Continuous Simulation Modeling of Internally Drained Basins & Basins With Limited Discharge Capacity: THE FUTURE IS HERE

Presented by
Devo Seereeram, Ph.D., P.E.
Professional Geotechnical Engineer
www.iag.net/~devo

What is long-term, continuous simulation modeling?

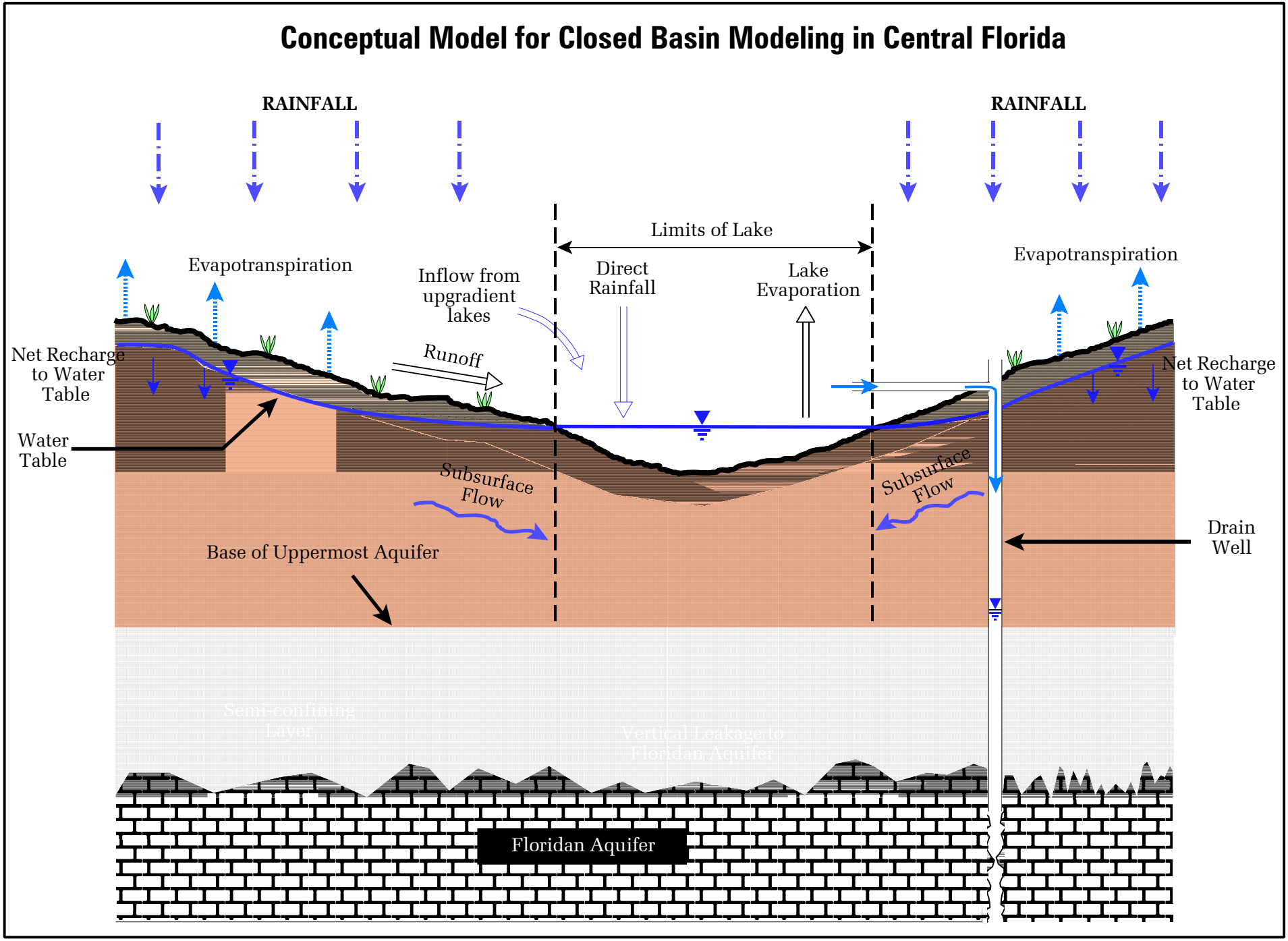
CITY OF DELTONA - STORMWATER MASTER PLAN

- A model which analyzes the day to the day hydrology of the system over a long period of time (say 3 to 100 years), taking into account all components of the system's water budget. See next slide.
- Such a model can predict, on a daily basis, stages, inflows, and discharge rates and volumes (both ground water & surface water).

CONCEPTUAL MODEL FOR CLOSED BASINS IN CENTRAL FLORIDA

What does it look like?
Let's see.....

Conceptual Model for Closed Basin Modeling in Central Florida



Continuous Simulation Modeling: WHY DO WE NEED IT?

- **In land-locked basins, excess cumulative rainfall over a 2 to 3 year period can result in stages which approach or exceed the 100 year flood elevations. After all, *is 210 inches of rain in 3 years more critical than 10.6 inches of rain in 24 hours?* Conventional modeling and current regulatory requirements do not address this type of occurrence which many of us saw first hand in 1994-1996.**

- **The engineer is also faced with the dilemma of selecting an initial stage for conventional flood modeling. The continuous simulation model allows the engineer to make a realistic estimate. A calibrated continuous simulation model also lets the engineer understand the true hydrology of a system & identify obvious input errors.**

WHAT HAPPENED IN 1994-1996

AS AN EXAMPLE, LET US TAKE A LOOK AT THE HISTORICAL WATER LEVEL FLUCTUATION IN LAKE SHERWOOD Orange County, Florida

Note: the drainwell was installed after Hurricane Donna

LAKE SHERWOOD

Notice: impact of drainwell installed in 1960, 12 ft rise in water level between July 1990 and December 1994, and water levels well above normal since July 1994

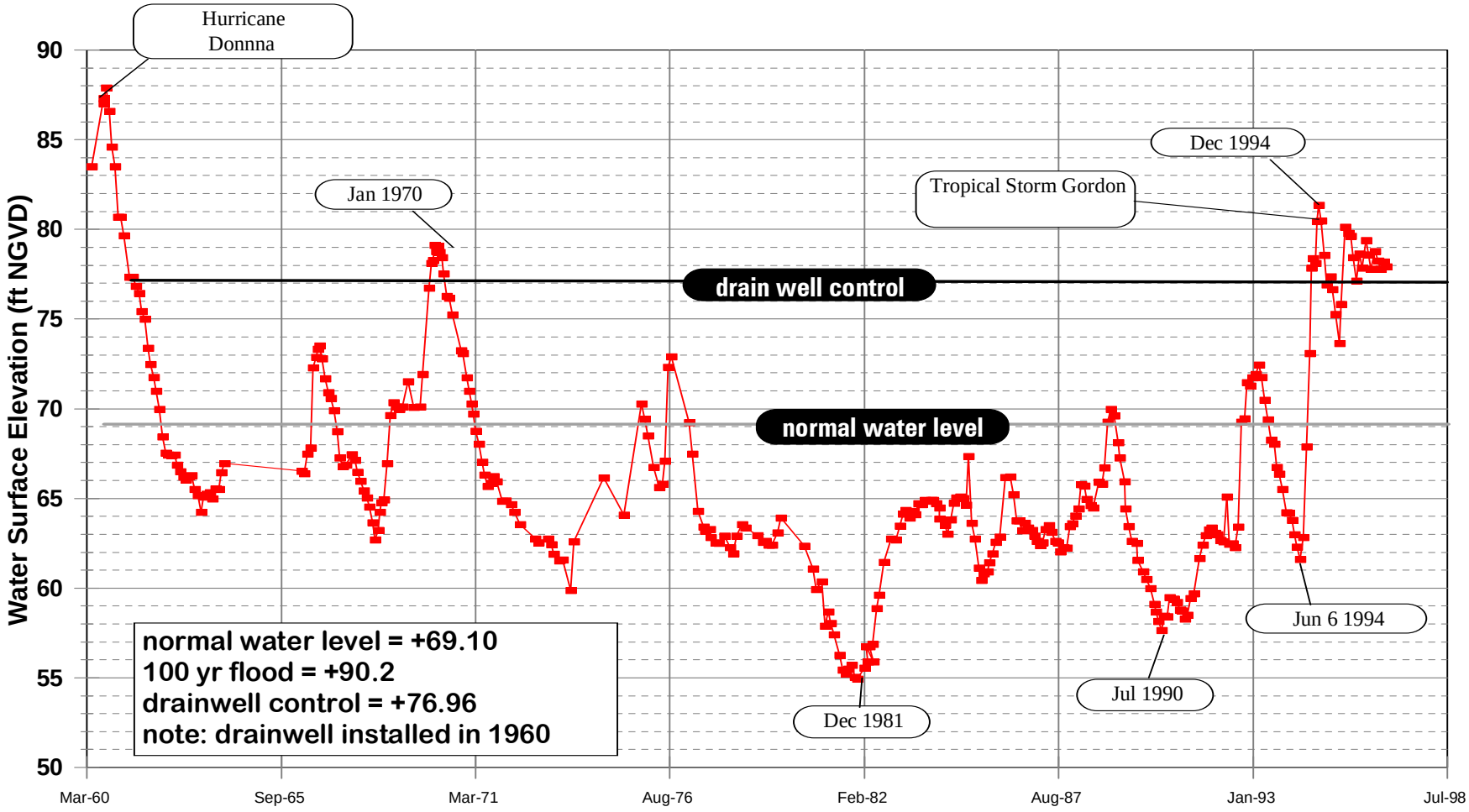


Figure 1. Historical Water Levels in Lake Sherwood (Orange County, Florida) [1960-present]

INPUTS NEEDED TO GENERATE CONTINUOUS SIMULATION HYDROGRAPH

PONDS VERSION 3 FOR WIN 95/NT

- Surface water inflow: DCIA area (acres), non-DCIA area (acres), CN for non-DCIA area. Note CN automatically adjusted daily based on antecedent rainfall.
- Evaporation loss & rainfall (daily)
- E.T. within non-DCIA area of watershed (daily)
- Artificial recharge within non-DCIA area of watershed

PARAMETERS USED TO DEFINE WATERBODY WITHIN AQUIFER SYSTEM FOR CONTINUOUS SIMULATION MODELING

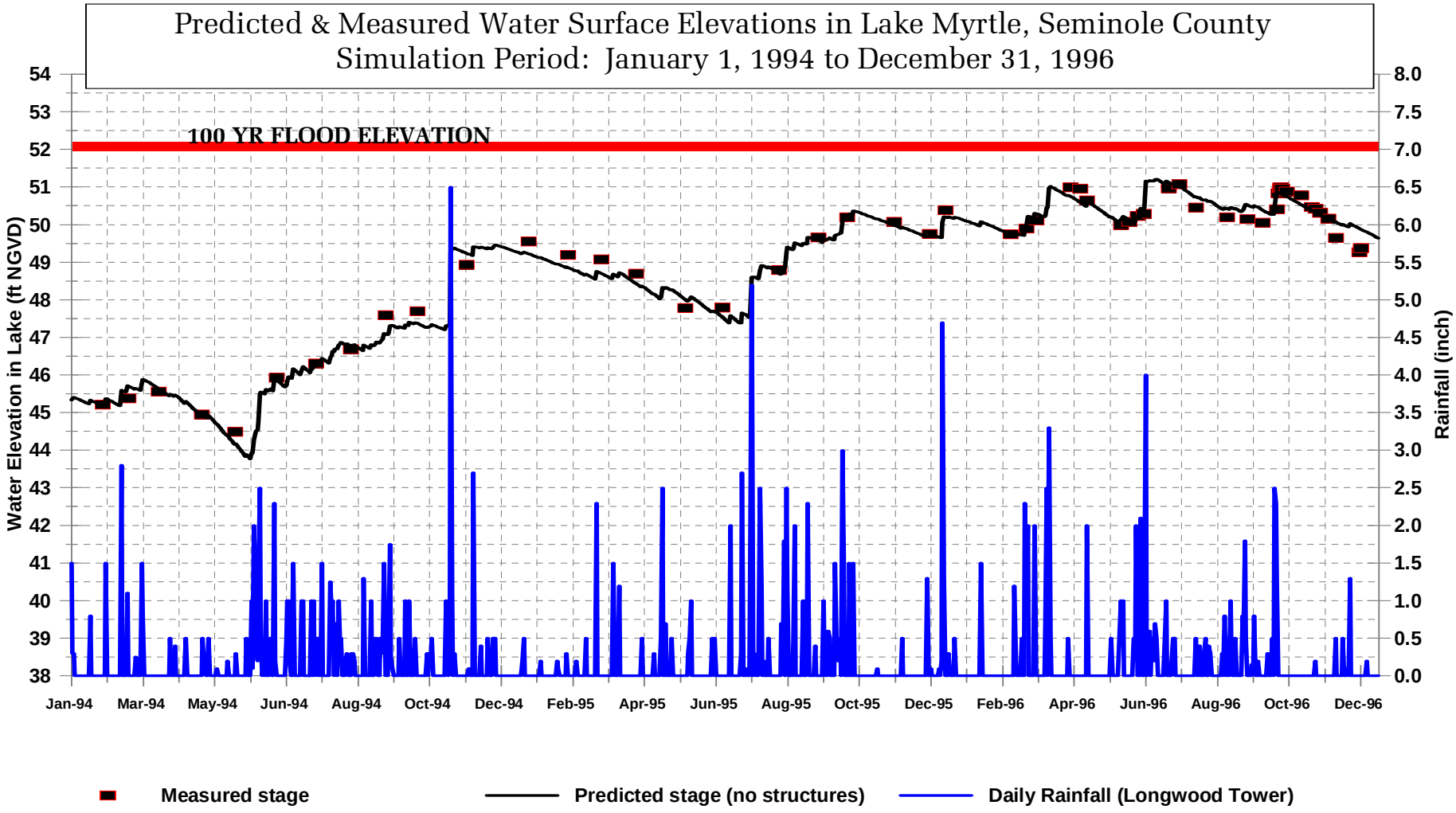
PONDS VERSION 3 FOR WIN 95/NT

- Stage-area relationship & perimeter of water body
- Typical parameters for surficial aquifer system: permeability, porosity, and depth of aquifer (from geotech report)
- Overflow discharge structures (up to 3)
- Vertical exchange of water between water body & Floridan aquifer (linear or non-linear relationship established by geotech). Can also be modeled as an equivalent discharge structure.

RECENT EXAMPLE OF A CONTINUOUS SIMULATION MODEL OF A CLOSED BASIN
Lake Myrtle, Seminole County

This study was funded by Seminole County Stormwater Dept

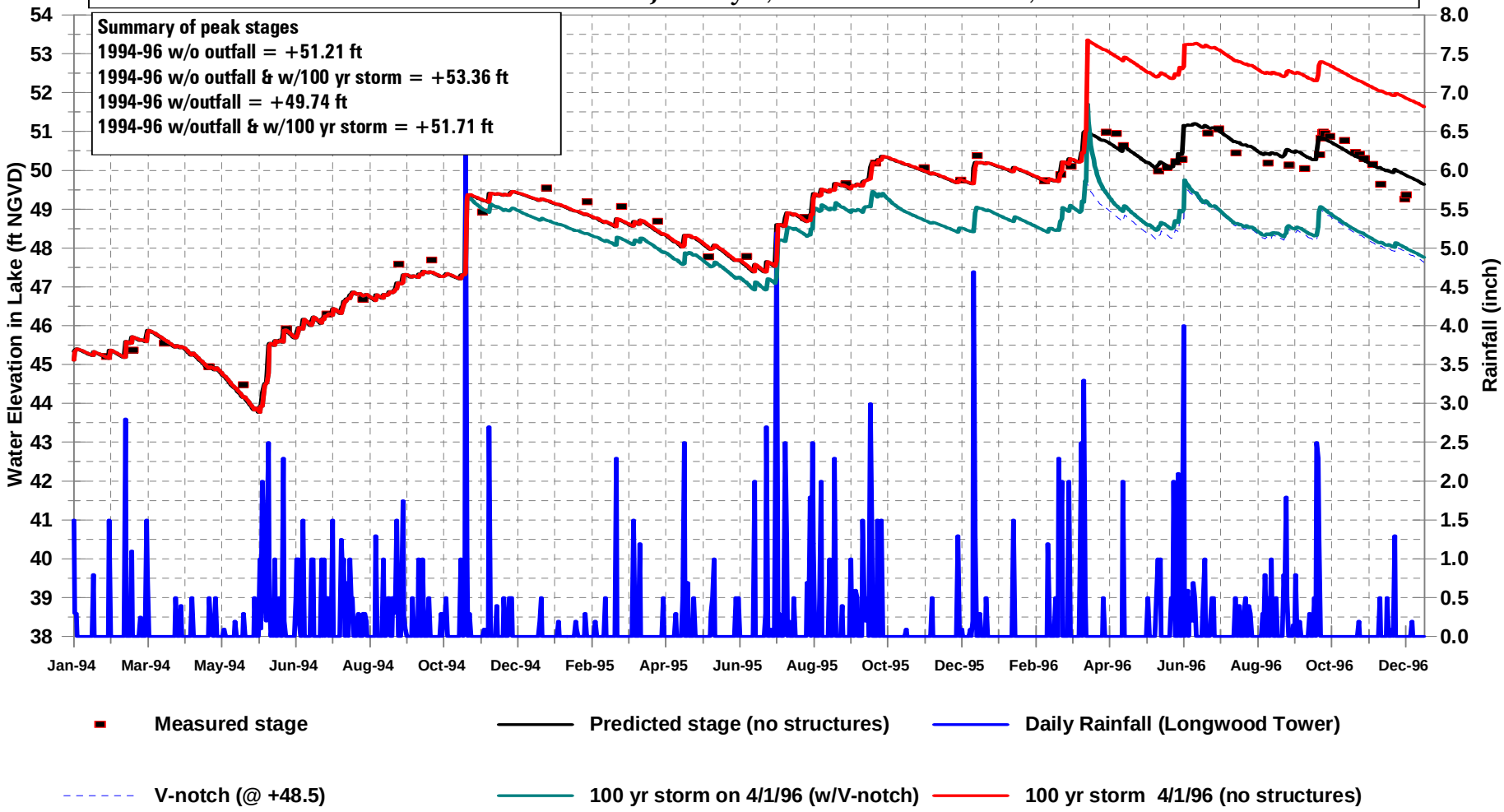
LETS TAKE A LOOK AT THE REMARKABLE CORRELATION BETWEEN THE MEASURED & PREDICTED STAGES FOR 1994 TO 1996



LAKE MYRTLE, SEMINOLE COUNTY
AN EXCELLENT FIT BETWEEN MEASURED & PREDICTED RESPONSE
WATER LEVELS ROSE TO WITHIN 1 FT OF 100 YR FLOOD ELEVATION IN 1996

LOOKING AT SOME HYPOTHETICAL SITUATIONS FOR LAKE MYRTLE

Figure 5. Predicted Water Surface Elevations in Lake Myrtle for Scenarios #1, #2, #3, & #4
Simulation Period: January 1, 1994 to December 31, 1996

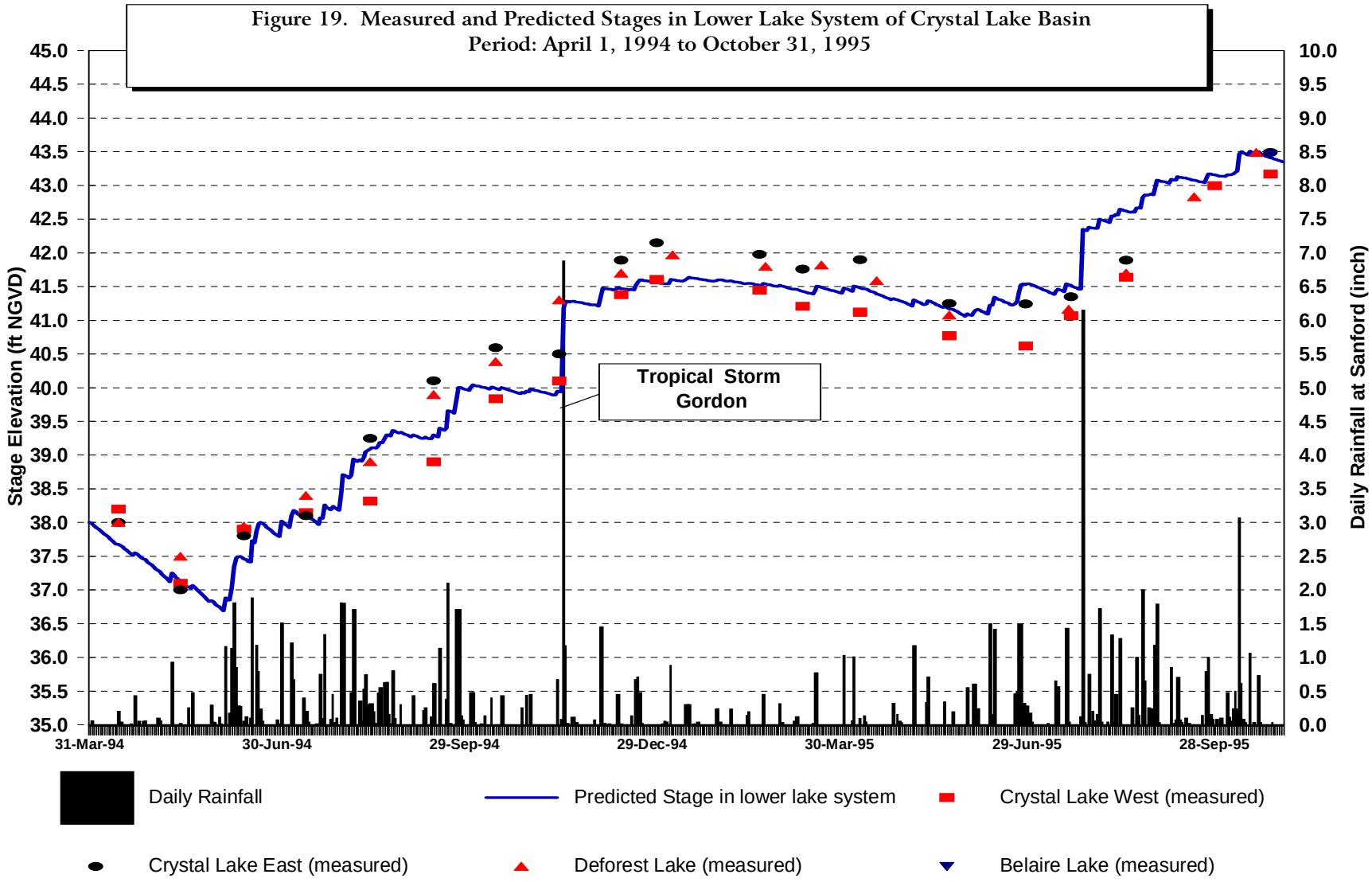


ANOTHER EXAMPLE OF A CONTINUOUS SIMULATION MODEL OF A CLOSED BASIN
Crystal Lake, Seminole County

This study was funded by Lake Mary & Seminole County

LETS TAKE A LOOK AT THE REASONABLE CORRELATION BETWEEN THE MEASURED & PREDICTED STAGES

RESULTS OF CRYSTAL LAKE BASIN MODEL - ANOTHER GOOD MATCH



SOME MORE EXAMPLES OF CONTINUOUS SIMULATION MODELS OF CLOSED BASINS
City of Ocoee, Orange County

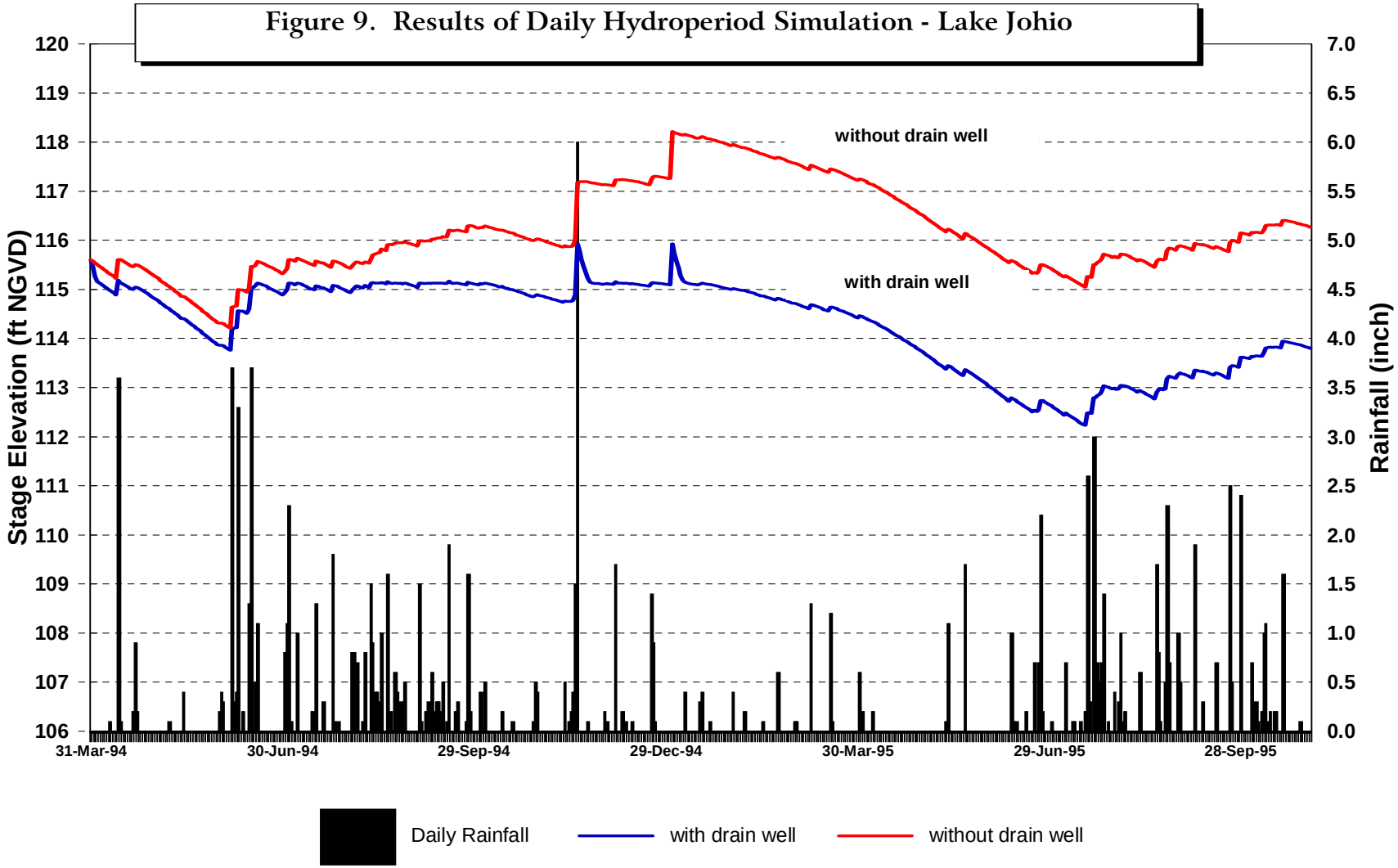
These studies were funded by City of Ocoee

Let us take a look at the importance of drainwells & increase in impervious area on water levels in some closed basins in Ocoee (Orange County, Florida)

LAKE JOHIO

CITY OF OCOEE

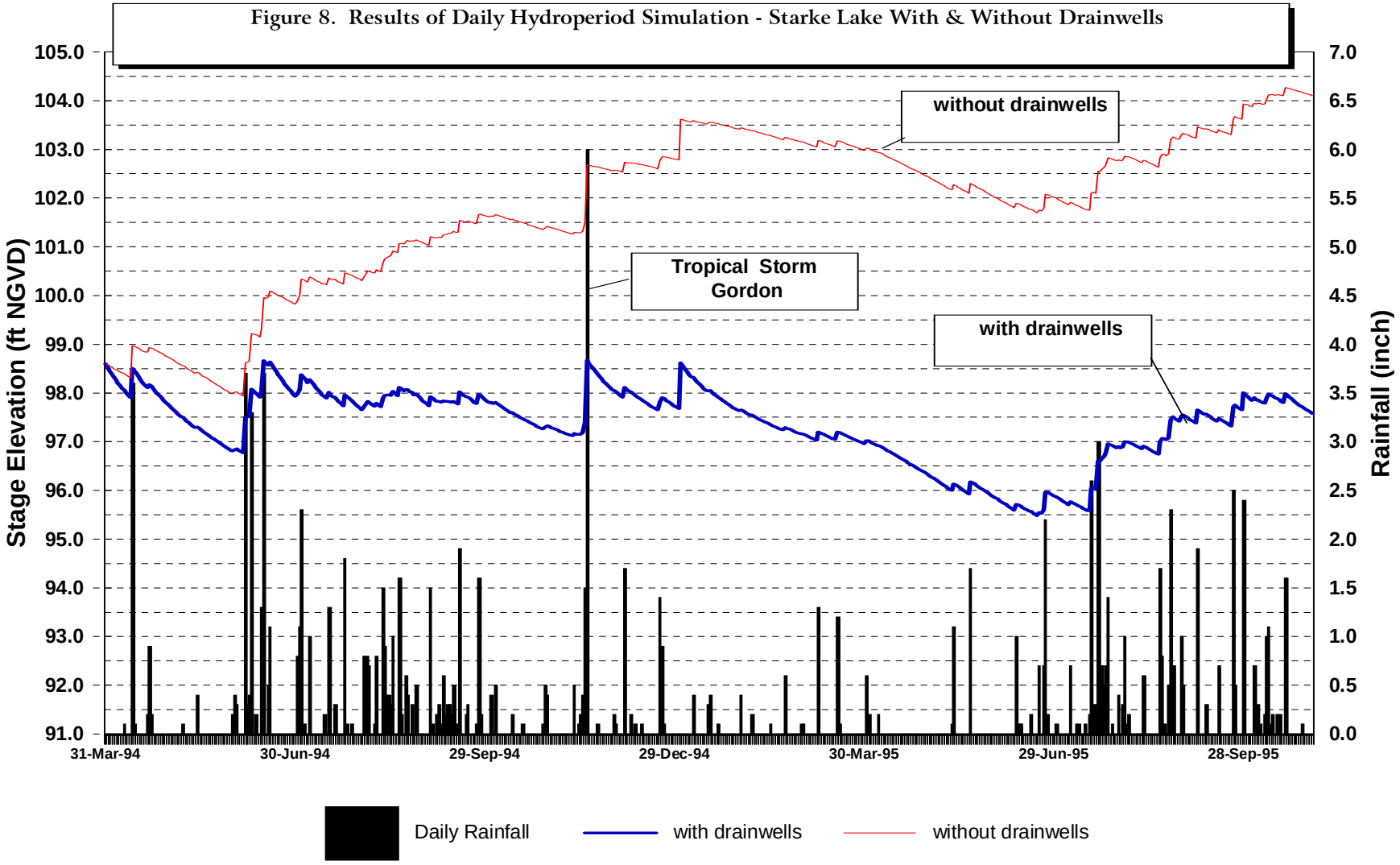
LAKE JOHIO IN OCOEE
LOOK AT THE IMPACT IF THE DRAINWELL WERE ABANDONED



STARKE LAKE

CITY OF OCOEE

STARKE LAKE IN OCOEE
SERIOUS CONSEQUENCES IF THESE DRAINWELLS DID NOT FUNCTION



AN EXAMPLE OF CONTINUOUS SIMULATION MODELING OF INTERCONNECTED BASINS
Cranes Roost, Altamonte Springs

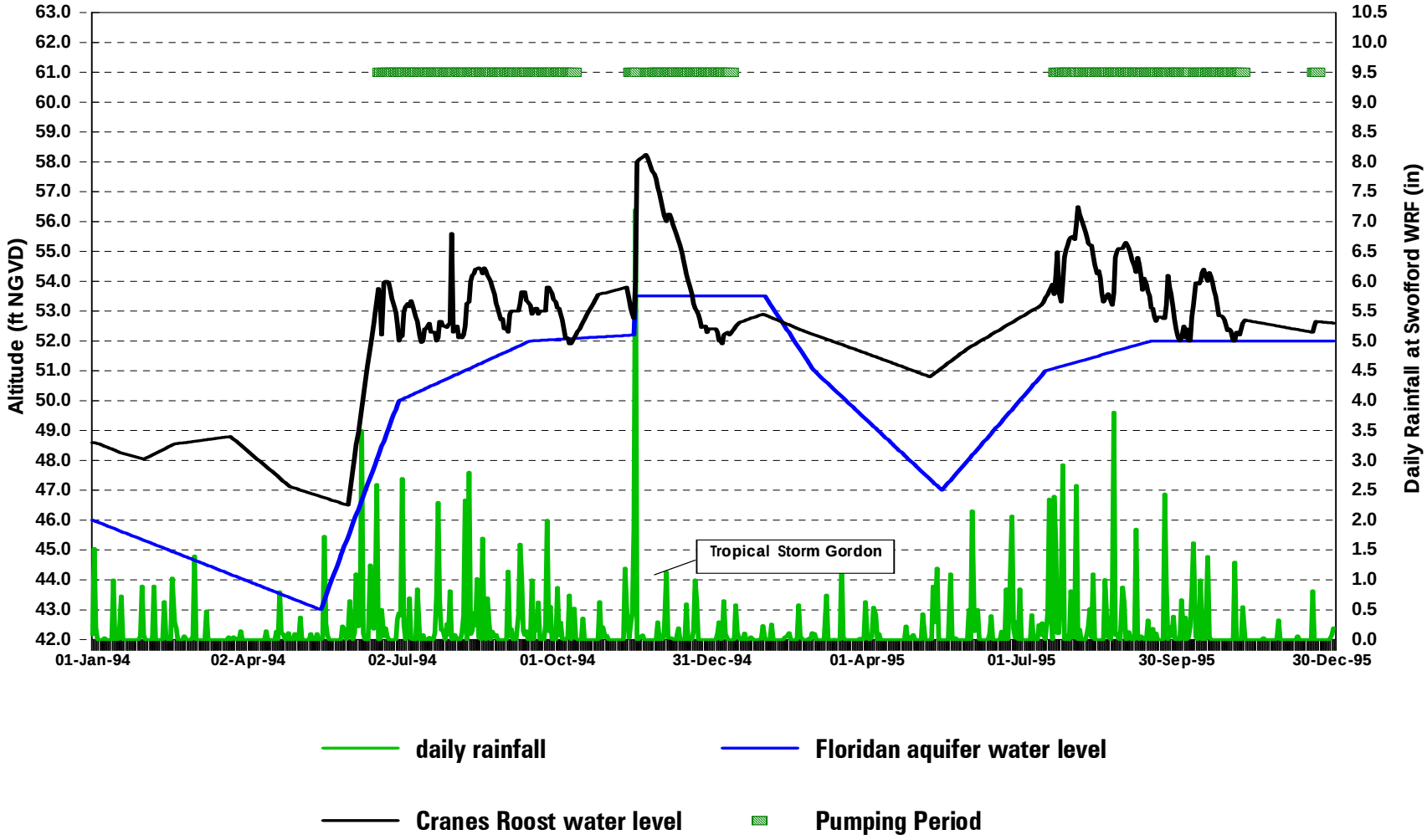
This study was funded by City of Altamonte Springs

The Cranes Roost water body is the terminal receiving lake for an approximately 1960± acre watershed that contains a variety of urban land uses, and three other major upgradient water bodies (subbasins), namely:

- **Lake Mobile,**
- **Lake Florida, and**
- **Lake Adelaide.**

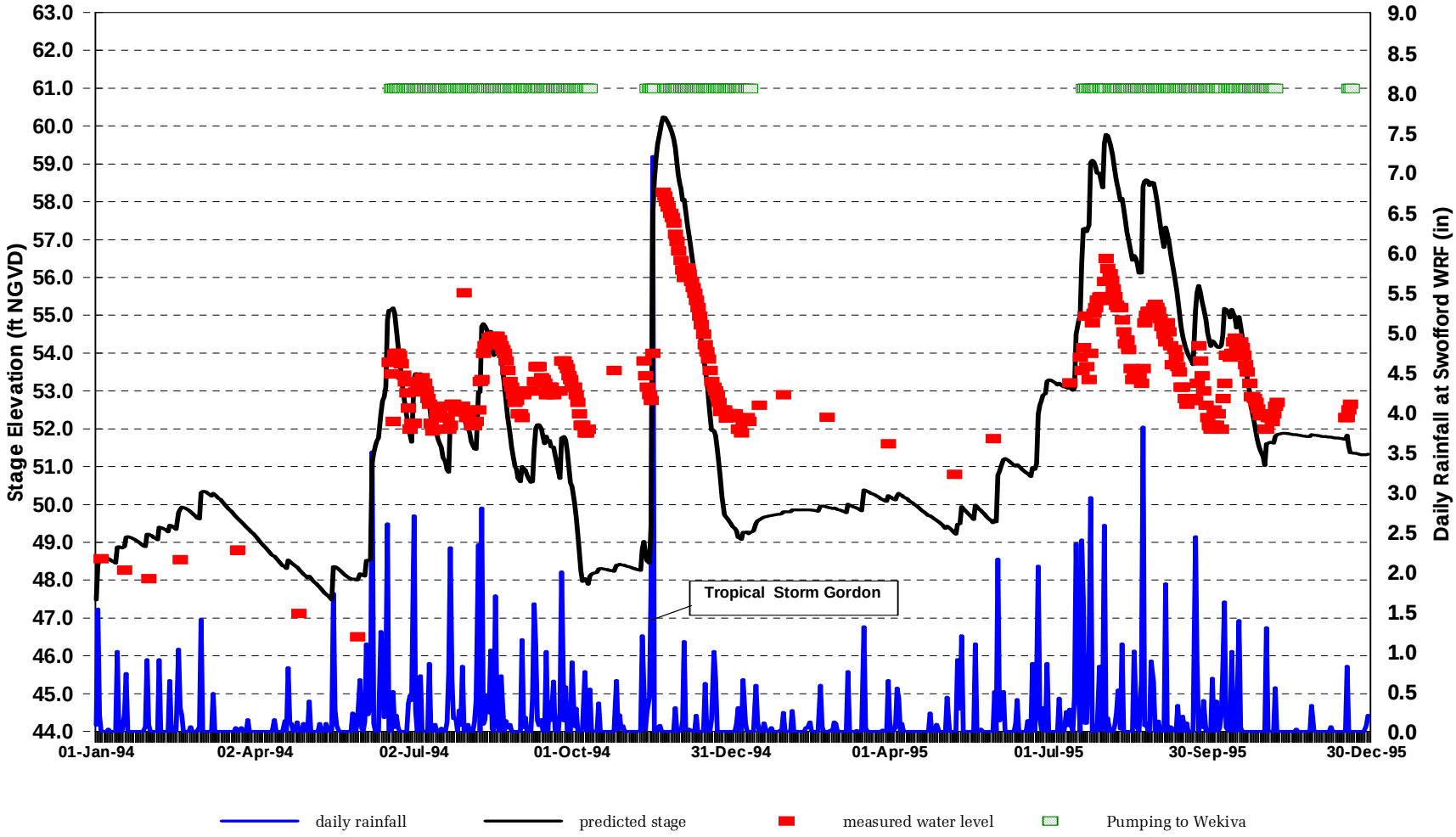
CRANES ROOST

Notice: this lake is well connected to Floridan aquifer and sometimes the Floridan aquifer discharges upward into the lake. Cranes Roost is also pumped with discharge to the Little Wekiva River when it exceeds a certain stage. Pumping periods are also shown. Four (4) upgradient lakes also flow into Cranes Roost.



CRANES ROOST IN ALTAMONTE SPRINGS

Note: A reasonable prediction by PONDS™ in spite of the complexity of the model.



AN EXAMPLE OF CONTINUOUS SIMULATION MODELING OF A SINKHOLE USED FOR STORMWATER RETENTION Orange County MSTU #6542-000

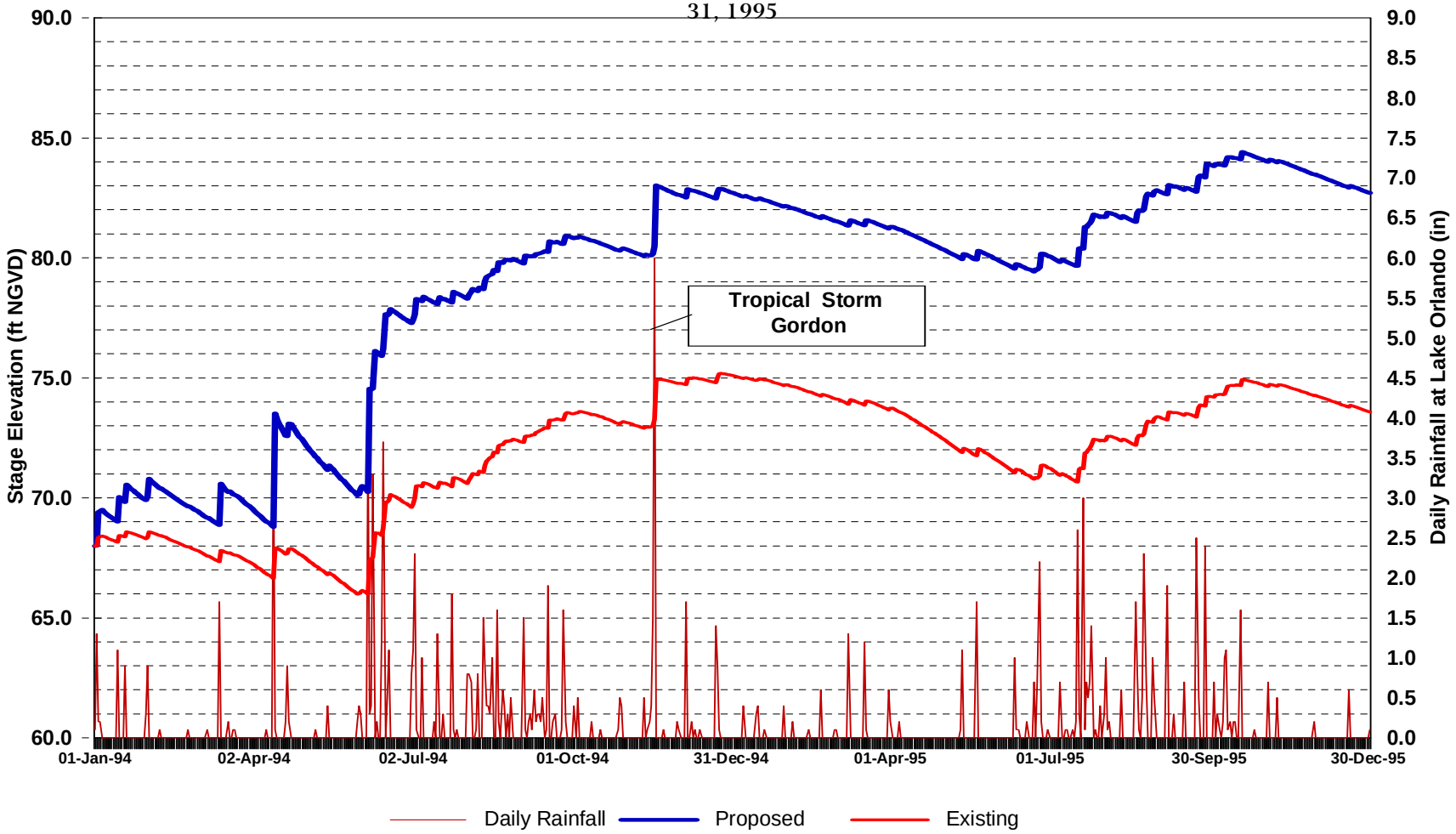
This study was funded by Orange County

Quantitative Hydrologic Modeling of Orange Co. MSTU Pond #6542-000, Beggs Road, Orange County, Florida

In summary, the continuous simulation modeling indicates that, in a wet period, Orange Co. MSTU Pond #6542-000 will stage to elevations which are probably as high as or higher than the 100 yr/24 hr or 25 yr/96 hr design storm events.

BEGGS ROAD SINKHOLE IN ORANGE COUNTY
SIGNIFICANT IMPACT OF FUTURE INCREASE IN IMPERVIOUS AREA

Figure 6. Predicted Stages in MSTU Pond #6542-000 for period: January 1, 1994 to December 31, 1995



AN EXAMPLE OF CONTINUOUS SIMULATION MODELING OF A SINKHOLE USED FOR STORMWATER RETENTION
County Road 491, Citrus County

This study was funded by Citrus County

The proposed improvements to County Road 491 will lead to a relatively small increase in the impervious area which drains toward the closed depressions. The objective of this study is to analyze the potential for the long-term accumulation of water in the depressional basins over an extended wet period (such as two consecutive “wet” years).

Although not presently required by regulatory agencies, the latter long-term scenario can sometimes be more critical, in terms of peak stage, than the design storm events used for permitting (such as the 100 year/24 hr event).

Figure 12. Predicted Stages in Basin B Depression for period: Jan 1, 1994 to Dec 31, 1995