# Flow Release Study

***Obtaining Dynamic Flow Routing Information on the Lower Saluda River***

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# Purpose

- Provide Information for Downstream Recreation Flow Assessment Study
  - Determine Approximate Rates of Stage Change, Arrival (Travel) Times, Total Stage Changes
- Study Different Flows Along Various Reaches of River
- Use to Calibrate HEC-RAS Model
- If Possible, Enhance Safety Systems

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# Terminology

- Stage: Depth of Water (in Feet)
- Rise: Change in Stage (in Feet)
- Rate of Rise: Time it Takes for Stage to Rise (Ex: 0.10 Feet Per Min)
- Arrival Time, or Travel Time: Time it Takes for Releases to Reach a Downstream Location
- Parameters are Specific to a Location and Flow

# Primary Purposes for Releases

- Lake Level Management
  - Usually a Scheduled Event
  - Long Duration (Several Hours or Even Days)
- Reserve Generation (Reserve Call)
  - Immediate Need for Replacement Power
  - Short Duration (Less Than Two Hours)
- Recreational Releases
  - Planned Events
  - Duration of Several Hours

# Data Collection Locations

- Eight Locations Determined by Members of Resource Conservation Groups
  - Primary Areas of Recreational Use
- Representative of Various Reaches of River
  - Narrow Channels with Steep Banks
  - Wide Rapids Areas
  - Dual Channels at Oh Brother Rapids

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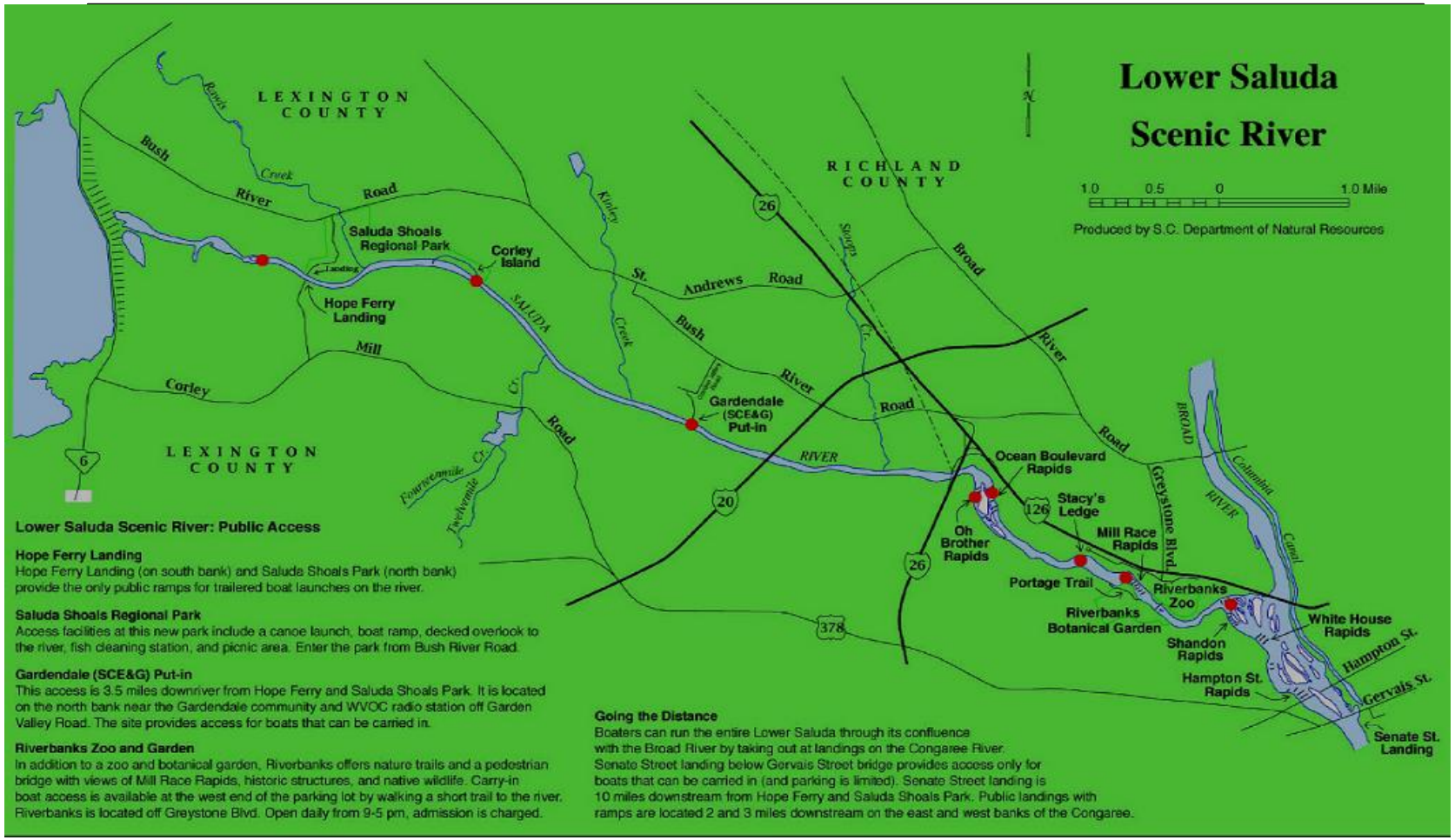
# Map of Locations

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# Field Installation

- Challenging Environment
  - Fast-Moving Water, Varying Depths, Rapids
  - Substrate Variations
  - Debris Loading
- Accessibility
- Minimize Equipment
  - Carrying to Location
  - Avoid Drawing Attention (Vandalism)

# Data Collection: Levelloggers

- Self-Contained, Programmable Pressure Transducer and Data Recorder
- Collects Pressure in Feet at Set Intervals
  - One Minute Intervals Selected
  - Also Collects Temperature
- Use Barologger to Eliminate Atmospheric Pressure Variations

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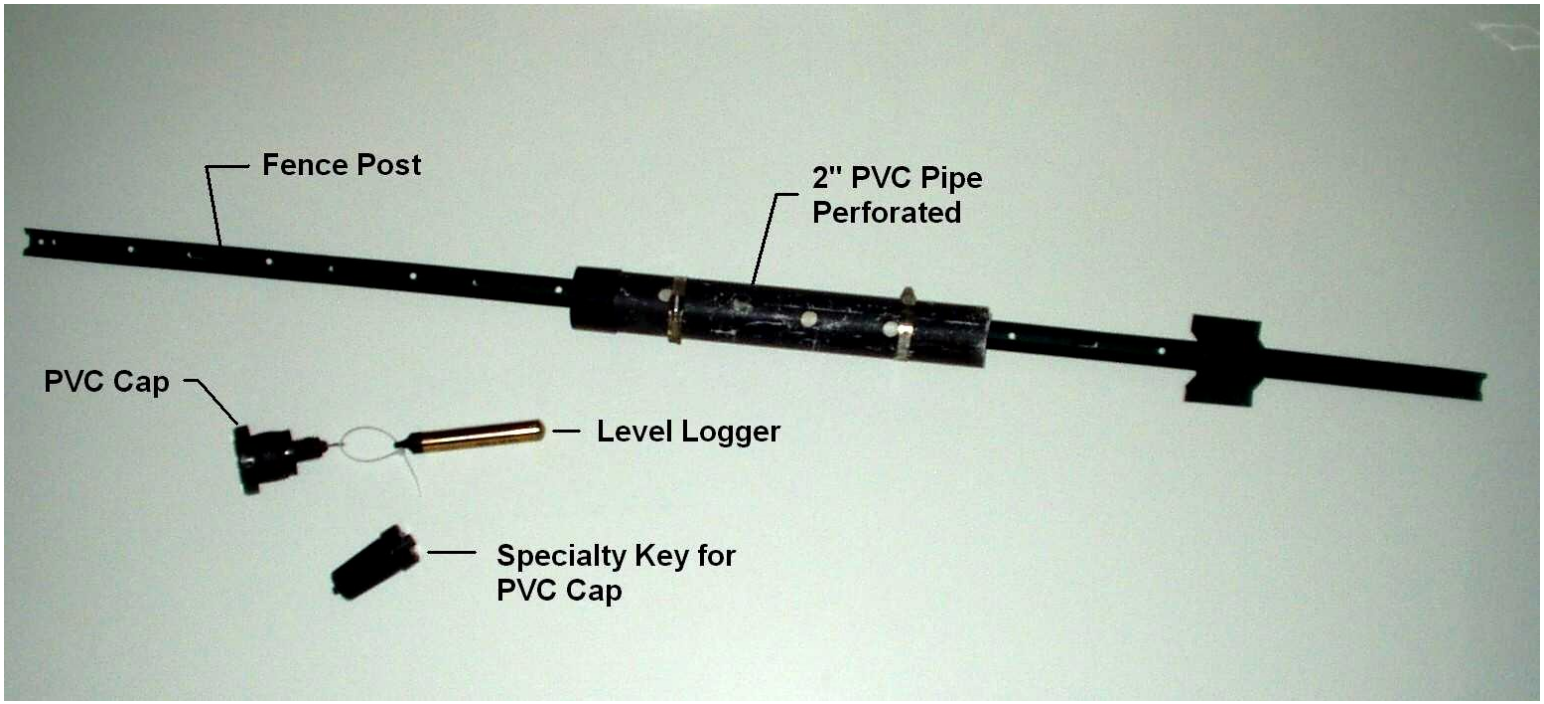
# LevelLogger Equipment

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# Typical Site Installations

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# Data Collection During Study

- Checked Sites Weekly
- Re-Install Any Failed Equipment Installations
  - Two Site Failures During Study
  - Did Not Lose Data, but Flow Events During Failures were Affected
- Collected Data During Site Visits To Prevent Losing

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# Flow Release Events

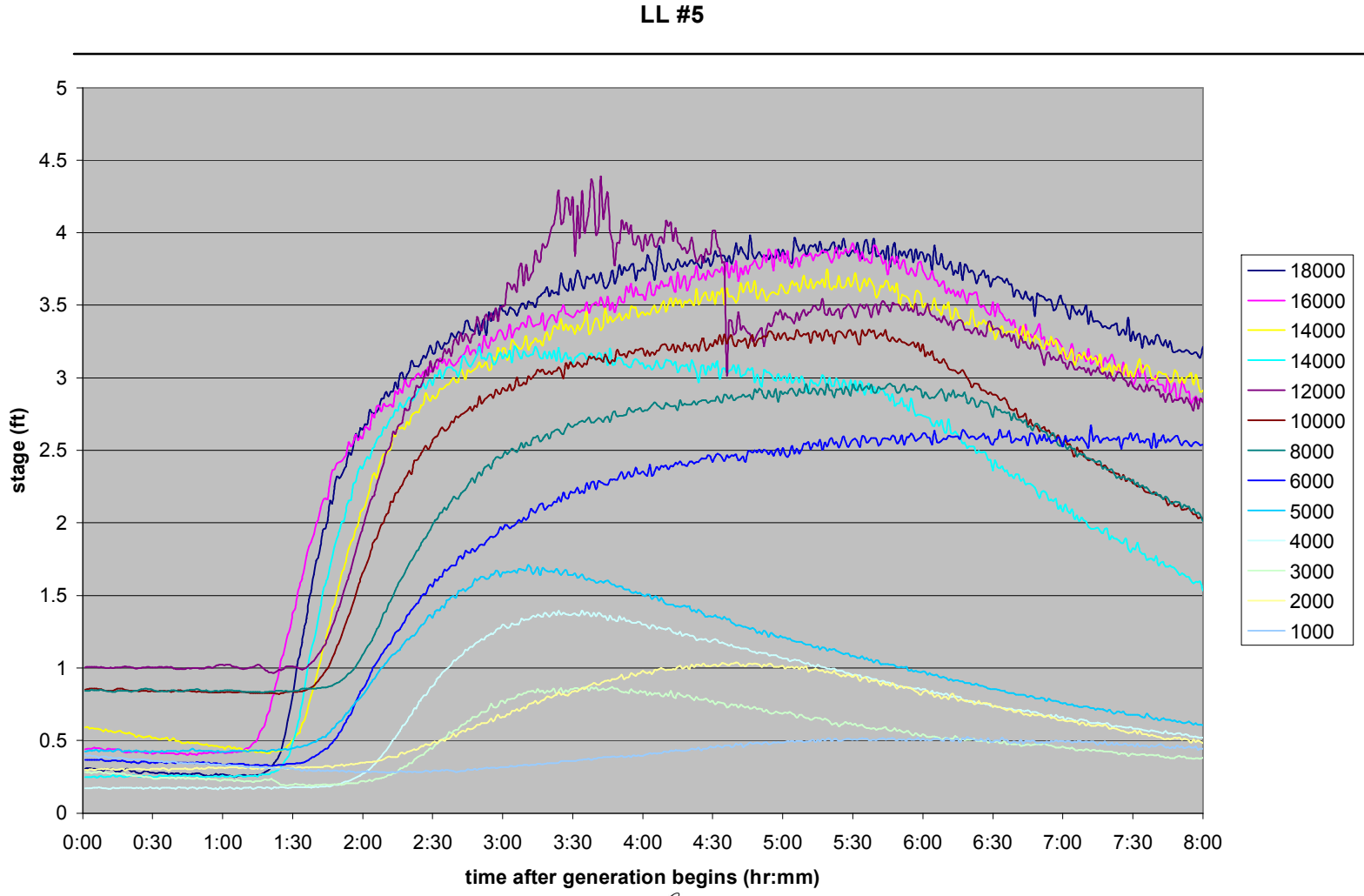
- Twelve Different Flows Released From January 22 - February 15, 2007
- 1,000 cfs Increments up to 6,000 cfs, then 2,000 cfs Increments to 18,000 cfs
- Release Durations Varied During Study
  - Shortest Release 1 hr 20 min, Mimics Reserve Call
  - Longest Duration ~6 hr, Mimics Recreation Release or Lake Level Management

# Data Evaluation

- Evaluate All Flow Events at Each Location
  - All Flows at Corley Island, All Flows at Mill Race, etc.
- Evaluate Individual Flow Events at All Locations
  - 5,000 cfs at All Locations, 12,000 cfs at All Locations, etc.
- Graphed Data for Examination

# Example of One Location, All Flows

*Preliminary Study Data

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# Example of One Flow, All Locations

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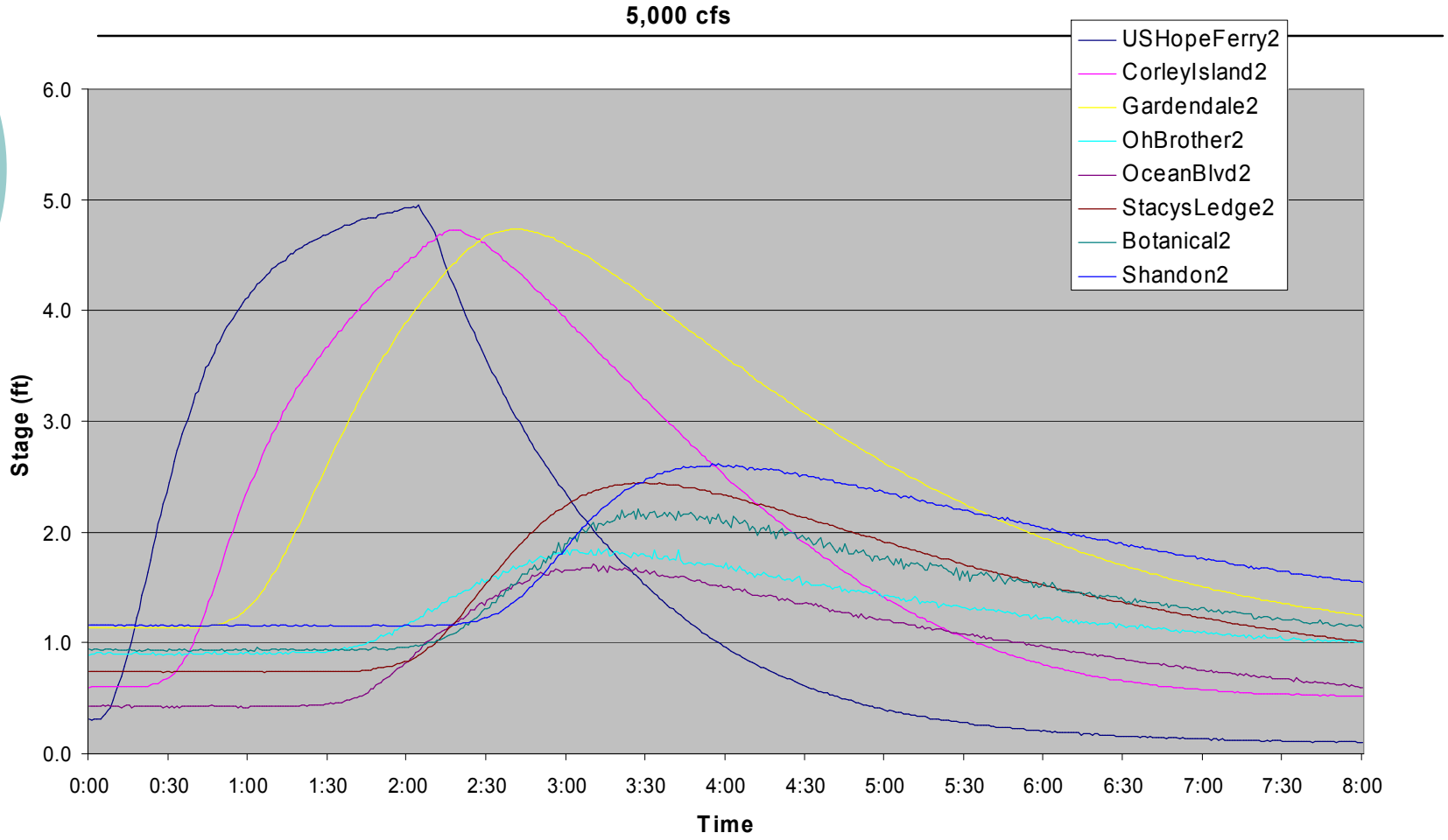


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# Data Evaluation, QA / QC

- Calculate Approximate Rates of Rise at Each Location for Each Flow
- Compare Arrival Times for Different Flow Events, Downstream Locations
- Consider Differences Between Sites: What Affects Rates of Rise, Travel Times, Total Stage?
- Does It Make Sense?

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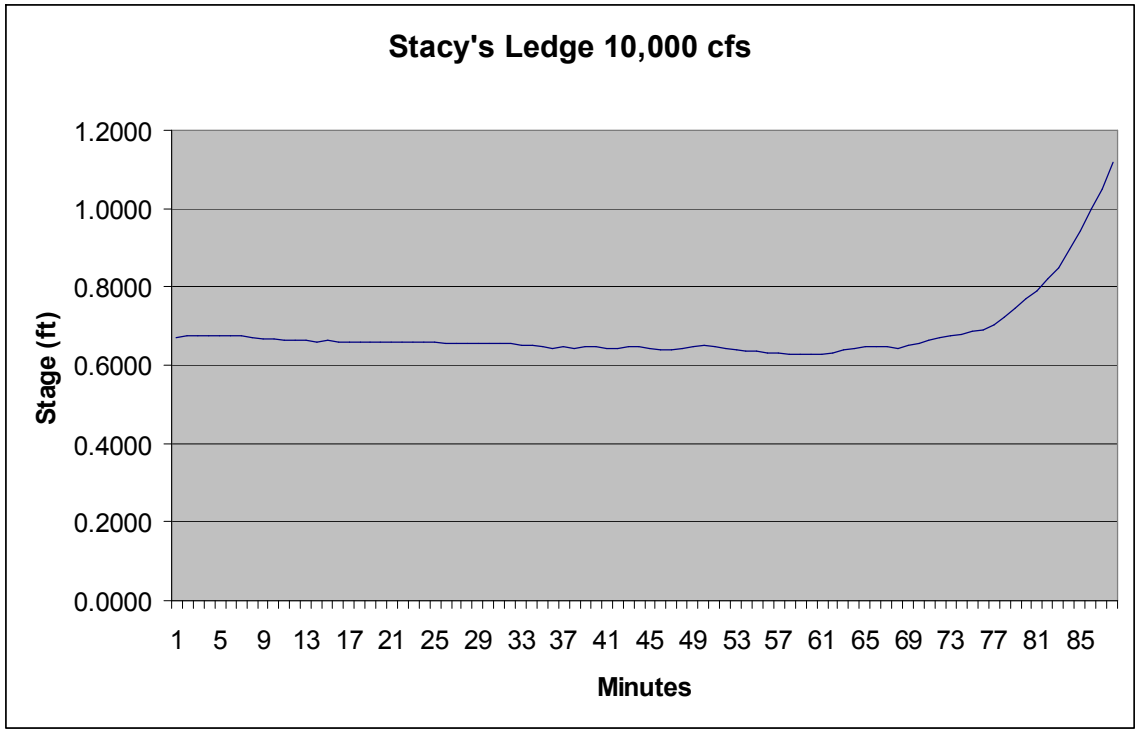
# Preliminary Results, QA / QC

- Some Results Not as Expected
  - Preliminary Arrival Time Problems
  - Discrepancy of Initiating Flows vs. Reaching Full Flows; Corrected with Revised Start Times
- Check Site Failures for Errant Data
  - Use Graphs to Determine Quality of Data
  - Noticeable Failure Points, Eliminate Flow Events as Necessary

# Complicated Study Evaluation

- Stabilization: How Long Does Each Site Take to Reach Maximum Stage?
  - No Such Thing as Complete Stabilization
  - Duration of Release Greatly Impacts Stages Reached for Each Flow Event
  - Release Duration Also Affects Time to Recede
- Selecting Arrival Times can Vary Due to Subtle, Continuous Stage Fluctuations

# Interpretation: Find Arrival Time




Subtle Stage Variations can Lead to Discrepancies of 15 Minutes or More with Human Interpretation

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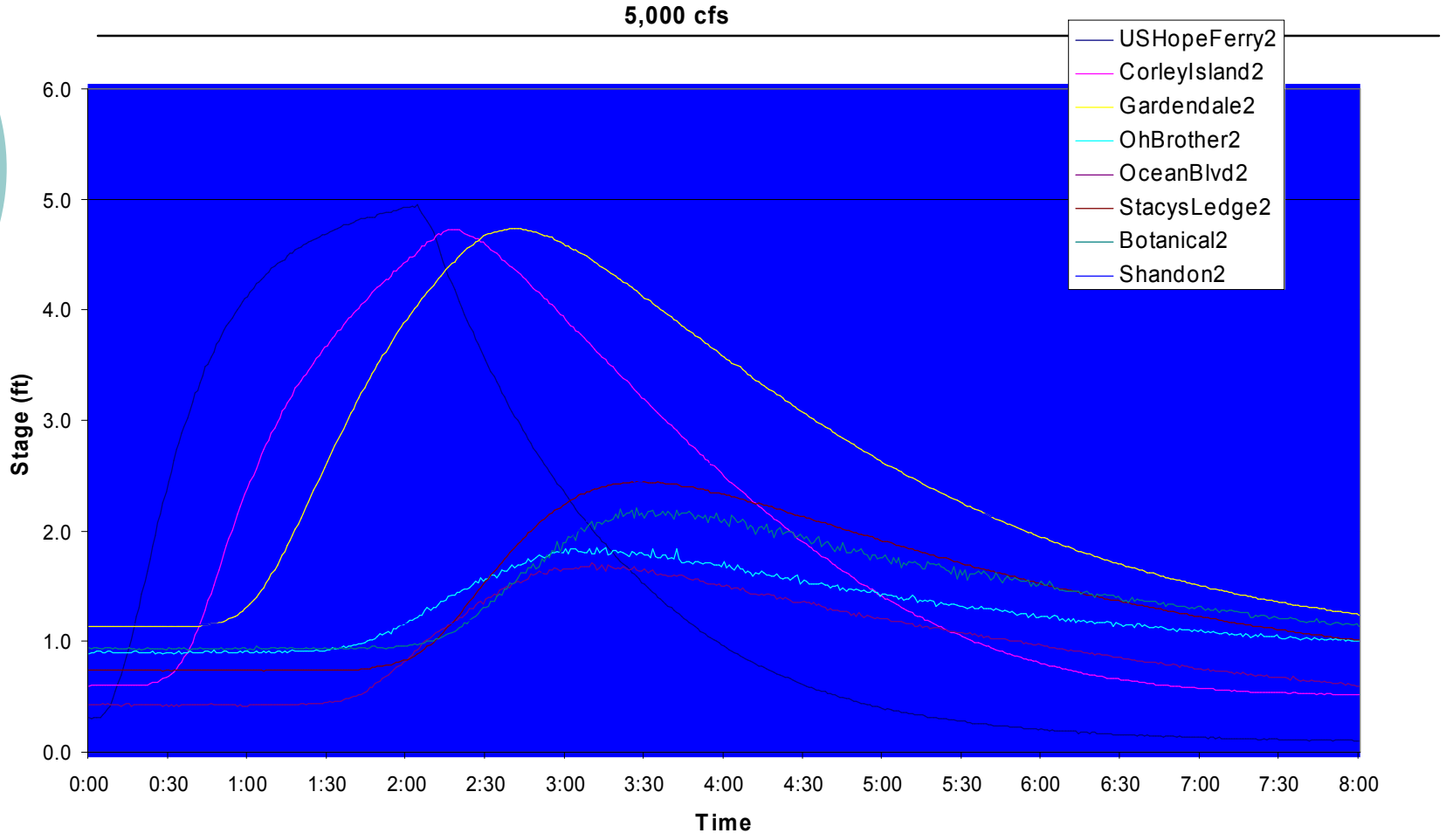
# Interpretation: Find Maximum Stage

*Preliminary Study Data

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# Accounting for Flow Variances

- Maximum Stage, Arrival Times, Time to Recede Difficult (or Impossible) to Determine from Actual Field Data
  - Flow Durations Varied
  - This Represents ***Real*** Operations
  - Not Reasonable to Conduct Field Study of All Flows for Multitude of Durations
  - Account for Precipitation?

# Using the River Model

- HEC-RAS Already Being Developed as Part of Operations RCG
  - River Analysis System, Being Developed in Conjunction with HEC-Res Model (Reservoir Operations Model)
- Calibrate River Model to Study Data
- Not Subject to Human Interpretation of Real-World Data (Proved to be Difficult and Inconsistent)

# Modeling Data for Various Events

- Can Run Multitude of Scenarios (Such as Flow Durations) at Each Location Studied
- Model can Account for Precipitation that Occurred During Study
- Yields Consistent Arrival Times and Maximum Stage
  - Based on Ideal (Constant) Starting Points, Not Fluctuating Stages

# Modeling Flows

- Run Same Flows for 1-1/2, 6, and 24 hours
- Check vs. Actual Field Study Results (Part of Calibration Procedure)
- Extract Parameters: Maximum Stage, Rates of Rise, Arrival Times, Time to Recede

# Questions?

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