McGuire Nuclear Station

Nuclear Service Water (RN) Strainer

NRC Region II Office
Atlanta, Georgia
18 September 2008

Introductions – Duke Participants

- Bruce Hamilton — McGuire Site Vice President
- Steven Capps — McGuire Engineering Manager
- Duncan Brewer — McGuire Safety Assurance Manager
- Jeff Nolin — McGuire MCE Engineering Manager
- Ken Ashe — McGuire Regulatory Compliance Manager
- Brian Anderson — McGuire MCE Engineering Supervisor
- Mike Kitlan — Probabilistic Risk Assessment
- Mike Weiner — McGuire Operations

Agenda

- Introductions
- Opening Remarks
- Exposure Period
- PRA Highlights and Results
- Actions Taken
- Closing Remarks

Opening Remarks

- The design deficiencies on the Nuclear Service Water (RN) system at McGuire do not meet Duke expectations
- The non-conformance of the strainer backwash function could and should have been found in prior reviews.
- We have taken corrective actions to address Alewife fouling and backwash capability
  - There were no challenges to the strainers during 2008.

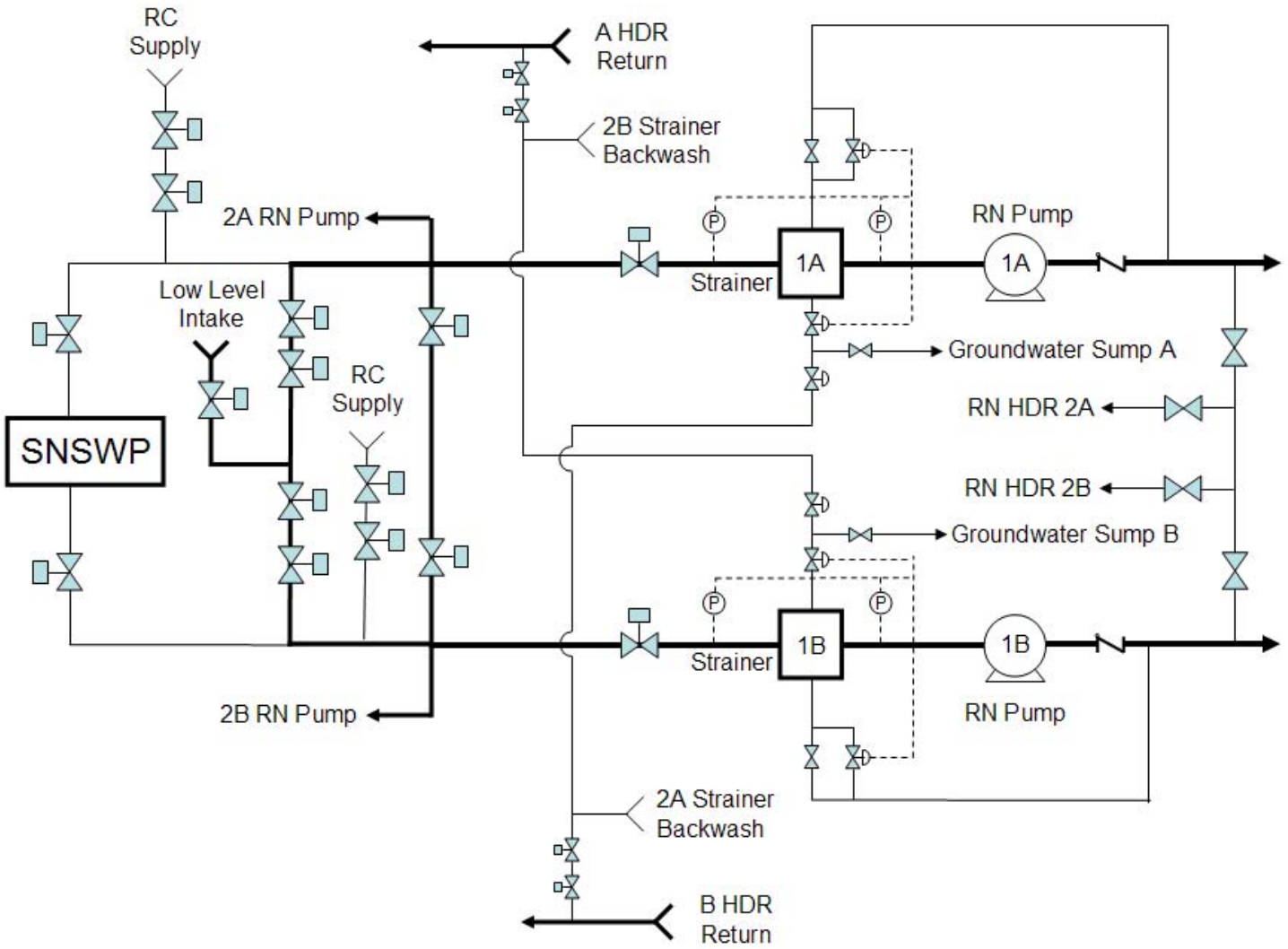
Opening Remarks – cont.

- As stated in your August 20, 2008 letter:
  - There was “an apparent violation of 10 CFR 50 Appendix B Criterion XVI, Corrective Action for the failure to correct a significant condition adverse to quality related to macro-fouling of the RN strainer.”
- In our Root Cause we concluded:
  - The plant configuration was changed without a comprehensive understanding of the design and licensing bases of the RN system. A key contributor to this was that in 1993, 2000 and again in 2003 we missed opportunities to follow through with corrective actions that could have identified the backwash issue and/or the alewife challenge.

Opening Remarks – cont.

- The following presentations will explain why we believe the risk significance of this event was very low
  - Our Nuclear Service Water (RN) System
  - Our evaluation of exposure periods
  - The key differences between our PRA results and your analysis
  - Our Corrective Actions to ensure that the systems perform as designed, and lessons learned are institutionalized into our programs, procedures and directives

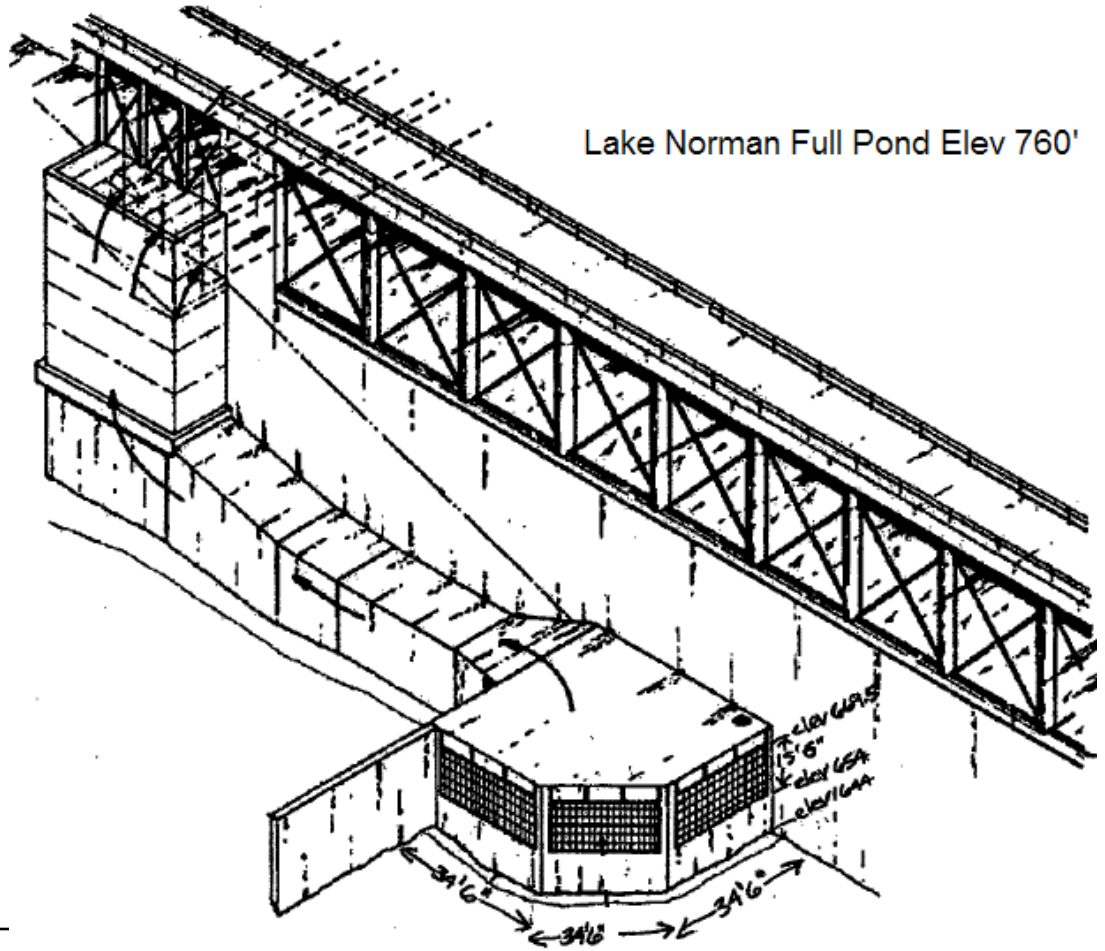
RN System Overview



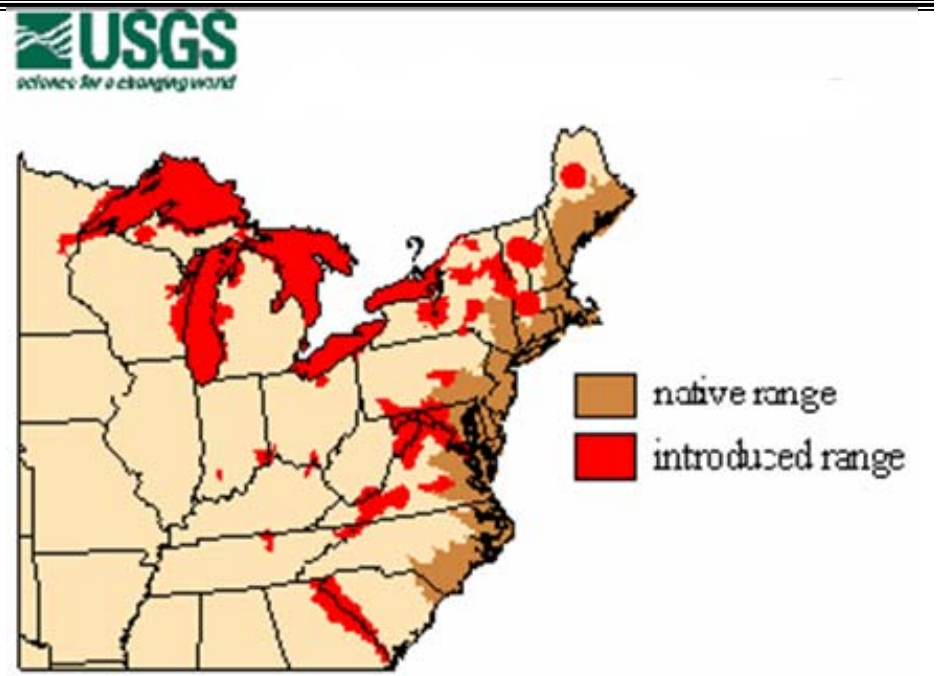
MNS Low Level Intake Structure

Top of intake structure- 735’

From July to November, stratification of water column results in water at the RN suction becoming de-oxygenated. Water near the surface remains oxygenated.



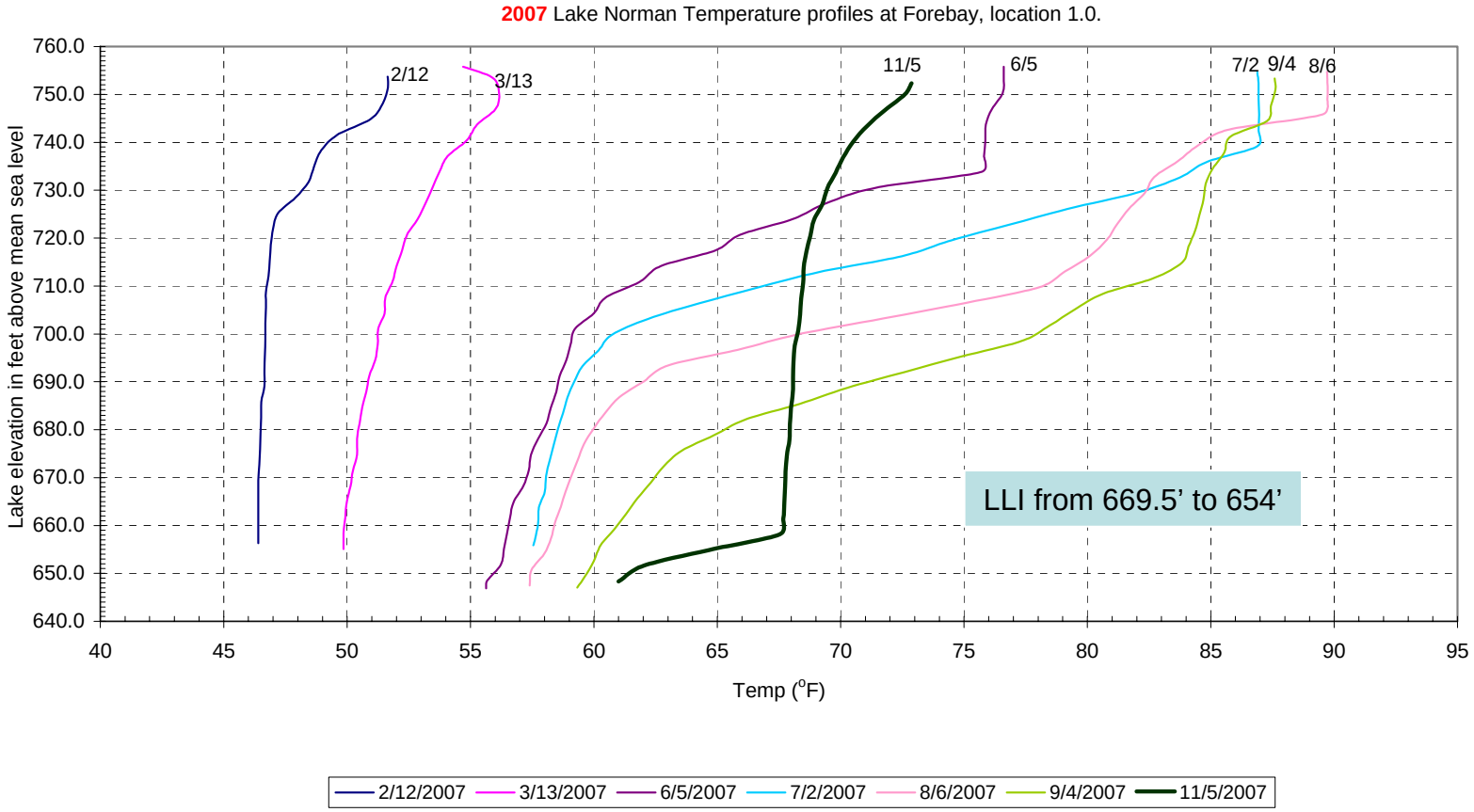
MNS Nuclear Service Water (RN) Strainer



MNS Nuclear Service Water (RN) Strainer

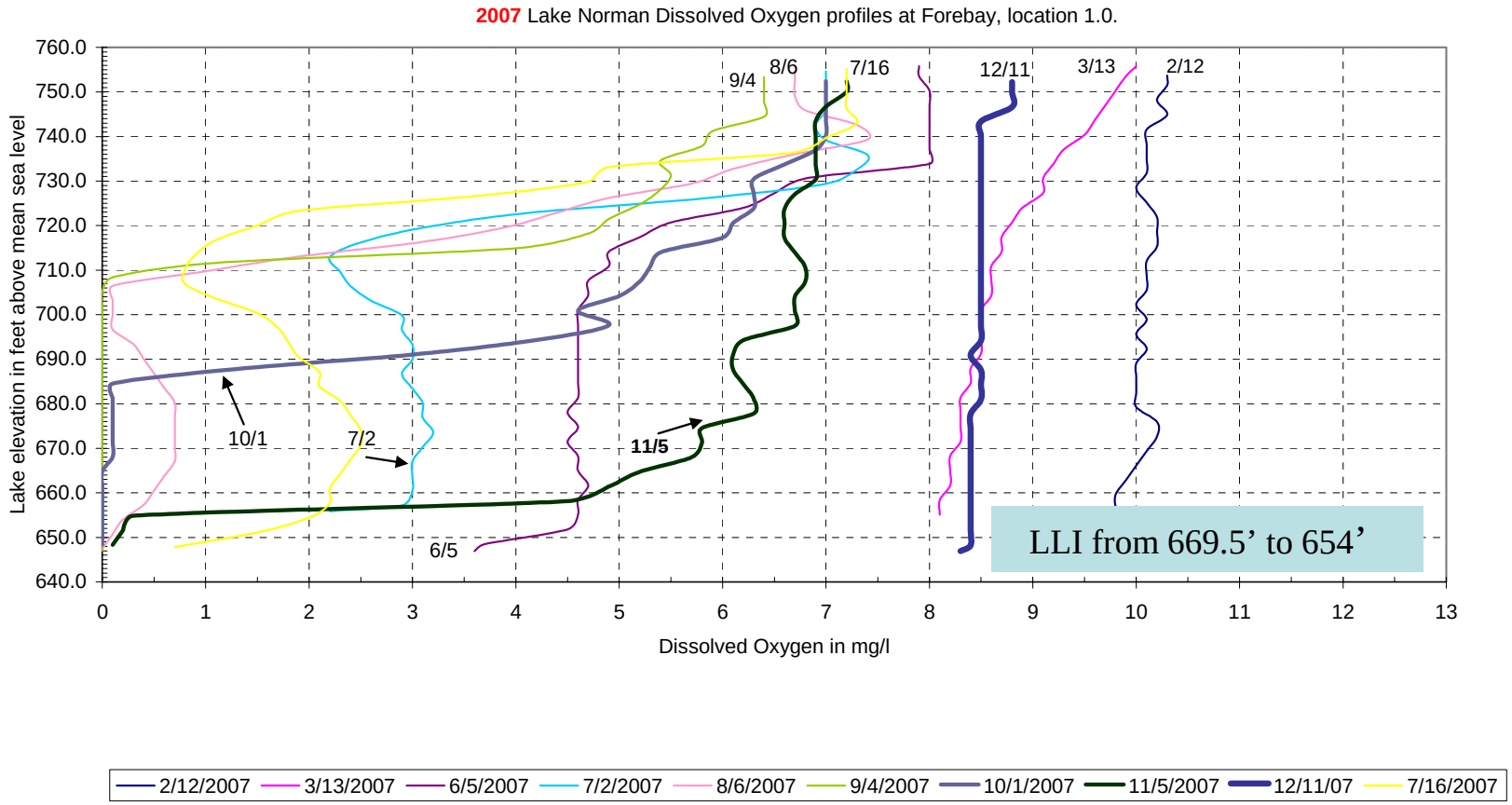
- Exposure Period - Alewife behavior in Lake Norman
  - Alewife remain dispersed in Lake Norman at relatively shallow depths for the vast majority of the year.
  - Water stratifies during the summer. A large volume of cool water remains in the deep sections of Lake Norman until lake turnover in November. Some adult Alewife descend during the late summer to find this cooler water.
  - Dissolved oxygen depletes in specific areas in the stratified water during the summer due to biological activity like decay. Water directly above the thermocline becomes uninhabitable (DO = 0 mg/L) pushing some of the Alewife deeper. By late July, the oxygenated cold water remaining is deeper where some fish concentrate.
  - Dissolved oxygen continues to decrease, and by the mid August there is no dissolved oxygen below ~50 feet depth. Dissolved oxygen remains zero until lake turnover in November.
  - Alewife constitute a macrofouling mechanism in Lake Norman, but only for a very short duration each year (potential exists from mid July to mid August).
  - No alewife have been identified in the SNSWP.

Lake Norman Temperature Profile



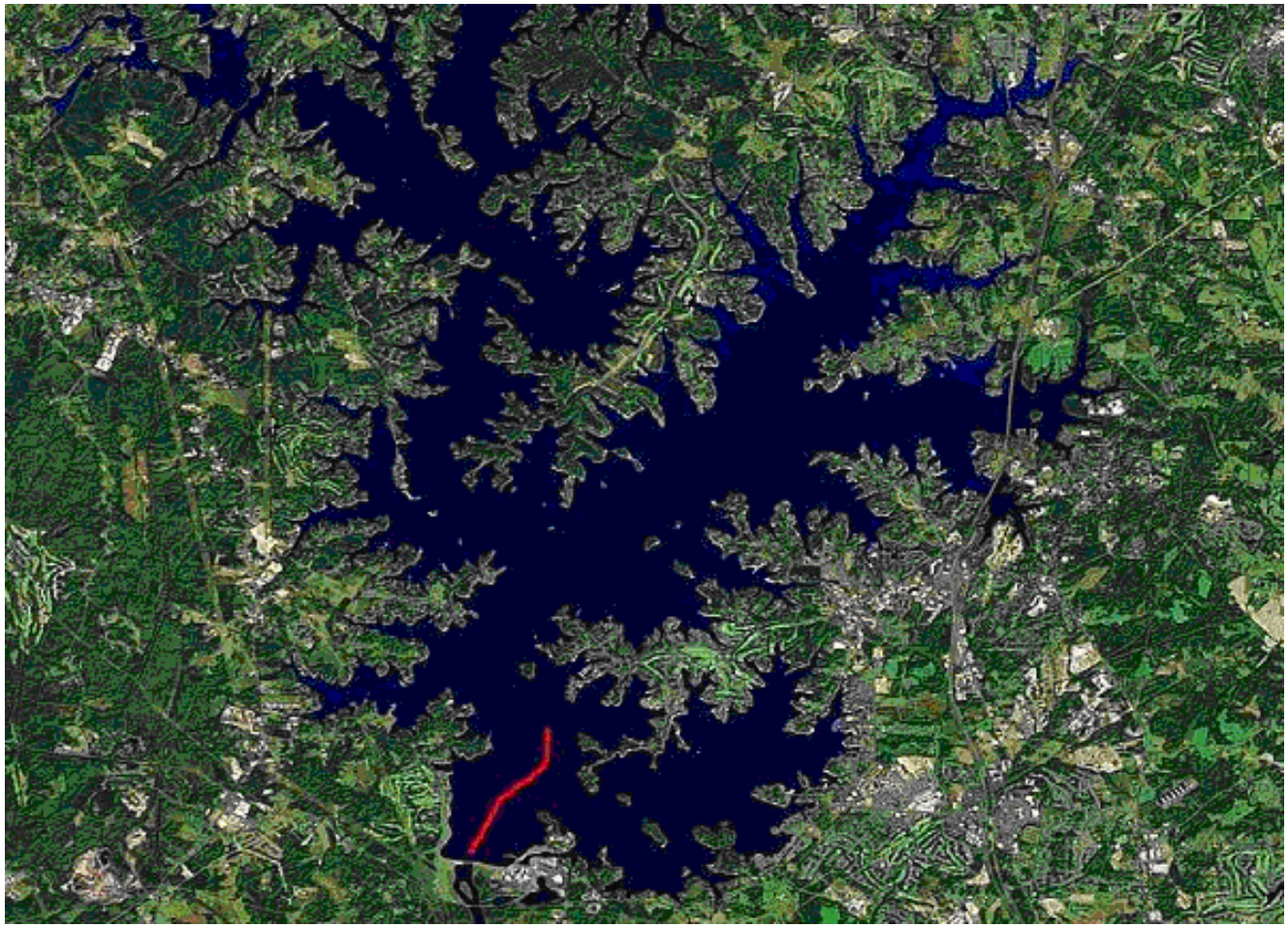
Enclosure 3

Lake Norman DO Profile

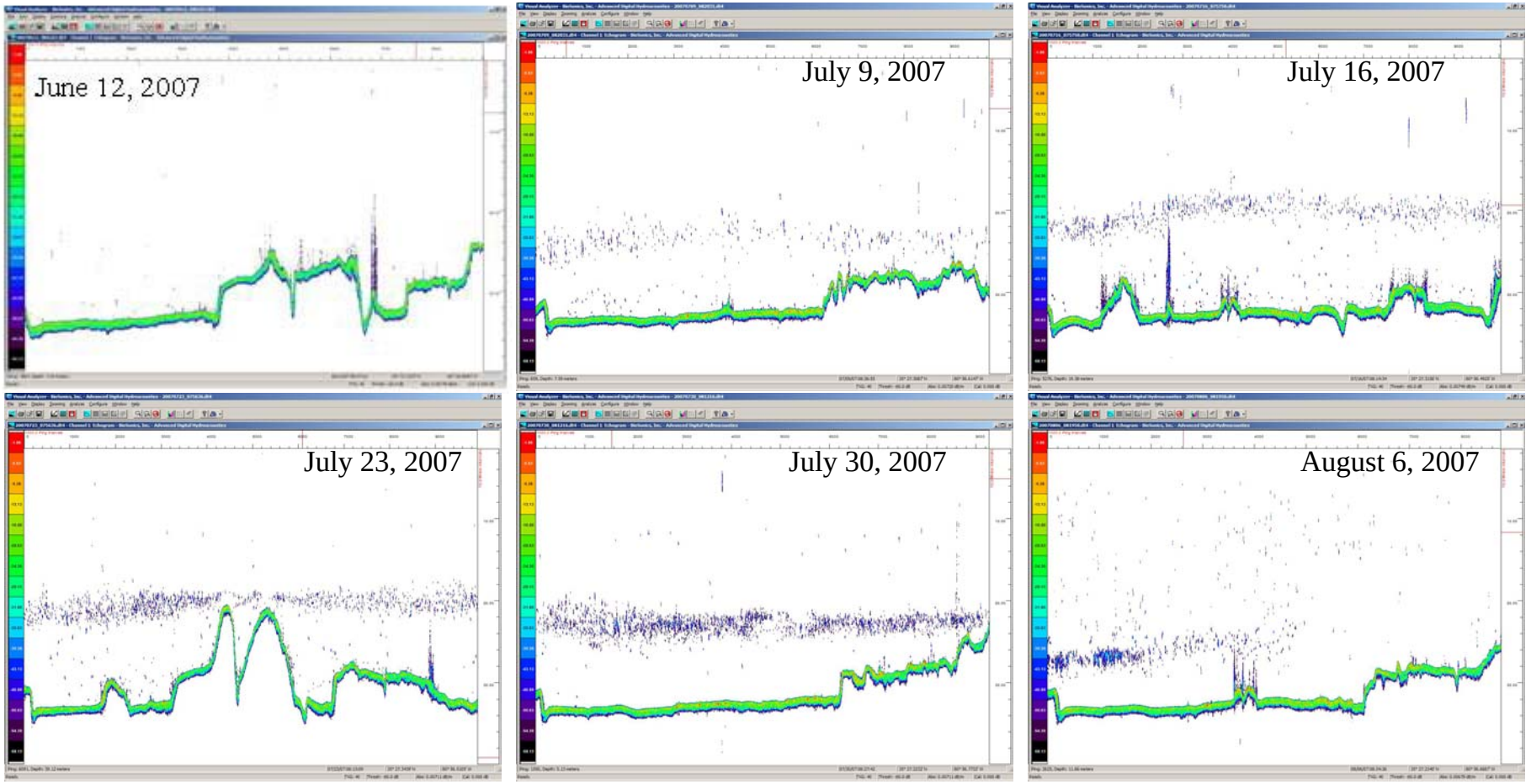


Enclosure 3

Main Channel Echogram Survey Results 2007



Main Channel Echogram Survey Results 2007

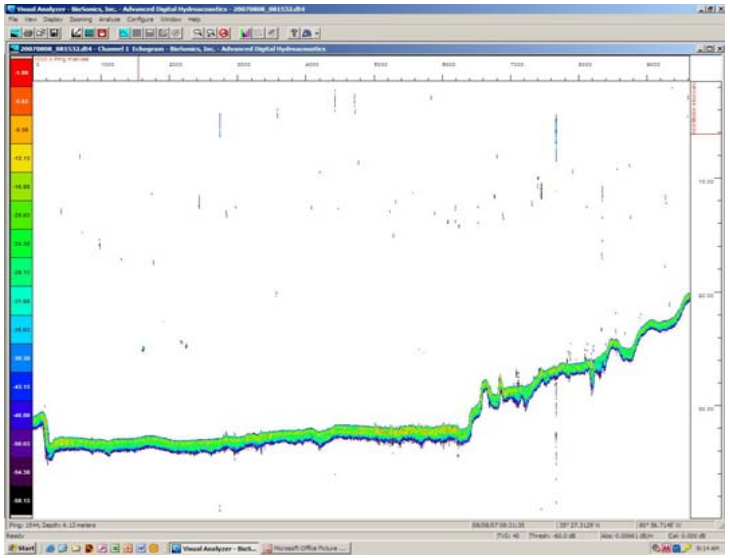


Green Line = Lake Bottom
Blue dots = Acoustic Reflections (fish)

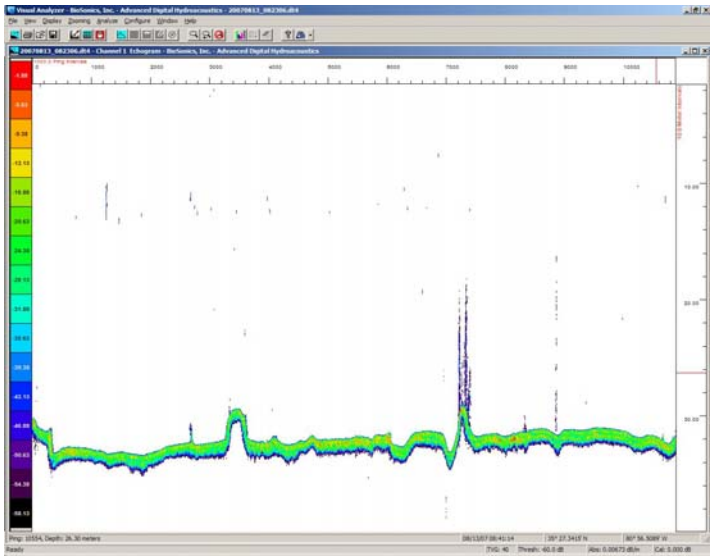
Left side = Cowans Ford Dam / Low Level Intake Structure
Right side = North end of Survey Route

Main Channel Echogram Survey Results 2007

August 8, 2007



August 13, 2007



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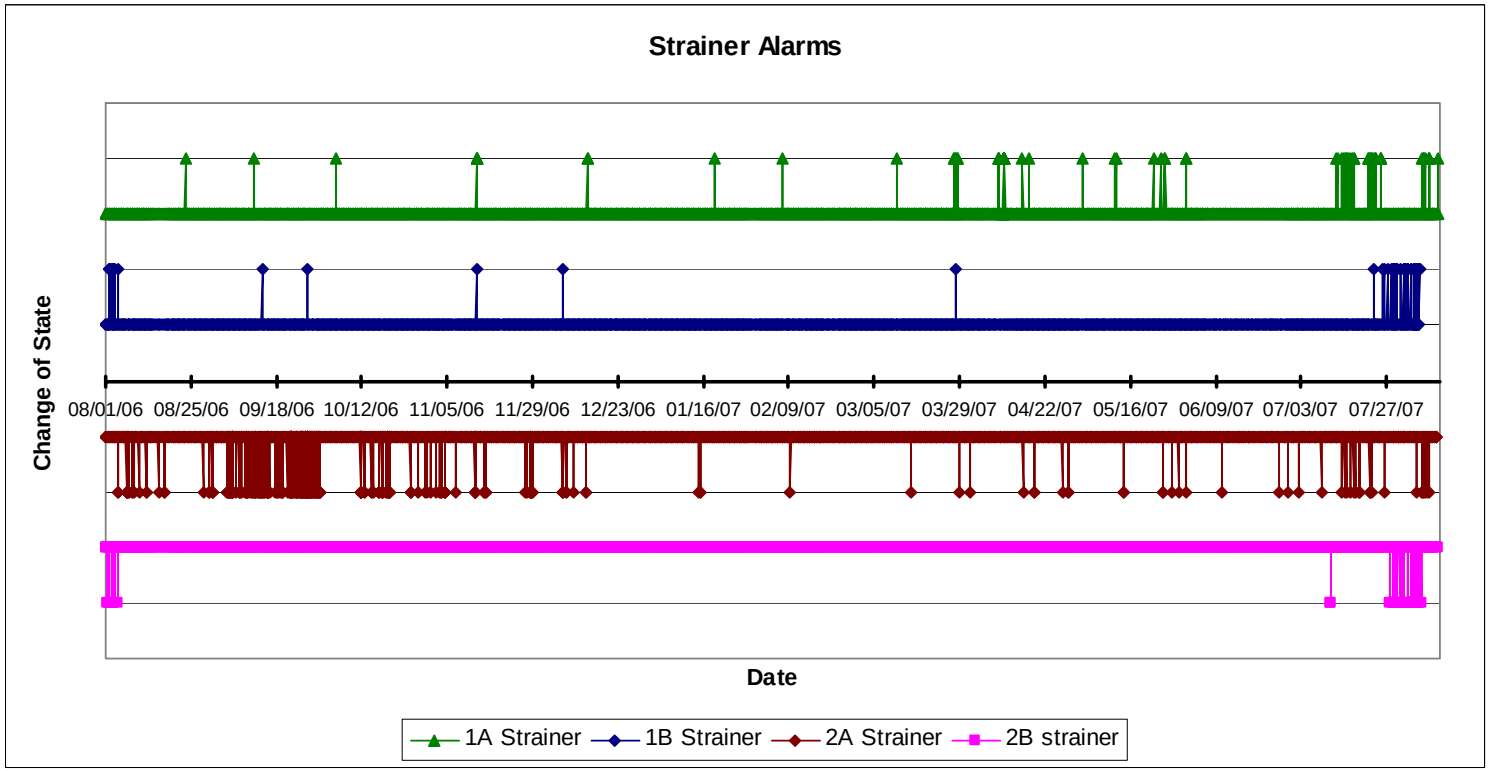
Alewife Conclusion

- Temperature, Dissolved Oxygen, Food Source, Reproduction and Predator Behaviors drive the movement of Alewife

- Period of Vulnerability to Alewife is limited to a couple weeks per year
  - In 2007 that was between the weeks of July 22nd and August 4th

Automatic Strainer Backwash Actuations



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MNS Nuclear Service Water (RN) Strainer

Typical operating pressure is 1.3 psid and the backwash set point is 1.86 psid

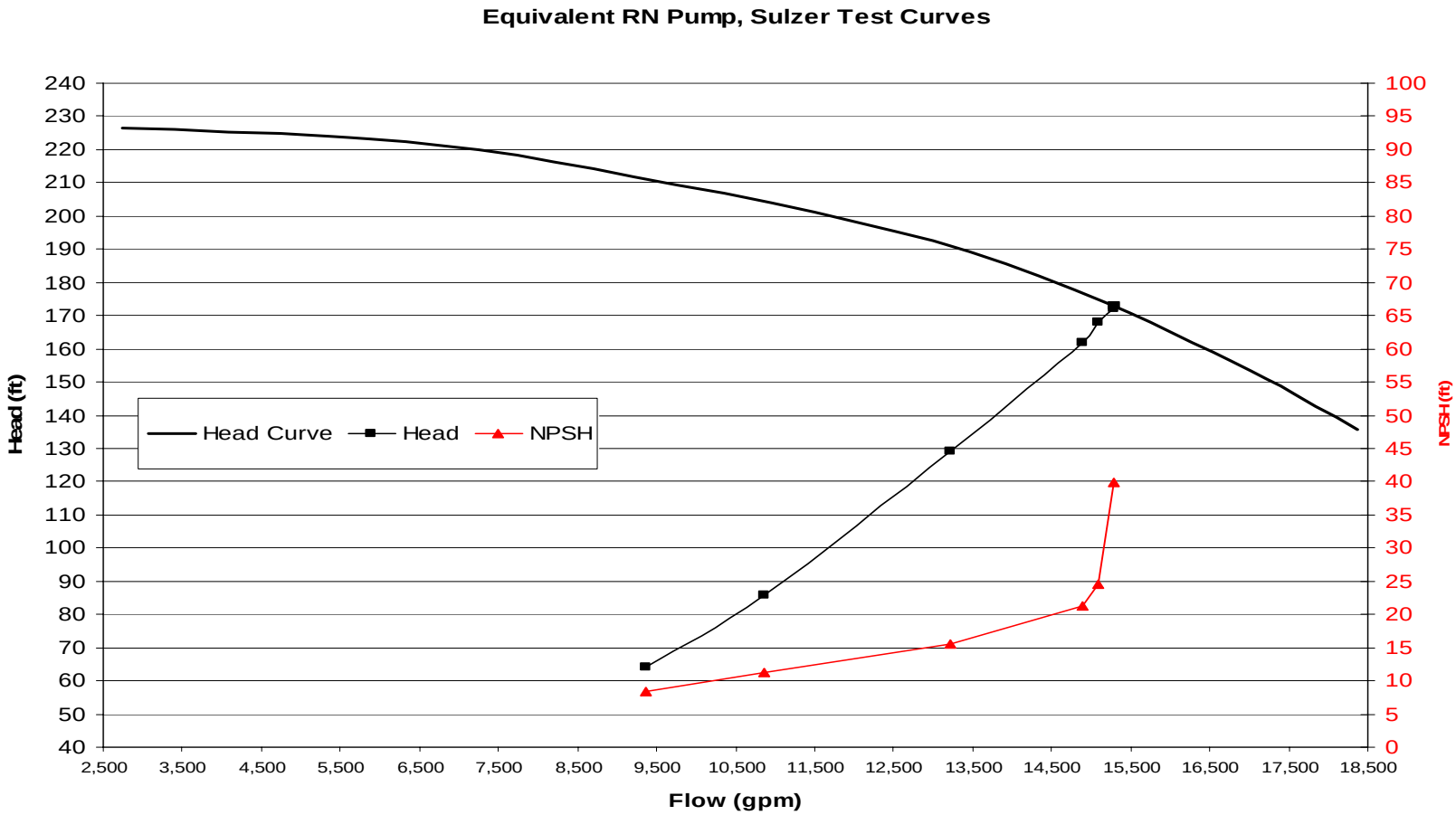
Causes of High DP readings

1. 2A Strainer – partially clogged low pressure tap
2. High Strainer Flow (testing / maintenance)
3. Alewife Fouling of Strainer

Pump Curve Margin

- Duke performed testing of a Nuclear Service Water Pump at Sulzer Pumps in Portland Oregon to better understand pump margins.
- The pump performed with NPSHa as low as 8 feet.
- Results indicate that as strainer differential pressure increases, the pump flow decreases until it “self corrects” to a new flow point.
- Required flow for essential loads is less than 6000 gpm
- Pump would easily deliver the essential loads even with significantly clogged strainers (greater than 10 psid).
- The pumps would not have failed during the low fouling rates observed, and there is a very large conservatism in the SDP assumptions.

RN Pump Testing Results



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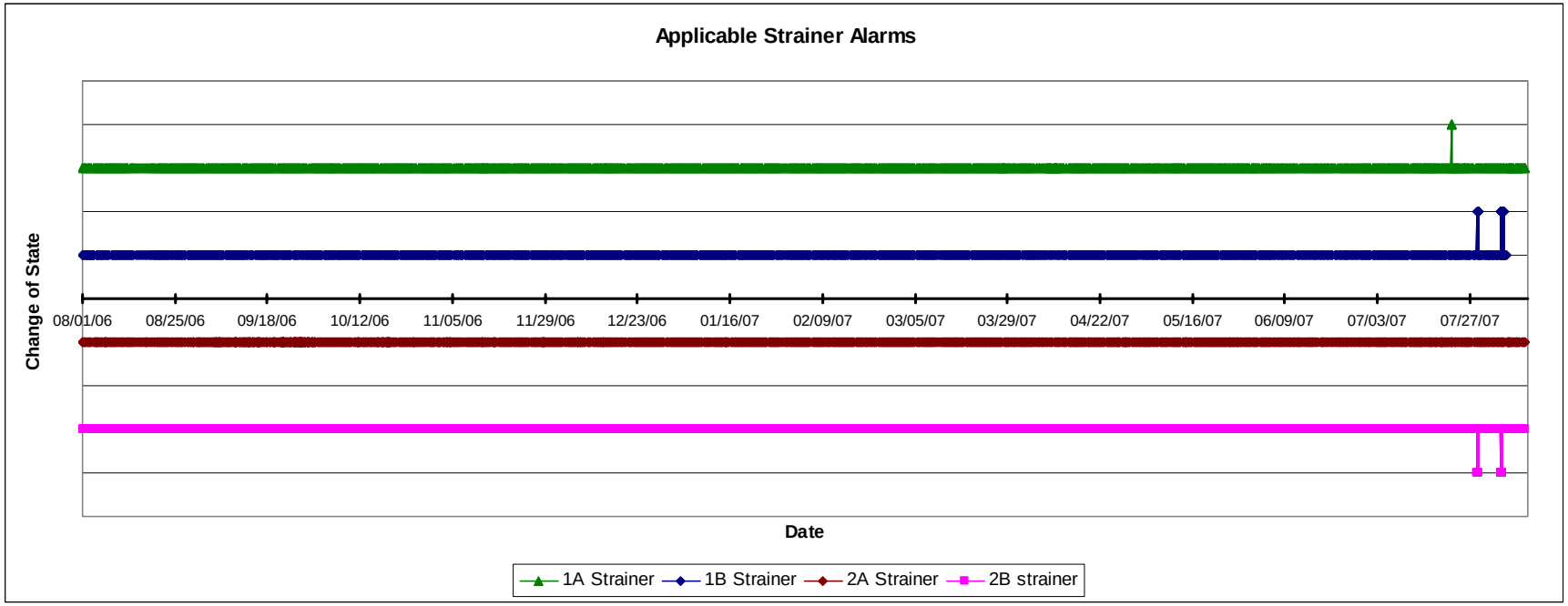
Backwashes Caused by Fouling



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Fouling Periods

- The actual fouling periods associated with alewife were as follows:
  - More than one backwash per hour:
    - Aug 03, 2007 22:29:59 thru
      Aug 04, 2007 09:59:04 (~ 11.5 hrs)
  - Less than one backwash per hour:
    - July 22, 2007 02:33:20 thru 06:36:31 (~ 4 hrs)
    - July 28, 2007 23:48:21 thru
      July 29, 2007 06:52:30 (~ 7 hrs)
    - Aug 04, 2007 12:53:57 thru 18:23:57 (~ 5.5 hrs)

RN Pump failure probability

- Evaluations of pump performance shows a very high probability that the pumps would not fail.
- More than ½ of the exposure period consists of relatively low fouling.
  - Backwashes less than 1 per hour.
  - 6 or less backwashes total on any train.
  - Quick clearing of alarms.
- Conservatively assuming 1 psid added to strainer for each Hi alarm, the strainer would have increased no more than 6 psid.
- Based on flow balance test performed during this period, RN had 42 feet of NPSH available.
- Considering an additional 6 psid strainer dP, there was still 28 feet of NPSH available. NPSH required is 20.5' at this design flow.
- RN pump tests show large margins to failure, even for these conservative assumptions:

28' available > 20.5' required >> 8' demonstrated by testing.

PRA Overview

- Duke and NRC results are consistent with respect to the events of concern:
  - Loss of Instrument Air
  - Initiators with safety injection actuation
- Primary differences
  - Relevant time period is much shorter in Duke analysis
  - RN Pump will continue to provide sufficient flow under observed fouling (50% credit)
  - Loss of Instrument Air Frequency
  - Duke credits additional operator actions under certain scenarios

PRA Overview

- Credited Operator Actions
  - Recovery of RN with the use of the other unit or RV (Containment Ventilation Cooling Water System)
    - We have a calculation that shows sharing of RN between units is acceptable
    - There is procedural guidance to manually clean the RV strainers if needed
  - Use of condensate system for Secondary Side Heat Removal
    - Manual valves have been tested
    - High confidence the check valves will perform as expected
      - Will test the check valves in the next couple days (during the outage)

CDP Comparison

UNIT 1 Description	CDP with NRC Fouling Durations	CDP using NRC methodology with reduced Fouling Durations
Base Case	1.24E-05	5.26E-06
Adjusted LOIA initiator Freq	1.14E-05	4.56E-06
Base LOIA freq, VI HRA hotwell/booster = 0.1	1.04E-05	3.80E-06
Adjusted LOIA Freq VI HRA hotwell/booster = 0.1	1.02E-05	3.66E-06
Adjusted LOIA Freq VI HRA hotwell/booster =0.1 SI LOCA HRA = 0.1	3.19E-06	1.72E-06

UNIT 2 Description	CDP with NRC Fouling Duration	CDP using NRC methodology with reduced Fouling Durations
Base Case	2.20E-05	5.35E-06
Adjusted LOIA initiator Freq	2.05E-05	4.70E-06
Base LOIA freq, VI HRA hotwell/booster = 0.1	1.88E-05	3.98E-06
Adjusted LOIA Freq VI HRA hotwell/booster = 0.1	1.85E-05	3.85E-06
Adjusted LOIA Freq VI HRA hotwell/booster =0.1 SI LOCA HRA = 0.1	5.42E-06	1.68E-6

PRA Conclusions

- The CCDP for this condition is estimated to be approximately 4.7 E-7. The Conditional Large Early Release Probability is non limiting.
- Additional factors not credited in the PRA
  - The event sequences allow time for Steam Generator Depressurization
  - The event sequences allow time to fully staff the Emergency Response Organization

MNS Nuclear Service Water (RN) System

- Actions Taken
  - Modification of Air-Operated backwash valves to allow manual operation (August 2007)
  - Immediate Compensatory Actions to manually backwash strainers (August 2007)
  - The Reactor Trip Emergency Procedure and Loss of Instrument Air Abnormal Procedure were revised to promptly place the “B” train on the SNSW Pond (August 2007)
  - Installed stainless steel fish fence on Low Level Intake. Eliminated Alewife fouling source for Nuclear Service Water System (July 2008)
  - Detailed monitoring by fisheries personnel to understand information relative to DO and lake stratification impact to alewife

MNS Nuclear Service Water (RN) System

- Pending Actions
  - Install Safety Related Strainer differential pressure instrumentation. (12/31/08)
  - Install fail-open actuators on Strainer Backwash inlet valves (on-line modifications- 2009).
  - Replace all four strainers.
    - Procurement of all four in progress
    - One strainer has been received.

MNS Nuclear Service Water (RN) System

- As part of GL 89-13, and SOER 07-02 program for Intake Water Blockage, Duke is committed to managing the intake systems.
- Monitor macro-foulant sources; environmental and fisheries programs to periodically assess Lake Norman and Standby Nuclear Service Water Pond conditions.
- Periodic inspections of the Low Level Intake Fence.

MNS Nuclear Service Water (RN) Strainer

RN Design Basis Review Project

- Research and update the UFSAR and DBD for the RN System strainer functions.

- Roadmap of primary RN System functions to determine if there are other vulnerabilities.

MNS Nuclear Service Water (RN) Strainer

- Design and Licensing Basis Training
  - An ongoing series of training sessions aimed to improve design and licensing basis knowledge has been in place since 2006.
- Programmatic and Culture Changes Related to the Corrective Action Program (CAP)
  - Increase the accountability for CAP by including health reviews as part of the CA Review Board charter
  - Improved monitoring of important corrective actions by establishing new priority code for significant actions
  - Continuing to focus on identifying organizational issues during causal analyses

Closing Remarks

- Duke clearly recognizes the vital safety function performed by the RN Strainers and the RN System as our Ultimate Heat Sink.
- The conditions resulting in this finding do not meet Duke expectations. Improvements have been made and will continue to be made with the system and design basis.
- The evaluation of Alewife behavior by fisheries science and acoustic surveys has shown that the exposure period was very small and predictable.
- The RN system is robust, such that the pump(s) would not have failed and the strainer would have continued to perform its function.
- Duke has enhanced its corrective action program

Closing Remarks

- Duke understands the significance of the violation, the design basis / licensing basis issues, and the corrective action program missed opportunities

- We understand and accept the apparent violation

- With all the information provided regarding the RN system performance and the alewife behavior, it is Duke's belief, that this event was of a very low safety significance.