

Markland and Greenup Gate Failures

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Markland Miter Gate Failure

27 September 2010

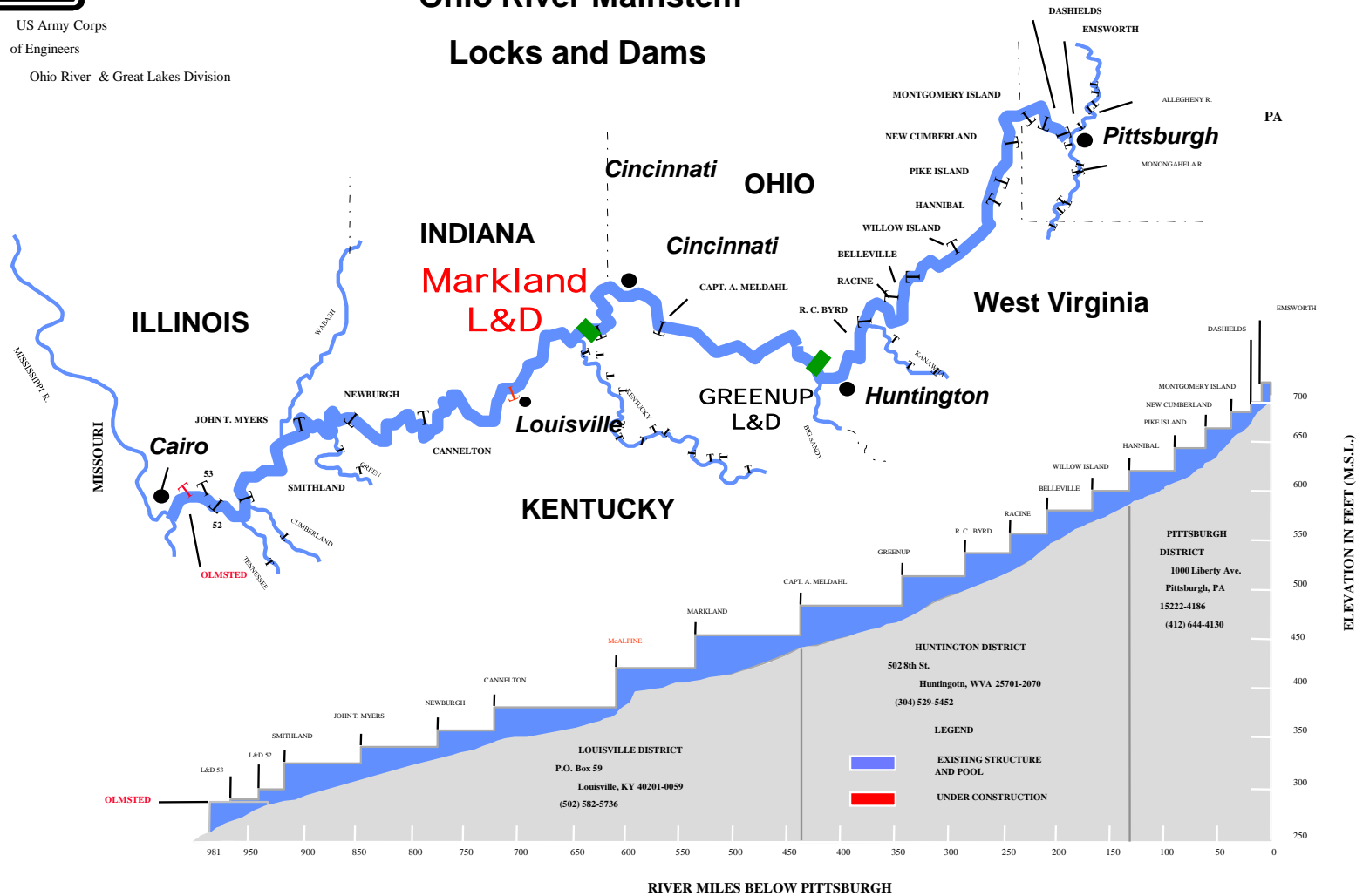


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US Army Corps
of Engineers
Ohio River & Great Lakes Division

Ohio River Mainstem Locks and Dams





Markland Gate Failure Chain of Events

Markland Gate Failure_0001.wmv



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Damage



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Response

- LRL Operations and Engineering determined the MW leaf was stable
- At 2030 on 27 September 2009 opening the auxiliary chamber to traffic.
- Ohio River reopens to traffic at Markland L/D.



Recovery and Repair

- New miter gate leaf contract is accelerated to a mid-March 2010 delivery.
- Helper boat contract is awarded.
- Corps contracts salvor to move RW miter gate leaf.
- Lifted MW leaf on 19 October and placed on the DeLong barge.



Recovery and Repair



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Recovery and Repair



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Recovery and Repair

- Fleet returns to Louisville to repair gate leaves on 13 November.
- Completed gate leaf repair 12 January 2010.
- Installation of repaired leaves was river dependent - the chamber had to be dewatered.



Repairs



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Path Forward

- Solenoids at projects checked.
 - ▶ Older units have been replaced.
- Operation of interlock systems checked.
 - ▶ Developing plans to enhance the interlocks.
- Reviewed lockage procedures with all lock operators
 - ▶ IMTS Training program being developed
- Install new main chamber gates - CY2011
 - ▶ 1st set delivered March, 2nd set due in July



System-Wide Recommendations

- Continue FEM implementation
- Maintenance interval and inspection procedure for solenoids and indicators
- Add “valve to gate” interlock
- Inspect/Improve control ergonomics
- Standardize lock operating procedures, training and certification



System-Wide Recommendations

- Increase public/customer awareness to report any unusual conditions during lockages
- Develop a system wide failure mode and effects analysis (FMEA)
- Develop a written checklist for each lock operation



Greenup Miter Gate Anchorage Failure

27 January 2010



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Miter Gate Anchorage Failure

27 Jan 2:16pm



Looking downstream – toe of gate dropped 1.2 ft



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Miter Gate Anchorage Failure

27 Jan 1416 hours



Broken Anchorage Arm



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Tow in Main Chamber – 3 Days

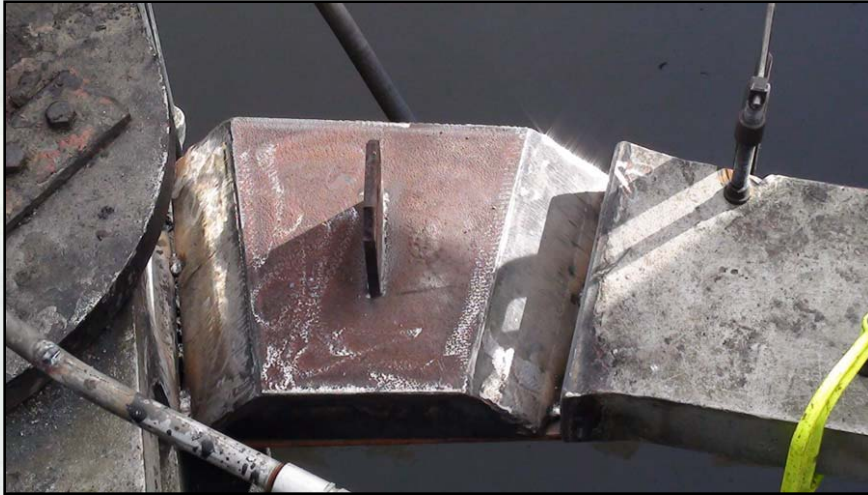


Could not remove till the miter gate was stabilized



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Initial Stabilization Efforts



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Removal of Tow

30 Jan 2010



Helper boat removing individual barges



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Additional Stabilization Efforts



Support anchor for anchorage bar that did not fail



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Additional Stabilization Efforts



River rising – up to 1 ft per hour



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Conditions Less Than Optimum



Snow, ice, wind and 8 degrees



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Connection of Lifting Beam

11 Feb 2010



Gate Lifter “Shreve” arrived from
Louisville District on 6 Feb



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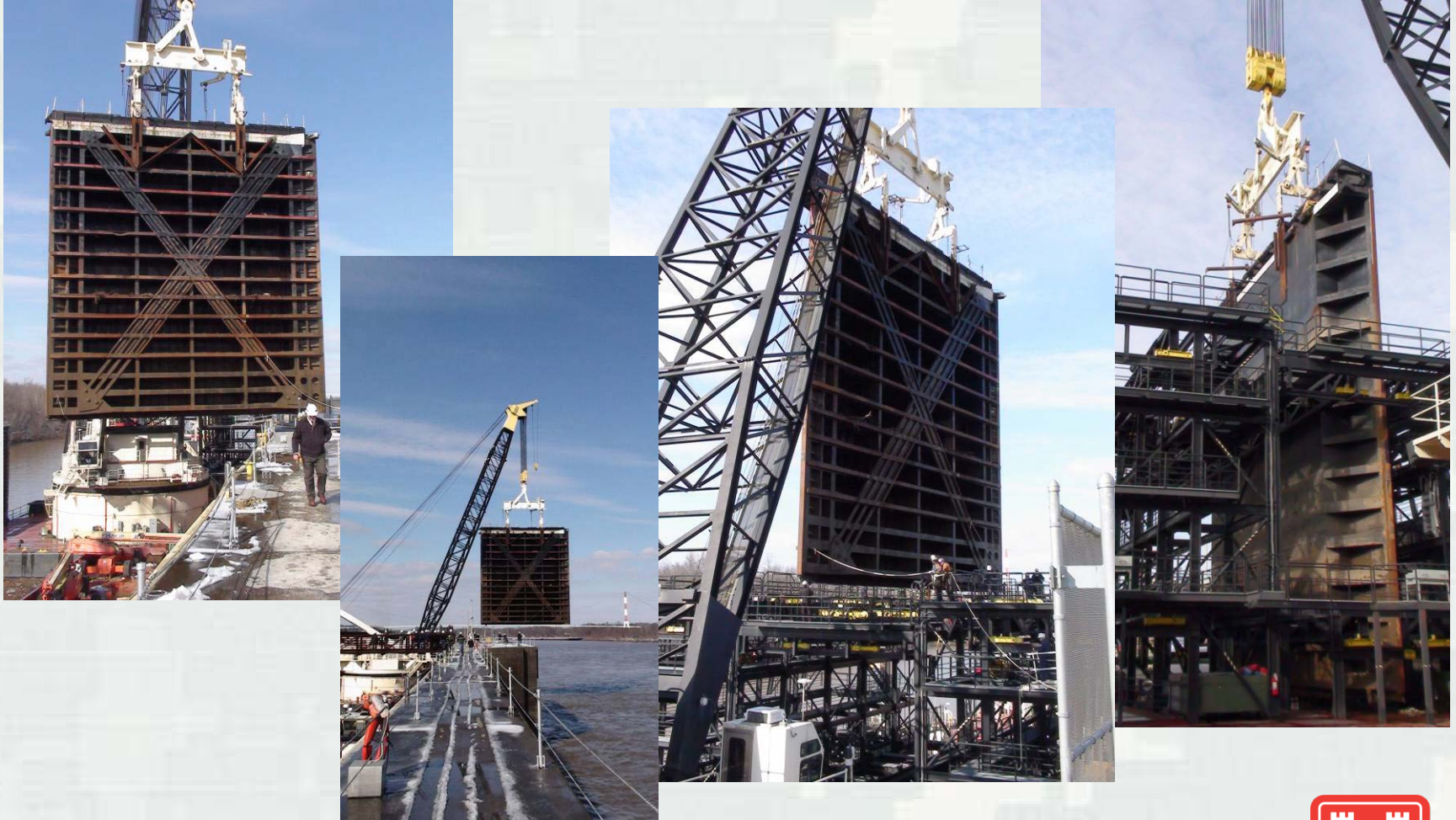
Lifting of Miter Gate

12 Feb 2010



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Lifting of Miter Gate



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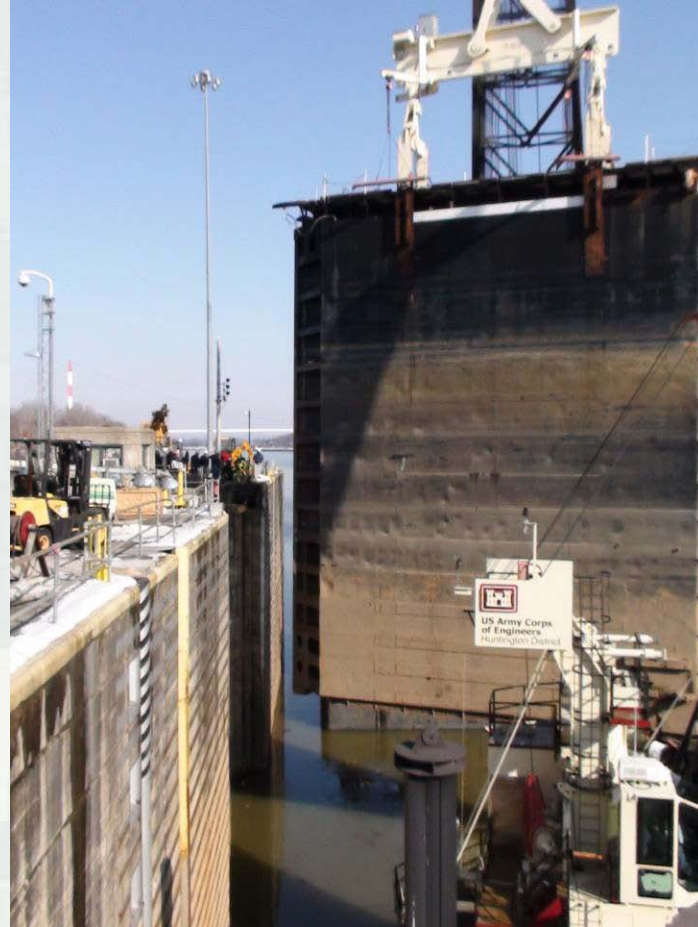
Minimal Damage to Miter Gate



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Reinstalling Miter Gate

19 - 22 Feb 2010



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Reinstalling Miter Gate

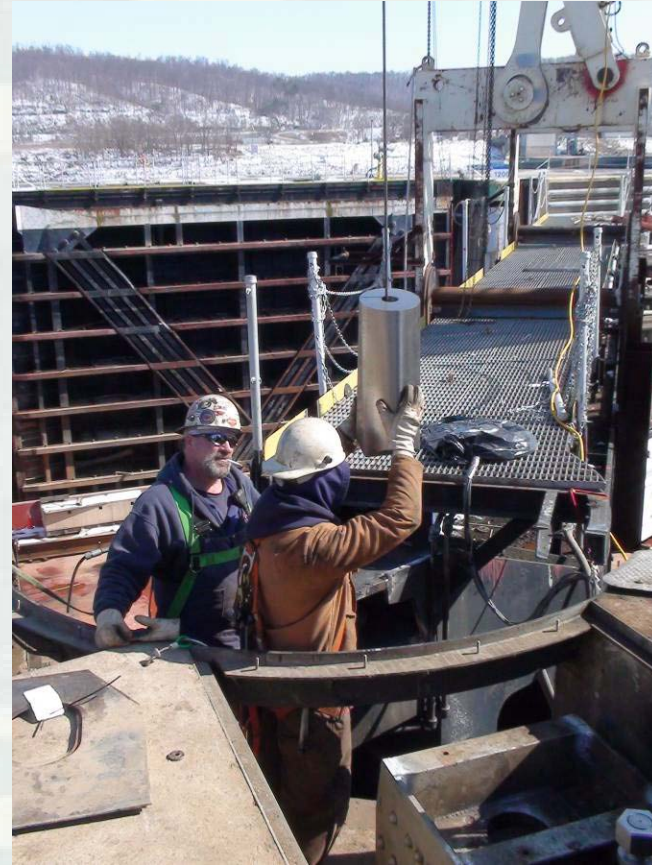


Final alignment and dive inspection



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Reinstalling Miter Gate



Replacing anchorage arms, links and pins



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Reinstalling Miter Gate



A final tap!



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Main Lock Back in Operation

22 Feb 2010, 7:40 pm



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Navigation During the Outage

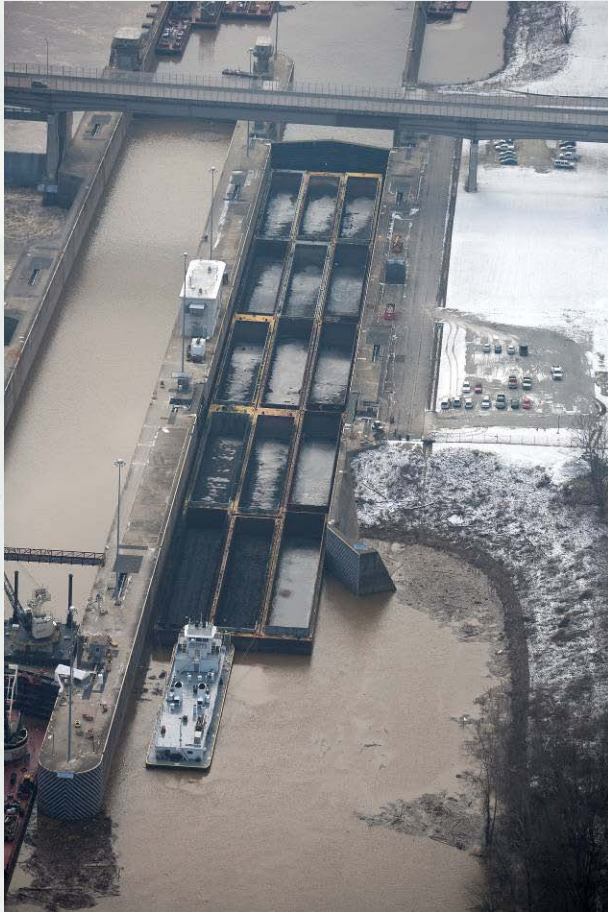


Immediate assignment of industry POC Richard Kern
and helper boat – Q management and prioritization



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Navigation During the Outage



Delay initially 59 hours and
leveled off at 36 hours



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Path Forward

- Dewater every 3 years
 - ▶ May cut to every 2 years
- Procure main chamber miter gates
 - ▶ Contract for one set awarded Sep 09
 - ▶ Contract for second set in FY11
- Greenup Major Rehab Report FY11/12

