

New methods for wetland water budgeting: WetBud

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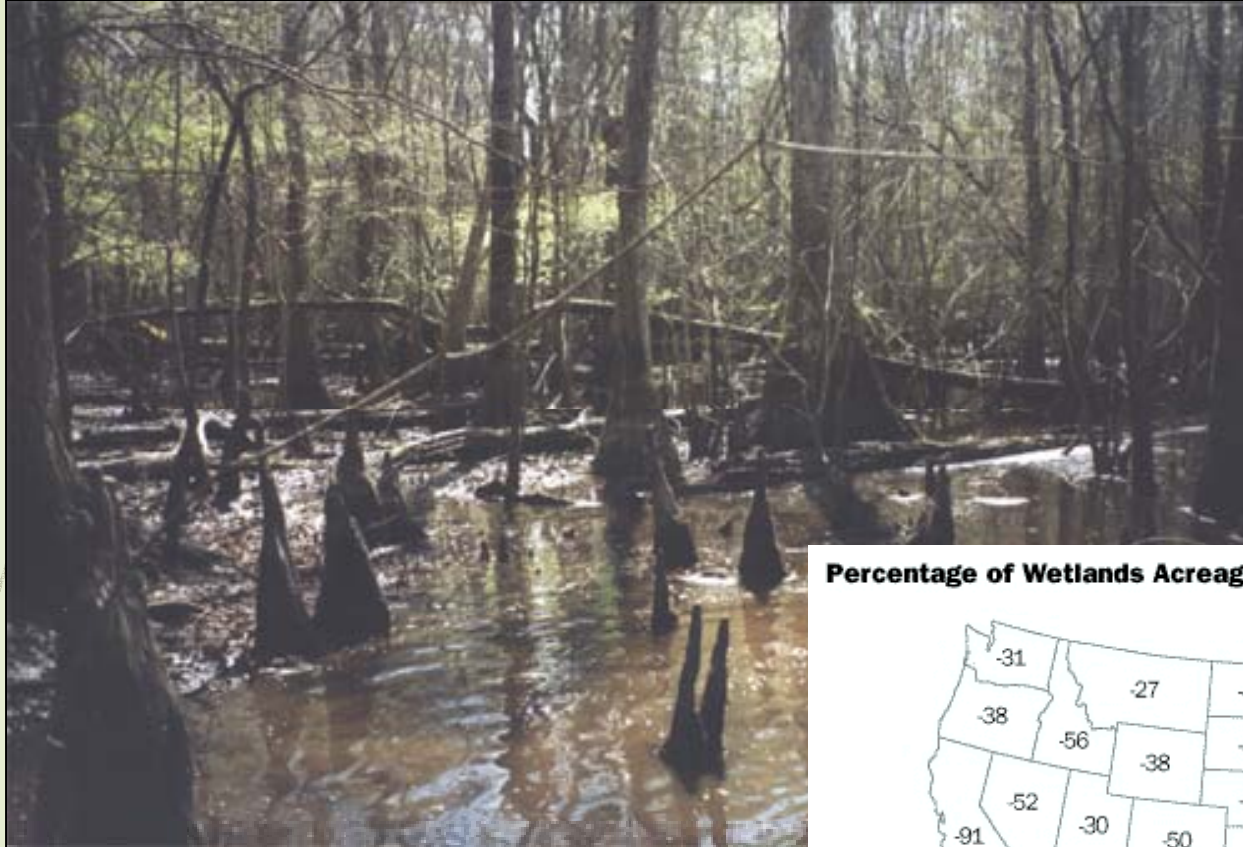
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Candice Piercy, **Tracy Thornton**, **Cal Smith**

Topics

1. Background
2. Initial Studies
3. WetBud Capabilities
and Interface
4. Verification Studies

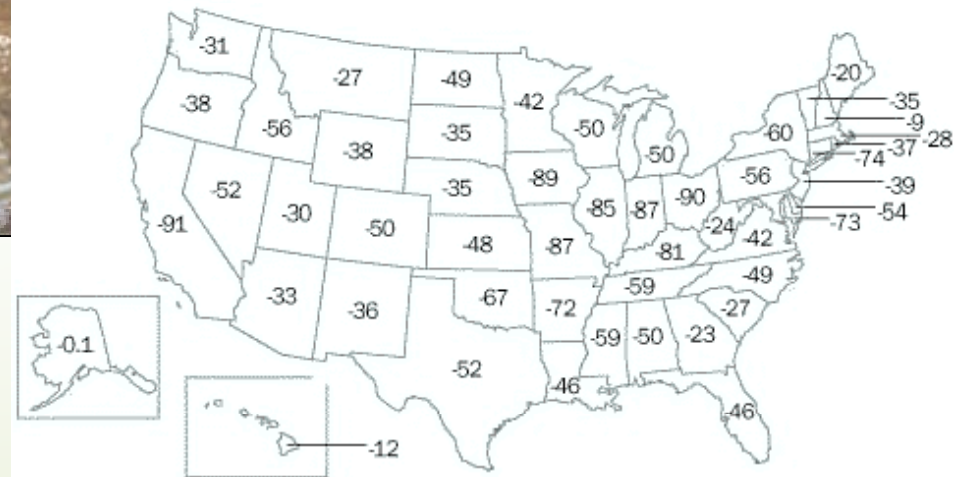
Wetlands provide habitat, improve water quality, control erosion, and store flood water



Since the 1780's, about 53% of all US wetlands have been lost

(Dahl, 2000)

Percentage of Wetlands Acreage Lost, 1780's-1980's



from Mitch and Gosselink, 1993

Wetland restoration and creation can help offset the effects of wetland loss

South Florida Water District – 62.5% of projects exhibited hydrologic problems

Erwin (1991)

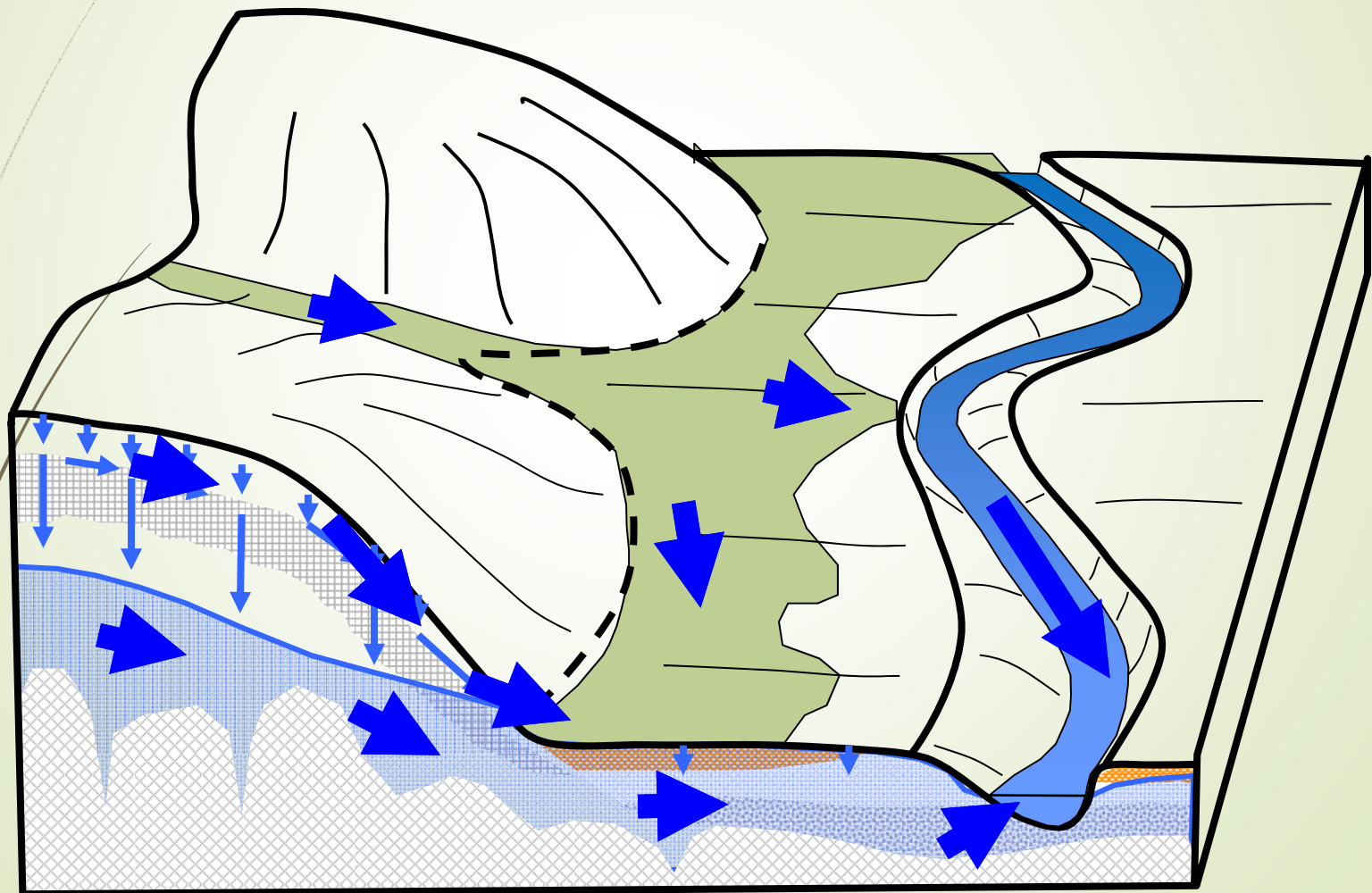


from Dahl, 2000 (US Fish and Wildlife)

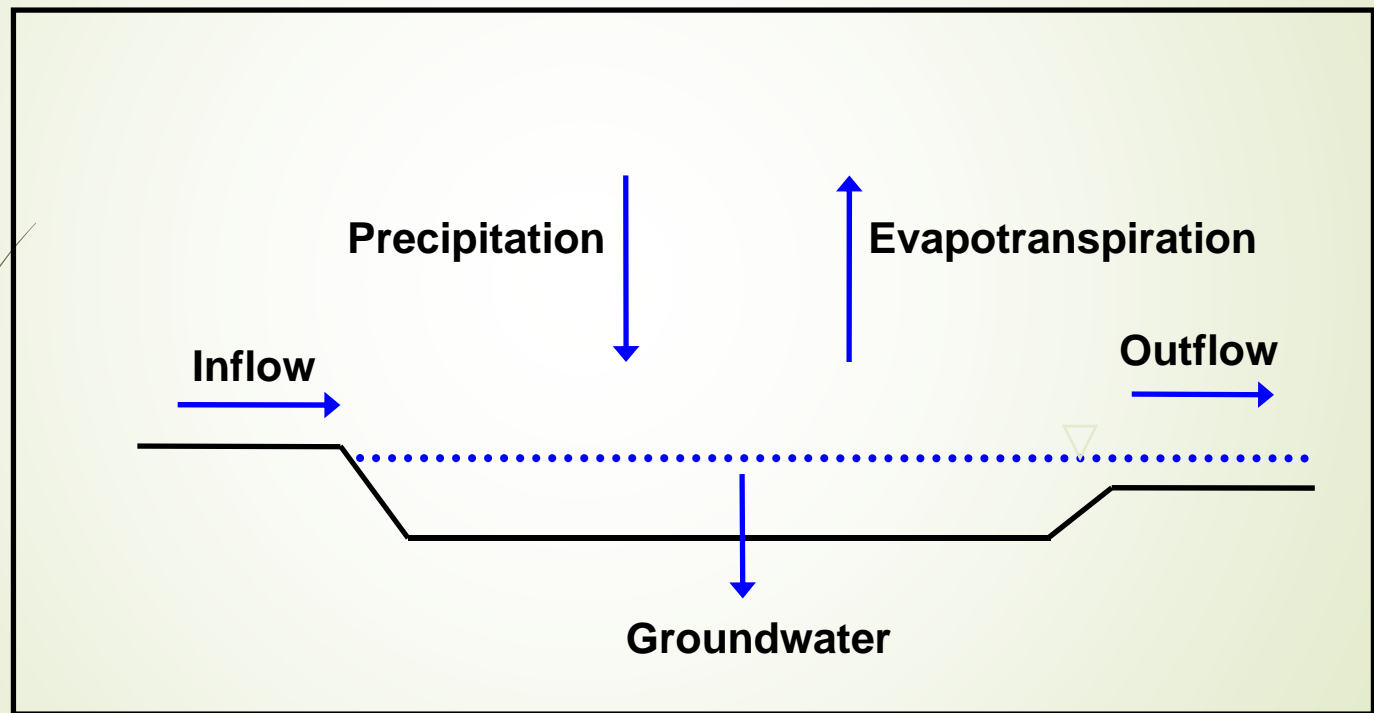
Many restored and created wetlands are too wet to effectively function

Cole & Brooks (2000)

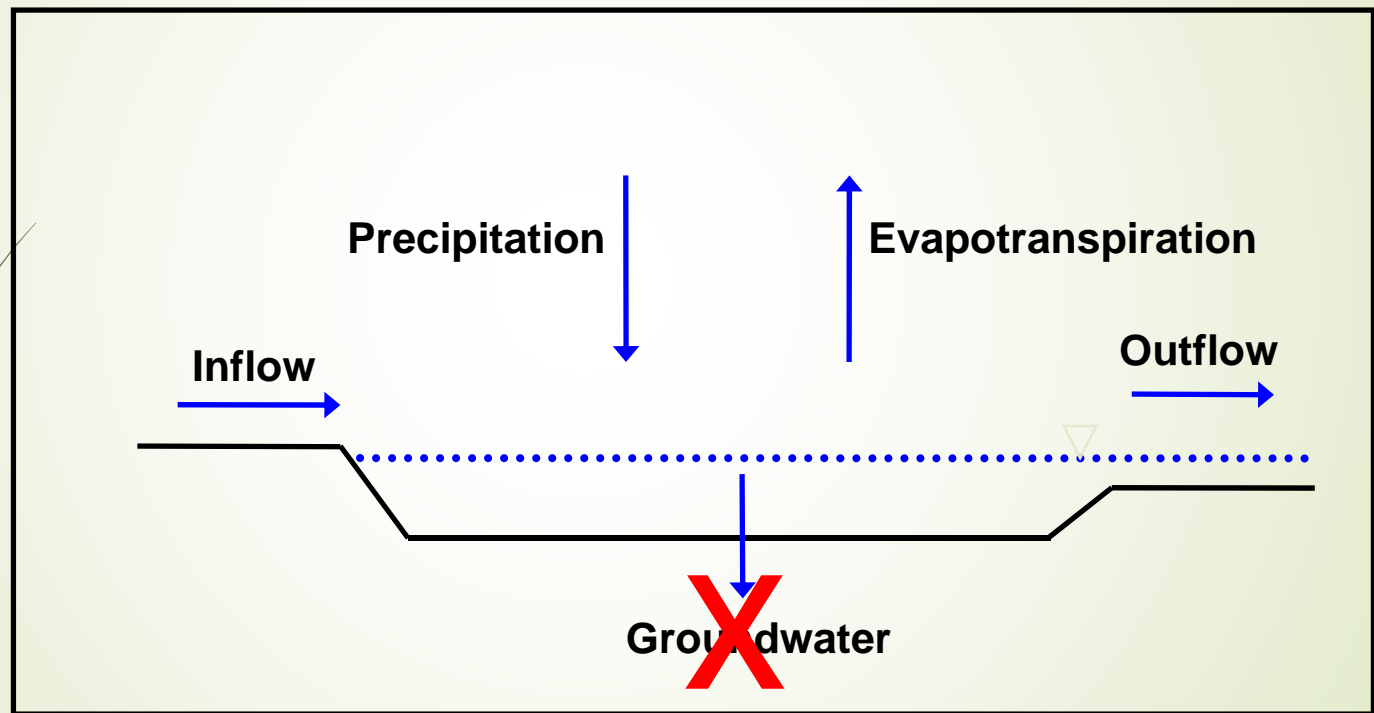
Piedmont Wetlands: the interface between uplands, groundwater, and surface water



A "simple" way to create a mitigation wetland is to create a perched system



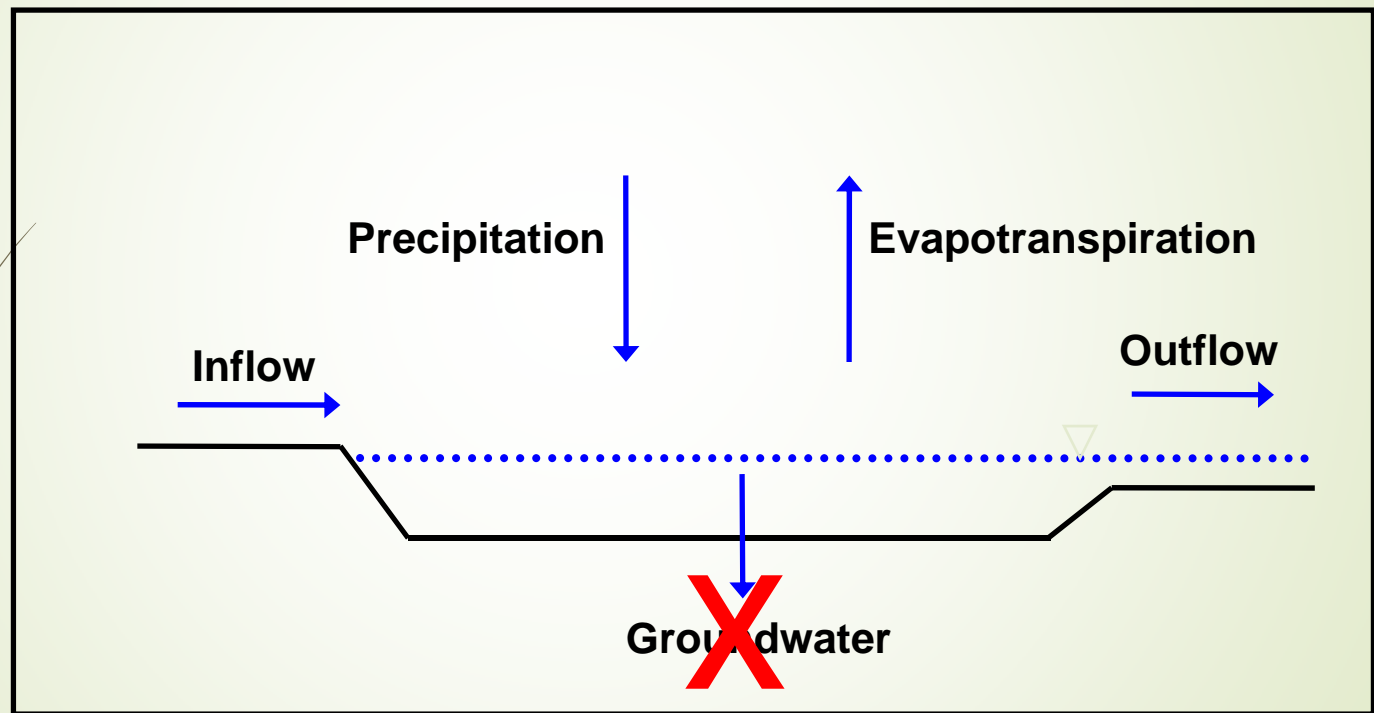
A "simple" way to create a mitigation wetland is to create a perched system



assume
negligible

A "simple" way to create a mitigation wetland is to create a perched system

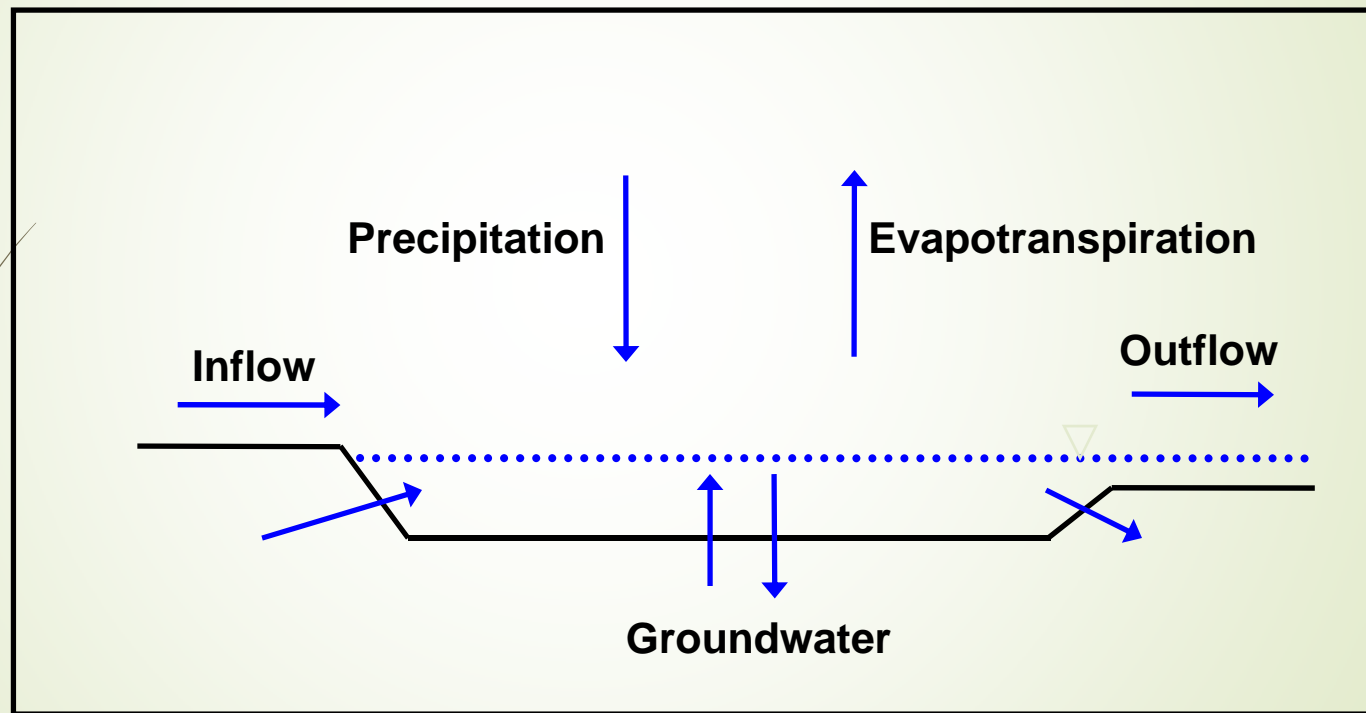
Can work on uplands with low permeability



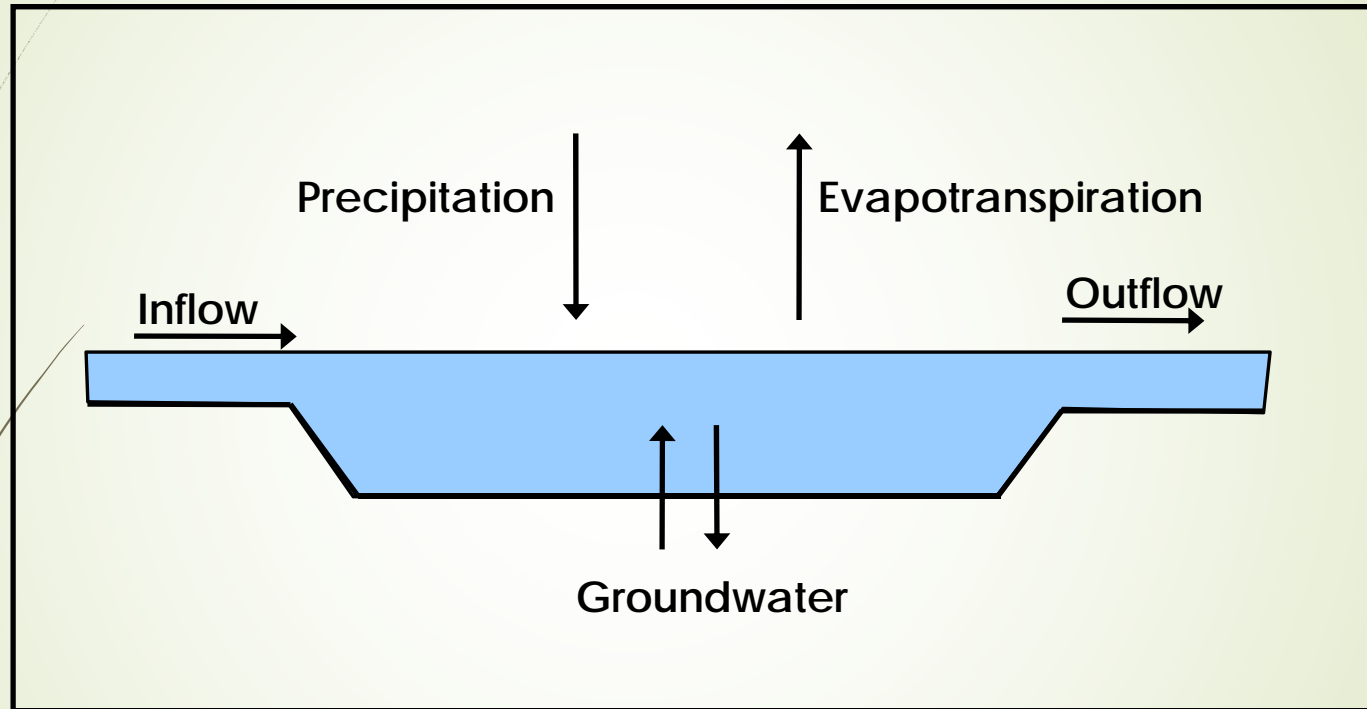
assume negligible

In most wetlands, Groundwater can seep
IN and OUT many places

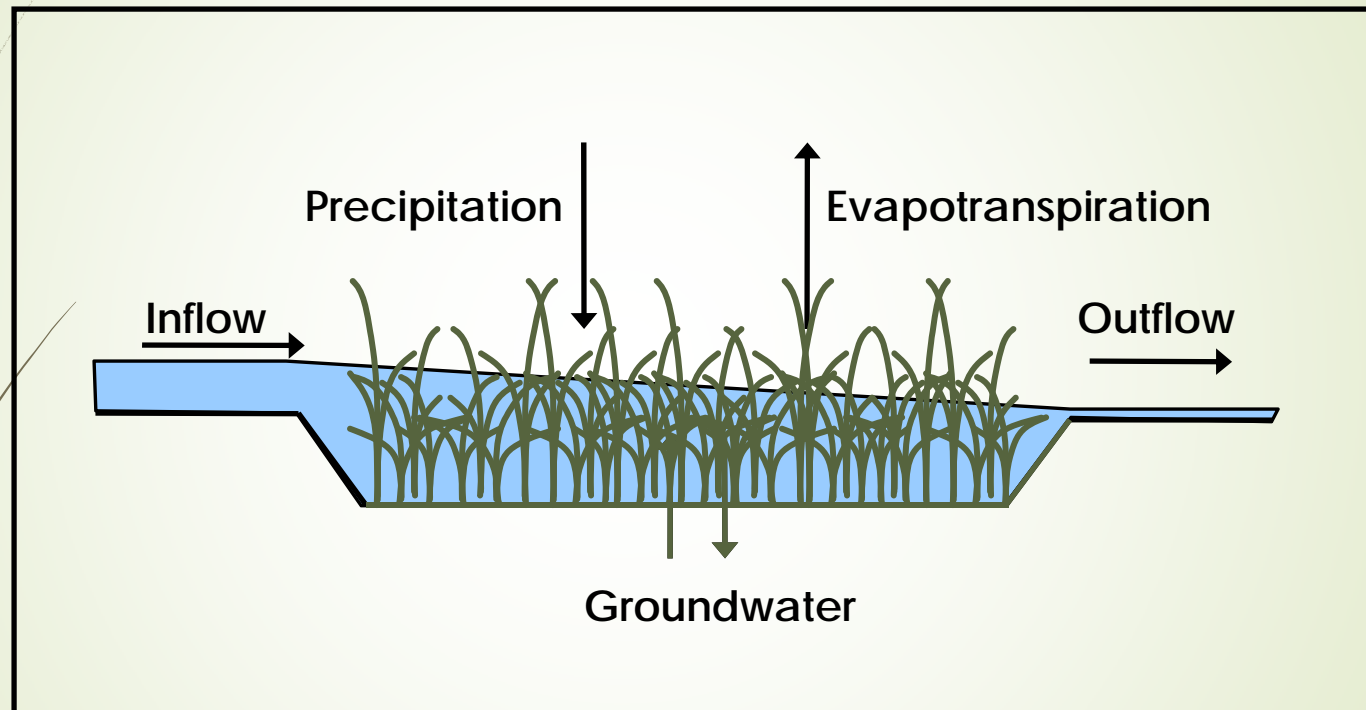
Ignore GW? the wetland can be "too wet"



Hydraulic resistance due to vegetation is typically ignored



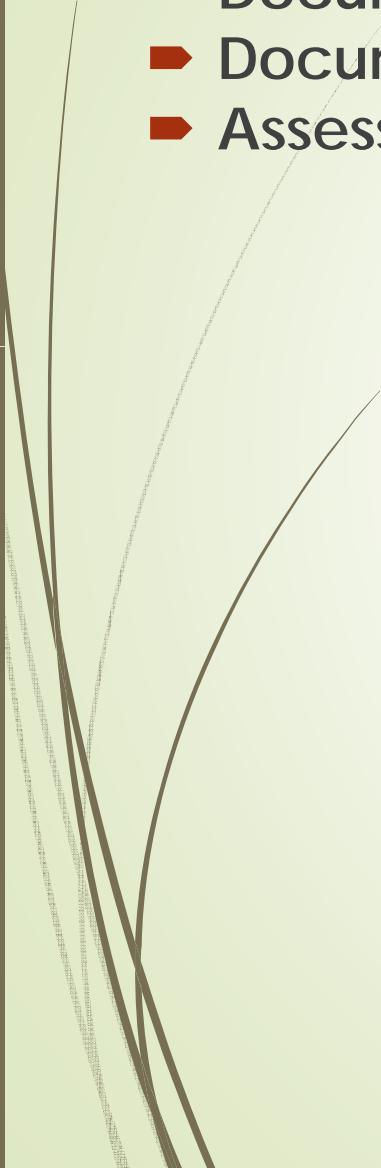
Hydraulic resistance due to vegetation is typically ignored



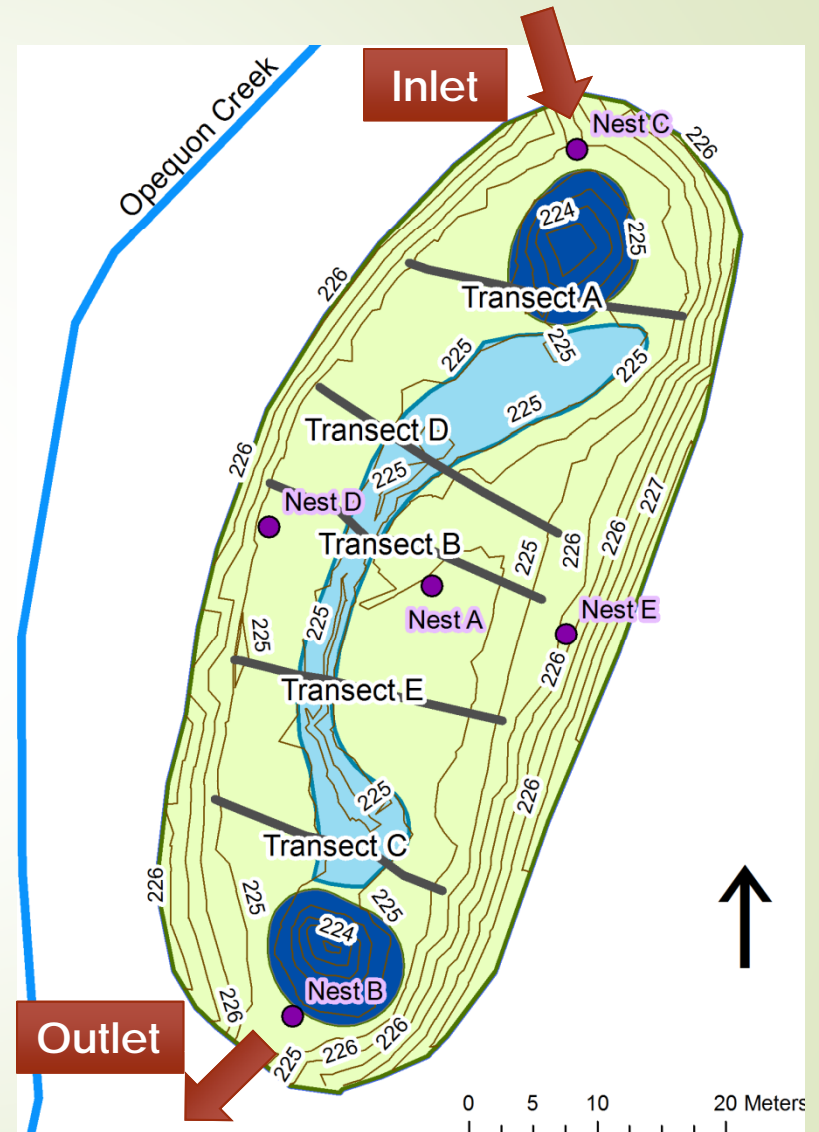
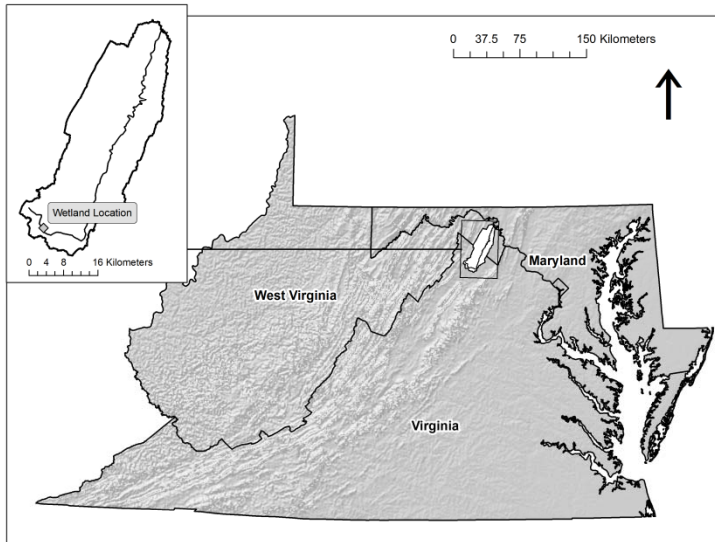
In designed wetland systems, Outflow is determined, all or in part, by hydraulic resistance due to vegetation

Wetland Water Budget Modeling

- Document known water budget methodologies;
- Document existing design and construction issues;
- Assess existing software and individual process-models;

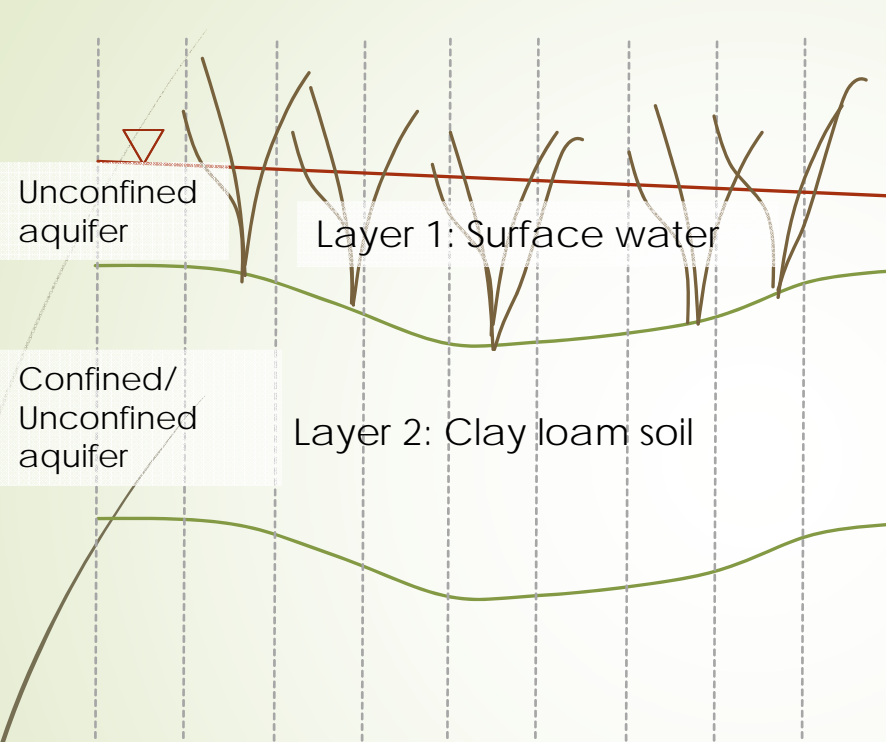


Modflow was tested as a possible tool to model wetlands



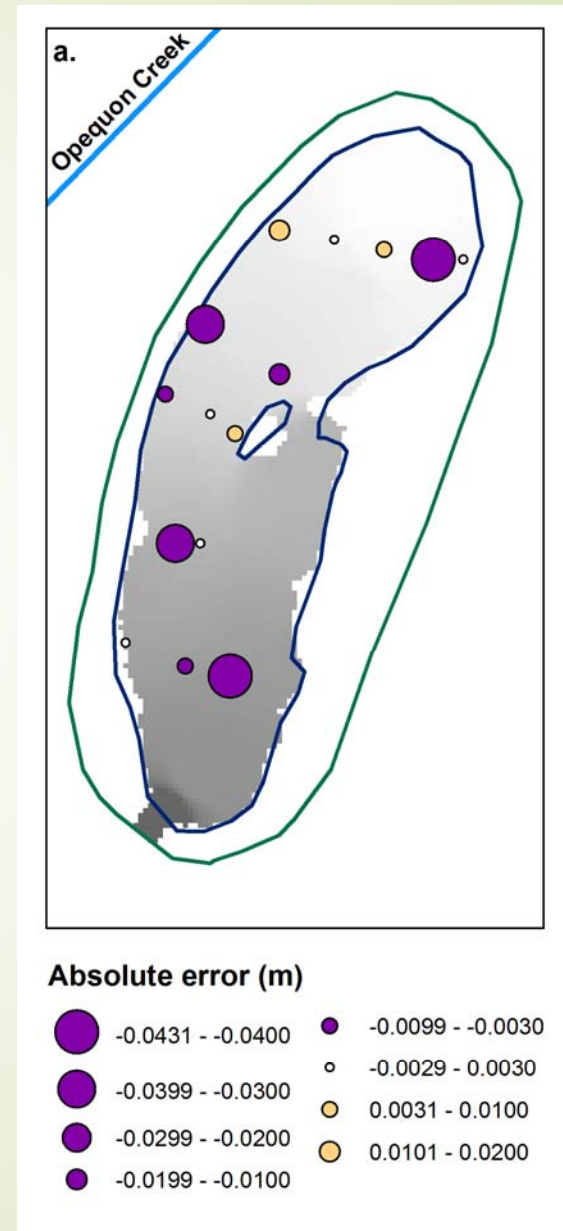
* Field study conducted by W. Cully Hession and Andrea Ludwig *

Wetland was modeled in MODFLOW as a two-layer aquifer system



Error ranged from -4.3 cm to 1.4 cm with a mean error of -1.1 cm

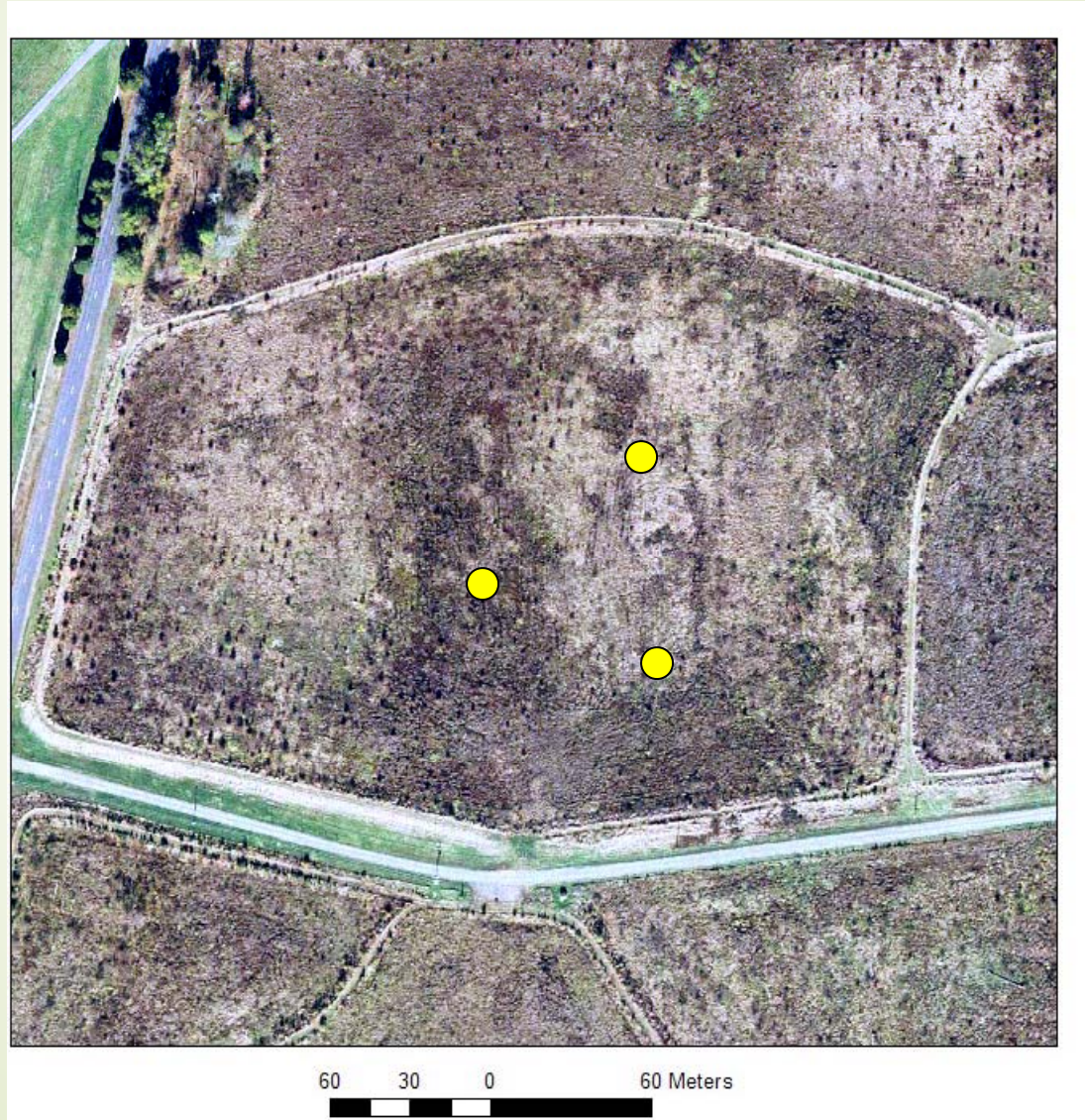
➤ close to the survey and digitization error



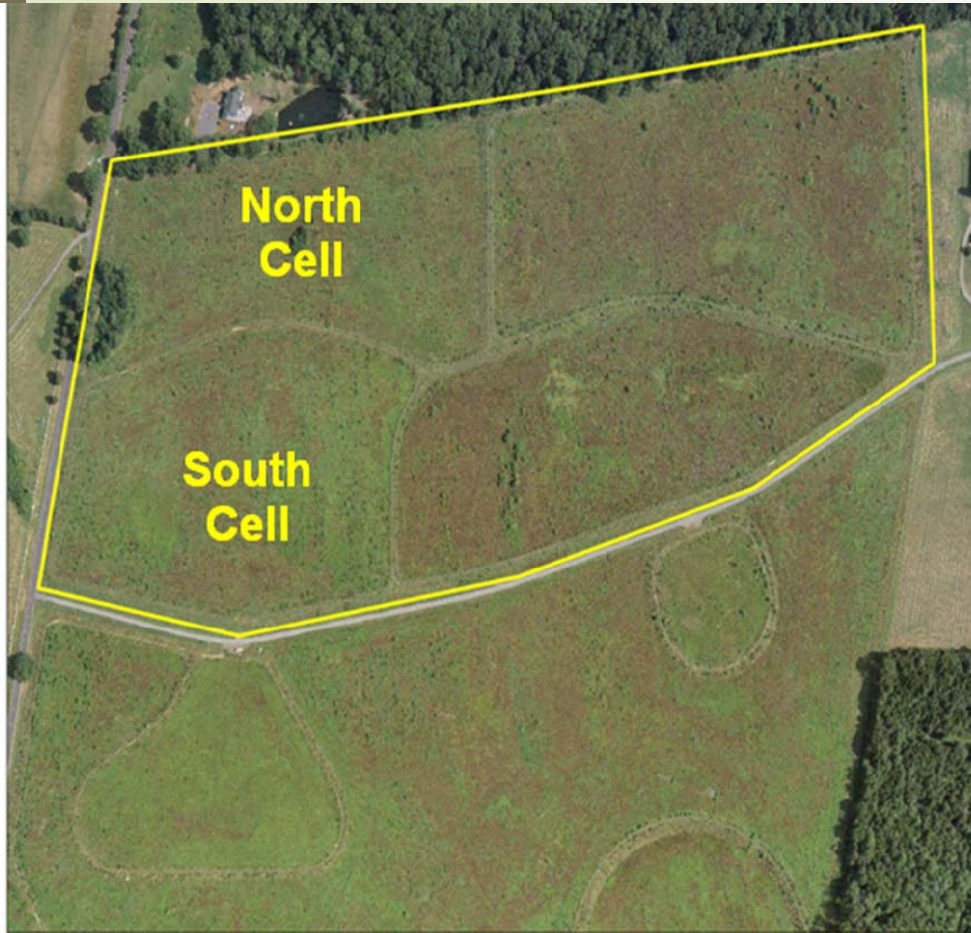
Modflow was also tested as a possible tool to model wetlands at Cedar Run 3 Wetland Bank



Water level data were collected in the southern cell via USACOE standard observation well installations

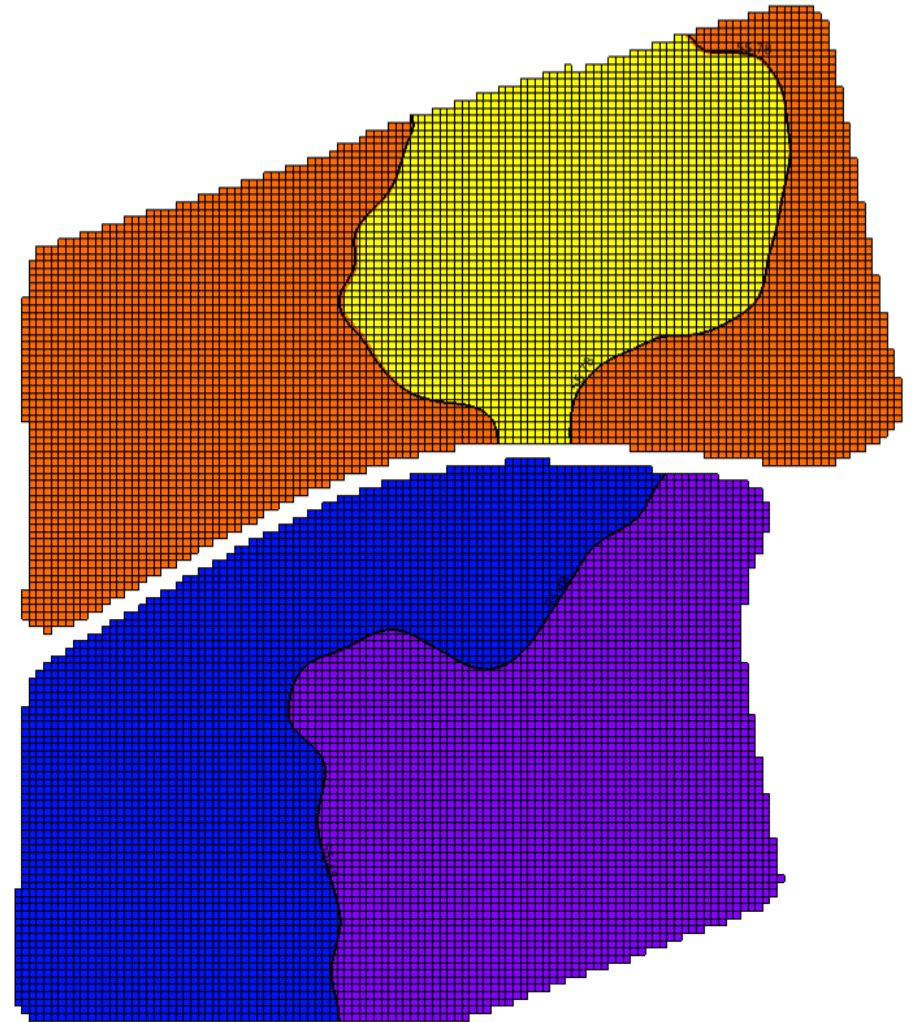


MODFLOW-2005



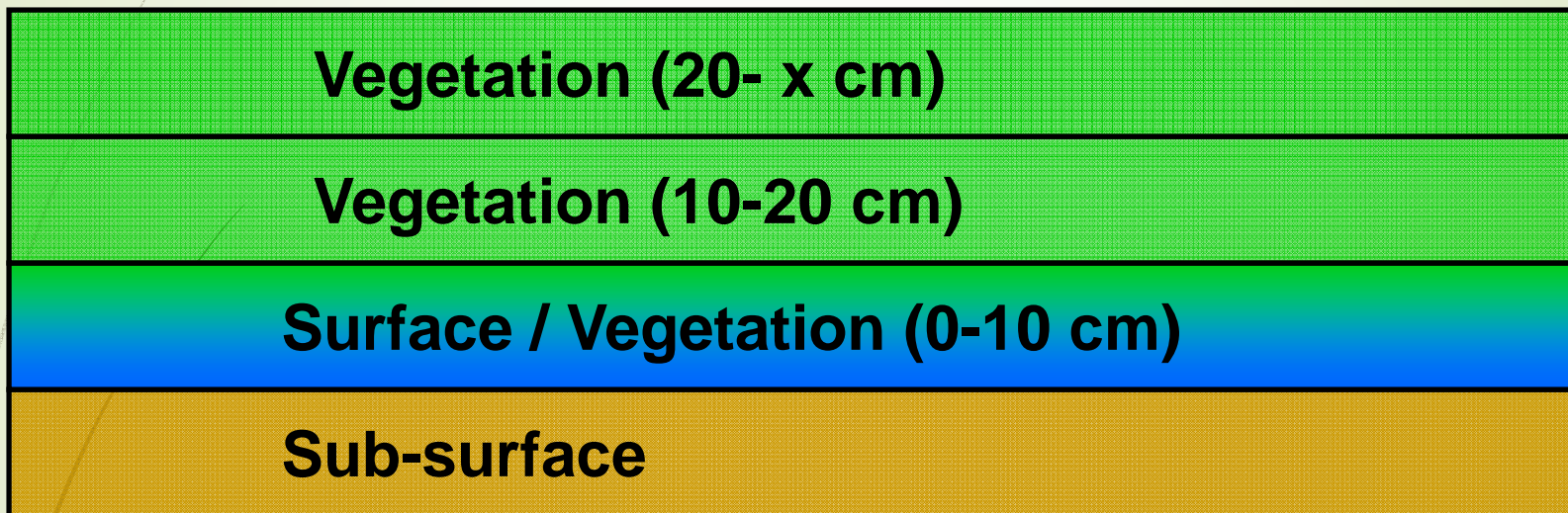
Cedar Run Wetlands Bank - Phase 3
August 2008
WSSI #6175AH
Scale: 1" = 400'

 Site Limits

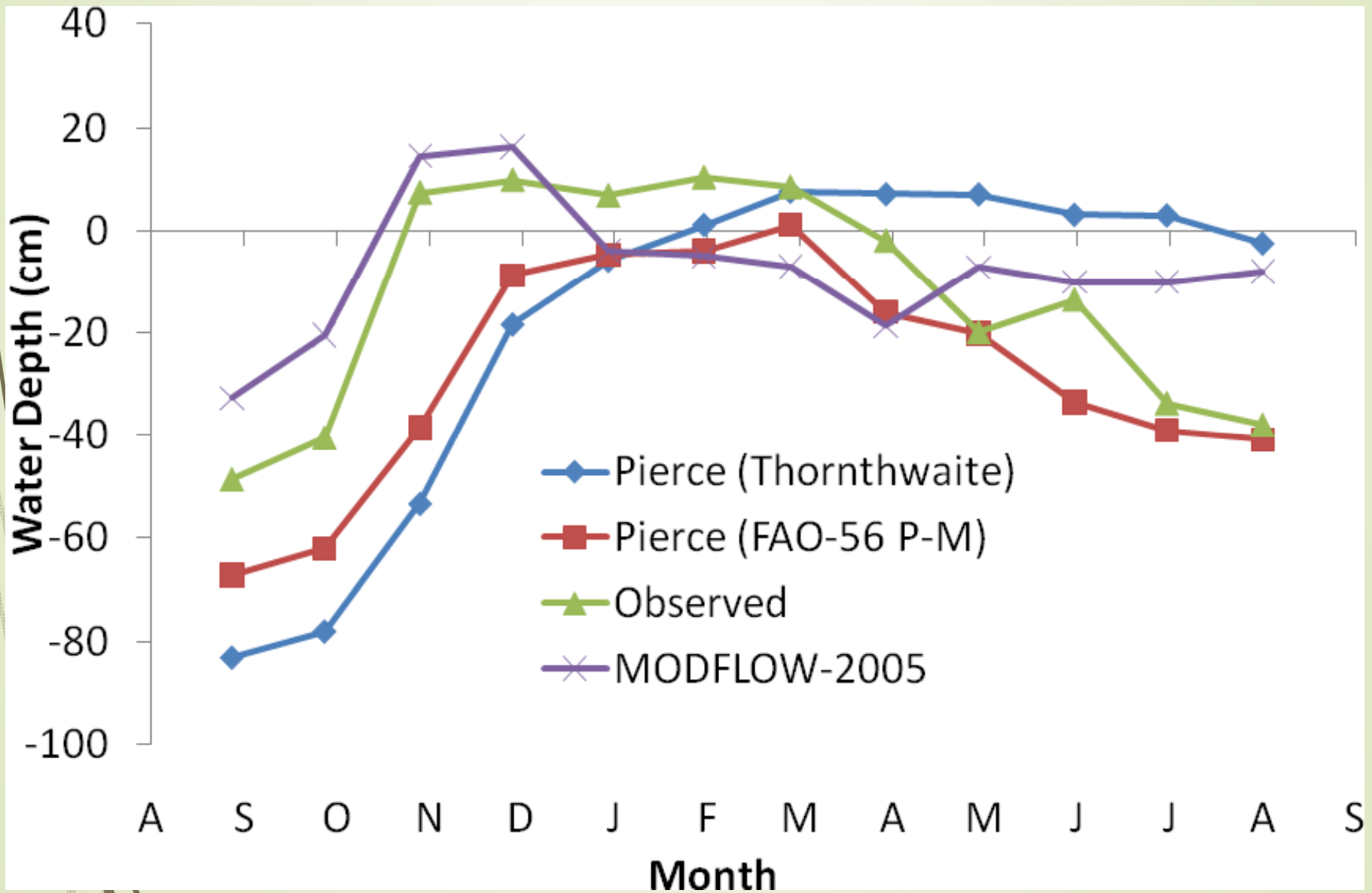


Aquaveo GMS 8.0

the wetland was represented as...



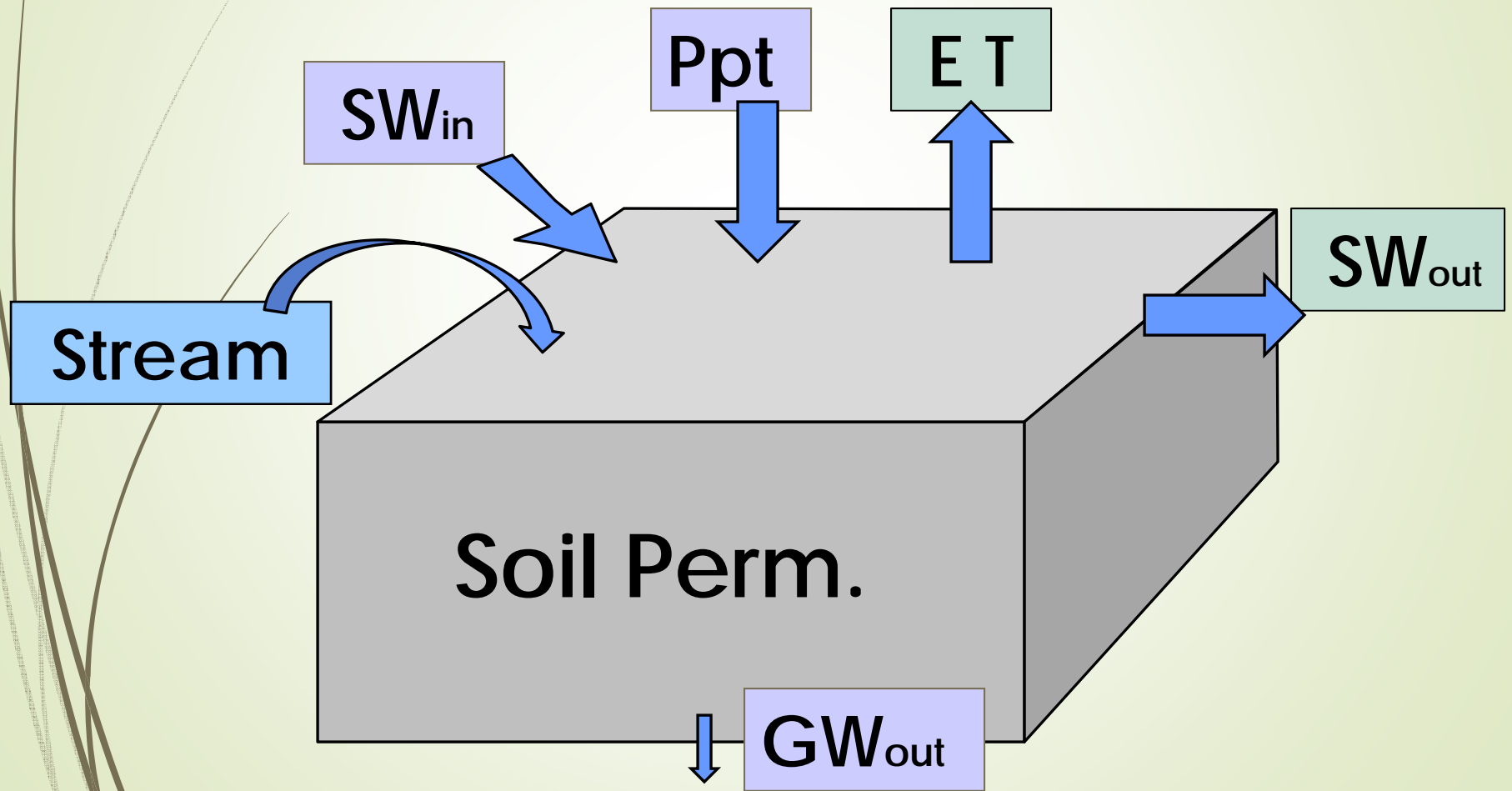
The Pierce model with FAO-Penman ET and Modflow performed best



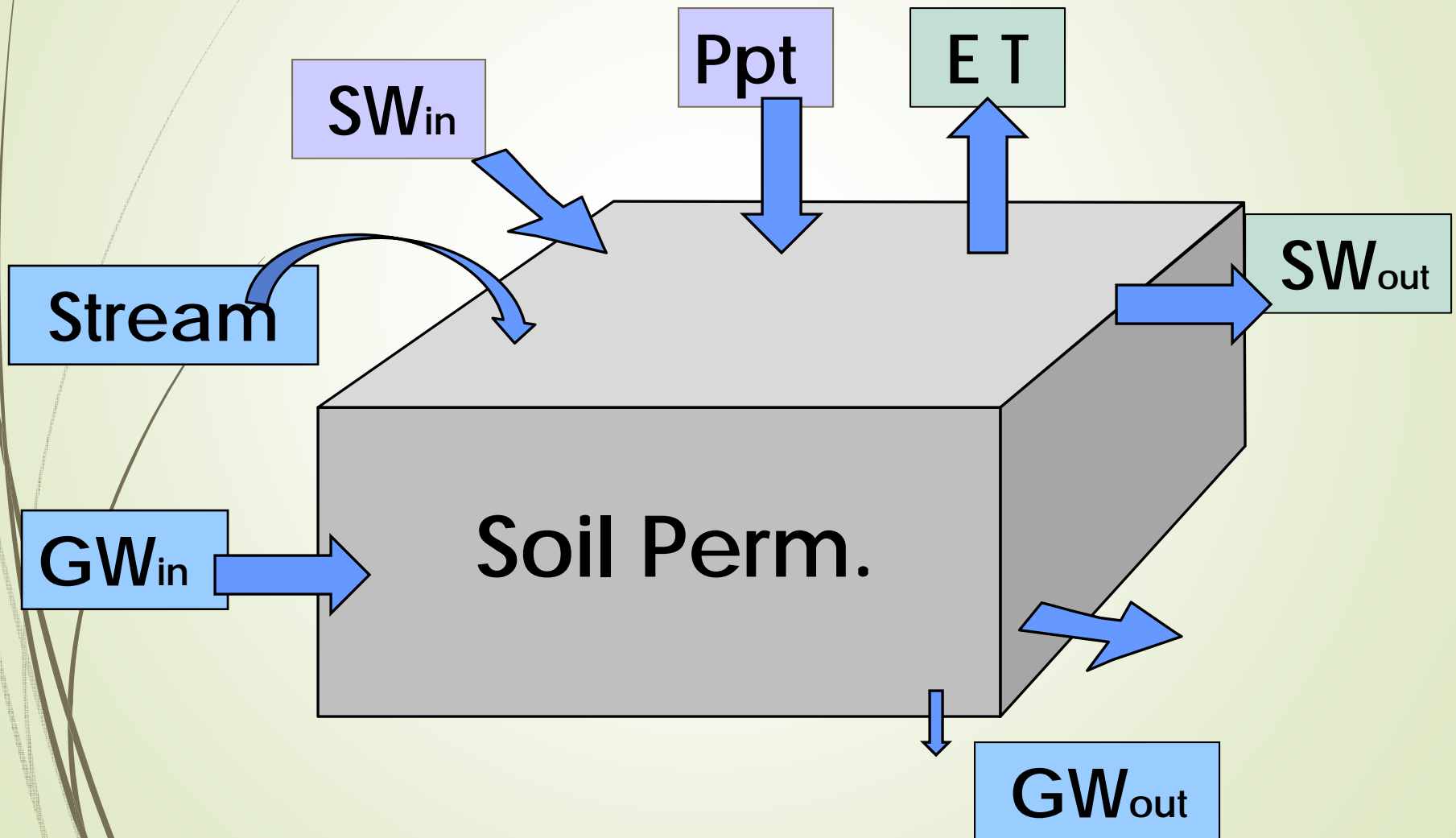
Wetland Water Budget Modeling

- Document known water budget methodologies;
- Document existing design and construction issues;
- Assess existing software and individual process-models;
- Develop a library of historic rainfall data;
- Classify each year as “dry,” “typical,” or “wet”;
- Develop model inputs based on Piedmont soil conditions;
- Provide additional model capability:
 1. Sloped wetlands
 2. Groundwater inputs
 3. Vegetation resistance
- Test model using data sets developed from two field sites;

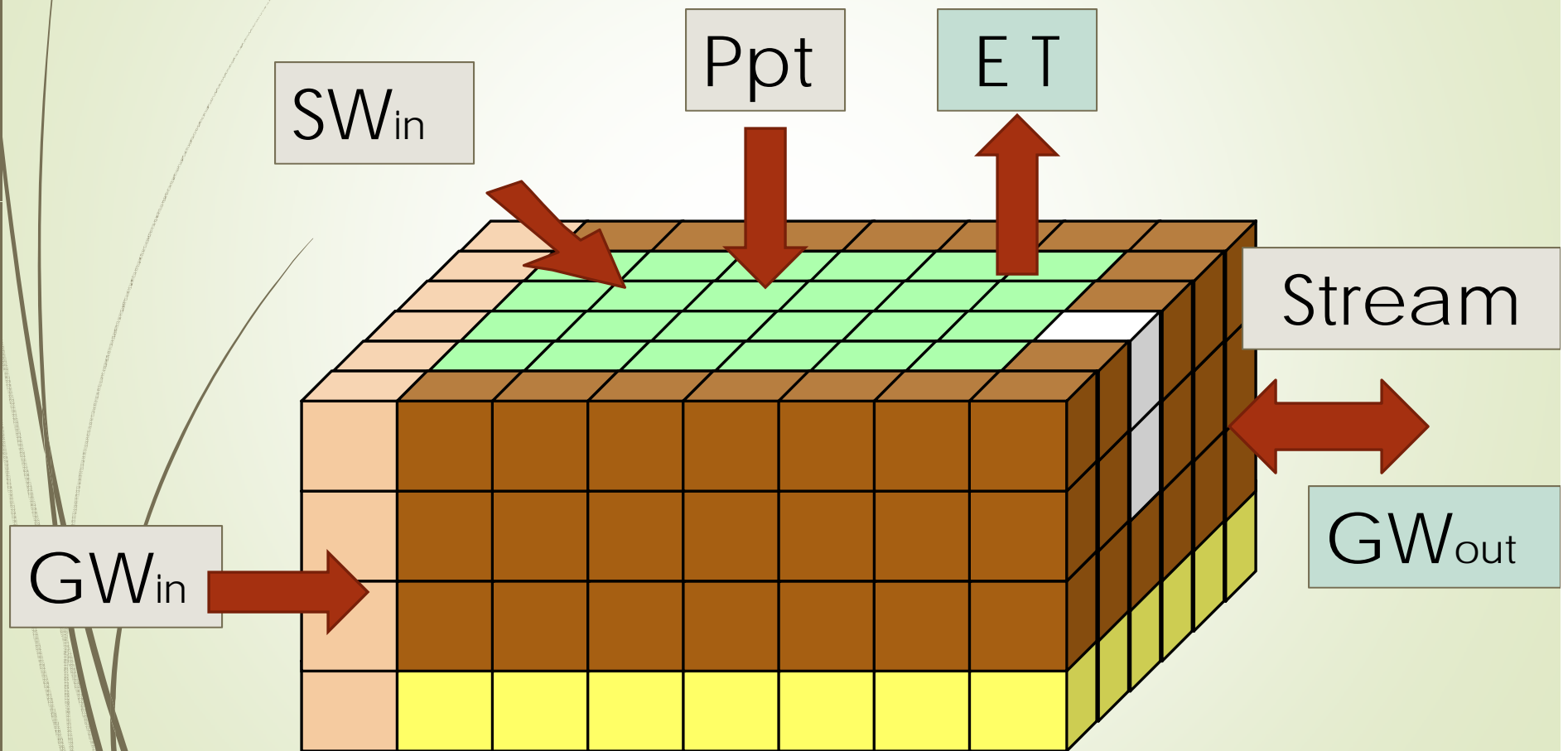
Pierce's model for depressional wetlands



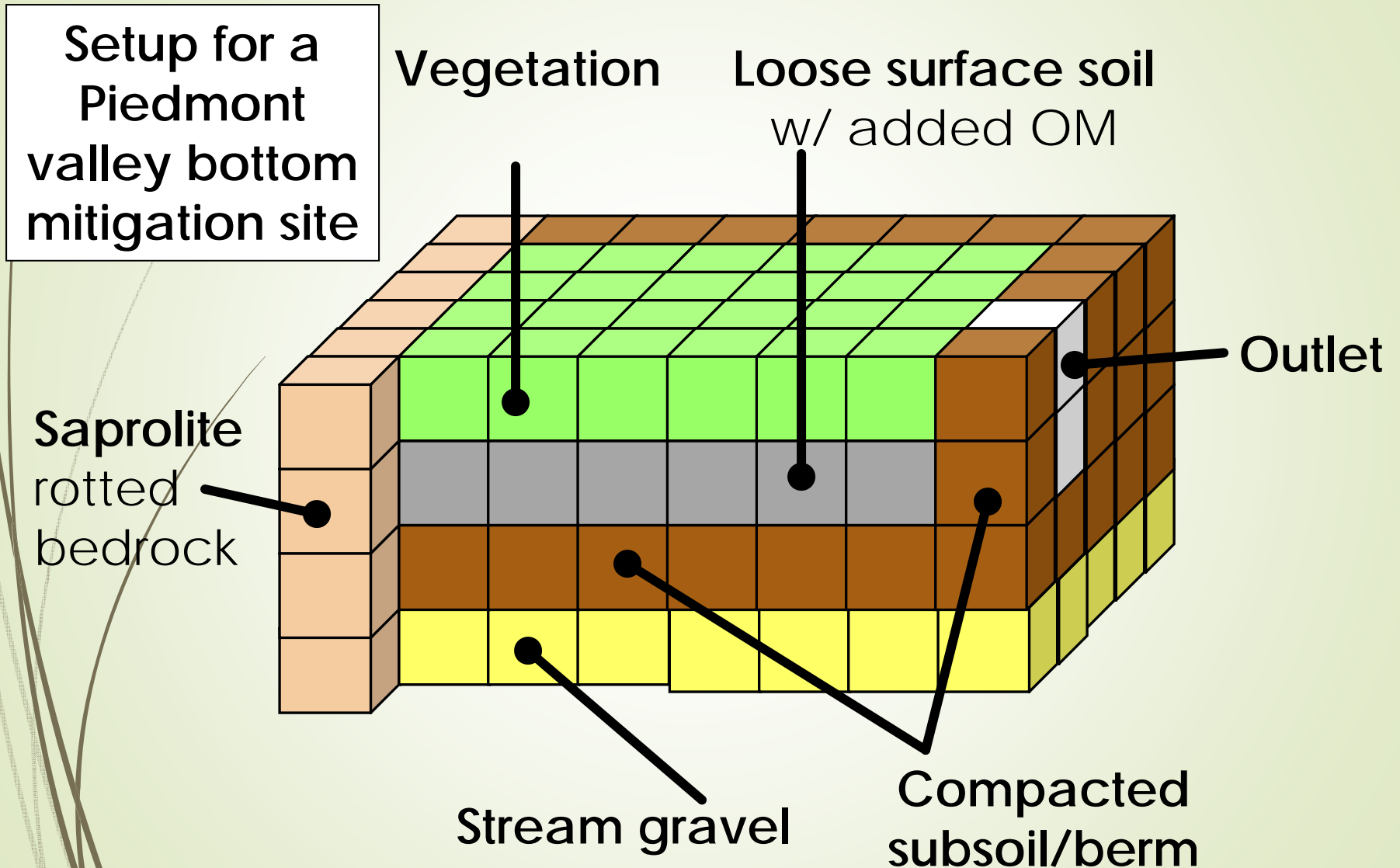
WetBud Basic Version



WetBud - Advanced Version

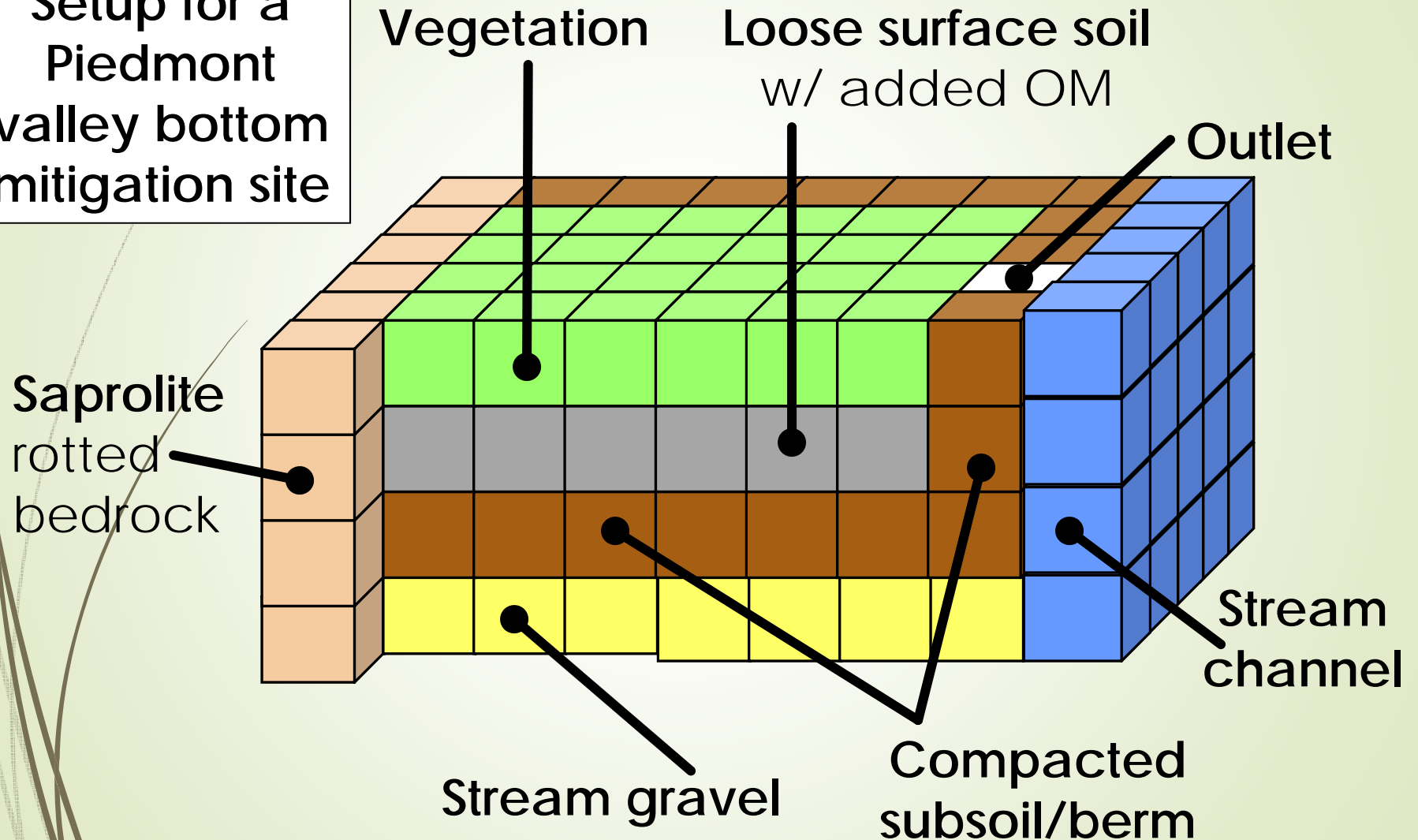


WetBud – Advanced Version



WetBud – Advanced Version

Setup for a
Piedmont
valley bottom
mitigation site



WetBud – Advanced Version

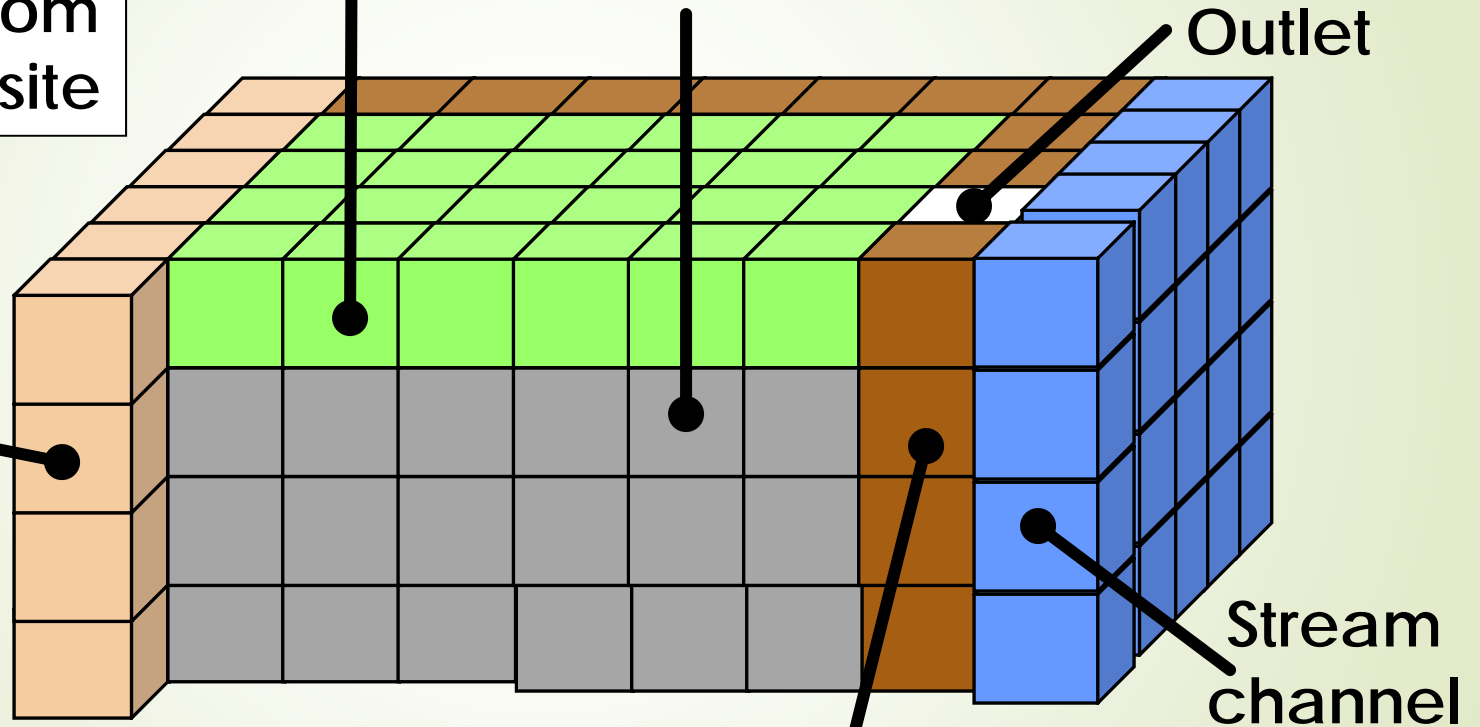
Setup for a Piedmont valley bottom mitigation site

Saprolite
rotted
bedrock

Vegetation

Wetland Substrate

Outlet



Compacted
subsoil/berm

Stream
channel

Building WetBud Model(s)

1. Create Project and Scenario

2. Build weather data

3. Determine WND years w/ WETS tables

4. User determines inputs and outputs

1. Calculate ET for WDN years (Thornthwaite, Penman)

2. Calculate SW_{in} using Curve Numbers

3. Input GW_{in} or calculate using W_{em} (well data)

4. Input or calculate Gw_{out}

5. Input or calculate overbank flow

Create Project and Scenario

Basic

Project Scenarios

New Scenario

SC_CODE	SC_DESCR
NW_Perman	CR_GW +
NW_Perman	Custom Range
NW_Perman	2010,2011,2012
NW_Thorn	CR_GW+
NW_Thorn	Custom Range
NW_Thorn	2010,2011,2012
SW_Perman	CR_GW +
SW_Perman	Custom Range
SW_Perman	2001,1982,1983
SW_Thorn	CR_GW+
SW_Thorn	Custom Range
SW_Thorn	2007,1982,1983

General | **Watershed Data** | Inputs and Outputs | PET Options | Management | Periods | Advanced Model

Code: SW_Thorn | Project: CR3 | Chart Settings (inches):

Description: Custom Range | 15 | Chart Settings (cm):

Elevation: 183 | Latitude: 38.6 | Longitude: -77.55 | Nearest Weather Station (Airport): 724036

Analysis Options:

- Simple Solution (fast)
- Advanced Solution (Modflow)
- Both

Specify Analysis Range:

Use Custom Range (mm-yyyy)

From yyyy-mm: 2009-01 | To yyyy-mm: 2012-05

Standard Analysis Years:

- Default Dry Year | Specified Dry Year: 2005
- Partial Year
- Default Avg Year | Specified Avg Year: 2008
- Partial Year
- Default Wet Year | Specified Wet Year: 2003
- Partial Year

Comment:

Create Project and Scenario

Advanced

The screenshot displays the 'Modflow Grid Setup' application window. The interface is divided into several sections:

- MP_CODE / MP_DESCR Table:**

MP_CODE	MP_DESCR
CR3_2009	New
CR3_2009	2009Thornthwaite
CR3_2010	2010Thornthwaite
CR3_Compar	#2009Thornthwaite
CR3_Small	Troubleshoot
CR3_Test	2010Thornthwaite
Matt Gloe	
- Boundary Conditions / Properties:** Includes a 'List Data' section with radio buttons for 'General Head', 'Drains', 'Monitoring Points', and 'No Flow Cells'.
- Grid:** A large grid with rows and columns numbered 1 to 11. The grid cells are colored green, indicating active or boundary cells.
- Current Layer:** A section with a checkbox and a dropdown menu.
- Current Zone / Property Set:** A dropdown menu showing 'ZF_A' and 'ZF_DESCR' with options '1 Outside_Bndy_CR3' and '2 Outside_Bndy_BF'.
- Bottom Panel:** Contains a scale bar (0 to 1000), a north arrow, and buttons for 'Print Current Grid', 'Initialize Layer', 'Copy From', 'Clear Layer', 'Test No Flow', 'Modify Zone Parameters', 'Cancel', and 'Close'.

Building WetBud Model(s)

1. Create Project and Scenario
2. Build weather data
3. Determine WND years w/ WETS tables
4. User determines inputs and outputs
 1. Calculate ET for WDN years (Thornthwaite, Penman)
 2. Calculate SW_{in} using Curve Numbers
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 4. Input or calculate Gw_{out}
 5. Input or calculate overbank flow

Build weather data

The screenshot shows the 'Weather Data' application interface. It is divided into several sections:

- Stations:** A list of weather stations with columns for 'ST_COI' and 'ST_LOCATION'. The list includes stations like Warrenton, VA; Oceana, VA; Norfolk, VA; Richmond, VA; Sterling, VA - IAD; Manassas Regional Ai; Washington-Reagan A; Lynchburg, VA; Roanoke, VA; Washington Dulles IA; Cedar Run Mannassas, VA; DCA National Airport; IAD Dulles Airport; RAWS Sol; and WSSI Cedar Run 3 (Matt).
- Weather Data Log:** A table with columns 'WL_' and 'WL_DATE'. It shows data for the year 2013, with dates from 2013-03-11 to 2013-03-11.
- Available Data:** A menu bar with options: 'Retrieve from the Web', 'Copy Station Data', 'Import from Excel', and 'Help'.
- Weather Daily:** A table with columns 'WD_DA', 'WD_TEI', 'WD_DE', 'WD_WI', 'WD_MI', and 'WD_MAX'. It displays daily weather data for the year 1999, from 1999-01-01 to 1999-01-17.
- Buttons:** 'Exit' and 'Delete Year' buttons are visible at the bottom.

WL_	WL_DATE
1999	2013-03-11
2000	2013-03-11
2001	2013-03-11
2002	2013-03-11
2003	2013-03-11
2004	2013-03-11
2005	2013-03-11
2006	2013-03-11
2007	2013-03-11
2008	2013-03-11
2009	2013-03-11
2010	2013-03-11
2011	2013-03-11
2012	2013-03-11

WD_DA	WD_TEI	WD_DE	WD_WI	WD_MI	WD_MAX
1999-01-01	19.80	9.80	5.20	10.90	30.00
1999-01-02	21.40	3.30	6.60	10.00	30.00
1999-01-03	32.70	27.50	7.90	19.40	45.00
1999-01-04	26.70	10.00	8.20	17.10	35.10
1999-01-05	19.80	3.10	8.90	15.10	24.10
1999-01-06	16.40	7.00	4.40	3.90	33.10
1999-01-07	33.10	12.80	11.00	28.90	36.00
1999-01-08	23.90	14.40	4.10	21.20	27.00
1999-01-09	35.10	31.90	10.90	24.10	44.60
1999-01-10	24.30	9.60	8.10	17.10	32.00
1999-01-11	25.30	9.50	5.20	16.00	30.90
1999-01-12	41.50	24.30	8.20	28.00	57.00
1999-01-13	49.70	36.60	7.70	45.00	59.00
1999-01-14	33.70	31.20	8.50	26.10	50.00
1999-01-15	28.90	25.20	5.80	21.00	37.00
1999-01-16	32.00	23.10	5.30	21.00	52.00
1999-01-17	41.90	28.00	4.50	27.00	57.90

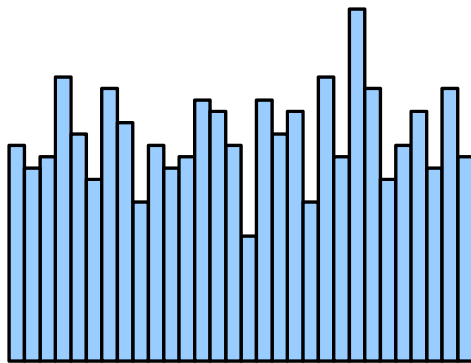
Building WetBud Model(s)

1. Create Project and Scenario
2. Build weather data
3. Determine WND years w/
WETS tables
4. User determines inputs and outputs
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Determine WND years w/ WETS tables:

#1: Which years have WET (or DRY or NORM) total ppt?

30-yr record
of annual
precipitation

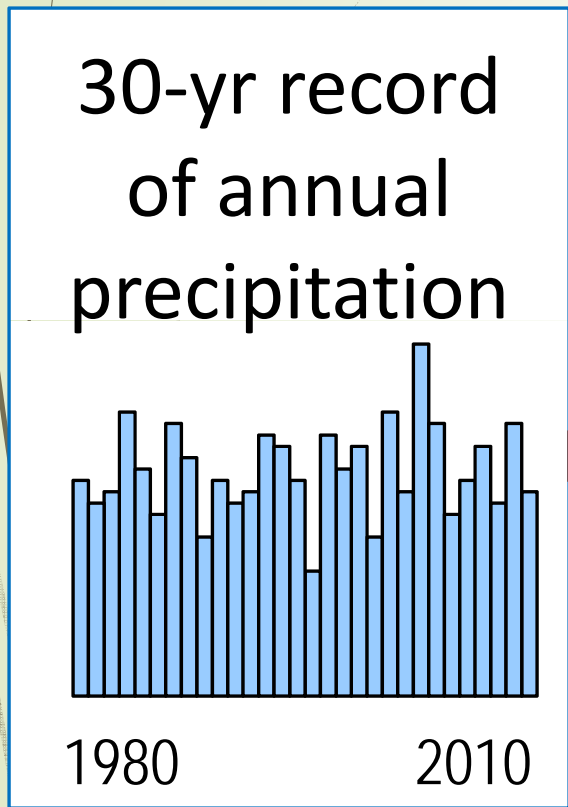


1980

2010

Determine WND years w/ WETS tables:

#1: Which years have WET (or DRY or NORM) total ppt?



29.32
29.62
29.95
30.67
31.74
32.57
33.82
34.99
35.77
35.84
35.94
35.96
36.16
36.38
36.63
37.57
37.73
38.07
39.57
39.80
40.23
40.60
40.84
41.41
46.02
47.33
50.32
50.50
51.02
51.89
51.97

DRY

35.33"

NORM

42.04"

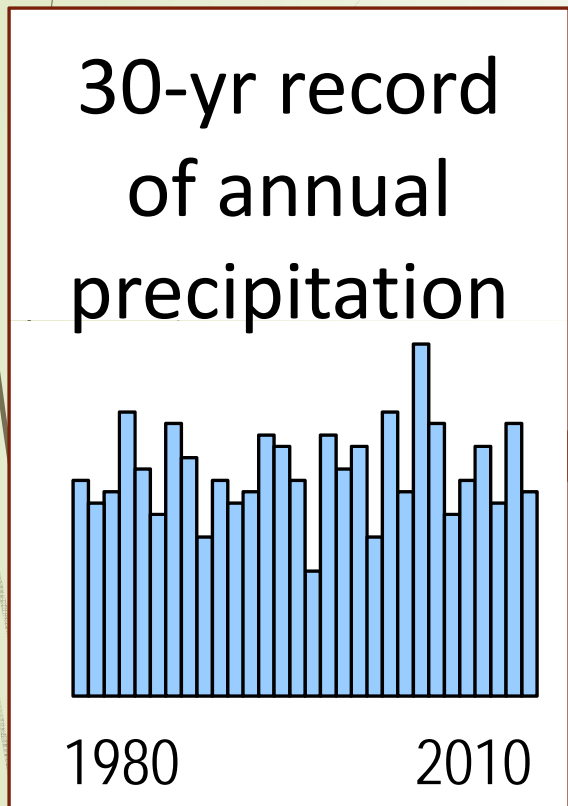
WET

Rank order annual ppt. values

Make splits with WETS Table Statistics

Determine WND years w/ WETS tables:

#1: Which years have WET (or DRY or NORM) total ppt?



29.32
29.62
29.95
30.67
31.74
32.57
33.82
34.99
35.77
35.84
35.94
35.96
36.16
36.38
36.63
37.57
37.73
38.07
39.57
39.80
40.23
40.60
40.84
41.41
46.02
47.33
50.32
50.50
51.02
51.89
51.97

DRY

1988

35.33"

NORM

1994

42.04"

WET

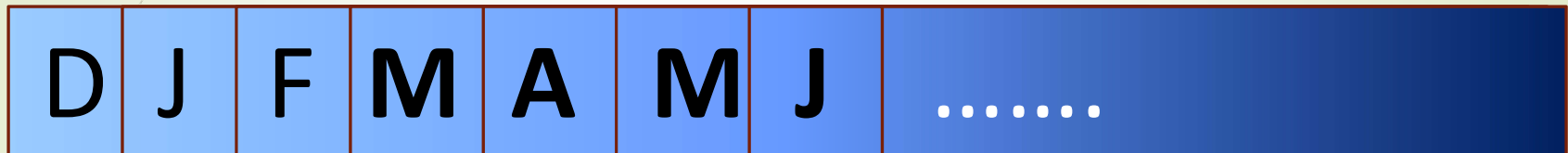
1975

Select the median value in each split

Determine WND years w/ WETS tables:

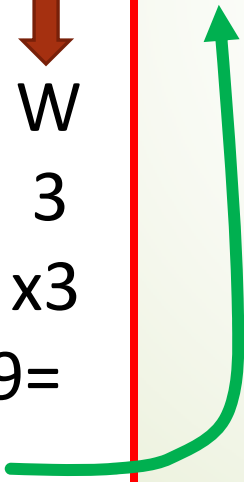
#2: Did 1975 have a WET "spring"?

2



##	##	##
↓	↓	↓
N	D	W
2	1	3
x1	x2	x3
2+2+9=		
13		
(6 to 18)		

N

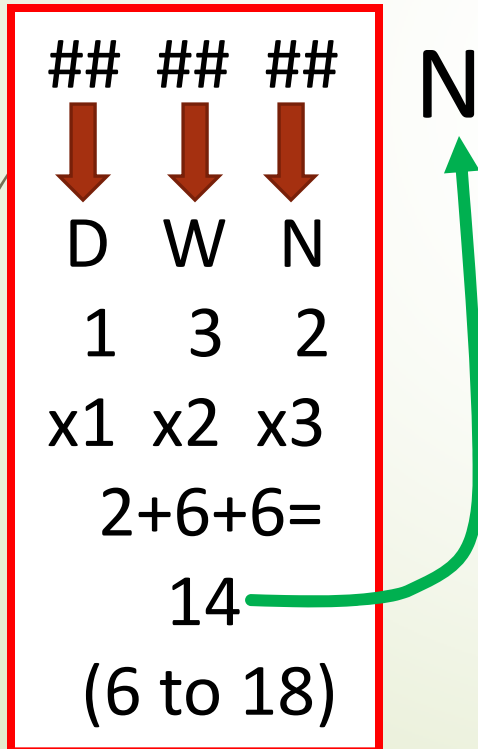
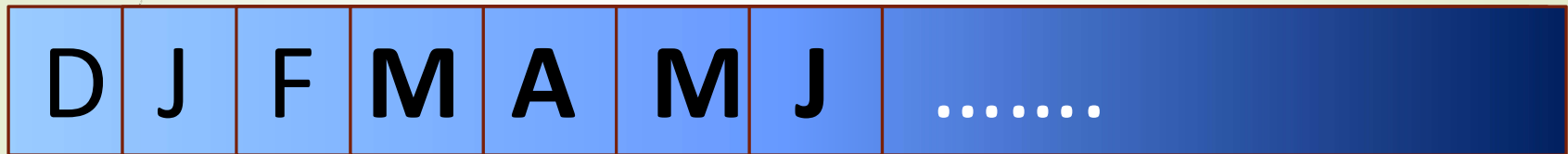


Do a WETS analysis for each Spring month

Determine WND years w/ WETS tables:

#2: Did 1975 have a WET "spring"?

2 +2

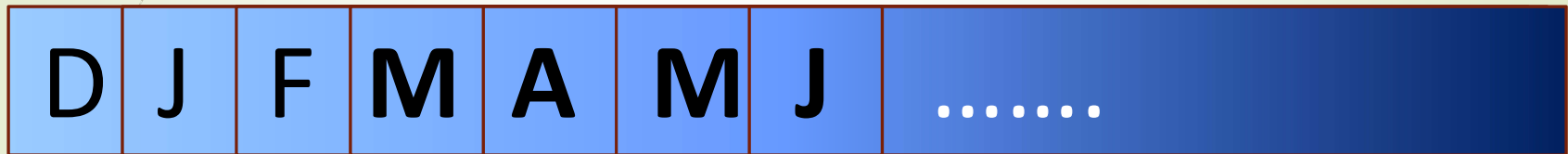


Do a WETS analysis for each Spring month

Determine WND years w/ WETS tables:

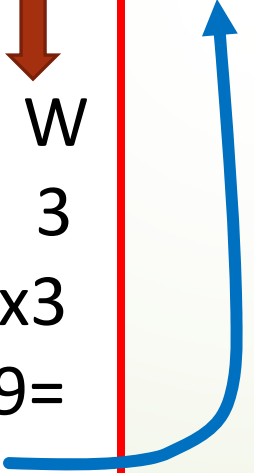
#2: Did 1975 have a WET “spring”?

$$2 + 2 + 3$$



##	##	##
↓	↓	↓
W	N	W
3	2	3
x1	x2	x3
3+4+9=		
16		
(6 to 18)		

W

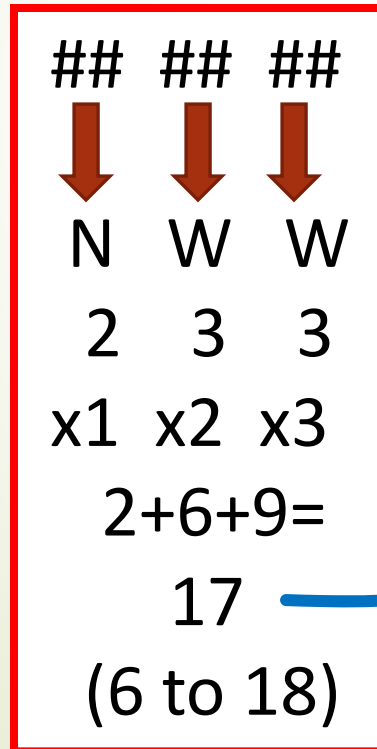
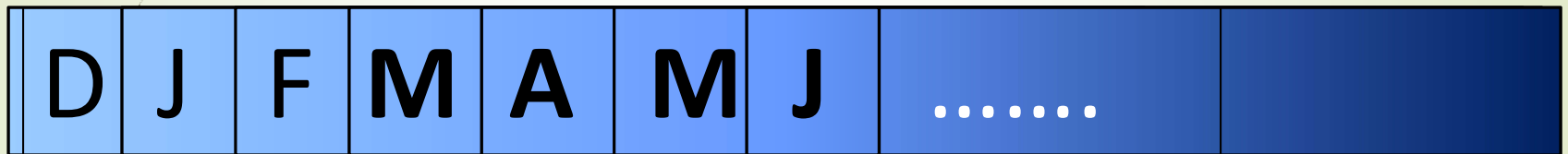


Do a WETS analysis for each Spring month

Determine WND years w/ WETS tables:

#2: Did 1975 have a WET “spring”?

$$2 + 2 + 3 + 3$$



W

Do a WETS analysis for each Spring month



Determine WND years w/ WETS tables:

#2: Did 1975 have a WET "spring"?

$$2 + 2 + 3 + 3 = 10$$

D	J	F	M	A	M	J
---	---	---	---	---	---	---	-------

N N W W

Score
determines if
Spring is WND

4-6 : DRY
7-9 : NORM
10-12: WET

Determine WND years w/ WETS tables:

#2: Did 1975 have a WET "spring"?

$$2 + 2 + 3 + 2 = 10$$

D	J	F	M	A	M	J
---	---	---	---	---	---	---	-------

N N W W

Score
determines if
Spring is WND

4-6 : DRY
7-9 : NORM
10-12: WET

A Year is WET if both the Spring and the
Annual Precipitation are both WET

Determine WND years

The screenshot shows the 'Weather Station Data (NOAA)' software interface. The 'Project Scenarios' window is open, displaying a table of scenarios and various configuration options. Two red boxes highlight specific areas: one around the 'Code' and 'Project' fields, and another around the 'Standard Analysis Years' section.

SC_CODE	SC_DESCR
NW_Penman	CR_GW +
NW_Penman	Custom Range
NW_Penman	2010,2011,2012
NW_Thorn	CR_GW+
NW_Thorn	Custom Range
NW_Thorn	2010,2011,2012
SW_Penman	CR_GW +
SW_Penman	Custom Range
SW_Penman	2001,1982,1983
SW_Thorn	CR_GW+
SW_Thorn	Custom Range
SW_Thorn	2007,1982,1983

General | **Watershed Data** | **Inputs and Outputs** | **PET Options** | **Management** | **Periods** | **Advanced Model**

Code: SW_Thorn | Project: CR3 | Chart Settings (inches): []

Description: Custom Range | Chart Settings (cm): []

Elevation: 183 | Latitude: 38.6 | Longitude: -77.55 | Nearest Weather Station (Airport): 724036

Analysis Options

- Simple Solution (fast)
- Advanced Solution (Modflow)
- Both

Specify Analysis Range

- Use Custom Range (mm-yyyy)

From yyyy-mm: 2009-01 | To yyyy-mm: 2012-05

Standard Analysis Years

- Default Dry Year | Specified Dry Year: 2005
- Partial Year
- Default Avg Year | Specified Avg Year: 2008
- Partial Year
- Default Wet Year | Specified Wet Year: 2003
- Partial Year

Comment: []

Building WetBud Model(s)

1. Create Project and Scenario
2. Build weather data
3. Determine WND years w/ WETS tables
4. User determines inputs and outputs

1. Calculate ET for WDN years (Thornthwaite, Penman)

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Building WetBud Model(s)

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 4. User determines inputs and outputs
 1. Calculate ET for WDN years (Thornthwaite, Penman)
- ## 2. Calculate SWin using Curve Numbers
3. Input GW_{in} or calculate using W_{em} (well data)
 4. Input or calculate Gw_{out}
 5. Input or calculate overbank flow

Calculate SW_{in} using Curve Numbers

Basic Analysis

Select Scenario

SC_COD	SC_DESCR
NW_Penmar	2010,2011,2012
NW_Penmar	CR_GW +
NW_Penmar	Custom Range
NW_Thorn	2010,2011,2012
NW_Thorn	CR_GW+
NW_Thorn	Custom Range
SW_Penmar	CR_GW +
SW_Penmar	Custom Range
SW_Penmar	2001,1982,1983
SW_Thorn	CR_GW+
SW_Thorn	Custom Range
SW_Thorn	2007,1982,1983

Calculate Budget

Recalc ET and Runoff

Show Results

Do NOT Apply Preset Chart Settings

Auto Show Results

Preserve Chart Scale

Delete ALL Scenario Results

Analysis: Water Budget Chart | Multiple Scenarios | Debug

Reference Station: 724036

Range (Dry, Normal, Wet)

- 2005
- 2008
- 2003
- 2009-01 <> 2012-05

Display Options

- (T)otal
- Total Ad(J)usted
- (W)ater Mass Balance
- (P)recip
- O(V)erbank
- (R)unoff
- Groundwater I(N)
- Initial (F)ill / Storage
- (E)vapotrans
- (O)utflow
- Groundwater O(U)T
- (A)ll

Export

Close

Inches of Water

Month (Jan - Dec)

Centimeters of Water

Month (Jan - Dec)

Building WetBud Model(s)

1. Create Project and Scenario
2. Build weather data
3. Determine WND years w/ WETS tables
4. User determines inputs and outputs
 1. Calculate ET for WDN years (Thornthwaite, Penman)
 2. Calculate SW_{in} using Curve Numbers
 3. Input GW_{in} or calculate using W_{em} (well data)
 4. Input or calculate Gw_{out}
 5. Input or calculate overbank flow

$$GW_{in} = K A \Delta h / \Delta x$$

(for Month B)

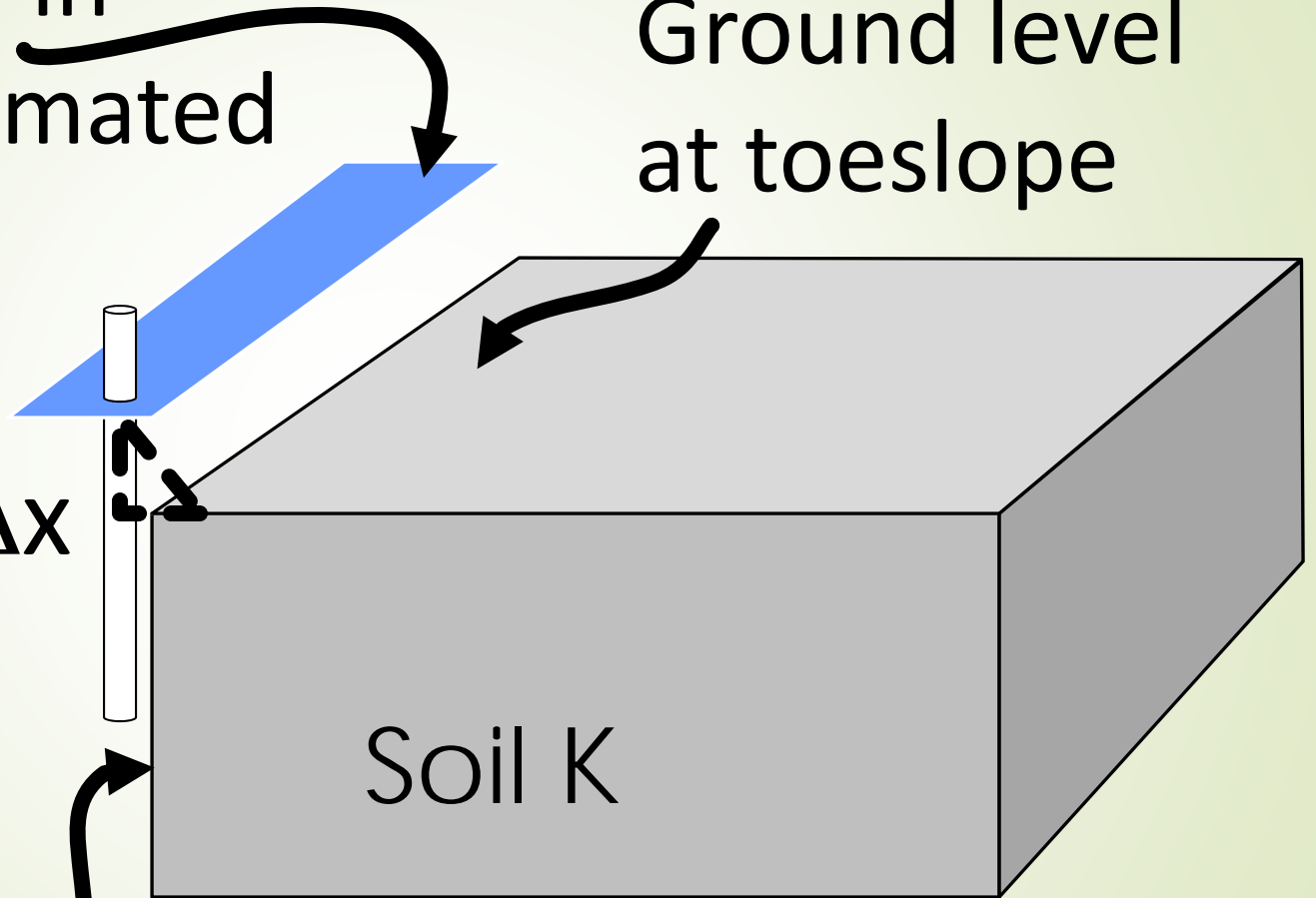
Water level in
aquifer estimated
by W_{em}
calc'ns

Ground level
at toeslope

$\Delta h / \Delta x$

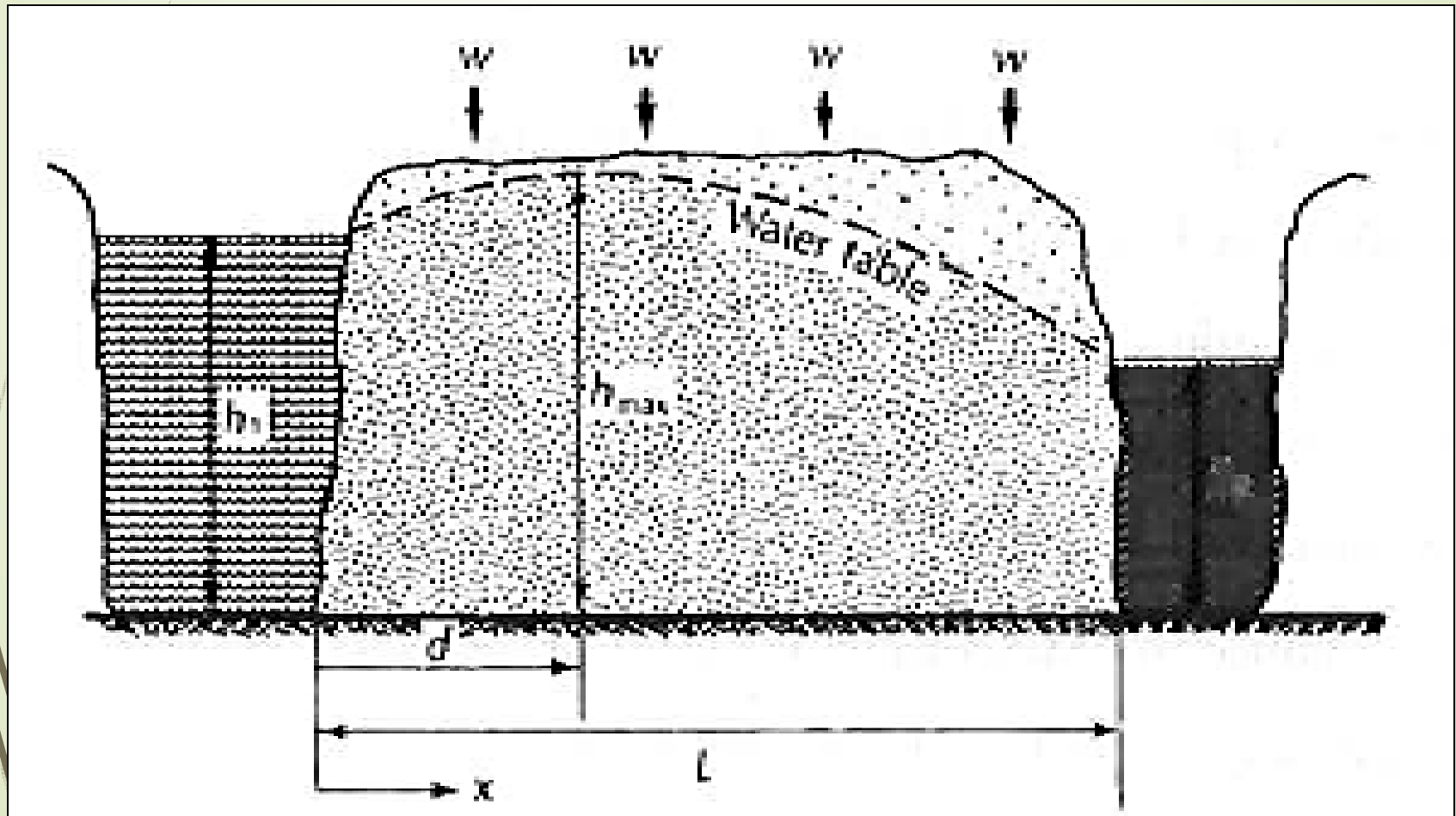
Soil K

A: cross-section of uphill end



W_{em} = “Effective Monthly Recharge”

W_{mo} = “Monthly Recharge” = $P_{ptmo} - ET_{mo}$



Effective Monthly Recharge: W_{em}

A time-weighted average recharge value

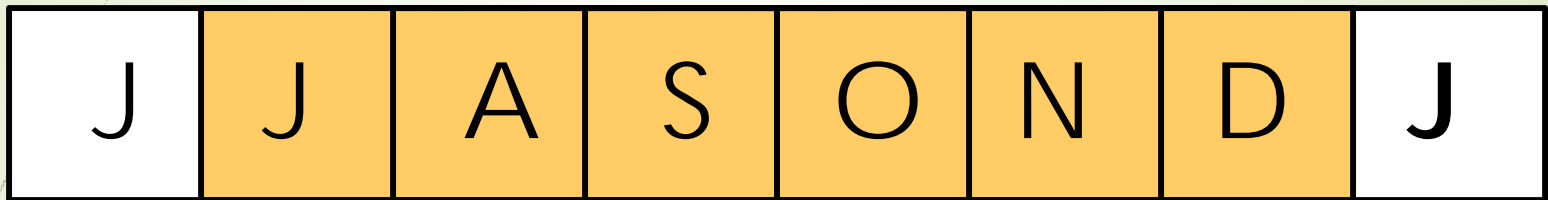
$$W_{em} = \sum_{a=1}^n W_{mo} \times d^{a-1}$$

$n = \#$ preceding months

Each month's recharge (Ppt - ET)

Response-decay factor (<1.0)

To predict the water table in Month A, how many month's W must you use?

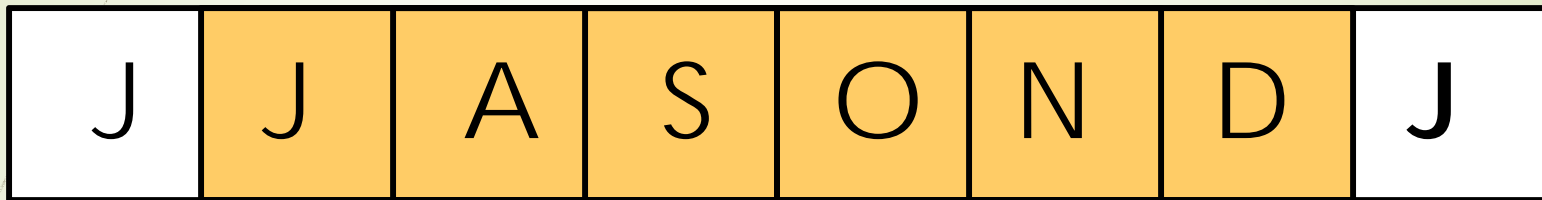


$$n = 6$$

$$W + W + W + W + W + W =$$

$$W_{em}$$

How much influence do past months have on water levels in Month A?



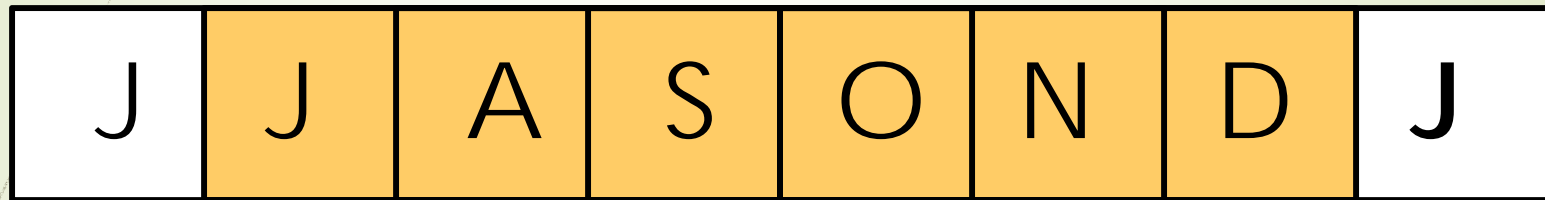
$$d = 0.99$$

$$W + W + W + W + W + W = W_{em}$$

$$d = 0.85$$

$$W + W + W + W + W + W = W_{em}$$

How much influence do past months have on water levels in Month A?



$$d = 0.99$$

$$W + W + W + W + W + W =$$

$$W_{em}$$

$$d = 0.85$$

$$W + W + W + W + W + W =$$

$$W_{em}$$

Must run every combination of n and d to find the best for prediction

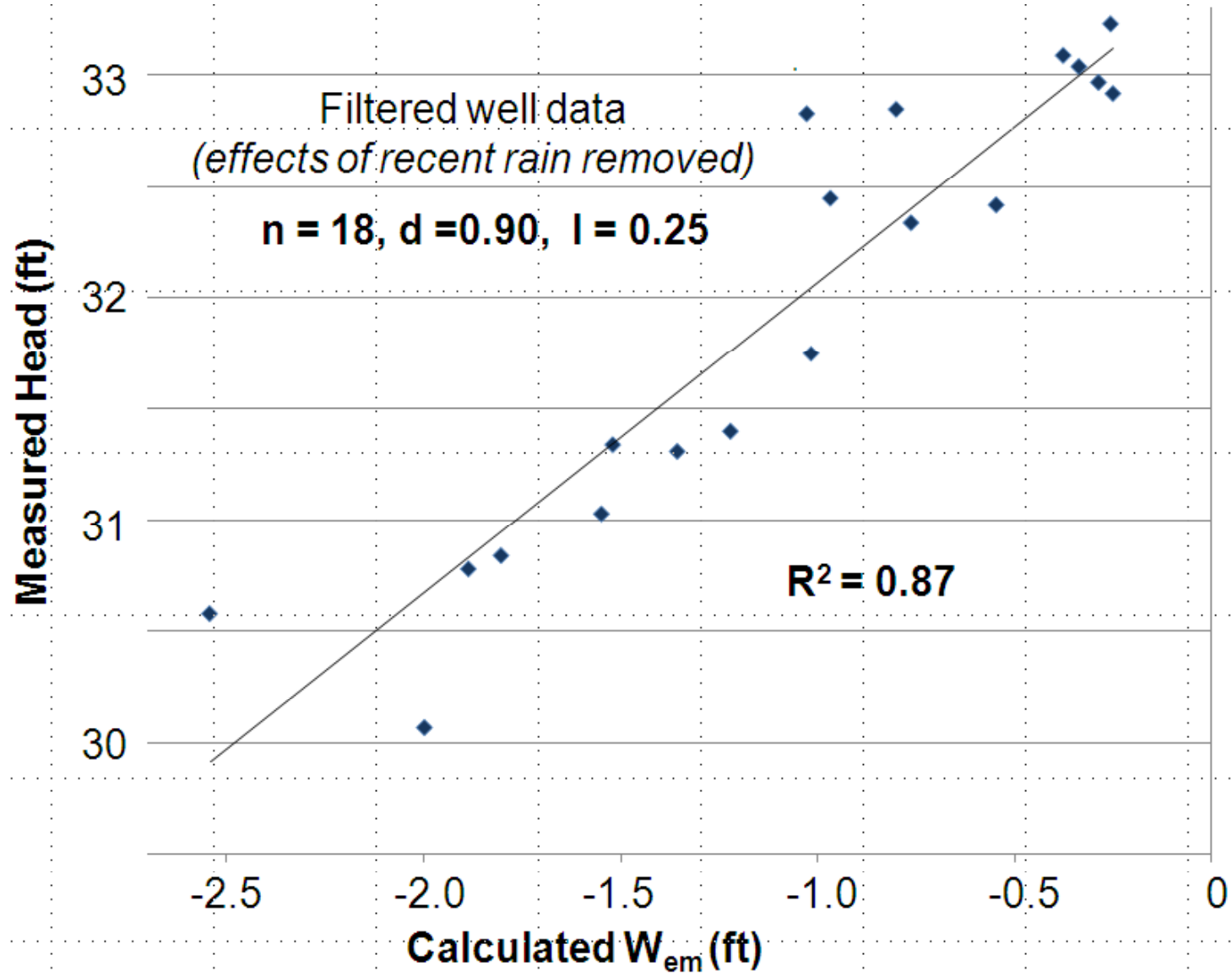
Matrix of correlation coefficients (R^2)

d: response-decay factor

n: # of antecedent months

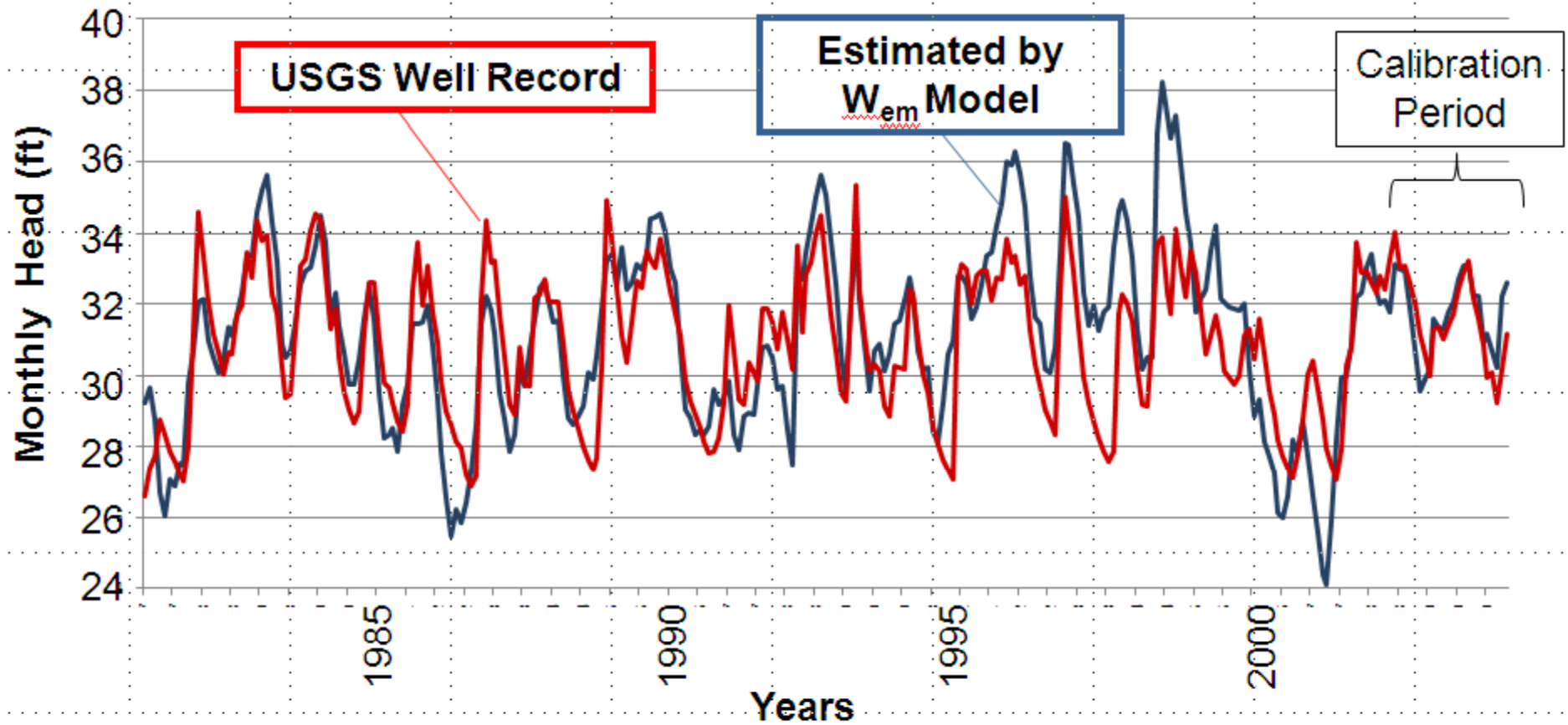
	0.99	0.9	0.85	0.8	0.7
1	0.045	0.045	0.045	0.045	0.045
2	0.1135	0.1135	0.1132	0.1125	0.1099
3	0.1336	0.1369	0.1382	0.139	0.1385
4	0.0953	0.1062	0.1121	0.1178	0.1267
5	0.2135	0.2135	0.212	0.2089	0.1972
6	0.3747	0.3565	0.3402	0.3198	0.2694
7	0.1452	0.1452	0.1452	0.1452	0.1452
8	0.4705	0.5043	0.4858	0.4438	0.3329
9	0.0849	0.0861	0.0861	0.4794	0.3428
10	0.4622	0.6484	0.6151	0.5259	0.3512
11	0.2021	0.2021	0.2021	0.2021	0.2021
12	0.2533	0.6793	0.6636	0.5451	0.3494
13	0.1567	0.6551	0.6473	0.5316	0.3455
14	0.188	0.705	0.662	0.5346	0.3457
15	0.258	0.7742	0.6955	0.5477	0.3475
16	0.4136	0.824	0.72	0.5597	0.3494
17	0.3884	0.8587	0.7356	0.5638	0.3496
18	0.3661	0.8711	0.7412	0.5653	0.3497
19	0.2022	0.858	0.7445	0.5652	0.3494
20	0.0474	0.8327	0.7263	0.5548	0.348
21	0.0013	0.7233	0.7023	0.5455	0.3468
22	0.0149	0.5455	0.6768	0.5405	0.3463

W_{em} vs Measured Head (2003-2005)



Verification of W_{em} Calculations

Groundwater Head - Measured and Predicted Monthly (1981-2005)



W_{em} = “Effective Monthly Recharge”

$$W_{mo} = \text{“Monthly Recharge”} = Ppt_{mo} - ET_{mo}$$

Must have at least 6 months of
water level measurements
from a well just uphill of site

W_{em} = “Effective Monthly Recharge”

$$W_{mo} = \text{“Monthly Recharge”} = Ppt_{mo} - ET_{mo}$$

Must have at least 6 months of
water level measurements
from a well just uphill of site

Can reconstruct GW levels
using weather data for times
with no well data

Input GW_{in} or calculate using W_{em}

Project Scenarios

New Scenario

SC_CODE	SC_DESCR
NW_Penman	CR_GW +
NW_Penman	Custom Range
NW_Penman	2010,2011,2012
NW_Thorn	CR_GW+
NW_Thorn	Custom Range
NW_Thorn	2010,2011,2012
SW_Penman	CR_GW +
SW_Penman	Custom Range
SW_Penman	2001,1982,1983
SW_Thorn	CR_GW+
SW_Thorn	Custom Range
SW_Thorn	2007,1982,1983

General | Watershed Data | **Inputs and Outputs** | PET Options | Management | Periods | Advanced Model

Water Inputs

Initial Fill (in) 3.000

Ground Water IN Options

No Groundwater IN Rate (in/mo)

Use Constant Rate

Use Variable Rate

Direct Surface Runoff into Wetland

Precipitation

Stream Overbank Flow

CR NW THN

Water Outputs

PET

Ground Water OUT Options

No Groundwater OUT Rate (in/mo)

Use Constant Rate 0.20000

Use Variable Rate

Waterlevel Adjustment

Soil Storage Factor (0-1) 0.25

Surface Storage Factor (0-1) 0.98

Average Wetland Depth to Weir

Use Constant Depth

Use Variable Depth

Depth (in) 3.000

Building WetBud Model(s)

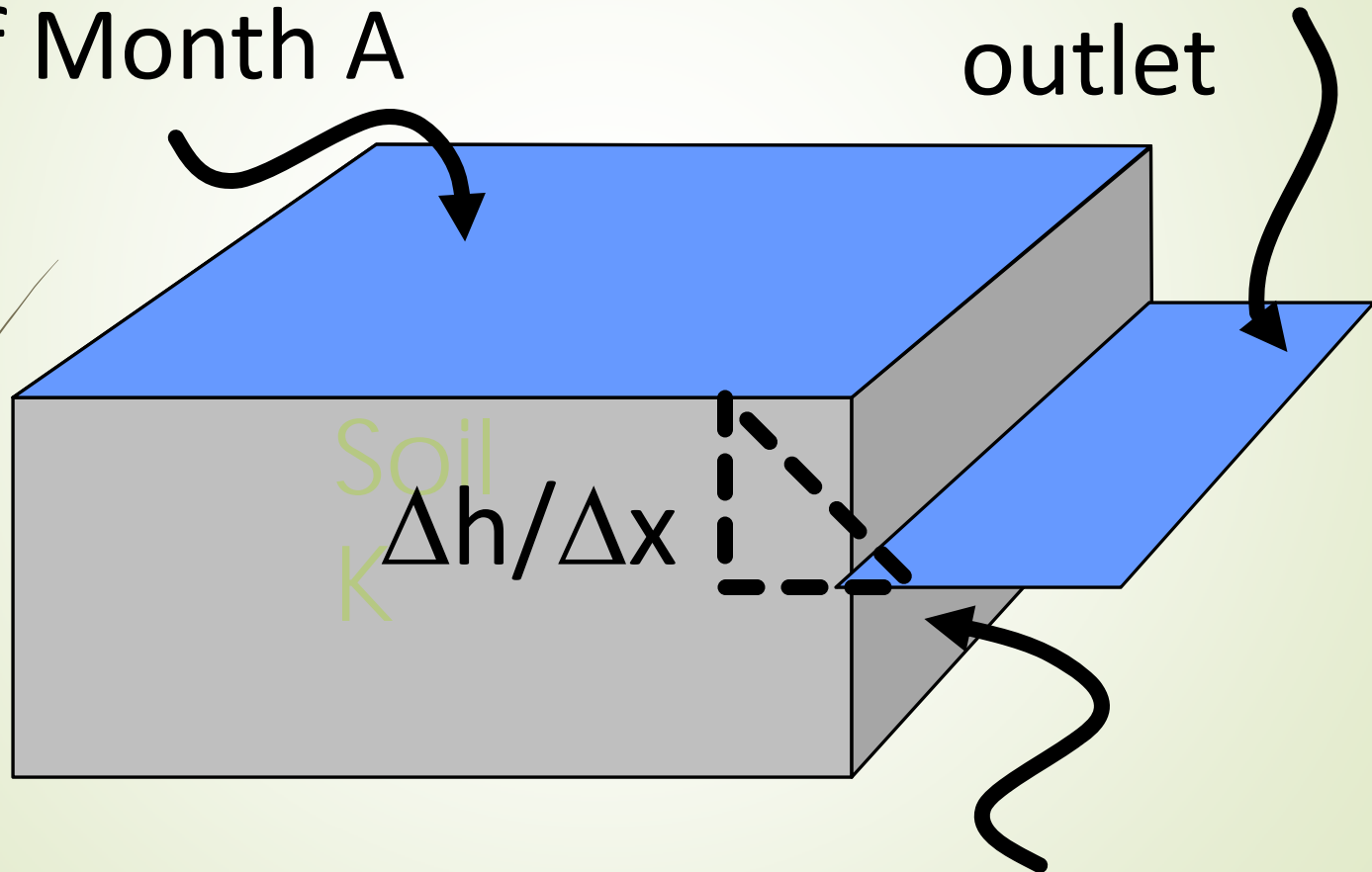
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 - 4. Input or calculate GW_{out}**
 5. Input or calculate overbank flow

$$GW_{\text{out}} = K A \Delta h / \Delta x$$

(for Month B)

Water level at
end of Month A

Water level below
outlet



A: cross-section of downhill end

Input or calculate GW_{out}

Project Scenarios

New Scenario

SC_CODE	SC_DESCR
NW_Penman	CR_GW +
NW_Penman	Custom Range
NW_Penman	2010,2011,2012
NW_Thorn	CR_GW+
NW_Thorn	Custom Range
NW_Thorn	2010,2011,2012
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General | Watershed Data | **Inputs and Outputs** | PET Options | Management | Periods | Advanced Model

Water Inputs

Initial Fill (in) 3.000

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Average Wetland Depth to Weir

Use Constant Depth

Use Variable Depth

Depth (in) 3.000

Export Exit

WetBud is being tested at four sites

Cedar Run 3 Wetland Bank

completed in October 2001 by WSSI

Bender Farms Wetland Bank

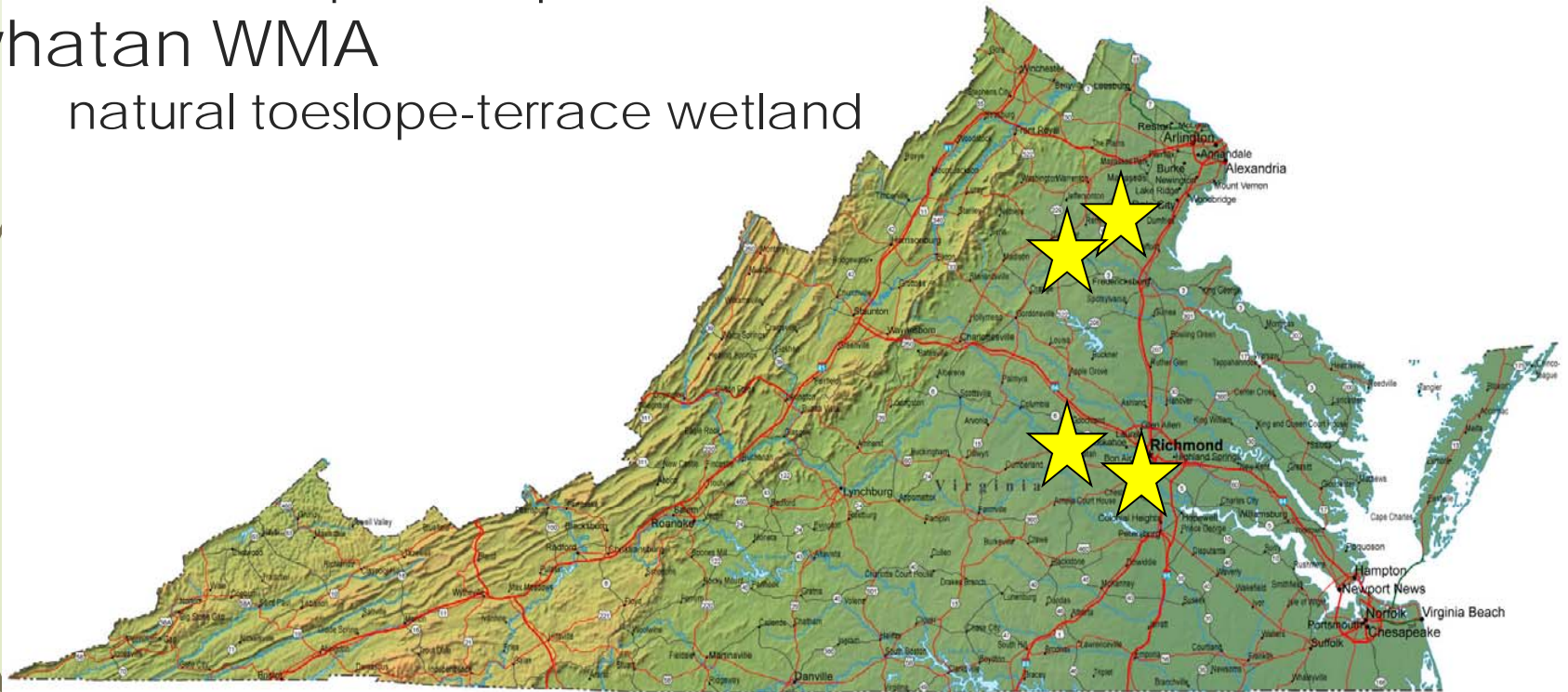
completed by Acorn Environ

Pocahontas State Park

natural toeslope-floodplain wetland

Powhatan WMA

natural toeslope-terrace wetland



WetBud is being tested at four sites

Cedar Run 3 Wetland Bank

completed in October 2001 by WSSI

Bender Farms Wetland Bank

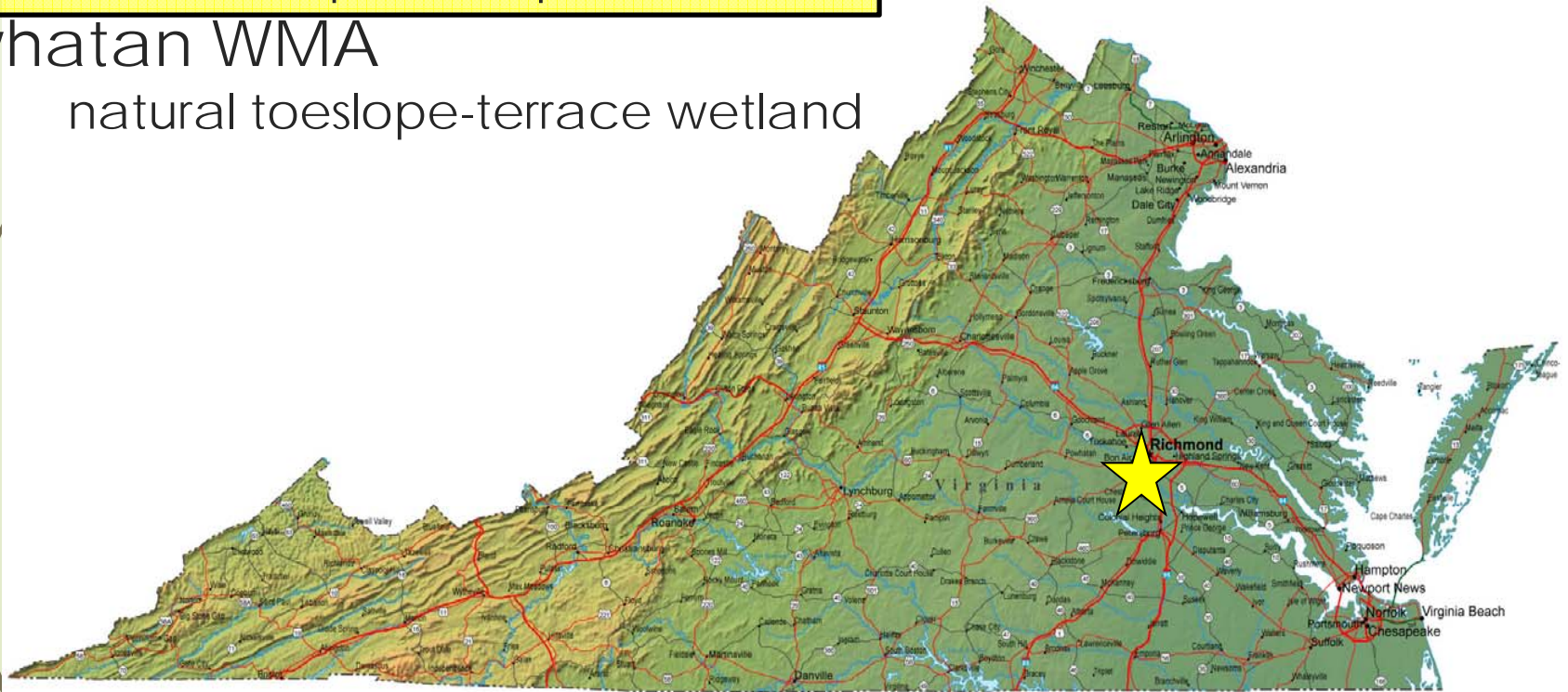
completed by Acorn Environ

Pocahontas State Park

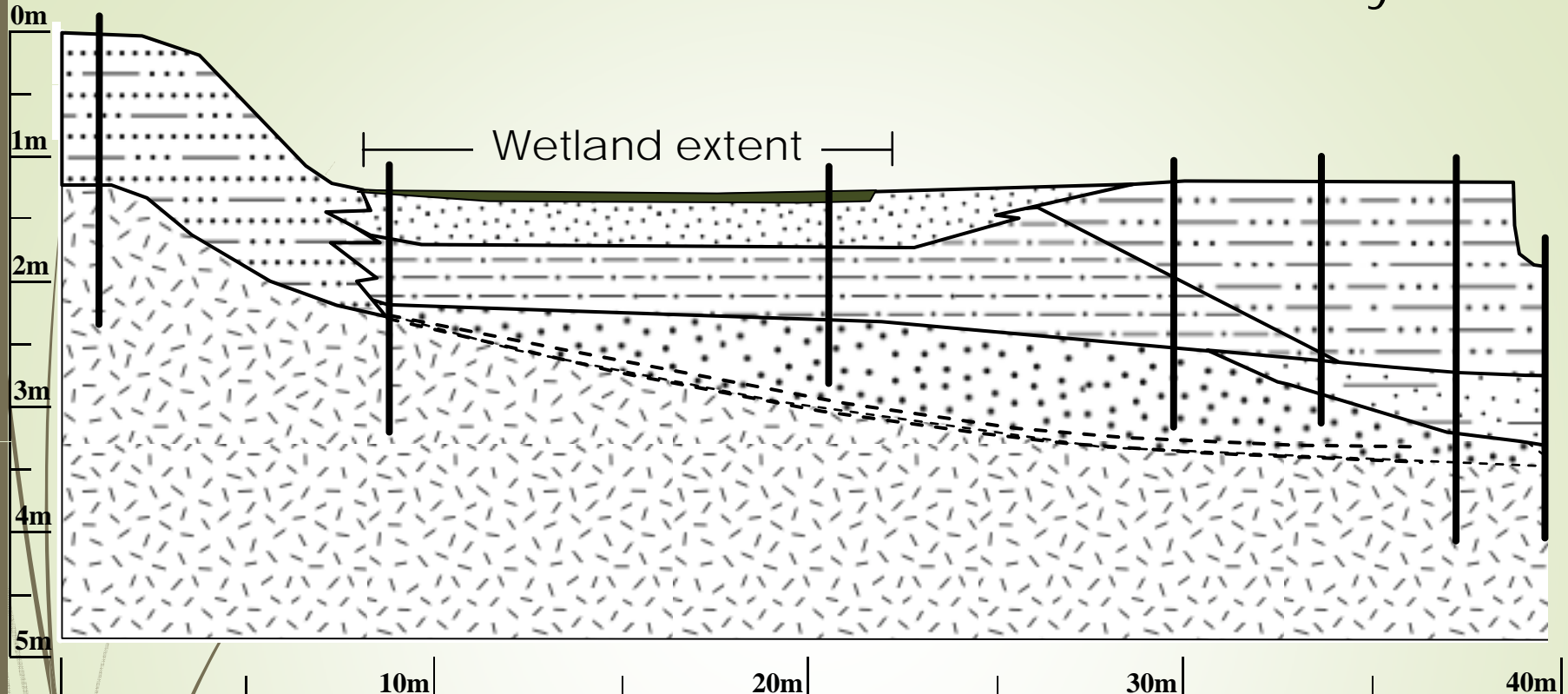
natural toeslope-floodplain wetland

Powhatan WMA

natural toeslope-terrace wetland



Cross-section of Pocahontas State Park study site



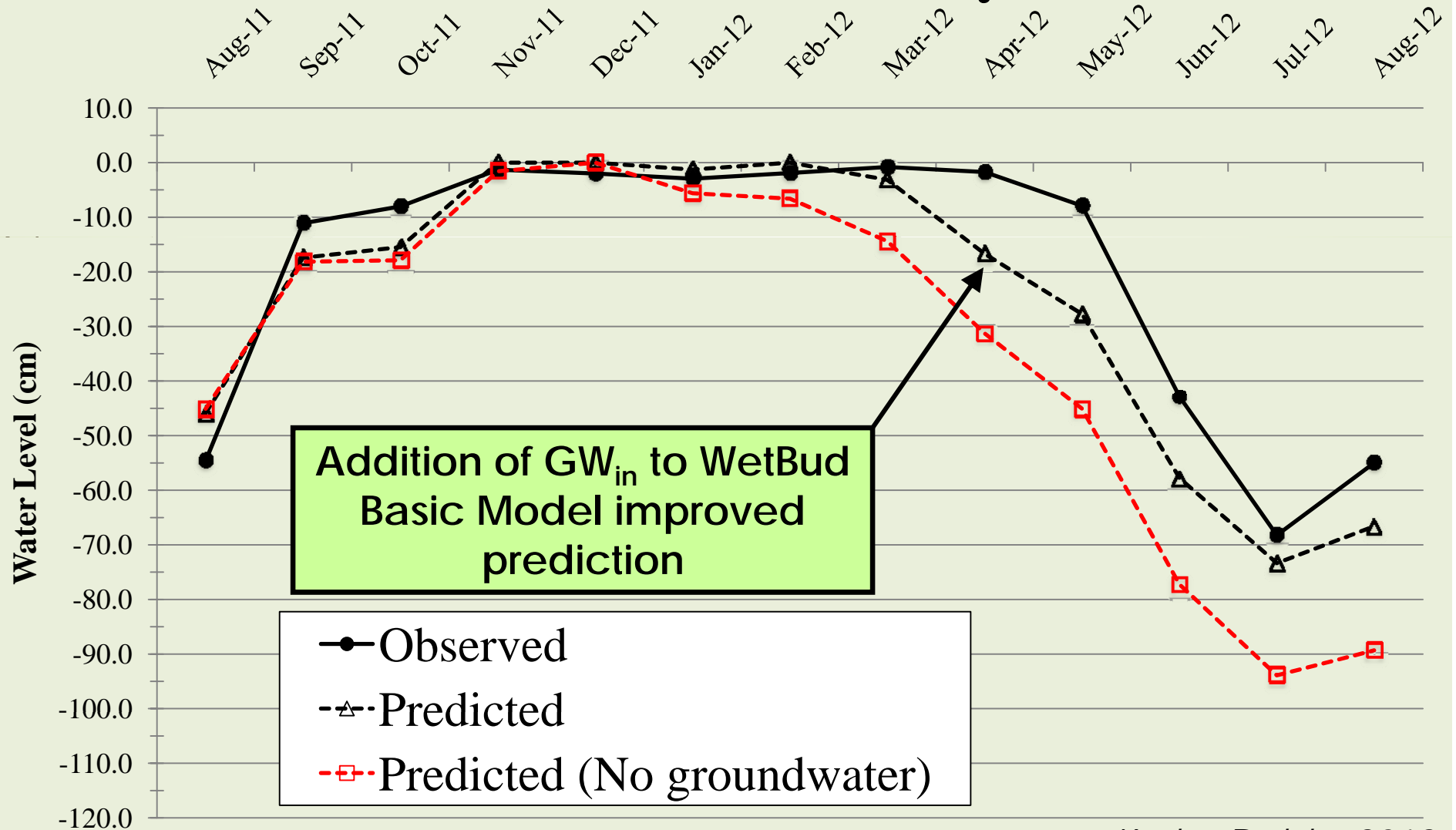
- | | | | |
|--|-----------------------|--|------------------------|
| | Granitic saprolite | | Fibrous muck |
| | Medium-fine sand | | Silty clay loam |
| | Dense, sandy clay | | Coarse sand |
| | Micaceous clayey sand | | Coarse sand and gravel |
| | Sandy loam | | |

Vertical black bars indicate locations and approximate depths of boreholes used for stratigraphic correlations. Dashed lines represent inferred contacts.

- Kerby Dobbs 2013

Basic Model output: toe-slope water level

Pocahontas State Park study site



- Kerby Dobbs 2013

WetBud is being tested at four sites

Cedar Run 3 Wetland Bank

completed in October 2001 by WSSI

Bender Farms Wetland Bank

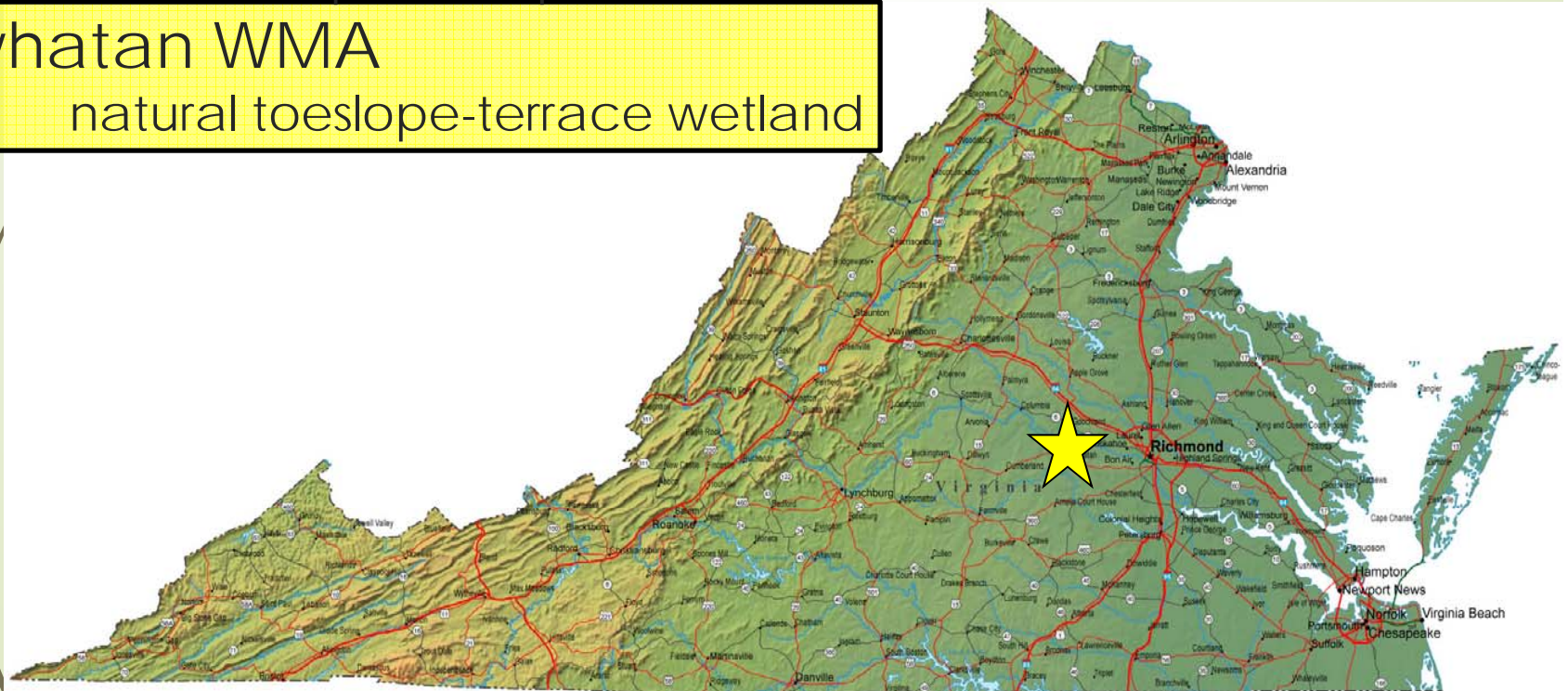
completed by Acorn Environ

Pocahontas State Park

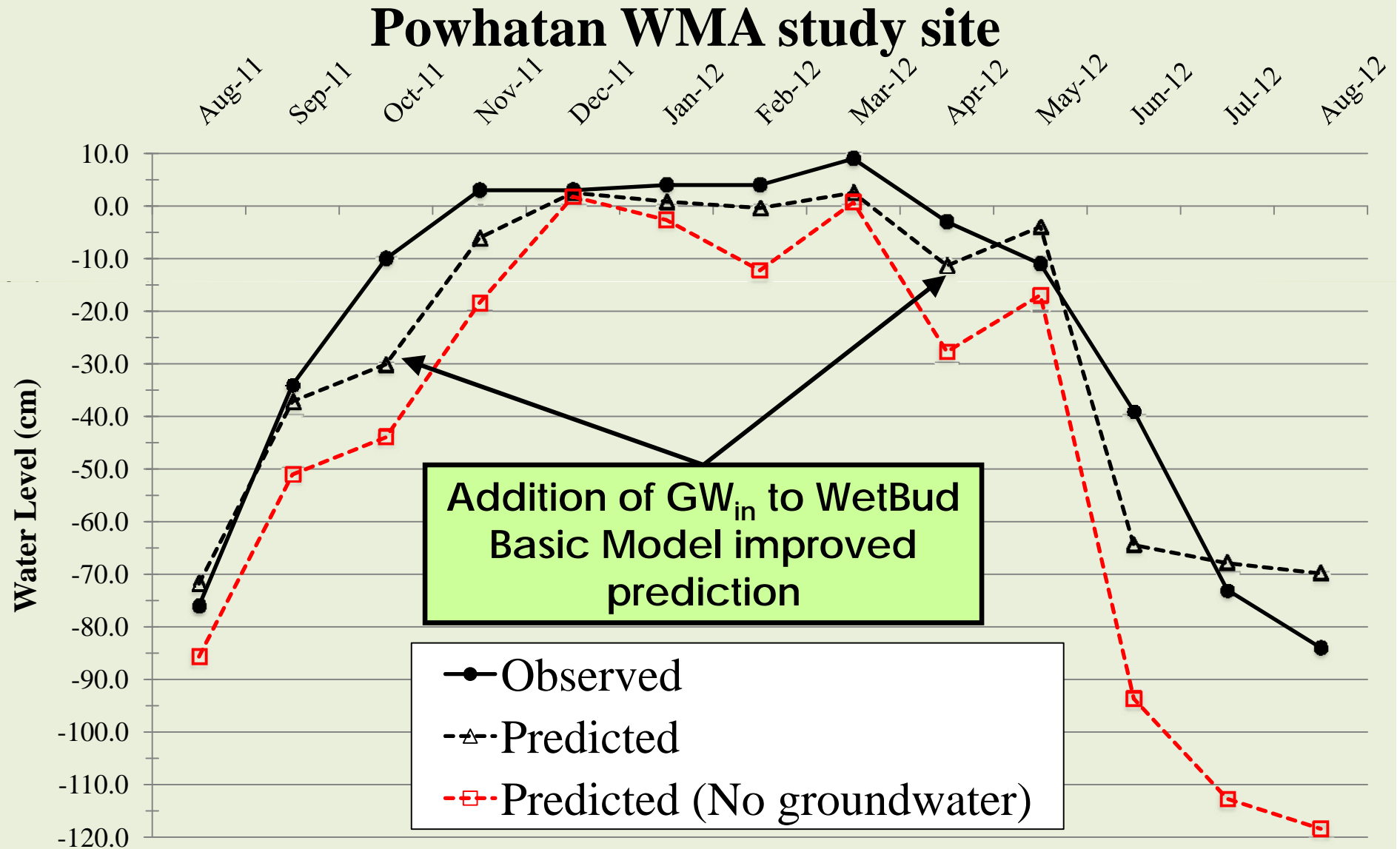
natural toeslope-floodplain wetland

Powhatan WMA

natural toeslope-terrace wetland



Basic Model output: toe-slope water level

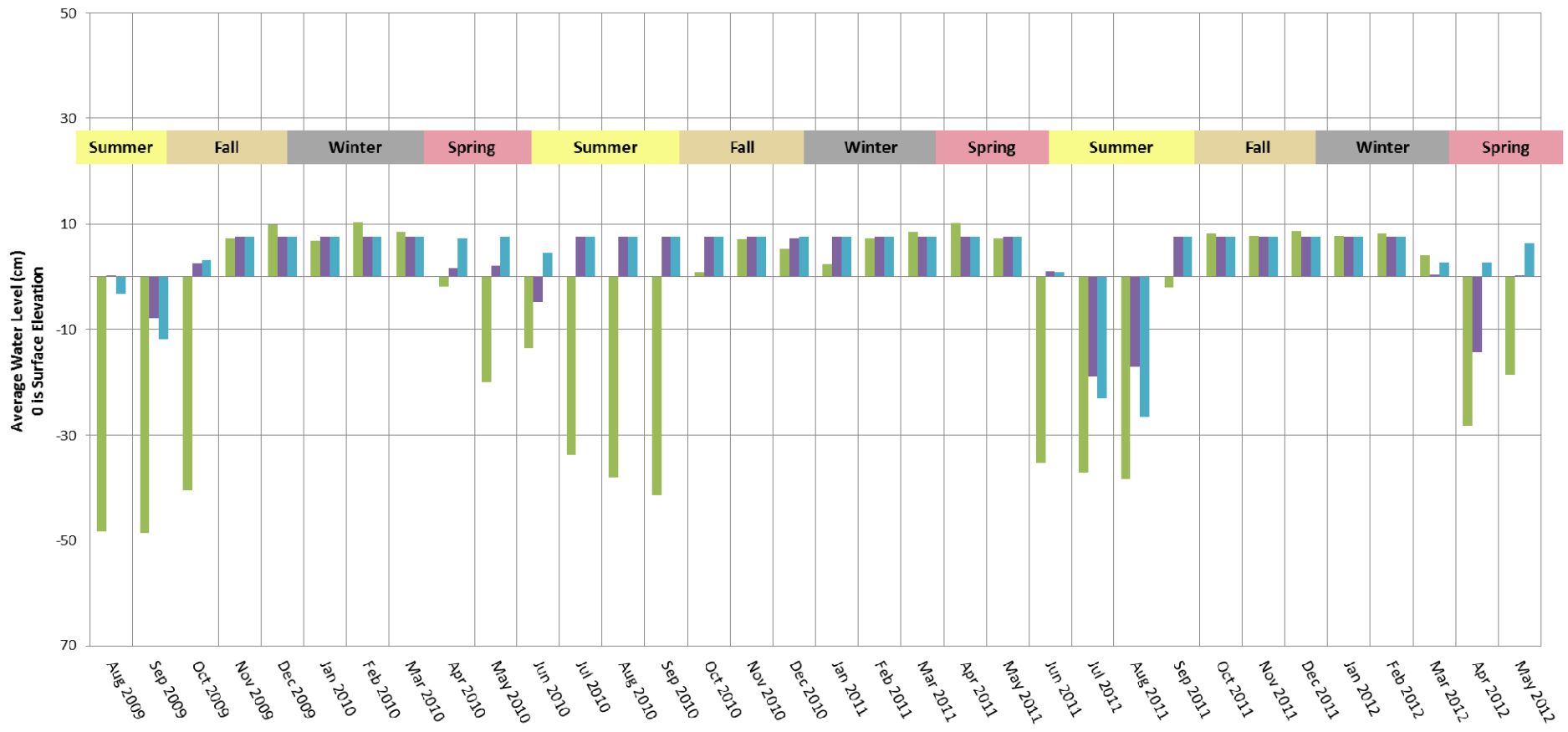


- Kerby Dobbs 2013

Cedar Run 3 Basic Model Results

- Average Monthly Well Data
- Penman Basic Model Results
- Thornthwaite Basic Model Results

Cedar Run 3 SW Basic Model Results



Ongoing Work

- Fully integrating Wem
- Overbank flow routines
- Advanced model wizard
- Completing testing (5 sites)
- Developing output for use in wetland hydrologic assessments;
- Developing an instruction manual;
- Developing training materials and workshops



Questions?