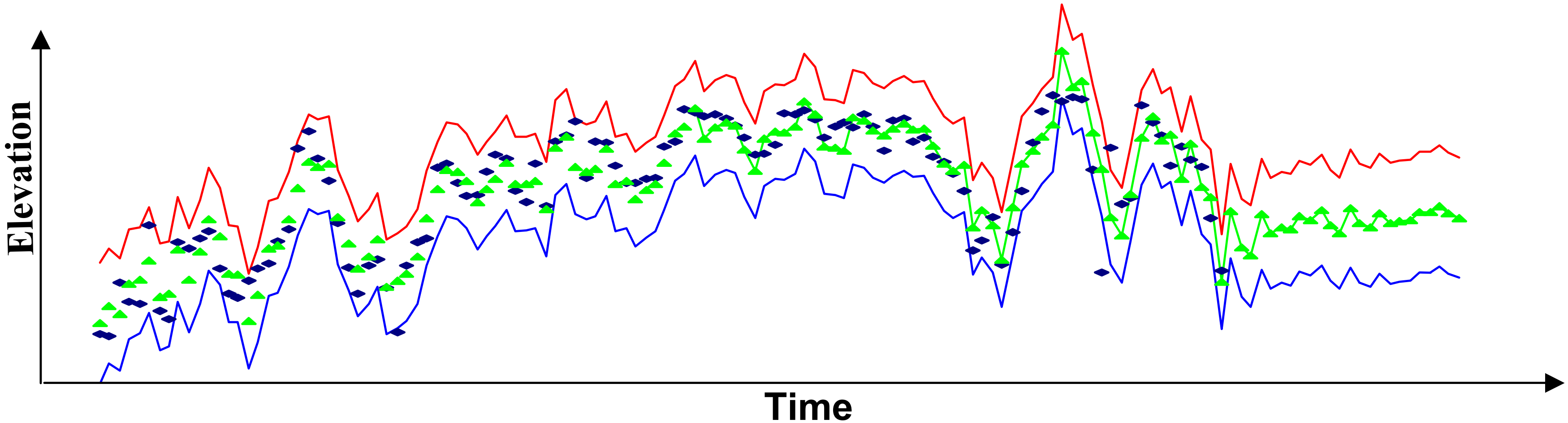
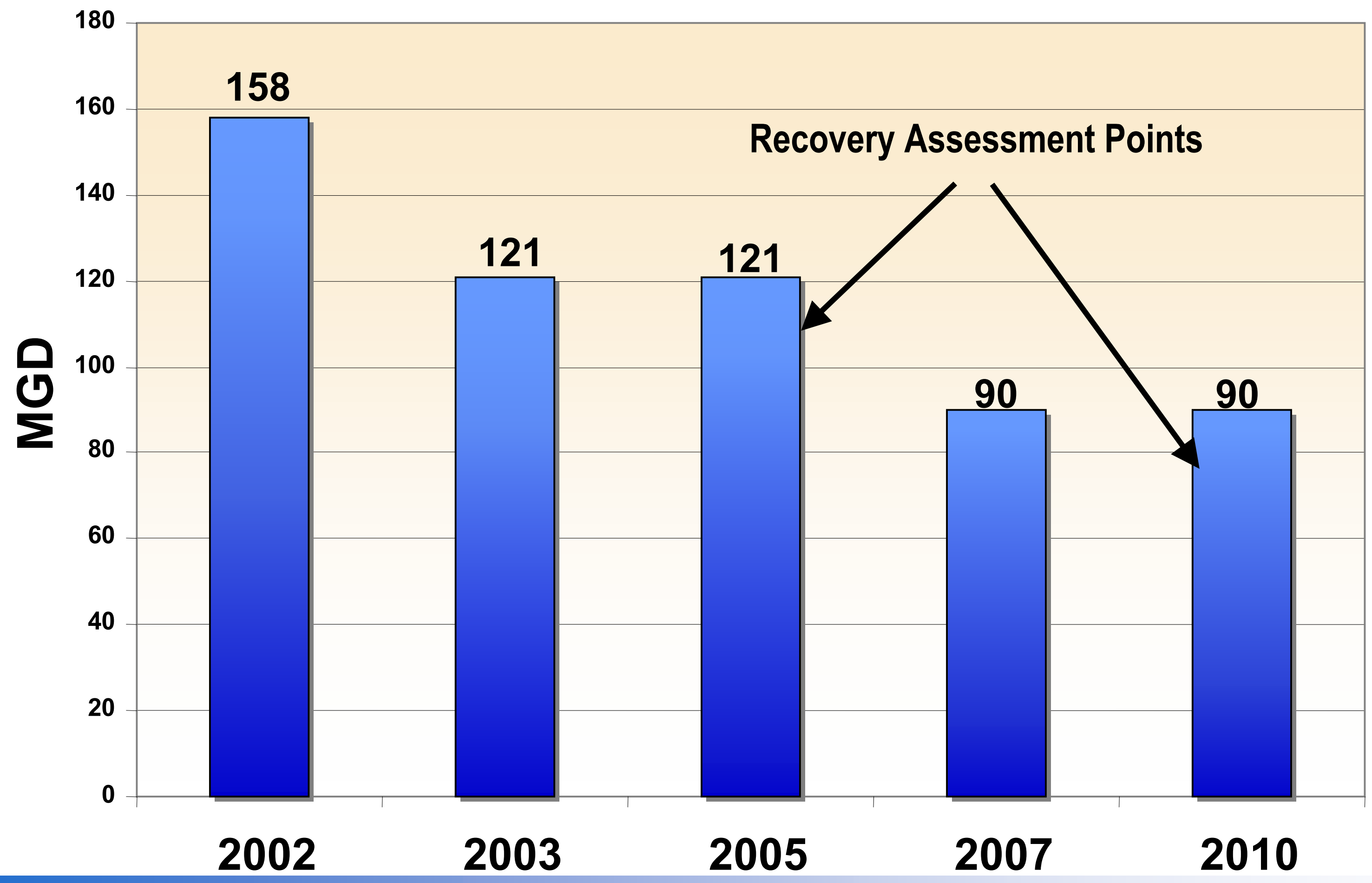
Update to
NTB Phase II
Local Technical Peer Review Group
December 3, 2003



Schedule for Pumpage Reductions



Recovery Analysis Methods and Data Requirements Study

Objectives:

- Evaluate, test, and recommend appropriate statistical methods to identify, quantify and forecast hydrologic recovery associated with pumpage reductions.

  Methods should:
  - Rely on field data (i.e. independent of other modeling tools).
  - Evaluate recovery in wetlands, lakes, streams, surficial aquifer and Upper Florida aquifer.
  - Distinguish between the effects of pumping reductions and meteorological effects and anthropogenic effects.

Recovery Analysis Methods and Data Requirements Study

Objectives (continued)

2) Identify data gaps in parameters, density of coverage, and monitoring frequency, which will limit utilization of recommended approach.
   - Temporal component
   - Spatial component
3) Recommend appropriate changes to environmental monitoring needed to address data gaps.

TAMPA BAY WATER

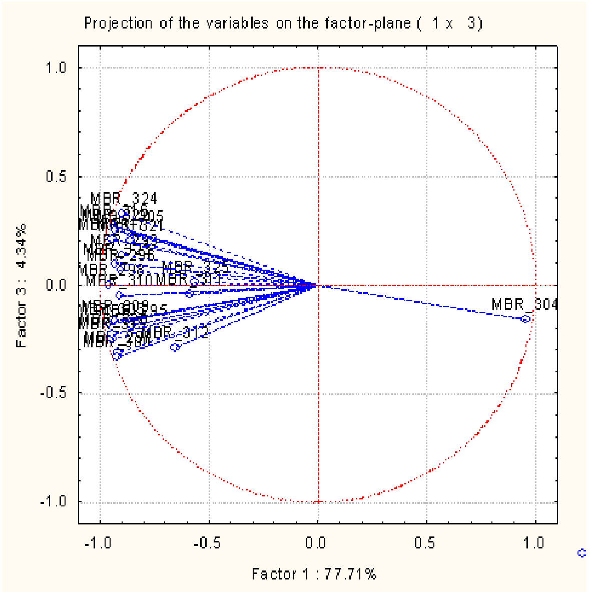
Recommended Approach

- Data Mining
  - Exploratory data analysis
  - Used to evaluate relationships between variables and to select variables for statistical models
- Transfer Function Noise (TFN) Modeling
  - Time series analysis technique
  - Assess recovery through time
- Geostatistical Techniques
  - Uses results from TFN models
  - Interpolates recovery across space

Data Mining

Principal Components Analysis (PCA)

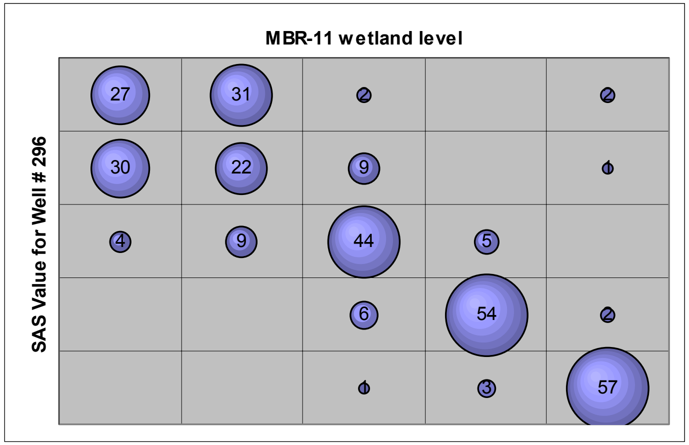
- Identifies weighted linear combinations of input variables (ex. pumping) that explain the variance in a response variable (ex. water level)
- The identified "principal components" are surrogate variables
- Can reduce variable dimensionality
- For recovery analysis:
  - How do individual well or combined well pumpage values explain water level variance?
  - What pumpage variables should be used?
  - Which datasets (sites) are closely related?
  - Which datasets are outliers?
  - Provides the ability to select representative monitoring well locations when many locations are available for selection.



Data Mining

Entropy Analysis

- Is a essentially counting method that characterizes the strength of the relationship between variables
- Can be used to examine SAS/wetland relationships
- Can screen-out non-communicating SAS/wetland pairs
- Provides the ability to rank sites with respect to interaction.



Data Mining: Proof-of-Concept

Data mining is used to evaluate relationships among variables and to select variables and monitoring sites for TFN model development.

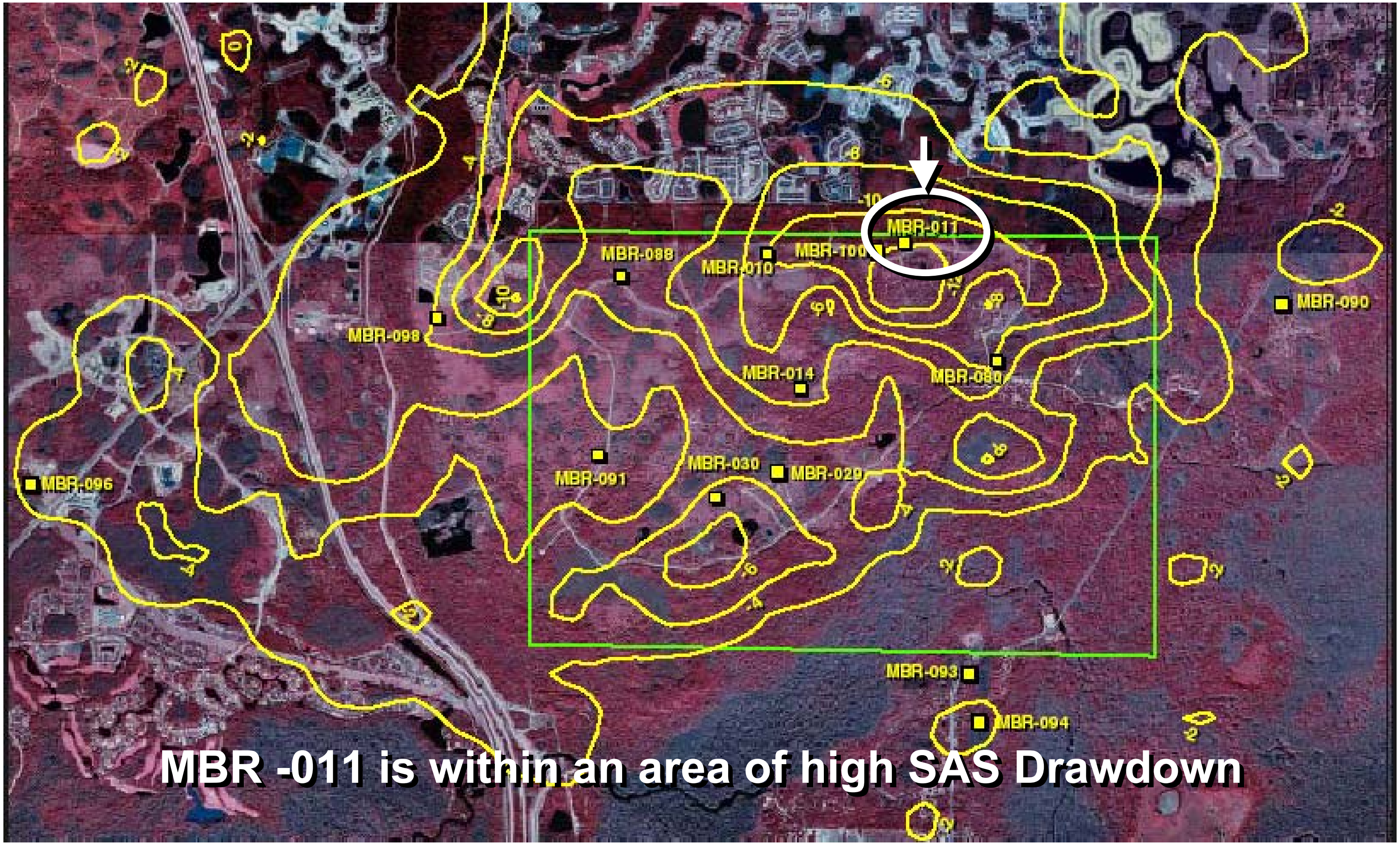
Results for Morris Bridge Wellfield

- Principal Components Analysis
  - PCA-derived variables not an appropriate surrogate for pumping data; recommend using monthly wellfield pumpage
  - Monitoring sites (UFAS, SAS, and wetlands) show clear clusters. Can aid in selecting representative sites. Location with respect to drawdown contours should also be considered.
- Entropy Analysis
  - Strong relationships between all SAS wells and wetland stage data. All wetlands were found to have significant association with more than one SAS well.

Transfer Function-Noise (TFN) Modeling

- Time series analysis technique
- Quantifies changes in water levels (response variable) in terms of pumping, rainfall, and evapotranspiration (input variables)
- Characterizes the importance of each input variable in the overall response variable behavior
- Allows prediction of water level changes with changed pumping for the same rainfall and evapotranspiration pattern
- Allows future prediction of elevation changes

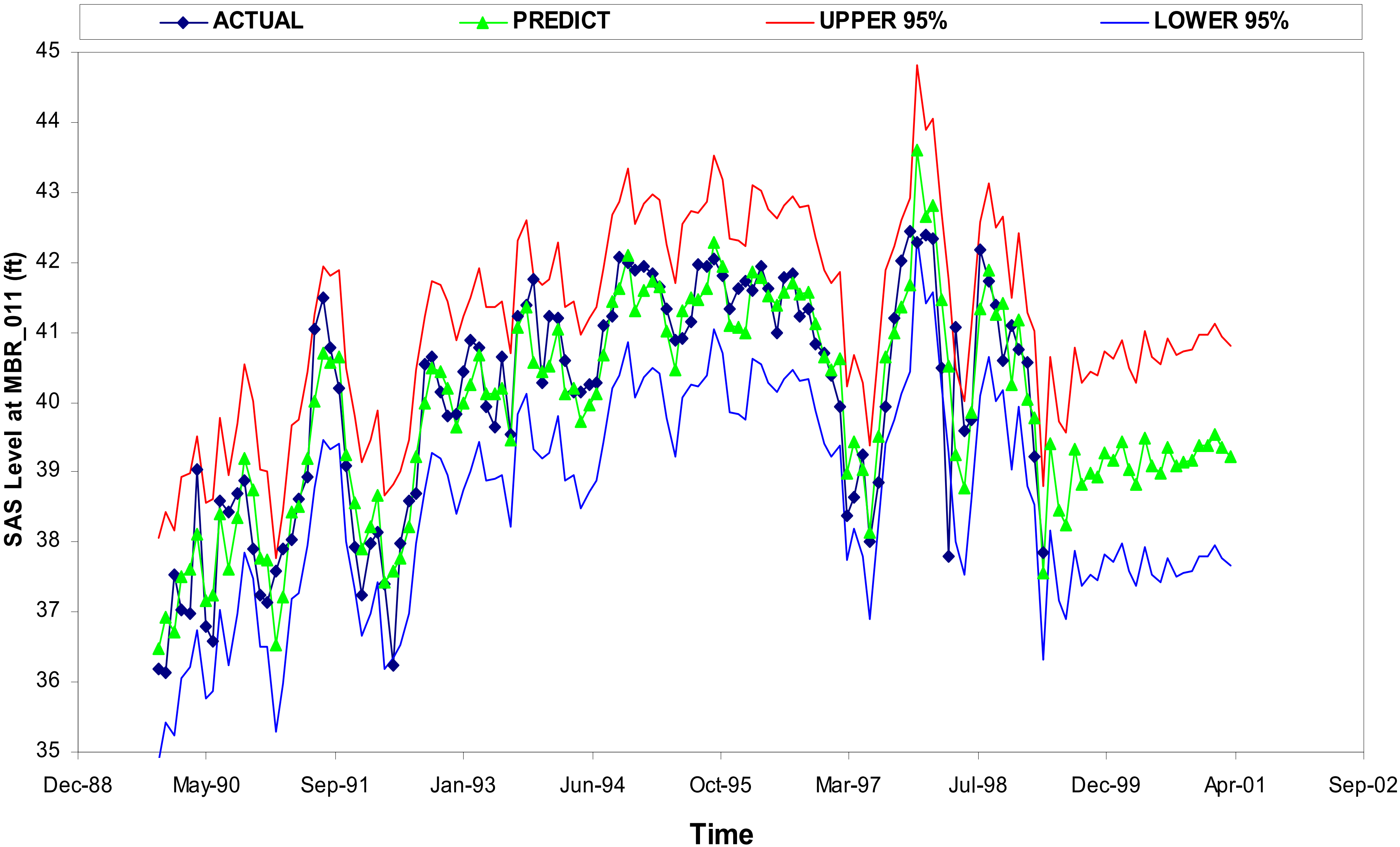
Proof-of-Concept: TFN Model for MBR-011



Proof-of-Concept: TFN Model for MBR-011

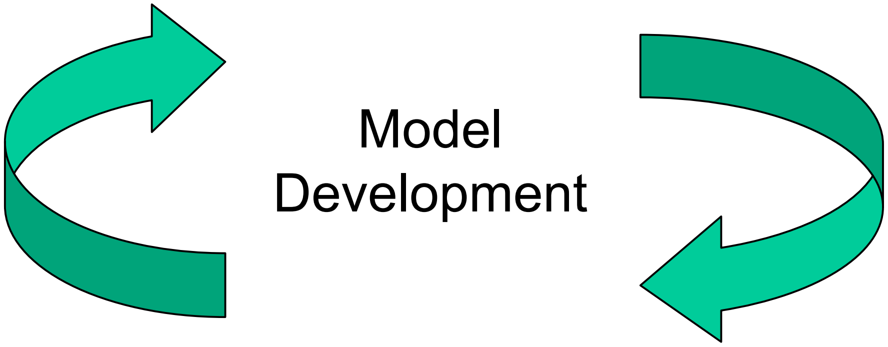
- Used monthly data for 1989 – 1998
- TFN model explains 87% of the variability in the wetland water level time series
- Pumping (72%), rainfall (9%), and ET (6%) all accounted for significant variability in the wetland water elevations at MBR-011
- Other model characteristics
  - Pumping and ET explain wetland water level decreases (-), while rainfall explains water level increases (+)
  - Wetland stage responds to rainfall without any time lag
  - Wetland response to pumpage may lag as much as three months

Water level time series, predicted time series, and 95% CIs



TFN Modeling - High Level of Effort

- 88 labor hours for senior analyst for one site (MBR-011)
- Multiple steps needed to develop models of the input and output variables (pumping, rainfall, ET time series)
- Iterative process is used to develop overall model structure and to complete diagnostic analyses at each step.



Spatial Recovery Analysis

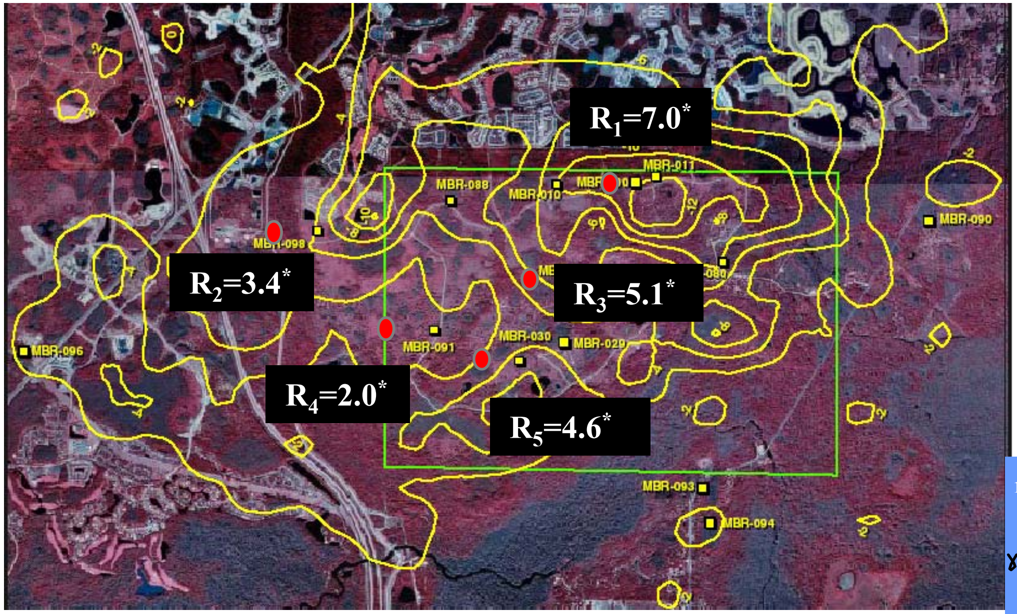
Geostatistics

Approach: Use the TFN results (water level recovery and recovery estimation errors) at the TFN locations as input to Kriging (Ordinary or Co-Kriging)

- Uses the TFN recovery values at the their locations
- It is unbiased (gives recovery estimates that are on average neither too high nor too low),
- Minimizes the variance of the recovery estimates (least squares)
- Provides the estimation error (standard deviation) of the recovery estimate
- Good interpolator – not a robust extrapolator

Geostatistics

Spatial Estimation of Recovery Using Kriging:

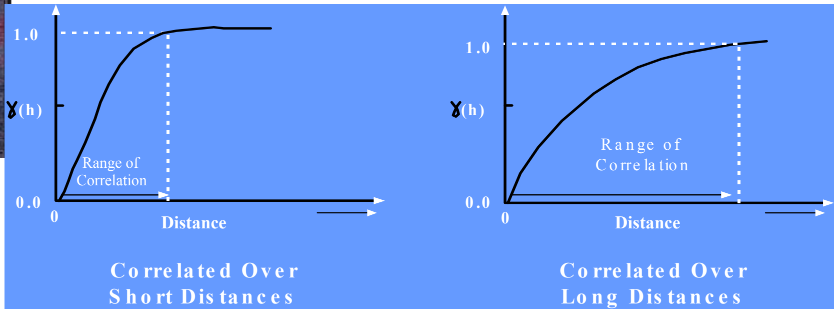


Kriging Steps:

1. Calculate the square differences between the measurements (variance)

2. Calculate the distance between the measurements

3. Plot the variance vs the distance (Covariance or Variogram)



** = recovery assumed for illustration purposes*

Data Gaps Evaluation

Time Series Data Gaps

Time series data at Morris Bridge and Cypress Bridge wellfields were evaluated for quantity and quality of data, and location

- Quality/Quantity considerations included:
  - missing data
  - censored data
  - obvious outliers
  - unusual trends and data ranges
- Location was evaluated with respect to “average” drawdown contours provided by Tampa Bay Water for both wellfields.

Data Gaps: Preliminary Findings

Temporal data:

- 84 month period of record minimum for TFN models
  - no more than 5% missing individual months
  - no period of missing data longer than three months
- Staff gauge and piezometer data from within a wetland can be combined.
- Transition or upland site SAS data may not be used either in combination with interior wetland data
- Future data collection is assumed to provide acceptable quality data.

Data Gaps: Preliminary Findings

Spatial Data:

- There will be sufficient data to model UFAS, SAS and wetland water levels in Morris Bridge & Cypress Bridge wellfields across a range of drawdown impacts.
- Monitoring site improvements in the last five years have been important. Newly installed wells will improve coverage for hydrologic recovery analyses.
- Lowest densities of monitoring wells occur in the highest impact areas. However, these areas are a relatively small fraction of the total area of each wellfield.
- Spatial coverage of the wellfield with respect to drawdown zones is not uniform, particularly at Cypress Bridge. Development has resulted in lack of available sites and loss of sites.

Data Gaps: Recommendations

Monitoring Stations:

- Improve or replace existing wetland and SAS monitoring sites to ensure that data censoring (water levels below the bottom of the gauge or recorder limit) does not occur.
- Installation of additional sites (for additional spatial coverage if needed) will provide sufficient data for time series analysis only after 7 years of monthly monitoring are completed.

Database

- Use existing quality control processes to ensure that the best and most continuous collection record is obtained for the remaining hydrologic recovery monitoring period (present through December 2005).

Data Gaps: Recommendations

Database (continued)

- Improve the quality and organization of the database
  - Provide necessary metadata (i.e., well depth, georeference information)
  - Complete the quality assurance process
- Provide a single ID number or name for each site
- Identify datasets useful for hydrologic recovery analyses. Provide a key code for these sites.
- Separate data that is of unacceptable quality so that the same data quality decisions can be executed by all users of the database.
- Generate a complete set of rainfall and ET data for each wellfield. Identify primary and secondary sites if data substitution is necessary.

Current Project Activities

- Continue TFN Proof-of-Concept - Two additional sites: one wetland and one adjacent SAS well, at Morris Bridge Wellfield.
- Prepare Technical Memoranda on work completed to date.
- Amend Contract - Expand Proof-of-Concept Task to perform TFN analyses at additional Morris Bridge wetlands to confirm robustness of TFN method and provide sufficient data for the spatial recovery proof-of-concept analysis.

Schedule

- February - April 2004
  - Develop additional Transfer Function Noise models for Morris Bridge wetland sites
- May - June 2004
  - Prepare Technical Memorandum on TFN Proof-of-Concept for Morris Bridge Wellfield.
- June 2004
  - Spatial Analysis Proof-of-Concept