



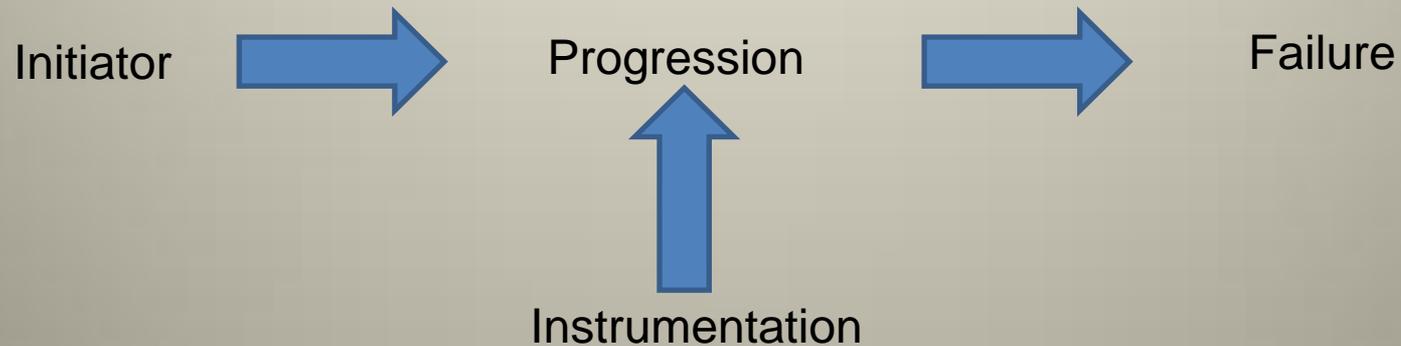
Dam Instrumentation Plan, Design and Evaluation for Dam Inspections



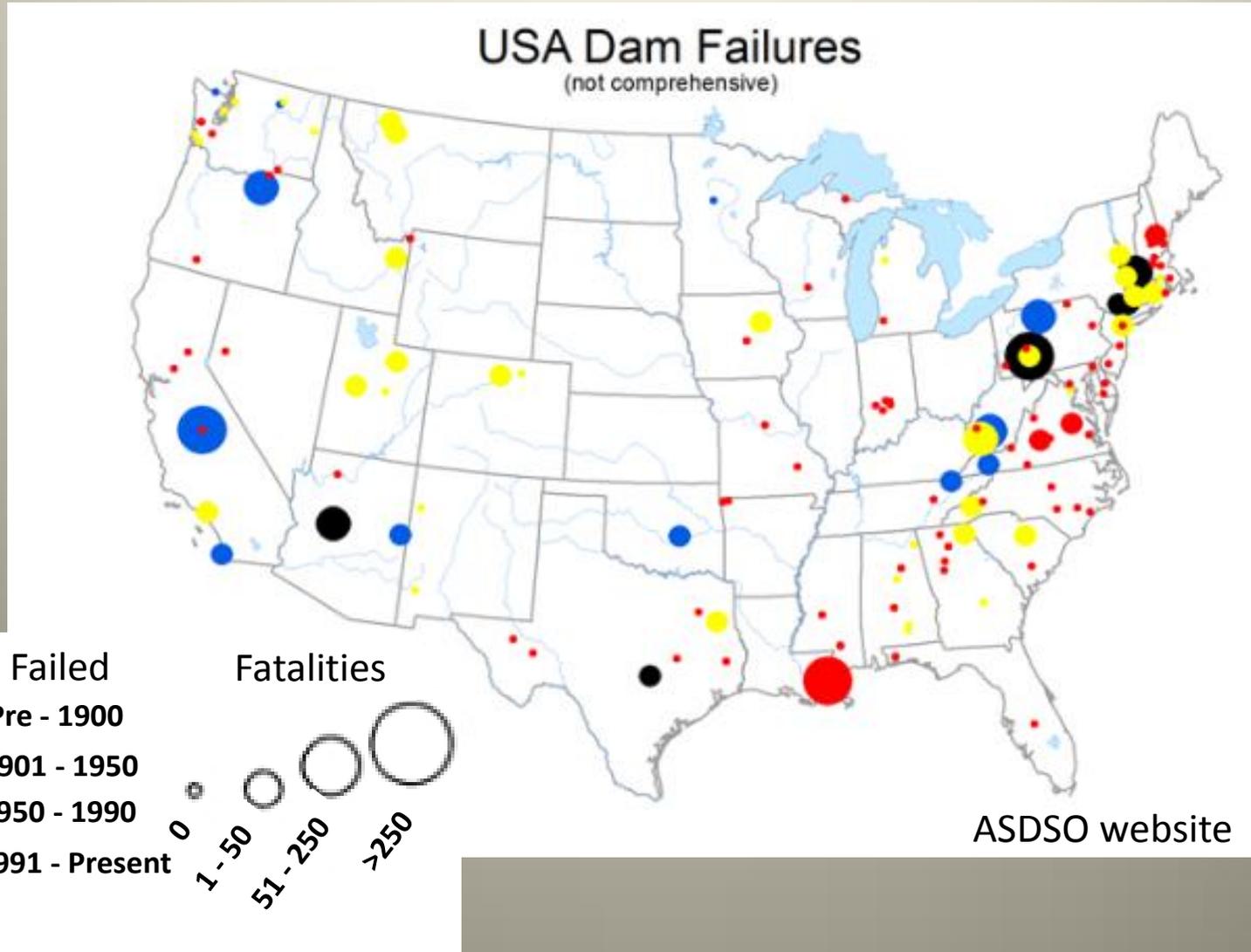
Loring Crowley, PE
May 17, 2016

Purpose - Potential Failure Modes

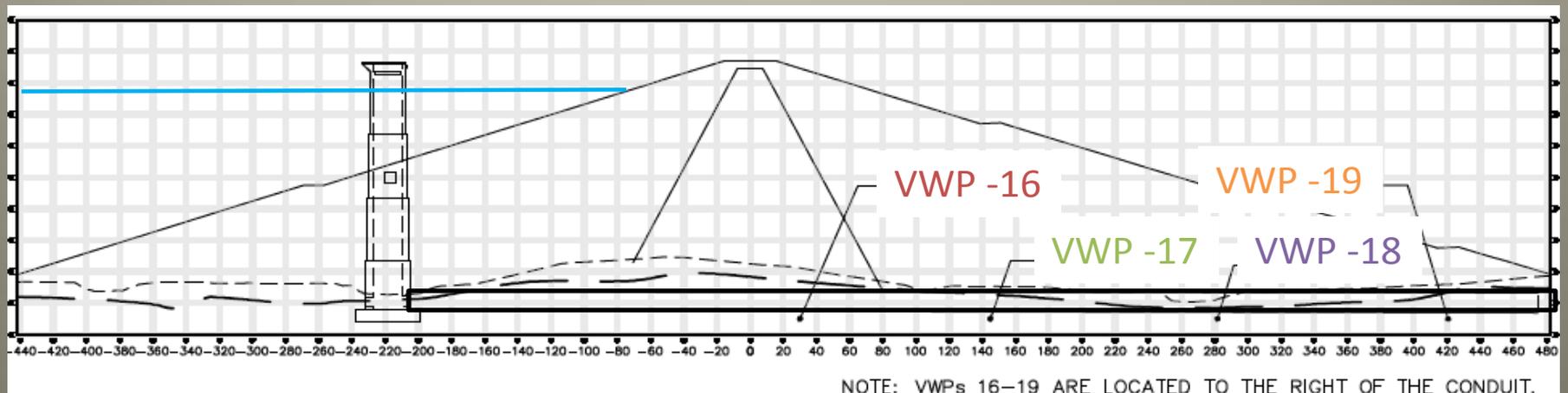
Process of PFM occurrence



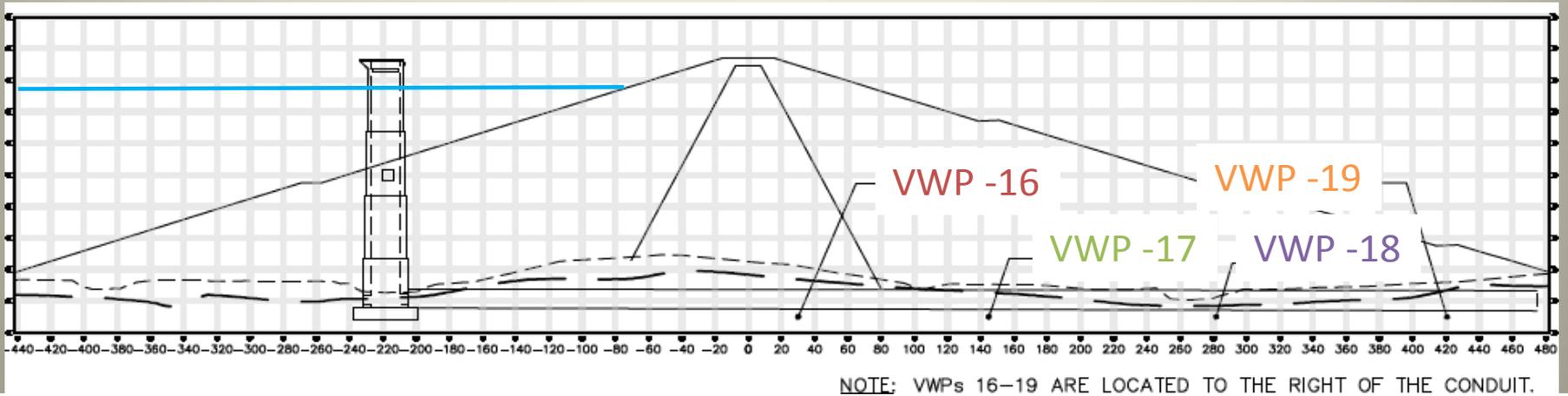
Purpose – Potential Failure Modes



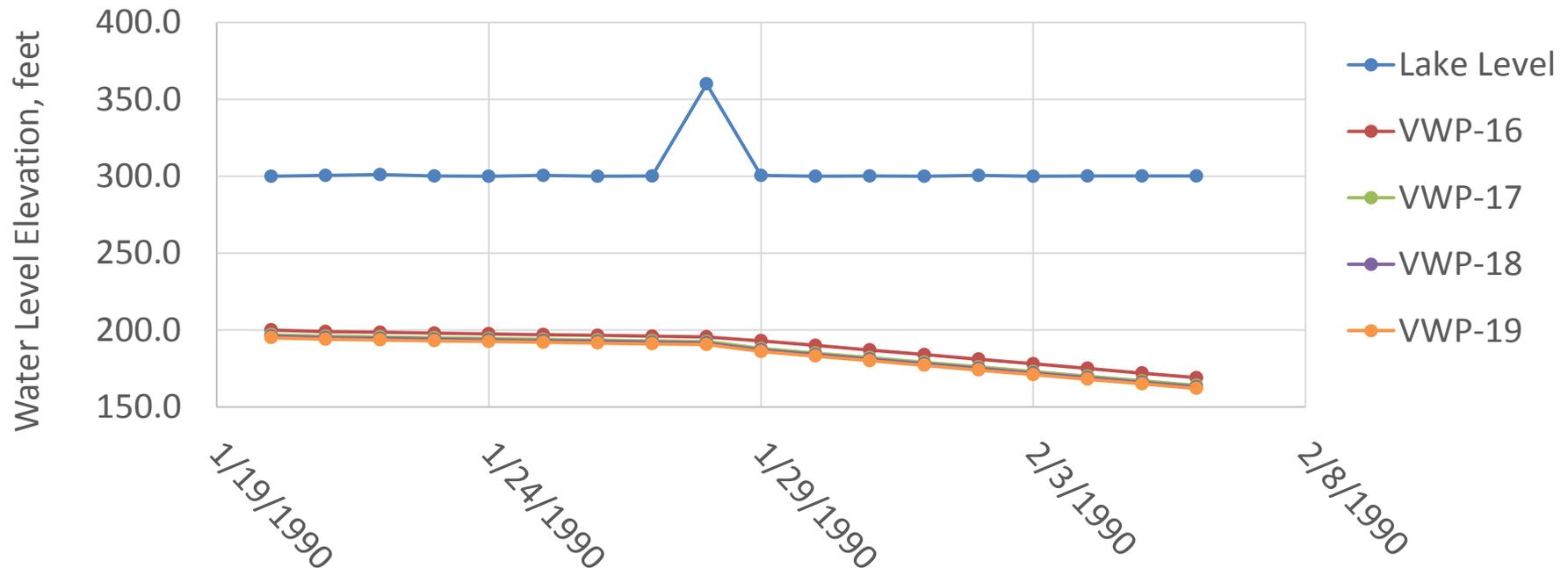
PFM – Piping Along Conduit



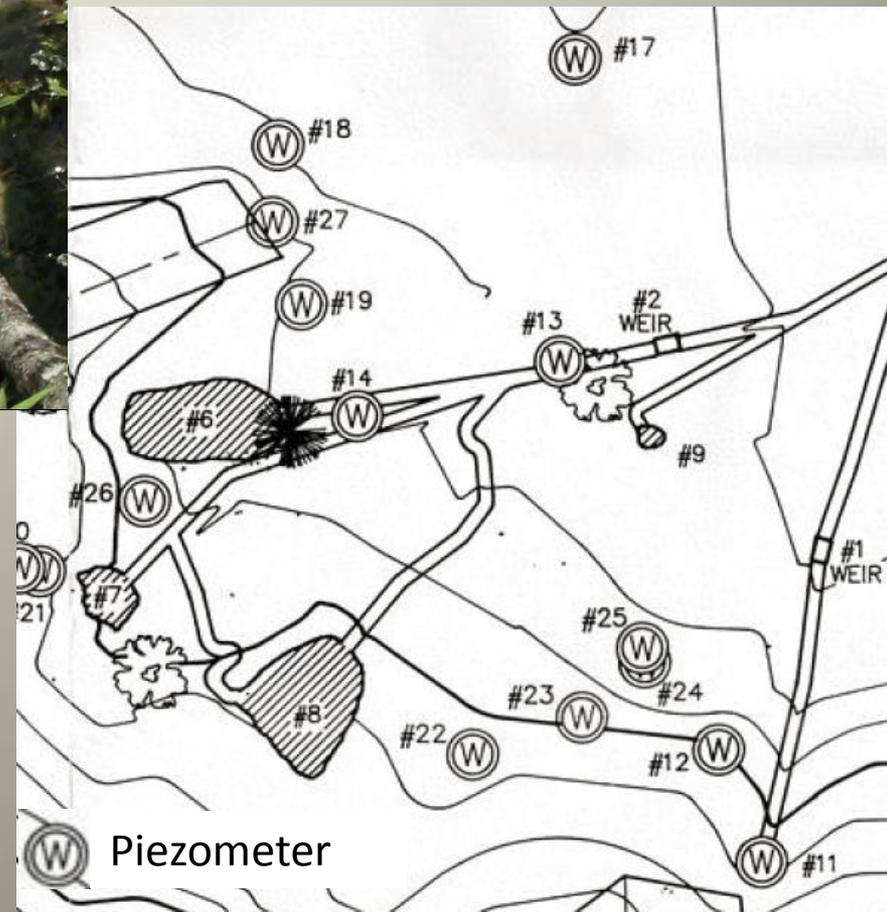
PFM – Piping Along Conduit



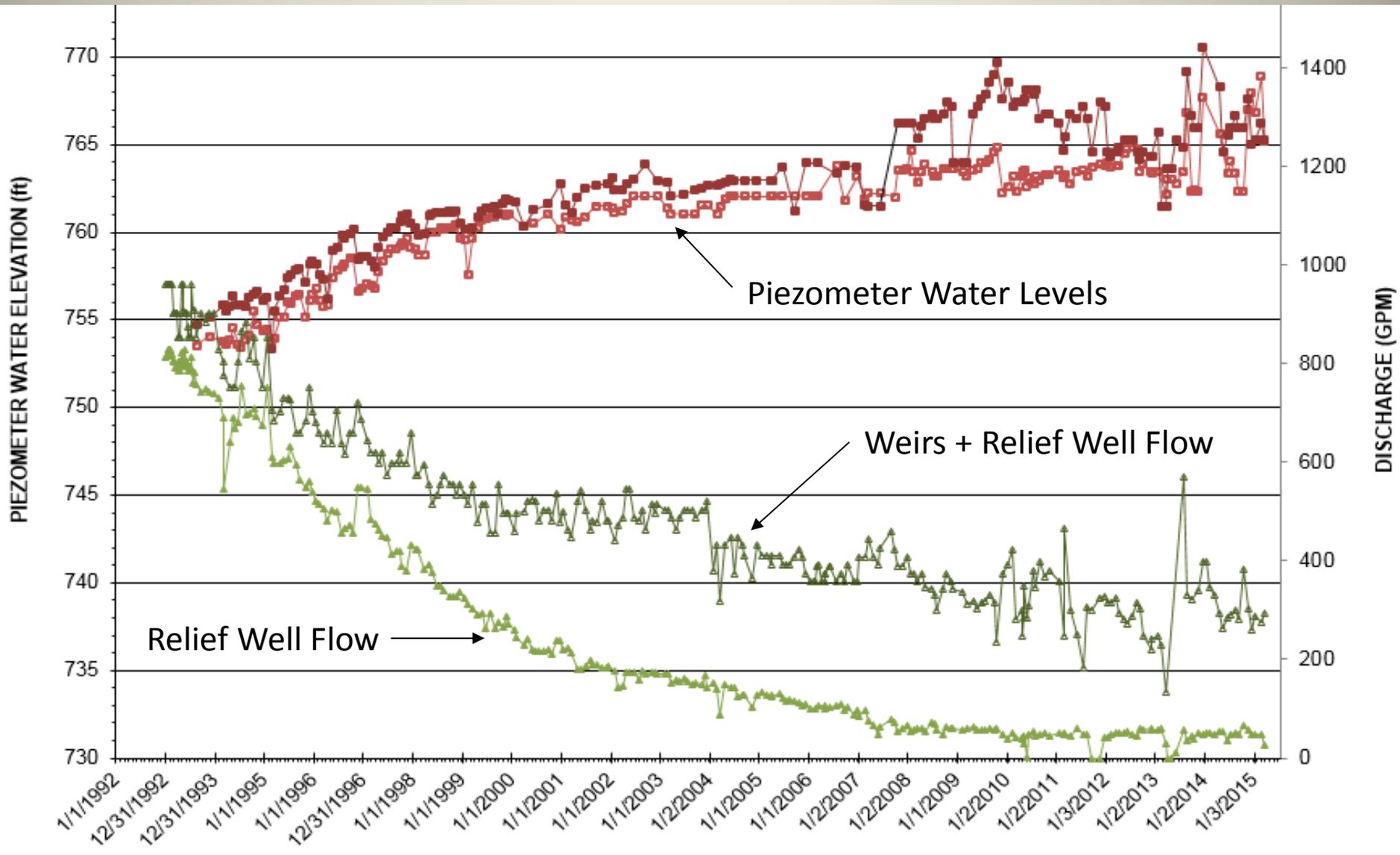
NOTE: VWPs 16–19 ARE LOCATED TO THE RIGHT OF THE CONDUIT.



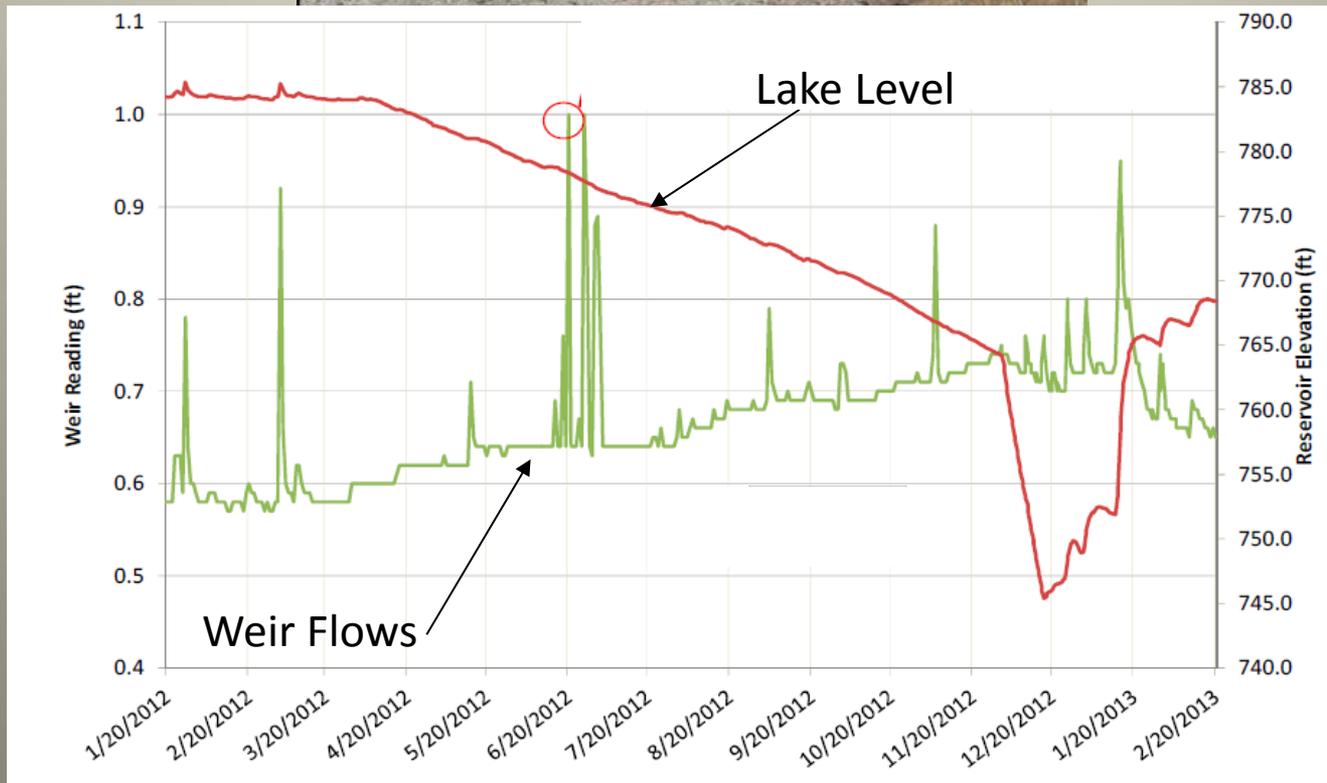
PFM – Uncontrolled Seepage/Boils



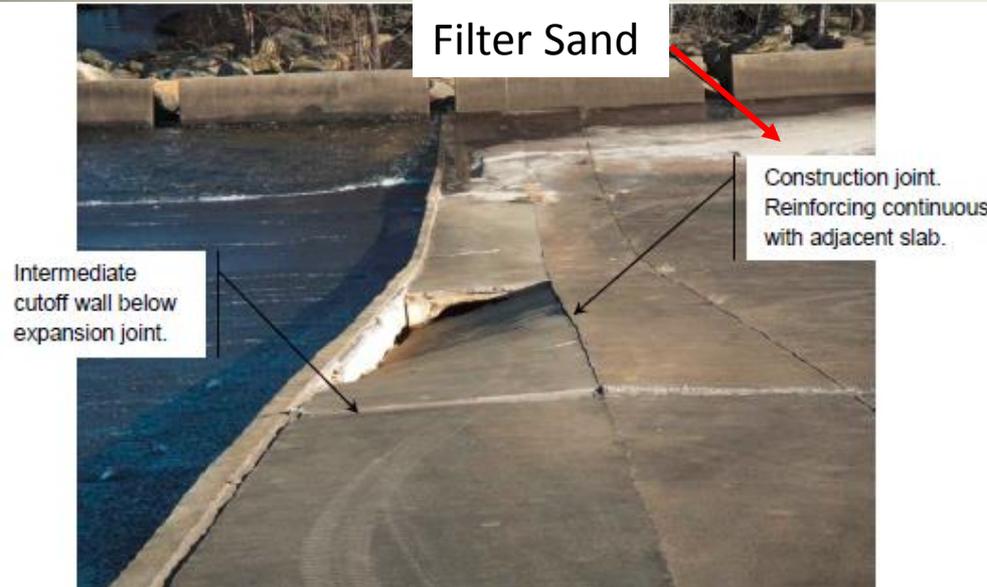
PFM – Uncontrolled Seepage/Boils



PFM – Internal Erosion

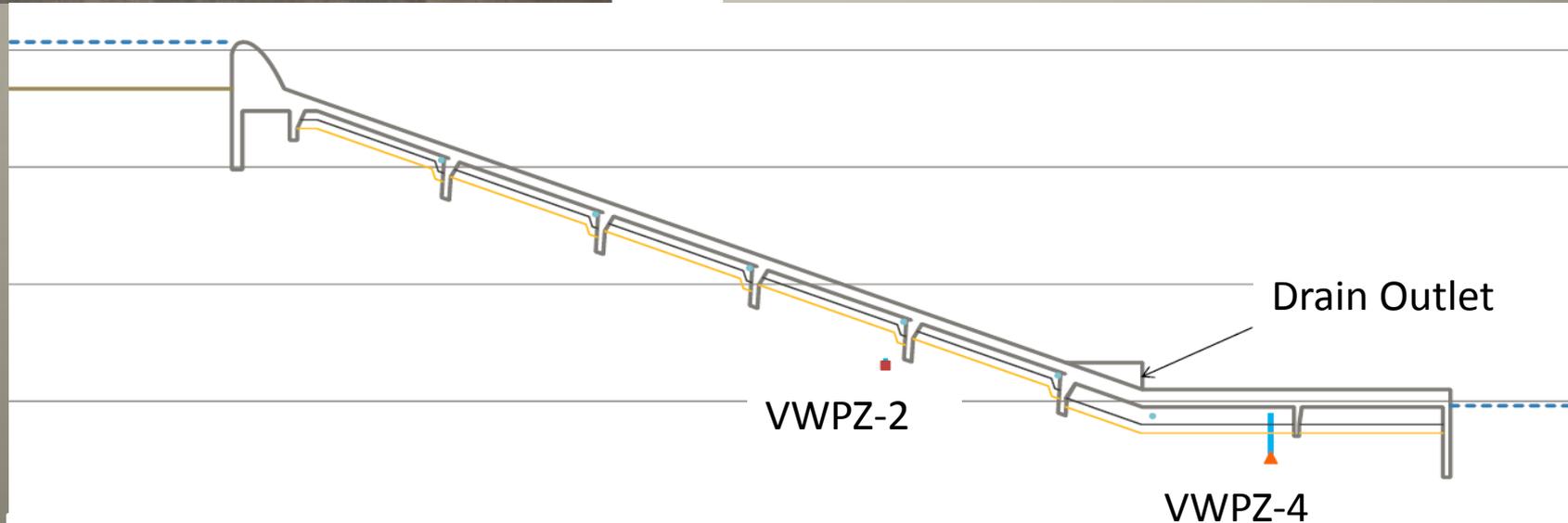


PFM – Undermining of Chute Spillway

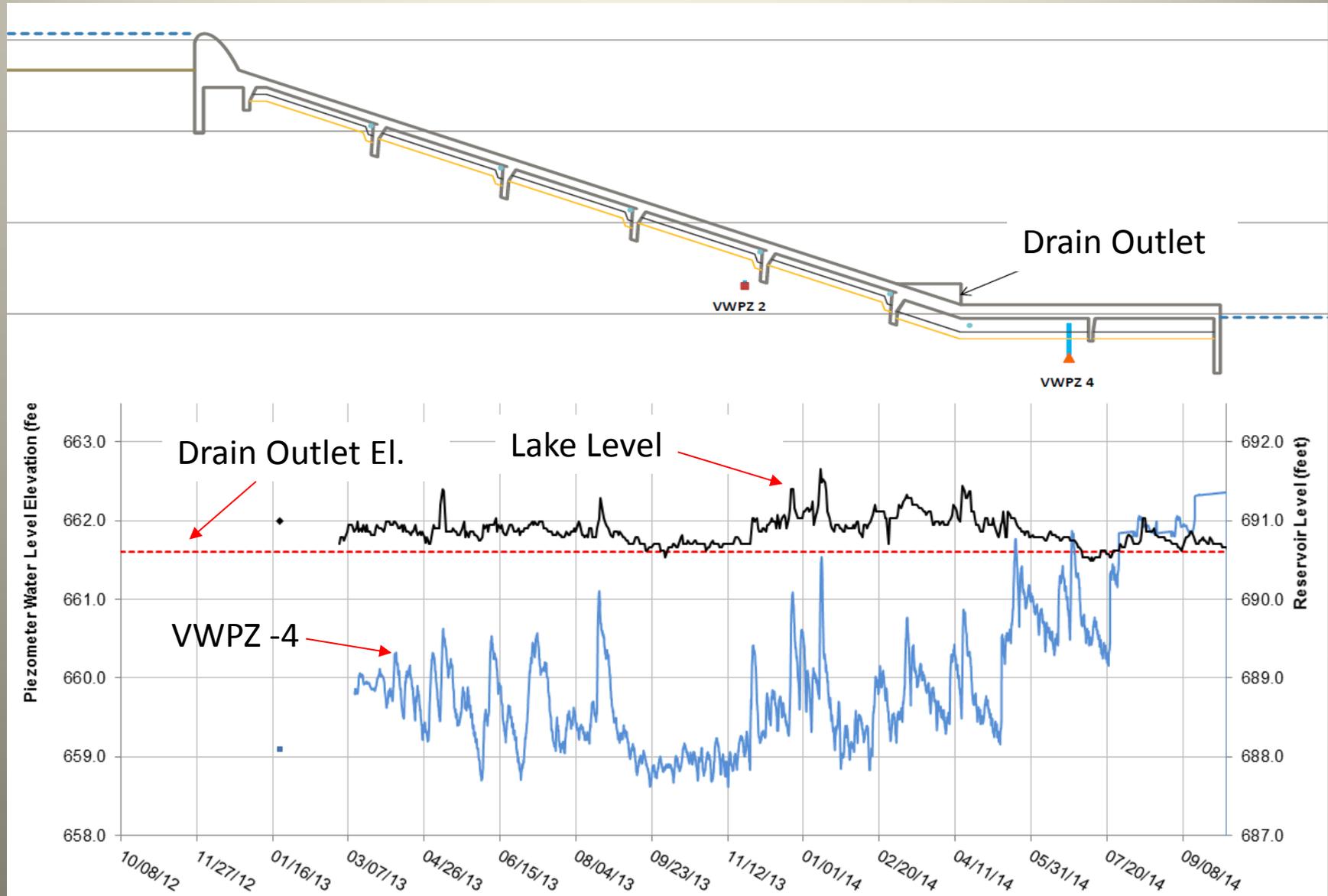


Instrumentation Indicators

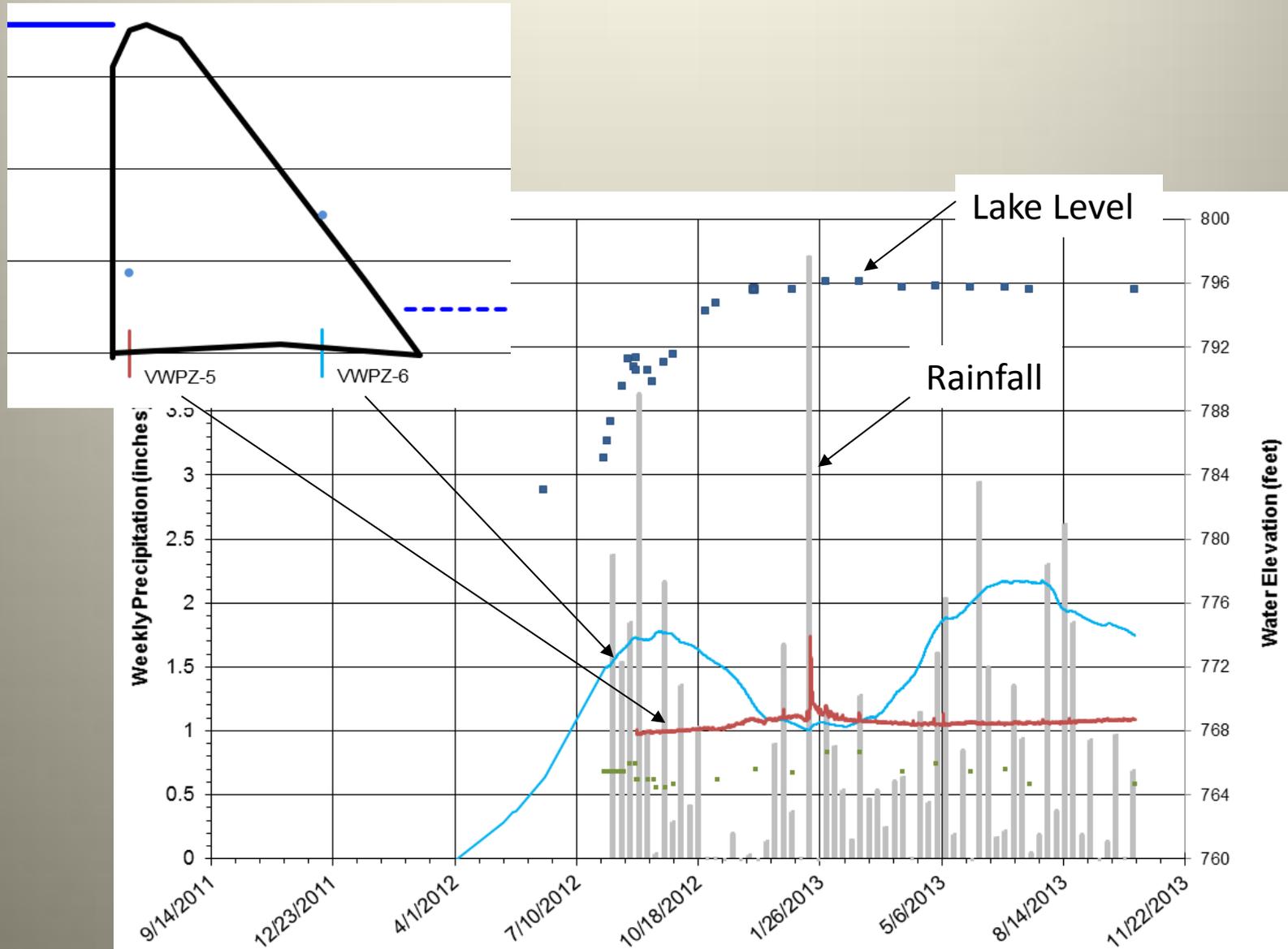
- Decline in water pressure indicated by **piezometers**
- Sharp increase in water pressure after rainfall event.
- Drain flows vs. pressure relationship



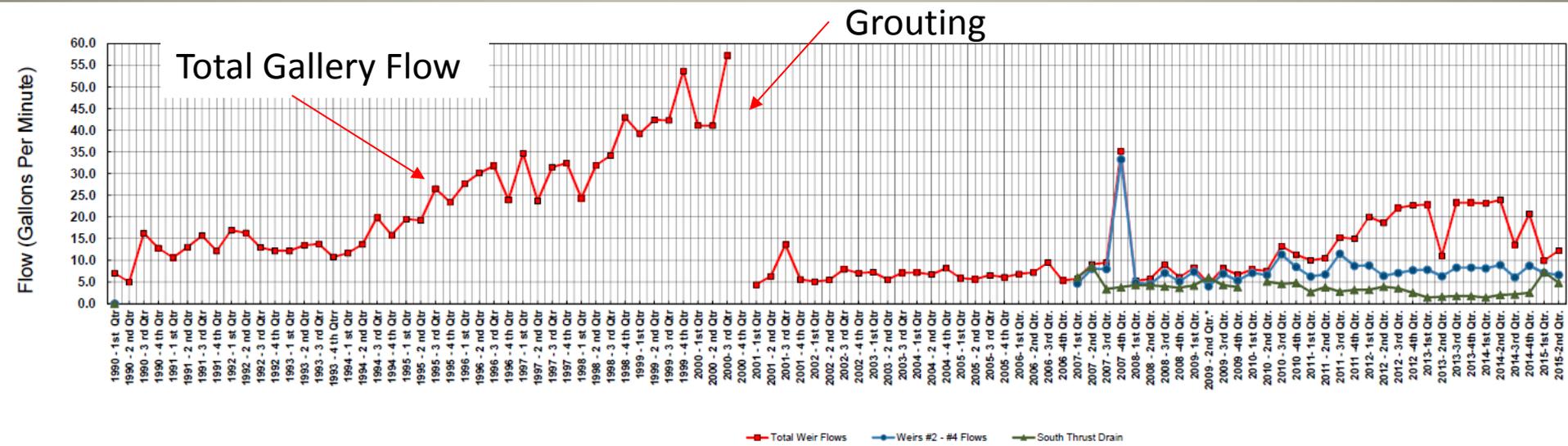
PFM – Undermining of Chute Spillway



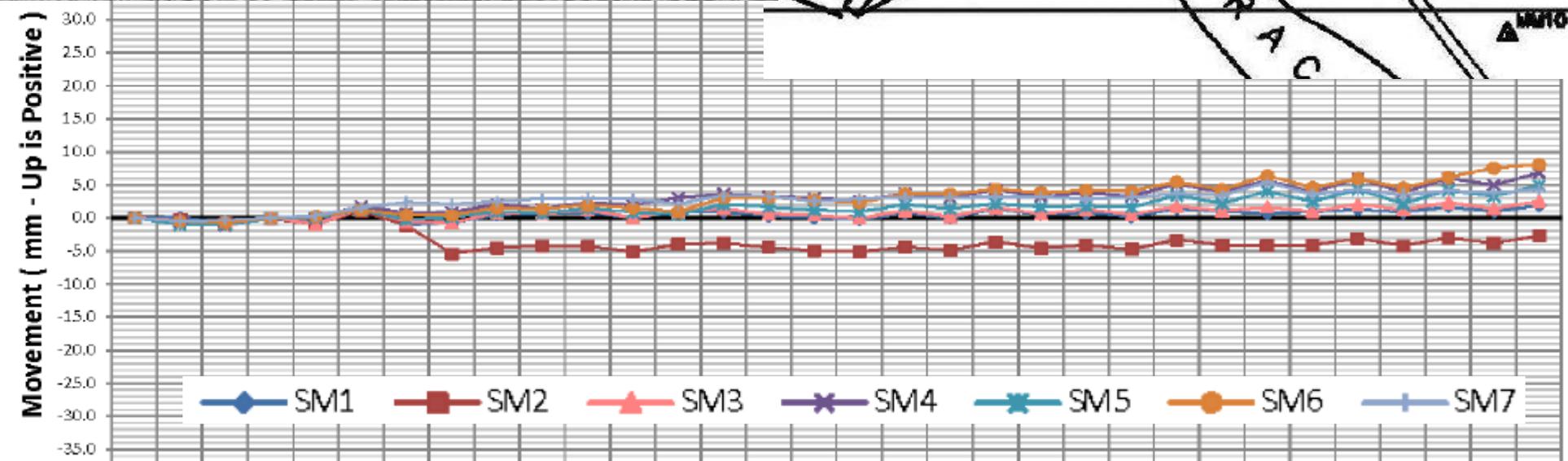
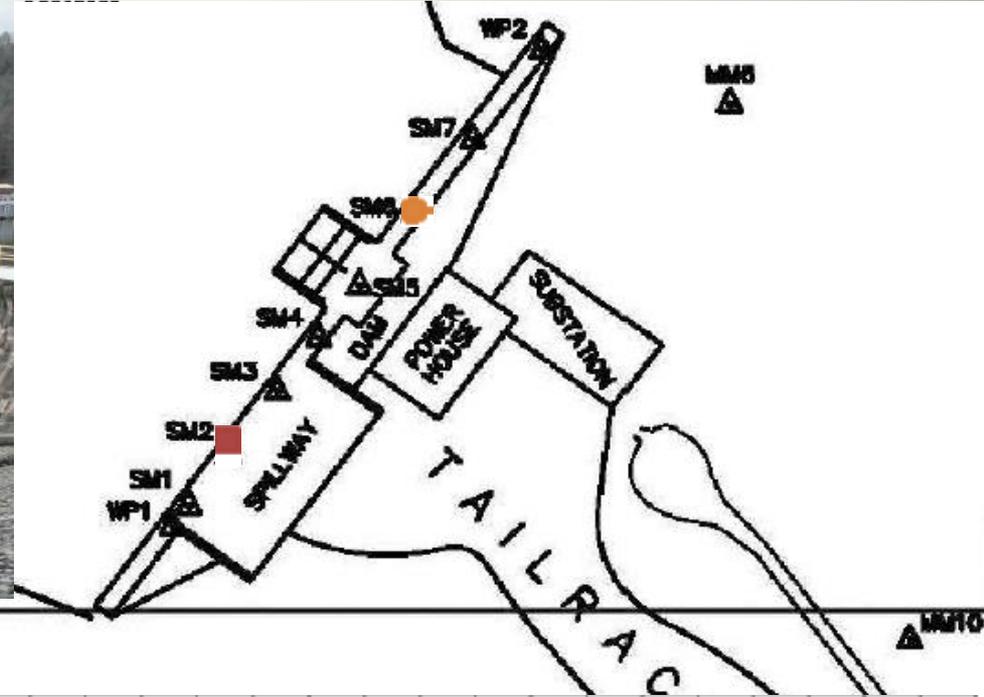
Evaluating Uplift



Evaluation of Flow Data



Evaluation of Structure Monitoring Points



Conclusions

- Instrumentation is important!
- Address exceedance data immediately
- Retain all raw data indefinitely
- Review data and trends timely
- Meaningful presentation of data
- Understand purpose for data collection

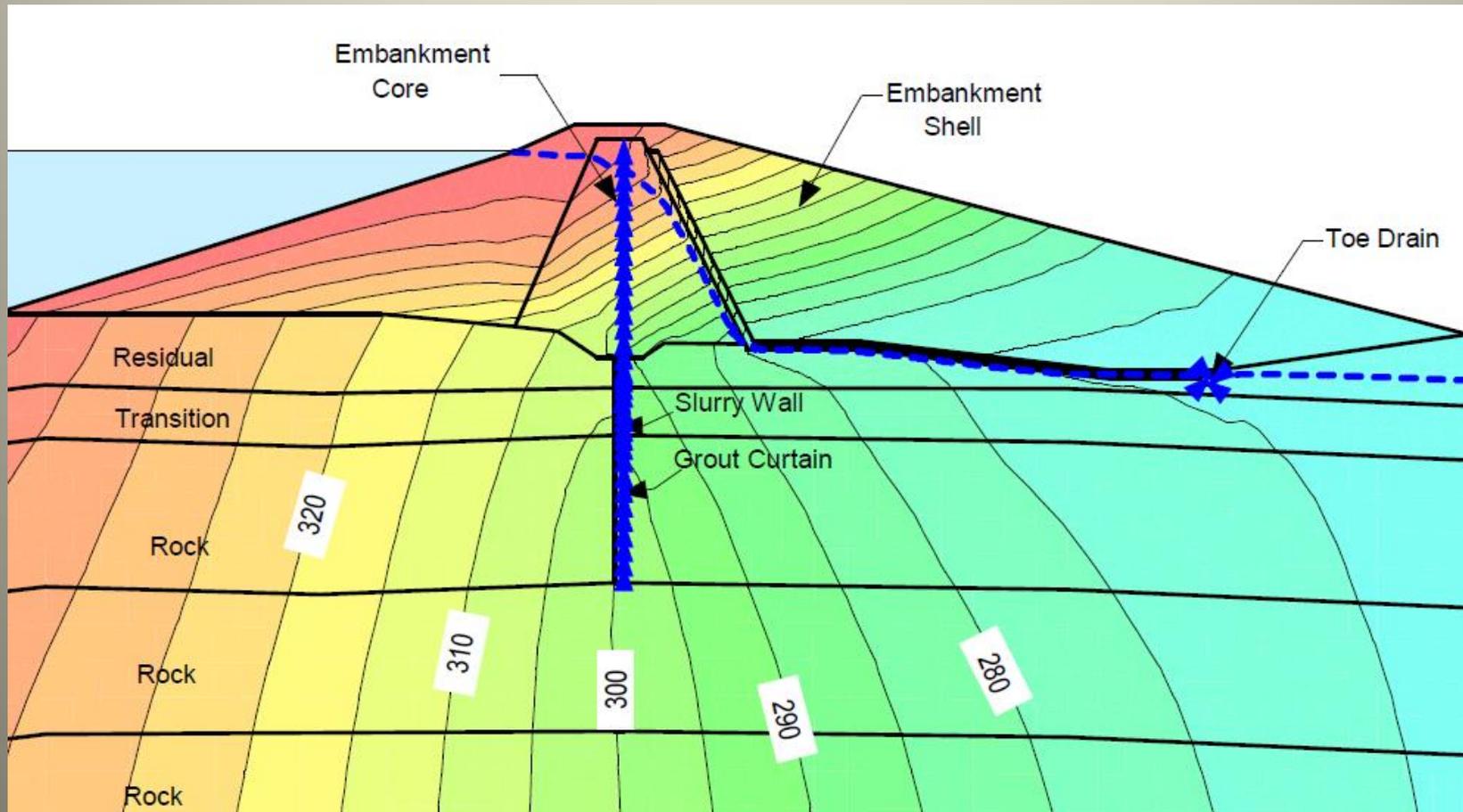
Types of Instrumentation

- **Water Level Monitoring**
 - Staff Gage
 - Transducer
- **Water pressure monitoring in dam/abutments**
 - Open standpipe vs. Vibrating wire piezometers (VWPs)
- **Movement Monitoring**
 - Inclinometers
 - Structure Monitoring Points
- **Flow Monitoring**
 - V-notch Weirs
 - Pipes
- **Temperature**
- **Vibration Monitoring**
- **Weather Station**
- **Extensometer**
- **Plumbines**



Performance Monitoring

- Design Basis Values – is it performing as expected?



Evaluation Methods - Exceedance

- Is the data real (instrument malfunction)?
- If it's real, what is the data telling us?
- Are there other visual/monitoring indicators supporting data?
 - SMP movement → Cracking
 - Seepage on downstream face of dam
 - Historical construction photographs