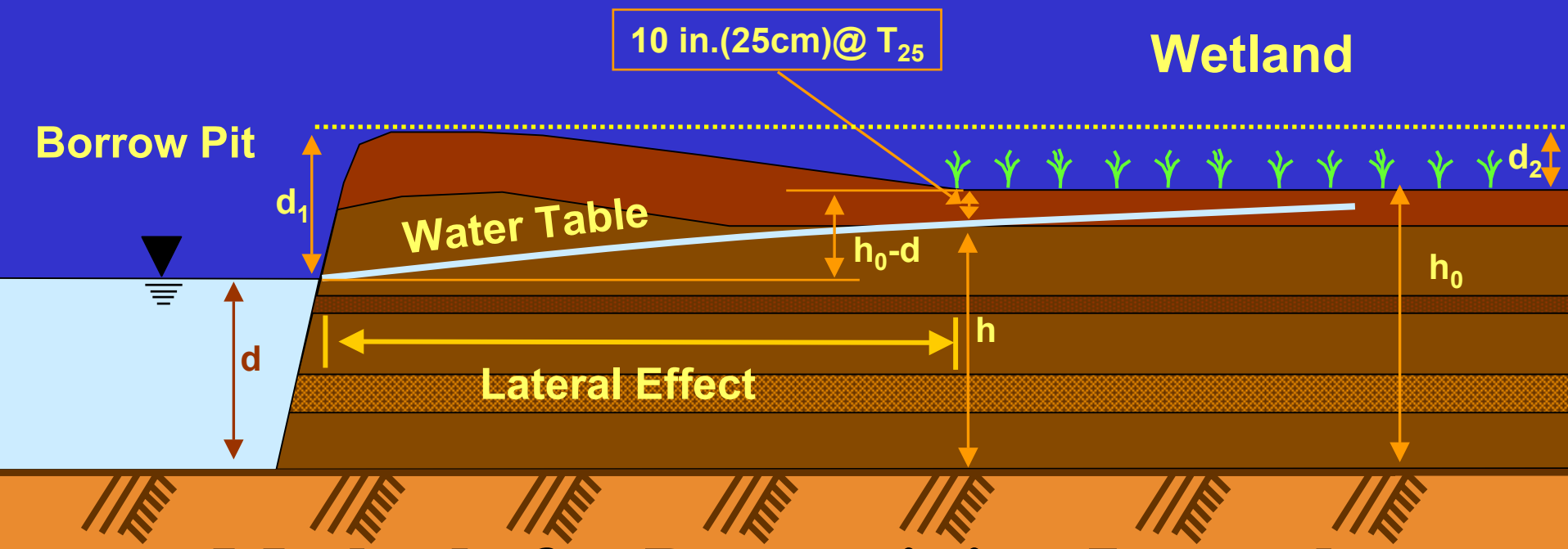


Methods for Determining Lateral Effects of a Borrow Pit on Adjacent Wetlands

1-23-07

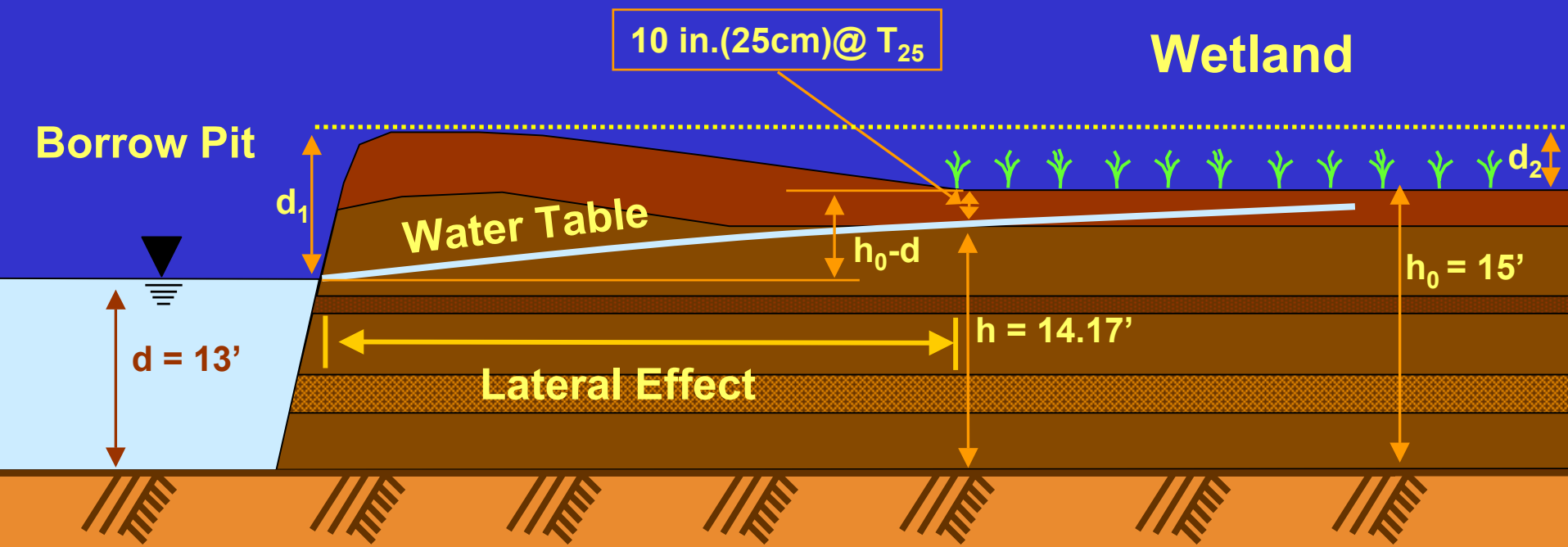
Objectives:

- Develop information necessary to estimate the lateral effect of wetland hydrology.
- Survey existing (closed) borrow pits to determine factors that might affect adjacent wetlands.
- Measure (record) water level rise after closure in 5 borrow pits and W.T.E. in adjacent wetlands.
- Develop a model to predict water balance in pit.
- Conduct workshops to teach use of the method

Example 1

- A borrow pit is to be excavated in a Goldsboro soil adjacent to a wetland.
- The depth of the pit will be 17 ft. with the bottom 15 ft below the surface of the wetland.
- Hydraulic conductivity of the soil is 2 in./hr and the drainable porosity is 0.035.
- What setback distance is require to avoid hydrologic impacts to the wetland.

Example 1



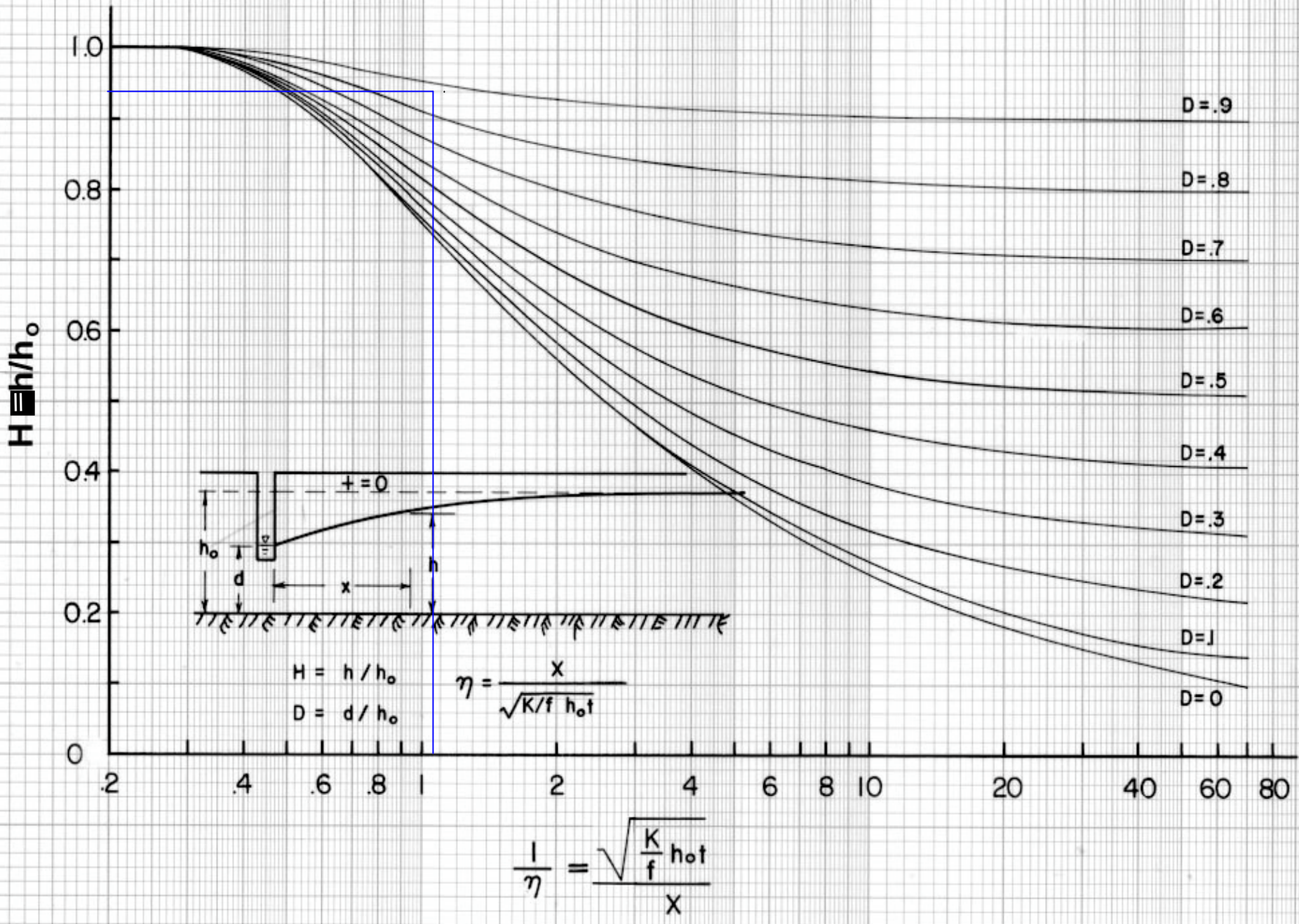
H= h/h_o = 14.17/15 = 0.94

D= d/h_o = 13/15 = 0.87

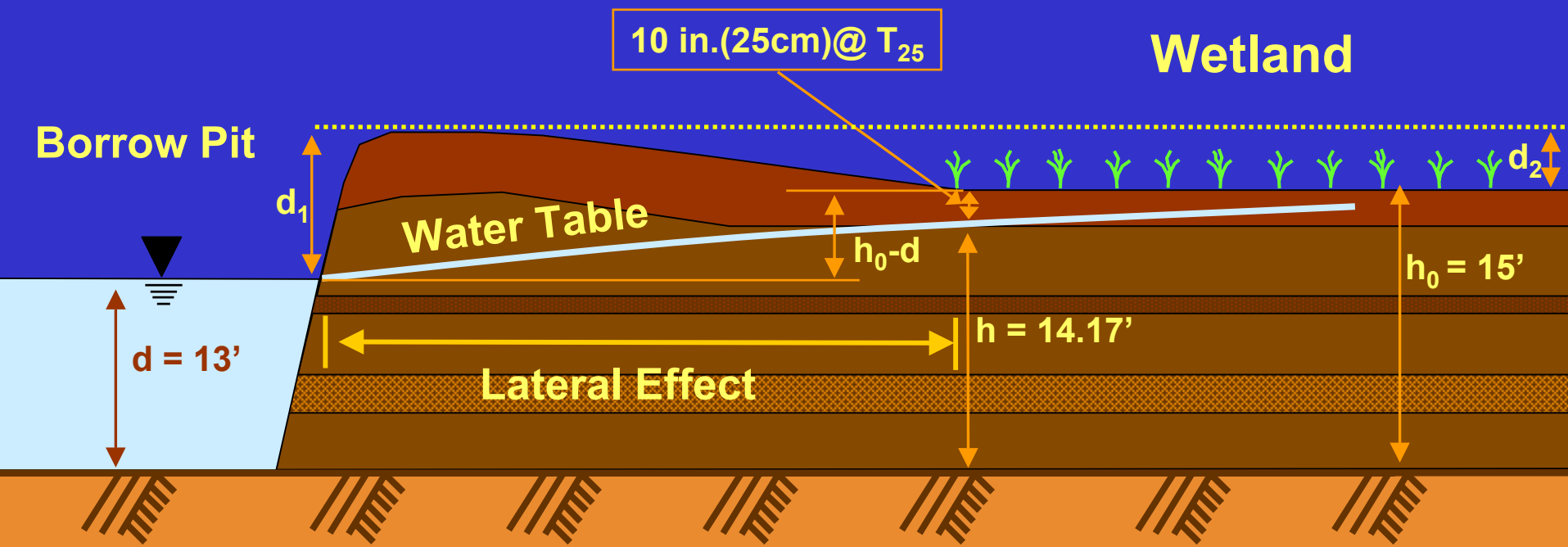
$$\frac{\sqrt{K/f\ h_o\ t}}{x} = 1/?$$

K= 2 in./hr = 4 ft/d, f = 0.035

$$x = \frac{\sqrt{\frac{4}{.035}\ 15 \cdot 5.2}}{1/?} =$$


H = h/h₀
1.0
0.8
0.6
0.4
0.2
0
.2
.4
.6
.8
1
2
4
6
8
10
20
40
60
80
D=.9
D=.8
D=.7
D=.6
D=.5
D=.4
D=.3
D=.2
D=1
D=0
± =0
h₀
d
x
h
H = h / h₀
D = d / h₀
η = X / √(K/f h₀t)
1/η = √(K/f h₀t) / X

Example 1



H= h/h_o = 14.17/15 = 0.94

D= d/h_o = 13/15 = 0.87

$$\frac{\sqrt{K/f\ h_o\ t}}{x} = 1.08$$

K= 2 in./hr = 4 ft/d, f = 0.035

$$x = \frac{\sqrt{\frac{4}{.035}15 \cdot 5.2}}{1.08} = 88 \text{ ft}$$

Setback distance = 88 ft

Location of Borrow Pits Surveyed

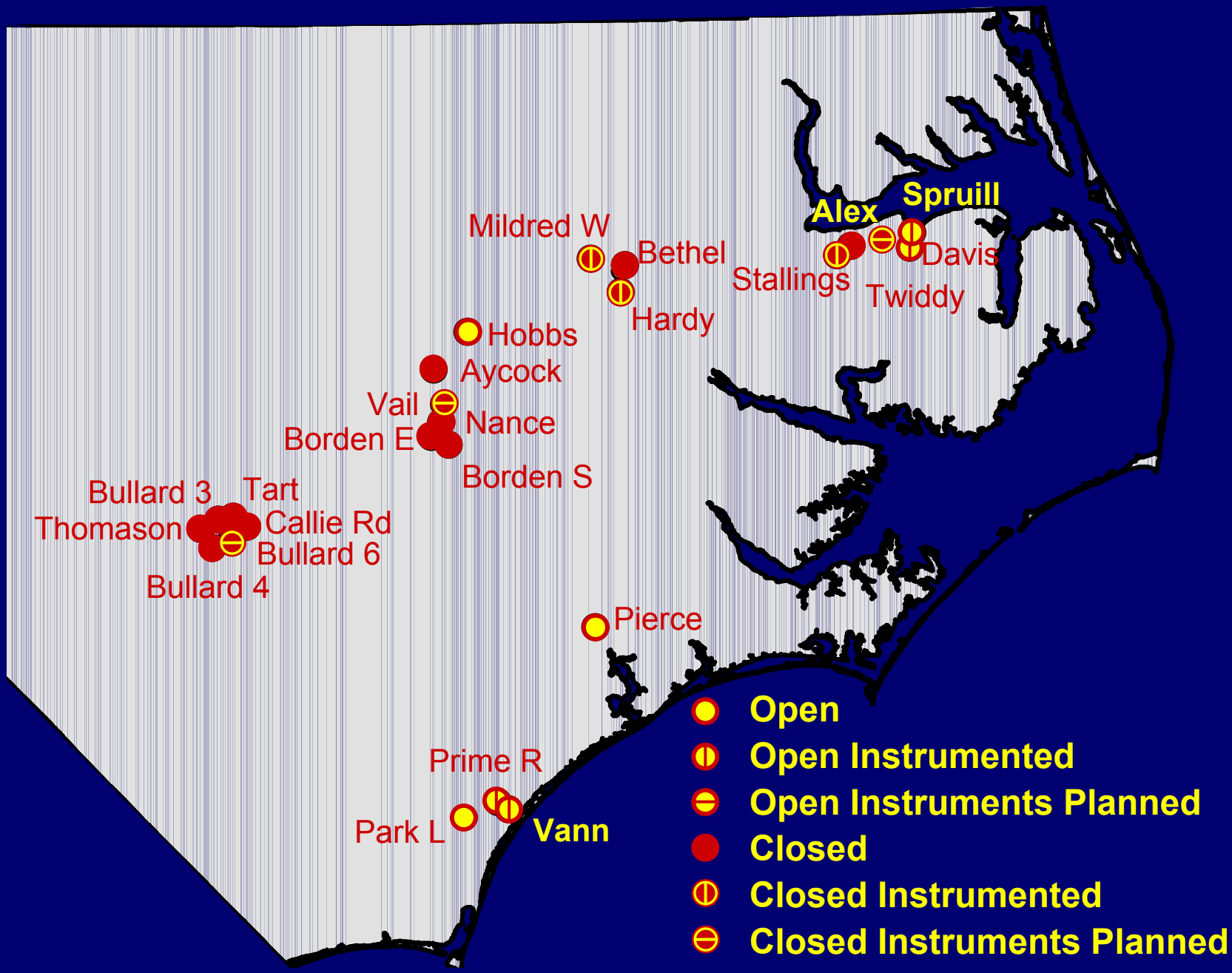


Table 1. Summary of Pit and wetland surface elevations

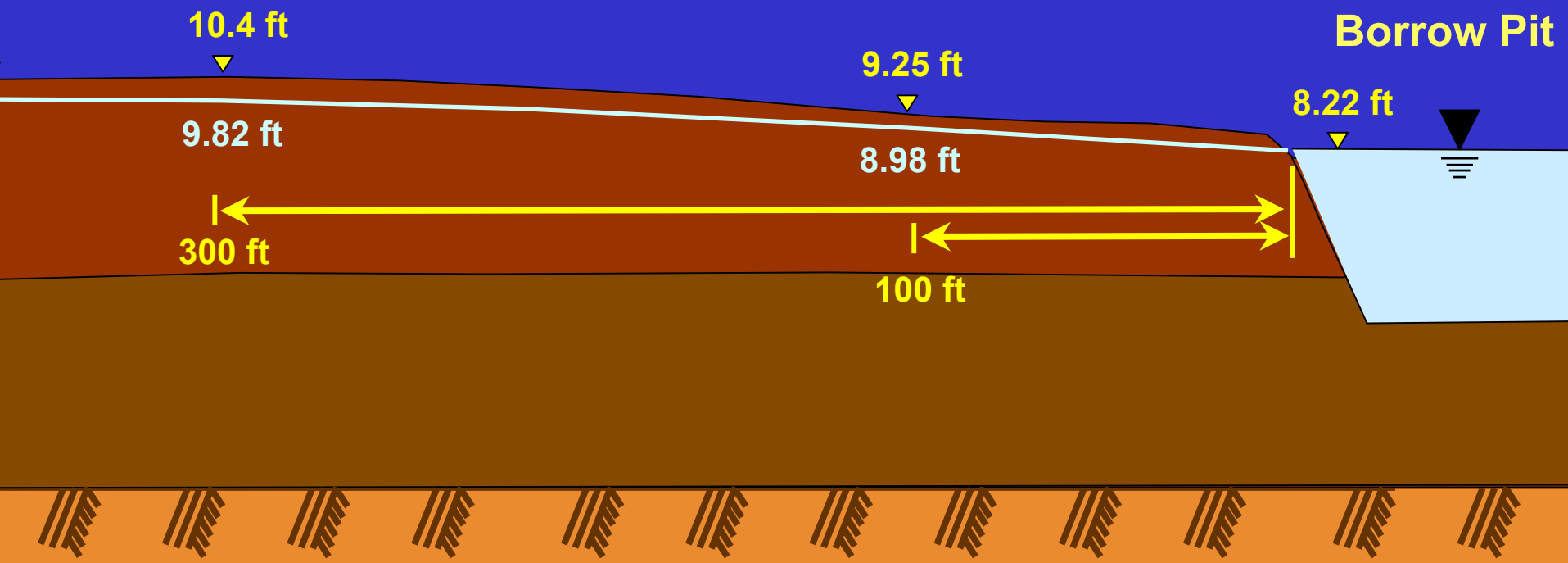
Name	WSE Pit (ft)	Wetland Sur El (ft)	Δh (ft)	Distance from Pit (ft
Bordon E	4.43	5.64	1.21	98
Bordon S	7.07	1.01	-6.06	176
Bullard 4	1.26	5.05	3.79	70
Bullard 6 tbi ?	5.74	8.13	2.39	315
Callie Road	4.13	8.43 ?	4.2	125
Hardy i	7.94	10.2	2.3	230
Mildred Woods i	8.22	9.25	1.03	100
Nance	5.33	1.77	-3.44	90
Pierce	7.45	4.82	-2.63	156
Stallings i	3.42	1.67	-1.75	100
Tart	10.23	5.08	-5.17	267
Twiddy tbi	2.52	2.5	0	127
Vail tbi	13.3	6.24	-7	100
Williams	2.89	5.6	2.7	112

Summary of survey of closed pits

Flow Direction	Number
Wetland to Pit	12
Pit to Wetland	9
Unclear	7
Total	28

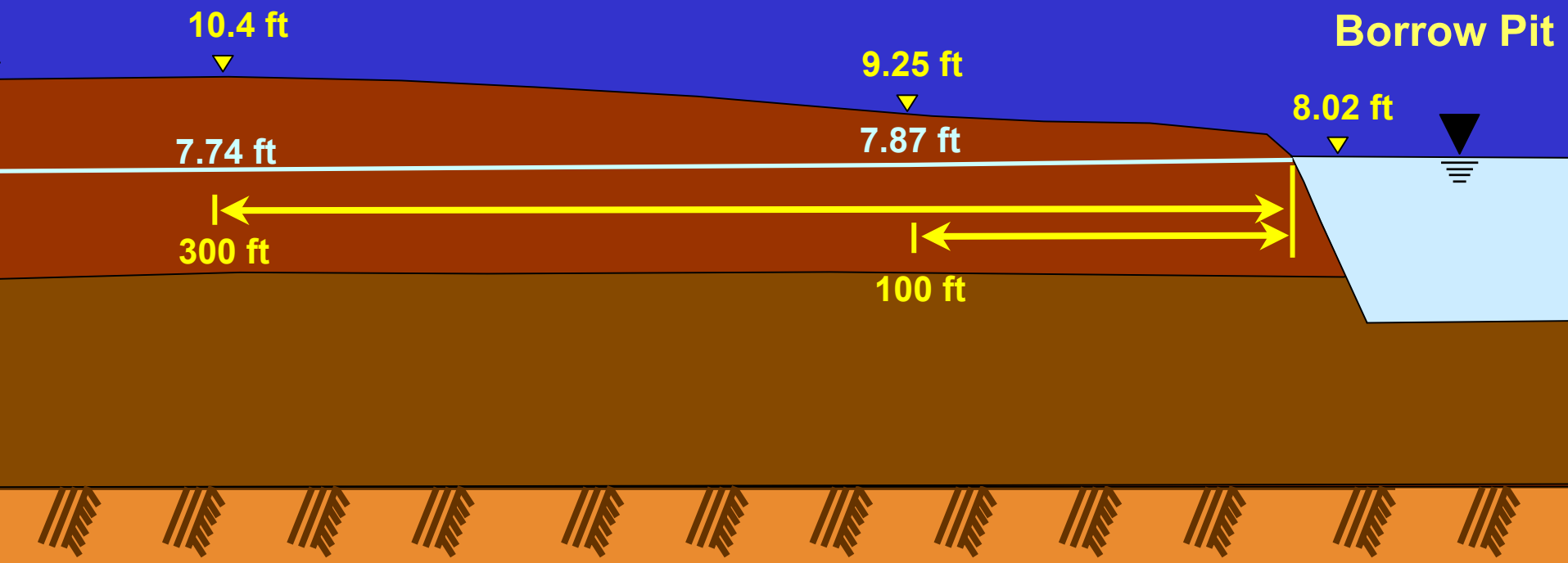
Mildred Woods Pit

May 3, 2005

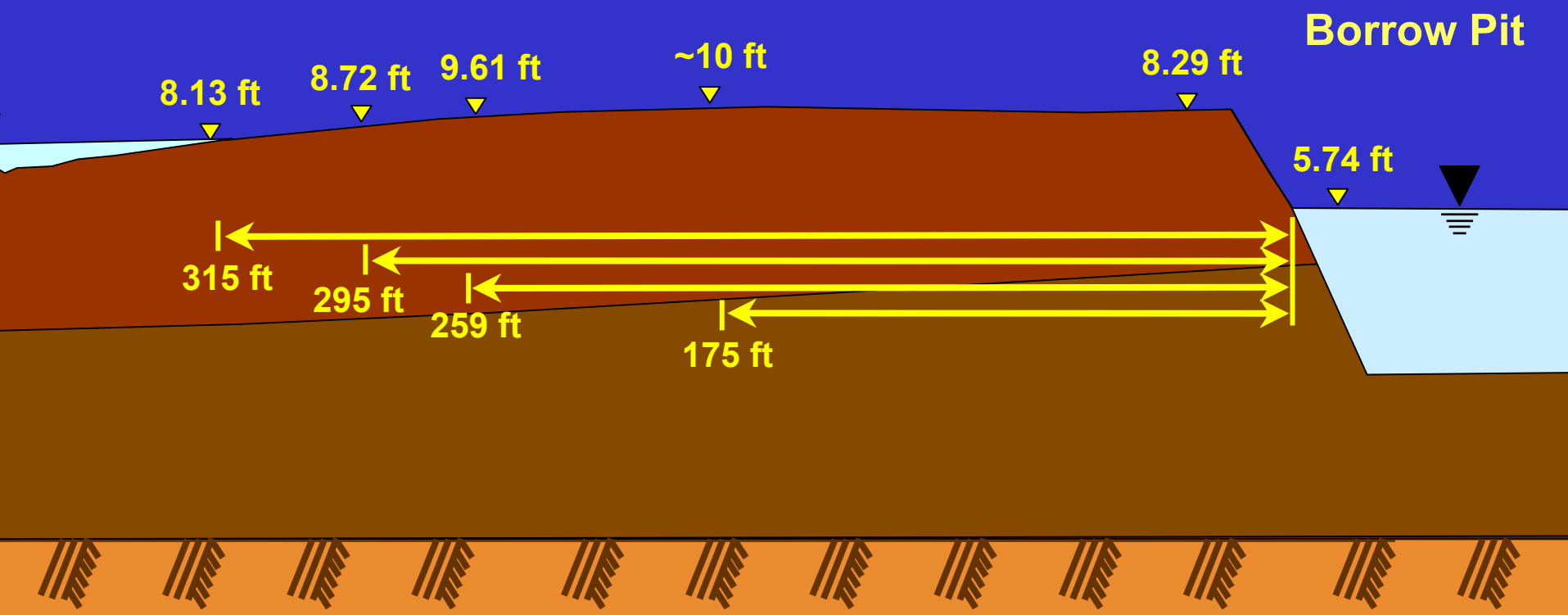


Mildred Woods Pit

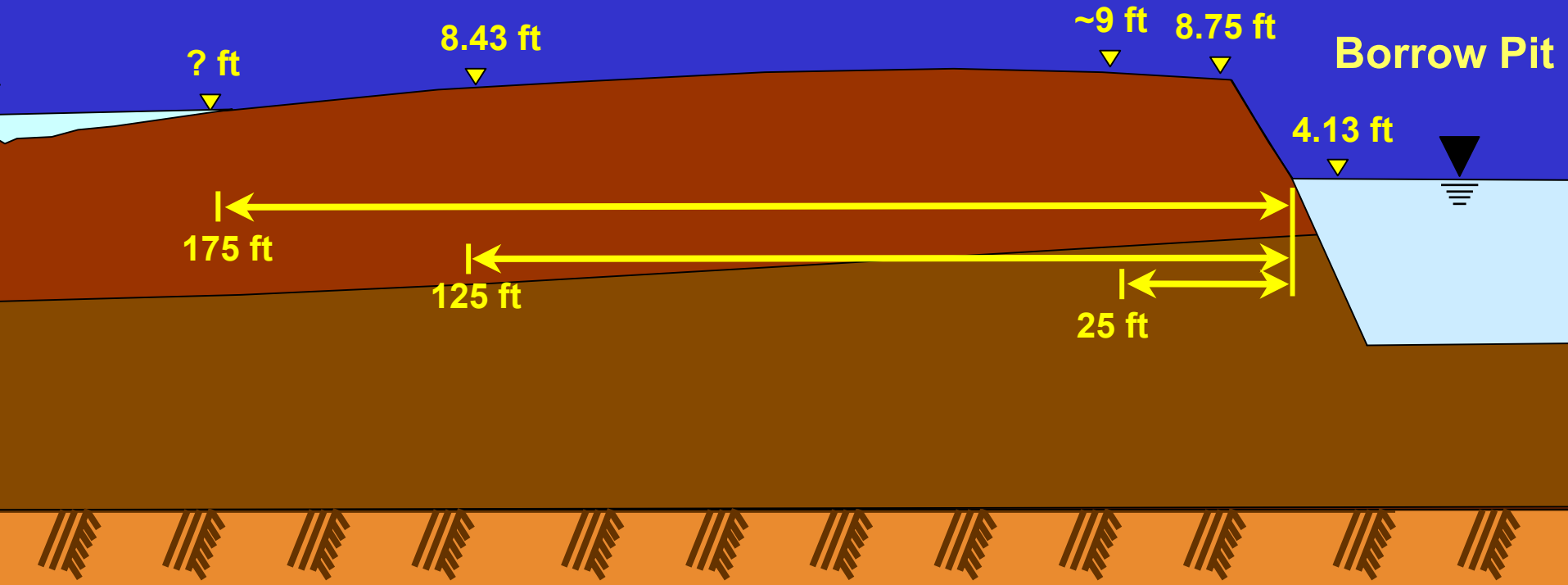
August 3, 2005



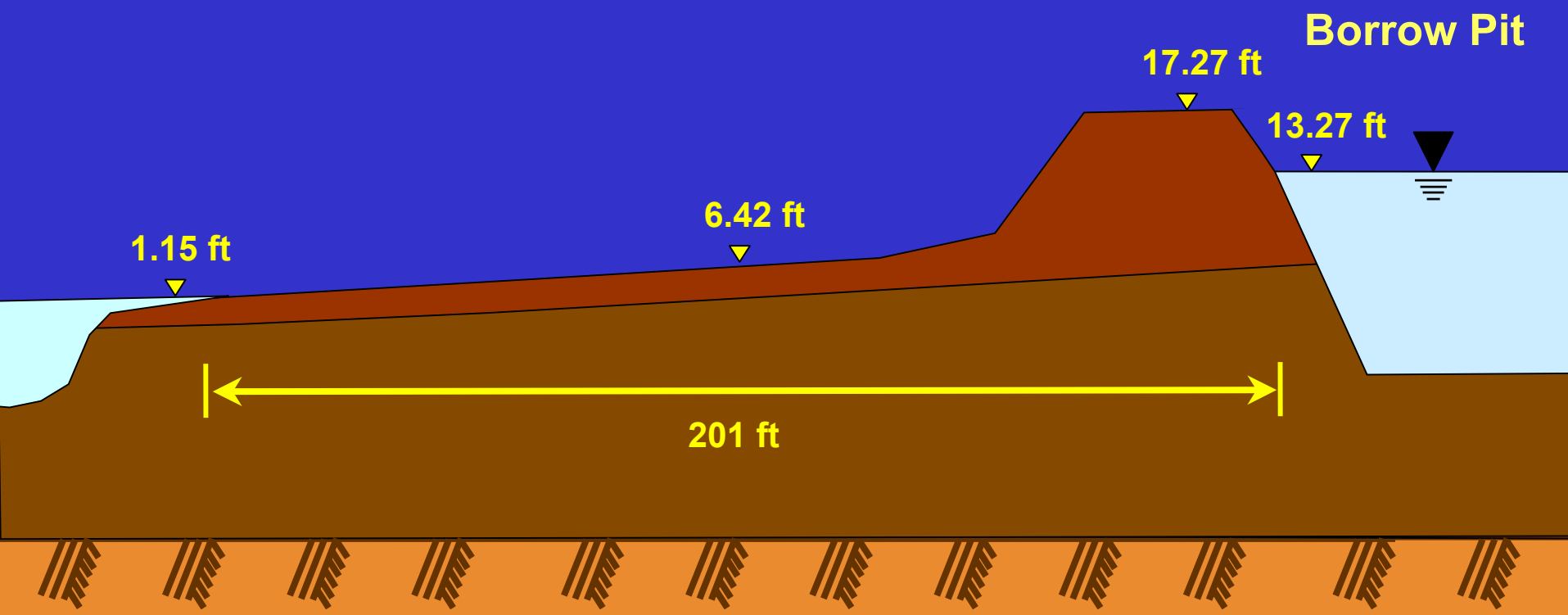
Bullard 6 Pit



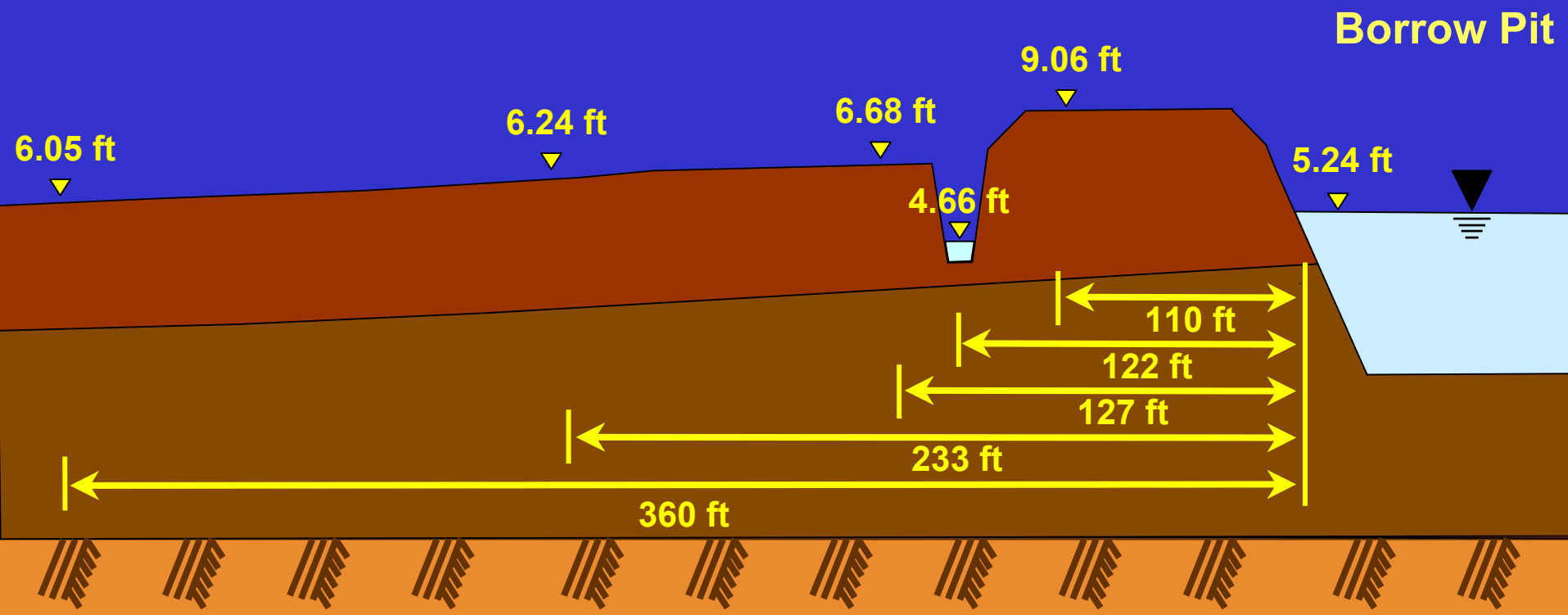
Callie Road Pit



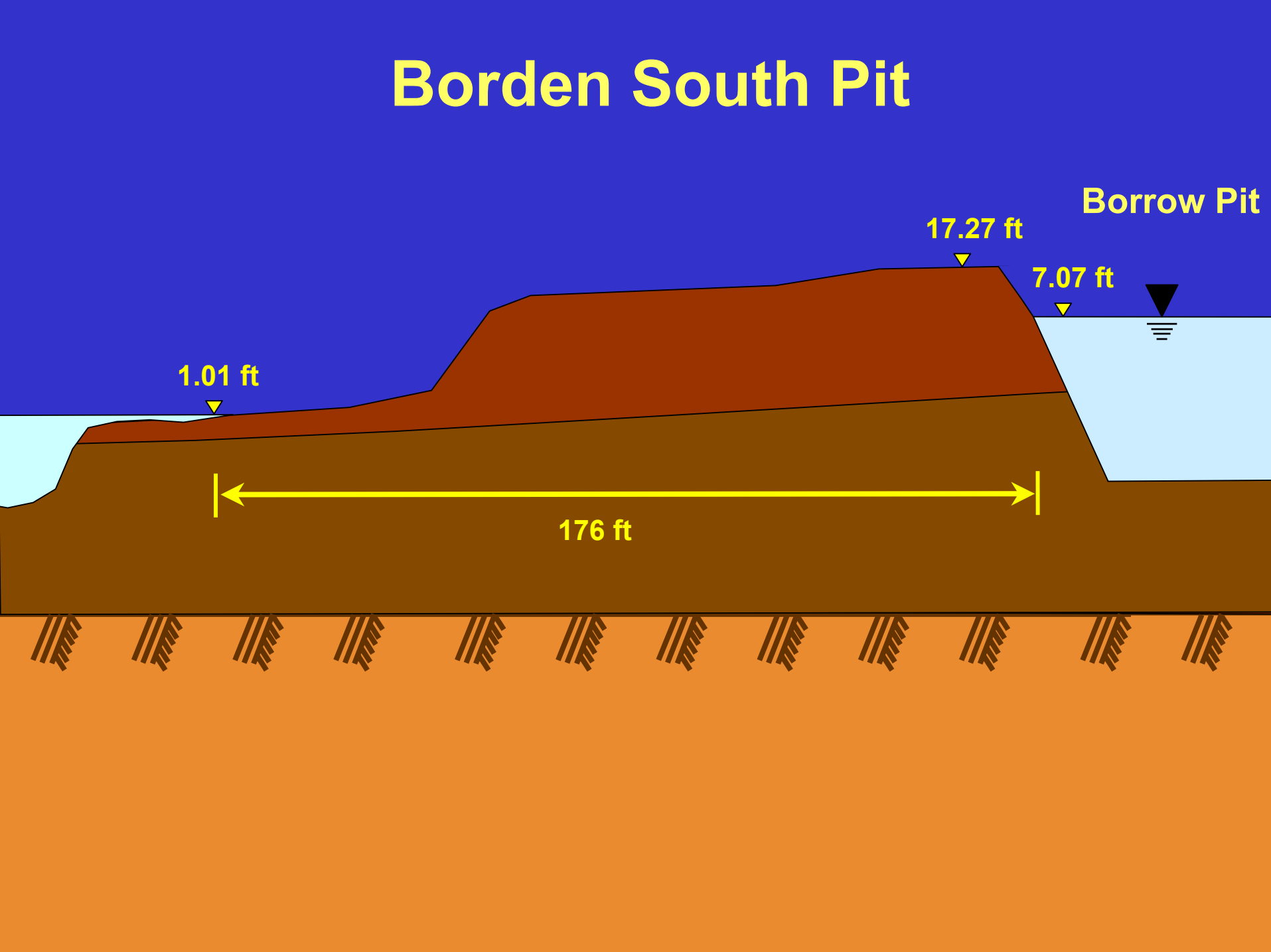
Vail Pit

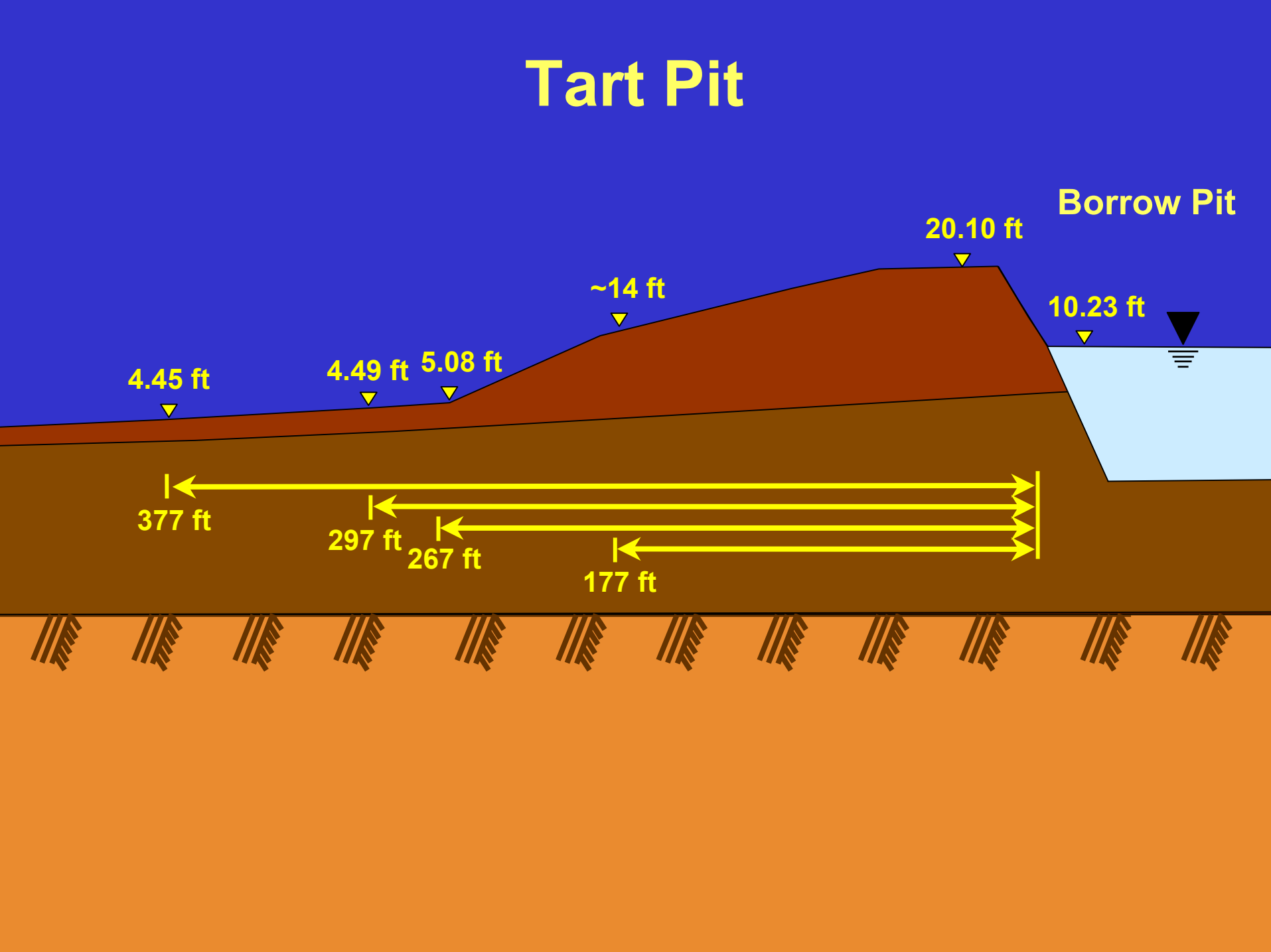


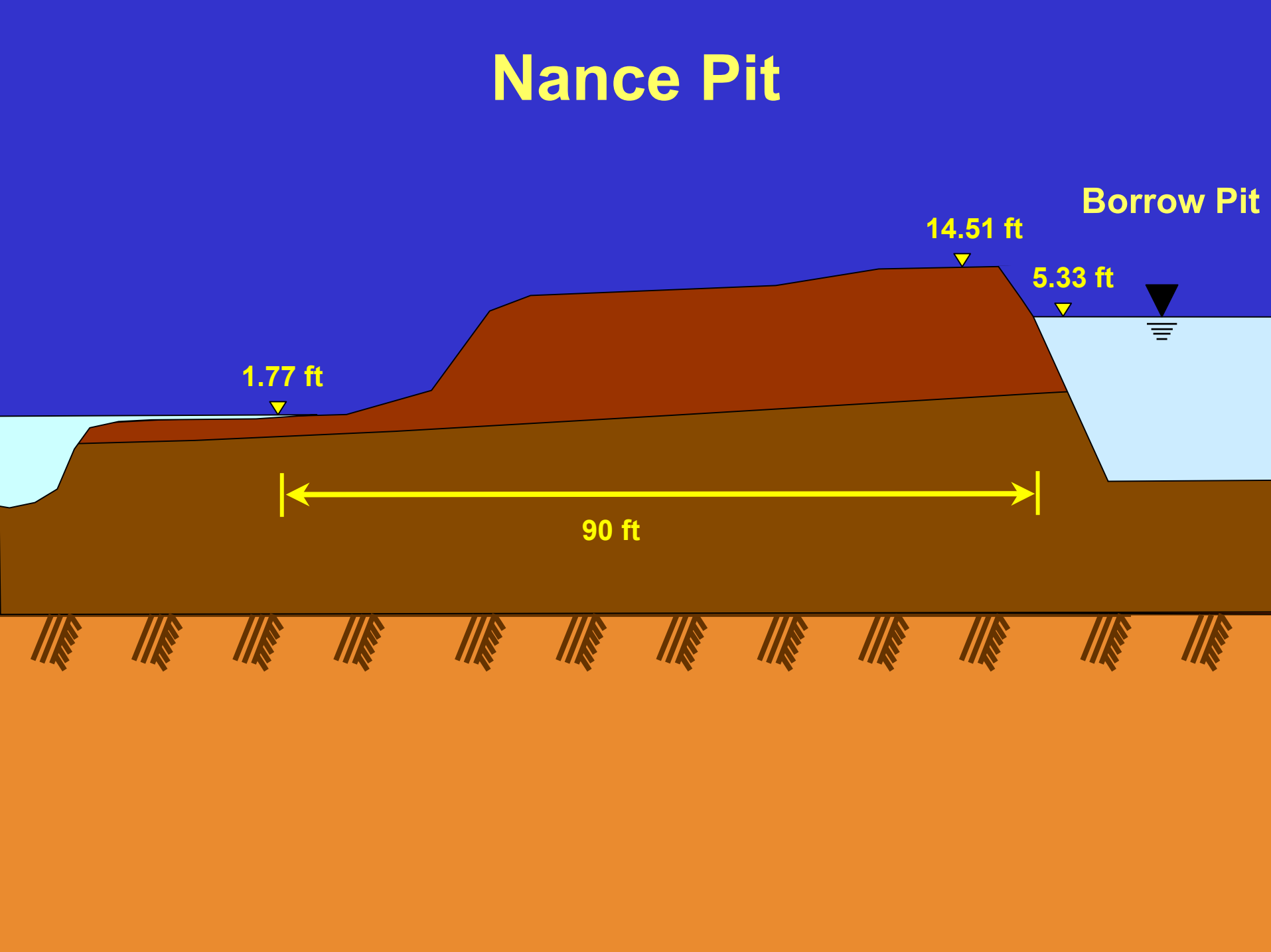
Alexander Pit



Borden South Pit




Tart Pit
Borrow Pit
20.10 ft
~14 ft
10.23 ft
4.45 ft
4.49 ft
5.08 ft
377 ft
297 ft
267 ft
177 ft


Nance Pit
Borrow Pit
14.51 ft
5.33 ft
1.77 ft
90 ft

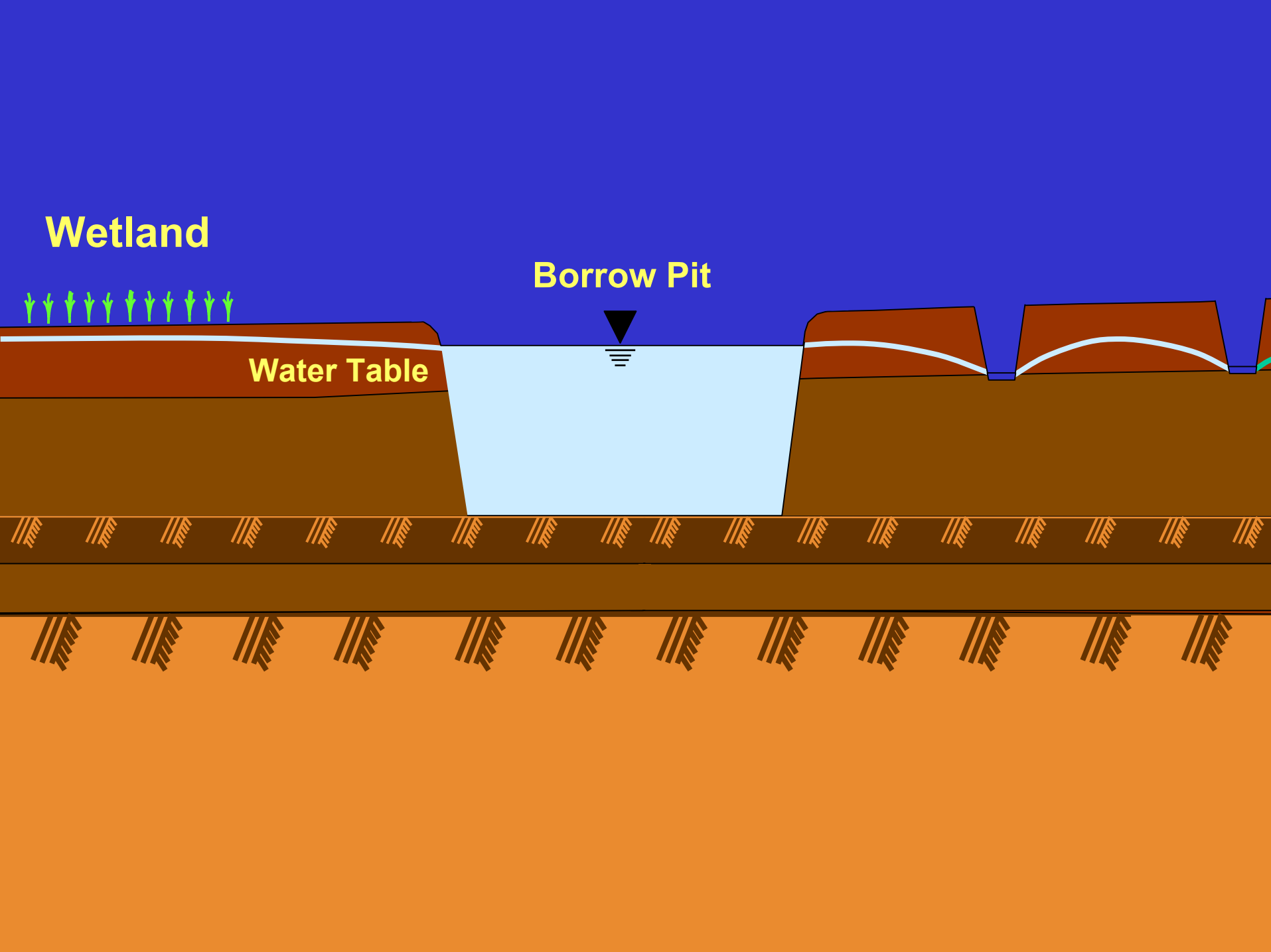
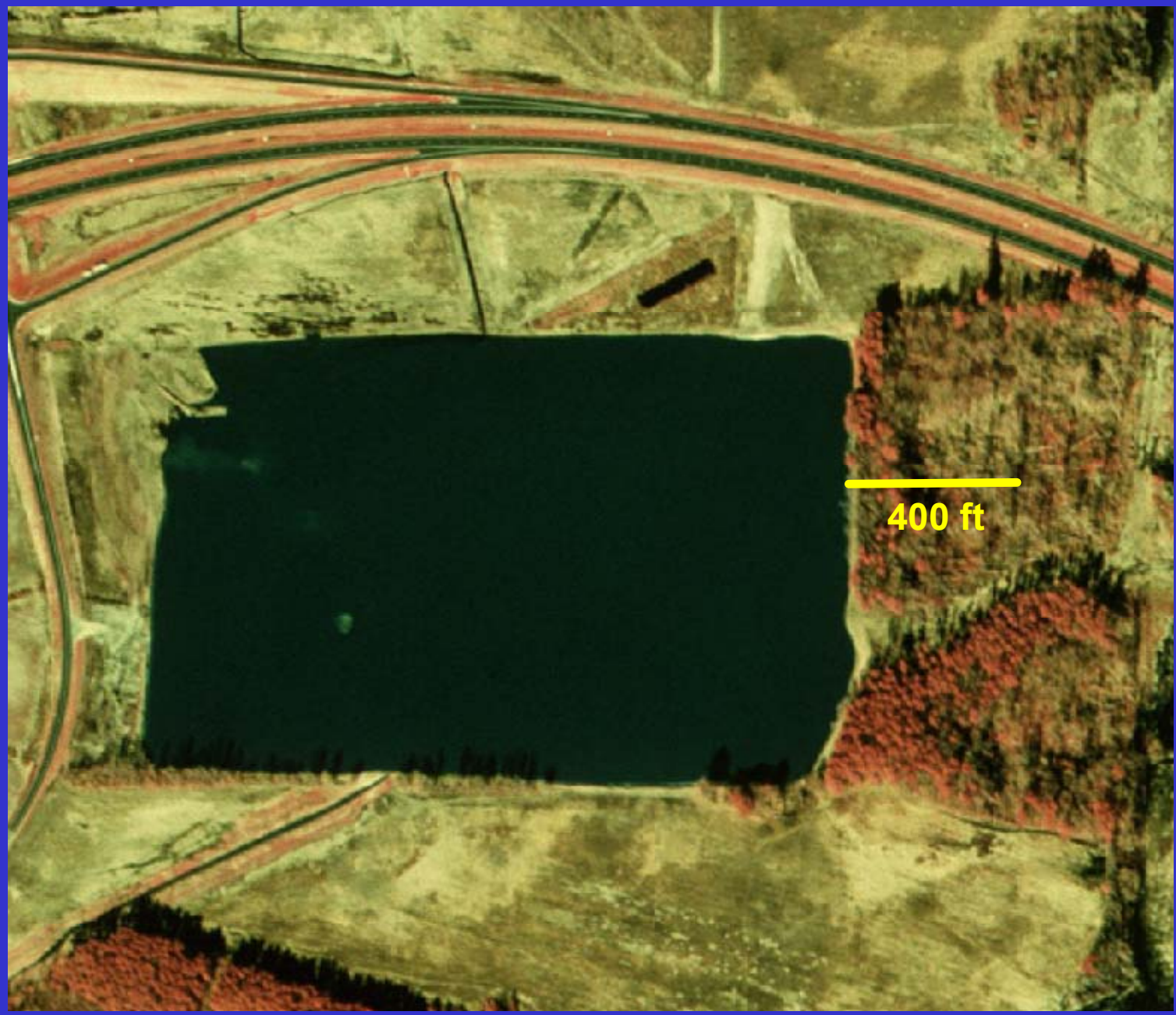

Wetland
Borrow Pit
Water Table

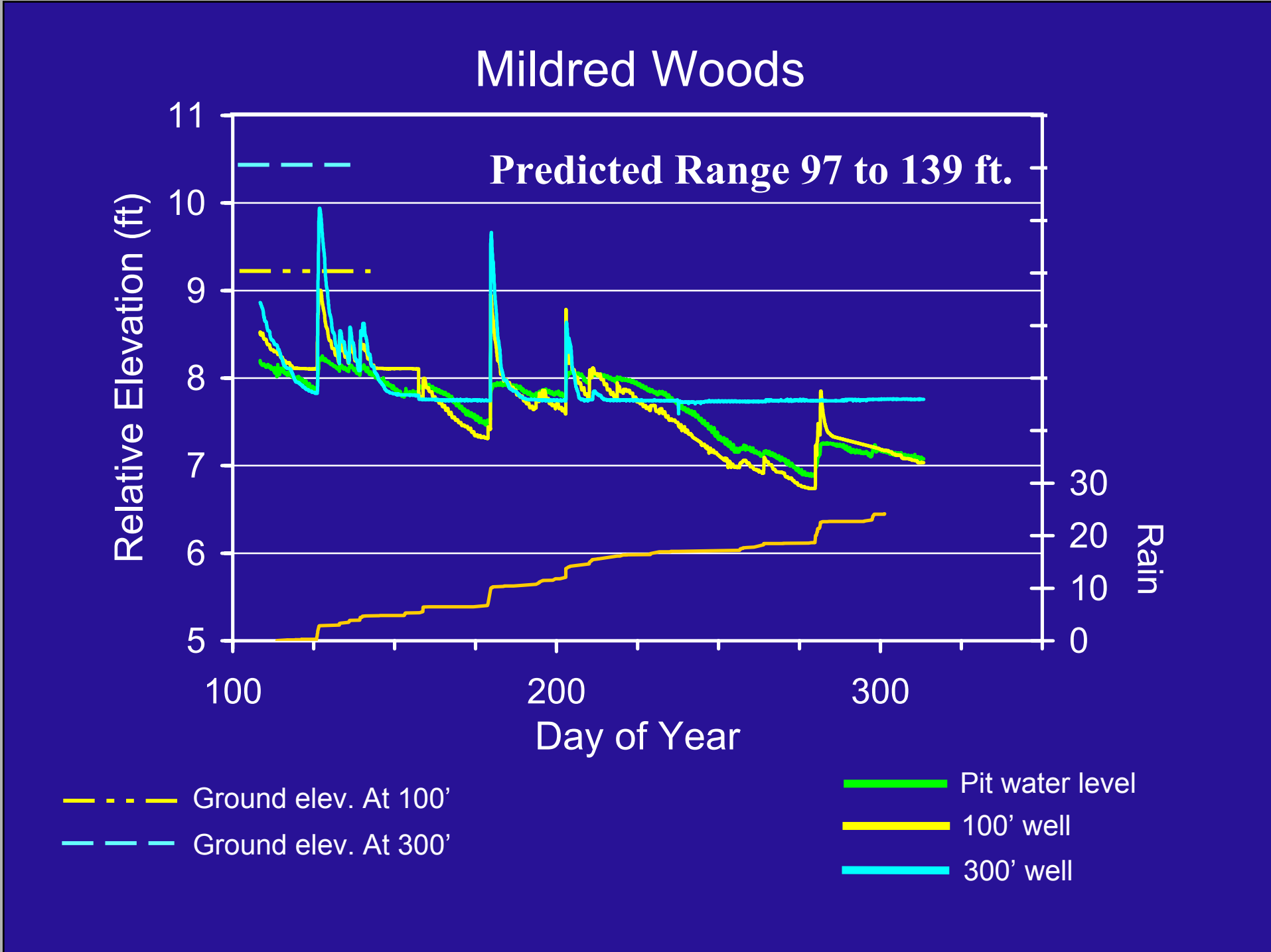
Table 2. Summary for pits with flow from pit to wetland

Name	WSE Pit (ft)	Wetland El (ft)	? h (ft)	Dist. from Pit (ft)
Stallings -i	3.42	1.67	- 1.75	100
Vail -tbi	13.3	6.24	-7.0	100
Borden S	7.07	1.01	-6.06	176
Pierce	7.45	4.82	-2.63	156
Nance	5.33	1.77	-3.44	90
Tart	10.23	5.08	-5.17	267

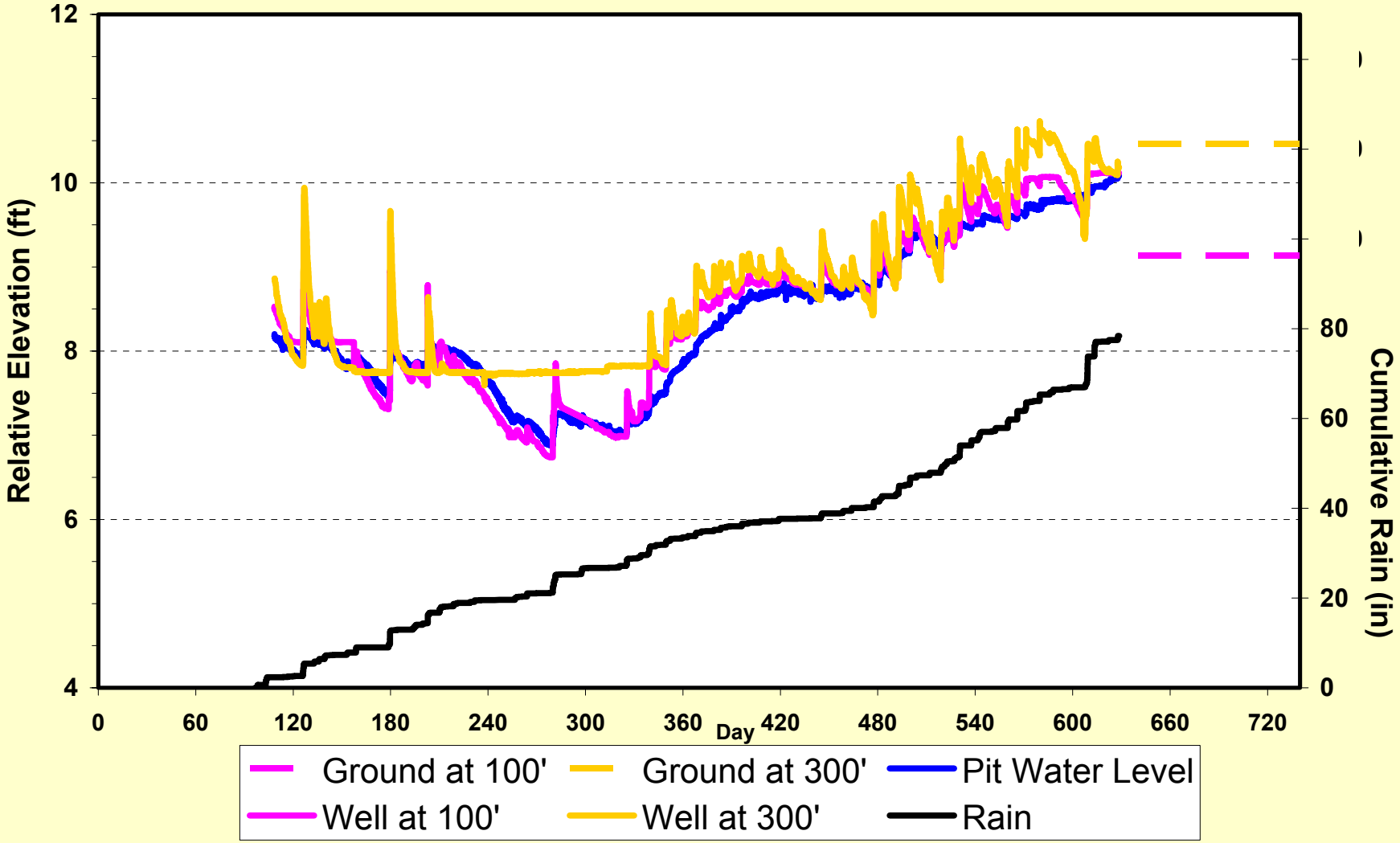
Instrumented Borrow Pits,

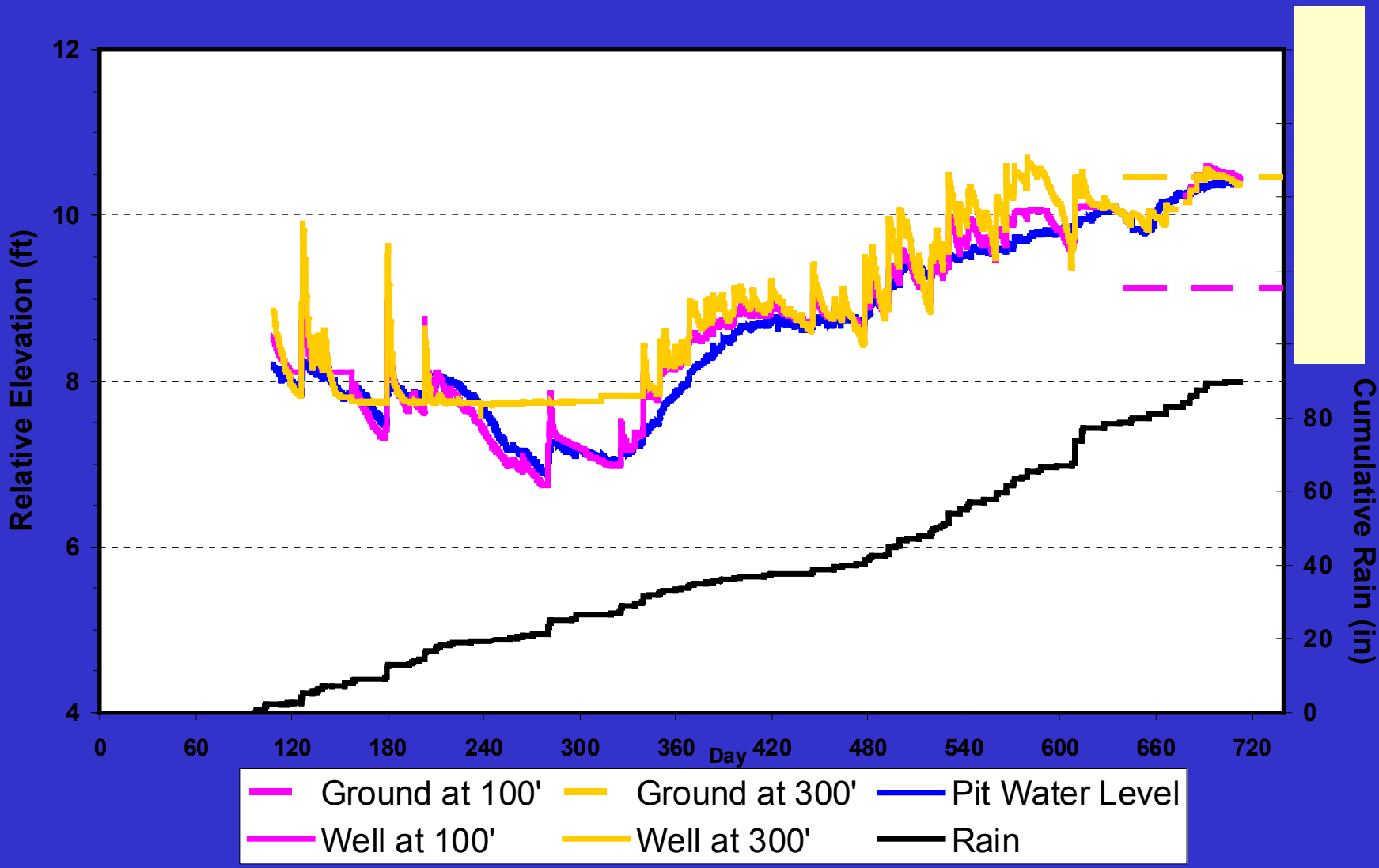
(Closed > 2 Years)


400 ft


Mildred Woods
Predicted Range 97 to 139 ft.
Relative Elevation (ft)
11
10
9
8
7
6
5
30
20
10
0
Rain
100
200
300
Day of Year
Ground elev. At 100’
Ground elev. At 300’
Pit water level
100’ well
300’ well

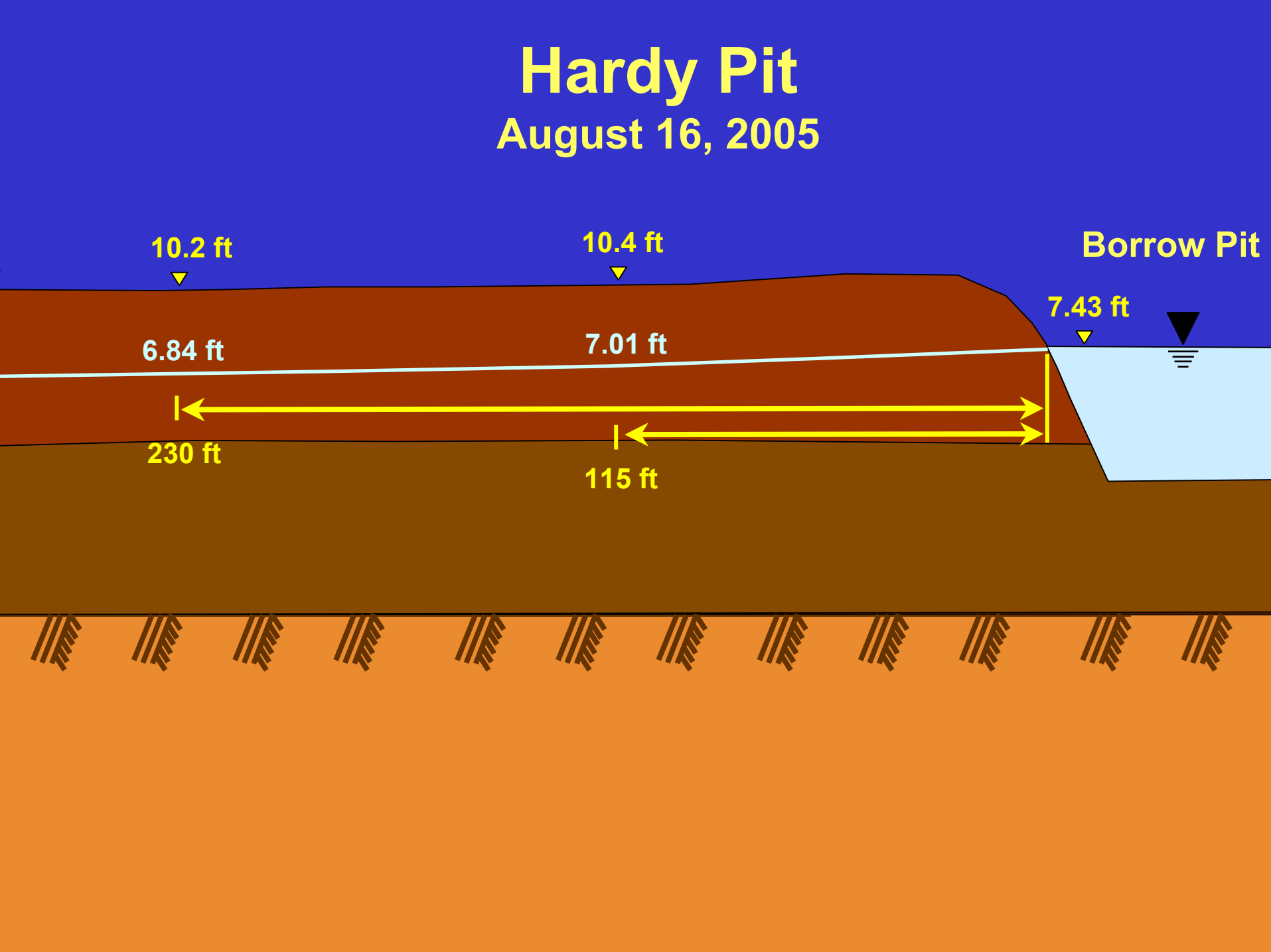
Mildred Woods Borrow Pit, Edgecombe County, 2005 - 2006




Mildred Woods Borrow Pit, Edgecombe County, 2005 - 2006
Relative Elevation (ft)
12
10
8
6
4
0
60
120
180
240
300
360
Day
420
480
540
600
660
720
Cumulative Rain (in)
80
60
40
20
0
Ground at 100'
Ground at 300'
Pit Water Level
Well at 100'
Well at 300'
Rain

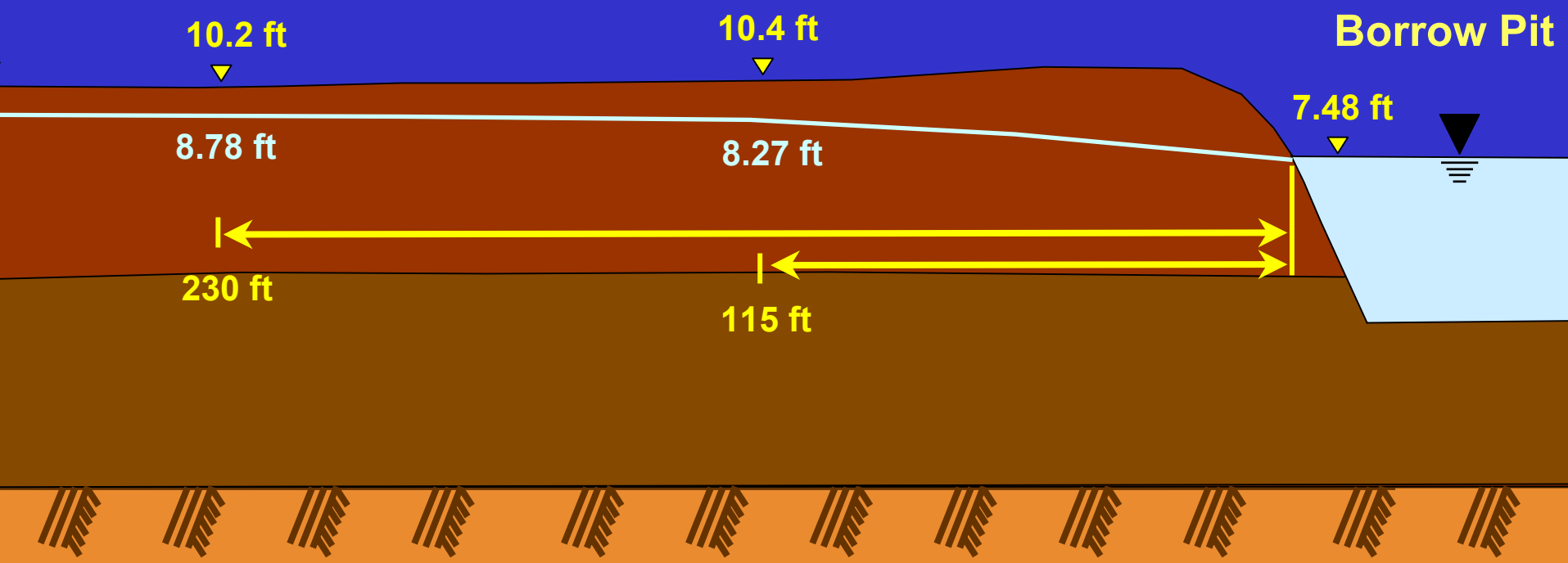
Hardy

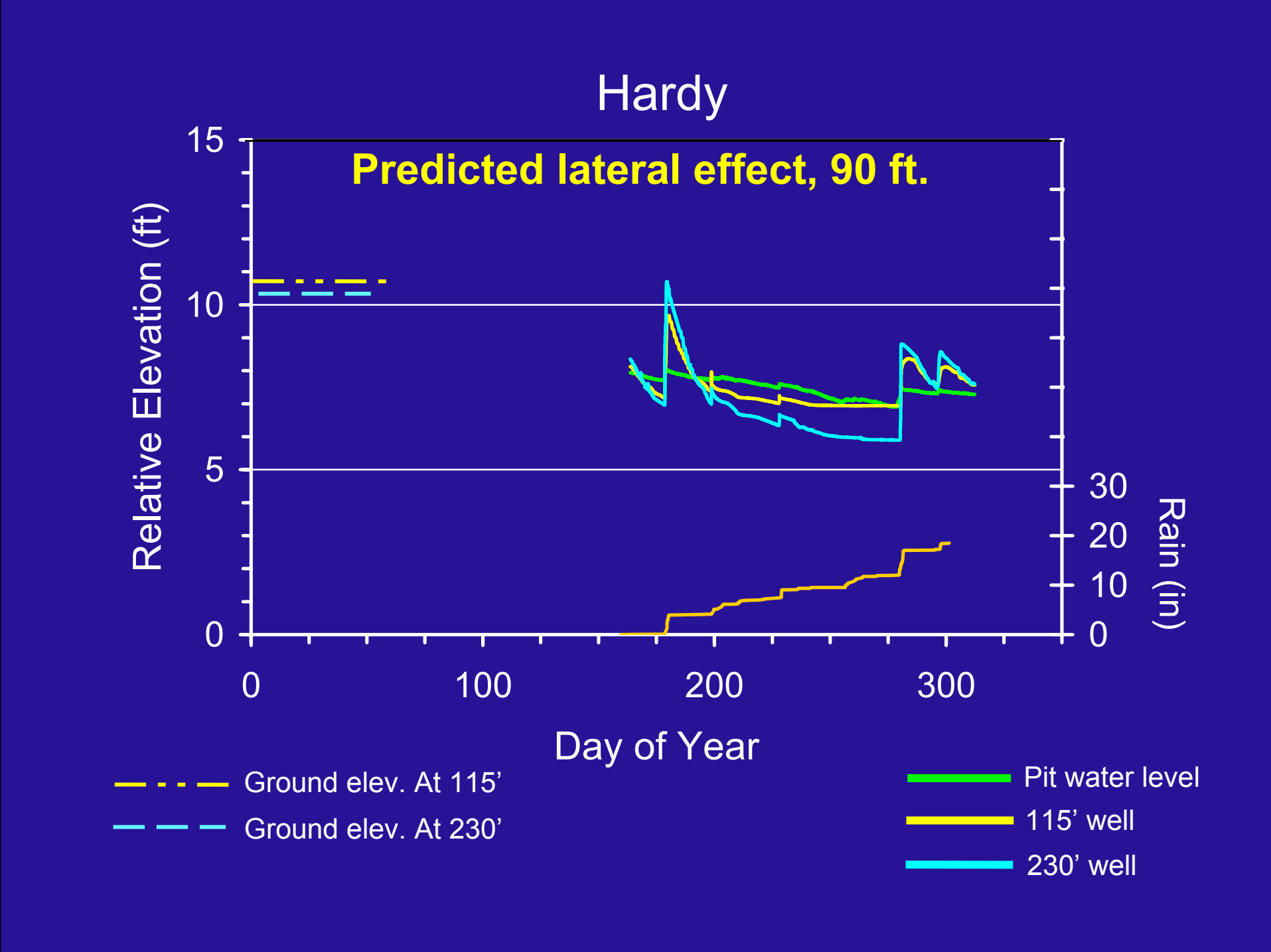
Pitt County

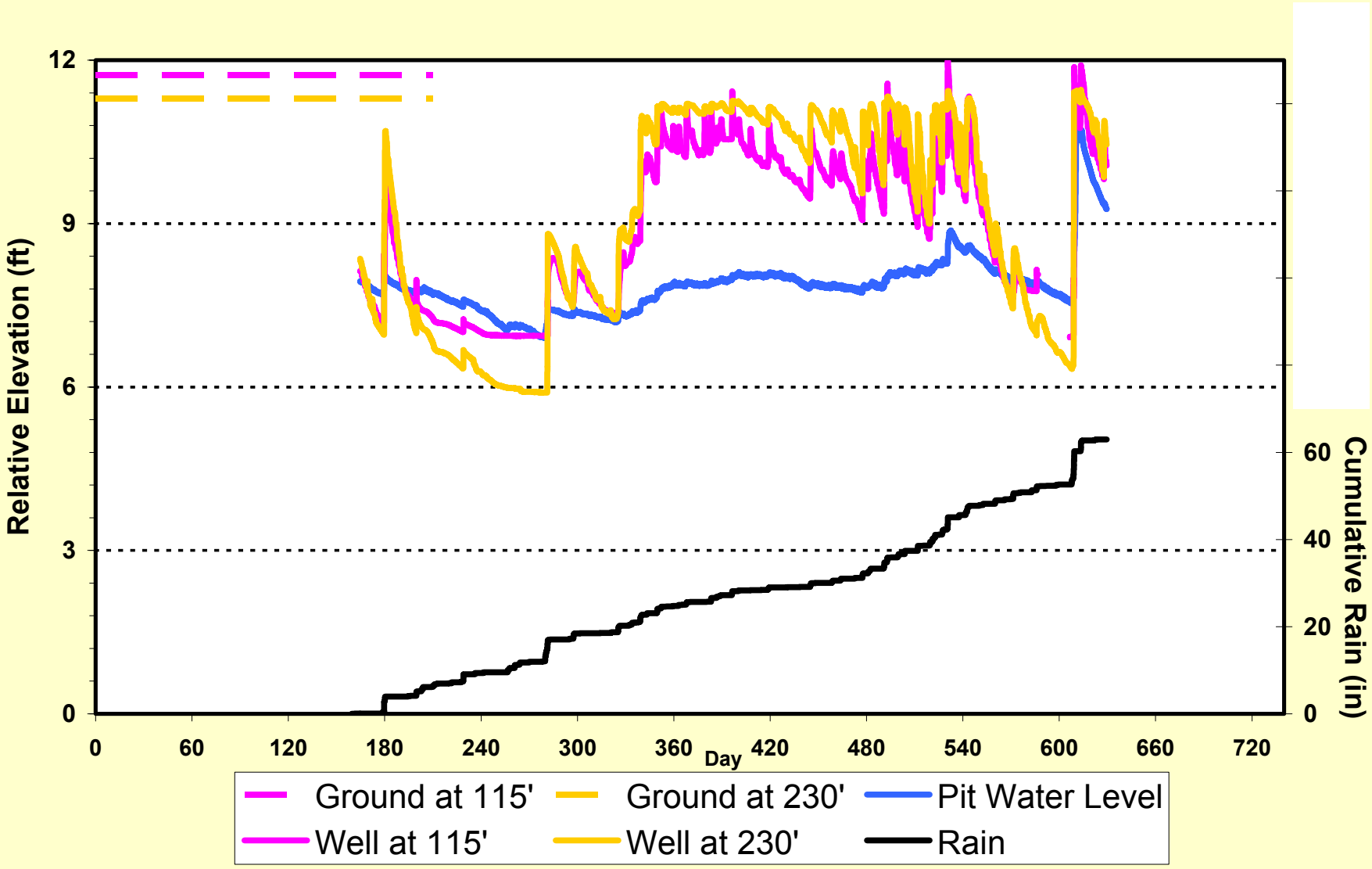

Hardy Pit
August 16, 2005
10.2 ft
10.4 ft
Borrow Pit
7.43 ft
6.84 ft
7.01 ft
230 ft
115 ft

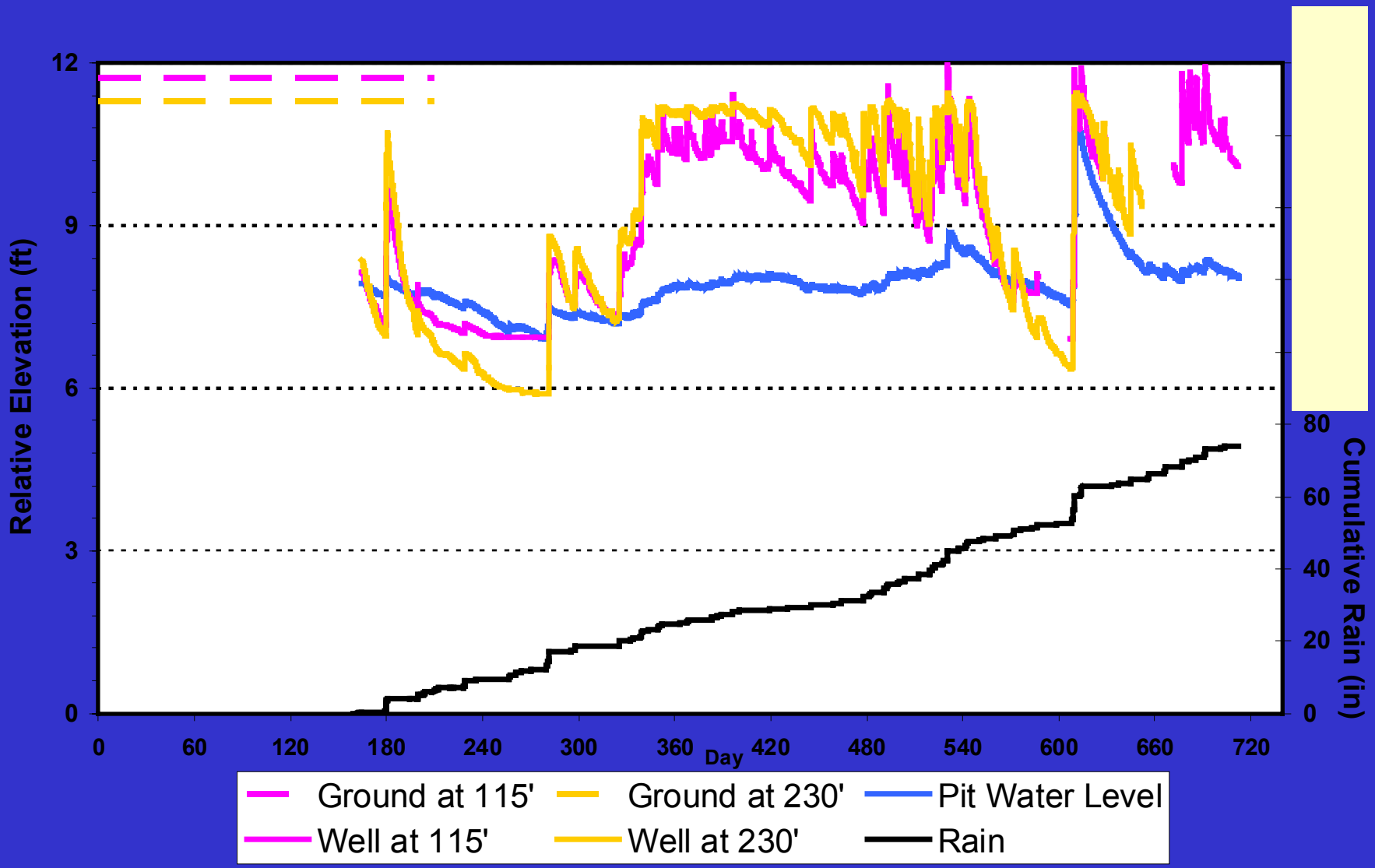
Hardy Pit

October 9, 2005



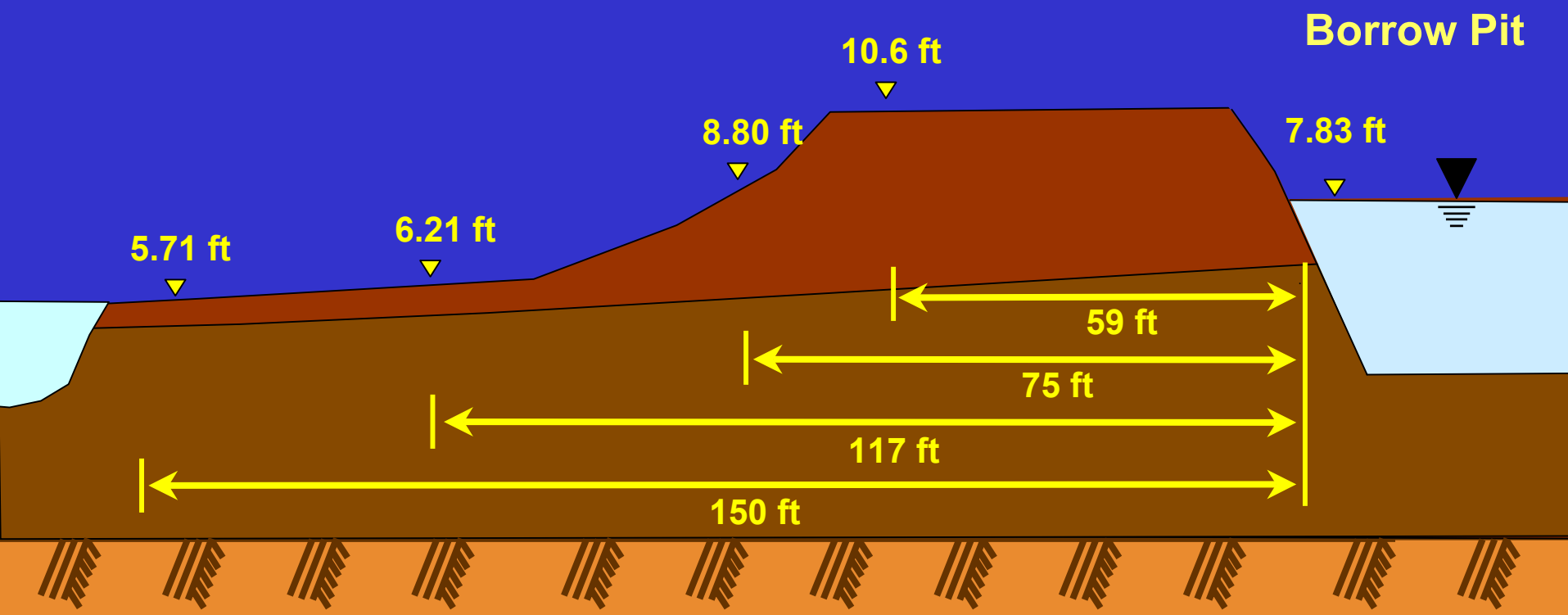

Hardy
Predicted lateral effect, 90 ft.
Relative Elevation (ft)
15
10
5
0
0
100
200
300
Day of Year
30
20
10
0
Rain (in)
Ground elev. At 115’
Ground elev. At 230’
Pit water level
115’ well
230’ well


Hardy Borrow Pit, Pitt County, 2005-2006
Relative Elevation (ft)
12
9
6
3
0
0
60
120
180
240
300
360
420
480
540
600
660
720
Day
Cumulative Rain (in)
60
40
20
0
Ground at 115'
Ground at 230'
Pit Water Level
Well at 115'
Well at 230'
Rain

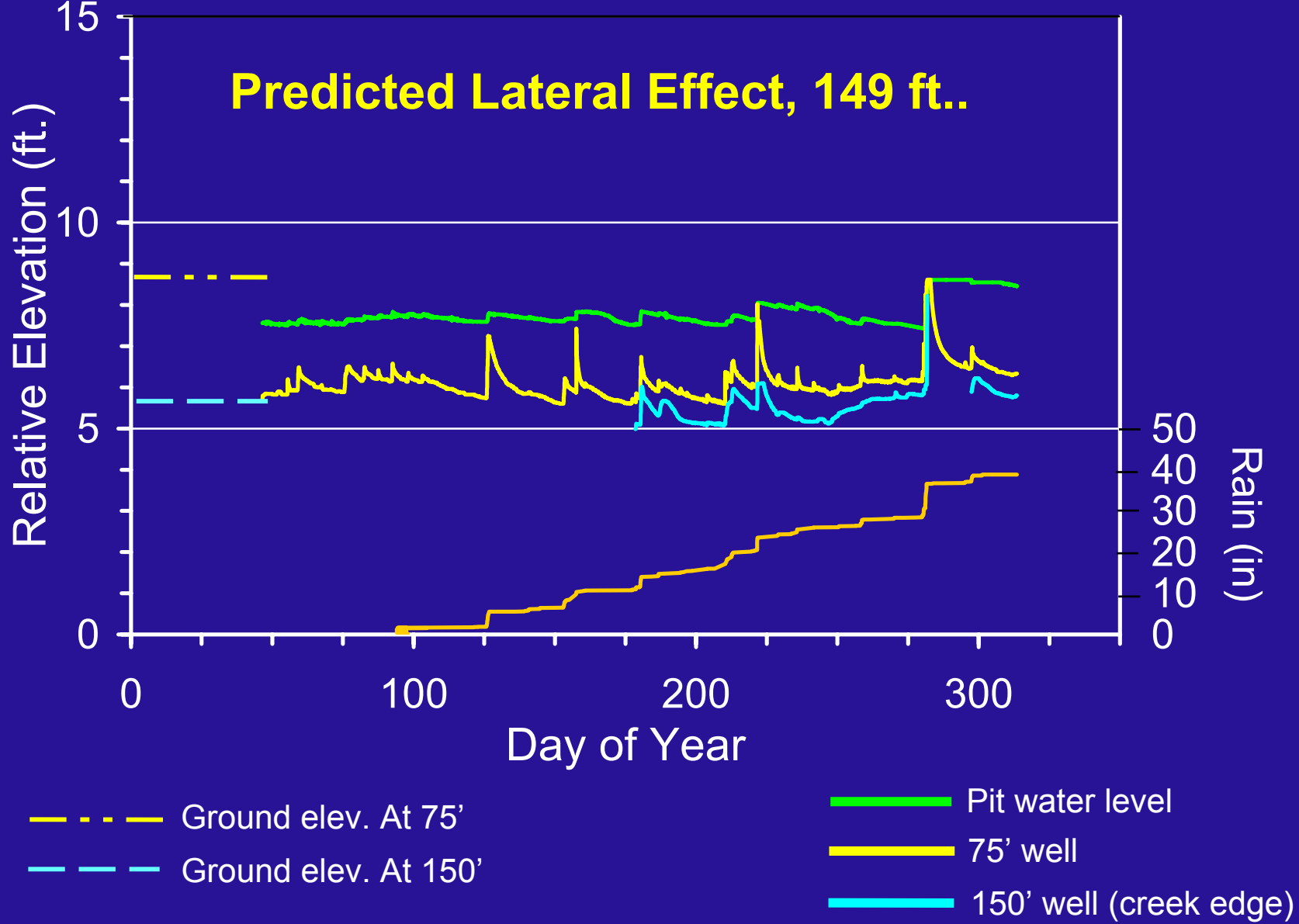

Hardy Borrow Pit, Pitt County, 2005-2006
Relative Elevation (ft)
12
9
6
3
0
0
60
120
180
240
300
360
420
480
540
600
660
720
Day
Cumulative Rain (in)
80
60
40
20
0
Ground at 115'
Ground at 230'
Pit Water Level
Well at 115'
Well at 230'
Rain


Stallings, Washington Co.

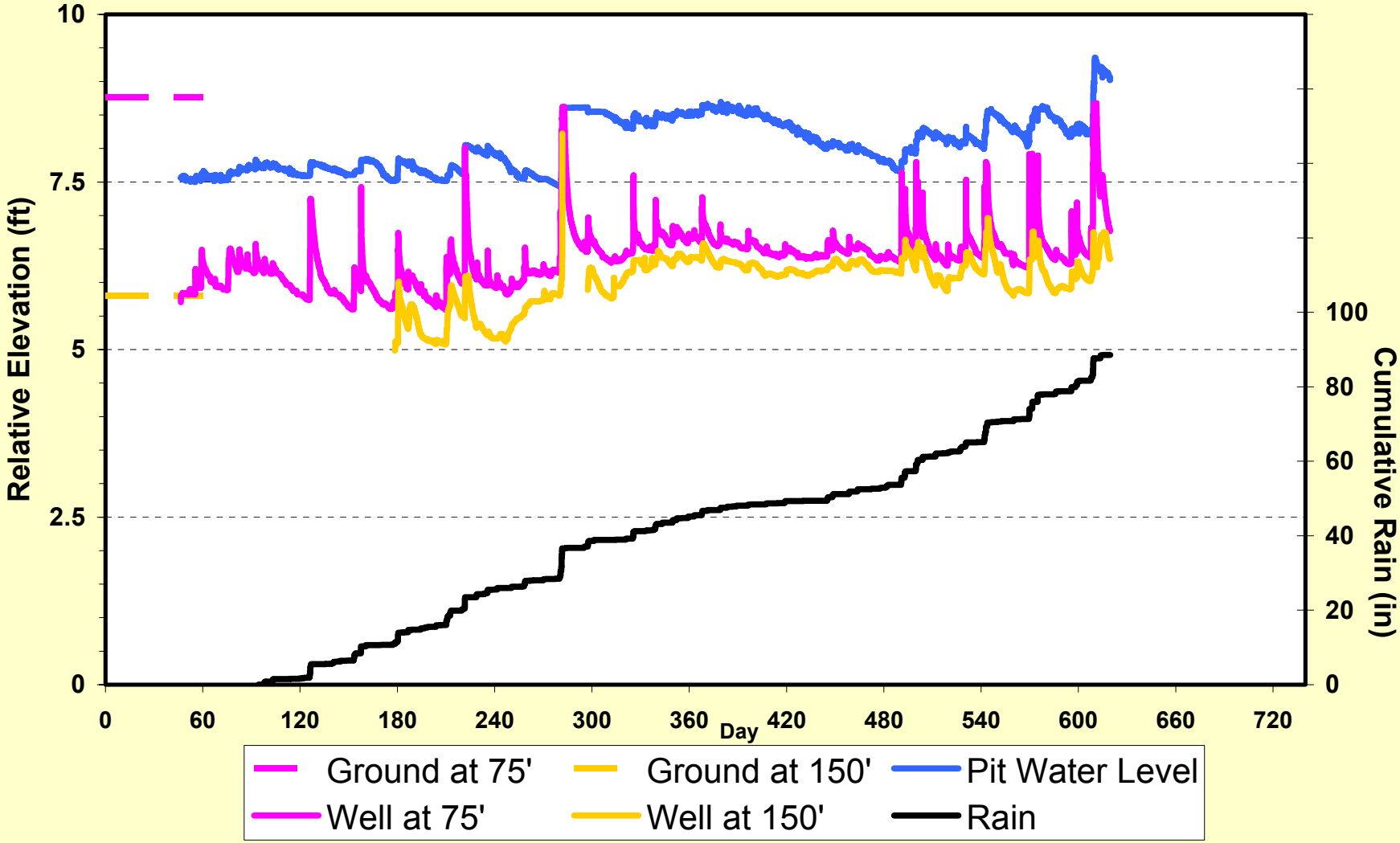
Stallings Pit

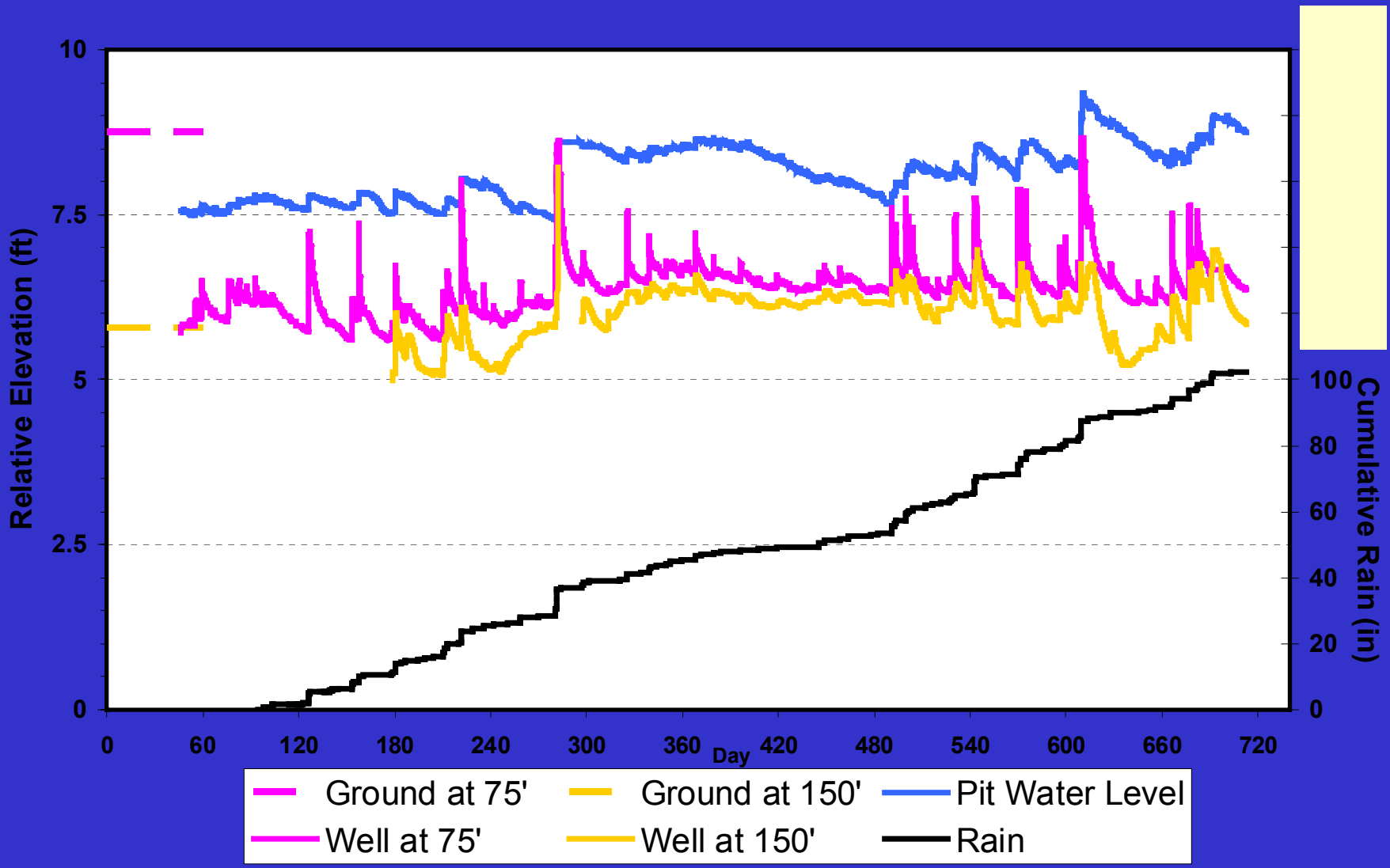


Stallings


Predicted Lateral Effect, 149 ft..
Relative Elevation (ft.)
15
10
5
0
0
100
200
300
Day of Year
50
40
30
20
10
0
Rain (in)
Ground elev. At 75’
Ground elev. At 150’
Pit water level
75’ well
150’ well (creek edge)

Stallings Borrow Pit, Washington County, 2005 - 2006



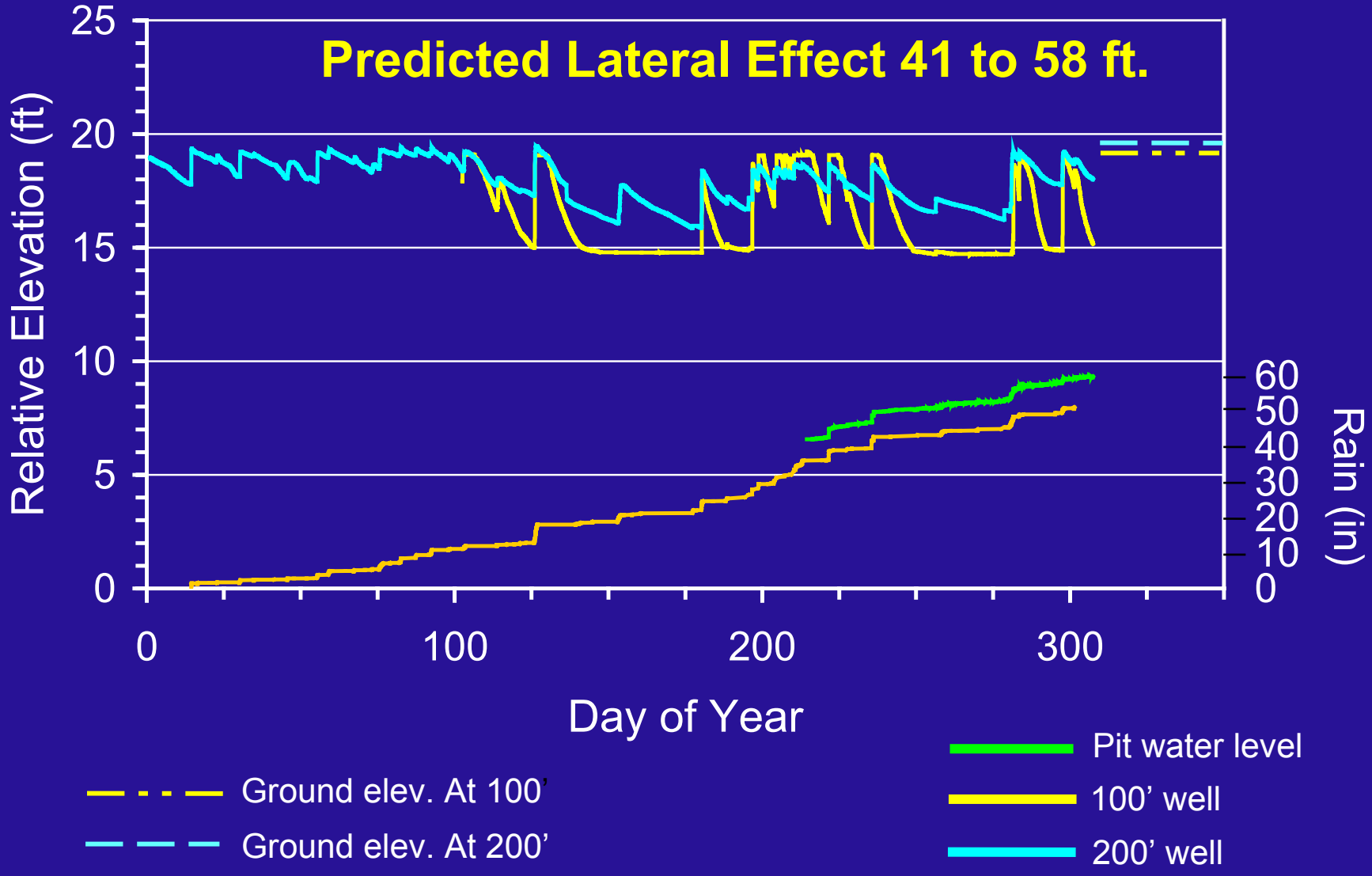

Stallings Borrow Pit, Washington County, 2005 - 2006
Relative Elevation (ft)
10
7.5
5
2.5
0
0
60
120
180
240
300
360
420
480
540
600
660
720
Day
Cumulative Rain (in)
100
80
60
40
20
0
Ground at 75'
Ground at 150'
Pit Water Level
Well at 75'
Well at 150'
Rain

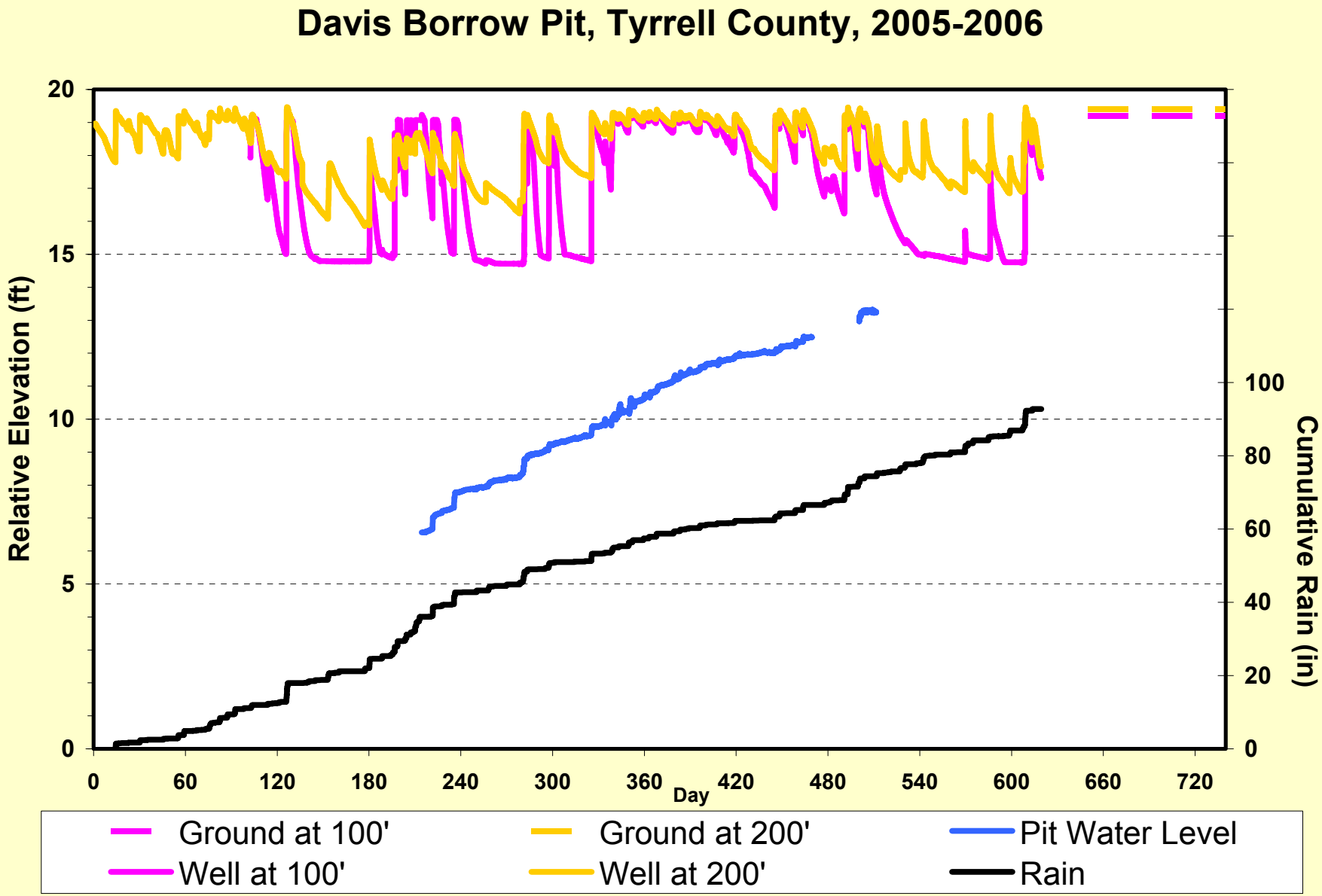
Instrumented Borrow Pits,

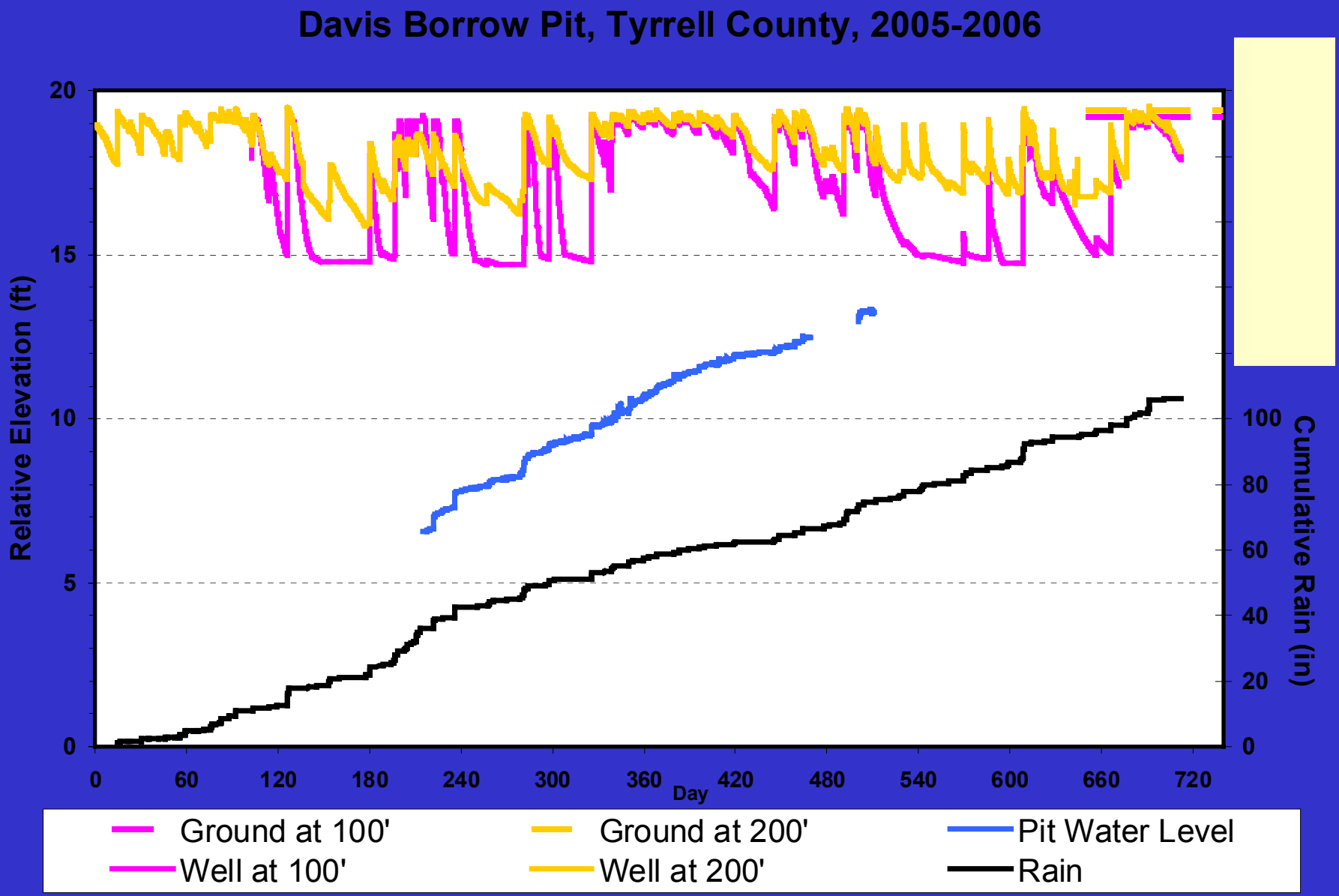
(Recently Closed)


400 ft
Davis

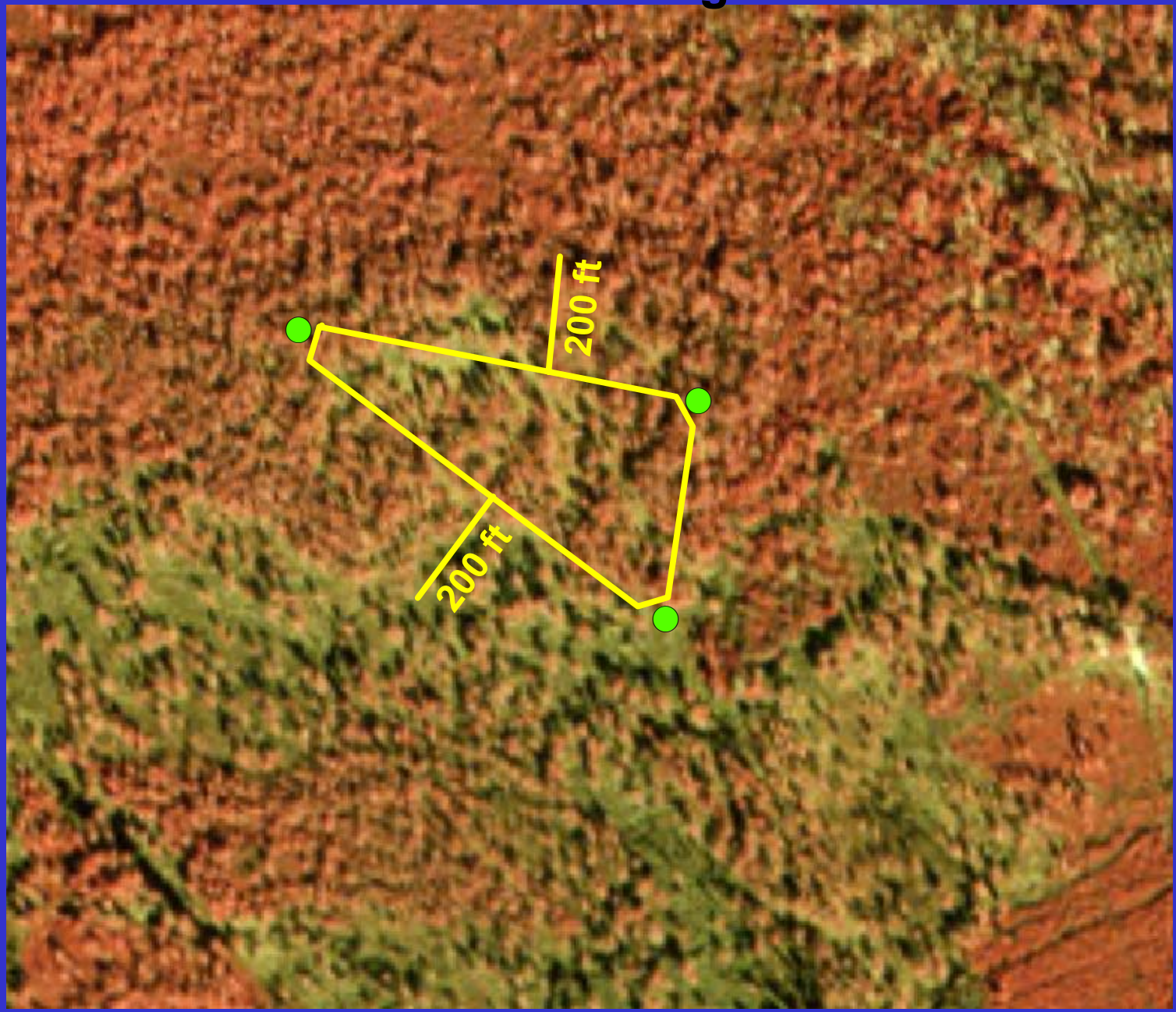
Davis

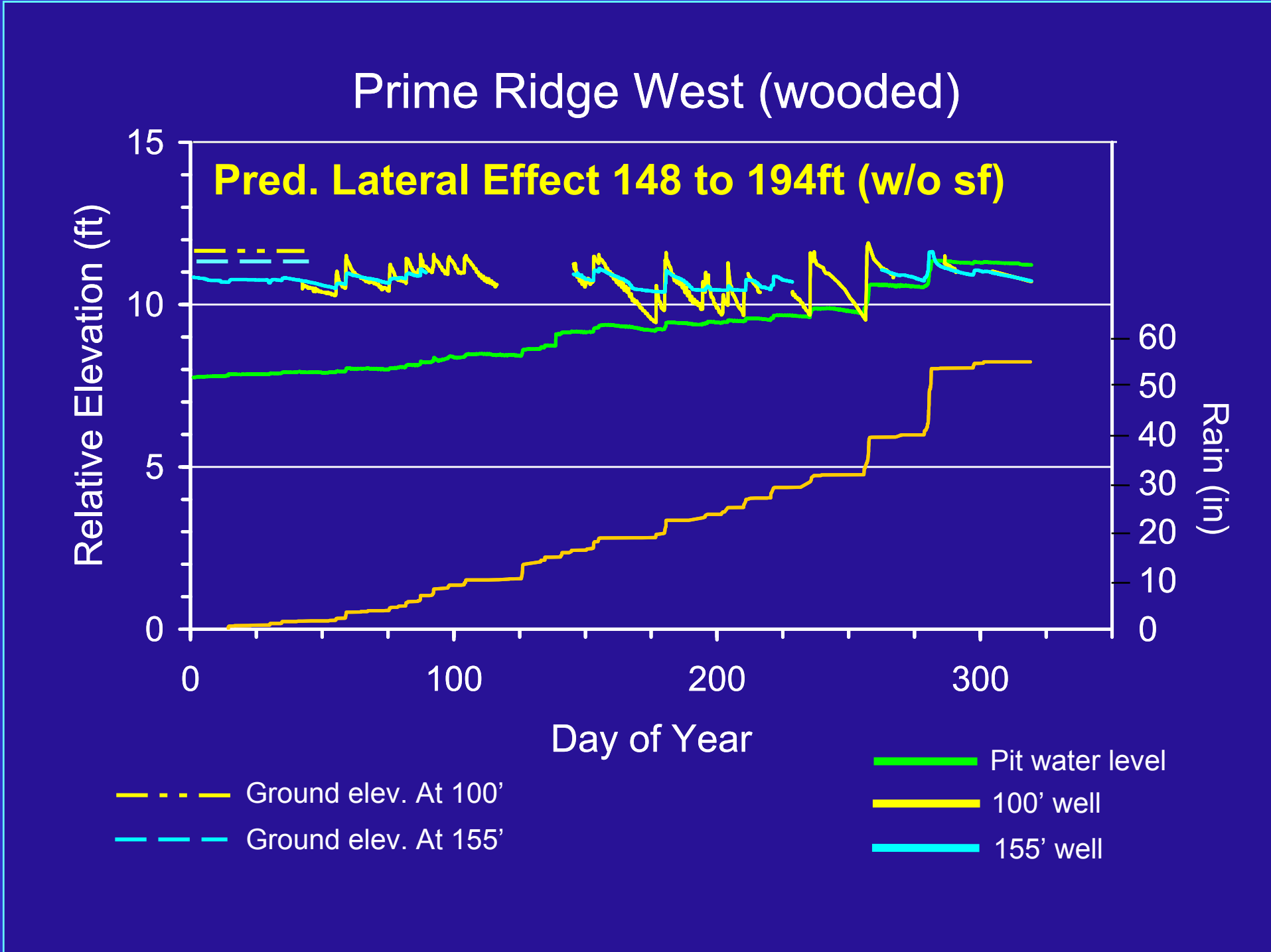

Predicted Lateral Effect 41 to 58 ft.
Relative Elevation (ft)
25
20
15
10
5
0
0
100
200
300
Day of Year
60
50
40
30
20
10
0
Rain (in)
Ground elev. At 100'
Ground elev. At 200'
Pit water level
100' well
200' well


Davis Borrow Pit, Tyrrell County, 2005-2006
Relative Elevation (ft)
20
15
10
5
0
0
60
120
180
240
300
360
420
480
540
600
660
720
Day
100
80
60
40
20
0
Cumulative Rain (in)
Ground at 100'
Ground at 200'
Pit Water Level
Well at 100'
Well at 200'
Rain

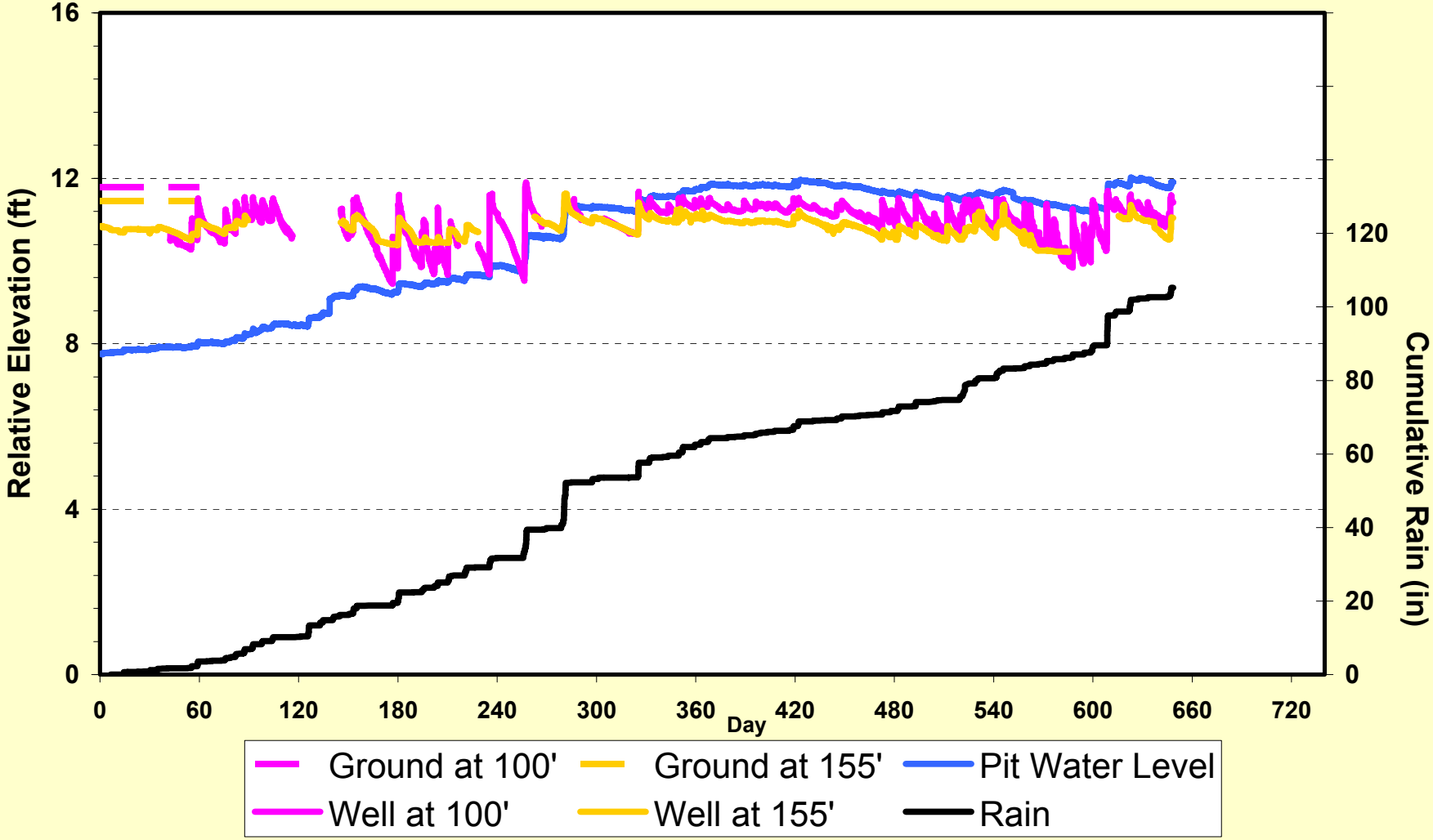

Davis Borrow Pit, Tyrrell County, 2005-2006
Relative Elevation (ft)
20
15
10
5
0
0
60
120
180
240
300
360
420
480
540
600
660
720
Day
Cumulative Rain (in)
100
80
60
40
20
0
Ground at 100'
Ground at 200'
Pit Water Level
Well at 100'
Well at 200'
Rain

Prime Ridge

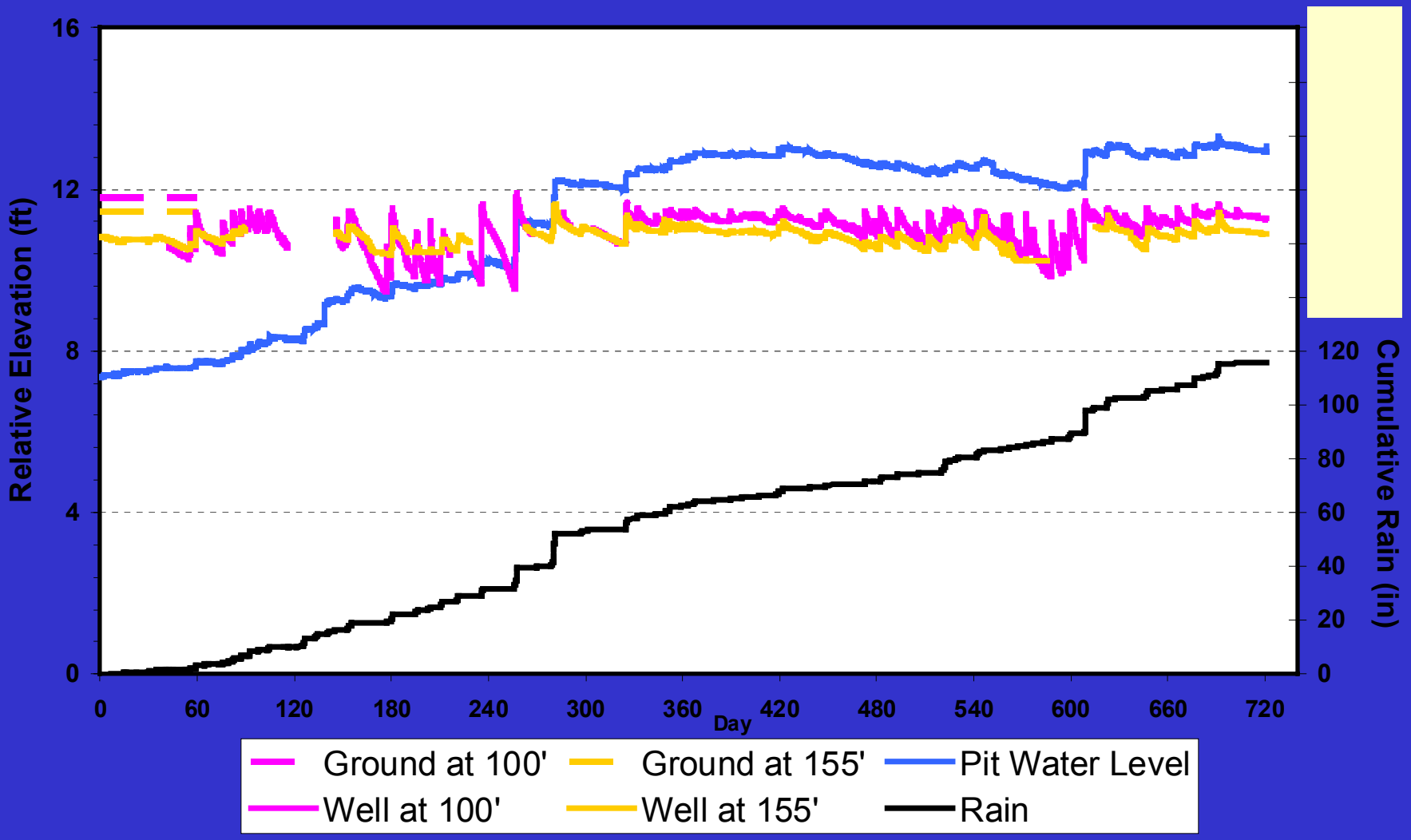


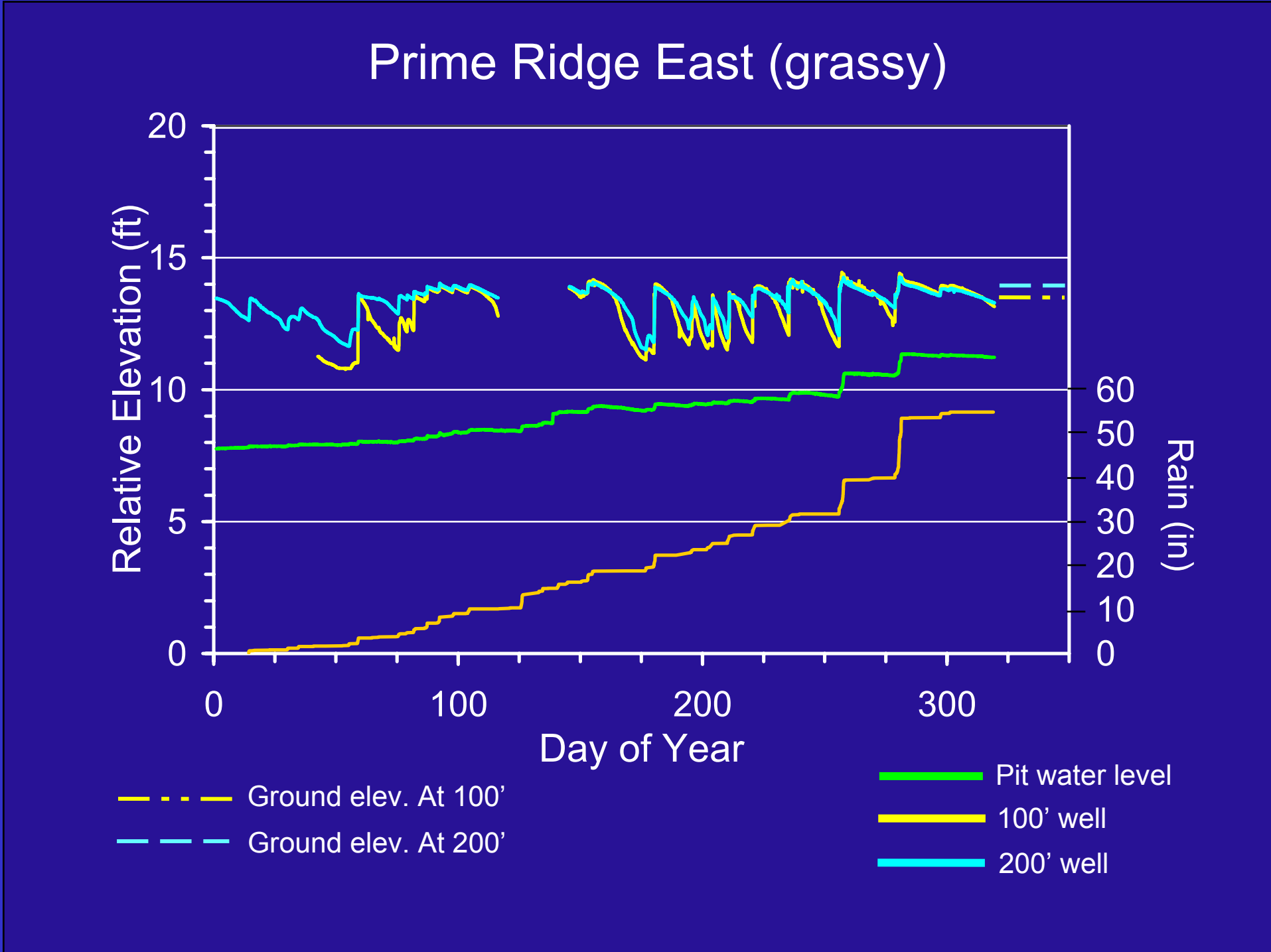

Prime Ridge West (wooded)
Pred. Lateral Effect 148 to 194ft (w/o sf)
Relative Elevation (ft)
15
10
5
0
0
100
200
300
Day of Year
60
50
40
30
20
10
0
Rain (in)
Ground elev. At 100'
Ground elev. At 155'
Pit water level
100' well
155' well

Prime Ridge Borrow Pit, West Transect, New Hanover County, 2005 - 2006

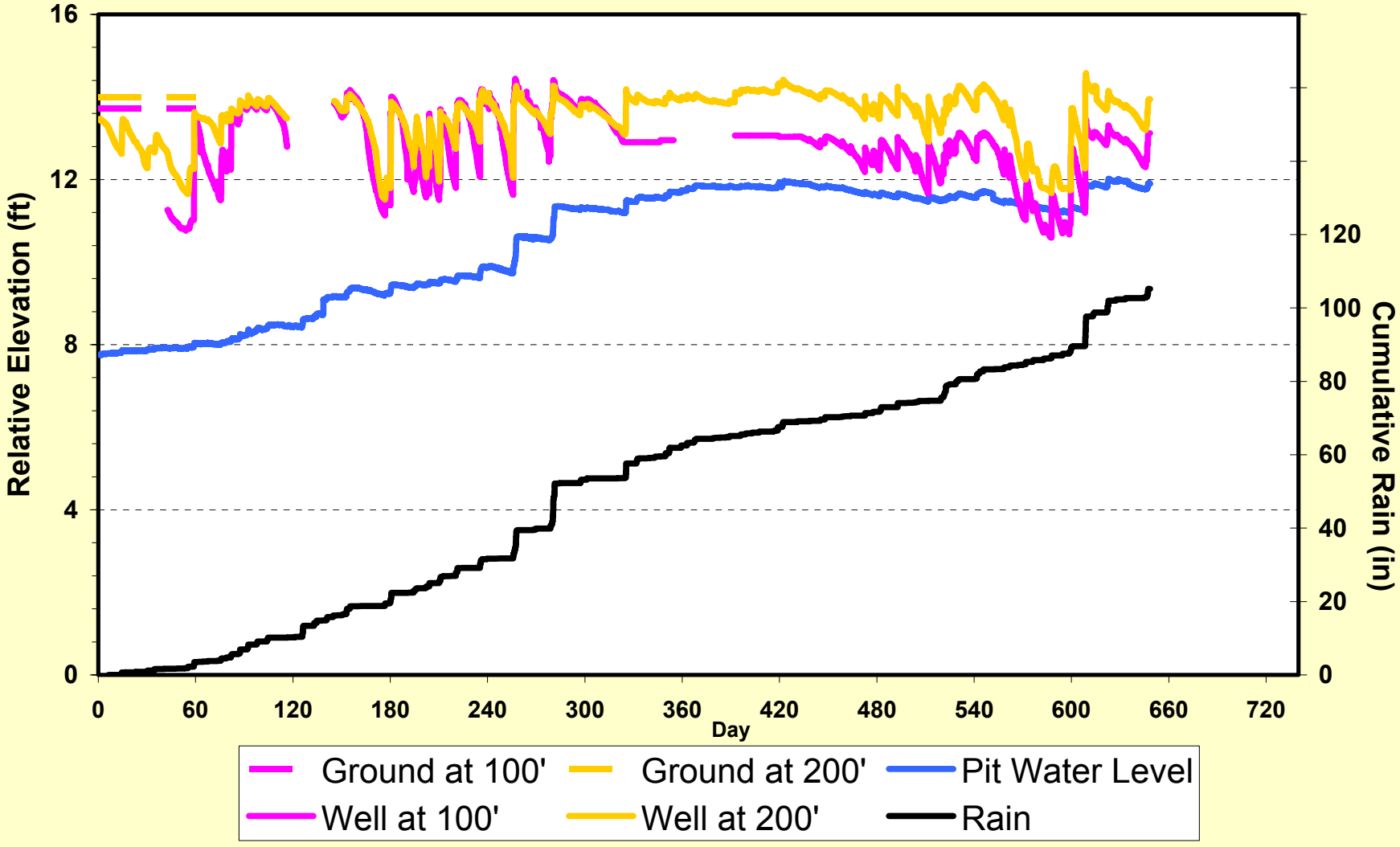


Prime Ridge Borrow Pit, West Transect, New Hanover County, 2005 - 2006

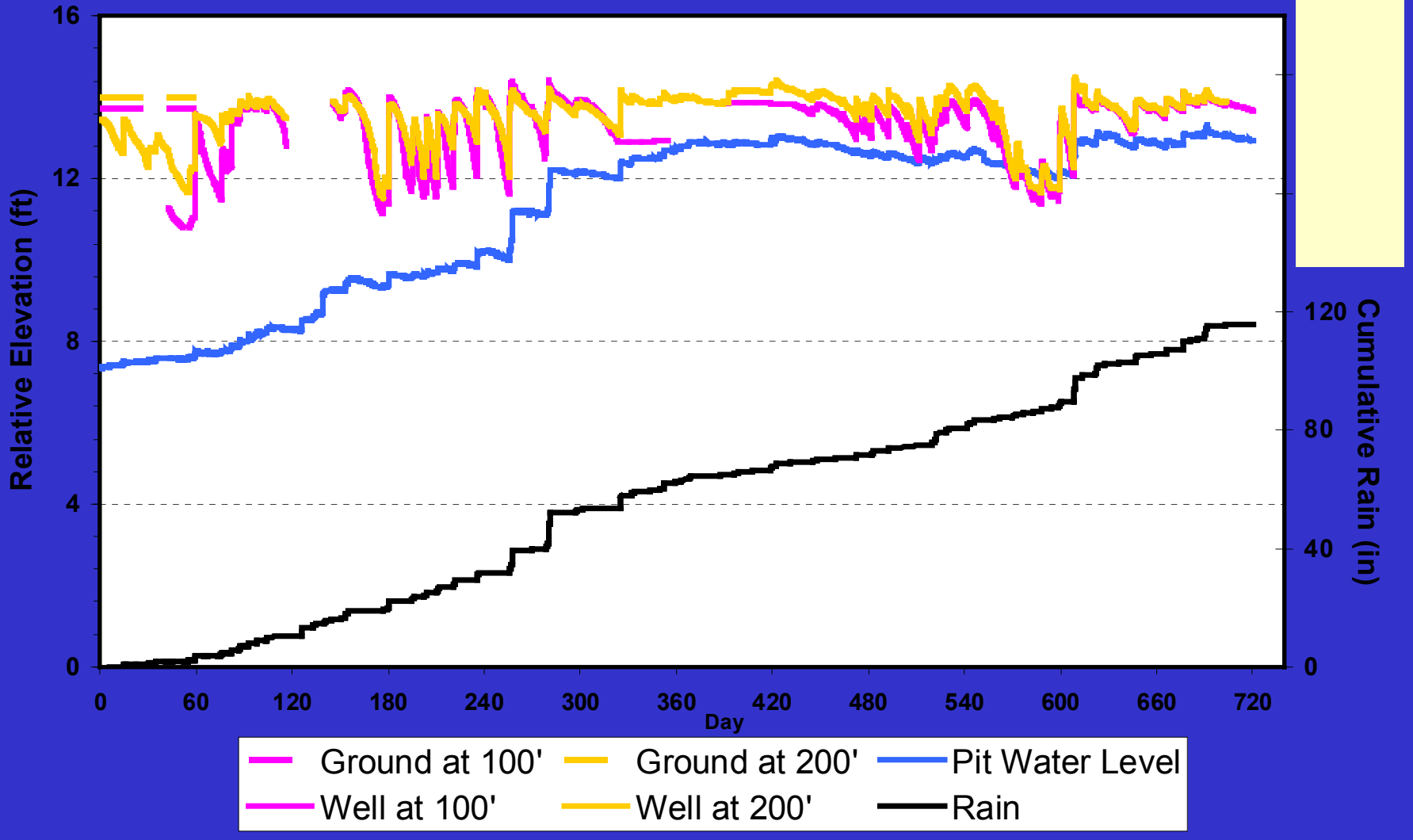


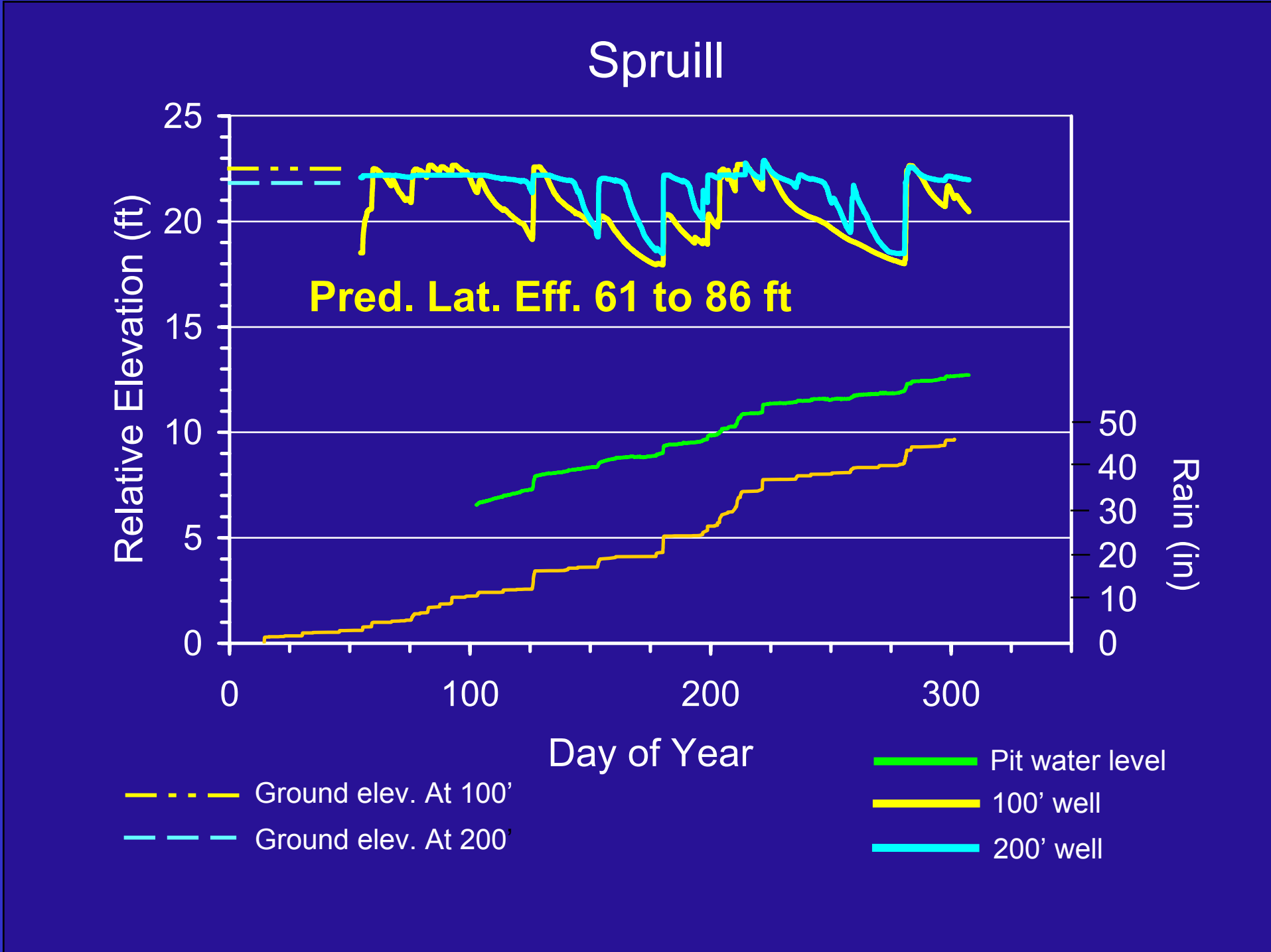

Prime Ridge East (grassy)
Relative Elevation (ft)
20
15
10
5
0
0
100
200
300
Day of Year
Rain (in)
60
50
40
30
20
10
0
Ground elev. At 100'
Ground elev. At 200'
Pit water level
100' well
200' well

Prime Ridge Borrow Pit, East Transect, New Hanover County, 2005 - 2006

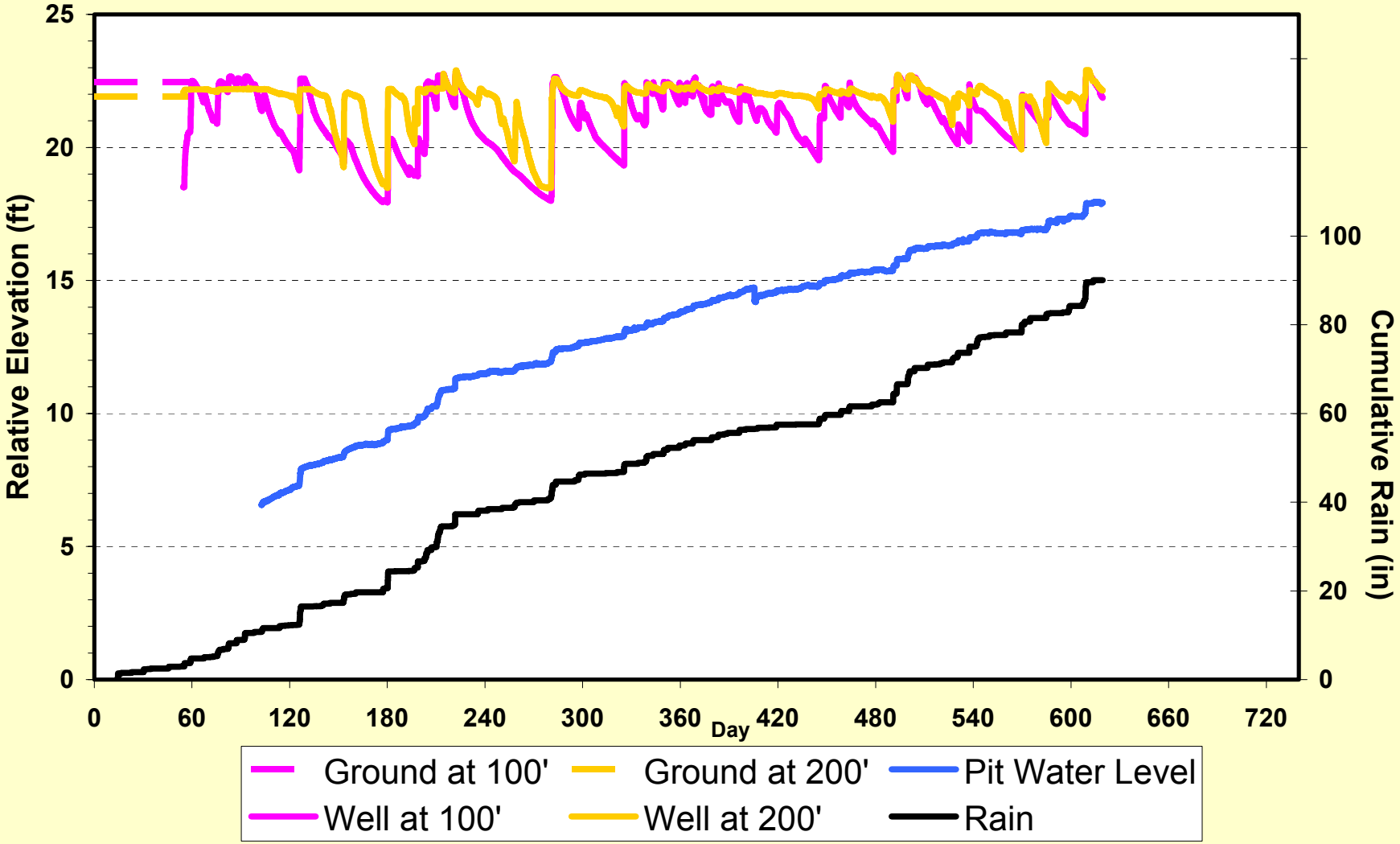


Prime Ridge Borrow Pit, East Transect, New Hanover County, 2005 - 2006

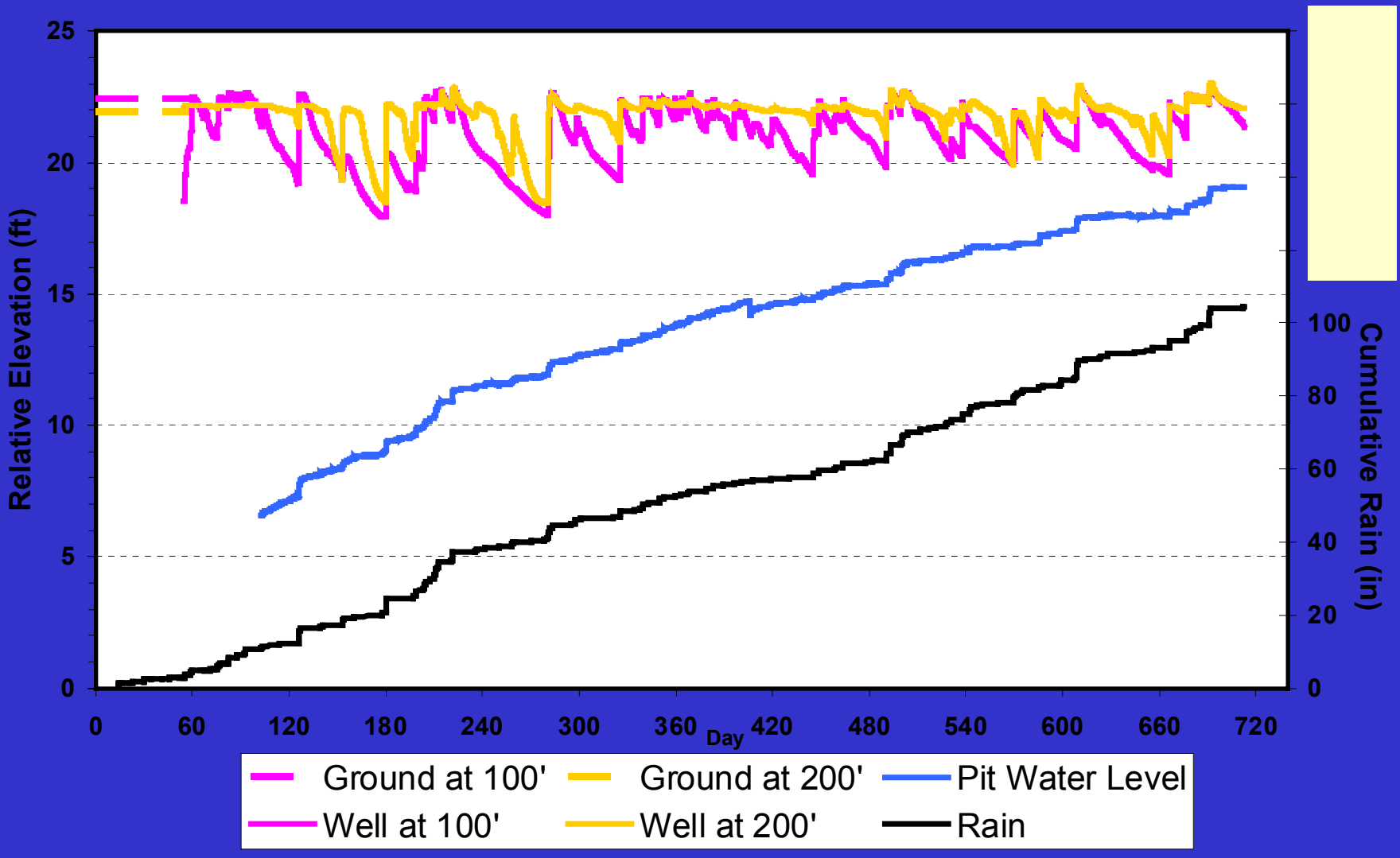



Spruill
Relative Elevation (ft)
25
20
15
10
5
0
Pred. Lat. Eff. 61 to 86 ft
50
40
30
20
10
0
Rain (in)
0
100
200
300
Day of Year
Ground elev. At 100'
Ground elev. At 200'
Pit water level
100' well
200' well

Spruill Borrow Pit, Tyrrell County, 2005 - 2006

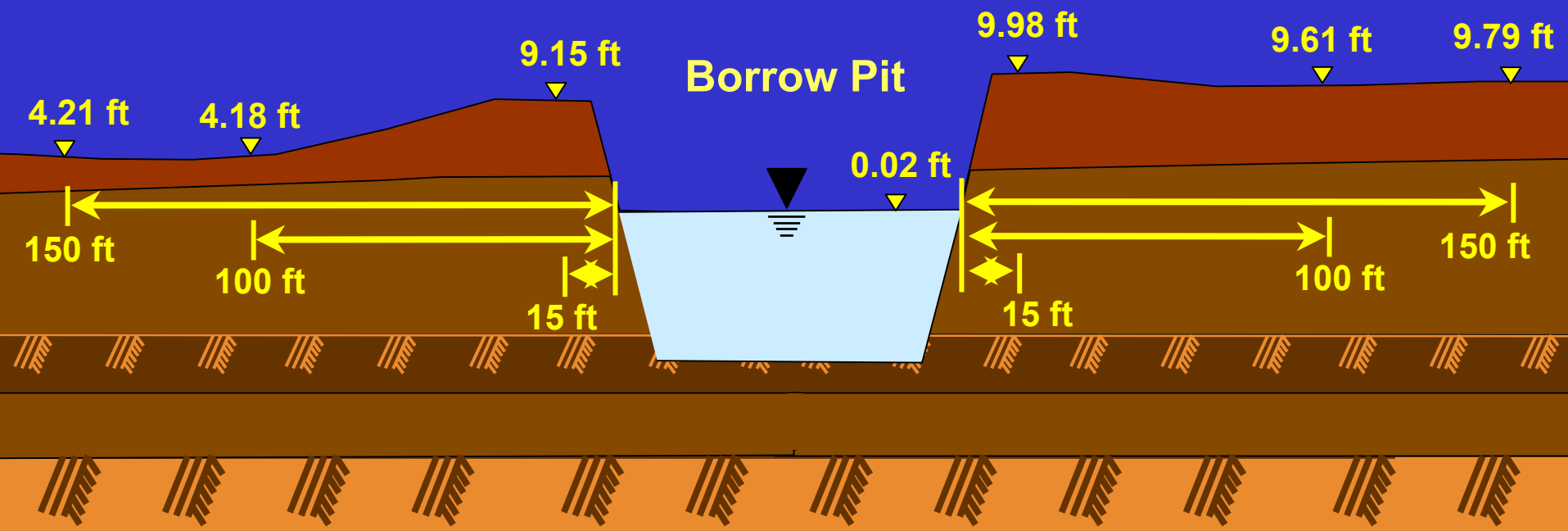


Spruill Borrow Pit, Tyrrell County, 2005 - 2006

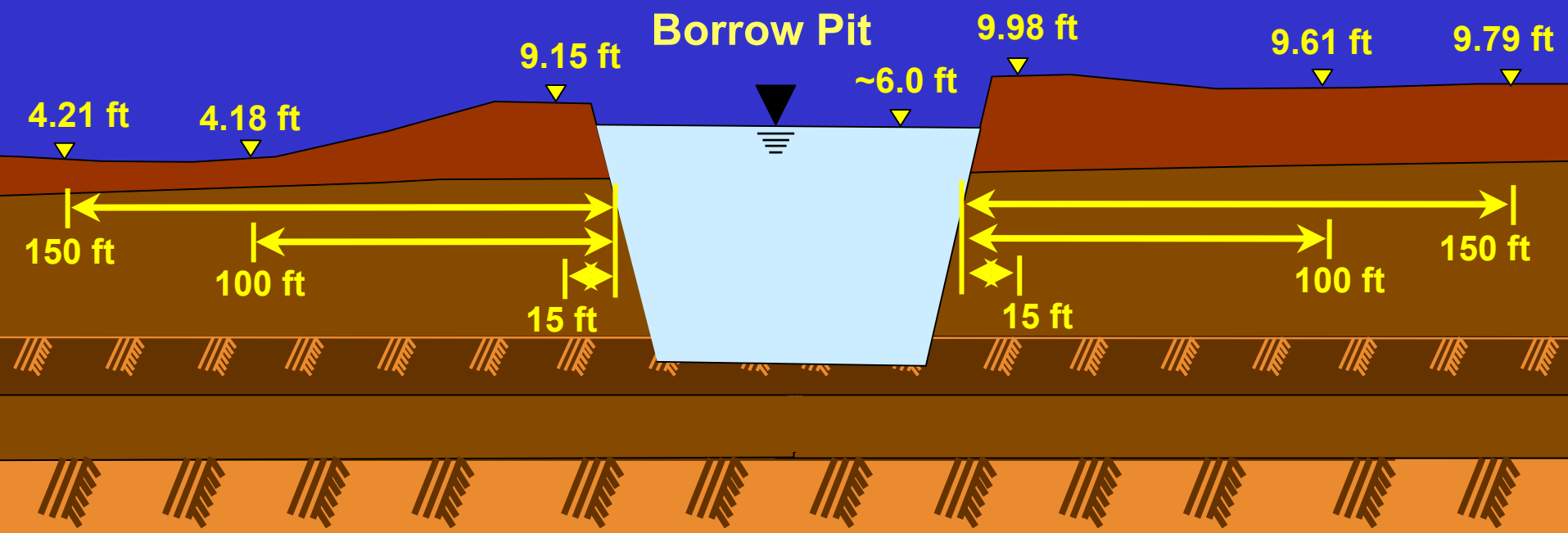


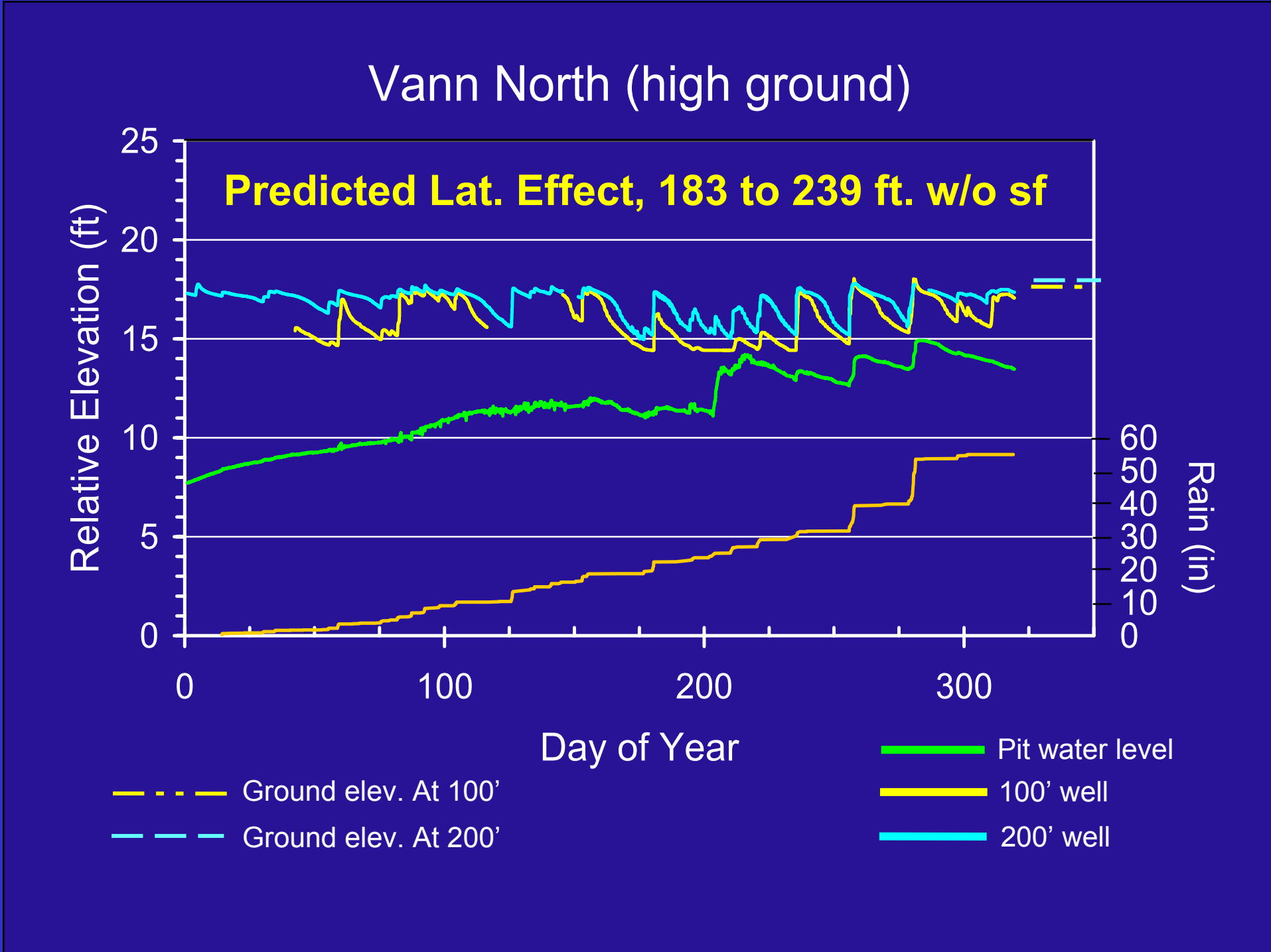

Vann, New Hanover Co.

Vann Pit (early 2005)

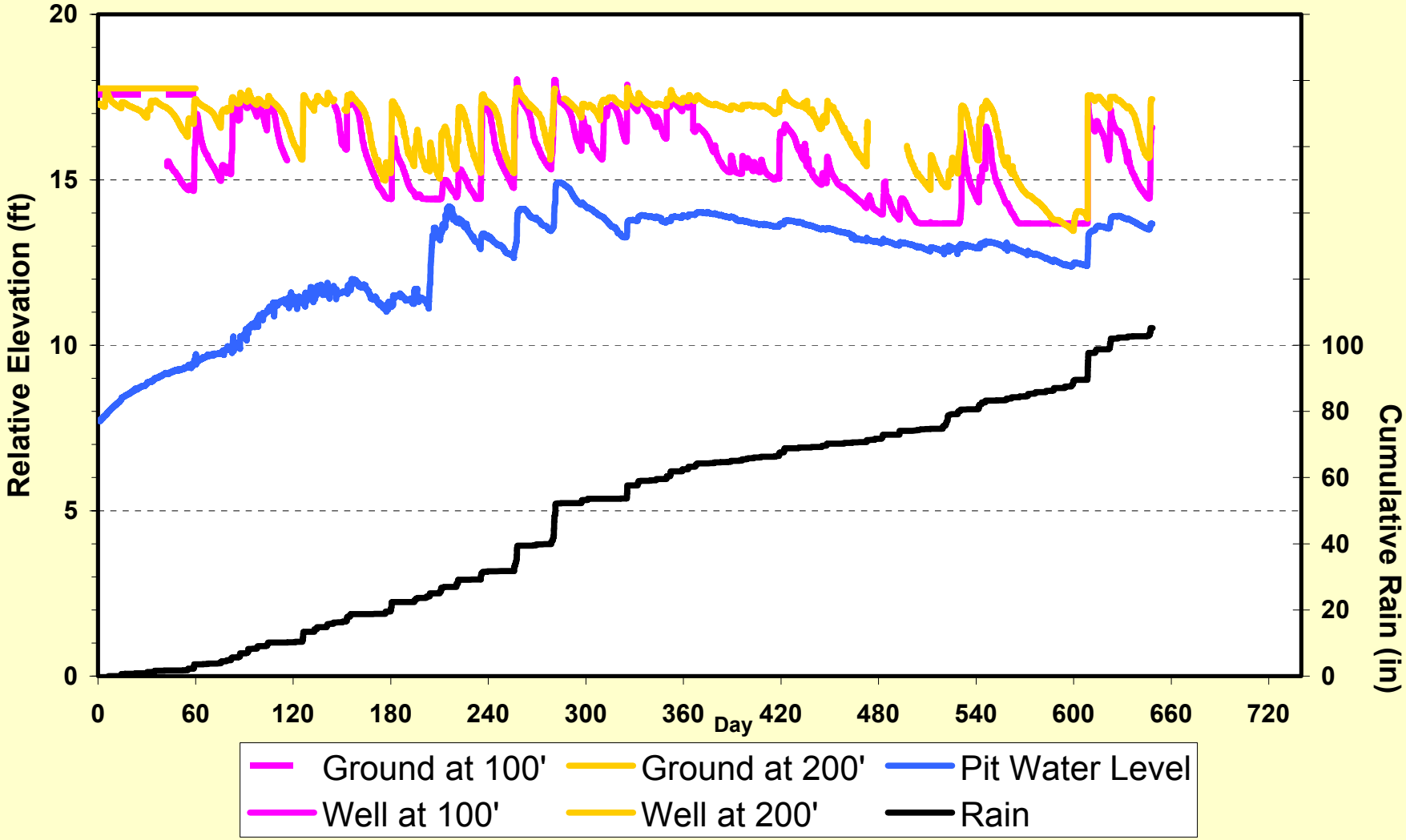


Vann Pit (late 2005)

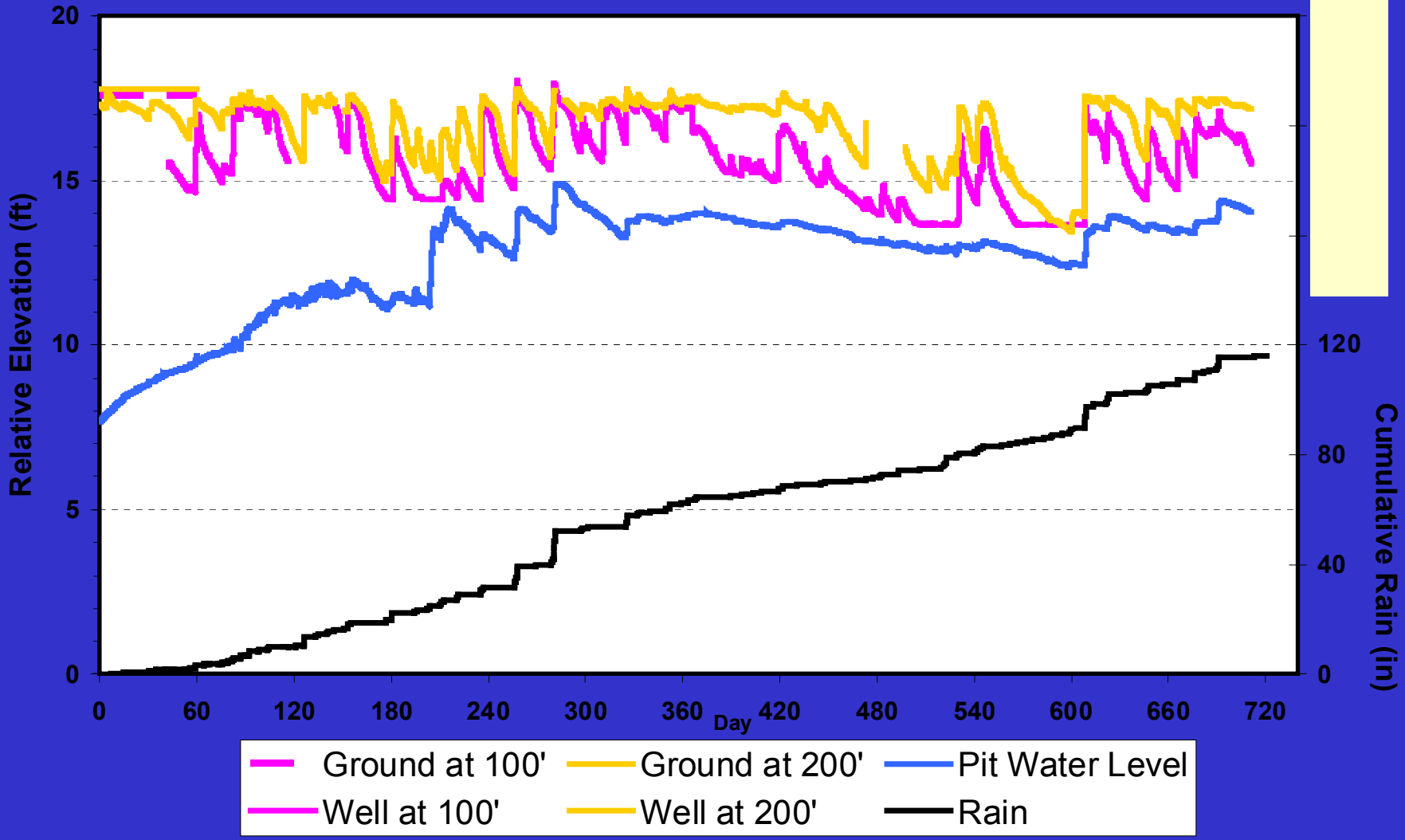


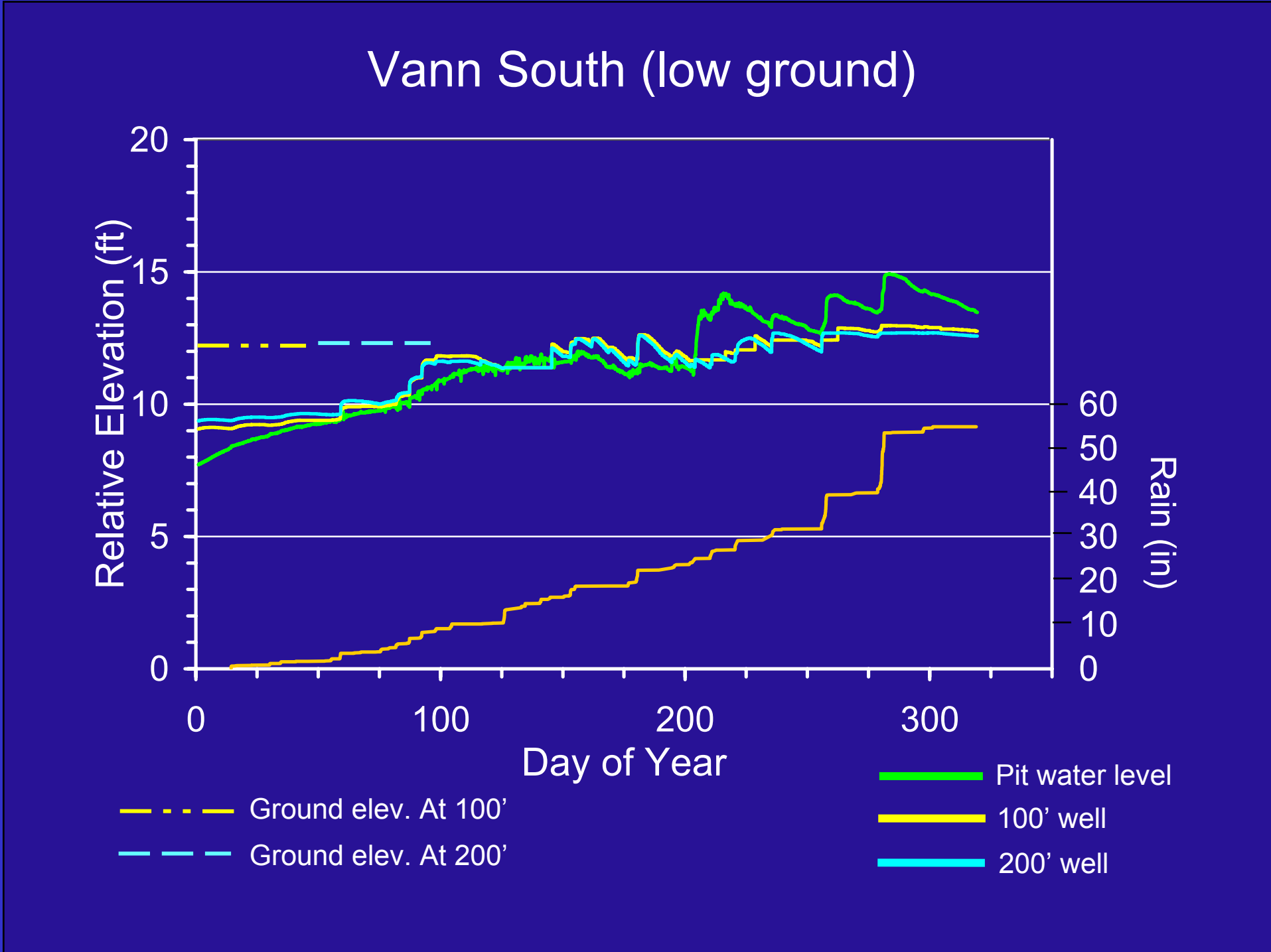

Vann North (high ground)
Predicted Lat. Effect, 183 to 239 ft. w/o sf
Relative Elevation (ft)
25
20
15
10
5
0
0
100
200
300
Day of Year
60
50
40
30
20
10
0
Rain (in)
Ground elev. At 100’
Ground elev. At 200’
Pit water level
100’ well
200’ well

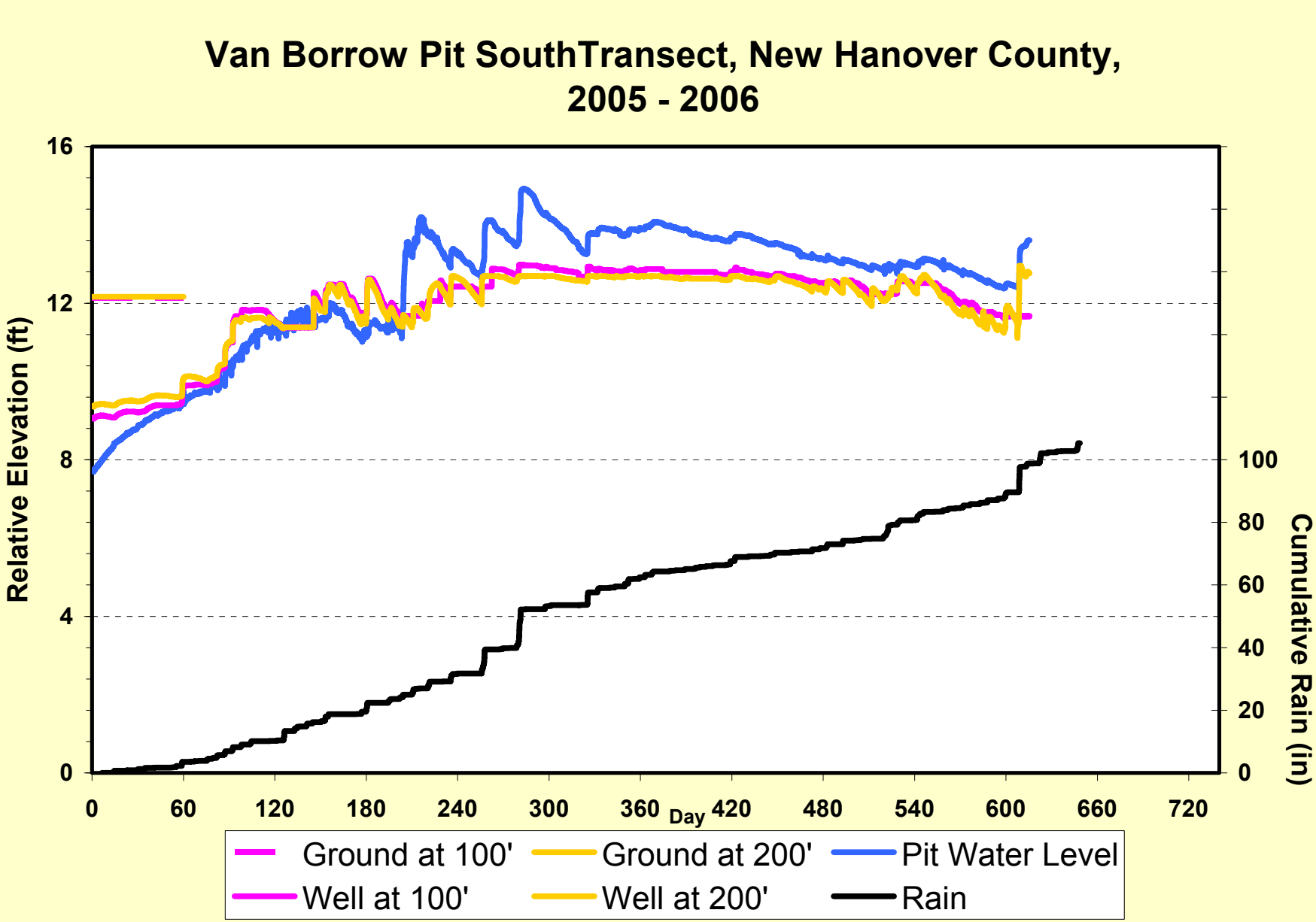
Van Borrow Pit North Transect, New Hanover County, 2005 - 2006



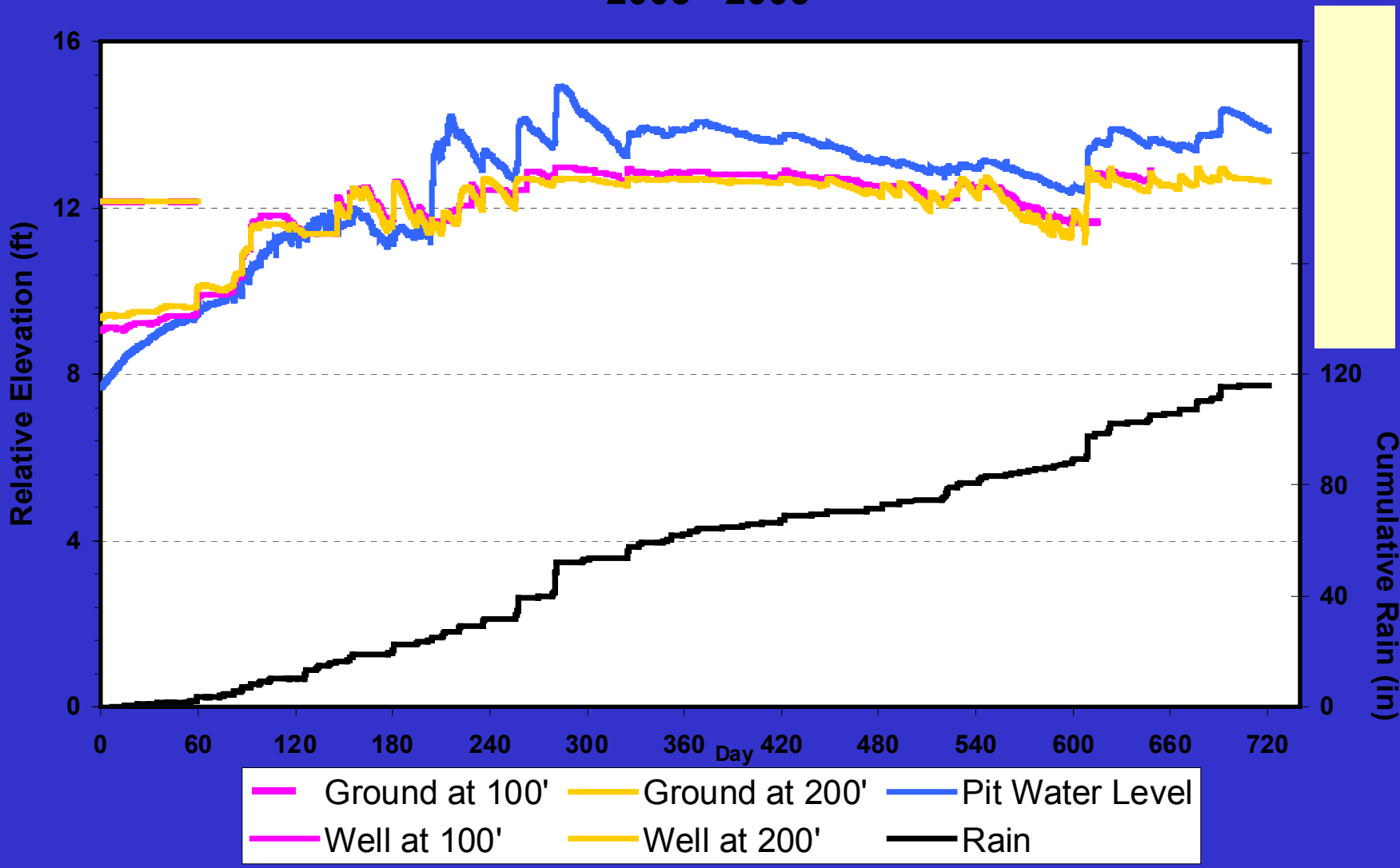
Van Borrow Pit North Transect, New Hanover County, 2005 - 2006




Vann South (low ground)
Relative Elevation (ft)
20
15
10
5
0
Rain (in)
60
50
40
30
20
10
0
0
100
200
300
Day of Year
Ground elev. At 100'
Ground elev. At 200'
Pit water level
100' well
200' well


Van Borrow Pit SouthTransect, New Hanover County, 2005 - 2006
Relative Elevation (ft)
16
12
8
4
0
0
60
120
180
240
300
360
420
480
540
600
660
720
Day
Cumulative Rain (in)
100
80
60
40
20
0
Ground at 100'
Ground at 200'
Pit Water Level
Well at 100'
Well at 200'
Rain

Van Borrow Pit SouthTransect, New Hanover County, 2005 - 2006



What is the difference between water level in pit and water level in adjacent wetland?

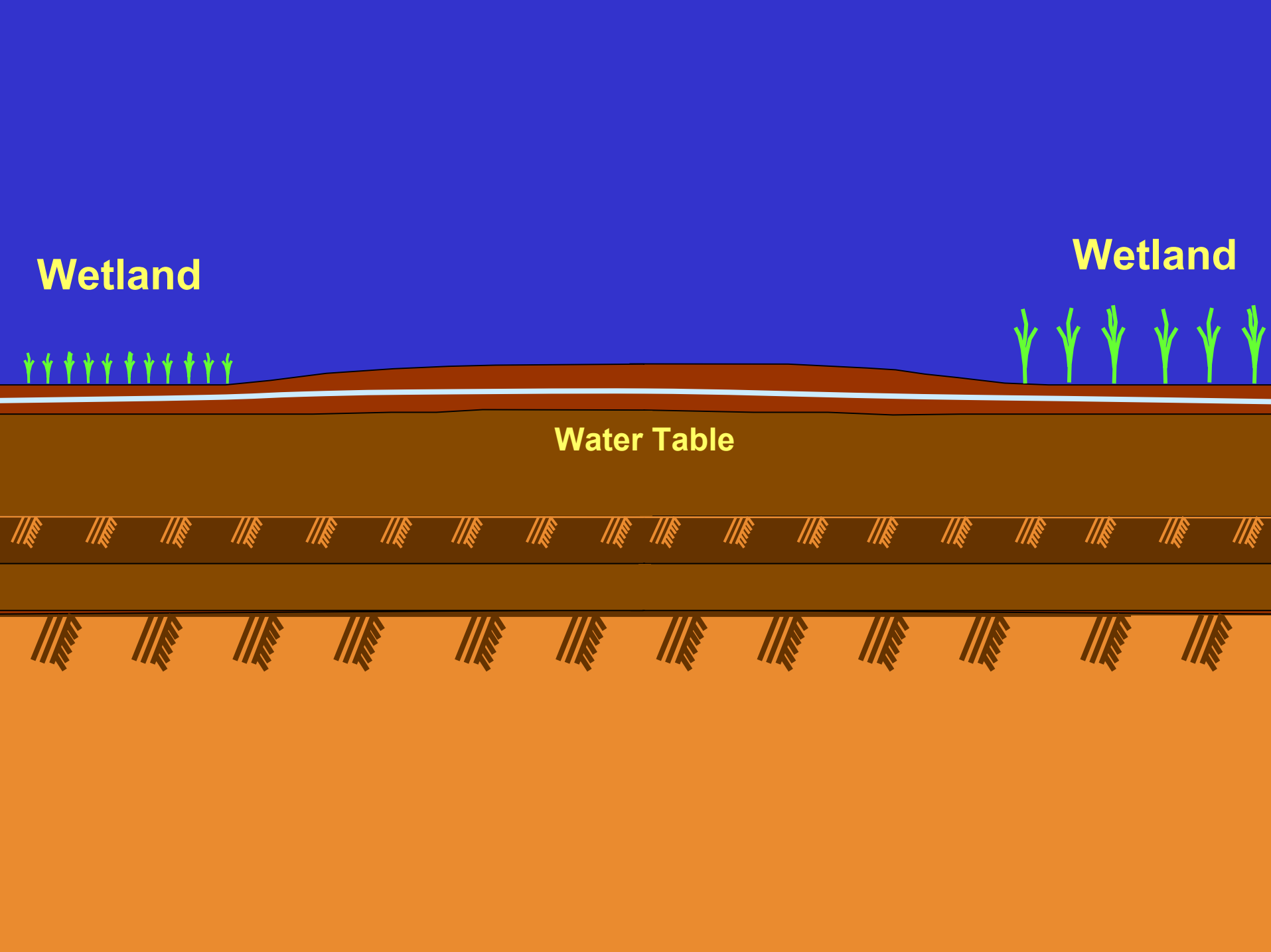
- Closed Pits with Measurements 13
- Gradient from wetland to Pit 7 (3.3’)
- Gradient from Pit to Wetland 6 (-4.2’)
- Overall average difference

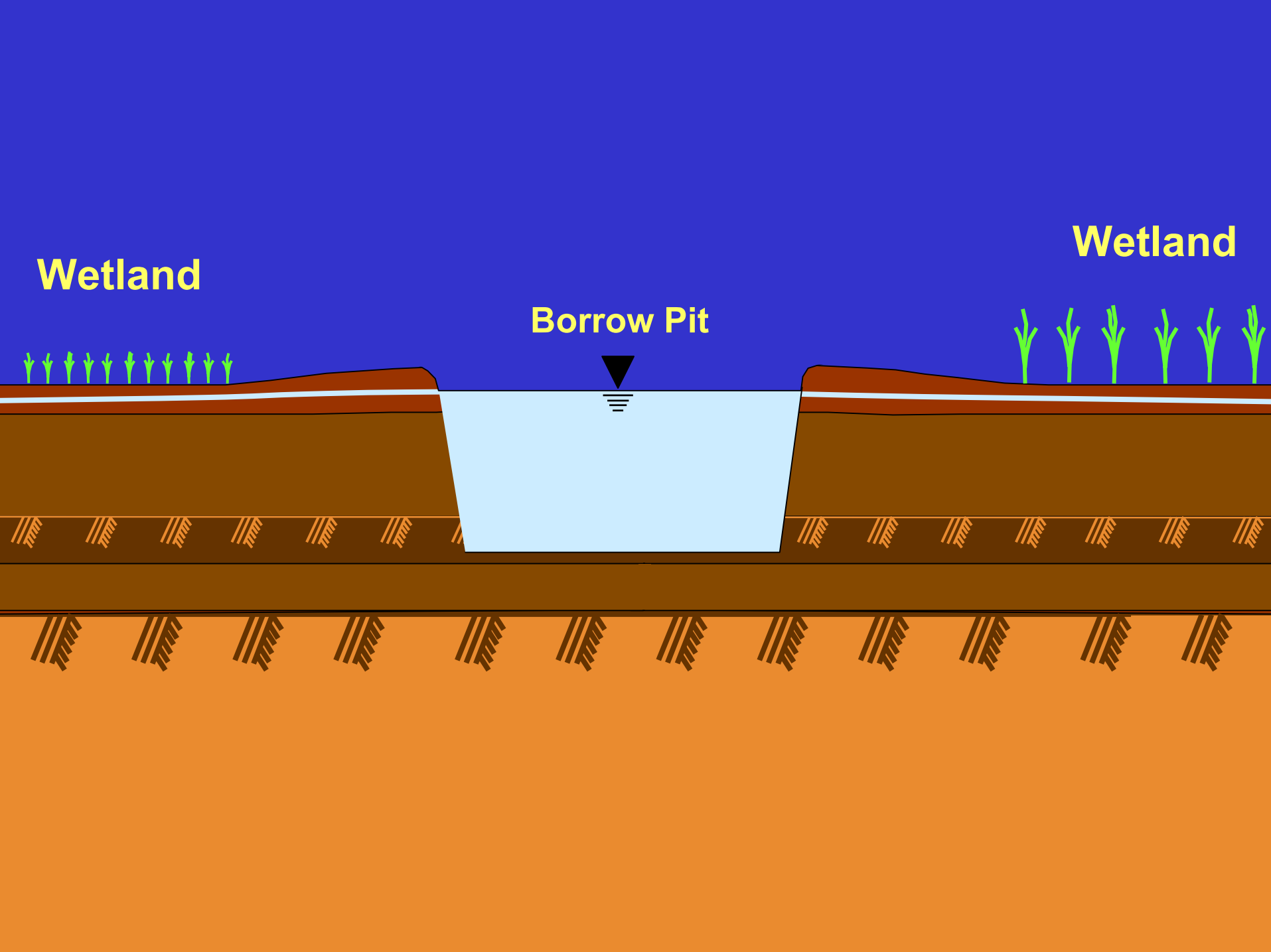
  Wetland **surface** to pit water level -0.2’

Monitored Pits

Difference in water level, wetland to pit (ft.)

- Mildred Woods © ~0
- Hardy © 2
- Stallings © - 2
- Twiddy © ?
- Davis ? (Waiting)
- Prime Ridge -2 (W), +1 (E)
- Spruil ? (waiting)
- Vann -1 to -2 (S), +2 to 3 (N)


Wetland
Wetland
Water Table


Wetland
Borrow Pit
Wetland

Summary

- Pits appear to fill to equilibrium in 1 year or less
- Seepage is from pit to wetland in about half of the cases
- Prediction method, as currently used, appears to overestimate lateral effect in most cases (probably because of assumption of 2 ft depth)