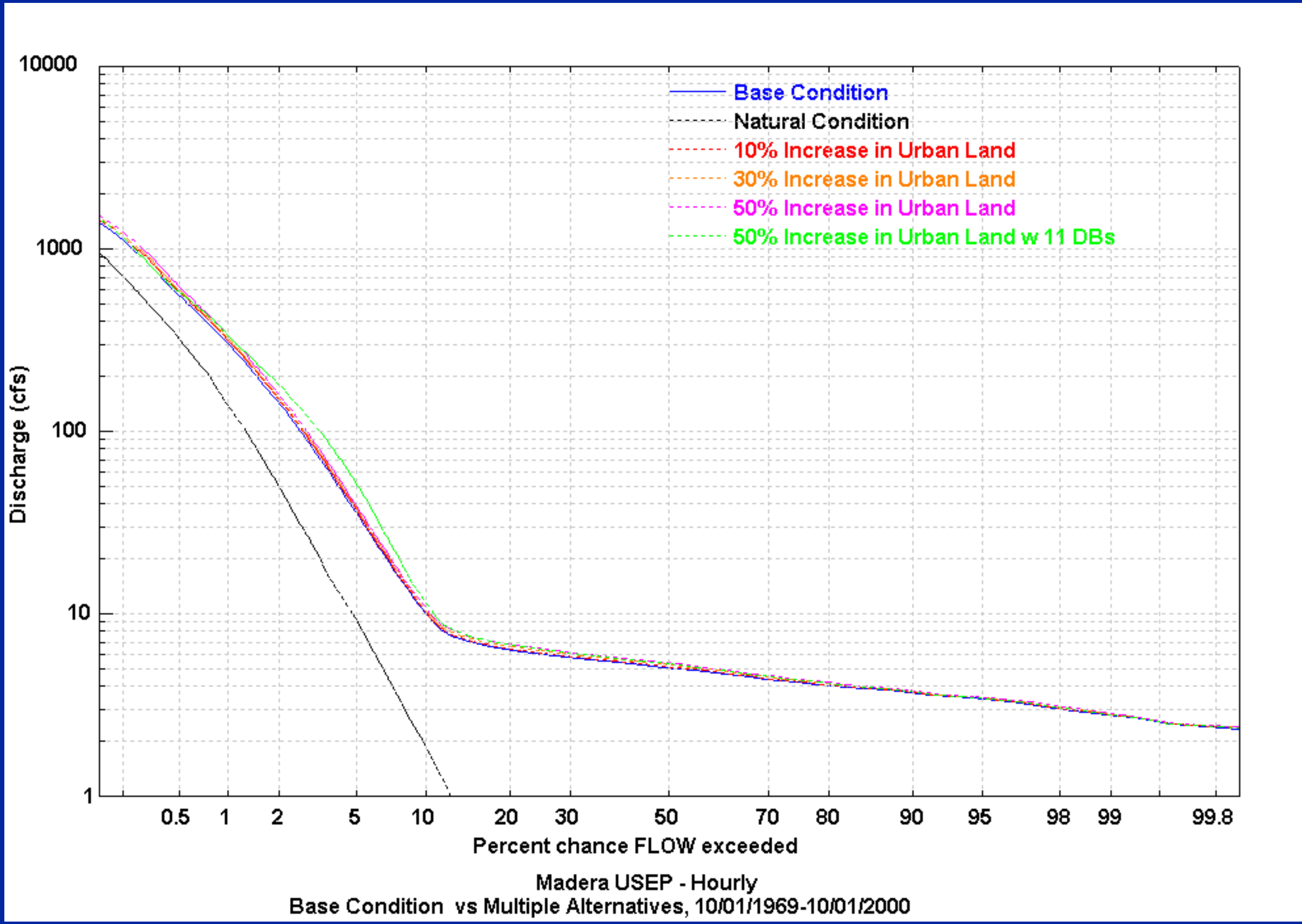
FLOW DURATION CURVES FOR MADERA USEP SITE FOR ALL SCENARIOS



STORM PEAK FLOWS (CFS) FOR ALL SCENARIOS BASED ON LOG PEARSON TYPE III ANALYSES

		Scenario						
Location	Return Period, yr	Natural	Base	+10% Urban	+30% Urban	+50% Urban	+50% Urban w 11 DBs	Observed
ROYAL	2	98	991	1031	1111	1195	514	1256
	5	1389	2359	2425	2555	2691	1480	2646
	10	4991	3776	3852	4004	4166	2628	3915
MADERA	2	213	1677	1810	1856	1964	1044	2199
	5	1867	4024	4225	4317	4491	2770	4418
	10	5744	6515	6734	6869	7081	4741	6431
RUNKLE CANYON	2	2	3	3	3	3	3	
	5	23	17	17	17	17	17	
	10	88	48	48	48	48	48	
DRY CANYON	2	1	13	14	16	18	18	
	5	13	58	61	67	73	73	
	10	48	129	134	144	155	155	
OAK CANYON #1	2	2	71	79	93	107	107	
	5	15	159	172	199	225	225	
	10	53	244	262	297	333	333	
OAK CANYON #2	2	2	63	69	83	96	24	
	5	15	140	152	176	200	70	
	10	49	216	232	264	296	126	

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WALNUT CREEK WATERSHED, IOWA

Agricultural Management Systems Evaluation Area (MSEA) Study

Joint USDA/ARS – EPA Effort

WALNUT CREEK WATERSHED, IOWA

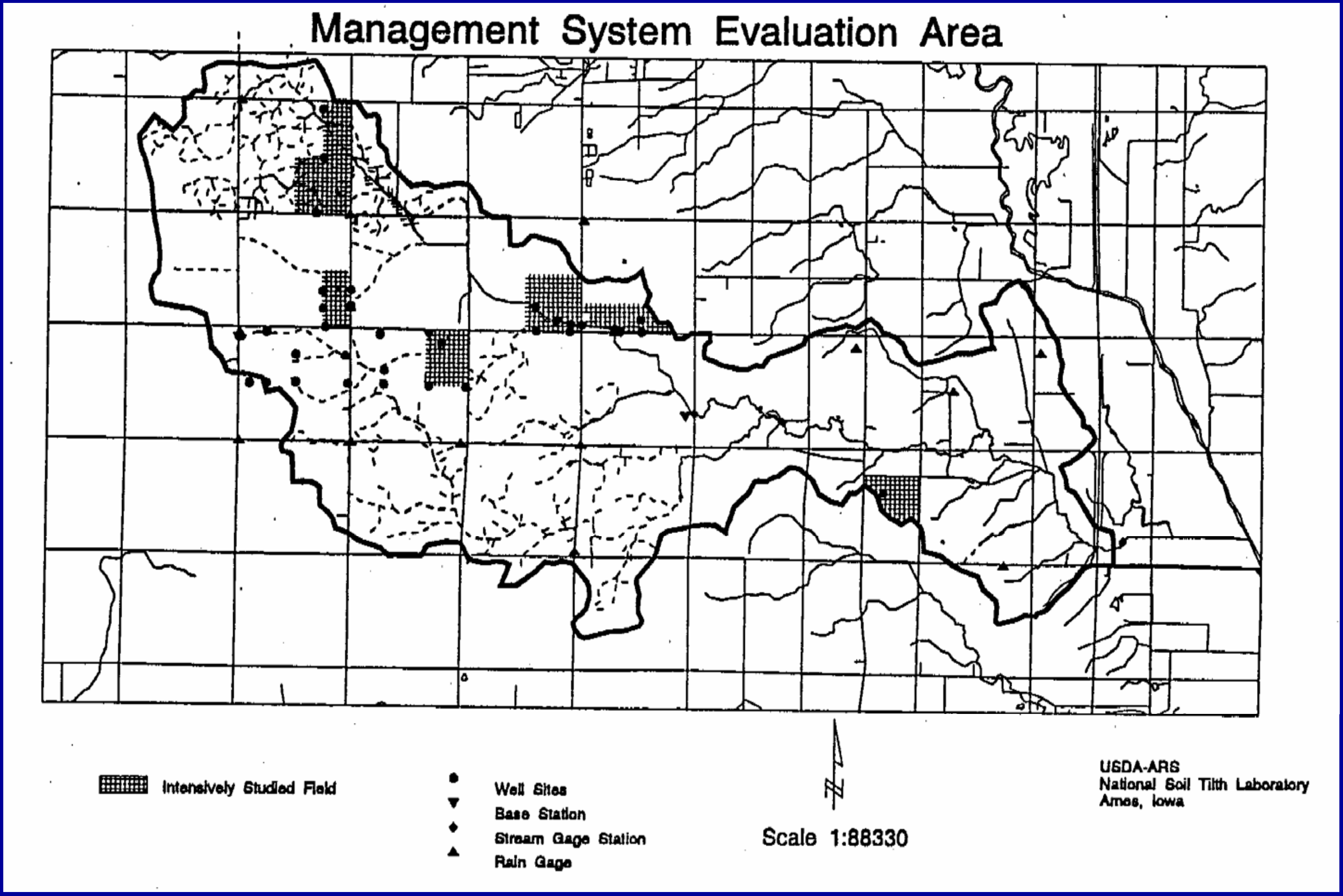


Table 3.3 Relative Impact of Selected BMP's on HSPF Parameters

MANAGEMENT PRACTICE[1]	Runoff Related									Sediment Related							Chemical Related								Soil Related		
	CEPSC (M)	UZSN (M)	LSUR	SLSUR	NSUR (M)	INFILT	INTFW (M)	LZETP (M)	SNOWCF	COVER (M)	KRER	SMFP	KSER	KGER	DETS - Tillage	AFFIX	SPS - Surface Chemical	UPS - UpperZone Chemical	Nutrient Input Surface Layer	Nutrient Input Upperzone	Adsorption/Desorption	Biochemical Transformation Rates	Nutrient Uptake Rate by Plants (M)	Pesticide (M) Degradation Rate	Soil Temperature	Soil Depths	Bulk Density
Nonstructural Measures																											
1. No Tillage	+	+	0	0	+	+	0?	−	+[7]	+	−,0	−,0	−	−	−	−0	+[8]	+[8]	+[8]	+[8]	+	−?	0?	0?	−+	?	+
2. Conservation Tillage	+	+	0	0	+	+	0?	0	+[7]	+	−,0	−,0	−	−	−	−0	+[8]	+	+	+	+	−?	0	0	−+	?	+
3. Contour Farming	0	+	0	0	0	0	+?	0	0	0	0	−	−0	−	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Graded Rows	0	0	+	−	0	0	0	0	0	0	0	−	−	−	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Contour Strip Cropping[2]	0	+	0	0	+?	+	+	0?	0	+,−	0	−	−	−	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Spring Plowing[3]	+	+	0	0	−?	−?	+	0	0?	−	0	0	0−	0−	0	?	0	0	0	0	0	0	0	0	−?	0	0
7. Sod-Based Rotation[4]	+,−	+	0	0	+	+	0?	+	0	+	−	0	−	−	−	?	−	−	−	−	+?	0	−	?	0	?	+
8. Winter Crop Cover	+	0,+	0	0	+	+	0	0	+	+	−?0	0	−	−	0?	0?	0	0	+	+	+?	0	+	?	0	0	0
9. Permanent Meadow	+,−	+	0	0	+	+	0	+	+	+	−?0	0	−	−	−?	0	−	−	−	−	0?	0	+?	?	−,+	?	+
10. Mechanical Cultivation	0	+	0	0	+	+	+	+,0	0	0	+,0	0	+,0	0	+	+,0	−	−	0	0	0?	+,−	0	?	+?	?	−?
11. Crop Rotation	+,−	0	0	0	0	0	0	+?	0	+,−	0	−0	0,−?	0	0	0	0−	0−	−	−	0	0	0	0	0	0	0
Structural Measures																											
1. Terraces	0	+	+	0	0	+	+	0	0	0	0	−	0−	−	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Diversions	0	0	+	0	0	−	0	0	0	0	0	0	0−	−	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Grassed Waterways[5]	−,+	+	0	0	+	+	0	0	0	+,−	−	0	−	−	−	0	−	−	−	−	0?	0	0?	0	0?	0?	+?
4. Filter Strips[6]	−,+	+	0	0	0	+	+	0	0	+,−	−	0	−	−	−	0	−	−	−	−	0?	0	0?	0	0?	0?	+?
5. Tile Drainage	0	0	0	0	0	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+?	0	0	0	0	0
6. Retention Basins	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Input Management Options																											
1. Improve Soil Fertility	+	+	0	0	0	+	−,0	+,0	+,?	+,0	−,0	0	0	0	0	0	0	0	0,−	0 −	+?	+	+	0?	0	0	?
2. Eliminate Excessive Applications	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−	−	−	−	0	0	0	0	0	0	0
3. Optimize Timing of Planting and Chemical Applications	0	0	0	0	0	0	0	0	0	+	−	0	0	0	0	0	−	−	−	−	0	0	+?	0	0	0	0
4. Control Release and Transformation Rates	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	−	−	0	+ −	+,−	?	0	0	0
5. Biological Control	0	0	0	0	0	0	0	+?	0	0	−0	0	0	0	0	0	−	−	0	0	0	0	0	0	0	0	0
6. Incorporate Applied Chemicals	0	+	0	0	+	+	+	+	0	0	+0	0	+	0	+	+0	−	+	−	+	0?	+,?	+	+ −	+?	?	−?

Footnotes to Management Practice Vs. HSPF Parameter Matrix

1. Many practices have effects which are time-dependent because they are applied in different seasons of the year. Comparisons indicate overall long term deviations from base conditions.
2. Parameter changes are considered only within the strips of grass or close-growing crops growing between the cultivated crops.
3. The overall effects of shifting plowing from fall to spring are considered.
4. Parameter changes are considered for the sod year only.
5. Parameter changes are considered only within the grassed waterway.
6. Parameter changes are considered only within the filter strips.
7. Crop residues catch drifting snow which can be represented by increasing SNOWCF.
8. Decrease in incorporation of chemicals into the soil results in an increase in surface availability. Also, nutrient leaching from crop residues can increase nutrient availability from the base condition

LEGEND

+ = increases parameter with respect to conventional practices

− = decreases parameter with respect to conventional practices

0 = does not result in effects significantly different than those of conventional practices

ALTERNATE SCENARIOS FOR WALNUT CREEK

Baseline Conditions: Current Practices (i.e. MASTER Farming System # 2)

- Corn-soybean rotation
- Fall Chisel plow, residues remain
- Atrazine applied @ 0.4 kg a.i./ha, and Metolachlor applied @ 1.12 kg a.i./ha
- Corn land treated at 61% with Atrazine, and 53% with Metolachlor
- Spring fertilizer application @ 209 kg N/ha, on corn only (100%) (31 kgN/ha urea applied and incorporated on 3/21, and 178 kgN/ha anhydrous NH_3 knifed in on 4/15)

Historical Conditions: Condition/Practices in 1960/70 (i.e. MASTER Farming System #1)

- Continuous corn (on all current cropland)
- Fall Moldboard plow; no residues remain
- Atrazine applied @ 3.36 kg a.i./ha; Metolachlor @ 2.24 kg a.i./ha
- Corn area treated at same levels as Baseline, for both pesticides and N fertilizer
- Fall fertilizer application @ 152 kgN/ha, spread and incorporated

Potential BMP Plan: Following Practices applied to Current (Baseline) Scenario

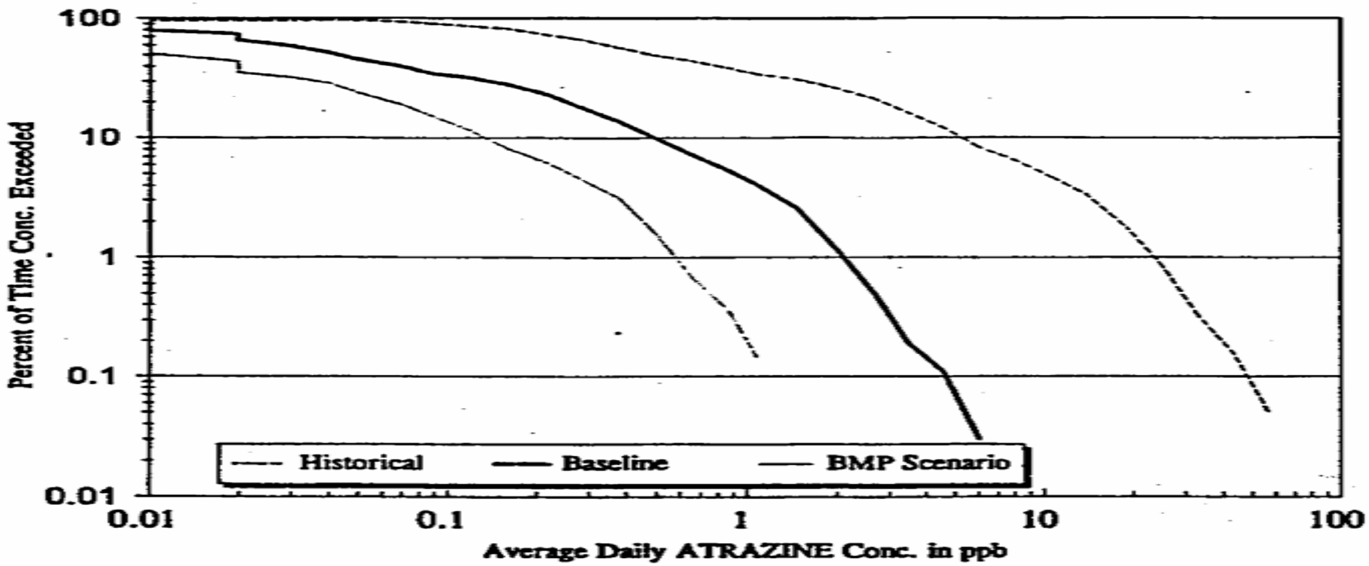
- MASTER Farming System No. 4: Crop Rotation - corn, soybeans, oats, meadow; 25% of crop land area planted in each crop.

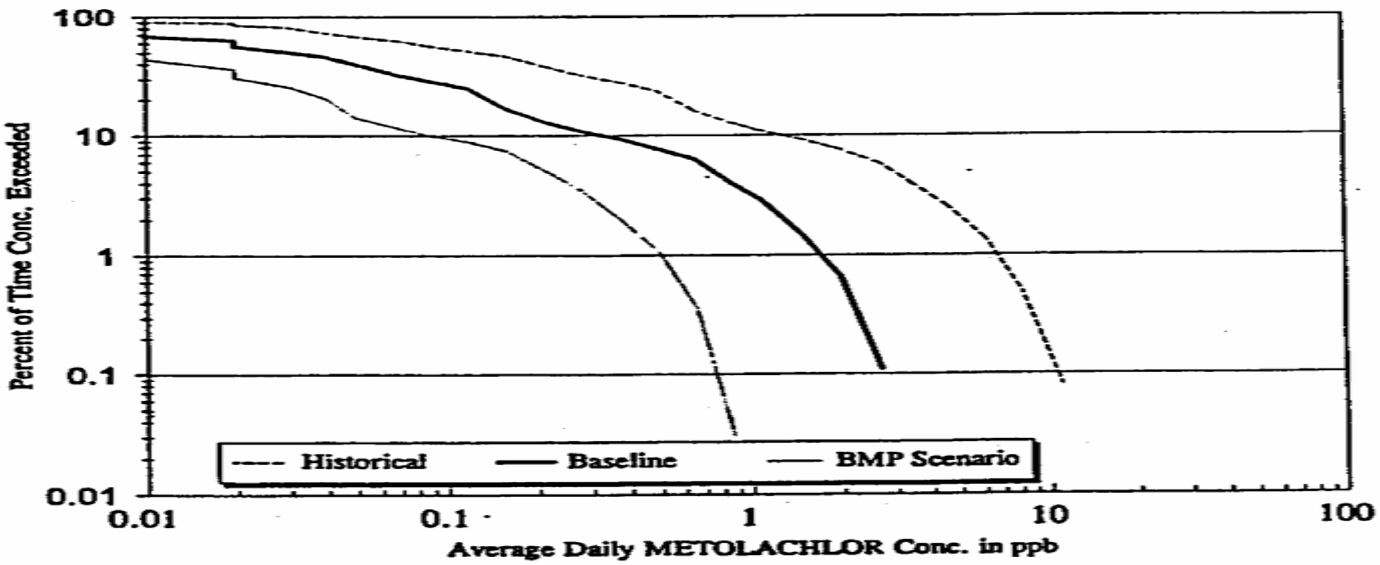
- Riparian buffer strips & grass water ways - represented by an 80% reduction in sediment and surface runoff pesticide and nitrogen loads (based on literature summary by Fawcett and Christiansen (1992)), and 40% reduction in shallow subsurface (Interflow) loads.

- No change to Baseline pesticide application rates.

- Split fertilizer applications @ 140 kgN/ha: 25% at planting, 50% at 4 weeks, and 25% at 8 weeks with anhydrous NH_3 knifed-in.

FREQUENCY ANALYSIS FOR ATRAZINE AND METOLACHLOR FOR ALL SCENARIOS





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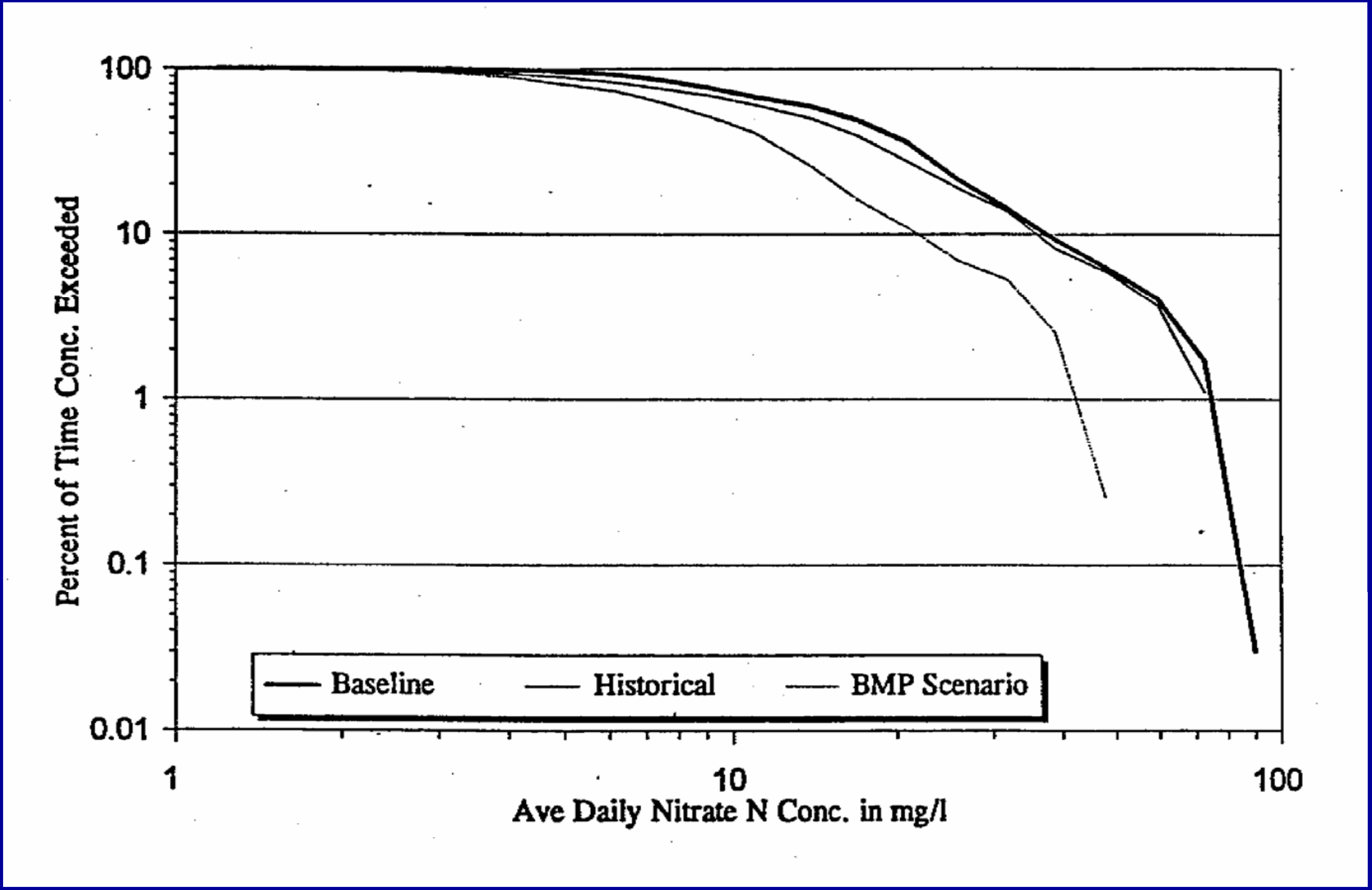
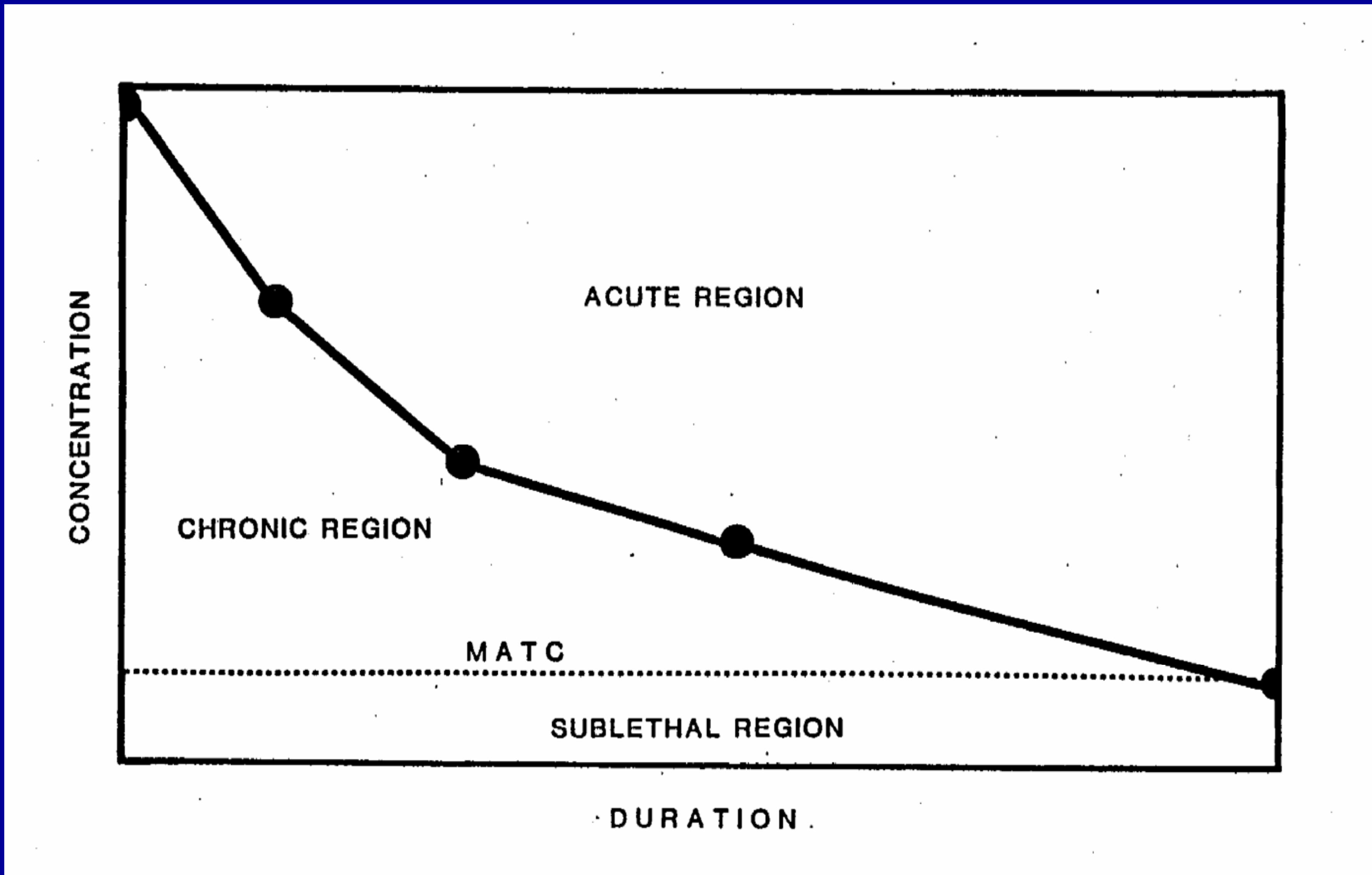
FREQUENCY ANALYSIS OF NITRATE FOR ALL SCENARIOS



LETHALITY ANALYSIS OF CHEMICAL CONCENTRATION DATA



PERCENT OF TIME DAILY PESTICIDE AND NO_3-N CONCENTRATIONS ARE EXCEEDED FOR ALTERNATIVE WALNUT CREEK SCENARIOS (Based on 10-year simulations)

Chemical/ Concentrations	HISTORICAL	BASELINE	BMP
Atrazine			
0.1 ppb	89.2	33.9	14.0
1.0 ppb	36.1	4.6	0.2
3.0 ppb	19.6	0.4	0.0
Metolachlor			
0.05 ppb	68.1	40.3	14.4
0.1 ppb	54.7	27.3	9.6
1.0 ppb	11.7	3.4	0.01
NO_3-N			
5.0 mg/l	90.4	97.3	82.7
10.0 mg/l	66.7	74.0	47.3
20.0 mg/l	31.2	39.7	12.0

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