Useful Storage

and the Hydrologic Cycle

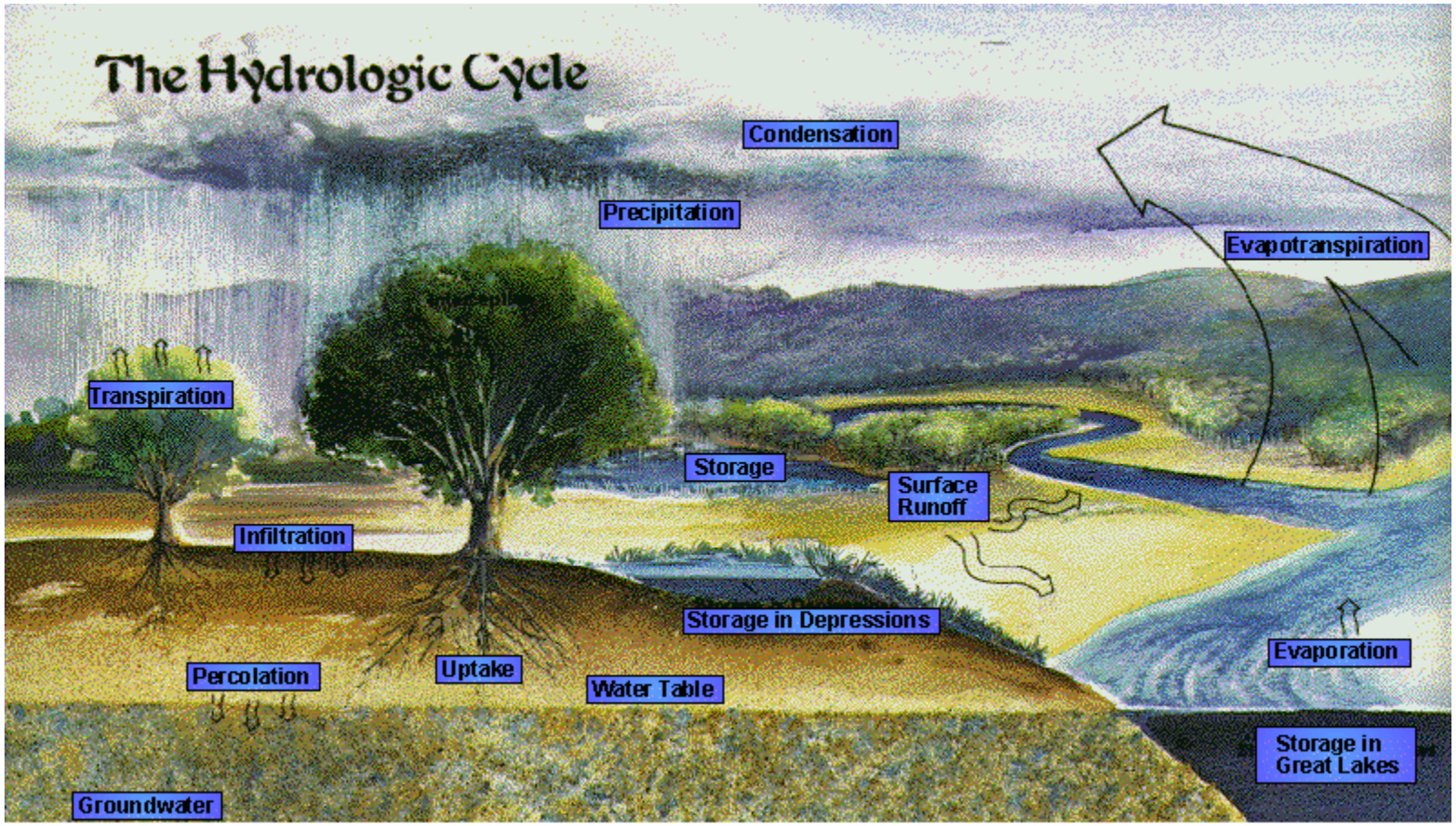
This is a presentation about water quantity.

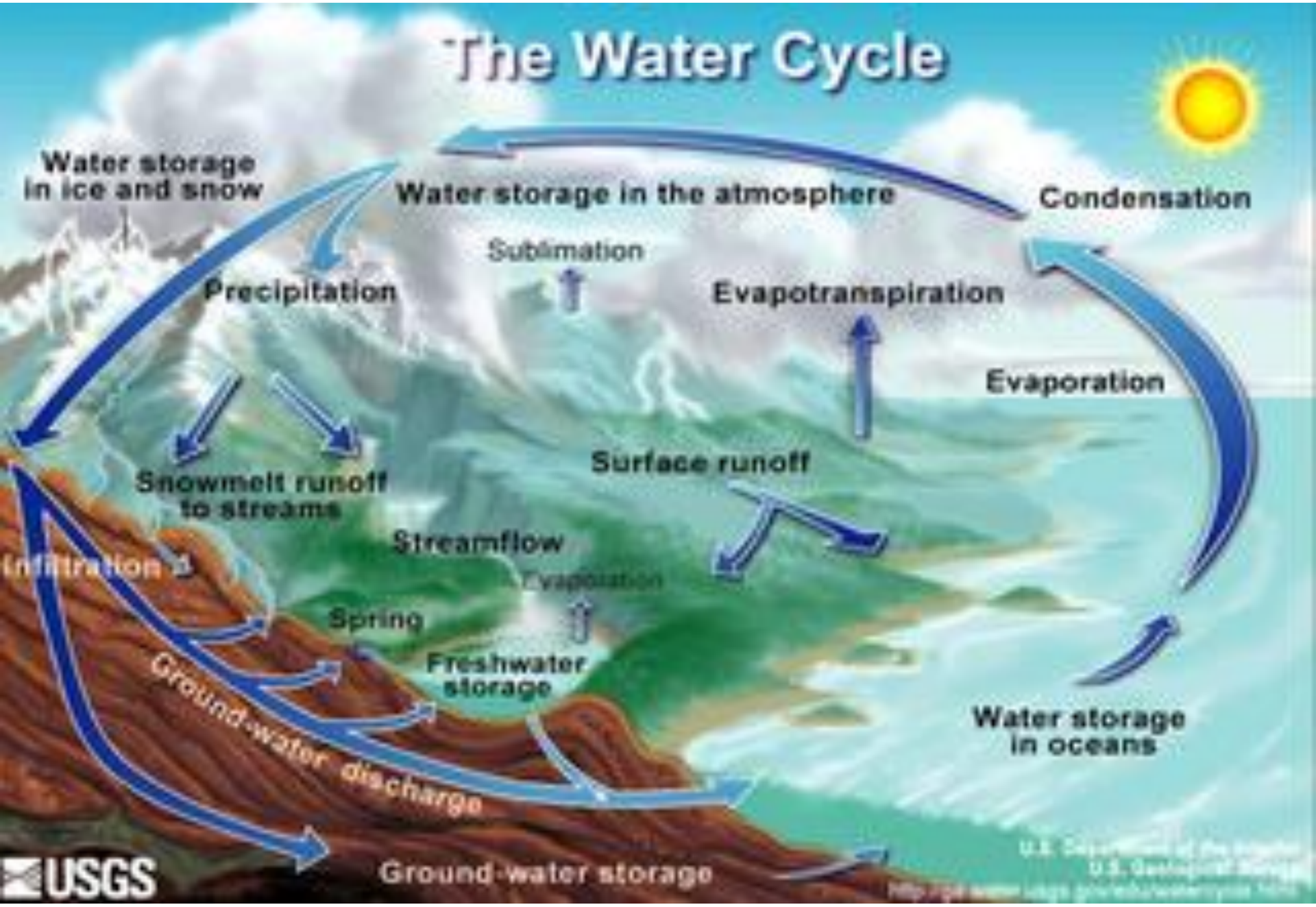
Sometimes we get too much rain.

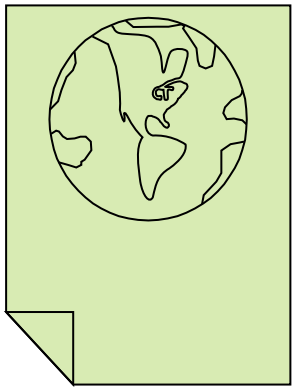
Sometimes we get too little rain.

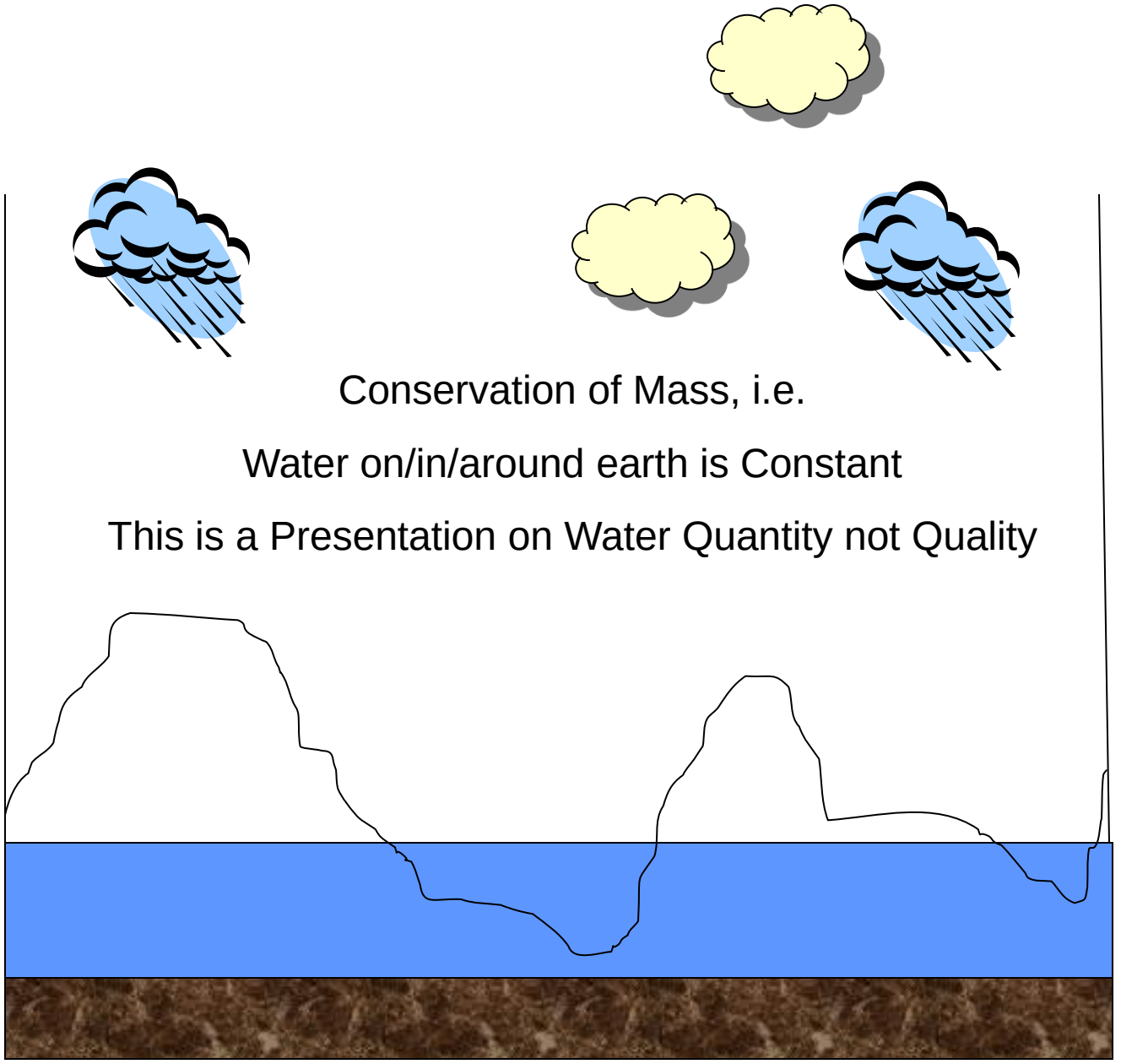
This is not a presentation regarding water quality.

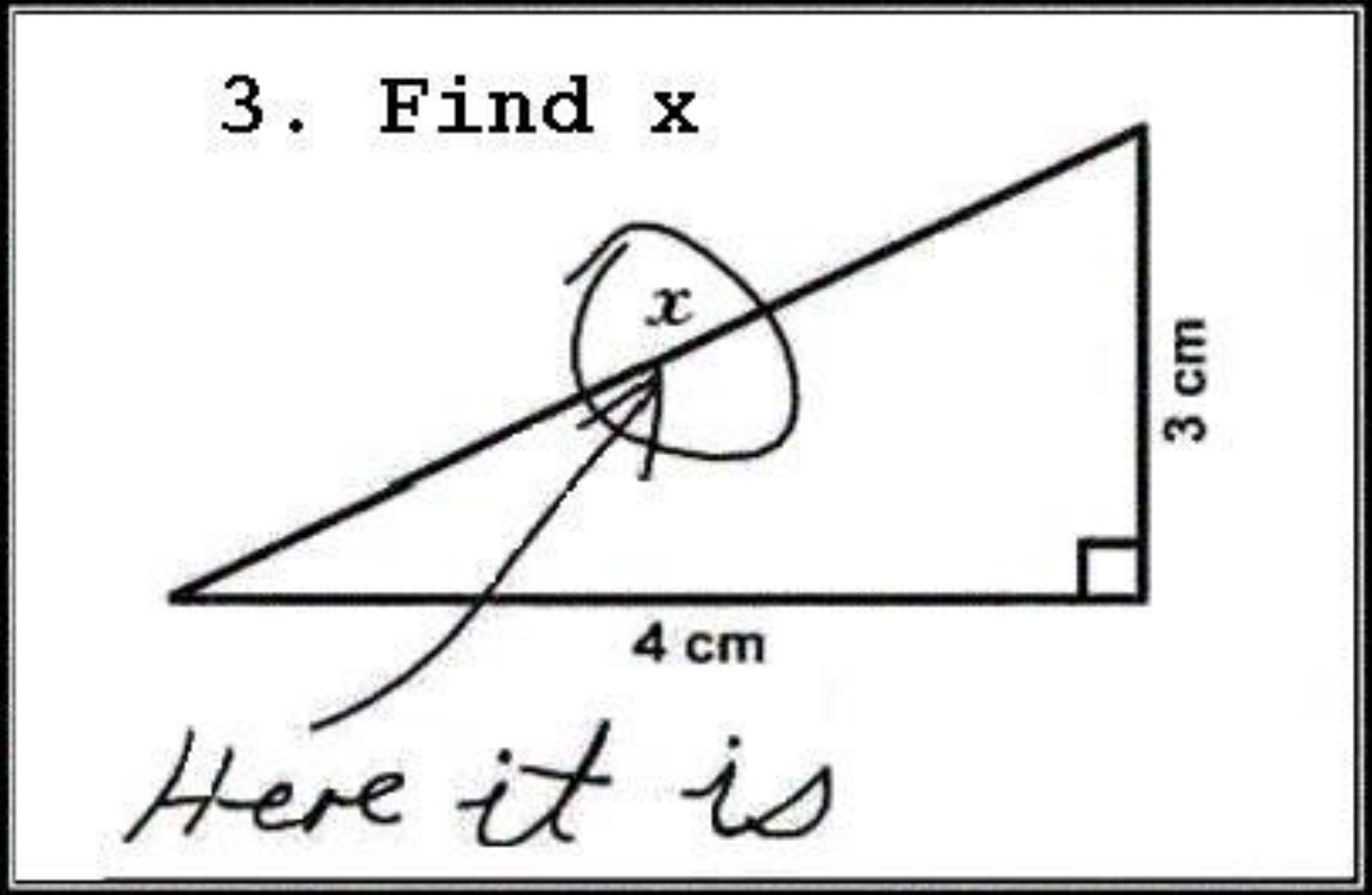
This is not a presentation regarding the environment.


The Hydrologic Cycle
Condensation
Precipitation
Evapotranspiration
Transpiration
Storage
Surface Runoff
Infiltration
Storage in Depressions
Evaporation
Percolation
Uptake
Water Table
Storage in Great Lakes
Groundwater


The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Surface runoff
Snowmelt runoff to streams
Streamflow
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
USGS

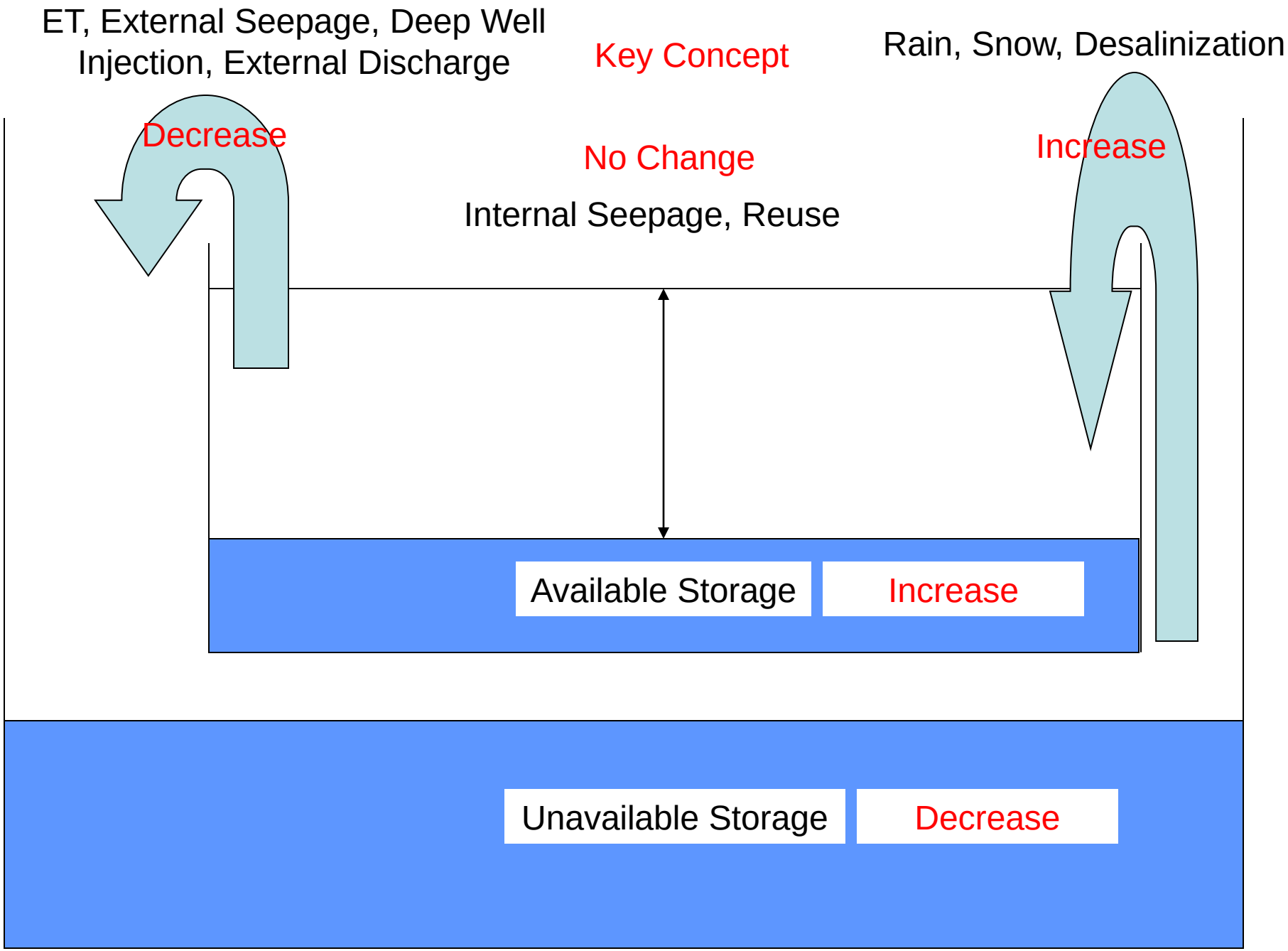



Conservation of Mass, i.e.
Water on/in/around earth is Constant
This is a Presentation on Water Quantity not Quality

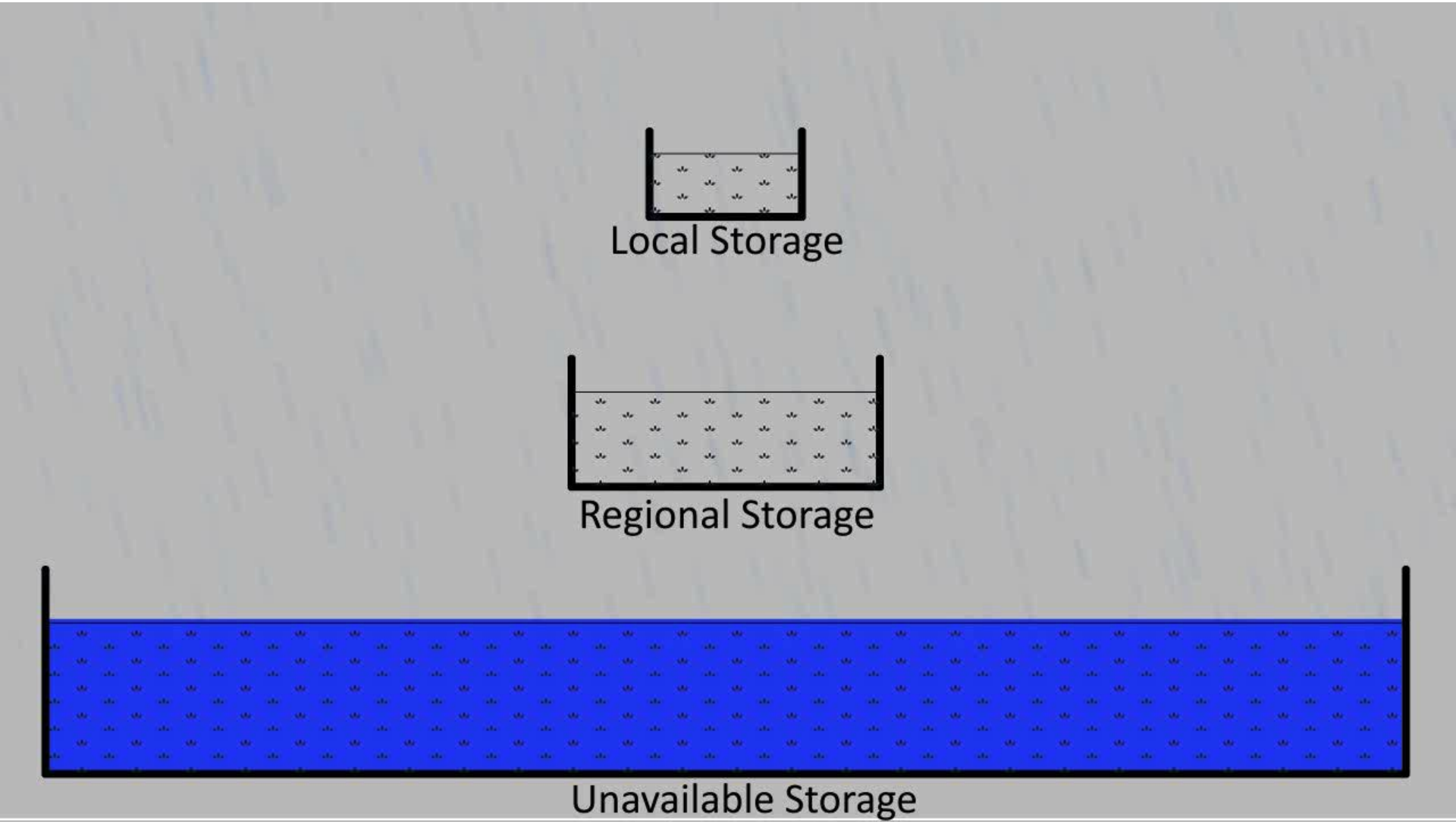


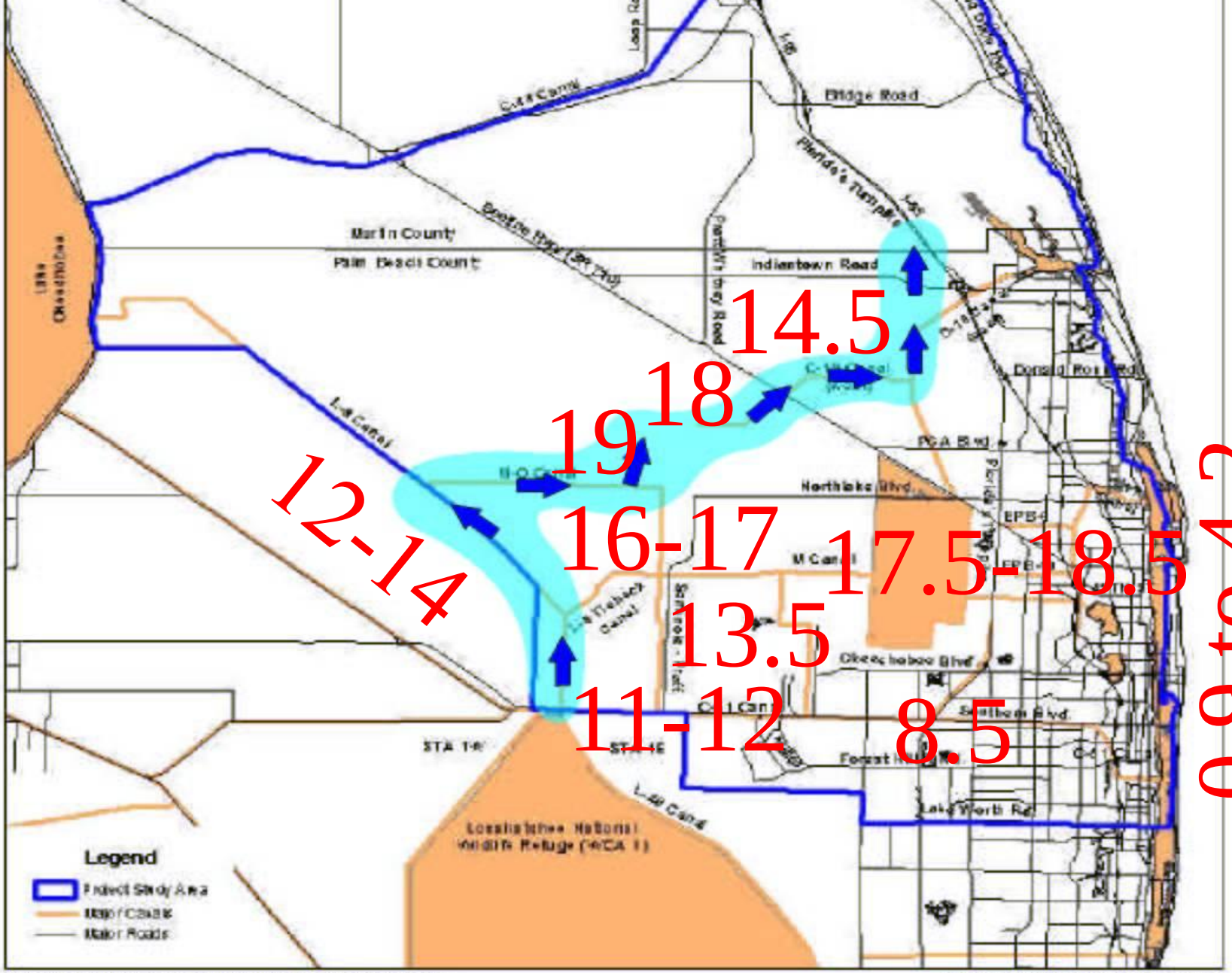
SIMPLICITY

The simplest solutions are often the cleverest
They are also usually wrong


ET, External Seepage, Deep Well Injection, External Discharge
Key Concept
Rain, Snow, Desalinization
Decrease
No Change
Internal Seepage, Reuse
Increase
Available Storage
Increase
Unavailable Storage
Decrease

Ideal Situation





SOURCE: Milian, Swain, and Associates, modified by E & E

Ecology and Environment, Inc., 2004

SCALE 1:425,000

0 2.5 0 5 Miles

KEY:

Estimating Active Storage Capacity

Mass Balance Equation of Reservoirs

$$S_{t-1} + Q_t - R_t - L_t = S_t$$

Where

S_{t-1} is storage at end of previous time interval

S_t is storage at end of current time interval

Q_t is inflows at current time interval

R_t is release at current time interval

L_t is loss (evap/seepage) at current time interval

Reservoirs have a fixed storage capacity, K, so

$S_t <= K$ for each interval

Mass Diagram Analysis (Rippl) Method

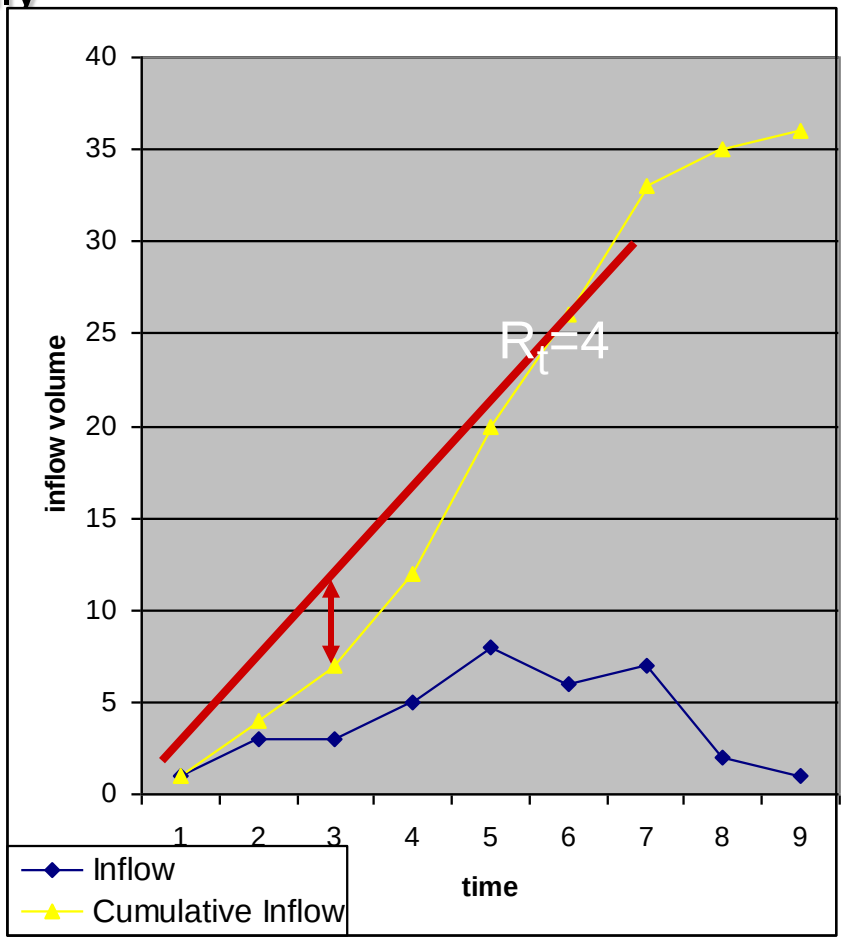
Find the maximum positive cumulative difference between a sequence of pre-specified (desired) reservoir releases R_t and known inflows Q_t.

Record of historical inflows is used, typically

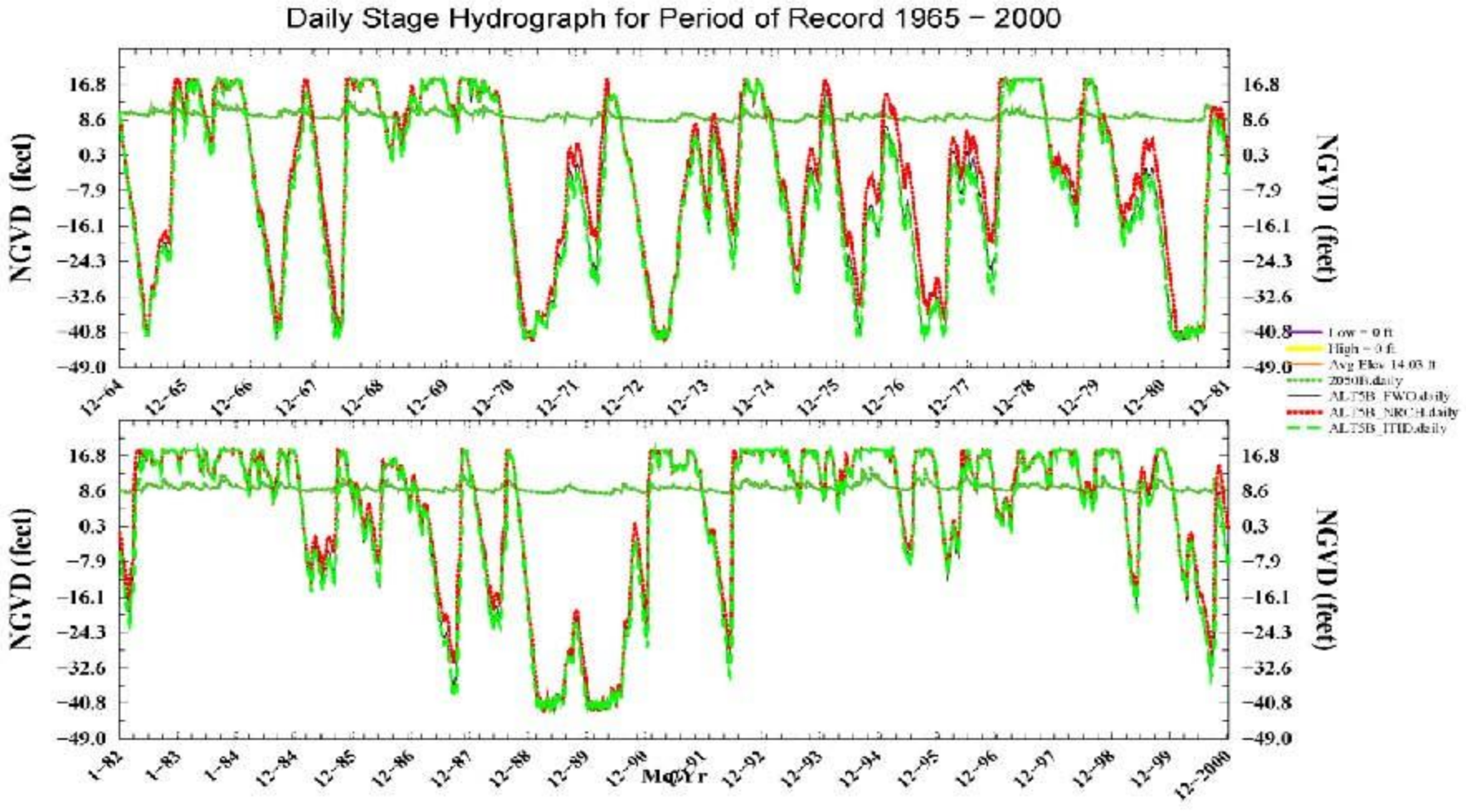
Example: Nine period-of-record flows:

[1, 3, 3, 5, 8, 6, 7, 2, 1]

1. Plot cumulatives
2. Add demand line
3. Find max deficit

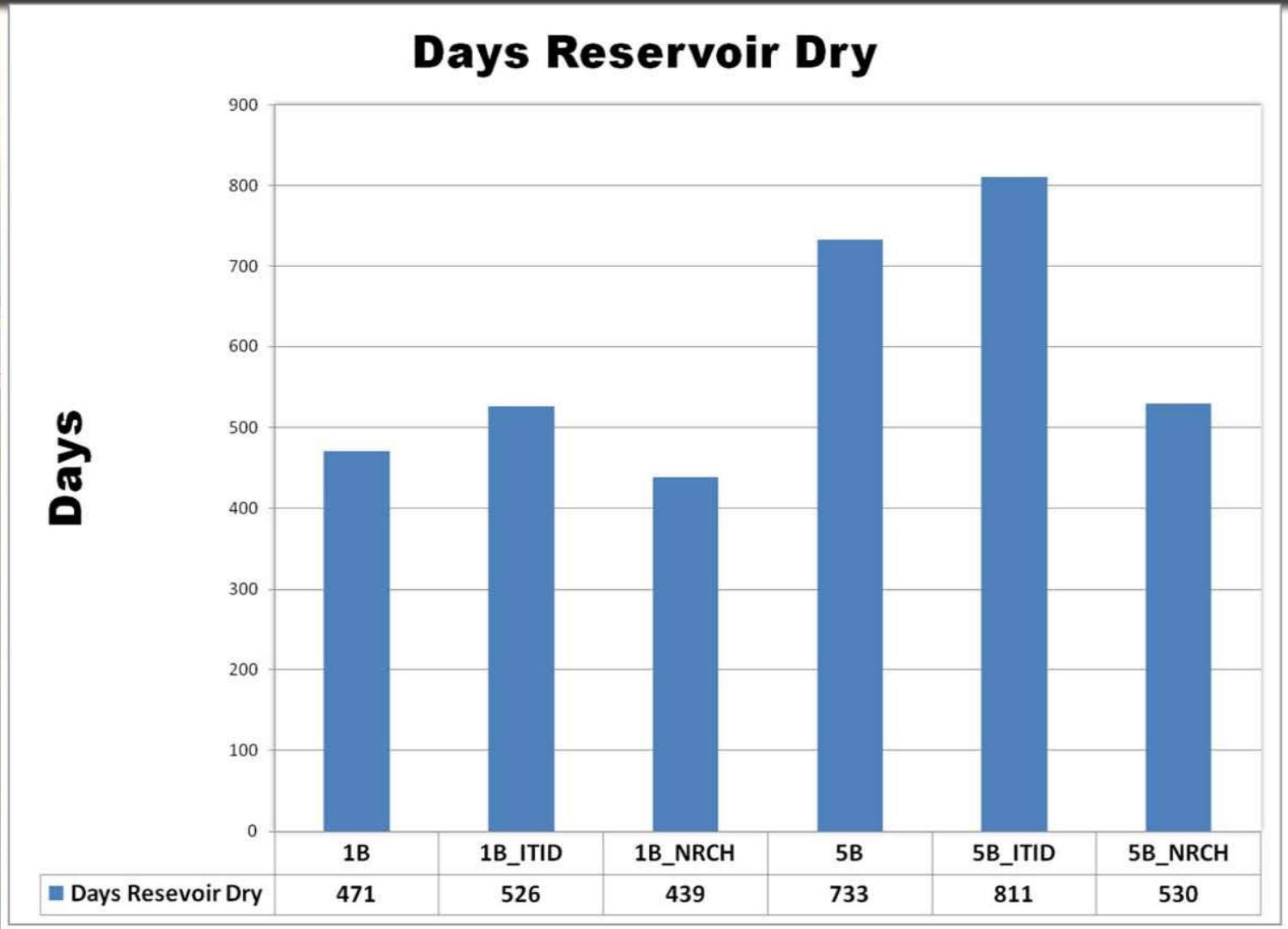


L-8RES



Run date: Wednesday, September 22, 2010 3:30:52 PM EDT
For Planning Purposes Only (#1)
Modflow LEC lecer SubReg onal GW Model

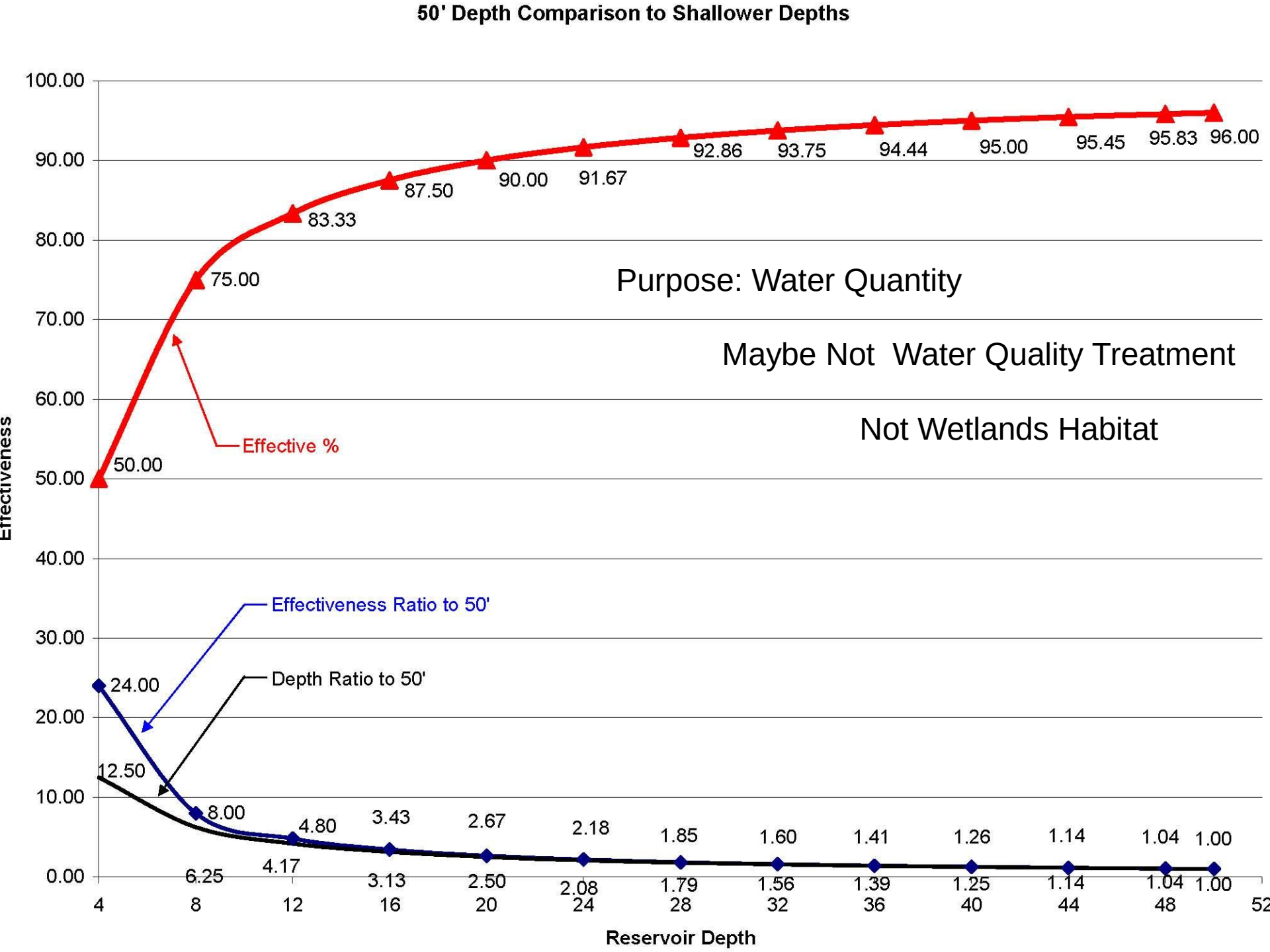
Time when the L8 Reservoir Was Empty



New Subject

Storage Effectiveness v Depth

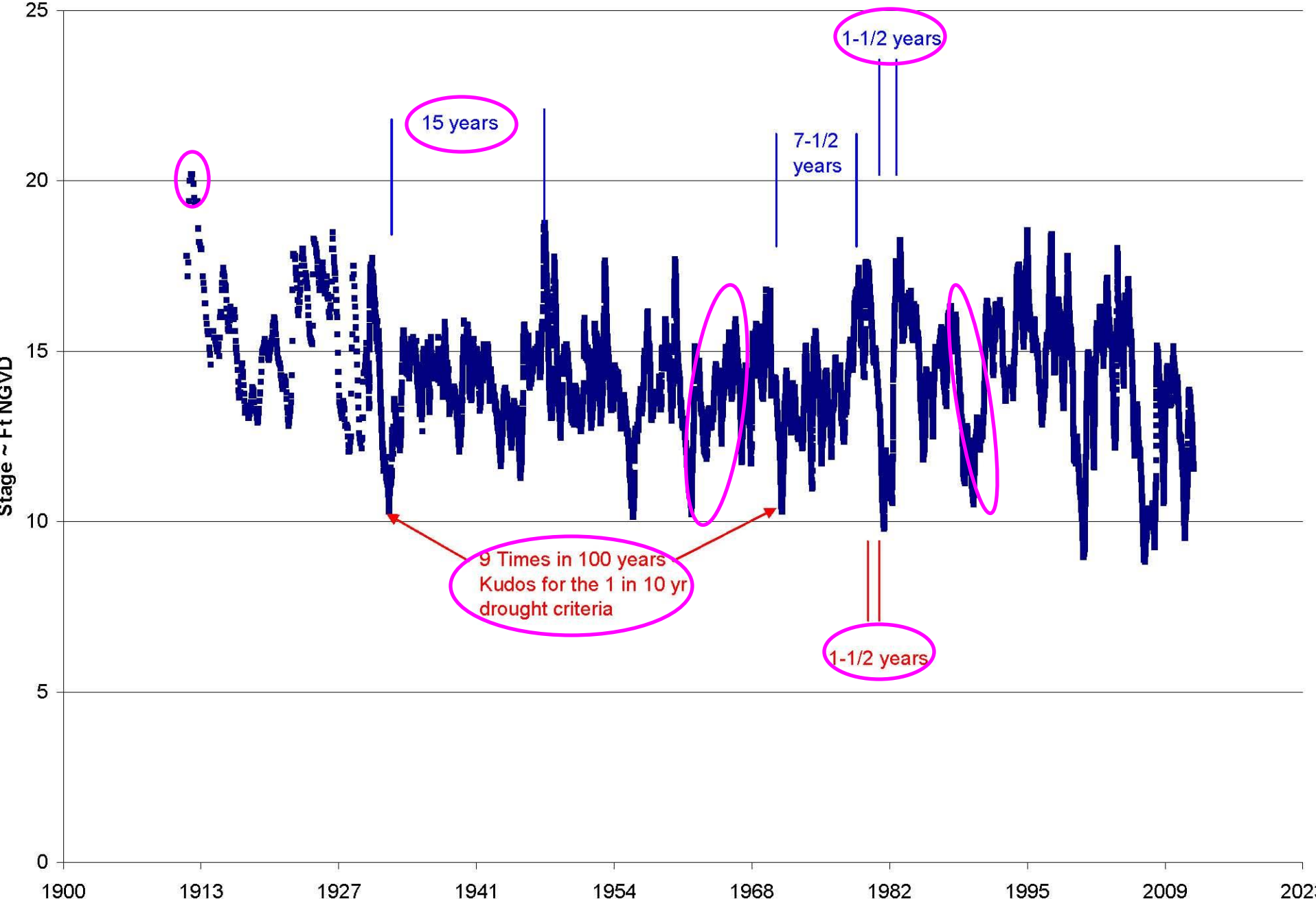
Lost Storage due to ET: No External Seepage or Discharge


50' Depth Comparison to Shallower Depths
Effectiveness
Reservoir Depth
Purpose: Water Quantity
Maybe Not Water Quality Treatment
Not Wetlands Habitat
Effective %
Effectiveness Ratio to 50'
Depth Ratio to 50'
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
4
8
12
16
20
24
28
32
36
40
44
48
52
50.00
75.00
83.33
87.50
90.00
91.67
92.86
93.75
94.44
95.00
95.45
95.83
96.00
24.00
8.00
4.80
3.43
2.67
2.18
1.85
1.60
1.41
1.26
1.14
1.04
1.00
12.50
6.25
4.17
3.13
2.50
2.08
1.79
1.56
1.39
1.25
1.14
1.04
1.00

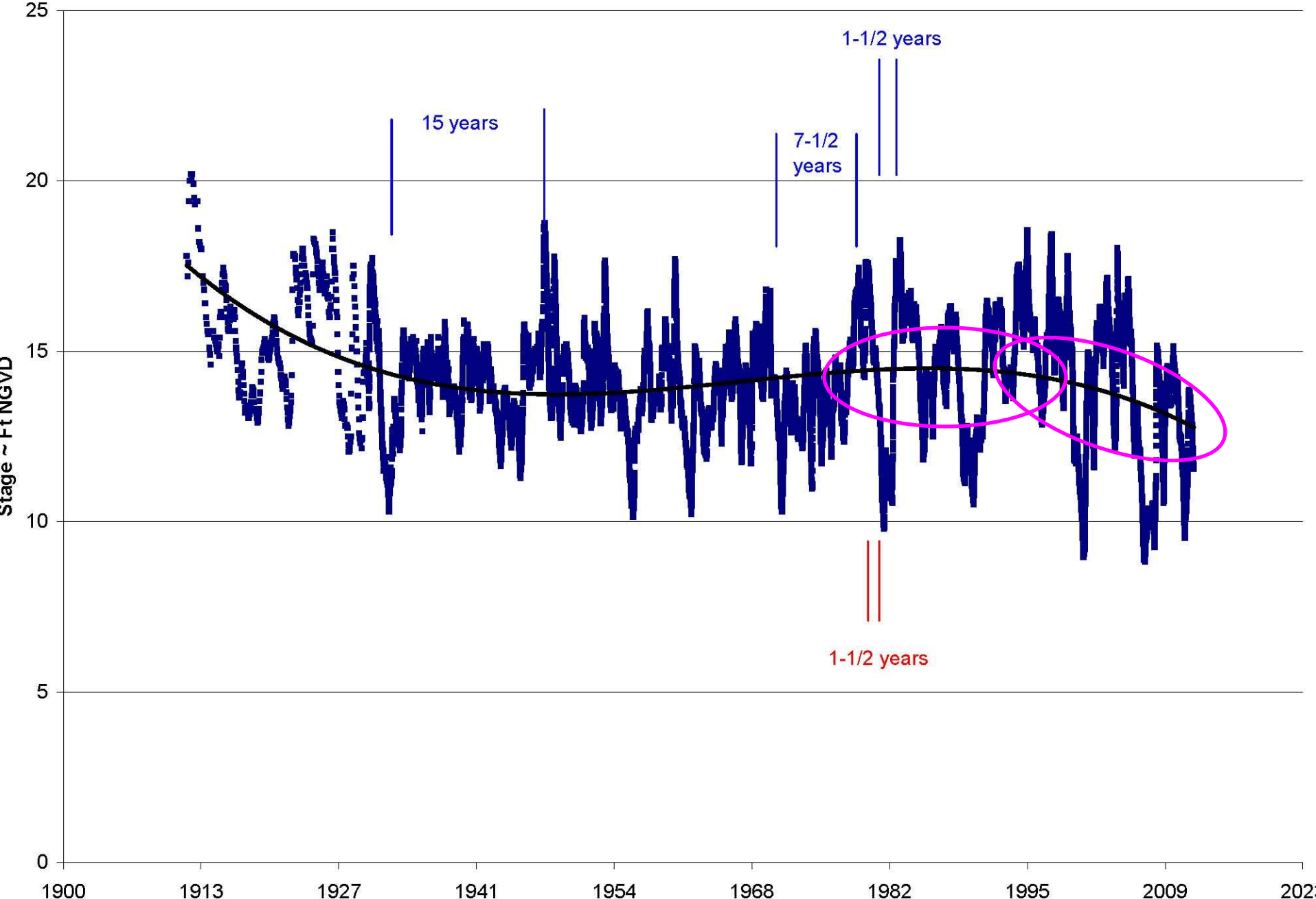
New Subject

Lake Okeechobee

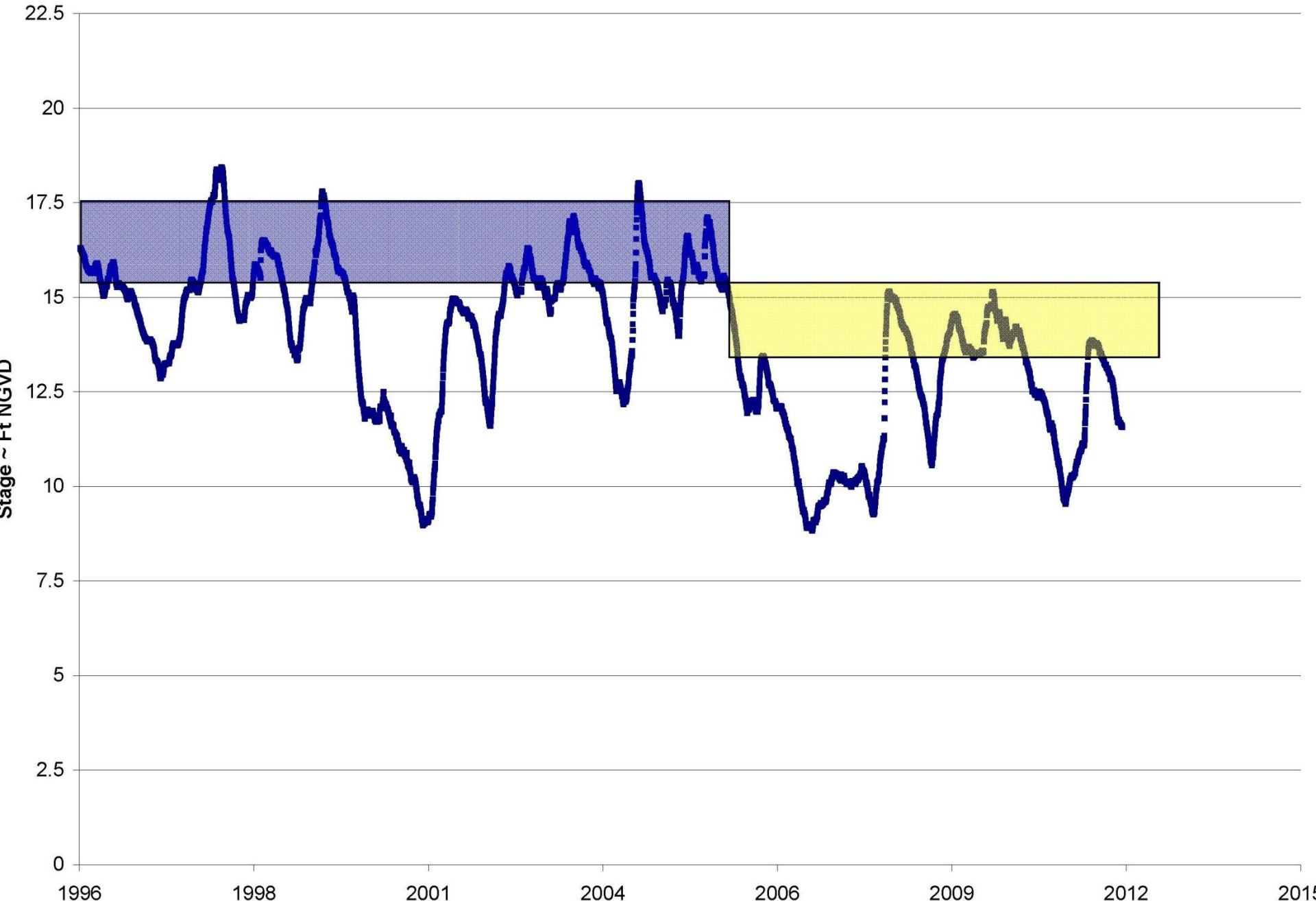
Lake Okeechobee



Lake Okeechobee

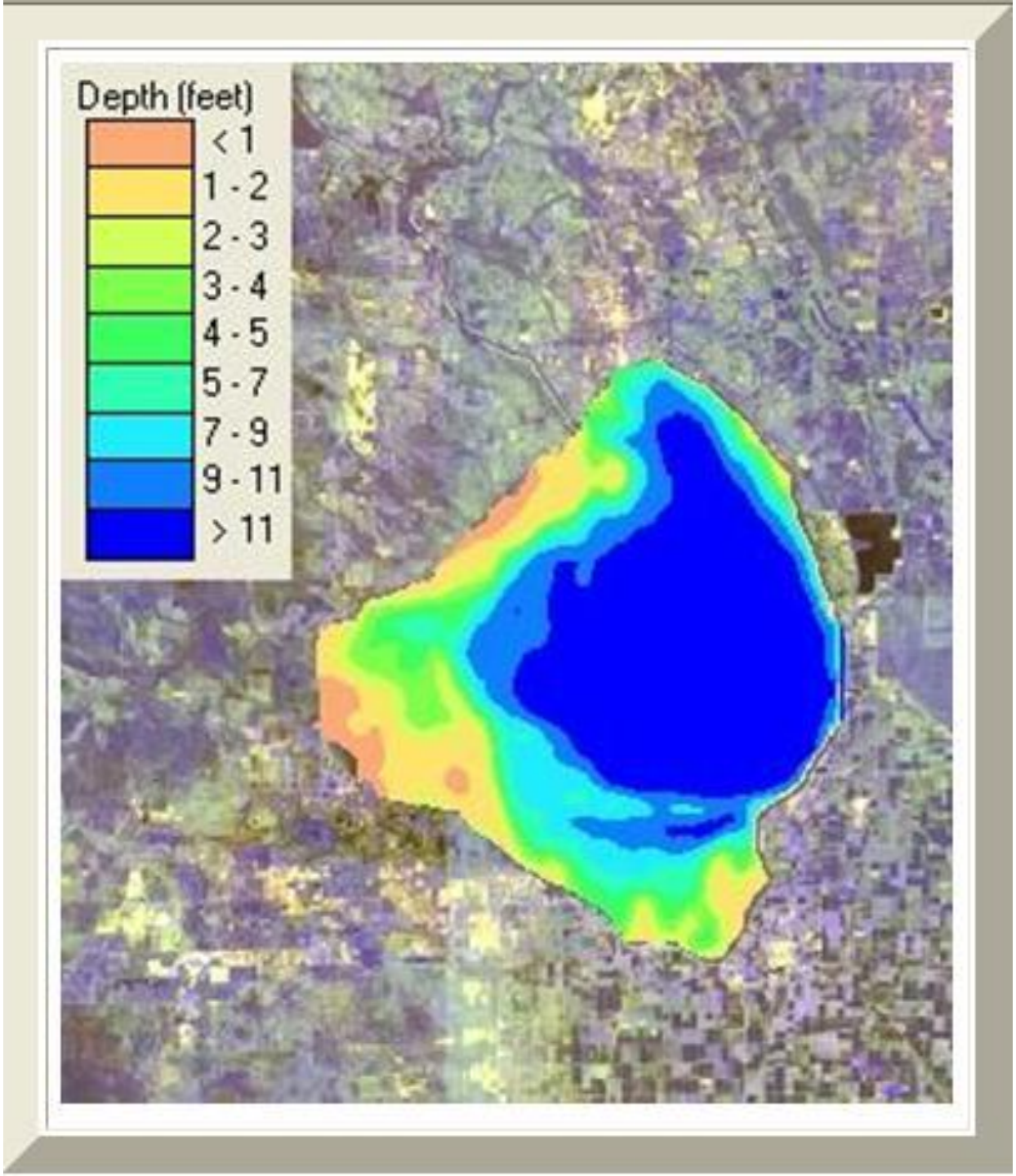


Lake Okeechobee



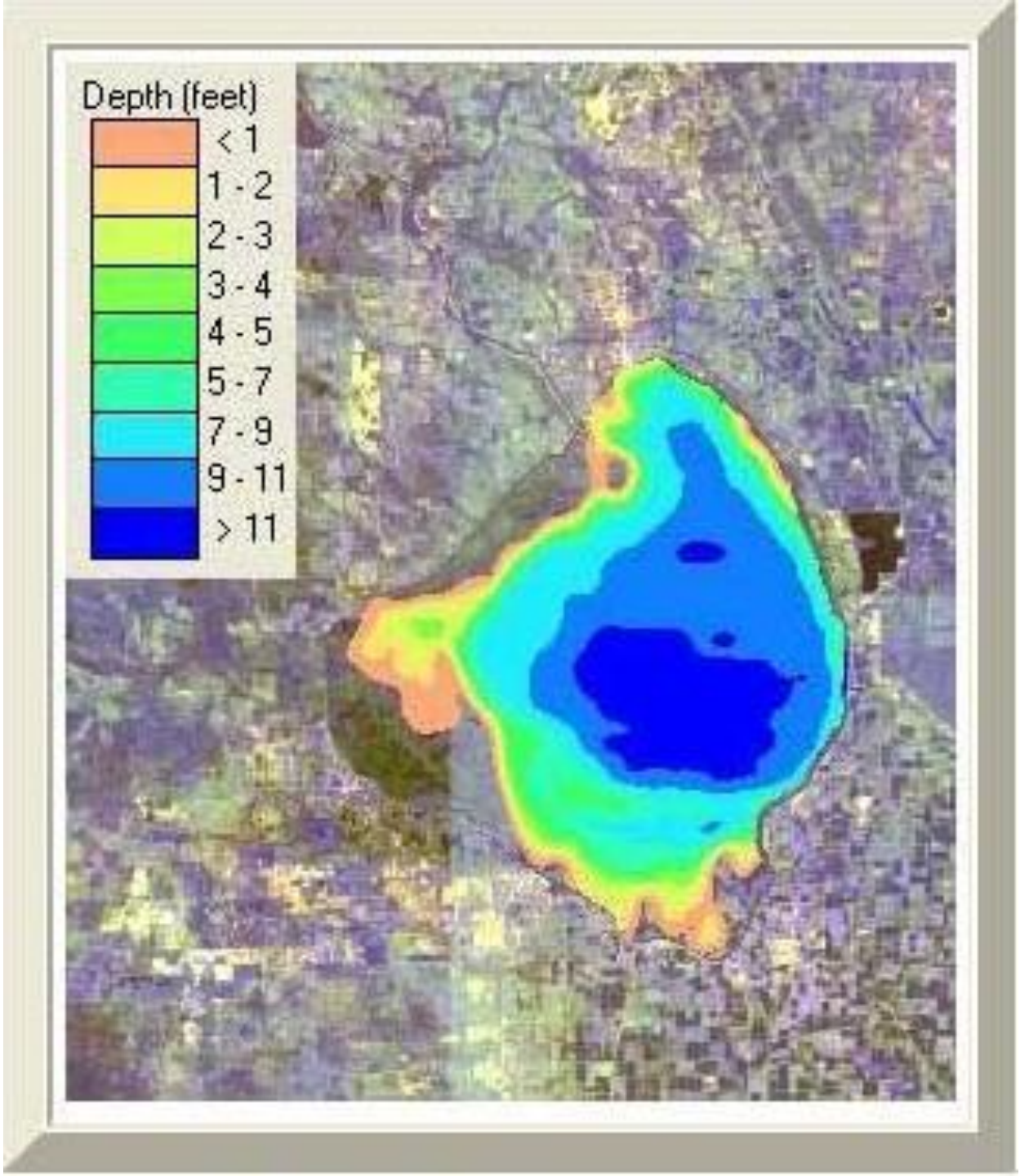
Elevation

= 14.5’

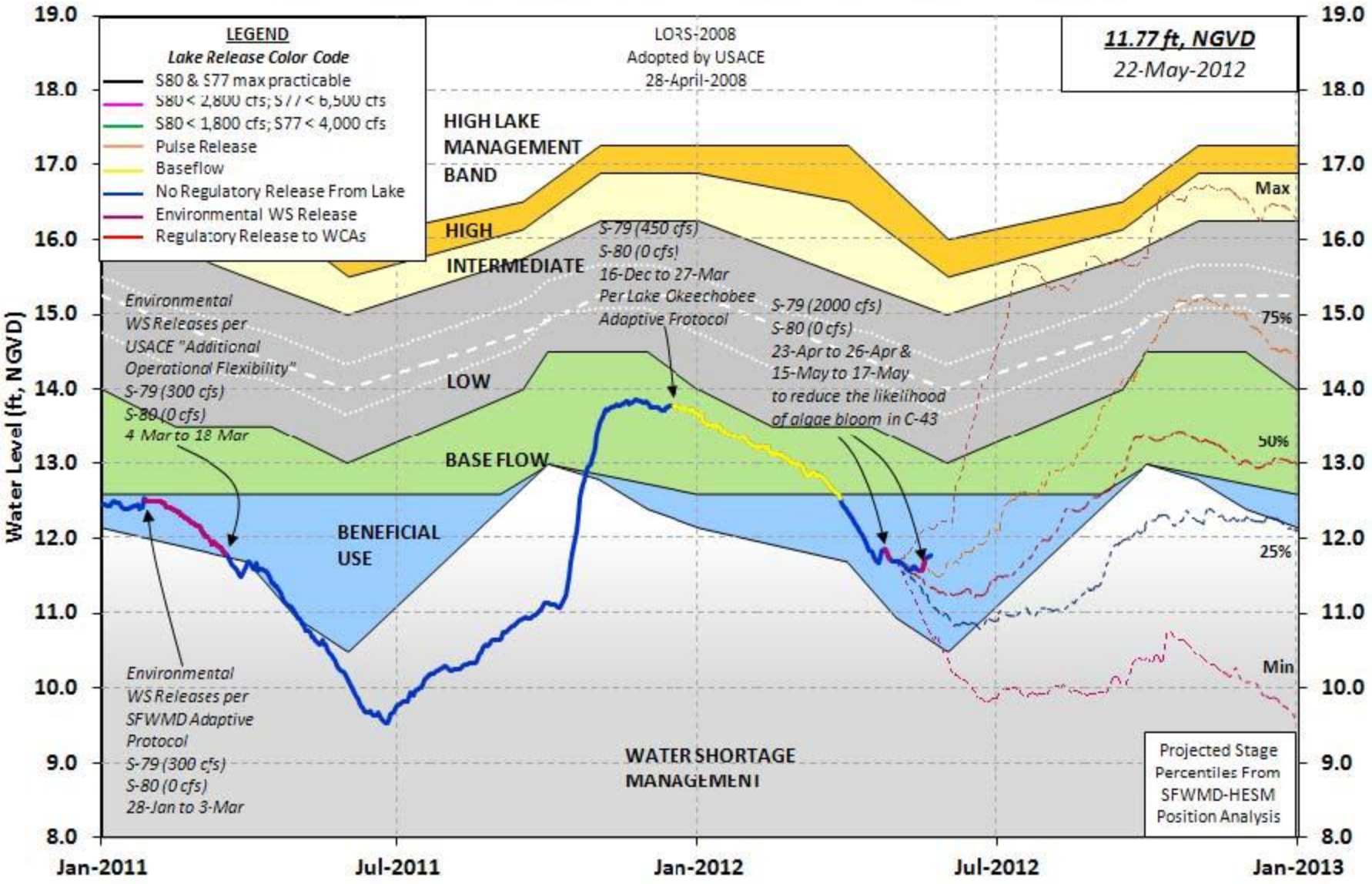


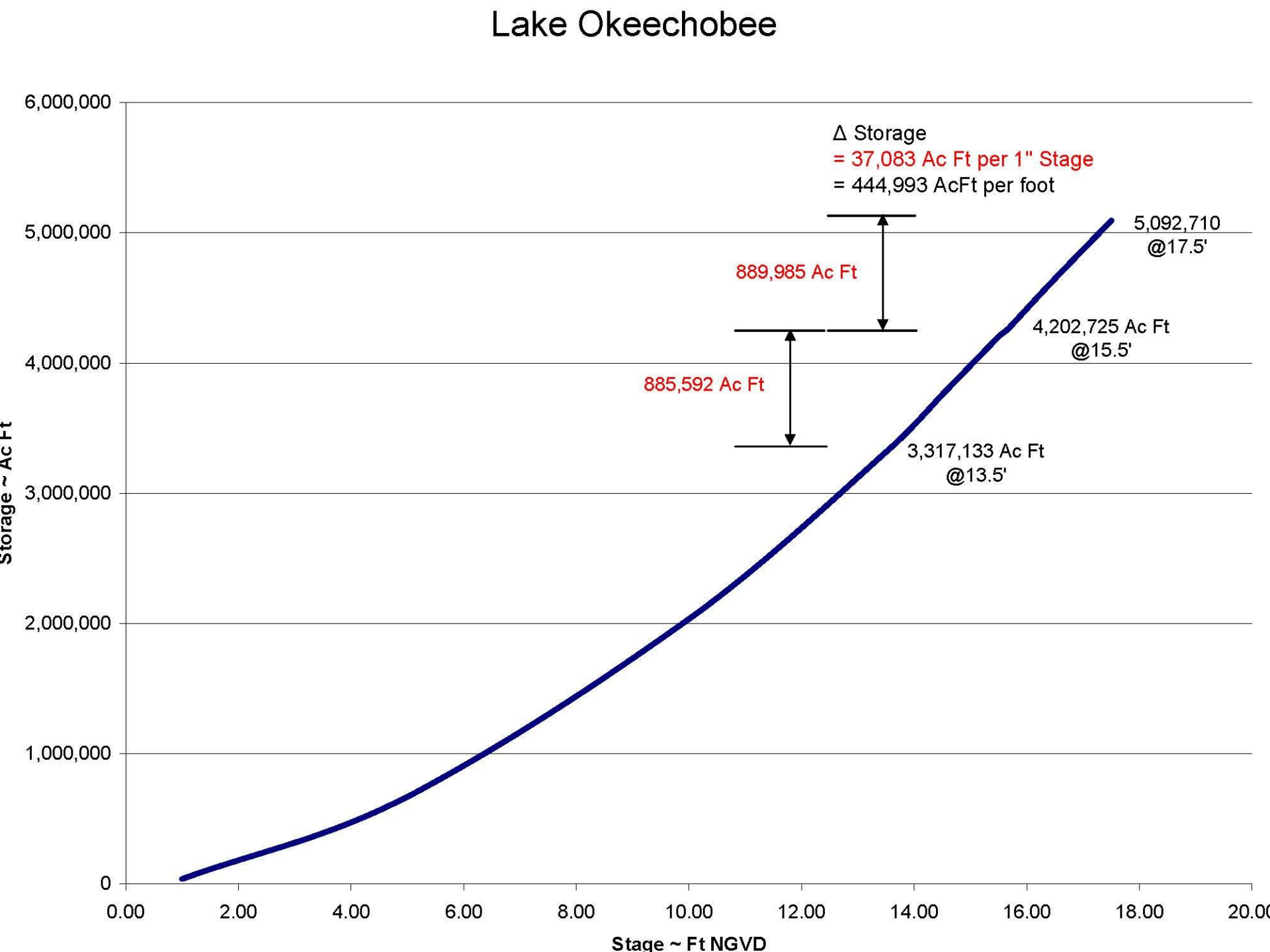
Elevation

= 12.0’



Lake Okeechobee Water Level History and Projected Stages




Lake Okeechobee
Δ Storage
= 37,083 Ac Ft per 1" Stage
= 444,993 AcFt per foot
889,985 Ac Ft
885,592 Ac Ft
5,092,710
@17.5'
4,202,725 Ac Ft
@15.5'
3,317,133 Ac Ft
@13.5'
Storage ~ Ac Ft
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Stage ~ Ft NGVD

Lake Okeechobee
Equivalent Storage Costs

C-51 Reservoir

~ $1,000,000,000+ for 75,000 Ac Ft

1” in Lake Okeechobee

= 37,083 Ac Ft

1” in Lake Okeechobee

=~ $500,000,000

2’ in Lake Okeechobee

=~ $12,000,000,000

SFWMD
WATER USE AND SUPPLY DEVELOPMENT PLAN
JUNE,1978

- ***INCREASED LAKE OKEECHOBEE STORAGE***

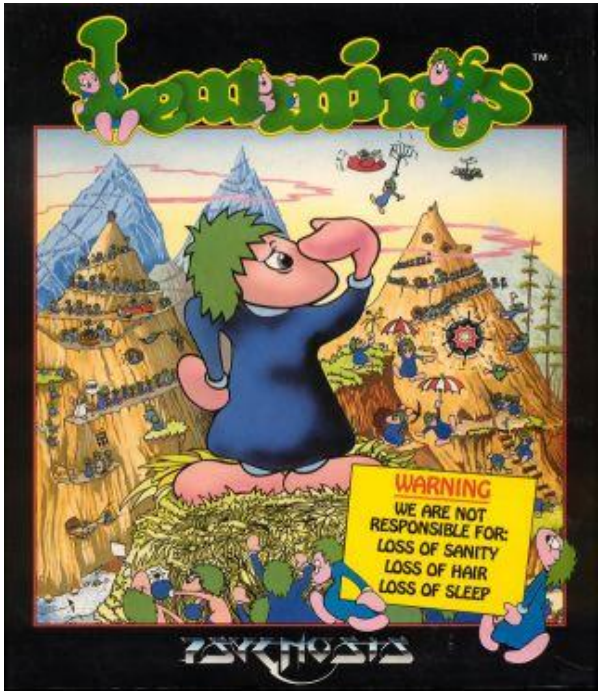
  1. The increased regulation schedule of 15.5 to 17.5 ft. msl., which can be attained with the existing facilities and is currently being considered by the Corps of Engineers, should be implemented as soon as possible.

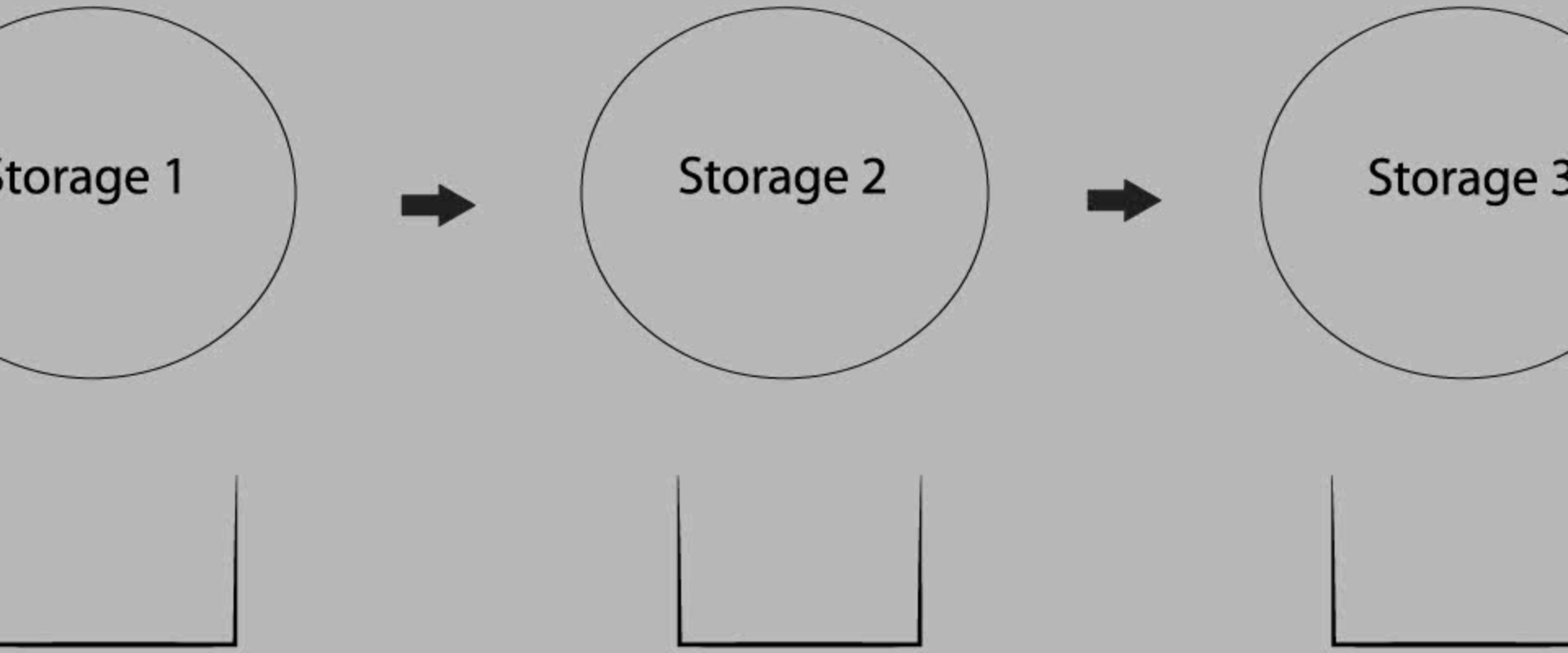
Additional Lake Okeechobee Storage

This alternative deals with increasing storage in Lake Okeechobee by allowing for the ability to increase stages. This would require additional modifications to the existing structures and levees...

By volume, Lake Okeechobee is the largest surface water body in south Florida. A Corps of Engineers report (1968) indicates this is the most effective location for additional surface storage. This study resulted in Congressional authorization for projects up to a maximum stage of 21.5 ft. msl...

Q: Is the current Lake Okeechobee Regulation Schedule the $12,000,000,000 Mistake?


Lemmings
WARNING
WE ARE NOT RESPONSIBLE FOR:
LOSS OF SANITY
LOSS OF HAIR
LOSS OF SLEEP
PSYGNOSIS


torage 1
Storage 2
Storage 3

Conclusions/Recommendations

- Increase Available Storage to meet Demands
- Minimum Storage Depth = 10’ (This is not an STA w/treatment goals or and environmental area w/habitat goals)
- Push for higher Lake Okeechobee Regulation Schedule up to 15.5’-17.5’ Depending on vegetation. Raise operations schedule as high as practicable. 13.5’ to 15.5’ is unacceptable.
- Promote conveyance to Regional Storage
- Reduce lost available storage to tide: seepage around salinity structures & seepage via groundwater (lower control elevations but more structures)
- Have the Technical Committee review and make recommendations back to the WRTF