Public Meeting

Robert A. Young Federal Building,
St. Louis, Missouri

Alton to Gale Organized Levee Districts, Illinois and Missouri (Continuing, Deficiency Corrections) Letter Report

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US Army Corps of Engineers
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Project Background

- The Alton to Gale Levee System began as numerous private small levees built during the depression years.

- During the 1940's and 1950's the Government created the combined system by raising existing levees and building new levees within the newly established levee districts (17 levee districts make up the Alton to Gale Levee System within Illinois and Missouri).

- All levees have heights ranging between 20 and 25 feet, a crown width of 20 feet and side slopes of 1 vertical on 3 horizontal.

- Locally available materials were used for construction, which include highly plastic clays.

Project Background (Continued)

- Shortly after construction was completed, certain portions of the levee system began experiencing levee slides. The U.S. Army Corps of Engineers began keeping an inventory of the slides that occurred starting in 1961. Data is not available for years prior to 1961, although it is known that slides did occur prior to that date.

- In 1979 and 1986, the St. Louis District submitted a Letter Report to USACE HQ requesting authority to repair levee slides with in the levee districts of the Alton to Gale System. 100% federal funds (construction general funds) were provided. The slides were repaired using a lime stabilization method. Additional CG funds were also provided in 2000 to repair existing slides.

- After flood events, PL84-99 funds have also been utilized to repair levee slides.

- The approach of repairing levee slides after they occur is only a short term solution, as levee slides continue to occur in the deficient levee sections. In addition, it does not address the vulnerability of continuous and impending levee slide failures prior to and during flood events.

Report Scope

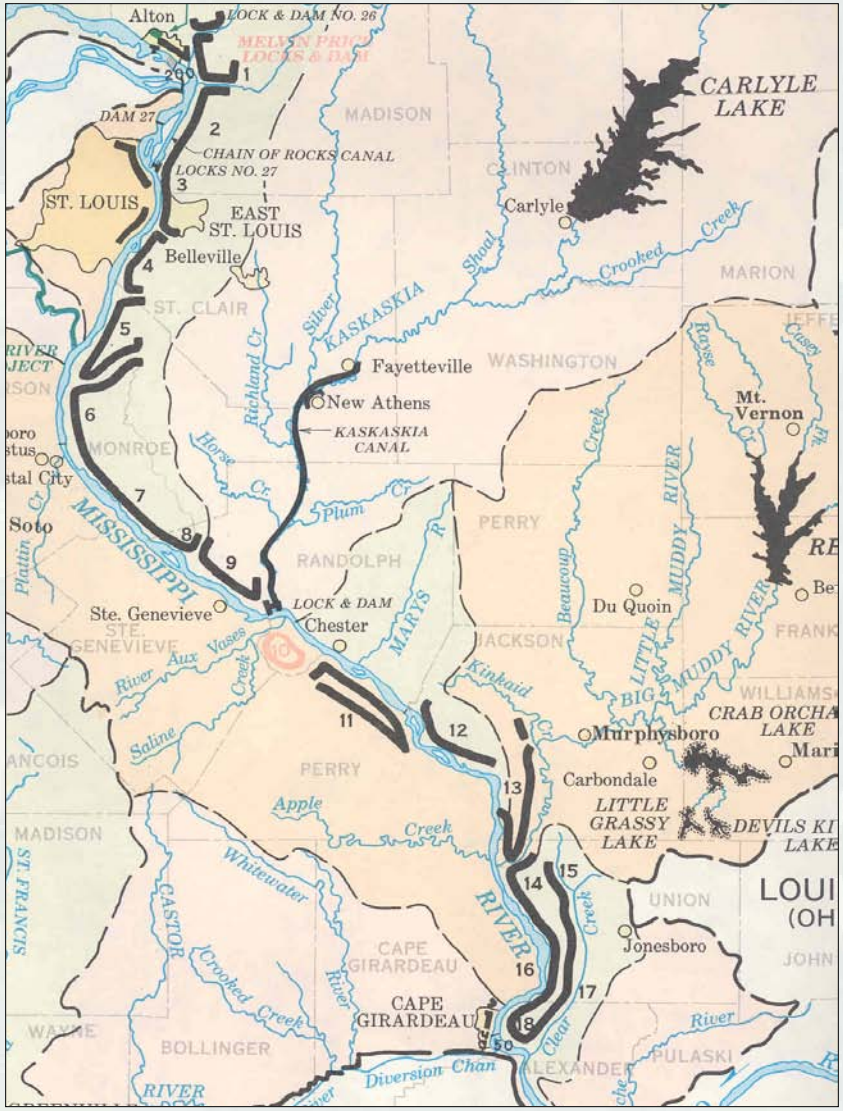
- The Assistant Secretary of the Army (Civil Works) requested USACE to further address the Alton to Gale design deficiency associated with the levee slides and determine a long term solution for the levee system.

- After reviewing the history of levee slides experienced by the seventeen levee districts in the Alton to Gale levee system, this report addresses the specific design deficiency found within portions of eleven of the levee districts.

- The report recommends a long term solution utilizing existing authorizations. Four alternative solutions are identified in the report and will be discussed in additional slides.

- Public safety is the Corp's number one priority. All alternatives will be fully evaluated prior to report being finalized to ensure the recommended plan takes into account public safety as well as costs.

Project Location Map & Typical slide pictures



Description of Design Deficiency

- In the areas where the highly plastic clays were utilized, these areas present a slope stability concern since the 1 on 3 slopes are too steep for the low residual strengths of the highly plastic clays.

- The instability problems are compounded with the high plasticity clay materials, since these clays will undergo extreme volume changes which are referred to as high shrink and swell potential characteristics.

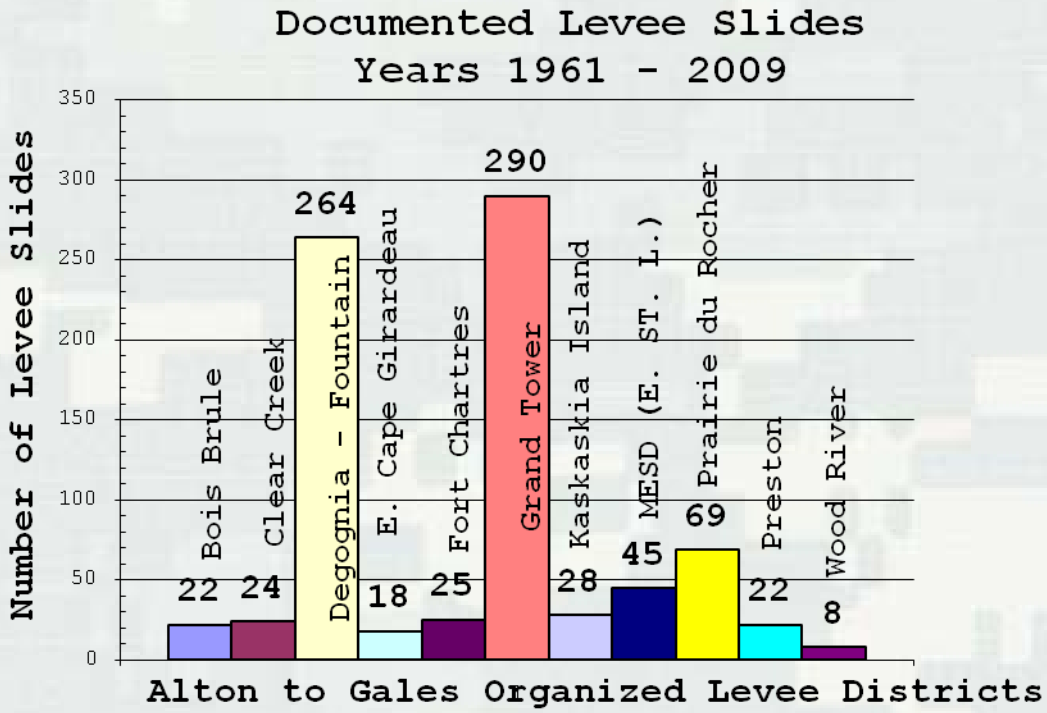
- During hot dry periods, large deep cracks develop in the embankment. Precipitation flows into the large deep cracks and pools within the cracks while the water is absorbed.

Description of Design Deficiency (cont'd)

- The Soils near the bottom of the embankment become saturated and loose their shear strengths.
- As the clay soils in the upper portions of the embankment absorb water and gain weight, the clays at and near the bottom of the embankment lose a considerable amount of shear strength.
- When the embankment weight exceeds the underlying shear strengths, excessive embankment movement occurs (i.e. Levee slides)
- The levee section is no longer stable, lacking integrity and the ability to resist the water pressures present during a flood.

Inventory of Slides

- An inventory has been maintained of all slides that have been repaired by the Federal Government since the year 1961. The recorded slides have occurred within the same reaches due to the inappropriate high plasticity clay soils used during the levee construction.



Levee Reaches With Reoccurring Slides

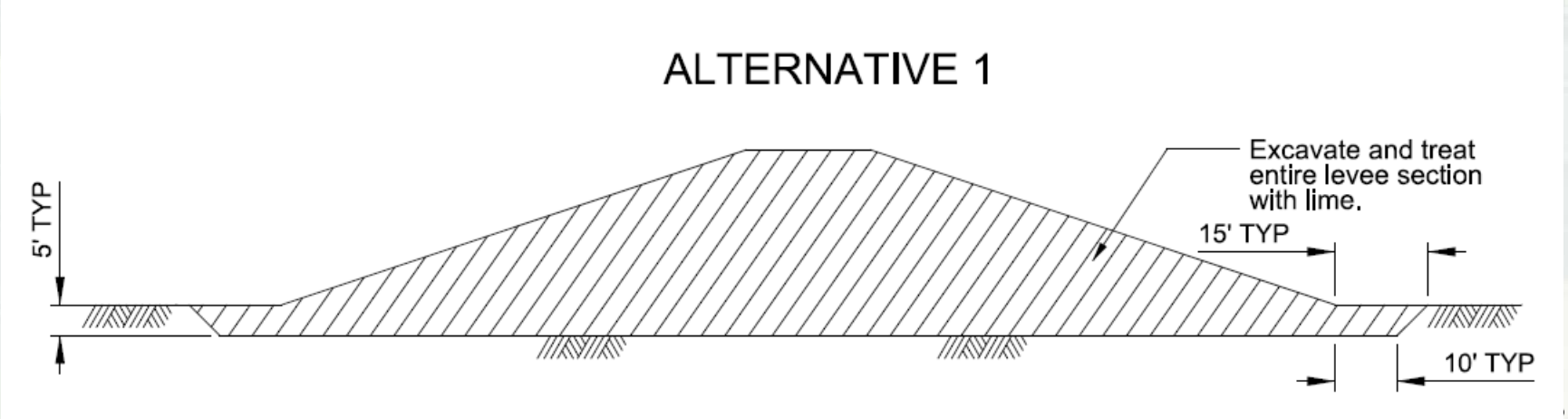
- From yearly inspections, repairs, and slide inventory, specific portions of 11 of the levee districts have been identified as exhibiting the design deficiency. The below table identifies the length of levee within each district that inappropriate soil was utilized in the original construction.

Alton to Gale Levee Districts	**Repair Length (miles)**
Bois Brule D&LD	0.66
Clear Creek D&LD	2.14
Degognia/Fountain Bluff D&LD	4.05
East Cape Girardeau D&LD	0.95
Fort Chartres D&LD	0.57
Grand Tower D&LD	7.33
Kaskaskia Island L&D	1.44
MESD (E. St Louis D&LD)	2.65
Prairie du Rocher D&LD	3.64
Preston D&LD	0.47
Wood River D&LD	0.38
Total	24.28 miles

Alternatives measures identified for long term fix

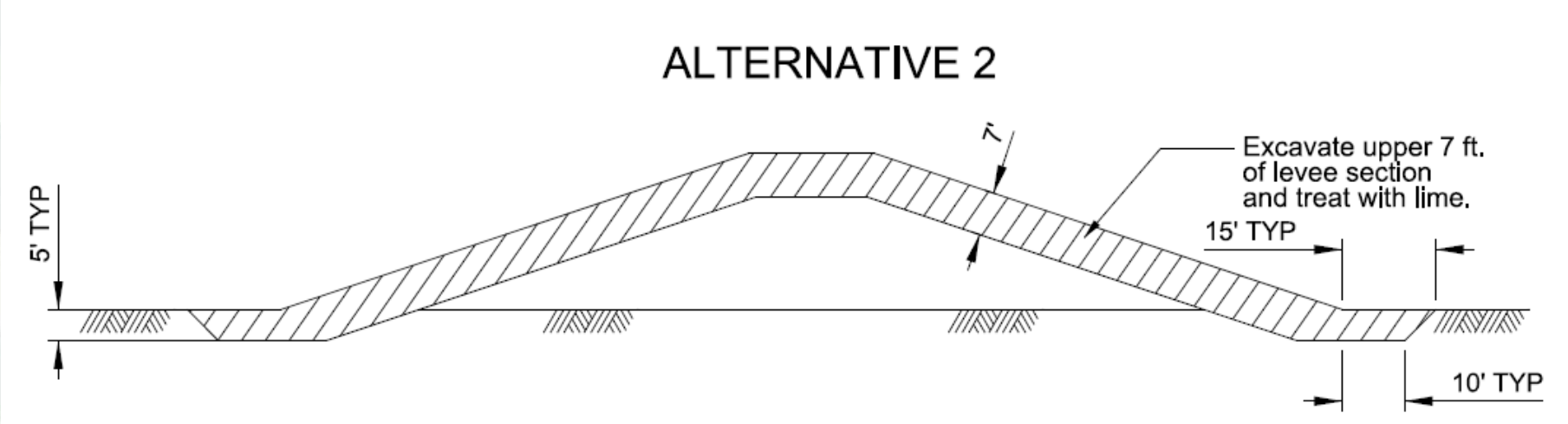
- There are four alternative plans for repairing levee reaches experiencing excessive slope failures that were considered. These are the only feasible alternatives identified that would ensure the authorized level of protection has a sufficient factor of safety. Anything less than a factor of safety of 1.4 was considered unacceptable.

- **Alternative #1:** Degrade the affected levee reach by excavating the entire levee embankment material down to natural ground, modify the soils by mixing in a hydrated lime, backfilling these modified materials, and compacting the fill in place.



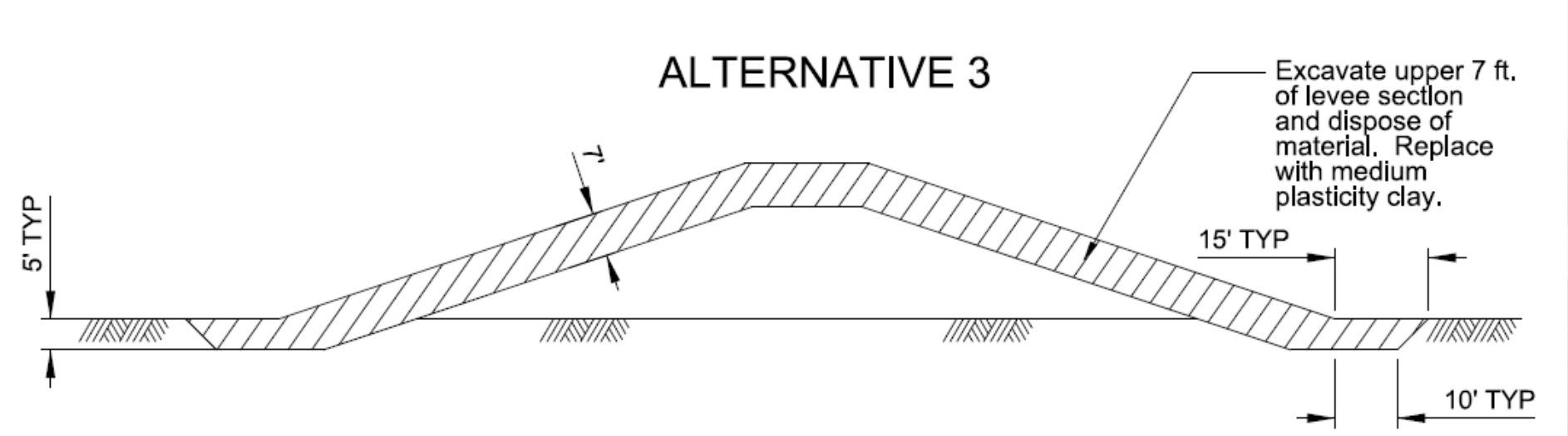
Alternatives measures identified for long term fix

- **<u>Alternative #2:</u>** Excavate the upper levee embankment materials down a minimum of seven feet, modify plasticity of the soils by mixing in a hydrated lime, backfilling these modified materials, and compacting the fill in place. The hydrated lime in the first two alternatives would be added in a ratio of 16 pounds of lime per square yard for each ten inch lift. The process consists of two applications of the hydrated lime mixture.



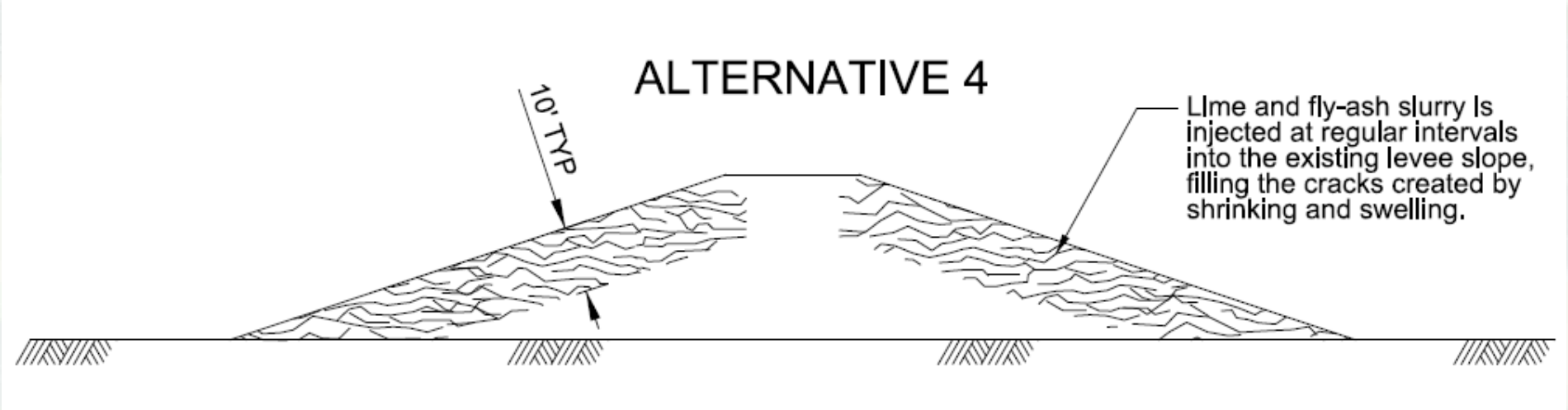
Alternatives measures identified for long term fix

- **<u>Alternative #3:</u>** Remove and discard the upper levee embankment materials down a minimum of seven feet, replace the high plasticity clays with suitable borrow material consisting of clays with better material characteristics and compacting the fill in place.



Alternatives measures identified for long term fix

- **<u>Alternative #4:</u>** Involves the use of injection of a lime/fly-ash slurry into the levee side slope using a series of injector rods on a track mounted vehicle. Injection typically begins at 12 to 18 inches from the surface and proceeds downward at depth increments of approximately 12 to 18 inches. When lime/fly-ash slurry is injected into expansive clays, it fills the cracks that form as a result of shrinking and swelling. A chemical reaction takes place between the calcium hydroxide (lime) and the silica and alumina naturally occurring in the clay. These are stabilizing compounds that result in increased shear strength in the weakness planes.



Details regarding Lime/Fly Ash Injection

- USACE Memphis District has utilized the lime/fly ash injection technique on similar projects since 1995. Since then, they have performed 14 projects and treated approx 17 miles on the Mississippi River and Tributaries (MR&T) projects.

- Lime and Class C fly ash are the construction materials for the recommended plan. These materials will need to meet the requirements of ASTM C 593 (Fly Ash and Other Pozzolans for Use with Lime) and ASTM C 977 (Quicklime and Hydrated Lime for Soil Stabilization)

- Class C Fly ash is produced from the burning of younger lignite or sub bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time.

Details regarding Lime/Fly Ash Injection (cont'd)

- The lime/fly ash injection process utilizes injector rods that have tips capable of dispersing slurry in a 360-degree pattern. In addition, the injections shall be in two sequences with a 48 hour cure time between the two applications. The first application has injections every 5 feet. The second application uses injections in between the first injections to ensure all cracks are filled.

- The use of the lime and fly ash in the grout injection process places the lime-ash mixture well inside the levee structure and is not an "exposed' utilization of the ash. The lime and ash grout undergo a chemical solidification/stabilization reaction

Draft Recommended Plan

- Based on the Economic Analysis that was completed, Alternative 4 (lime/ fly ash injection) is the current recommended plan.
- However, the report is still in draft format and all comments from the public and the Independent External Peer Review will be incorporated prior to the report being finalized.
- Although overall project cost is a factor in determining the recommended plan, we will not compromise safety to lower costs.
- It is the policy of USACE that all of its technical, engineering and scientific work will undergo an open, dynamic, and rigorous review process.
- Based on the public concerns received regarding the usage of fly ash, additional technical, scientific and engineering sources both internal and external to the Corps are being consulted to ensure public safety concerns are adequately addressed.

Current Status of Report and Way Ahead

- The draft letter report was reviewed by Agency Technical Review (ATR) in Feb/Mar this year. The ATR was composed of technical experts within the Corps of Engineers but outside of the Mississippi Valley Division. Comments were incorporated into the report.

- The draft Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) were distributed for public review in May for a 30 day review period. Comments have been received and are being incorporated as required.

- The draft report is currently being reviewed by an Independent External Peer Review (IEPR) team. The review is underway and comments are due to USACE in August this year.

- Once the current reviews are complete and the documents have been revised, the EA will be posted for public review again and another public meeting will be held prior to final report submission.

- The ASA-CW has final approval authority on this letter report.

A copy of this presentation can be accessed at:

www.mvs.usace.army.mil