U. S. ARMY CORPS OF ENGINEERS LOUISVILLE DISTRICT

2016 LEVEE SAFETY MEETING

"SHARED RISKS, SHARED SOLUTIONS"

Sheraton Louisville Riverside Hotel,
Jeffersonville, IN

9-10 February 2016

AGENDA

Tuesday 9 February 2016

9:00 to 9:15	Opening Remarks - Day 1	Colonel Christopher Beck, P.E., Commander, Louisville District
9:15 to 10:15	Overview of the Levee Safety Program	Eric Halpin, P.E., HQ Assistant to Dam and Levee Safety
10:30 to 11:00	Presentation by Risk Cadre - Levee Risk Assessments	Greg Werncke, P.E., Senior Technical Advisor, Risk Management Center (RMC)
11:00 to 11:45	Understanding the Preservation of Large Diameter Gravity Pipes with Structural Epoxy - Spray-In-Place-Pipe Liner (SIPP)	Danny Warren, Warren Environmental Inc., A&W Maintenance Inc.
11:45 to 12:15	Interim Policy on Inspection	Matthew Whelan, P.E. - Levee Safety Area Representative (LSAR) Upper Wabash
1:15 to 1:45	Abandoning/Sealing/Removing Obsolete Project Components	Ross Wright, P.E. Levee Safety Area Representative (LSAR) Lower Ohio and Green Rivers
1:45 to 2:15	Controlling Water with Water - Dam-It Dams	Brian Francis, Dam-It Dams Product Specialist
2:15 to 2:45	Public Alerts and Warnings: What really matters?	Will Lehman, Economist at Hydrologic Engineering Center (HEC)
3:00 to 3:30	Installation and Inspection of Reinforced Concrete Pipes (RCP)	Trygve Hoff, American Concrete Pipe Association (ACPA) Region Engineer that serves KY, OH, & IN
3:30 to 4:30	Levee Safety Areas (LSA) - Levee sponsors will provide short discussions on lessons learned on their projects. For example - issues with gate replacements; rebuild of pumps, mowing techniques, etc.	Levee Safety Area Representatives (LSARs) - Alvey, Inspector; Bryan, PE; Lasoski, PE; Wright, PE; Whelan, PE.
7:30 to 8:00	**Presentation: Silver Jackets Overview**	Brandon Brummett, P.E., PMP - Louisville District Outreach Coordinator

"Life Safety is Paramount"

v 4.0

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Wednesday 10 February 2016

8:30 to 8:45	Opening Remarks - Day 2	John Bock, P.E., Chief, Engineering Division and Levee Safety Officer (LSO)
8:45 to 9:15	Painting and Repainting Waterfront Steel Structures	Mark Jelinek, Sherwin Williams
9:15 to 9:45	Programs and Project Management Studies	Amy Babey, PMP, Chief of Plan Formulation Section
9:45 to 10:15	Discuss Silver Jackets Study for Metro Louisville Emergency Preparedness Plan (EPP)	Nathan Bryan, P.E., Levee Safety, Geotechnical Engineer
10:30 to 11:00	Cannelton Relief Well Project	Rick Hockett, PG, Risk Cadre, Geologist
11:00 to 11:30	Overtopping Leading to Levee Breaches	Terry Sullivan, P.E., Geotechnical/Geology Branch Chief, Eastern Division, Risk Management Center, Institute of Water Resources
11:30 to 12:30	USACE Assistance During Emergency Operations	Don Walker, Emergency Operations Manager, Emergency Operations Center (EOC) Louisville District
1:30 to 2:00	Western Excelsior - Current Work on New Orleans Levee Systems	Lee Pierce, Western Excelsior
2:00 to 2:30	Mechanical Solutions to Pump Station & Levee Components	Mark Robertson, P.E., Regional Technical Specialist (RTS) Mechanical Engineer LRL
2:30 to 3:00	H&H Presentation on Revised Wabash River Discharges and Potential Impacts to Levee Sponsors Maintaining Levees Along the Wabash River; & Potential Update Study to Ohio River Discharges - Study.	Richard Pruitt, P.E., Chief of Hydrology & Hydraulics Section

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Painting and Repainting Waterfront Steel Structures

21 January 2016

Protective & Marine Coatings

Learning Objectives

- Explain why we paint waterfront steel structures
- Describe the value of the various surface preparation methods
- Identify typical waterfront coatings based on
  - UFGS 09 97 02 Painting Hydraulic Structures
  - UFGS 09 97 13.26 Coating of Steel Waterfront Structures (April 2006)*

Waterfront Protective Coatings

- Solution Vinyl (impact immersion only)
- Coal Tar Polyamide Epoxy (C-200a)
- Flake-filled Amine Cured Epoxy
- Surface Tolerant Polyamide Epoxy
- Surface Tolerant Amine Cured Epoxy
- Moisture Cured Urethane (MCU)
- Aliphatic Polyurethane Topcoats

DO NOT
ENTER

ROAD
CROSSING
GATE

Corrosion Prevention

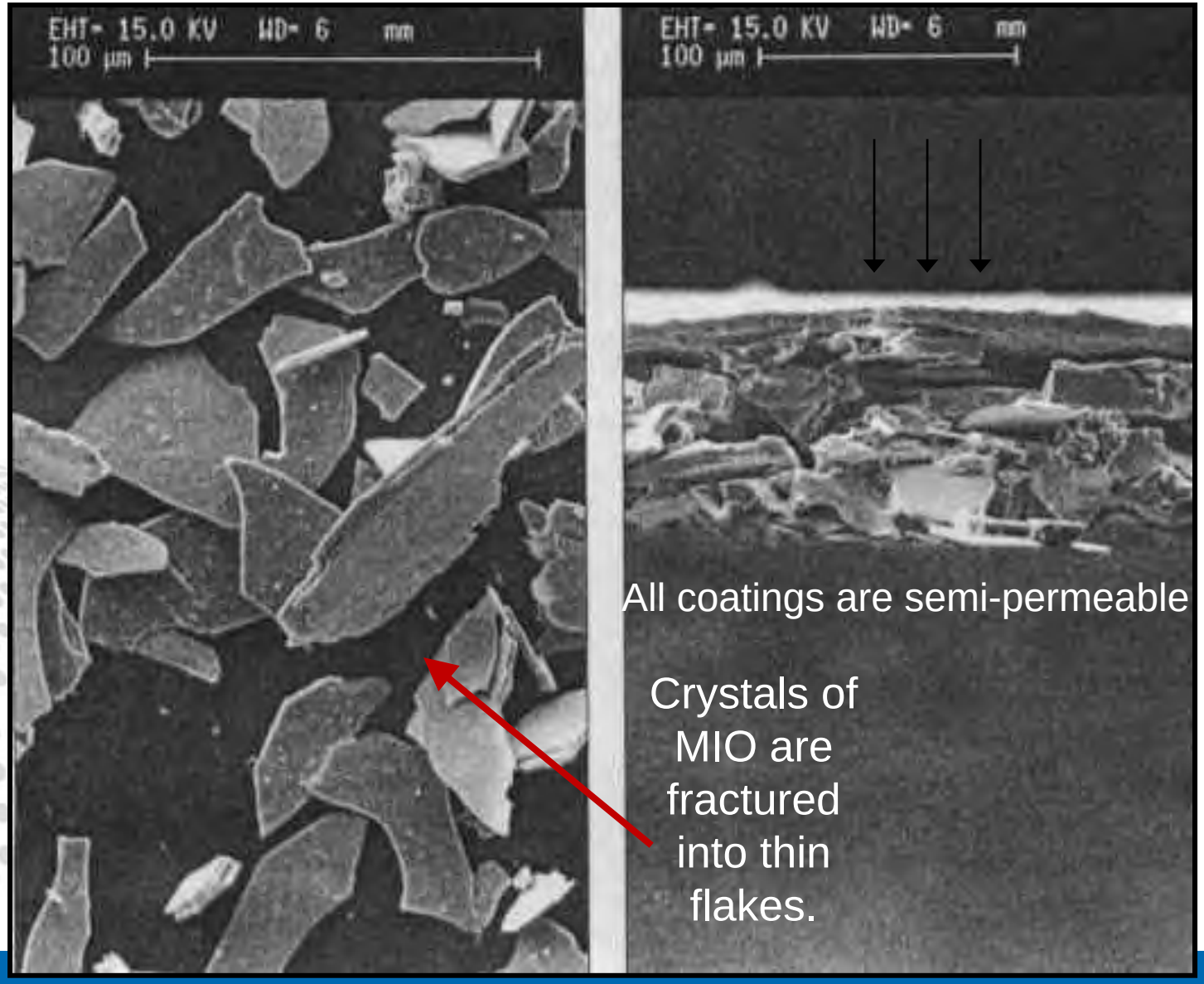
Corrosion is the electro-chemical process requiring an anode, cathode, a metallic pathway, and an electrolyte (e.g. water

Steel wants to go back to iron ore!

How Coatings Protect Surfaces

- Inhibitive
  - NOT in immersion
- Sacrificial
  - Zinc-rich
- **Barrier**
  - Immersion
  - Add flakes for better barrier

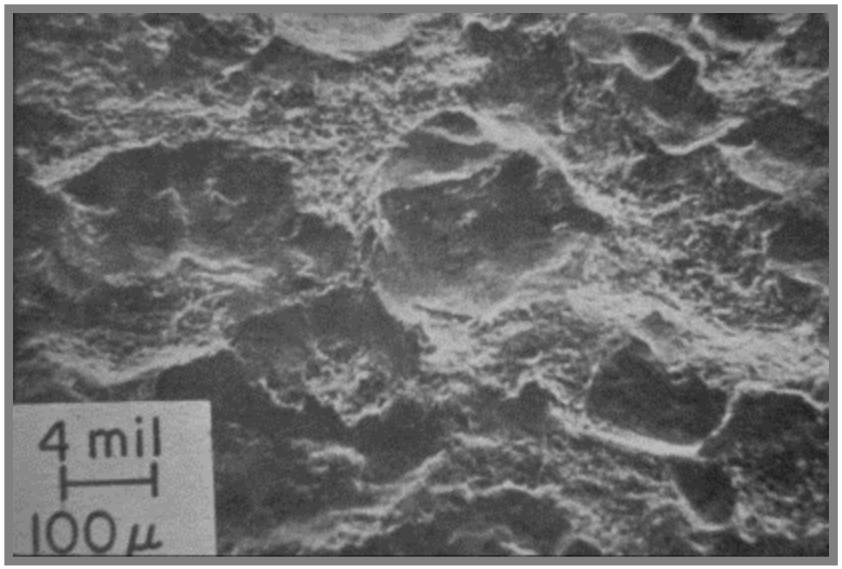
Add Flake Fill



Surface

Flakes then align in parallel fashion.

Surface Preparation



- Clean and Profile
- Paints Adhere to the Surface by Mechanical and / or Chemical Bond
- Whatever interferes with mechanical or chemical bond will, in turn, interfere with adhesion.

Standards

SSPC-SP 1	**Solvent Cleaning**
SSPC-SP 2	**Hand Tool Cleaning**
SSPC-SP 3	**Power Tool Cleaning**
SSPC-SP 5 / NACE 1	White Metal Blast Cleaning
SSPC-SP 6 / NACE 3	Commercial Blast Cleaning
SSPC-SP 7 / NACE 4	Brush-Off Blast Cleaning
SSPC-SP 8	Pickling
SSPC-SP 10 / NACE 2	**Near-White Blast Cleaning**
SSPC-SP 11	**Power Tool Cleaning to Bare Metal**
SSPC-SP 14 / NACE 8	Industrial Blast Cleaning
SSPC-SP 15	**Commercial Power Tool Cleaning**
SSPC-SP 16	Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals
SSPC-SP WJ-1/NACE WJ-1	Clean To Bare Substrate
SSPC-SP WJ-2/NACE WJ-2	Very Thorough Cleaning
SSPC-SP WJ-3/NACE WJ-3	Thorough Cleaning
SSPC-SP WJ-4/NACE WJ-4	Light Cleaning

First: SSPC-SP1 Solvent Cleaning

"Solvent Cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces."

"Solvent" can also be steam, water etc.

This is the first step by definition in every surface preparation standard !!!

Best: SSPC-SP10 Near-White Blast

"A Near-White Blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter, except for *staining* as noted below…
"… random staining shall be limited to no more than 5% of each unit area of surface (9 in^2), and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings …"

Not So Much: SSPC-SP2 / SP3

"Hand and Power Tool Cleaning removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Mill scale, rust, and paint are considered adherent if they cannot be removed by lifting with a dull putty knife."

Better: Power Tool SSPC-SP11 / 15

“ A bare metal power-tool cleaned steel surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, rust, coating, oxides, mill scale, corrosion products, and other foreign matter. Slight residues of rust and coating are permitted to remain in the lower portions of pits if the original surface is pitted “

“Random staining shall be limited to no more than 33 percent of each unit area of surface (SP 15)”

Epoxy in Immersion

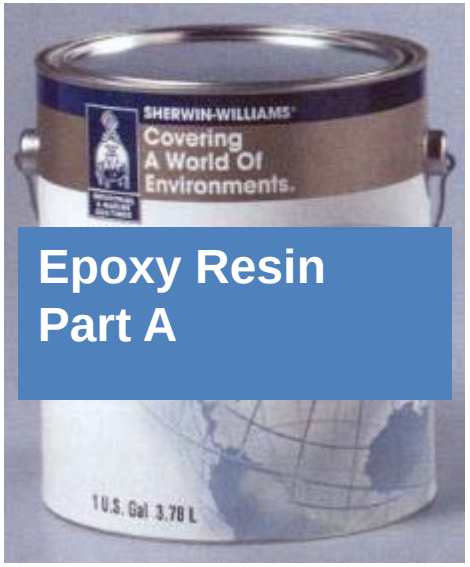
- Epoxy Resins Which Cross-Link with Polyamides, Amines, or Other Hardeners.
- They Cure by Polymerization –

  The chemical

  joining of polymer

  chains

Catalyzed Epoxies



Epoxy Resin
Part A

+

Hardener
Part B

=

Product
Part C

Two Component Epoxies

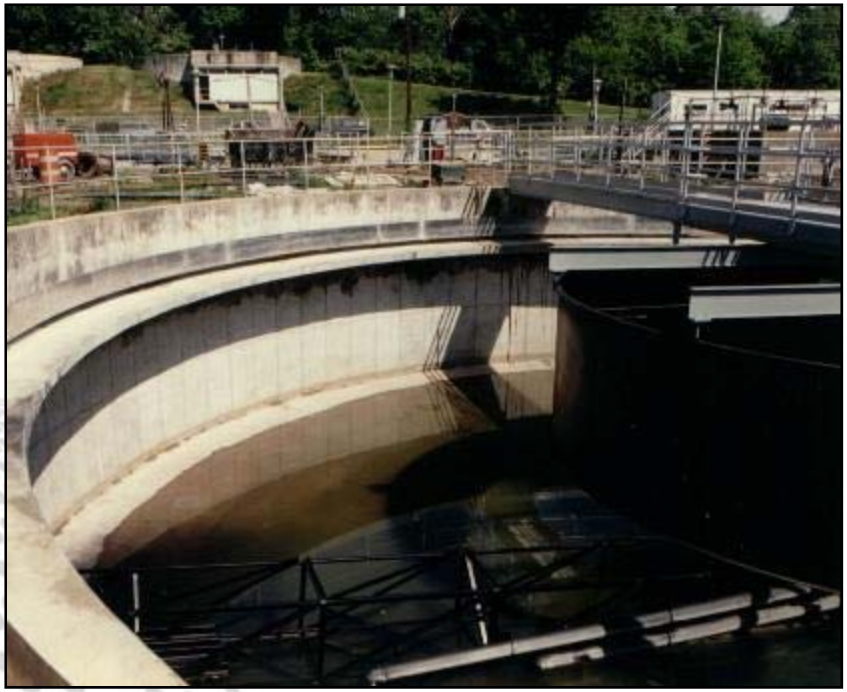
- **Usually an Induction Time Req'd (sweat – in time)**
- **Chalk and Fade on Exterior Exposure (UV)**
- **Recoat Window Restrictions May Apply**

*** Limited Pot Life**
*** Solvent Odor**

Solvent Based Epoxies

- Excellent Alkali, Solvent, and Water Resistance
- Good Abrasion Resistance
- Good Acid Resistance
- Good Exterior Durability *but ...*
- High Film Builds Possible in One Coat
- Low Temperature Application Available
- Dry Heat Resistance to 250° F

C-200a
Coal Tar Epoxy



Tar-Guard Low VOC
Coal Tar Epoxy

- Requires 2 coats
- <100 g/L
- Available in red

Protective & Marine Coatings

HI-MIL SHER-TAR® EPOXY

PART A	B69B40	BLACK
PART B	B60V40	HARDENER

Revised 10/10 — **PRODUCT INFORMATION** — 4.71

PRODUCT DESCRIPTION

HI-MIL SHER-TAR EPOXY is a high build, polyamide cured, epoxy coal tar coating, which can be applied at high film thickness in one coat.

- Chemical resistant
- Corrosion and abrasion resistant
- High build in a single coat

PRODUCT CHARACTERISTICS

Finish:	Semi-Gloss
Color:	Black
Volume Solids:	68% ± 2%, mixed
Weight Solids:	77% ± 2%, mixed
VOC (calculated): mixed	Unreduced: <340 g/L; 2.8 lb/gal Reduced 25%: <430 g/L; 3.59 lb/gal
Mix Ratio:	2 components, premeasured 3:1 4 gallons mixed

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	**24.0** (600)	**35.0** (875)
Dry mils (microns)	**16.0** (400)	**24.0** (600)
~Coverage sq ft/gal (m²/L)	**45** (1.1)	**68** (1.7)
Theoretical coverage **sq ft/gal** (m²/L) @ 1 mil / 25 microns dft	**1088** (26.6)	

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 29.0 mils wet (725 microns):

	@ 50°F/10°C	@ 77°F/25°C 50% RH	@ 100°F/38°C
To touch:	10 hours	8-10 hours	2 hours
To handle:	48 hours	48 hours	6 hours
To recoat:			
minimum:	24 hours	16 hours	8 hours
maximum:	72 hours	48 hours	16 hours
To cure:	7 days	7 days	7 days

If maximum recoat time is exceeded, abrade surface before recoating.
Drying time is temperature, humidity, and film thickness dependent.

Pot Life:	6 hours	4 hours	1 hour
Sweat-in-Time:	1 hour	30 minutes	15 minutes

Shelf Life:	12 months, unopened Store indoors at 40°F (4.5°C) to 100°F (38°C)
Flash Point:	110°F (43°C) PMCC, mixed
Reducer/Clean Up:	Reducer #54, R7K54

RECOMMENDED USES

For use over prepared substrates such as steel and concrete in industrial environments.

- Penstocks
- Dam gates
- Offshore drilling rigs
- Liner for clarifiers
- Marine applications
- Heavy duty structural coating
- Non-potable water tank and pipe coating
- Acceptable for use with cathodic protection systems

PERFORMANCE CHARACTERISTICS

Substrate*: Steel
Surface Preparation*: SSPC-SP6/NACE 3
System Tested*:
1 ct. Hi-Mil Sher-Tar @ 20.0 mils (500 microns) dft/ct
*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	101 mg loss
Adhesion	ASTM D4541	600 psi
Direct Impact Resistance	ASTM D2794	>80 in. lbs.
Dry Heat Resistance (quench test only)	ASTM D2485	350°F (177°C)
Flexibility	ASTM D522, 180° bend, 1" mandrel	Passes
Moisture Condensation Resistance	ASTM D4585, 100°F (38°C), 1000 hours	No failure
Pencil Hardness	ASTM D3363	4H
Salt Fog Resistance	ASTM B117, 1000 hours	Excellent
Sea Water Immersion	ASTM D870 2 years	No blistering, cracking, or rusting
Water Vapor Permeability	ASTM D1653	0.021 perm-in.
Wet Heat Resistance	Non-immersion	120°F (49°C)

Provides performance comparable to products formulated to federal specifications: DOD-P-23236A (SH) Class 2. (Replaces MIL-P-23236) Type 1, Class 2, SSPC-Paint 16.

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Glass Flake Reinforced Amine Epoxy

- Upgrade to coal tar epoxy
- Corrosion, impact, and abrasion resistant
- Direct to metal application
- Up to 20 mils dry in a single coat
- Enhanced performance and edge protection

Protective & Marine Coatings

SHER-GLASS FF

GLASS FLAKE REINFORCED EPOXY

		Series
Part A	B62-525	Standard Hardener
Part B	B62V525	Low Temp Hardener
Part B	B62V526	

Revised 3/11

Product Information

4.37

Product Description

SHER-GLASS FF is a glass flake reinforced amine epoxy coating formulated for immersion service or where steel or concrete protection is desired, in a wide range of harsh industrial environments.

- The use of pre-wetted glass flake allows for consistent mixing and application
- Re-inforced film enhances performance and edge protection
- Excellent immersion service performance
- Corrosion, impact, abrasion resistant
- Direct to metal application for tanks and structural steel
- Up to 20.0 mils (500 microns) dry in a single coat

Product Characteristics

Finish:	Semi-Gloss
Color:	Red Oxide, Black, Haze Gray
Volume Solids:	76% ± 2% mixed, (calculated)
Weight Solids:	87% ± 2% mixed, (calculated)
Mix Ratio:	4:1 (2 components)
VOC (EPA Method 24): (mixed)	Unreduced: <250 g/L; 2.08 lb/gal 10% Reduced: <276 g/L; 2.30 lb/gal

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	**10.0** (250)	**26.0** (625)
Dry mils (microns)	**8.0** (200)	**20.0** (500)
~Coverage sq ft/gal (m^2/L)	**61** (1.5)	**152** (3.7)
Theoretical coverage **sq ft/gal** (m^2/L) @ 1 mil / 25 microns dft	**1216** (29.8)	

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 15.0 mils wet (375 microns):

With B62V525	@ 55°F/13°C	@ 77°F/25°C *50% RH*	@ 120°F/49°C
To touch:	7 hours	4 hours	80 minutes
To handle:	9 hours	4.5 hours	90 minutes
To recoat:			
minimum:	48 hours	18 hours	4 hours
maximum:	60 days	60 days	45 days
To cure:	14 days	7 days	3 days
Heat Cure:	8 hours @ ambient, then 16 hours @ 140°F (60°C)		
Pot Life:	4 hours	2 hours	30 minutes
Sweat-in-time:	30 minutes	15 minutes	none

If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent.

Drying Schedule @ 15.0 mils wet (375 microns):

*With B62V526**	@ 40°F/4.5°C	@ 77°F/25°C *50% RH*
To touch:	24 hours	2 hours
To handle:	48 hours	2.5 hours
To recoat:		
minimum:	48 hours	8 hours
maximum:	30 days	14 days
To cure:	10 days	5 days
Heat Cure:	8 hours @ ambient, then 16 hours @ 140°F (60°C)	
Pot Life:	2 hours	30 minutes
Sweat-in-Time:	10 minutes	none

If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent.

***Do not use Sher-Glass Low Temp Hardener above 80°F (27°C)**

Product Characteristics (Cont'd)

Shelf Life:	Part A: 24 months Part B: 36 months Store indoors at 40°F (4.5°C) to 100°F (38°C).
Flash Point:	80°F (27°C), PMCC, mixed
Reducer/Clean Up:	Xylene R2K4, or R7K100

Recommended Uses

For use over prepared steel or concrete in the following environments:

- Petro-chemical and power plants
- Immersion in fresh or salt water
- Water and waste water facilities
- Marine - ships, barges, and offshore structures
- High humidity and moisture areas
- Areas requiring good chemical resistance to splash, spillage, and fumes
- Acceptable for use in areas of high H2S
- Acceptable for use with cathodic protection systems

Performance Characteristics

Substrate*: Steel

Surface Preparation*: SSPC-SP10/NACE 2

System Tested*:

1 ct. Sher-Glass FF @ 15.0 mils (375 microns) w/ Standard Hardener

*unless otherwise noted below

Test Name	Test Method	Results
Adhesion	ASTM D4541, Patti Tester	1100 psi
Corrosion Weathering Resistance	ASTM D5894, 12 cycles, 4032 hours	Rating 10 per ASTM D714 for Blistering; Rating 10 per ASTM D610 for Rusting
Direct Impact Resistance	ASTM D2794	32 in. lbs.
Dry Heat Resistance	ASTM D2485, Method A, Water Quench Test	400°F (204°C) (discolors)
Flexibility	ASTM D522	6% elongation - Passes 3/4 inch mandrel
Moisture Condensation Resistance	ASTM D4585, 100°F (38°C), 4200 hours	Rating 10 per ASTM D714 for Blistering; Rating 10 per ASTM D610 for Rusting
Pencil Hardness	ASTM D3363	3H
Salt Fog Resistance	ASTM B117, 4200 hours	Rating 10 per ASTM D714 for Blistering; Rating 10 per ASTM D610 for Rusting

Epoxy coatings may darken or yellow following application and curing.

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Standard Epoxy

Also:

- Macropoxy 646 PW

Protective & Marine Coatings

MACROPOXY® 646 FAST CURE EPOXY

PART A	B58-600	SERIES
PART B	B58V600	HARDENER

Revised 5/11 — **PRODUCT INFORMATION** — 4.53

PRODUCT DESCRIPTION

MACROPOXY 646 FAST CURE EPOXY is a high solids, high build, fast drying, polyamide epoxy designed to protect steel and concrete in industrial exposures. Ideal for maintenance painting and fabrication shop applications. The high solids content ensures adequate protection of sharp edges, corners, and welds. This product can be applied directly to marginally prepared steel surfaces.

- Low VOC
- Low odor
- Chemical resistant
- Abrasion resistant
- Outstanding application properties
- Meets Class A requirements for Slip Coefficient, 0.36 @ 6 mils / 150 microns dft (Mill White only)

PRODUCT CHARACTERISTICS

Finish:	Semi-Gloss
Color:	Mill White, Black and a wide range of colors available through tinting
Volume Solids:	72% ± 2%, mixed, Mill White
Weight Solids:	85% ± 2%, mixed, Mill White
VOC (EPA Method 24): mixed	Unreduced: <250 g/L; 2.08 lb/gal Reduced 10%: <300 g/L; 2.50 lb/gal
Mix Ratio:	1:1 by volume

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	7.0 (175)	13.5 (338)
Dry mils (microns)	5.0* (125)	10.0* (250)
~Coverage sq ft/gal (m²/L)	116 (2.8)	232 (5.7)
Theoretical coverage **sq ft/gal** (m²/L) @ 1 mil / 25 microns dft	1152 (28.2)	

*May be applied at 3.0-10.0 mils dft as an intermediate coat. Refer to Recommended Systems (page 2). See Performance Tips section also.

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 7.0 mils wet (175 microns):

	@ 35°F/1.7°C	@ 77°F/25°C 50% RH	@ 100°F/38°C
To touch:	4-5 hours	2 hours	1.5 hours
To handle:	48 hours	8 hours	4.5 hours
To recoat:			
minimum:	48 hours	8 hours	4.5 hours
maximum:	1 year	1 year	1 year
To cure:			
Service:	10 days	7 days	4 days
Immersion:	14 days	7 days	4 days

If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent.
Paint temperature must be at least 40°F (4.5°C) minimum.

Pot Life:	10 hours	4 hours	2 hours
Sweat-in-time:	30 minutes	30 minutes	15 minutes

When used as an intermediate coat as part of a multi-coat system:

Drying Schedule @ 5.0 mils wet (125 microns):

	@ 35°F/1.7°C	@ 77°F/25°C 50% RH	@ 100°F/38°C
To touch:	3 hours	1 hour	1 hour
To handle:	48 hours	4 hours	2 hours
To recoat:			
minimum:	16 hours	4 hours	2 hours
maximum:	1 year	1 year	1 year

PRODUCT CHARACTERISTICS (CONT'D)

Shelf Life:	36 months, unopened Store indoors at 40°F (4.5°C) to 100°F (38°C).
Flash Point:	91°F (33°C), TCC, mixed
Reducer/Clean Up:	Reducer, R7K15
In California:	Reducer R7K111 or Oxsol 100

PERFORMANCE CHARACTERISTICS

Substrate*: Steel
Surface Preparation*: SSPC-SP10/NACE 2
System Tested*:
1 ct. Macropoxy 646 Fast Cure @ 6.0 mils (150 microns) dft
*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	84 mg loss
Accelerated Weathering-QUV[1]	ASTM D4587, QUV-A, 12,000 hours	Passes
Adhesion	ASTM D4541	1,037 psi
Corrosion Weathering[1]	ASTM D5894, 36 cycles, 12,000 hours	Rating 10 per ASTM D714 for blistering; Rating 9 per ASTM D610 per rusting
Nuclear Decontamination	ASTM D4256/ANSI N 5.12	99% Water Wash; 95% Overall
Direct Impact Resistance	ASTM D2794	30 in. lb.
Dry Heat Resistance	ASTM D2485	250°F (121°C)
Exterior Durability	1 year at 45° South	Excellent, chalks
Flexibility	ASTM D522, 180° bend, 3/4" mandrel	Passes
Fuel Contribution	NFPA 259	5764 btu/lb
Humidity Resistance	ASTM D4585, 6000 hours	No blistering, cracking, or rusting
Immersion	1 year fresh and salt water	Passes, no rusting, blistering, or loss of adhesion
Radiation Tolerance	ASTM D4082 / ANSI 5.12	Pass at 21 mils (525 microns)
Pencil Hardness	ASTM D3363	3H
Salt Fog Resistance[1]	ASTM B117, 6,500 hours	Rating 10 per ASTM D610 for rusting; Rating 9 per ASTM D1654 for corrosion
Slip Coefficient, Mill White	AISC Specification for Structural Joints Using ASTM A325 or ASTM A490 Bolts	Class A, 0.36
Surface Burning	ASTM E84/NFPA 255	Flame Spread Index 20; Smoke Development Index 35 (at 18 mils or 450 microns)
Water Vapor Permeance	ASTM D1653, Method B	1.16 US perms

Epoxy coatings may darken or discolor following application and curing.

Footnotes:
[1]Zinc Clad II Plus Primer

DISCLAIMER

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and pertain to the product offered at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

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Low Temp. Epoxy

Protective & Marine Coatings

DURA-PLATE® 235
MULTI-PURPOSE EPOXY

PART A	B67-235	SERIES COLORS
PART B	B67V235	HARDENER

Revised 6/11 — **PRODUCT INFORMATION** — 4.67

PRODUCT DESCRIPTION

Dura-Plate 235 Multi-Purpose Epoxy is a modified epoxy phenalkamine, formulated specifically for immersion and atmospheric service in marine and industrial environments. Dura-Plate 235 provides exceptional performance in corrosive environment, and can be applied at temperatures as low as 0°F (-18°C).

- Self-priming
- Low temperature application, 0°F (-18°C)
- Surface tolerant - damp surfaces
- Provides salt water and fresh water immersion resistance
- Approved as a primer per MIL-PRF-23236, Type V, Class 7, Grade C
- Outstanding application properties

PRODUCT CHARACTERISTICS

Finish:	Semi-Gloss
Color:	Wide range of colors available
Volume Solids:	68% ± 2%, mixed
Weight Solids:	79% ± 2%, mixed
VOC (EPA Method 24):	Unreduced: <280 g/L; 2.33 lb/gal Reduced 10%: <327 g/L; 2.72 lb/gal
Mix Ratio:	4:1 by volume

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	6.0 (150)	12.0 (300)
Dry mils (microns)	4.0* (100)	8.0* (200)
~Coverage sq ft/gal (m²/L)	136 (3.3)	272 (6.6)
Theoretical coverage **sq ft/gal** (m²/L) @ 1 mil / 25 microns dft	1088 (26.6)	

*See Performance Tips section

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 6.0 mils wet (150 microns):

	@ 0°F/-18°C	@ 40°F/4.5°C	@ 77°F/25°C 50% RH	@ 120°F/49°C
To touch:	18 hours	3.5 hours	2 hours	20 minutes
To handle:	36 hours	12 hours	3.5 hours	40 minutes
To recoat:				
minimum:	36 hours	12 hours	3.5 hours	40 minutes
maximum:	6 months	6 months	6 months	6 months
Cure to service:	30 days	14 days	7 days	3 days

If maximum recoat time is exceeded, abrade surface before recoating.

Drying time is temperature, humidity, and film thickness dependent.

Pot Life:	16 hours	8 hours	4 hours	1 hour
Sweat-in-time:	1 hour	30 minutes	15 minutes	5 minutes

Shelf Life:	Part A: 36 months, unopened Part B: 24 months, unopened Store indoors at 40°F (4.5°C) to 100°F (38°C).
Flash Point:	116°F (47°C) PMCC, mixed
Reducer/Clean Up:	Reducer R7K104

RECOMMENDED USES

For use over prepared steel and masonry surfaces.

- Salt water and fresh water immersion resistance
- Ballast tanks, offshore and marine structures
- Bilges and wet void areas
- Above- and below- water hull areas
- Decks and superstructures
- Water and waste water tanks
- Acceptable for use with cathodic protection systems.
- Dura-Plate 235 Black meets or exceeds the performance criteria of C-200; SSPC Paint 16; and Mil-P-23236B(SH) Type I or IV Class 2
- Suitable for use in USDA inspected facilities
- Conforms to MPI # 101

PERFORMANCE CHARACTERISTICS

Substrate*: Steel

Surface Preparation*: SSPC-SP10/NACE 2

System Tested*:

2 cts. Dura-Plate 235 @ 5.0 mils (125 microns) dft/ct

*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060 CS17 wheel, 1000 cycles, 1 kg load	65 mg loss
Adhesion	ASTM D4541	850 psi
Direct Impact Resistance	ASTM D2794	10 in lb
Dry Heat Resistance	ASTM D2485	250°F (121°C)
Moisture Condensation Resistance	ASTM D4585, 100°F (38°C), 2000 hours	Rating 10 per ASTM D610 for rusting; Rating 10 per ASTM D714 for blistering
Pencil Hardness	ASTM D3363	H

IMMERSION
(Ambient temperature)

- Salt Water ..... Recommended
- Fresh Water ..... Recommended
- Ballast Tank Mix ..... Recommended

Epoxy coatings may darken or yellow following application and curing.

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Moisture Cured Urethanes (MCU)

- Can be applied during high humidity
- Single Component
- Fast Recoat / Fast Cure Times
- Low Temperature Application 20° F.

  - Special Reducers Required
  - Unused Portion Has Limited Shelf Life
  - Needs Relative Humidity to Cure

Protective & Marine Coatings

COROTHANE® I COAL TAR

B65B11

Revised 11/10

PRODUCT INFORMATION

5.06

PRODUCT DESCRIPTION

COROTHANE I - COAL TAR is a single component, moisture curing urethane with micaceous iron oxide designed for low temperature and immersion application. It is high solids and low VOC.

- Low temperature application - down to 20°F (-7°C)
- Can be immersed after 4 hours cure at 77°F (25°C)
- Superior to coal tar epoxy for flexibility, weathering, corrosion resistance, heat resistance, and impact resistance
- Contains micaceous iron oxide
- Enhanced coating strength and edge protection with micaceous iron oxide addition

PRODUCT CHARACTERISTICS

Finish:	Low Gloss
Color:	Black
Volume Solids:	64% ± 2%
VOC (calculated):	<340 g/L; 2.8 lb/gal

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	**8.0** (200)	**11.0** (275)
Dry mils (microns)	**5.0** (125)	**7.0** (175)
~Coverage sq ft/gal (m^2/L)	**151** (3.7)	**211** (5.2)
Theoretical coverage **sq ft/gal** (m^2/L) @ 1 mil / 25 microns dft	**1056** (25.8)	

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 8.0 mils wet (200 microns):

	@ 40°F/4.5°C	@ 77°F/25°C 50% RH	@ 100°F/38°C
To touch:	4 hours	1 hour	20 minutes
To recoat:			
minimum:	18 hours	4 hours	2 hours
maximum:	3 days	3 days	3 days
To cure (85%)*:	4 days	3 days	3 days
To immerse:	24 hours	4 hours**	1 hour

*This product will continue to cure for up to 6 months.
**4 oz/gal of Corothane I KA Accelerator required.
If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent.

Shelf Life:	12 months, unopened Store indoors at 40°F (4.5°C) to 100°F (38°C).
Flash Point:	>90°F (32°C), PMCC
Reducer/Clean Up:	Reducer #100, R7K100

RECOMMENDED USES

- Coating for steel or concrete which is immersed or exposed to splash zones, high humidity, sewage, or buried environments
- For application during cold and/ or damp conditions limiting the use of typical epoxies and urethanes
- As a substitute for coal tar epoxy

PERFORMANCE CHARACTERISTICS

Substrate*: Steel
Surface Preparation*: SSPC-SP6/NACE 3
System Tested*:
1 ct. Corothane I Coal Tar @ 6.0 mils (150 microns) dft
*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	123 mg loss
Adhesion	ASTM D4541	800 psi
Corrosion Weathering (Zinc Primer/Coal Tar)	ASTM D5894, 3024 hours, 9 cycles	Rating 10 per ASTM D714 for blistering; Rating 9 per ASTM D610 for rusting
Direct Impact Resistance	ASTM D2794	80 in. lbs.
Dry Heat Resistance	ASTM D2485	240°F (115°C)
Flexibility	ASTM D522, 180° bend, 1/8" mandrel	Passes
Moisture Condensation Resistance (Zinc Primer/Coal Tar)	ASTM D4585, 100°F (38°C), 1008 hours	Rating 10 per ASTM D714 for blistering; Rating 10 per ASTM D610 for rusting
Pencil Hardness	ASTM D3363	HB
Salt Fog Resistance (Zinc Primer/Coal Tar)	ASTM B117, 2000 hours	Rating 10 per ASTM D714 for blistering; Rating 9 per ASTM D610 for rusting
Wet Heat Resistance	Non-immersion	185°F (85°C)

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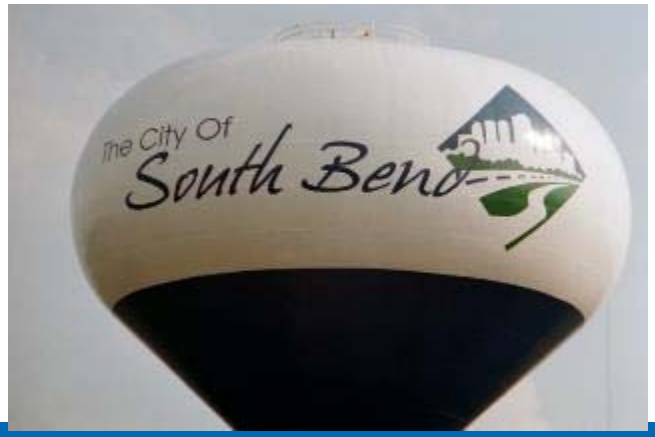
Aliphatic Polyurethane Topcoats

- A polyurethane coating is derived from the reaction product of an isocyanate component and a resin blend component.
- Good Chemical Resistance
- Hard, Yet Flexible Films
- Excellent Color and Gloss Retention
- Low-temperature MCU topcoats
- Not for full-time immersion



Protective & Marine Coatings

ACROLON™ 218 HS
ACRYLIC POLYURETHANE

PART A	B65-600	GLOSS SERIES
PART A	B65-650	SEMI-GLOSS SERIES
PART B	B65V600	HARDENER

Revised: July 23, 2013

PRODUCT INFORMATION

5.22

PRODUCT DESCRIPTION

ACROLON 218 HS is a low VOC, polyester modified, aliphatic, acrylic polyurethane formulated specifically for in-shop applications. Also suitable for industrial applications. A fast drying, urethane that provides color and gloss retention for exterior exposure.

- Can be used directly over organic zinc rich primers (epoxy zinc primer and moisture cure urethane zinc primer)
- Color and gloss retention for exterior exposure
- Fast dry
- Outstanding application properties

PRODUCT CHARACTERISTICS

Finish:	Gloss or Semi-Gloss	
Color:	Wide range of colors available	
Volume Solids:	65% ± 2%, mixed, may vary by color	
Weight Solids:	78% ± 2%, mixed, may vary by color	
VOC (EPA Method 24):	Unreduced:	<300 g/L; 2.5 lb/gal
mixed	Reduced 10% with R7K15:	<340 g/L; 2.8 lb/gal
mixed	Reduced 8% with MEK, R6K10:	<340 g/L; 2.8 lb/gal
Mix Ratio:	6:1 by volume, 1 gallon or 5 gallon mixes premeasured components	

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	**4.5** (112.5)	**9.0** (225)
Dry mils (microns)	**3.0** (75)	**6.0** (150)
~Coverage sq ft/gal (m^2/L)	**175** (4.3)	**346** (8.5)
Theoretical coverage **sq ft/gal** (m^2/L) @ 1 mil / 25 microns dft	**1040** (25.5)	

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 6.0 mils wet (150 microns):

	@ 35°F/1.7°C	@ 77°F/25°C 50% RH	@ 120°F/49°C
To touch:	4 hours	30 minutes	20 minutes
To handle:	18 hours	6 hours	4 hours
To recoat:			
minimum:	18 hours	8 hours	6 hours
maximum:	3 months	3 months	3 months
To cure:	14 days	7 days	5 days
Pot Life: (reduced 5% with Reducer R7K15)	4 hours	2 hours	45 minutes
Sweat-in-Time:		None	

If maximum recoat time is exceeded, abrade surface before recoating. Drying time is temperature, humidity, and film thickness dependent. Paint temperature must be at least 40°F (4.5°C) minimum.

Shelf Life:	Part A* - 36 months, unopened Part B - 24 months, unopened Store indoors at 40°F (4.5°C) to 100°F (38°C).
*Aluminum (Part A, Rex # B65SW655) has a shelf life of 24 months.	
Flash Point:	55°F (13°C), Seta, mixed
Reducer/Clean Up:	
Spray:	Reducer R7K15, MEK R6K10, or R7K111
Brush / Roll:	Reducer #132, R7K132 or R7K111

RECOMMENDED USES

Specifically formulated for in-shop applications.
For use over prepared metal and masonry surfaces in industrial environments such as:

- Structural steel
- Rail cars and locomotives
- Conveyors
- Bridges
- Wind Towers - onshore and offshore
- Offshore platforms - exploration and production
- Suitable for use in USDA inspected facilities
- Conforms to AWWA D102 Outside Coating Systems #4 (OCS-4), #5 (OCS-5) & #6 (OCS-6)
- Acceptable for use in high performance architectural applications
- Acceptable for use over Stampede 1 and Stampede 1H Caulking
- A component of INFINITANK
- Over FIRETEX hydrocarbon systems
- Suitable for use in the Mining & Minerals Industry
- Tank exteriors
- Pipelines
- Ships

PERFORMANCE CHARACTERISTICS

Substrate*: Steel
Surface Preparation*: SSPC-SP10/NACE 2
System Tested*:
1 ct. Macropoxy 646 @ 6.0 mils (150 microns) dft
1 ct. Acrolon 218 HS Gloss @ 4.0 mils (100 microns) dft
*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance[1]	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	43 mg loss
Adhesion	ASTM D4541	975 psi
Corrosion Weathering[2]	ASTM D5894, 9 cycles, 3024 hours	Rating 10 per ASTM D610, for rusting; Rating 10 per ASTM D714, for blistering
Direct Impact Resistance[1]	ASTM D2794	50 in. lb.
Dry Heat Resistance[1]	ASTM D2485, Method A	200°F (93°C)
Flexibility[1]	ASTM D522, 180° bend, 1/8" mandrel	Passes
Humidity Resistance[2]	ASTM D4585, 100°F (38°C), 1500 hours	Rating 10 per ASTM D610, for rusting; Rating 10 per ASTM D714, for blistering
Pencil Hardness	ASTM D3363	3H
Salt Fog Resistance[2]	ASTM B117, 7000 hours	Rating 10 per ASTM D610, for rusting; Rating 9 per ASTM D714, for blistering

Meets the requirements of SSPC Paint No. 36, Level 3 for white and light colors. Dark colors may require a clear coat.

Complies with ISO 12944-5 C5I and C5M requirements.

Footnotes:
[1] *Finish coat only tested*
[2] *Primer* — *Zinc-Clad II Plus*
Intermediate — *Macropoxy 646*
Finish — *Acrolon 218 HS*

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Summary

- Explain why we paint waterfront steel structures
- Describe the value of the various surface preparation methods
- Identify typical waterfront coatings based on
  - UFGS 09 97 02 Painting Hydraulic Structures
  - UFGS 09 97 13.26 Coating of Steel Waterfront Structures (April 2006)*

Waterfront Protective Coatings

- Solution Vinyl (impact immersion only)
- Coal Tar Polyamide Epoxy (C-200a)
- Flake-filled Amine Cured Epoxy
- Surface Tolerant Polyamide Epoxy
- Surface Tolerant Amine Cured Epoxy
- Moisture Cured Urethane (MCU)
- Aliphatic Polyurethane Topcoats

Questions?

www.SSPC.org

OR

www.Sherwin.com/protective

LEVEE RECONSTRUCTION

Amy S. Babey, PMP

Chief, Environmental Support Section

Louisville, KY

February 10, 2016

US Army Corps of Engineers

BUILDING STRONG®

Reconstruction History

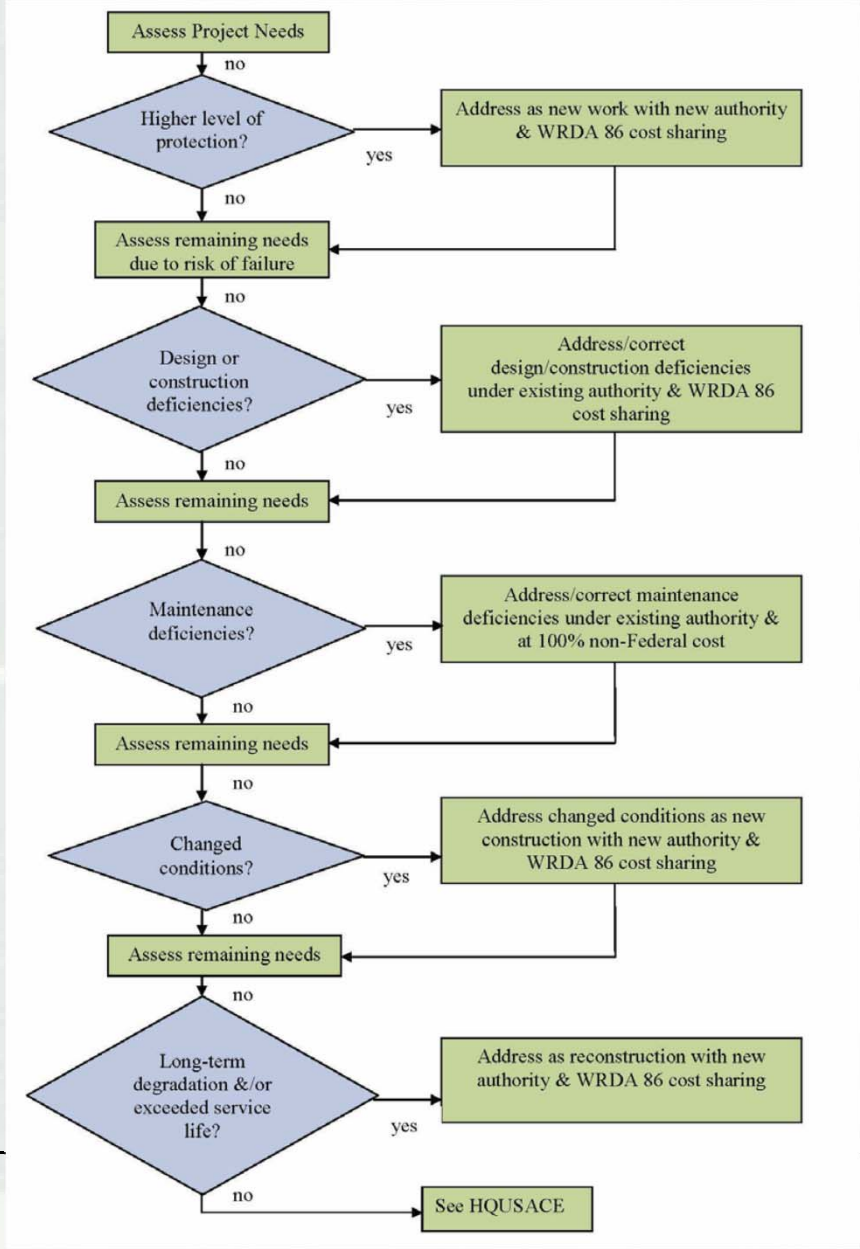
- Federally-constructed structural FRM projects prior to 1986 were responsible for O&M of the flood protection system
- WRDA 1986 required non-federal sponsors to pay 100% of OMRR&R costs for structural FRM projects
- Recognized that project features may exceed expected functional service life
- Memo issued August 16, 2005 that provided guidance on reconstruction of Corps structural FRM projects

What is Reconstruction

- Address the major performance deficiencies caused by a long-term degradation of the foundation, construction materials, and engineering systems that have exceeded their expected service lives and the resulting inability of the project to perform its authorized project functions.

- In addressing reconstruction needs, the latest design standards and efficiency improvements should be incorporated into the project.

Reconstruction Decision Logic



Reconstruction Affirmation

- Long-term Degradation of Project Feature that has Exceeded Service Life (Not due to Deficient O&M activities)
  - If due to lack of O&M, can be part of reconstruction but at 100% non-federal cost
- Project Feature Obsolete and/or Replacement Parts Unavailable
- New or Altered Project Feature Based on Design Analysis
- Project Feature Altered Based on Current Safety Standards
- Project Feature Altered Based on Current Design Criteria

Initiating Reconstruction

- Submit Letter of Intent to appropriate Corps District referencing SMART planning and new single-phase study
- Identify appropriate study authority and receive appropriation of federal funds
- Define scope, limiting consideration to individual project features
  - Closure structures, pump stations, gravity drains, relief wells, etc.
  - Compare with and without reconstruction condition
  - Consider interior and exterior flooding
  - Consider environmental sustainability

Key Points

- Reconstruction is intended to address major deficiencies that have exceeded their service life
- All reconstruction projects will be brought up to the latest design standards and efficiency improvements
- Local sponsors will assume all responsibility for OMRR&R following reconstruction

Questions??

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Chief, Planning Branch
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Sharon.M.Bond@usace.army.mil

Enhancement to Emergency Preparedness Plan (EPP)

Presenter Name: Nathan H. Bryan, PE

Geotechnical Engineer

Louisville District

Levee Safety Area Representative (LSAR) for

Middle Ohio, KY, & Salt River

US Army Corps of Engineers

BUILDING STRONG®

Statement of Purpose

- Prepare detailed models & associated mapping of several potential breach scenarios (levee failures) of the Louisville-Metro Levee System during flood conditions.
  - Identify potential levee vulnerabilities
- Provide these detailed models to local emergency managers as well as state and county officials.
- Identify possible mitigation and/or preparation/training needs for the levee system and its stakeholders.

Authority

- Assistance for this study was granted under the auspices of the National Silver Jackets Program, through its state team.

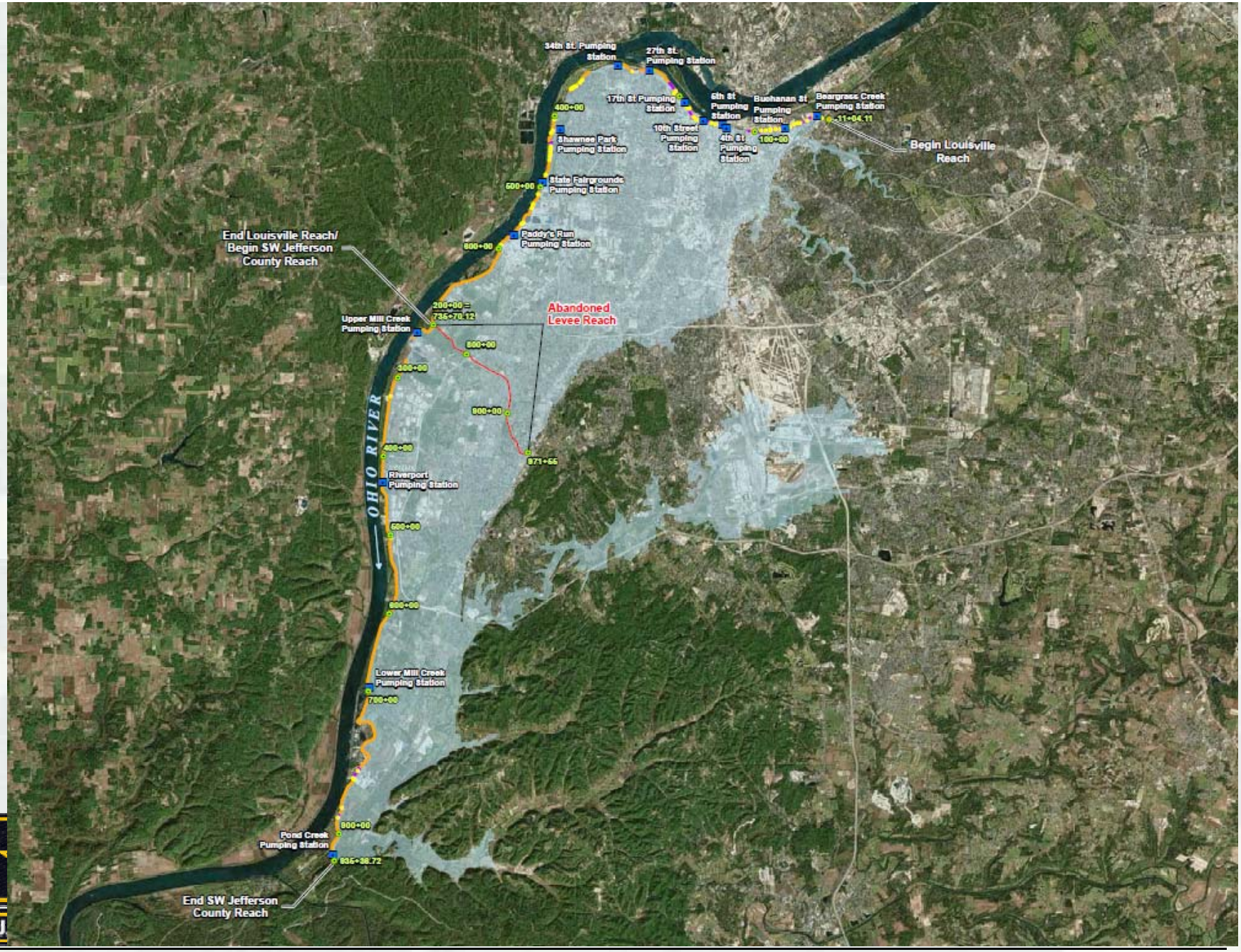
- The National SilverJackets Program was established based on the National Flood Risk Management Program (NFRMP) initial guidance with the objective to foster open and collaborative mitigation planning, response and recovery efforts within USACE programs, activities, and initiatives; and externally with federal, state, local, and tribal partners.

Study Outline

- **Develop an H&H model**
- **Identify Potential Levee Vulnerabilities**
  - I-Walls
  - Levee Buttress Slope (Carbide Industries)
- **Model Breach Scenarios (Potential Vulnerabilities)**
  1. Downtown I-Wall (1937 Flood & 50% Loading)
  2. Rubbertown Buttress Slope (1937 Flood & 50% Loading)
- **Identify Consequences**
- **Identify Major Issues & Recommendations**

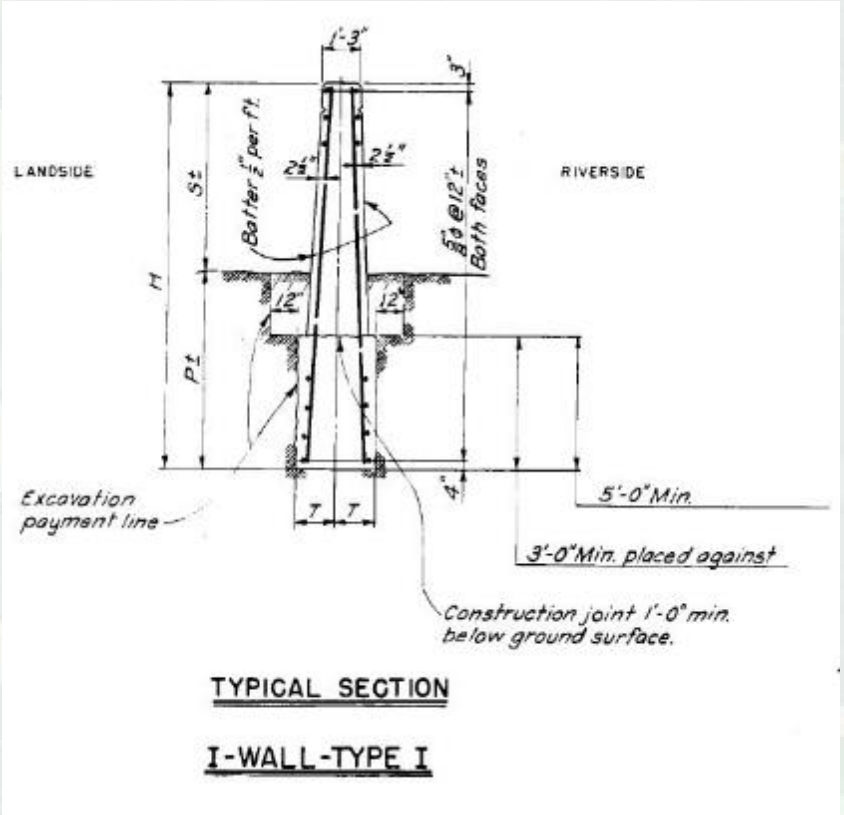
Levee Information

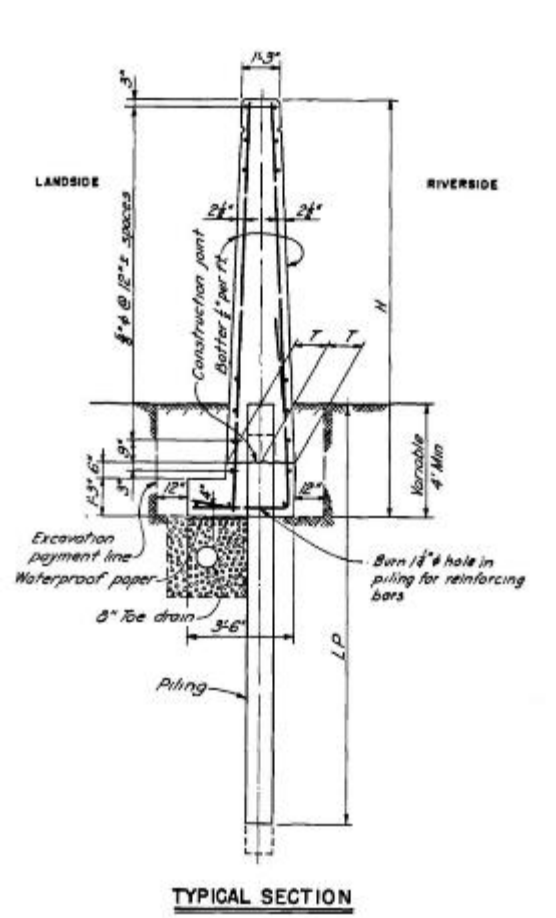
Local Sponsor	Louisville & Jefferson County MSD
Levee System (miles)	25.91 total length
	19.7 embankment
	3.77 floodwall
	15 pumping stations / 152 gates
Abandoned Levee Reach	~4.5 miles, Louisville Reach, STA 735+70.12 to 971+55
Leveed Area	~48,768 acres (~64.4 sq. miles)
Flood of Record	March 13,1964 (Louisville Reach)
	March 7, 1997 (Louisville & Southwest Jefferson Reach)
Construction Completion Date	1956 (Louisville Reach)
	1989 (Southwest Jefferson Reach)
Population at Risk	200,494 (Day), 200,318 (Night)
Total Building Count	~85,282
Potential Property Damages	~$13,249,063,280


34th St. Pumping Station
27th St. Pumping Station
17th St Pumping Station
6th St Pumping Station
Buchanan St Pumping Station
Beargrass Creek Pumping Station
10th Street Pumping Station
4th St. Pumping Station
Shawnee Park Pumping Station
State Fairgrounds Pumping Station
Paddy's Run Pumping Station
Begin Louisville Reach
End Louisville Reach/ Begin SW Jefferson County Reach
Abandoned Levee Reach
Upper Mill Creek Pumping Station
OHIO RIVER
Riverport Pumping Station
Lower Mill Creek Pumping Station
Pond Creek Pumping Station
End SW Jefferson County Reach

Potential Levee System Vulnerability #1

Project I-Walls – Typical Details

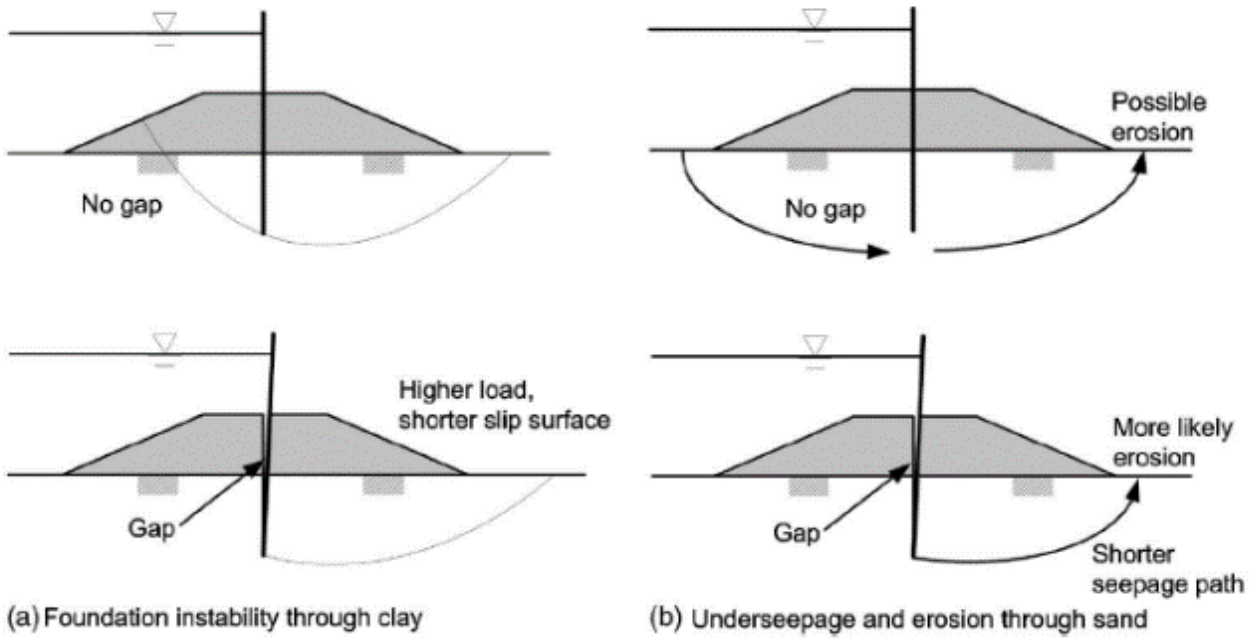




I-Wall –Type II

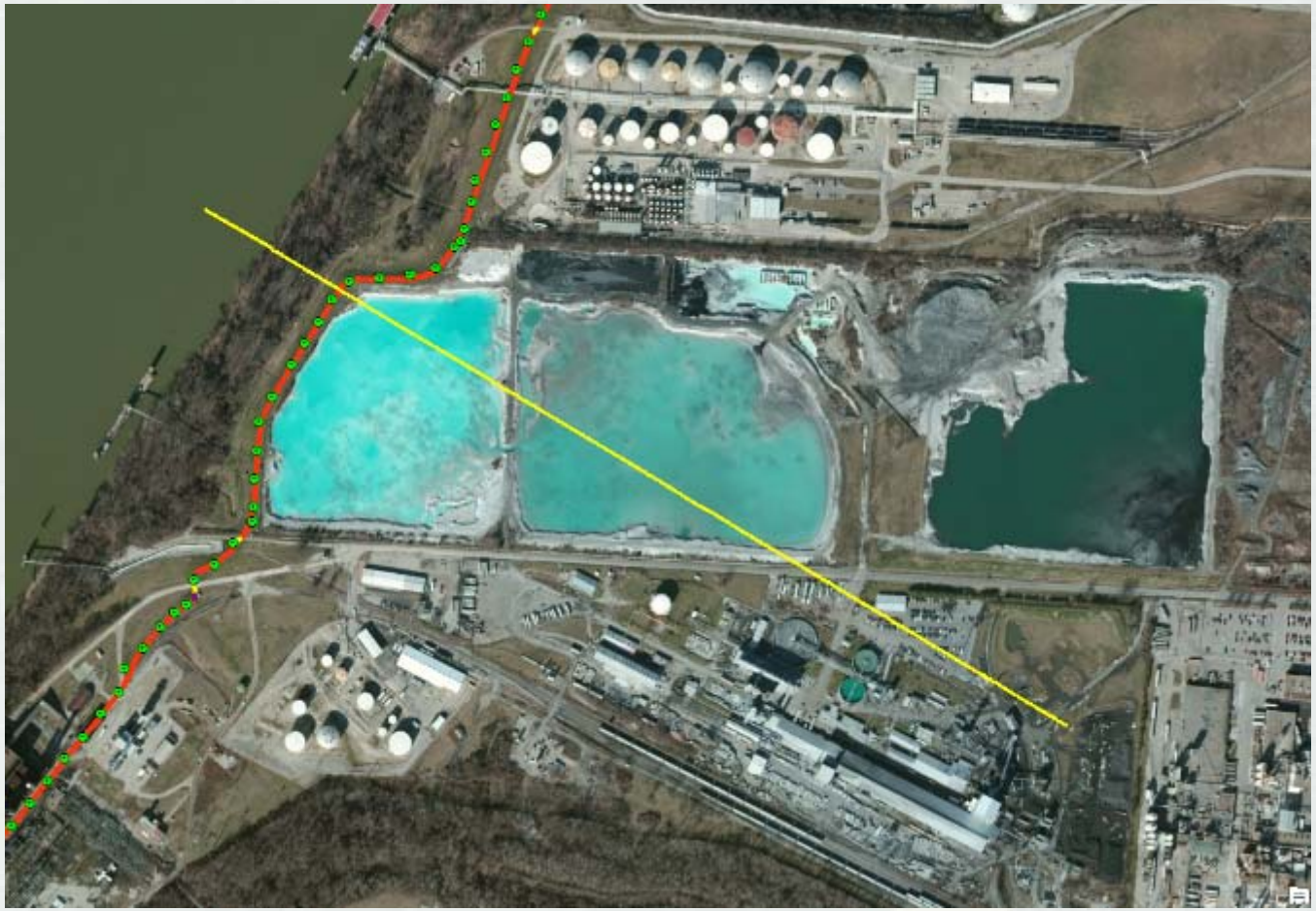
Potential Levee System Vulnerability #1

I-Wall Failure Mechanism (Post Katrina – Lessons Learned)



Potential Levee System Vulnerability #2

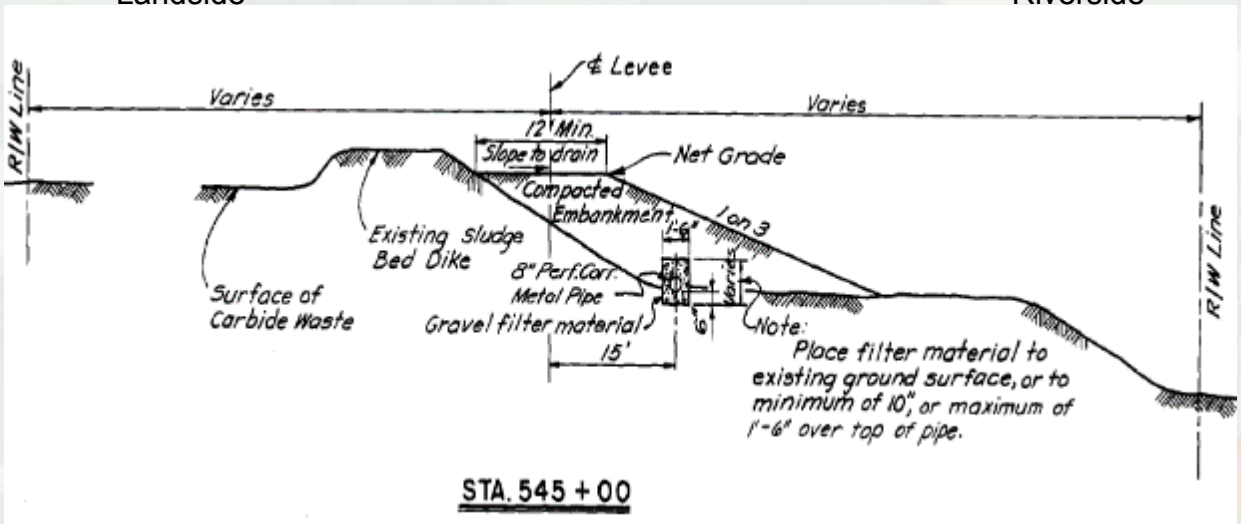
Buttress Slope - Carbide Industries



Potential Levee System Vulnerability #2

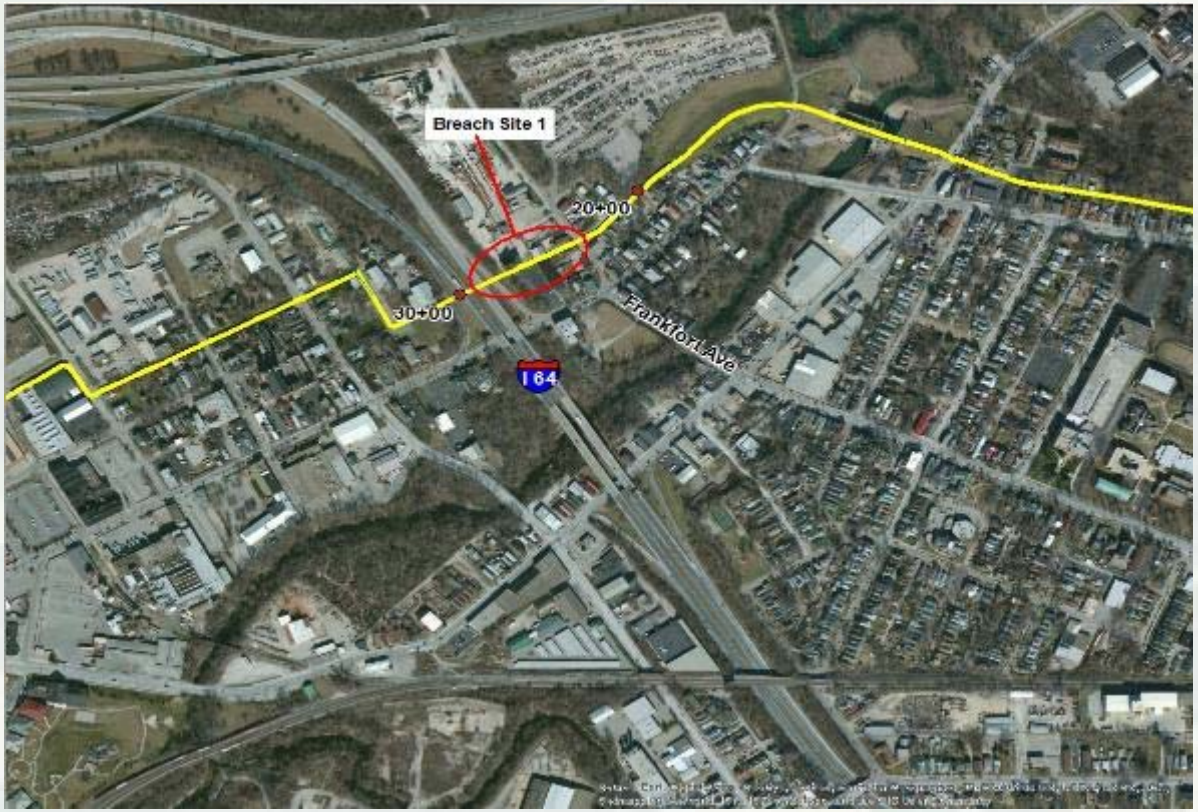
Buttress Slope – As-Built Details

Landside Riverside



Breach Site #1 (I-Wall Location)

Scenarios 1&2



Location: STA 23+78 to 26+93
Breach Width: 315-lf
Breach Time: Peak Stage
No Scour

Scenarios
1 - 50% Floodwall Loading
2 - 1937 Floodwall Loading

Breach Site #2 (Buttress Slope/Carbide)

Scenarios 3-5

Location: STA 541+00 to 546+00
Breach Width: 500-lf
*Secondary Breach Assumed
Breach Time: Peak Stage
No Scour

Scenarios
3 - 50% Flood Loading
4 - 1937 Flood Loading
Abandoned Levee Reach Fully Degraded
5 - 1937 Flood Loading
Abandoned Levee Reach Fully Intact
Culverts in Closed Position

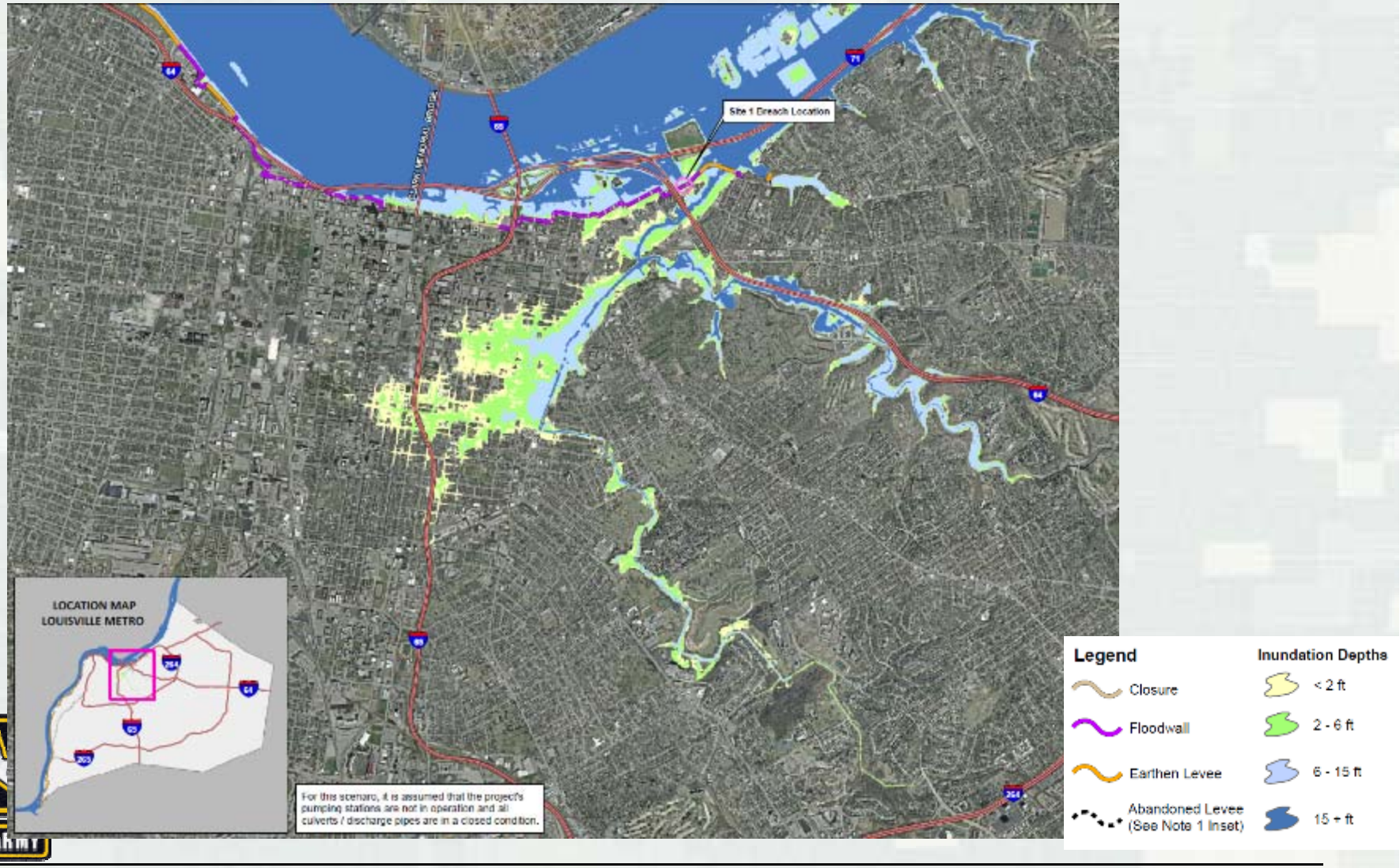
H&H Model Assumptions

- Because the levee was designed for the 1937 Flood elevation plus three feet, and because the subsequent construction of upstream flood control reservoirs provides at least four feet of additional flood risk reduction, there is currently about seven feet of freeboard above a flood event equal to the 1937 Flood. However, for this study, this was not taken into consideration and the actual 1937 flood hydrograph was utilized.
- Topographic data (~2-ft intervals) derived from LIDAR survey (i.e. LOJIC).
- Bridge openings/culverts were not modeled.
- Assumed that Pump Stations are not in operation.
- No interior rainfall.

Breach Inundation Maps

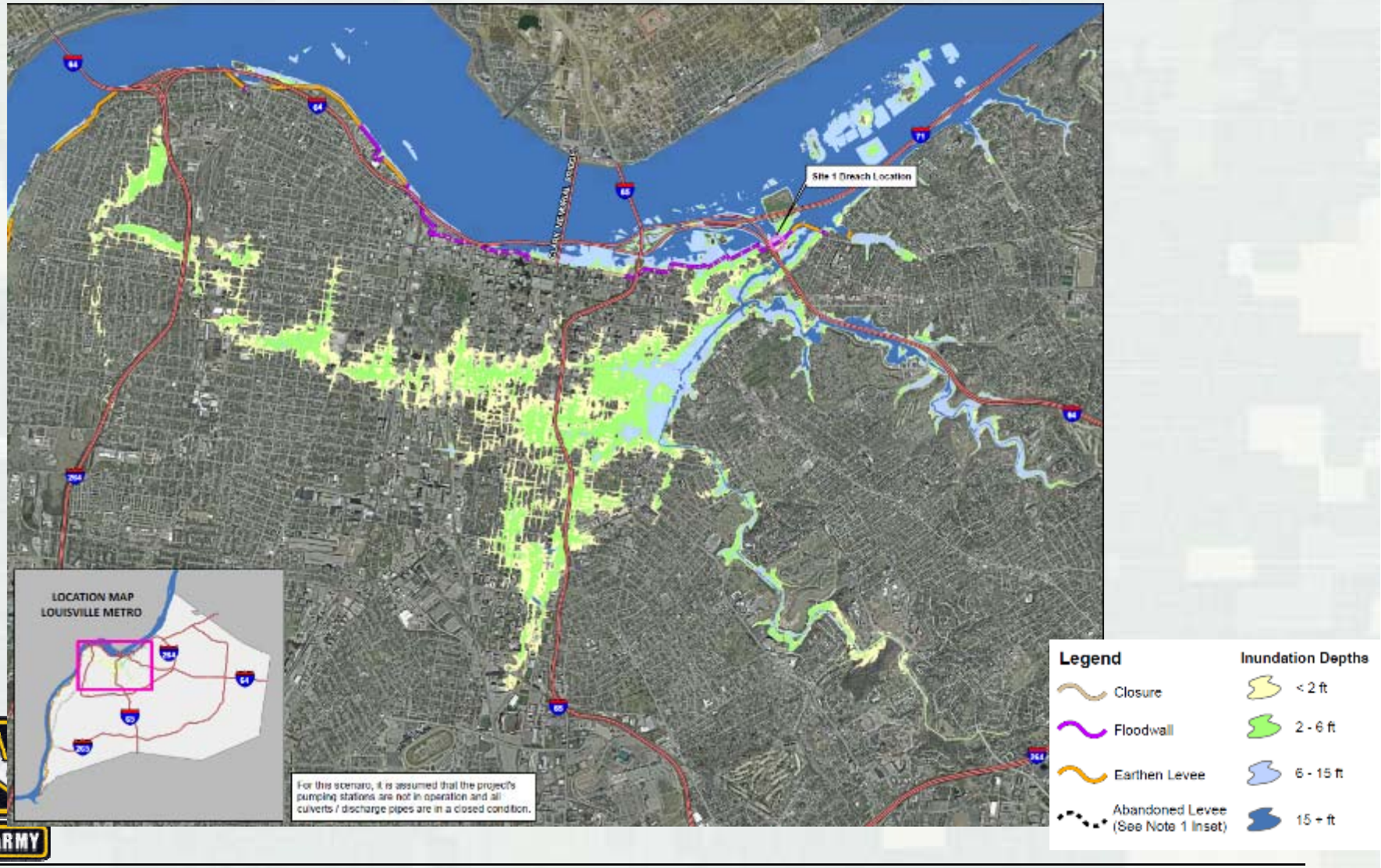
Breach Scenario 1 (Max. Depth Grid)

Breach Site #1 (I-Wall Location) – 50% Floodwall Loading



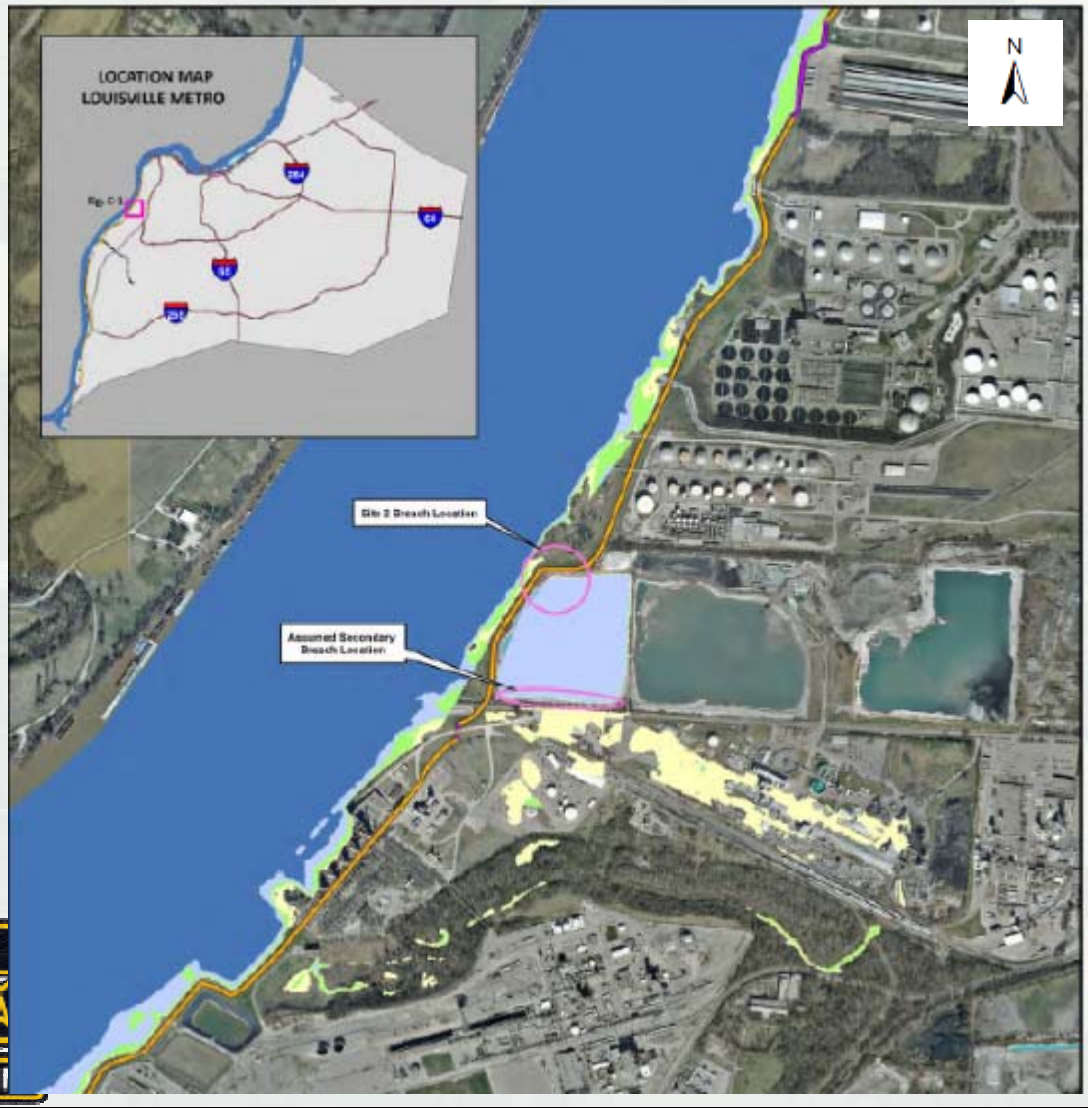
Breach Scenario 2 (Max. Depth Grid)

Breach Site #1 (I-Wall Location) – 1937 Flood Loading



Breach Scenario 3 (Max. Depth Grid)

Breach Site #2 (Buttress Levee) – 50% Embankment Loading



Legend

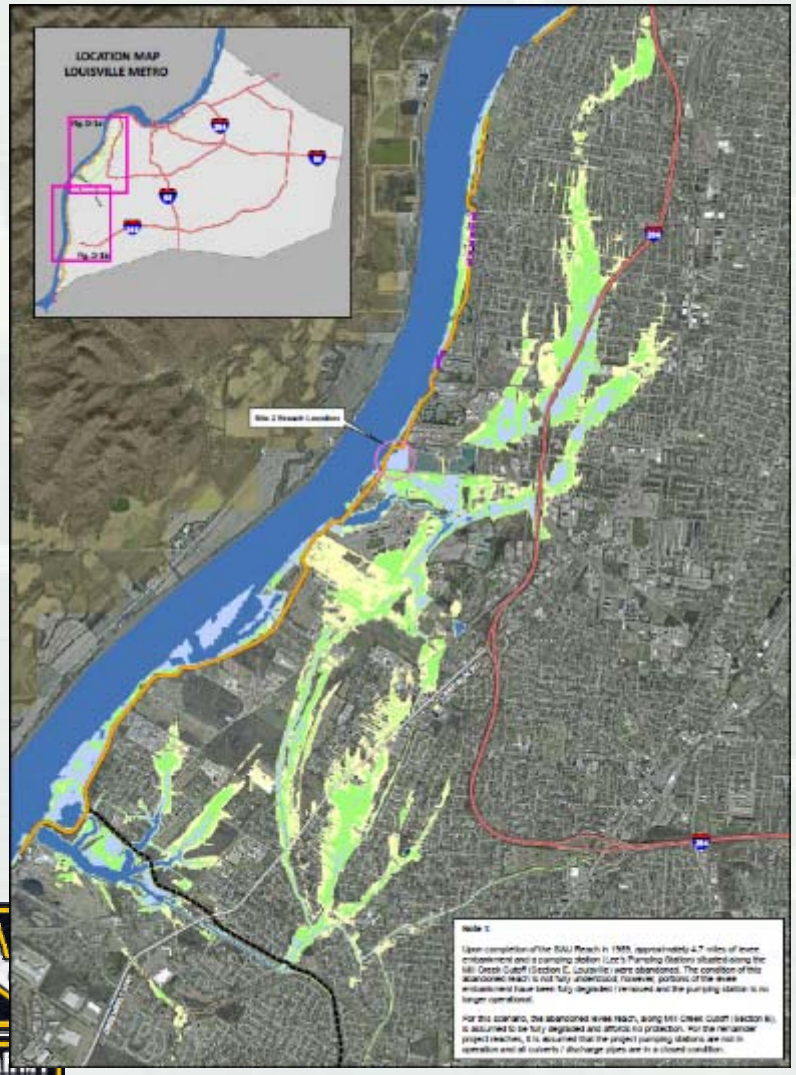
- Closure
- Floodwall
- Earthen Levee
- Abandoned Levee (See Note 1 Inset)

Inundation Depths

- < 2 ft
- 2 - 6 ft
- 6 - 15 ft
- 15 + ft

Breach Scenario 4 (Max. Depth Grid)

Breach Site #2 (Buttress Levee) – 1937 Flood Load



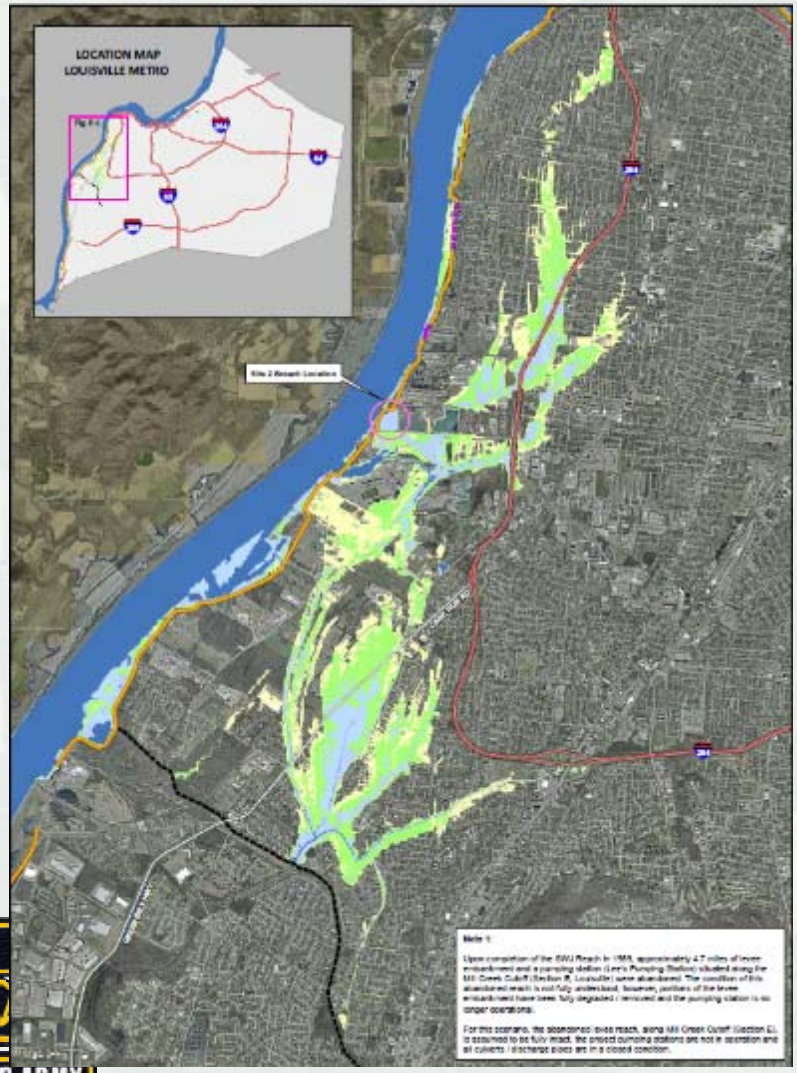
Assumptions:

- Abandoned Levee Reach Fully Degraded

Legend	Inundation Depths
Closure	< 2 ft
Floodwall	2 - 6 ft
Earthen Levee	6 - 15 ft
Abandoned Levee (See Note 1 Inset)	15 + ft

Breach Scenario 5 (Max. Depth Grid)

Breach Site #2 (Buttress Levee) – 1937 Flood Load



Assumptions:

- Abandoned Levee Reach Fully Intact
- Culverts Closed

Legend	Inundation Depths
Closure	< 2 ft
Floodwall	2 - 6 ft
Earthen Levee	6 - 15 ft
Abandoned Levee (See Note 1 Inset)	15 + ft

Consequences
(Population and Structures at Risk)

Event Description	Structures	Structure Value At Risk	Population Day	Population Night
Leveed Area	79,600	22,337,680,000	293,600	237,700

Scenario	Event Description	Structures	Population Day	Population Night
One	Flood Wall - 50%	1,600	8,700	5,700
Two	Flood Wall - 1937	4,500	25,200	14,500
Three	Carbide - 50%	1	50	3
Four	Carbide - 1937	2,700	6,100	7,400
Five	Carbide - 1937 - OL	3,900	8,100	10,400

Consequences
(Est. Life Loss & Economic Damages)

Event		Population		Best Case Life Loss		Medium Case Life Loss		Worst Case Life Loss	
Scenario	Event Description	Day	Night	Day	Night	Day	Night	Day	Night
One	Flood Wall - 50%	8,700	5,700	1	0	6	3	86	42
Two	Flood Wall - 1937	25,200	14,500	2	1	9	4	140	61
Three	Carbide - 50%	50	3	-	-	-	-	-	-
Four	Carbide - 1937	6,100	7,400	1	1	4	4	41	36
Five	Carbide - 1937 - OL	8,100	10,400	1	1	5	6	50	57

Scenario	Event Description	Structures	Economic Damages ($)
One	Flood Wall - 50%	1,600	299,720,000
Two	Flood Wall - 1937	4,500	669,520,000
Three	Carbide - 50%	1	520,000
Four	Carbide - 1937	2,700	161,450,000
Five	Carbide - 1937 - OL	3,900	351,720,000

Major Findings

1. The project incorporates approximately 4,456-lf of I-walls. Approximately 1,792-lf of the project I-walls do not meet current USACE guidance for stability. However, based on the fact that there is limited soil information for this project and the locations of these I-walls are spread over a project which is 25.9 miles in length, all project I-walls greater than 6-ft in height on the landside (excluding transitional I-walls) are considered deficient and are recommended for further evaluation.

2. Stability of the levee buttress slope between levee STA 536+65 and 553+34 is not well understood and should be further evaluated. MSD recently completed a subsurface investigation; however, stability of this reach is not fully understood. If a levee failure were to occur at this location, the pond dike would also have to fail along the east and/or southern perimeter for flood waters to exit the pond; however, this is a conservative assumption.

3. The condition and performance of the abandoned levee reach and the Mill Creek Cutoff Embankment is not fully understood. The two abandoned pumping stations are in disrepair and are non-functional.

   If a levee breach were to occur, operation and performance of the abandoned levee reach and performance of the Mill Creek Cutoff embankment may be critically important with regards to life safety and property damages. Portions of the abandoned reach have been partially and/or fully degraded (or is non-functional) and some of the flood gates are approaching the end of their service life and/or may be non-functional. <Reference Following Slides>

Major Findings (Cont.)

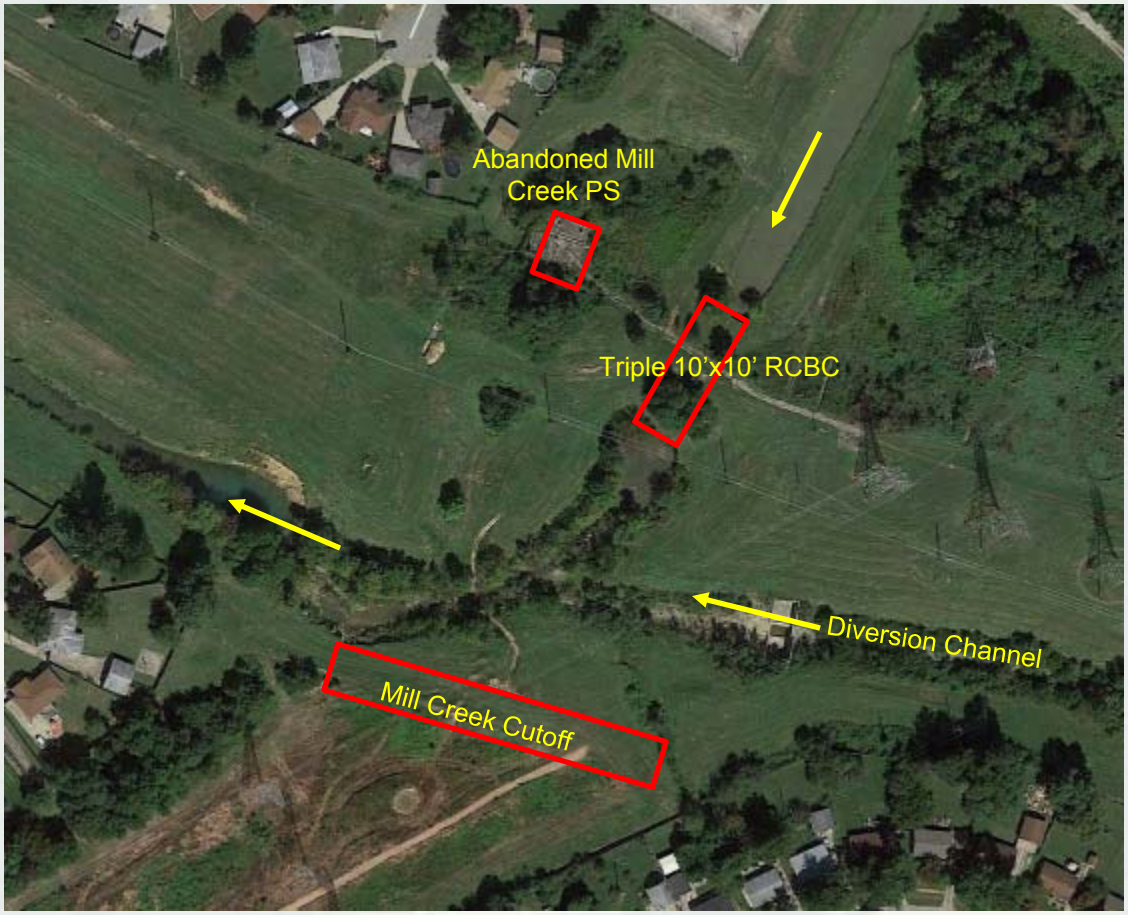
Scenario #4 – 1937 Flood Event Load, Assumes Abandoned Reach Fully Degraded & Pump Stations Not Operating

* A controlled breach of the Mill Creek Cutoff would direct some of the floodwater south toward the Lower Mill Creek PS.

Scenario #5 – 1937 Flood Event Load, Assumes Abandoned Reach Fully Intact, Pump Stations Not Operating, All Gates Closed

* A controlled breach of the levee in the vicinity of the Triple Box Culvert may direct additional floodwater south/west toward Upper Mill Creek PS.

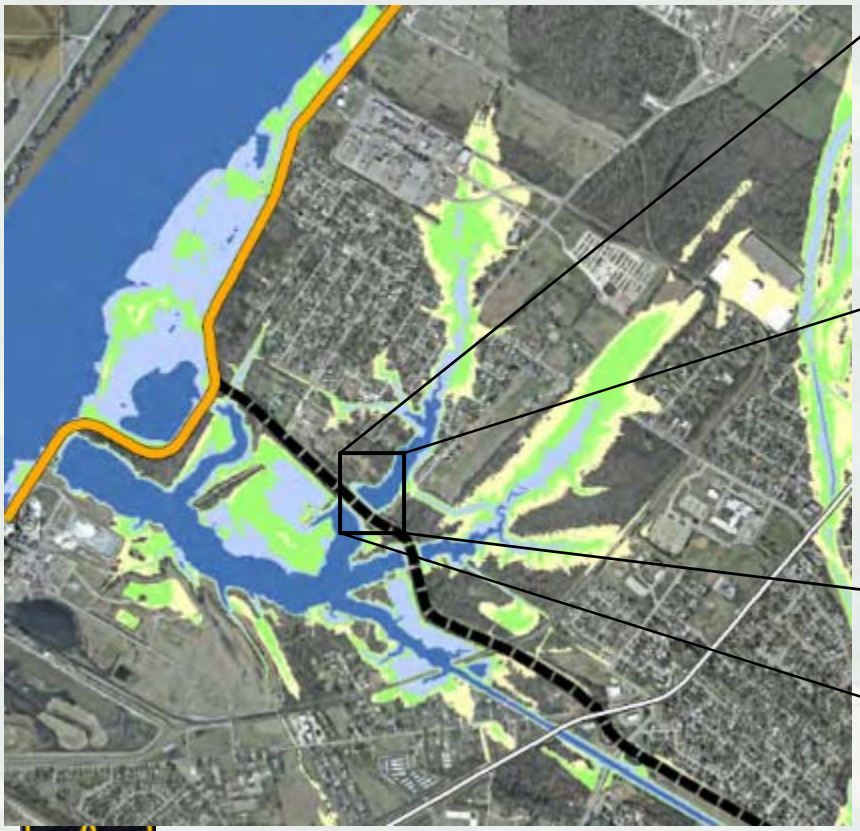
Major Findings (Cont.)



Vicinity Abandoned Levee STA 841+54.70

Major Finding (Cont.)

Abandoned Levee Reach – Culvert at STA 758+71



Scenario #4 – 1937 Flood Event Load, Assumes Abandoned Reach Fully Degraded & Pump Stations Not Operating

Abandoned Levee STA 758+71: Heavily Corroded 96-inch CMPP
(Condition Observed During 2013 Demonstration Project)

Recommendations

1. Recommend Sponsor update existing Emergency Response Plan (ERP) and incorporate those items referenced in the provided USACE Emergency Preparedness Plan (EPP) template. Example items: 1) Flood Warning and Pre-Scripted Messages, 2) Add GIS Maps with Levee Features, 3) Add Known Levee Vulnerabilities, 4) Add USACE Flood Fight Response Information – Advance Measures, Post Flood Response, 5) Add USACE Flood Fighting Techniques, 6) Provide General Evacuation Information.

2. Understand Risk Associated with Project I-walls <I-wall loading occurs at an 0.0045 ACE, 220-yr event or greater >
   Recommended Further Evaluation
   Floodwall Remediation if Not Meeting USACE Requirements (EC 1110-2-6066, ETL 1110-2-575)

New Orleans Floodwall Remediation, Concrete Wall Buttress

- At least 1,792-lf of Project I-walls (~40%) do not meet USACE criteria (i.e. embedment/height ratio, inadequate factor of safety).
- Recommend all non-transitional I-wall (> 6-ft) be further evaluated due to limited soil data.
- Awaiting further guidance on how to proceed from HQ.

Recommendations (Cont.)

3. Understand risk associated with Carbide Sludge Pond and reported dewatering activities. Submit for permit review and approval the planned dewatering activities at Carbide Industries associated with the pond dewatering. Additional evaluation and modification of the landside slope is likely warranted.

4. Coordinate and participate in a Tabletop exercise with the Jefferson County EMA, USACE and other local, state and emergency support partners in order to identify possible issues/risks that may occur during a flood emergency.

   Based on the Tabletop exercise, prepare a Risk Management Plan (RMP). Potential issues which may be incorporated into the RMP may include:

   - Floodproofing and flood protection barriers for critical structures (e.g. sandbags etc.);
   - Identification of transportation resources, evacuation routing, emergency shelters and staging areas;
   - Potential power outages;
   - Potential security issues (e.g. terrorism, vandalism, or other violent activities);
   - Coincident flood events (e.g. main flooding source in community hits flood stage at same time as small tributaries in leveed area);
   - Impacts of unexpected failures (e.g. pumps, gates, or other critical features during a response);
   - Higher than expected releases from an upstream dam that could impact flood volumes;
   - Other unexpected perils (e.g. hazardous debris, materials, displaced animals or wildlife);
   - Securing of storage tanks for emergency vehicles and auxiliary power systems.

Replacement Relief Well Project Cannelton, Indiana Levee System

Richard (Rick) B. Hockett, P.G.

Geologist

Louisville District Risk Cadre

Geotechnical and Dam Safety Section

10 February 2016

US Army Corps of Engineers
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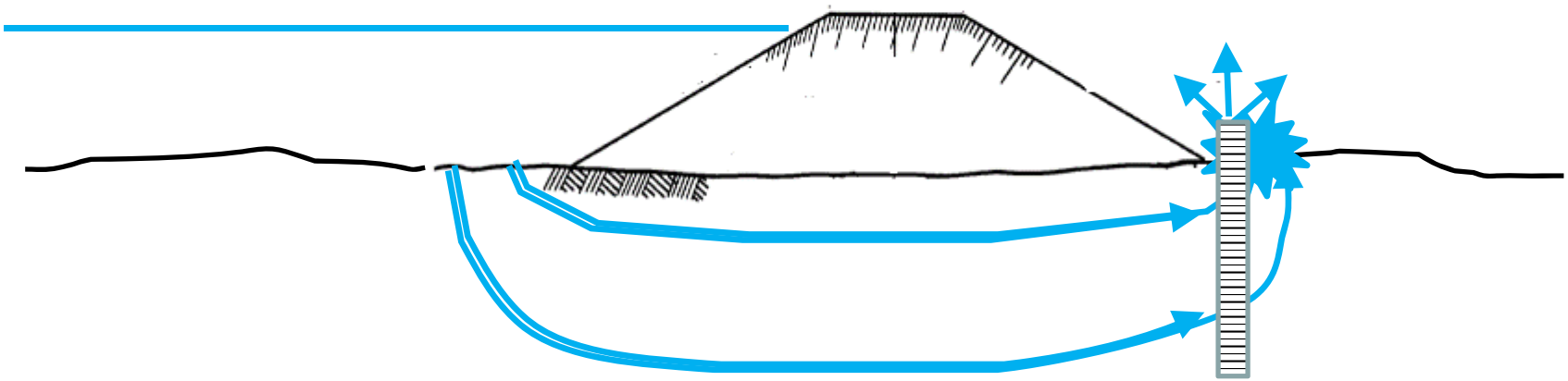
What is a Relief Well?



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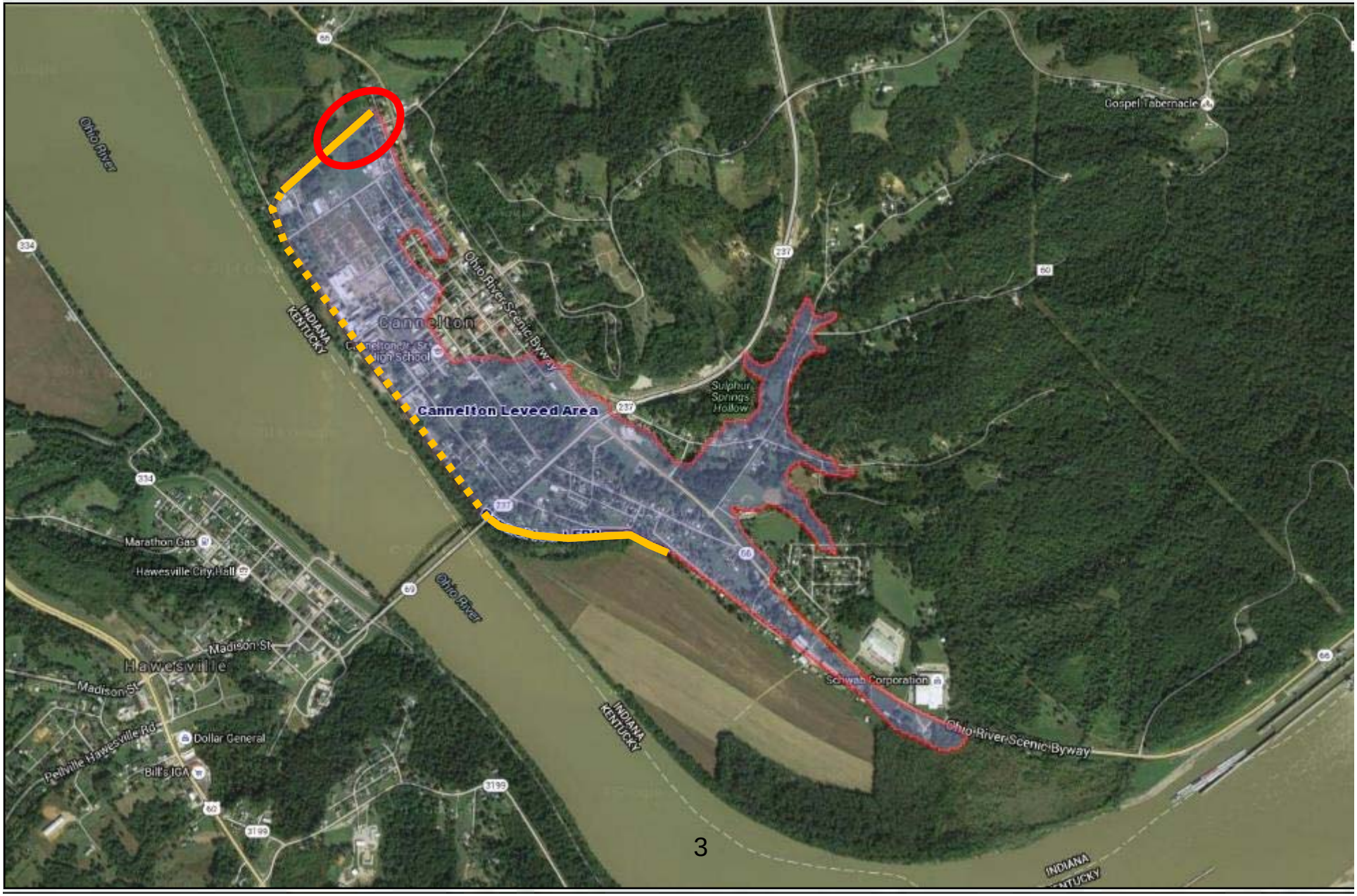
Cannelton Levee System



Seepage History

- Levee construction completed in 1952.
- Relief drain on landside toe.
- Seepage occurred during 1955 flood.
- USACE designed relief well system in 1956.
- Relief well system installed in 1957.

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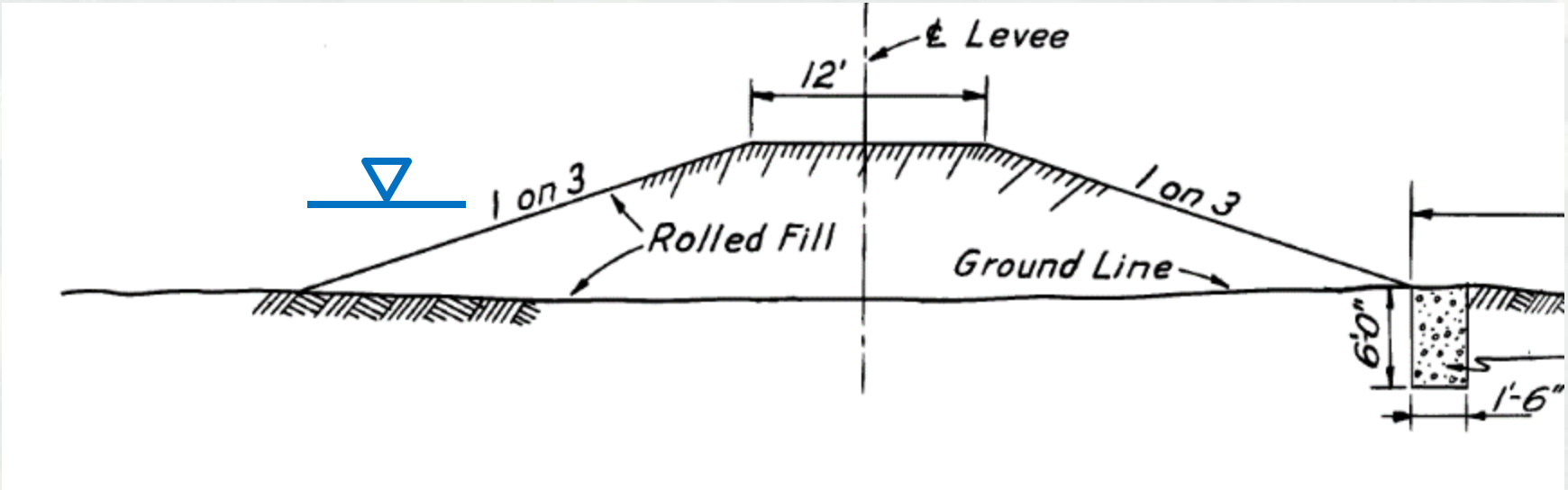
1955 Flood Loading

Flood elevation	396 ORD (15-year recurrence interval)
Crest elevation	409 ORD
Toe elevation	382 ORD (27 ft max section)

~50% load



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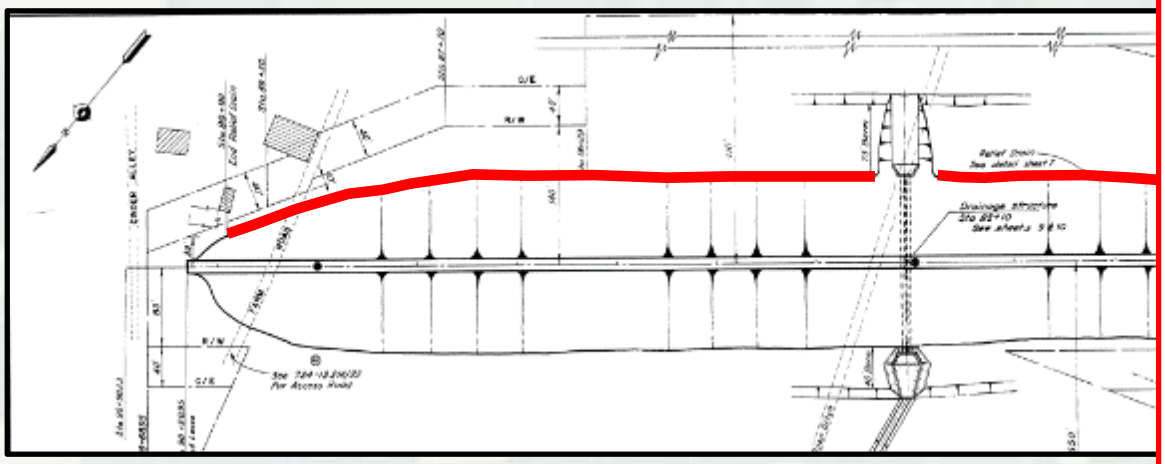
The largest boil, approximately two feet in diameter … was brought under control by building a sandbag ring around it to a height of approximately two feet … thus increasing the required uplift pressure…

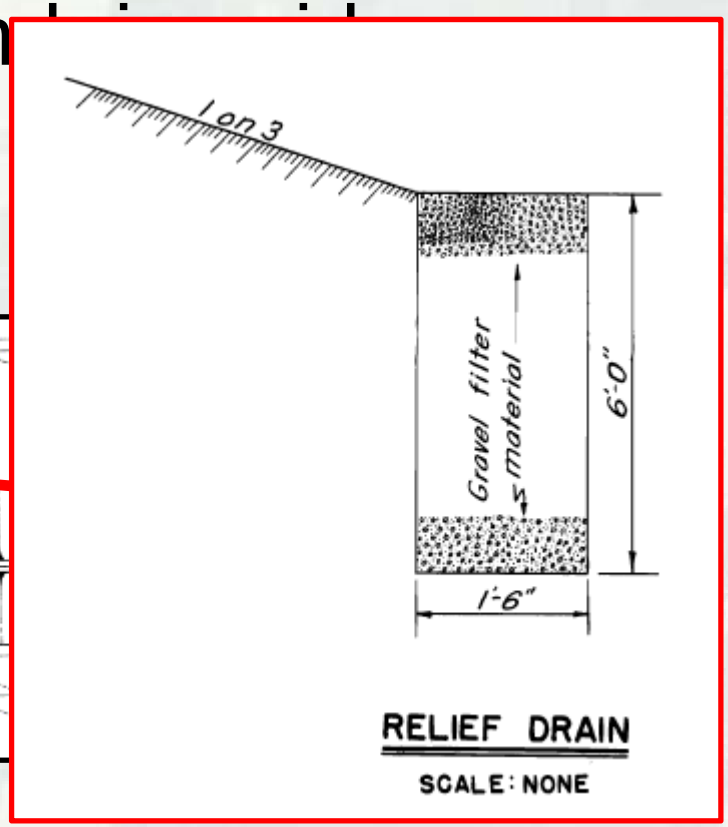
…most serious seepage…. …ils and

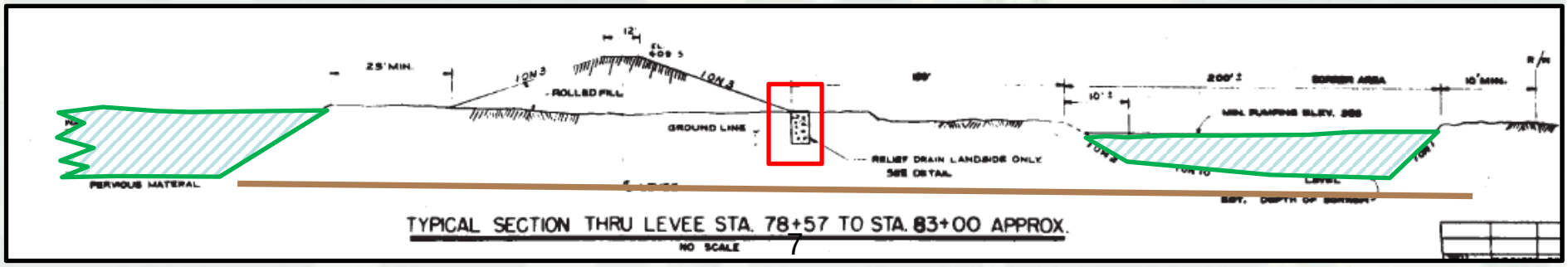
This pit also serves as a ponding area for the Fourth Street Pumping Plant.

Original Levee Design

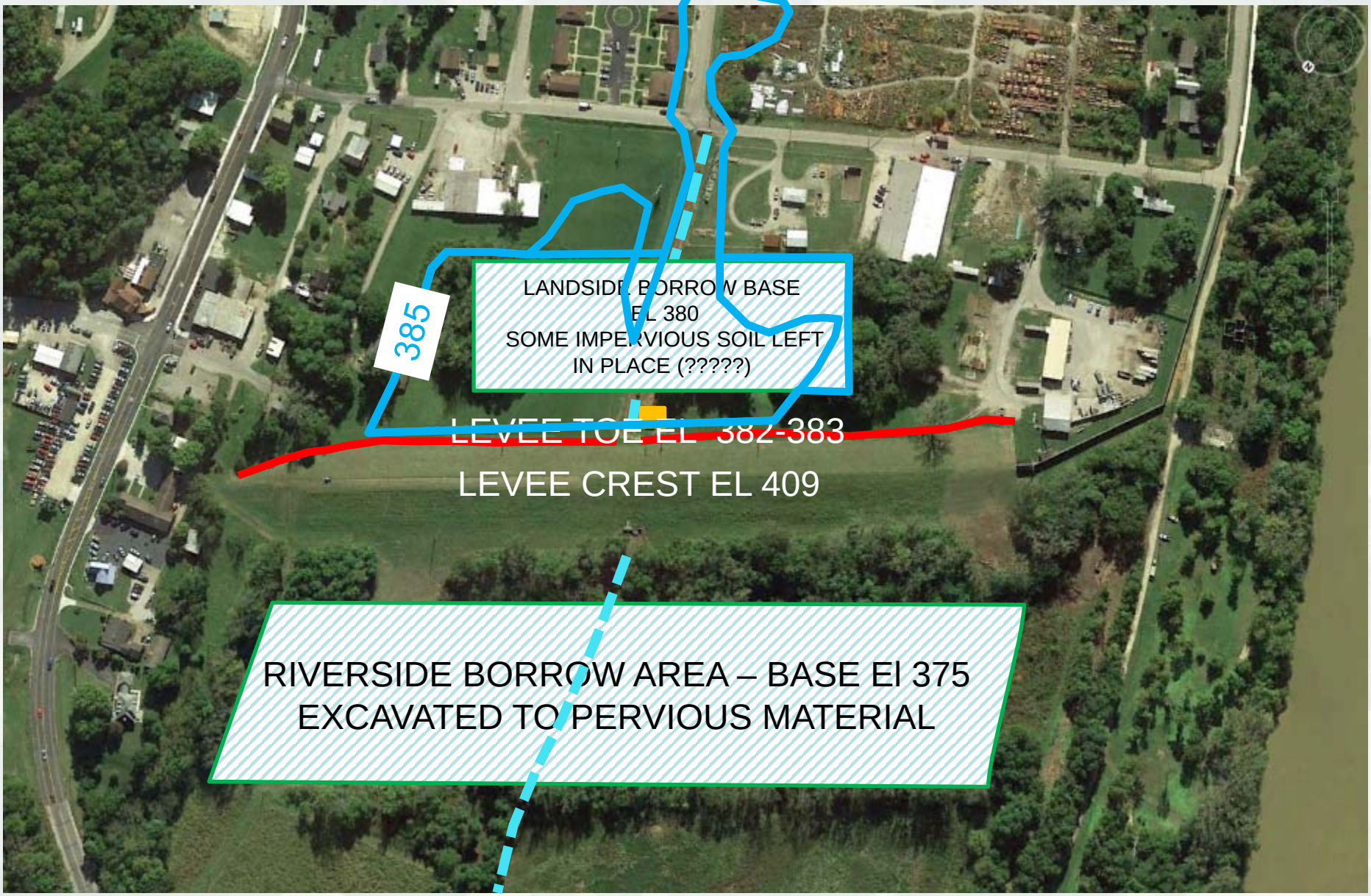
- Borrow areas on landside an
- Relief drain at landside toe.
  - Gravel filled trench.



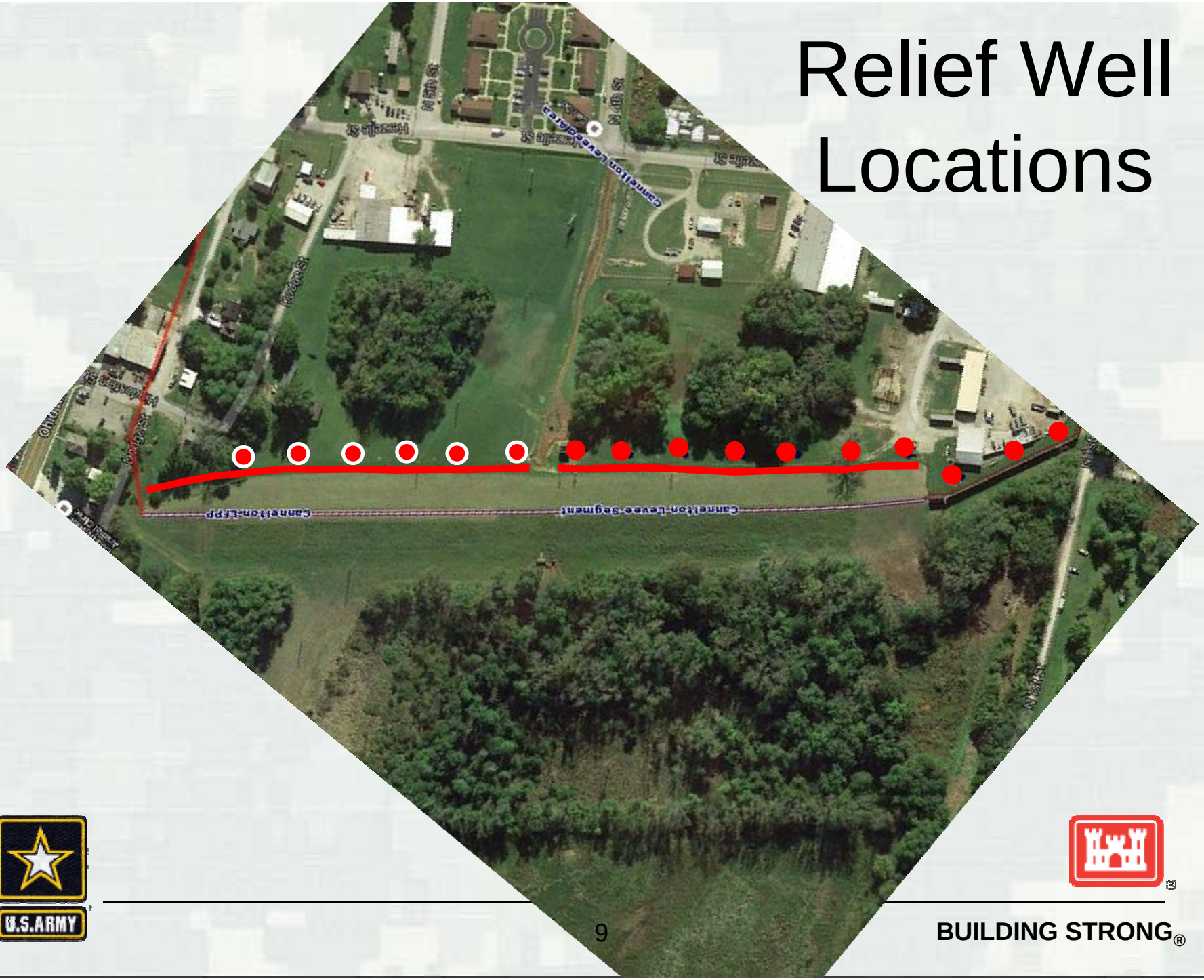




As-built Project Features



Relief Well Locations



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Original Relief Well Design

3-03. Well Screen. a. General. The well screen shall be 12-inch diameter, perforated, bituminous-coated corrugated metal pipe fabricated from No. 14 U. S. Standard gage zinc-coated corrugated metal sheets and shall be of the diameter shown on the drawings. Perforated sections shall have 7/16 inch diameter holes punched on approximately 1-1/2-inch centers in 2 circumferential rows per corrugation, namely in the outside valleys of the corrugations and on the upper tangents, except at circumferential laps. The holes shall be evenly staggered. The base metal, fabrication, and galvanizing shall conform to Federal Specification QQ-C-806a, for "Culverts; Iron or Steel, Zinc-Coated," Type I, except that the average weight of the zinc coating shall be not less than 2.0 ounces per square foot of sheet metal and the weight of zinc coating on any one sample shall be not less than 1.8 ounces per square foot of sheet metal. The weight of coating is the total amount on both sides of a sheet, expressed in ounces per square foot of sheet. Both sides of the metal sheet shall be coated with a layer of asbestos fiber applied in sheet form by pressing into the molten zinc coating. The asbestos fiber shall be evenly distributed over the surfaces and thoroughly embedded in the zinc coating. Immediately after the zinc coating has solidified, the asbestos fibers shall be thoroughly saturated with a bituminous saturant. The finished sheet shall be similar and equal to Armco asbestos-bonded

Discharge Point

LSE Project Milestones

- Levee System Evaluation (LSE) per FEMA requirements began in 2012.
- Stability analysis during LSE identified relief wells as essential to integrity of levee.
- Relief well inspection showed poor condition, and pumping tests showed poor performance.
- No baseline pumping tests were found.
- Cannelton Levee System could not be certified without pressure relief.
- Terracon designed the replacement relief well system; design included test borings, lab testing, and 3D groundwater modeling.
- City obtained funding from Indiana Office of Community and Rural Affairs (OCRA).
- Ortman Drilling installed the new wells and collector system.

What went wrong?

- Relief well screens silted in.
- Possible causes:
  - Backflow from Fourth Street ditch through collector manifold pipe.
  - Silt entered wells through well screens.

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Relief Well Collector

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Blame it on the Geology!

- Original relief wells screened from ~20 ft below ground surface to top of rock or El 294. Wells constructed with 68-ft screens.
- Test borings revealed three layers of silt or clay within the screened interval. Much of the intervening sand was poorly graded fine and medium sand.

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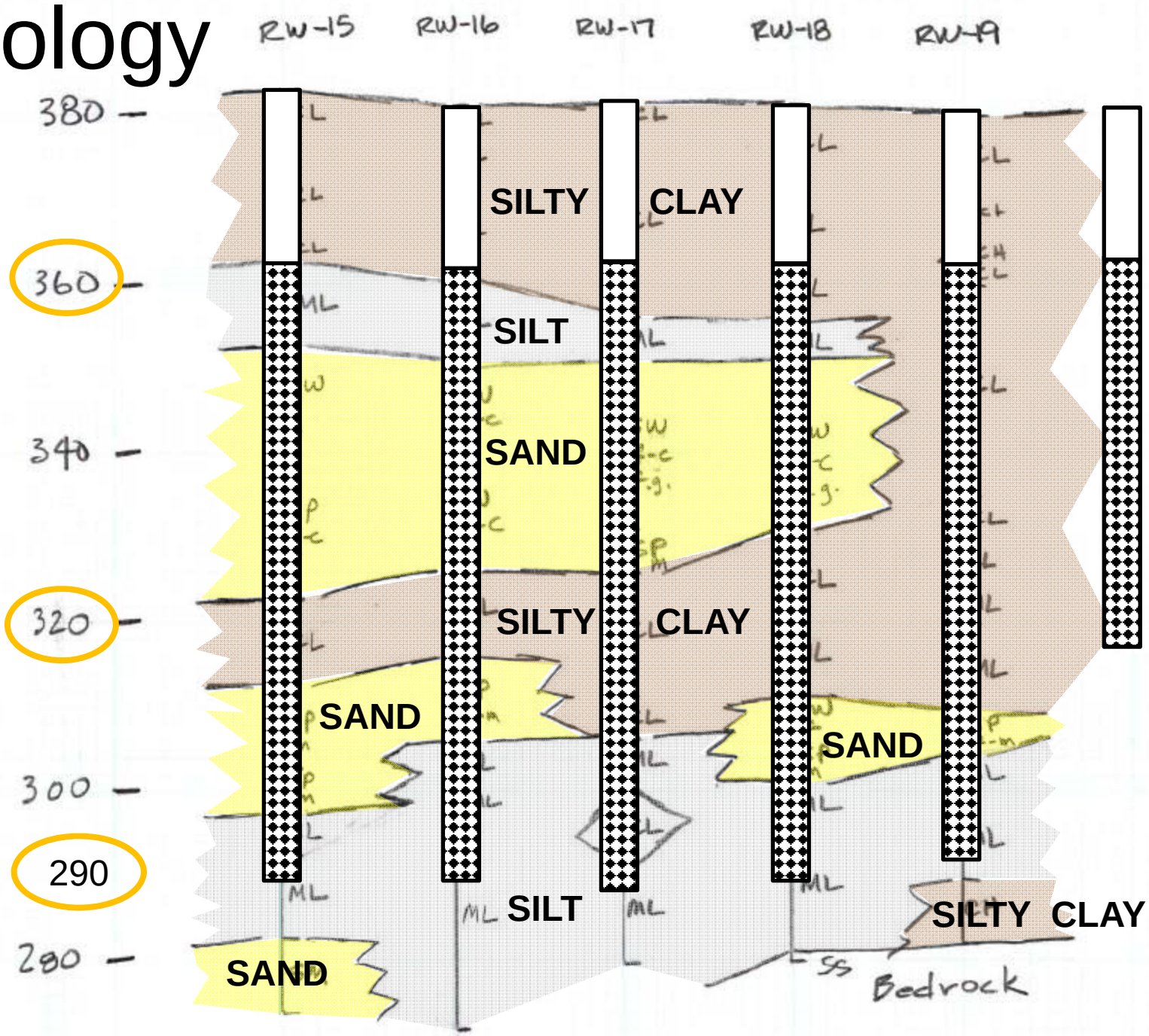
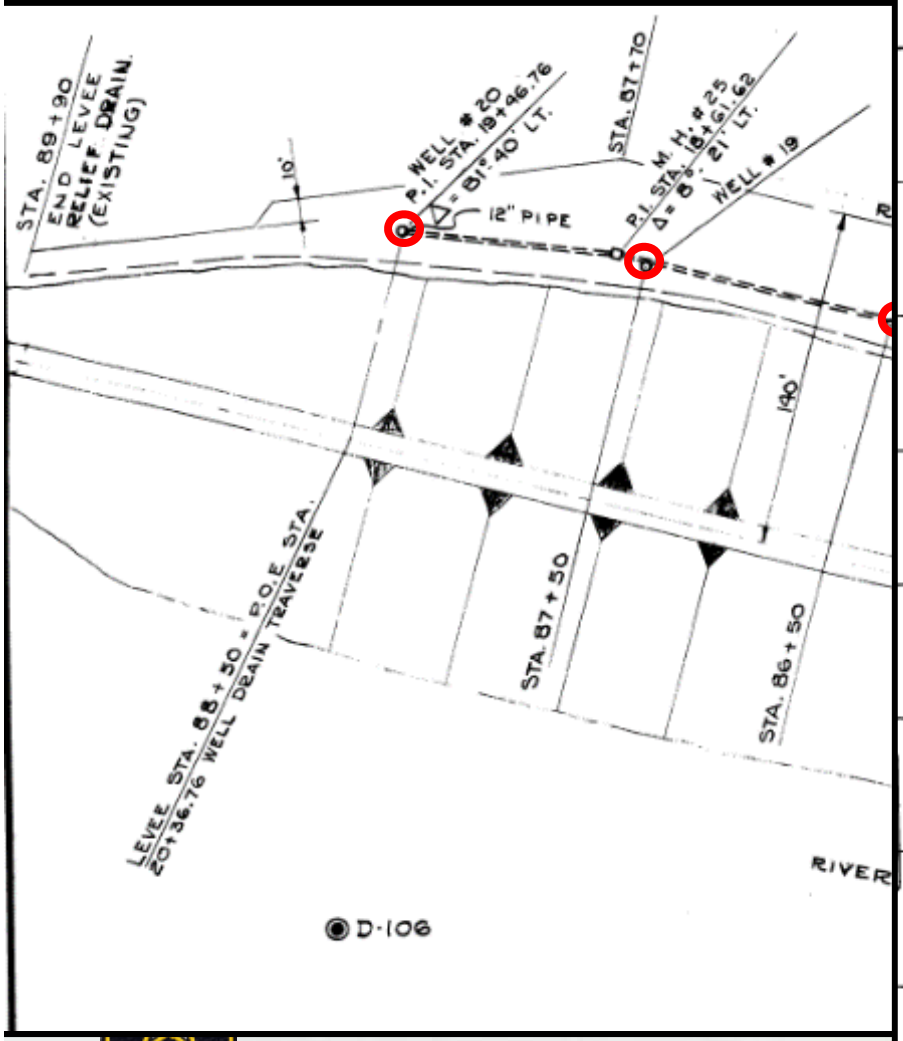
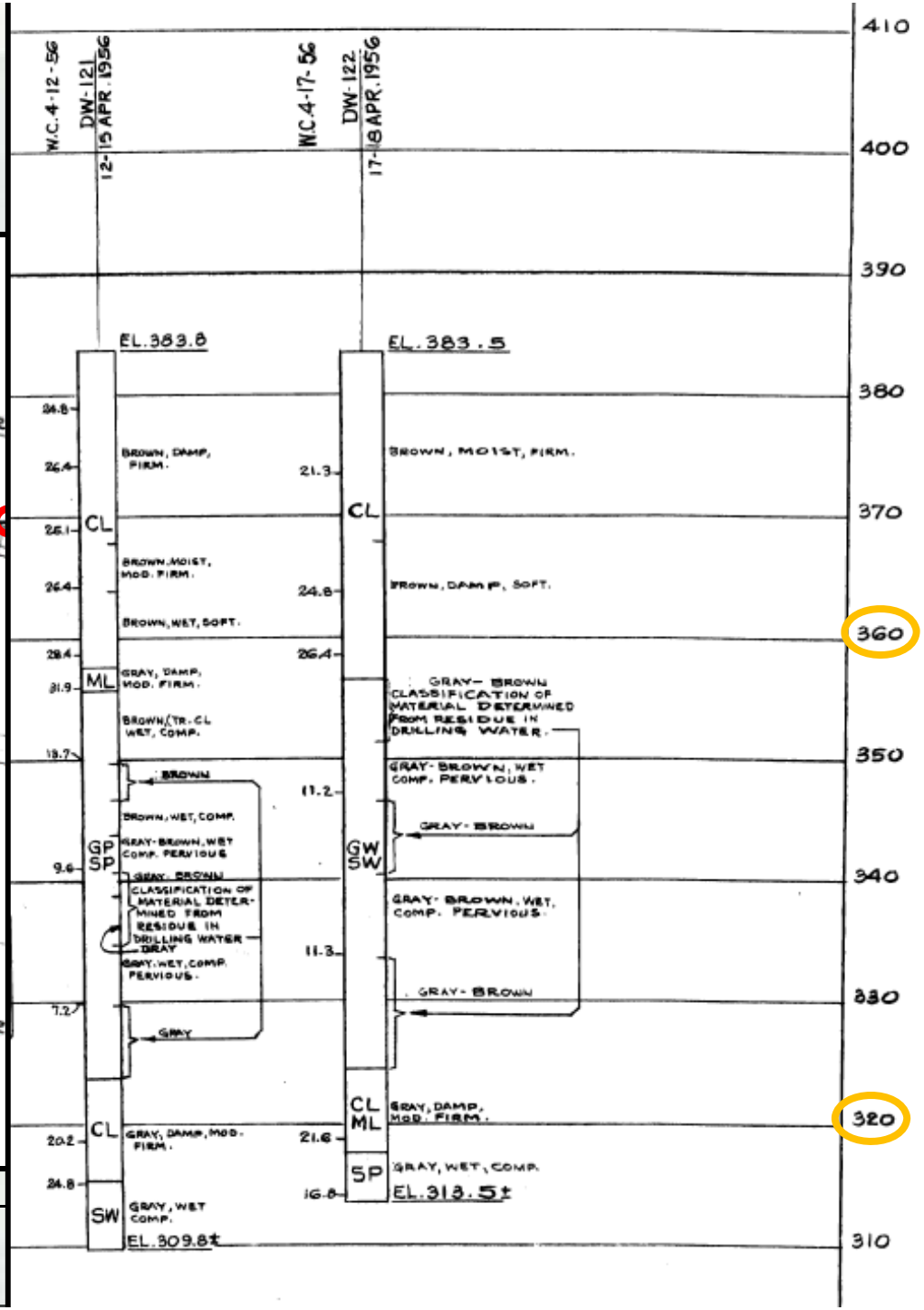
Geology


RW-15
RW-16
RW-17
RW-18
RW-19
380
360
340
320
300
290
280
SILTY CLAY
SILT
SAND
SILTY CLAY
SAND
SAND
SILT
SILTY CLAY
SAND
Bedrock

Design Borings

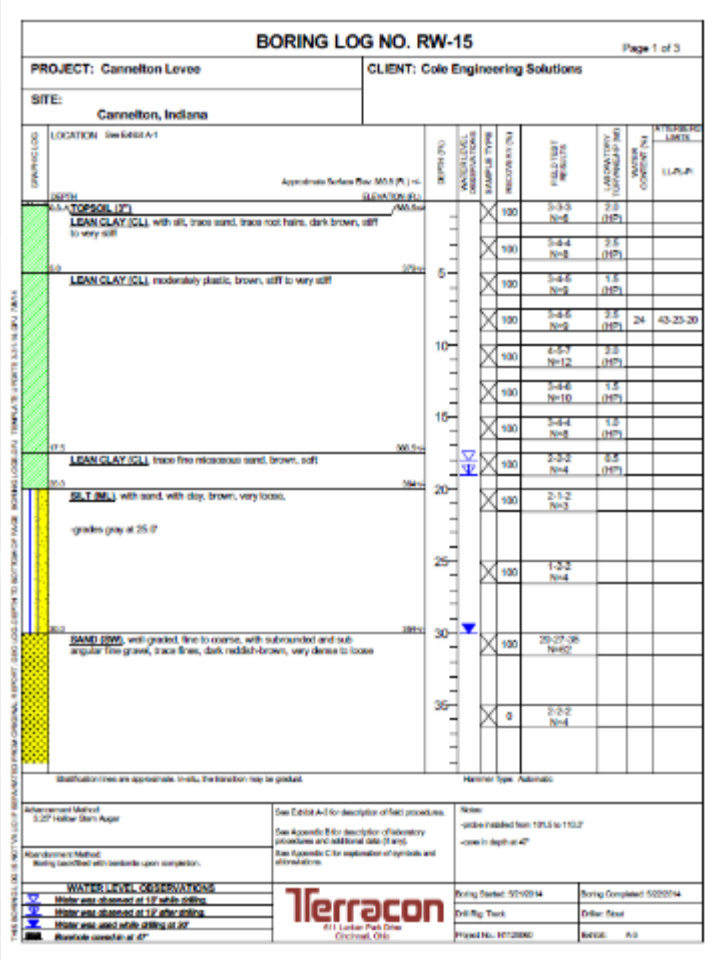


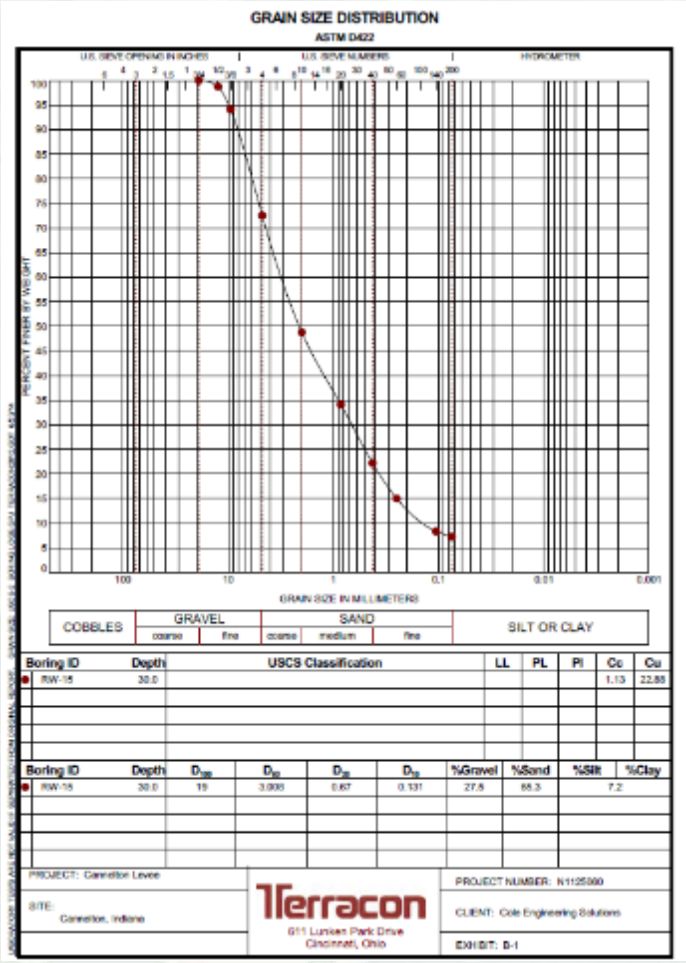


U.S.ARMY

New Relief Well Design

Test Borings and Lab Testing





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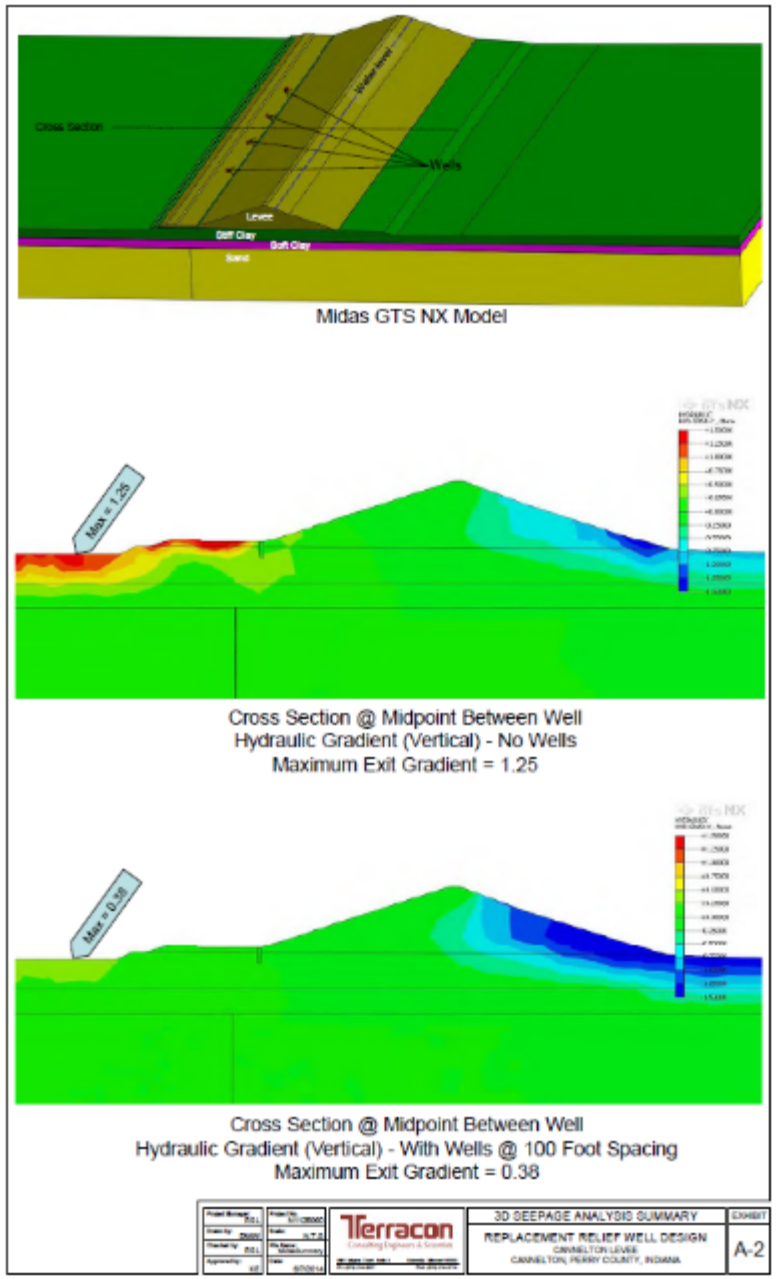

3D Seepage Model

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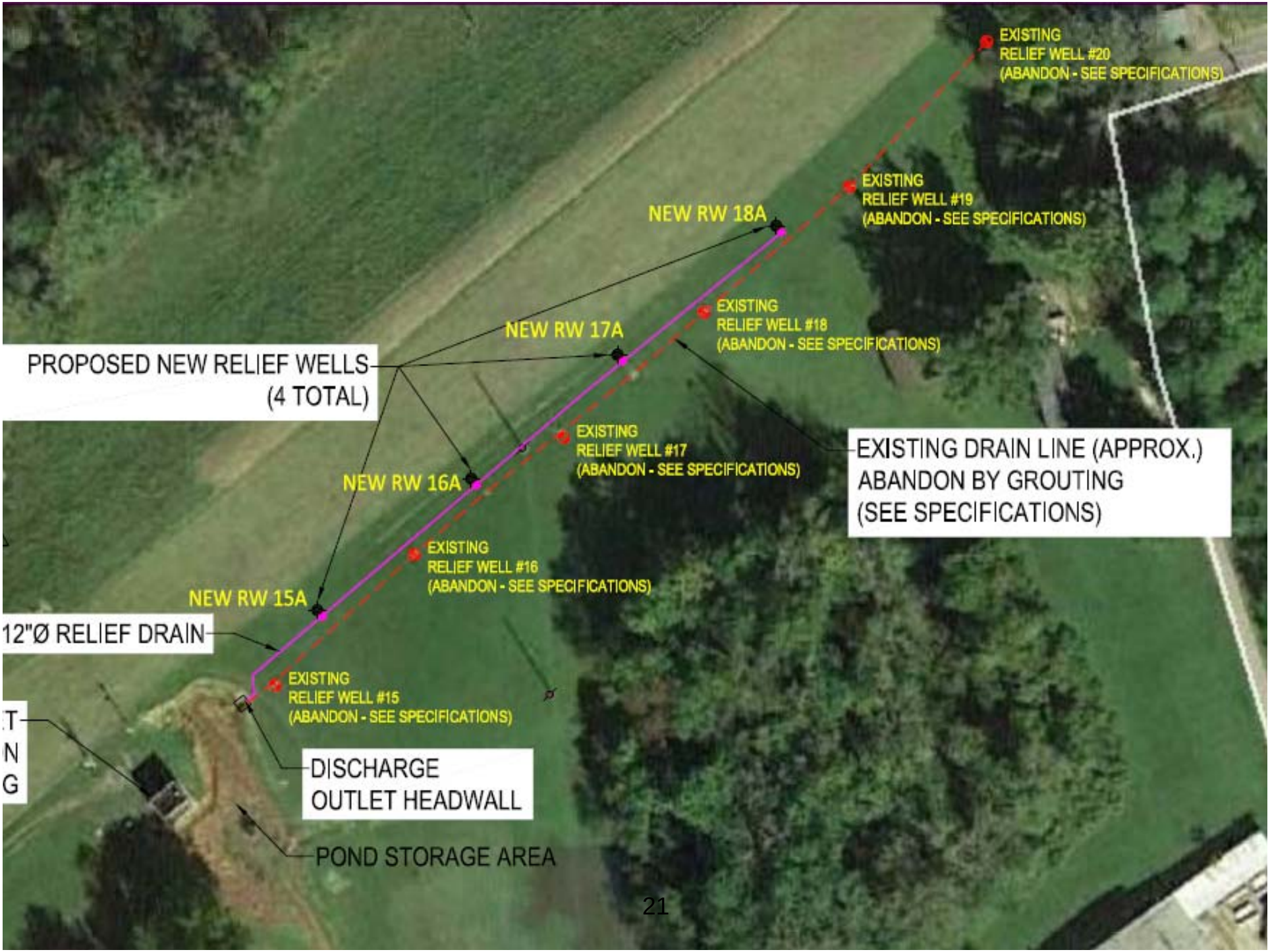
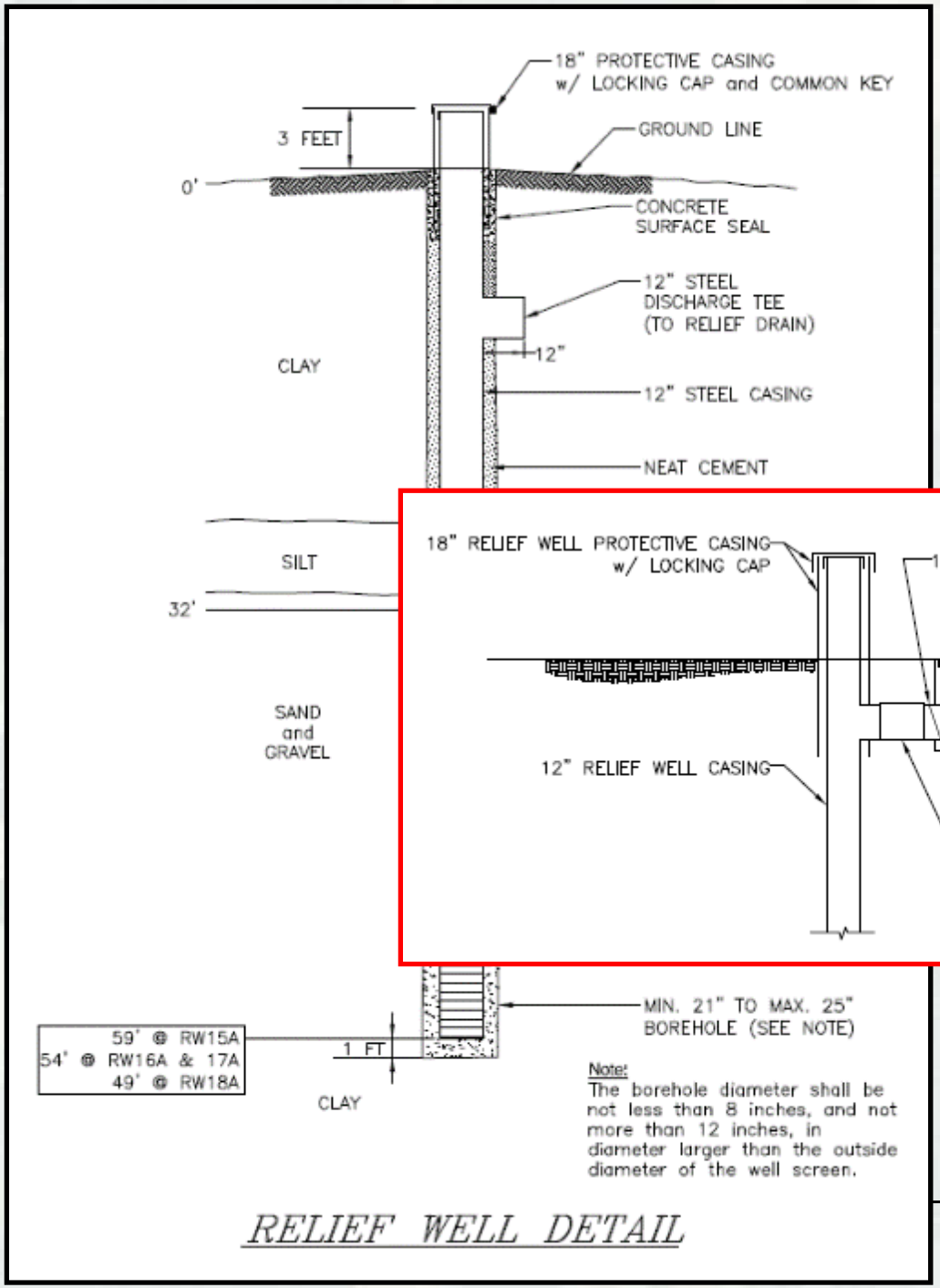
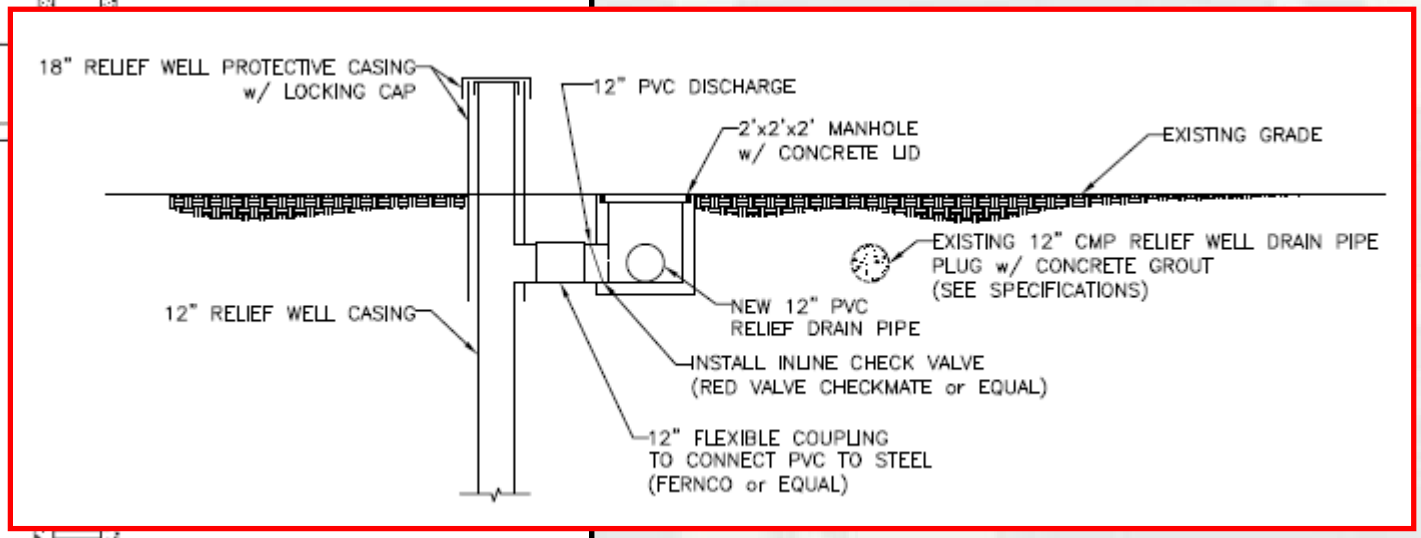
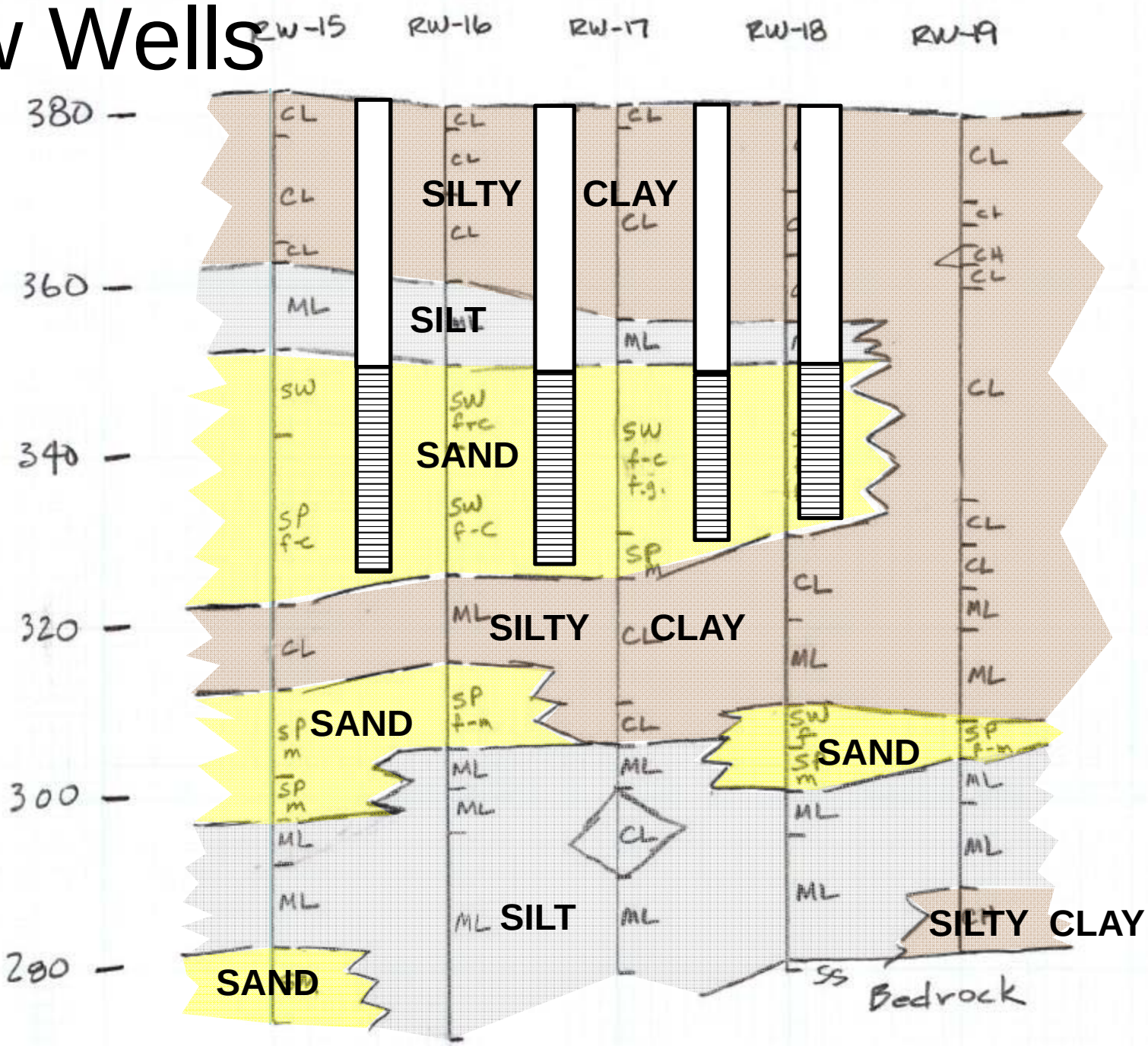

EXISTING
RELIEF WELL #20
(ABANDON - SEE SPECIFICATIONS)
EXISTING
RELIEF WELL #19
(ABANDON - SEE SPECIFICATIONS)
NEW RW 18A
EXISTING
RELIEF WELL #18
(ABANDON - SEE SPECIFICATIONS)
NEW RW 17A
PROPOSED NEW RELIEF WELLS
(4 TOTAL)
EXISTING
RELIEF WELL #17
(ABANDON - SEE SPECIFICATIONS)
EXISTING DRAIN LINE (APPROX.)
ABANDON BY GROUTING
(SEE SPECIFICATIONS)
NEW RW 16A
EXISTING
RELIEF WELL #16
(ABANDON - SEE SPECIFICATIONS)
NEW RW 15A
12"Ø RELIEF DRAIN
EXISTING
RELIEF WELL #15
(ABANDON - SEE SPECIFICATIONS)
DISCHARGE
OUTLET HEADWALL
POND STORAGE AREA

New System Design





New Wells


RW-15
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SILTY CLAY
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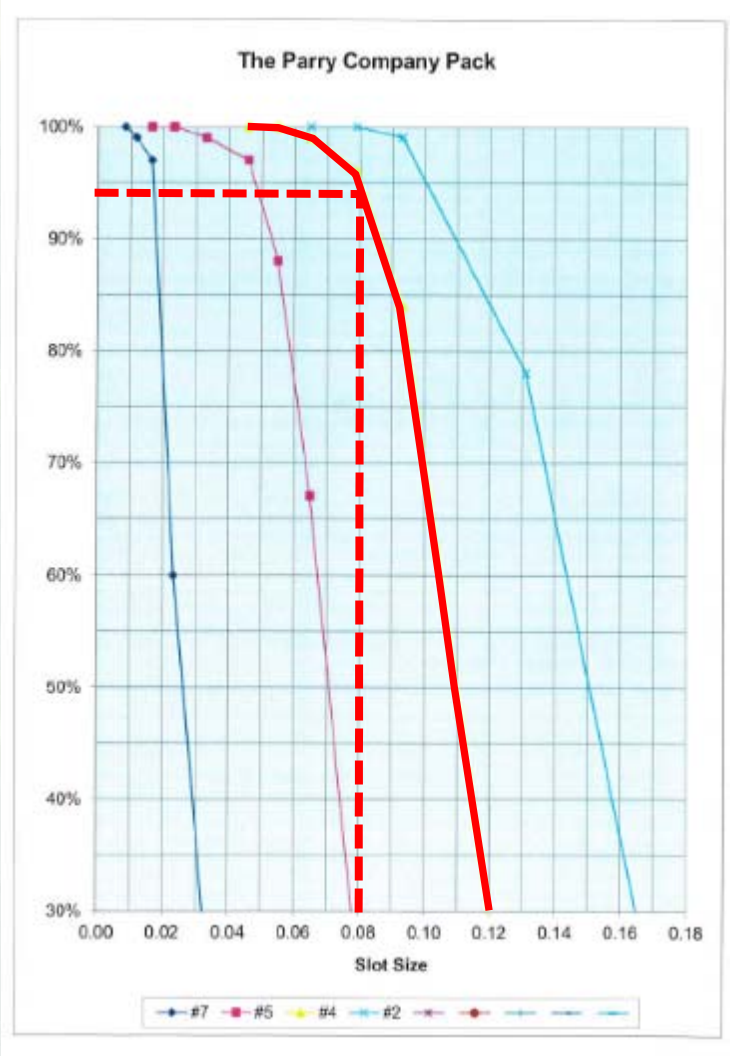
SAND
Bedrock



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Pumping Tests

- New wells were pumped at 100 gpm, 200, gpm, and 300 gpm for one hour each.
- The drawdowns in the wells at these pumping rates becomes the baseline well condition.
- Pumping tests every five years are compared to this standard.

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Lessons Learned

- Relief wells must be tested and maintained.
- Understand the subsurface before designing wells.
- Use a modern well system design.
- Use appropriately sized well screen and filter pack.

Questions?

Thank you for your time and attention.

Overtopping Leading to Levee Breaches

Terry M. Sullivan, P.E.

Geotechnical/Geology Branch Chief,
Eastern Division

Risk Management Center

10 Feb 2016

US Army Corps of Engineers
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Why does Overtopping Breach Some Levees….

East Carrol Parish, LA.
May 2011:
Mississippi River Breach at Bunches Bend; secondary levee at Lake Providence, LA.

…and not others?

Mississippi River overtopping Bird's Point Levee, Missouri May 2, 2011:
USACE blew up levee at Bird's Point Floodway using prepared charges in accordance with plan one day later

Why does Overtopping Breach Some Levees….

St. Barnard Parish, New Orleans, Hurricane Katrina Sept 2005:
19,000 ft. of levee between Bayou Bienvenue (Sta. 383+00) & Bayou Dupre (Sta 704+00) severely damaged from overtopping and scour, and lost approximately 12' of levee section

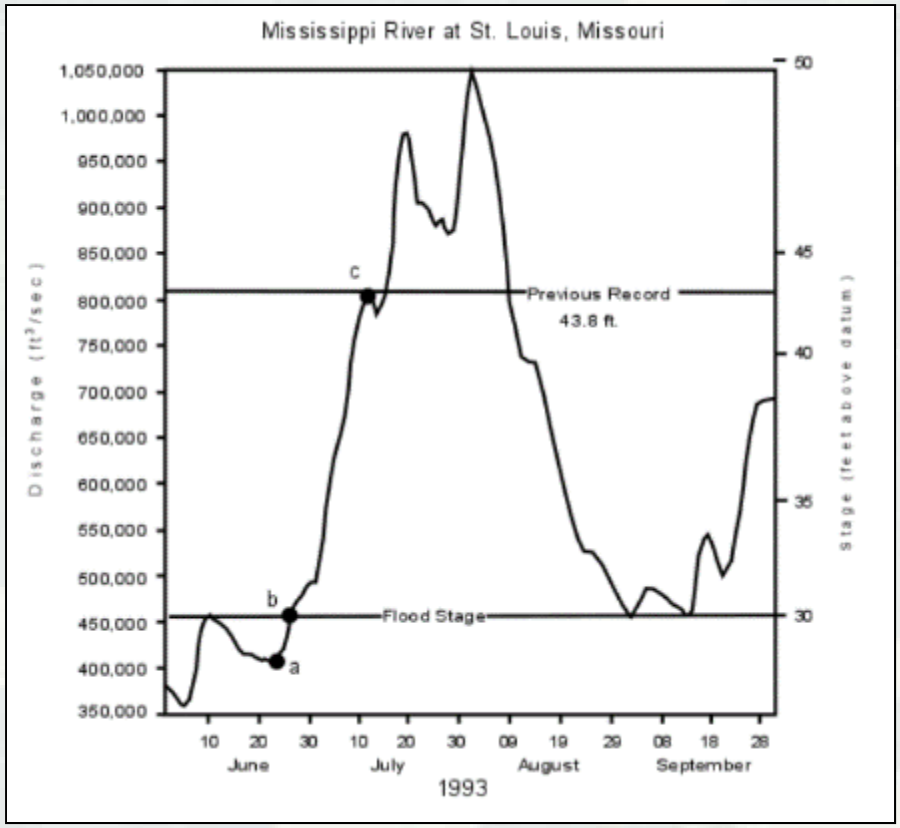
…and not others?

St. Barnard Parish, New Orleans, Hurricane Katrina Sept 2005:
Overtopping resulted in intermittent, localized Scour on the Levee South of the GIWW, Between IHNC and Paris Rd.

Factors Influencing Likelihood of Overtopping Leading to Breach

- Duration of overtopping
  - Short term - Hurricane loading or river with a small drainage area (flash flood)
  - Long term - associated with major inland river systems
- Height of overtopping above levee crown
- Wind-driven waves are greater problem for coastal (hurricane) levees than inland levees.
- Armoring/turf quality/root system depth
  - Seasonal weather can influence this
  - Mowing can work against erosion resistance
- Soil type
  - Rolled earth, properly compacted clay embankment is best
  - Levees constructed from silt and sand do not do as well in overtopping

Obviously **Duration** of Overtopping is a Part of the Reason Levees Often Breach in Overtopping Events



>30 consecutive days above previous record

Source: "River Flooding" lecture from "Natural Disasters", Tulane University, Prof. Stephen A. Nelson, 2015

Conversely Short **Duration** of Overtopping *May* Reduce Likelihood of Breach

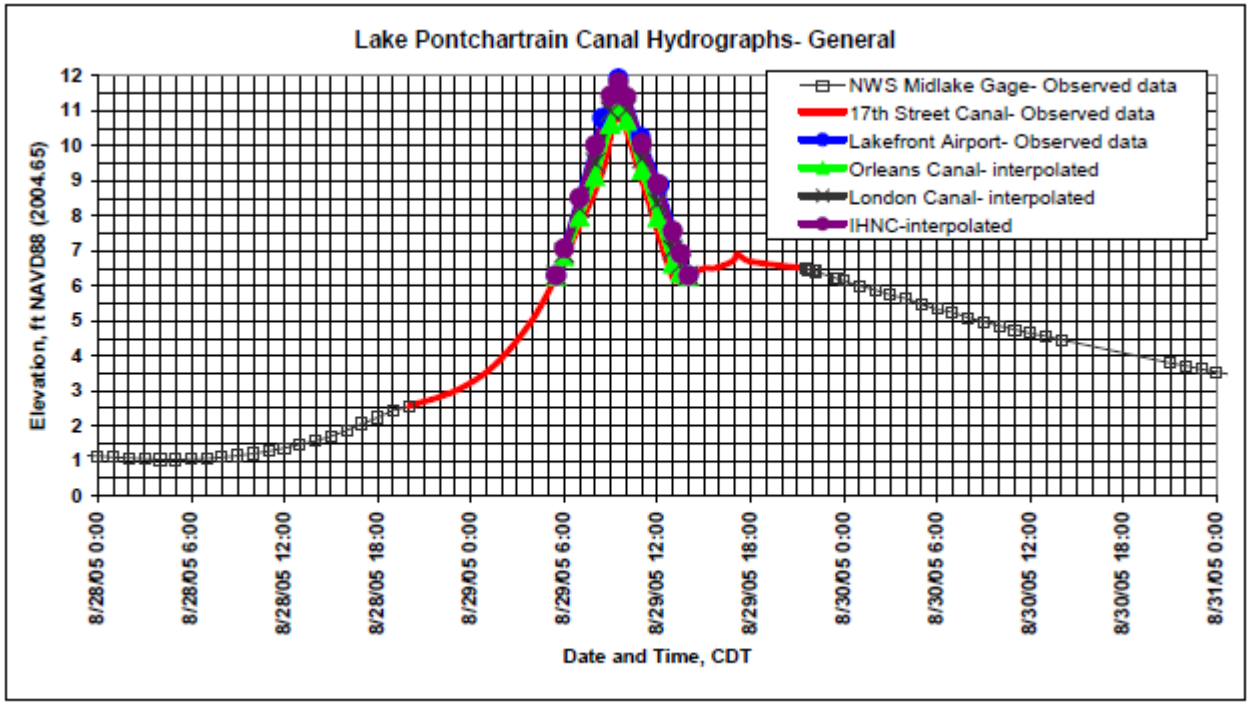
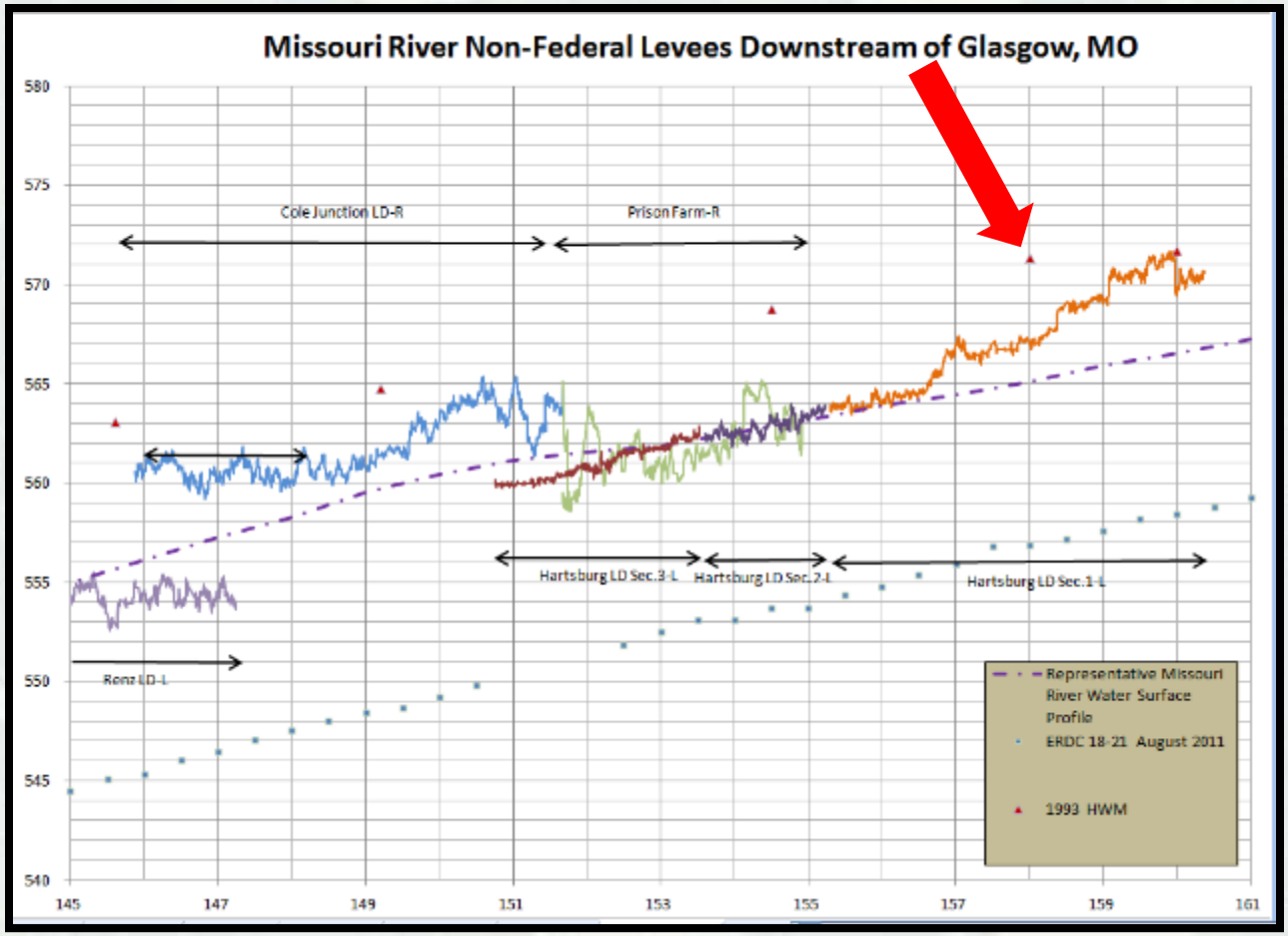


Figure 1-5. Constructed and interpolated hydrographs at canal entrances- general view.

Hurricane Katrina Storm Surge peak duration was only 8 Hours

Source: IPET Report, Volume IV "The Storm" – Technical Appendix IV-1-9. U.S. Army Corps of Engineers.

Depth of Overtopping Flow is a Factor



Source: Levee Screening for Hartsburg 1 Levee, Kansas City District, 2015

Combination of Great Duration and Great Depth of Overtopping

Table 1. Some locations with new record stages in the upper Mississippi River Basin (from Parrett and others, 1993). [ft, feet; mm/dd/yy, month, day, and year]

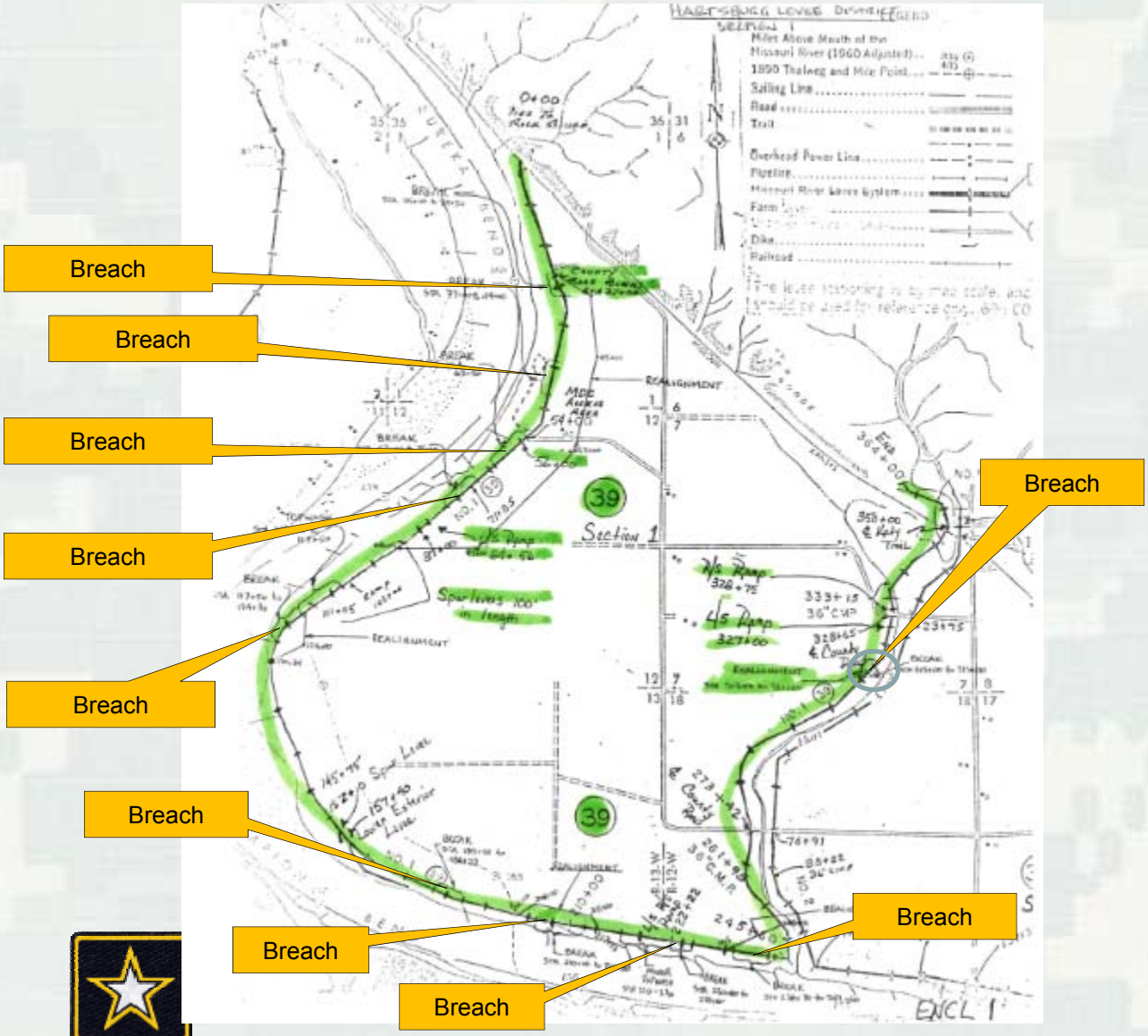
	Flood stage (ft)	Old record		New record	
		Stage (ft)	Date (mm/dd/yy)	Stage (ft)	Date (mm/dd/yy)
Mississippi River					
Rock Island, IL	15	22.5	04/28/65	22.6	07/09/93
Keithsburg, IL	13	20.4	04/27/65	24.2	07/09/93
Quincy, IL	17	28.9	04/23/73	32.2	07/13/93
Hannibal, MO	16	28.6	04/25/73	31.8	07/16/93
Clarksville, MO	25	36.8	04/24/73	37.7	07/29/93
Winfield, MO	26	36.9	04/27/73	39.6	08/01/93
Grafton, IL	18	33.2	04/28/73	38.17	08/01/93
Alton, IL	21	36.7	04/28/73	42.72	08/01/93
St Louis, MO	30	43.23	04/28/73	49.58	08/01/93
Chester, IL	27	43.32	04/30/73	49.74	08/07/93
Missouri River					
St. Joseph, MO	17	26.82	04/23/52	32.07	07/26/93
Kansas City, MO	32	36.20	07/14/51	48.87	07/27/93
Boonville, MO	21	32.82	07/17/51	37.10	07/29/93
Jefferson City, MO	23	34.2	07/18/51	38.6	07/30/93
Hermann, MO	21	35.79	10/05/86	36.97	07/31/93
St. Charles, MO	25	37.50	10/07/86	40.04	08/02/93

Table 2. Levee failures during the Great Flood of 1993 (from Larson, 1996).

Corps of Engineers District	Number of failed or overtopped levees	
	Federal	Non-Federal
St. Paul, MN	1 of 32	2 of 93
Rock Island, IL	12 of 73	19 of 185
St. Louis, MO	12 of 42	39 of 47
Kansas City, MO	6 of 48	810 of 810
Omaha, NE	9 of 31	173 of 210
Totals	40 of 226	1,043 of 1,345

Source: "The Great Flood of 1993 on the Upper Mississippi River—10 Years Later" By Gary P. Johnson, Robert R. Holmes, Jr., and Lloyd A. Waite, all U.S.G.S.

Hartsburg (Missouri) Levee: 1993 Flood Damage



(1) Levee breaks at stations:

25+00 to 29+50	185+50 to 188+55
37+00 to 44+10	200+00 to 212+80
55+00 to 62+50	230+40 to 233+60
67+00 to 75+60	236+70 to 242+60
117+50 to 124+30	315+00 to 317+00

(2) Topwash at stations:

108+15 to 117+50
220+00 to 230+00

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Armoring/turf quality/root system depth

- Testing has been performed in Vietnam, France, the Netherlands and in several labs in the U.S.
- Hurricane Katrina disaster generated extensive testing in the U.S. (ARS 2005; CSU 2010, 2013).
- Inter-Agency Performance Evaluation Task Group (IPET) Report launched extensive research.
- Focus on Rough Estimates of Erosion Rates from CSU Testing
- More Refined Estimates of Erosion Rates Using CSU Testing Results and Adaptation of Conventional Erosion Models

Typical Overtopping Breach Process for Levees Constructed from Cohesive Soils

Figure 1. Observed erosion processes during overtopping tests: (a) rills and cascade of small overfalls during stage 1, (b) consolidation of small overfalls during stage 1, (c) headcut at downstream crest, transition from stage 1 to stage 2, (d) headcut at upstream crest, transition from stage 2 to stage 3, (e) flow through breach during stage 3, and (f) transition from stage 3 to stage 4. (Hanson et al., 2005a).

Source: "Physical Modeling of Overtopping Erosion and Breach Formation of Cohesive Embankments" by Hanson, et al, U.S. Dept. of Agriculture Agricultural Research Station (ARS), Hydraulics Laboratory at Stillwater, OK in 2005.

Breach "Initiation" and "Formation" Stages for Levees Constructed from Coheisve Soils

Figure 12. Generalized description of observed erosion processes during ARS overtopping tests: a) rills and cascade of small overfalls during Stage I, b) consolidation of small overfalls during Stage I, c) headcut at downstream crest, transition from Stage I to Stage II, d) headcut at upstream crest, transition from Stage II to Stage III at breach initiation $t = t_3$, e) flow through breach during Stage III, and f) transition from Stage III to Stage IV at breach formation $t = t_5$.

I. Flow over the embankment initiates at $t = t_0$. Initial overtopping flow results in sheet and rill erosion with one or more master rills developing into a series of cascading overfalls (Figure 12a). Cascading overfalls develop into a large headcut (Figure 12b and 12c). This stage ends with the formation of a large headcut at the downstream crest and the width of erosion approximately equal to the width of flow at the downstream crest at $t = t_1$,

II. The headcut migrates from the downstream to the upstream edge of the embankment crest. The erosion widening occurs due to mass wasting of material from the banks of the gully. This stage ends when the headcut reaches the upstream crest at $t = t_2$ (Figure 12d),

III. The headcut migrates into the reservoir lowering of the crest occurs during this stage and ends when downward erosion has virtually stopped at $t = t_3$ (Figure 12e). Because of the small reservoir size, the peak discharge and primary water surface lowering occurred during this stage, and

IV. During this stage breach widening occurs and the reservoir drains through the breach area (Figure 12f). In larger reservoirs, the peak discharge and primary water surface lowering would occur during this stage ($t_3 < t < t_4$) rather than during stage III. This stage may be broken into two stages for larger reservoirs depending on the upstream head through the breach.

Four Stages of Overtopping Breach Progression

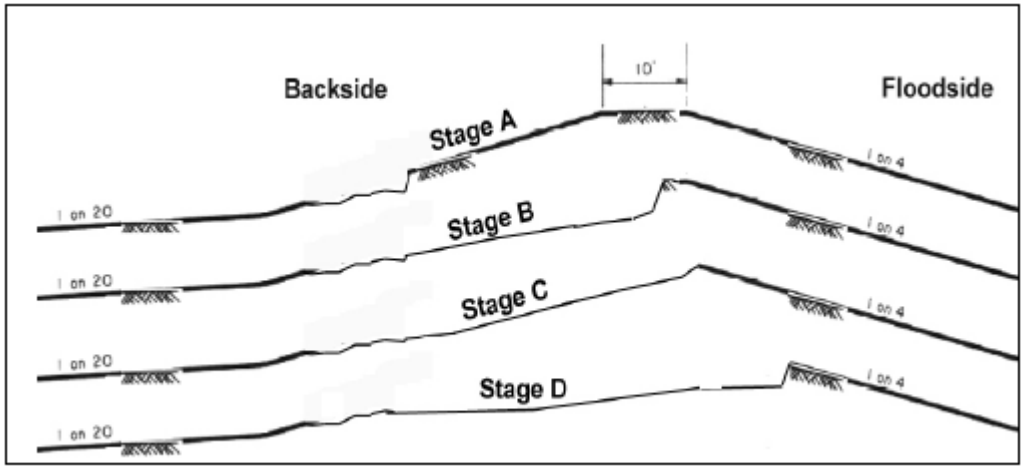


Figure 72. Erosion progression stages.

Source: IPET Report, Volume V "The Performance – Levees and Floodwalls" – U.S. Army Corps of Engineers.

Stage A. Initial overtopping causes surface sheet and rill erosion which develops into a series of cascading overfalls. The highest forces develop from the backside slope down to the backside toe, and the crown is not initially exposed to these large hydraulic forces. The cascading overfalls develop into one large headcut that migrates from the slope to the crest such that the erosion width approximately matches the overtopping width.

Stage B. The headcut continues to migrate from the backside crest (crown) to the floodside crest.

Stage C. The crest drops as a breach begins to develop.

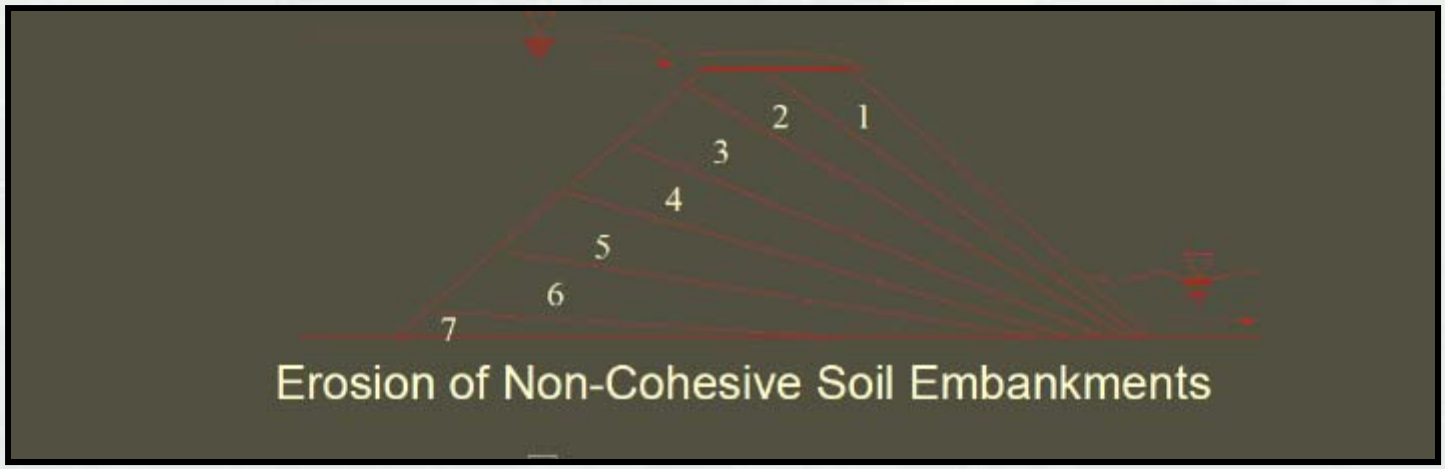
Stage D. The breach opening erodes out to the toe and the breach widens.

Four Stages of Overtopping Breach Progression

St. Barnard Parish, New Orleans, Hurricane Katrina August 2005

Source: IPET Report, Volume V "The Performance – Levees and Floodwalls" – U.S. Army Corps of Engineers.

Different Soil Types May have Differing Erosion Patterns



Rough Estimation of Erosion Rates for Levee Turf Based On CSU Flume Test Results

Wave Overtopping Simulator Testing
of Proposed Levee Armoring Materials

Prepared for
United States Army Corps of Engineers
New Orleans District

Prepared by
Christopher I. Thornton
Bryan N. Scholl
Steven R. Abt

December 2010

Colorado State University
Daryl B. Simons Building of the
Engineering Research Center
Fort Collins, Colorado

Colorado State University

DRAFT

Full-Scale Wave Overwash Resiliency Testing of Dike and Embankment on Florida Sandy Soils

Prepared for
U.S. Army Corps of Engineers, Jacksonville District
Jacksonville, Florida

Prepared by
Christopher I. Thornton
Steven A. Hughes
Bryan N. Scholl
Natalie Youngblood

May 2013

Colorado State University

Daryl B. Simons Building of the
Engineering Research Center
Fort Collins, Colorado

DRAFT

CSU Test Apparatus and Samples

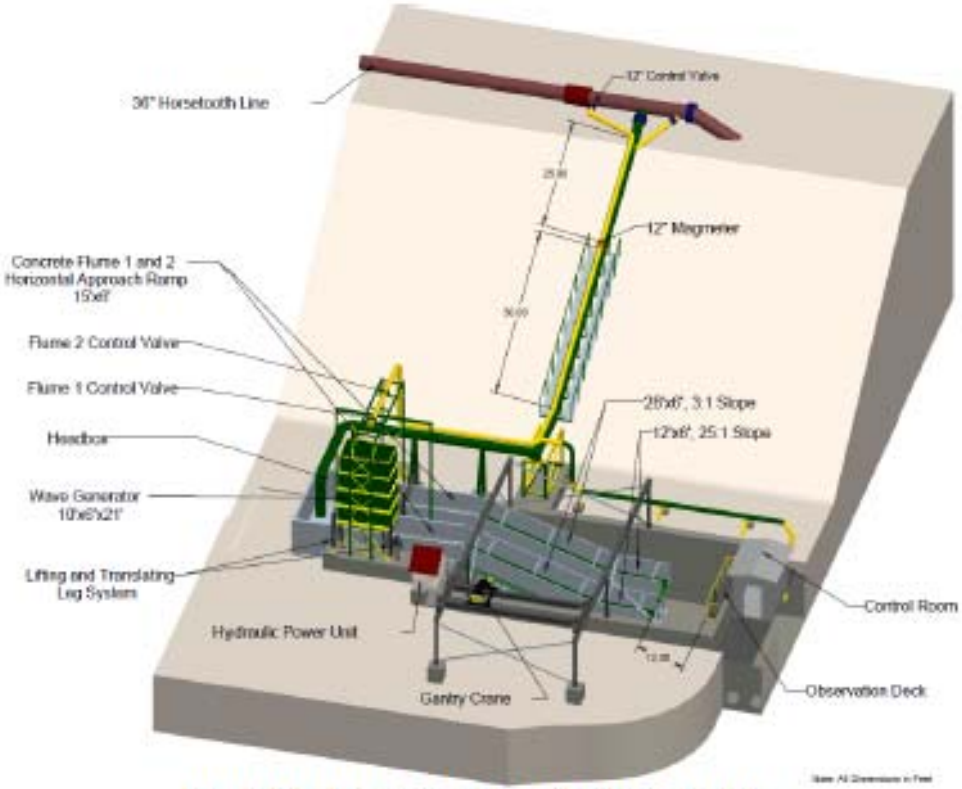


Figure 2-4. Wave overtopping facility schematic

a. Unloading/Uncovering vegetated trays

Samples are split into two trays:
A lower bent section and an upper inclined upper flat section.
The two are connected at a "smooth" transition, that as will be shown, appears to interfere with flow.

CSU Test Apparatus and Samples (Florida)

1. Bahia grass grown in trays with substantial irrigation:

2. Grass is mown; continued watering.

3. Watering was reduced on some trays to reproduce dry, hot summer conditions.

Figure 2-11: Completed installation of Bahia grass vegetated tray

Levee Grass Armoring Fails

Event Information	
Overtopping Flow Rate:	0.01 cfs/ft
Type of Loading:	Constant overtopping flow

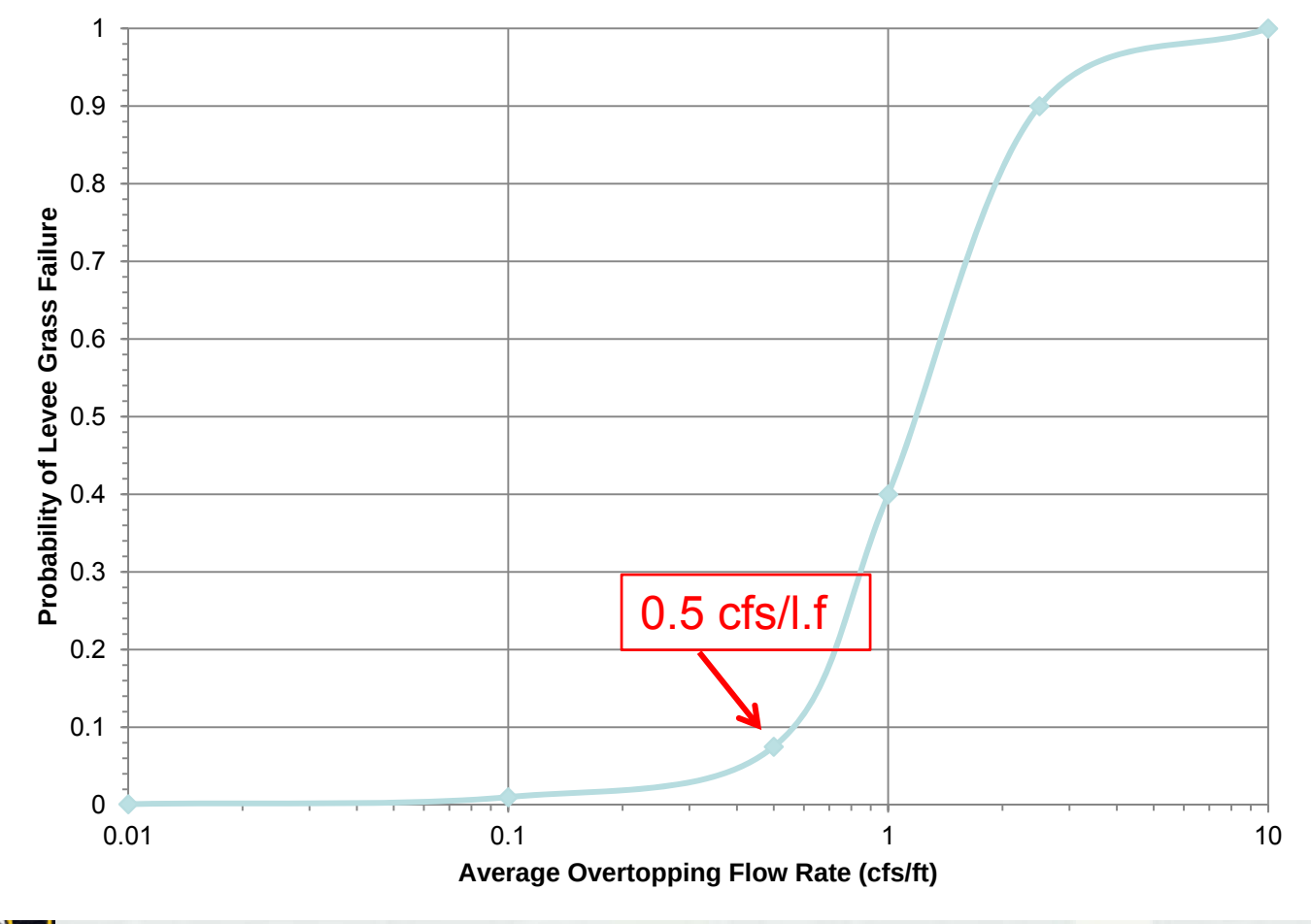
Influence Factors	
More Likely Factors	**Less Likely Factors**
• Can't count on 100% grass coverage due to salinity in the levee environment • No case histories of actual levee performance • If levee materials contain silt or sand, their erosion resistance would be reduced • Levees could contain man-made or animal defects that could lead to poor performance	• 0.01 cfs/ft is less than European standard design flow for sandy sites (typically as high as ~0.1 cfs/ft) • The levee embankment soils will be clay which is expected to have a tolerable flow rate on the order of 0.1 cfs/ft • Vietnamese case histories indicate Bermuda Grass slopes can begin to sustain damage at overtopping rates of 0.5 to 0.7 cfs/ft (Trung et al, 2010 and Trung et al, 2011) • USCS allows grass-lined channel velocities of up to 5 ft/sec (USDA-SCS, 1984) • New Orleans District earthen channels are designed for velocities of less than 3 ft/sec • The Netherlands model studies showed that nominal grass cover can withstand up to 0.54 cfs/ft (Wise, 2010) • CSU model studies showed that Bermuda Grass with exceptionally high root density did not fail at flow rates of approximately 4 cfs (Thornton et al, 2010)

Event Information	
Overtopping Flow Rate	1.0 cfs/ft
Type of Loading:	Constant overtopping flow

Influence Factors	
More Likely Factors	**Less Likely Factors**
• Can't count on 100% grass coverage due to salinity in the levee environment • No case histories of actual levee performance • If levee materials contain silt or sand, their erosion resistance would be reduced • Levees could contain man-made or animal defects that will lead to poor performance • 0.1 cfs/ft is in the maximum range of the European standard design flow for sandy sites • The soils are clay here which is expected to have a tolerable flow rate on the order of 0.1 cfs/ft • Vietnamese case histories indicate Bermuda Grass slopes can begin to sustain damage at overtopping rates of 0.5 to 0.7 cfs/ft (Trung et al, 2010 and Trung et al, 2011) • The Netherlands model studies showed that nominal grass cover can withstand 0.6 cfs/ft (reference, year)	• USCS allows grass-lined channel velocities of up to 5 ft/sec (USDA-SCS, 1984) • New Orleans District earthen channels are designed for velocities of less than 3 ft/sec • CSU model studies showed that Bermuda Grass with exceptionally high root density did not fail at flow rates of approximately 4 cfs (Thornton et al, 2010) • The levees are anticipated to be entirely composed of clay without a sand core

MC/MVN Final Draft IEPR
RMC/MVN Final Draft

Probability of Grass Armor Failure as a Function of Average Overtopping Flow Rate



This curve is for a particular turf type, constructed on a levee constructed with clayey soil.

Source: Morganza-to-the Gulf Levee Risk Assessment– U.S. Army Corps of Engineers, 2013.

How Fast Does Underlying Soil Erode?

Table 3-1. Test matrix

Run	Discharge (cfs/ft)	Approx. Run Duration (min)	Tray ID	Treatment	Run	Discharge (cfs/ft)	Approx. Run Duration (min)	Tray ID	Treatment
1a	0.1	60	n/a	bare clay	10a	2.4	65	1	Bermuda grass w/ HPTRM
1b	0.2	20	n/a	bare clay	10b	2.6	70	1	Bermuda grass w/ HPTRM

How Fast Does Underlying Clay Soil Erode?

Figure 3-2. Bare clay soil test installation

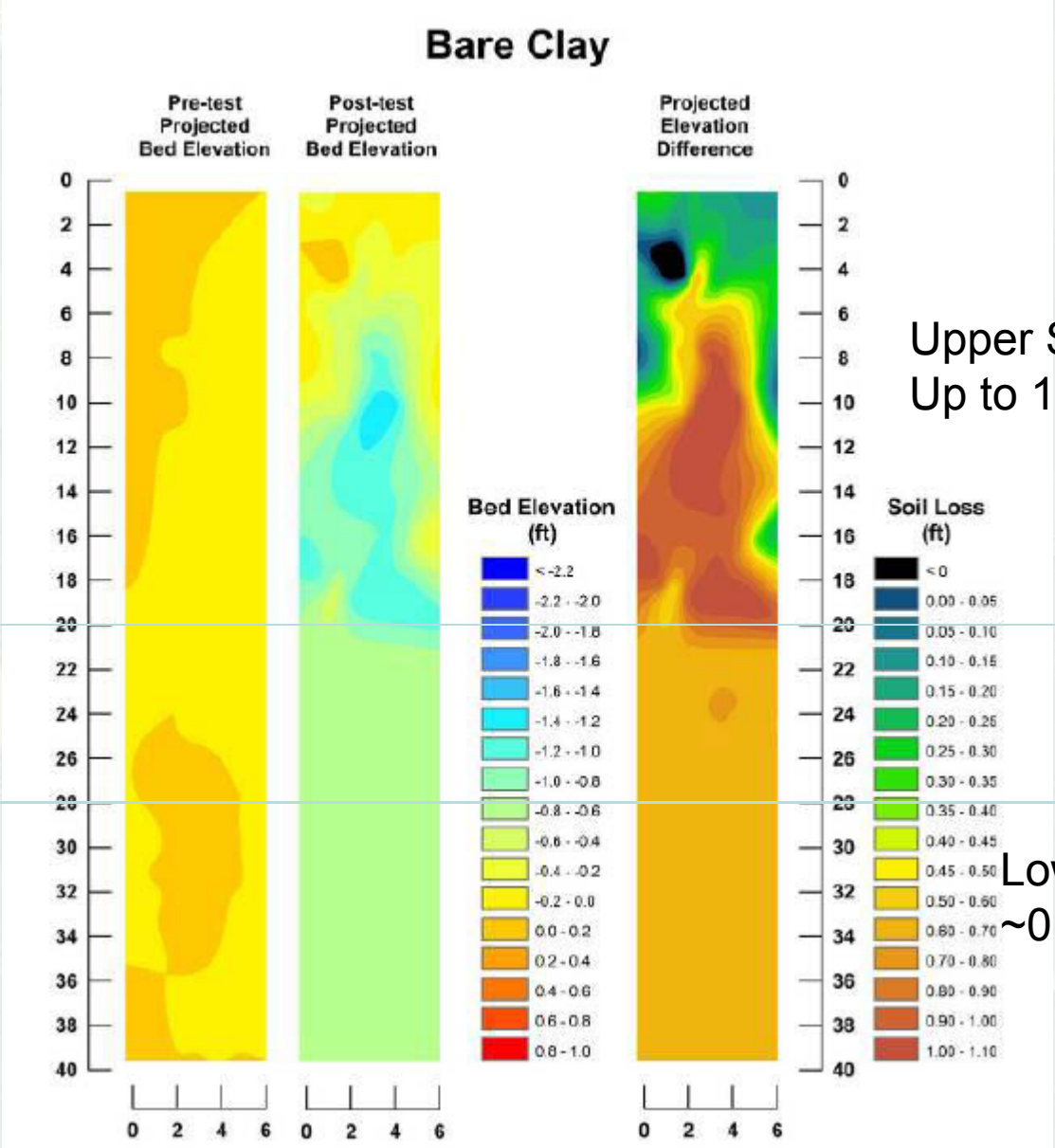
a. Bare clay soil slope, upper 20 ft

Up to 1' erosion after 1:00

b. Bare clay soil slope, lower 20 ft

Little to no loss after 1:00

Source: Colorado State University testing 2010 for New Orleans District



Smoothing Transition?

Bend

Upper Section
Up to 1' erosion after 1:20

Lower Section
~0.6' to 0.7 after 1:20

Approximate Erosion Loss Rates for Clay Soils

Bare Clay	q = 0.1 cfs/ft	q = 0.2 cfs/ft
Upper Steep Slope	<1 ft / hour (apparent problem with concentration at transition)	Slightly more (transition problem
Lower Flatter Slope	<0.1 ft / hour	~1.95 ft / hour

- More testing of this type needs to be done for different soil types.
- Very expensive testing.
- Very difficult to reproduce construction engineered fill practices within the confines of the flume.

Soil Erosion Rate Model

$$\dot{\varepsilon} = k\,(\tau - \tau_c)$$

where:

k = erodibility coefficient or detachment rate coefficient (ft^3/lb-hr)

τ = effective hydraulic stress on the soil boundary (psf)

τ_c = critical shear stress (psf) i.e., the shear stress at which erosion starts

Current-Induced Shear Stress

$\tau_s = \frac{1}{2} \rho f_c V^2$

where:

ρ = mass density of water (lbm/ft^3)

f_c = current friction factor (dimensionless)

= $2(2.5(\ln(30h/k_b)-1))^{-2}$ (Danish Hydraulic Institute (DHI), 2007)

where:

h = water depth (ft)

k_b = bed roughness (ft)

V = current speed (ft/s)

= V_{ave} , average current speed for straight channels, and if a levee reach is located on the outside of the channel bend, then

= V_{ss} , maximum velocity in the bend.

Soils and Erosion Resistance Parameters
Critical Shear Stress and Erosion Rate Constant

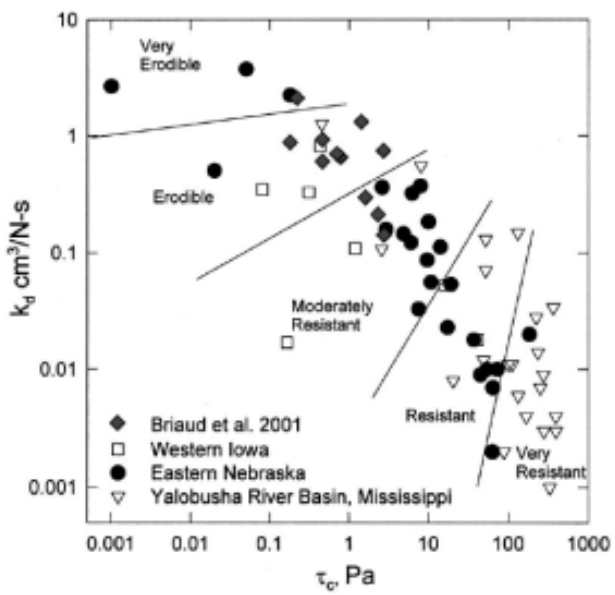


Fig. 2. τ_c versus k_d from cohesive streambed tests

Silts in upper left;

Sands and softer clays towards the middle

Stiff clays in lower right

Source: Hanson and Simon (2002).

Breach Erosion Generally Related to Water Height Above Crown and Soil Type

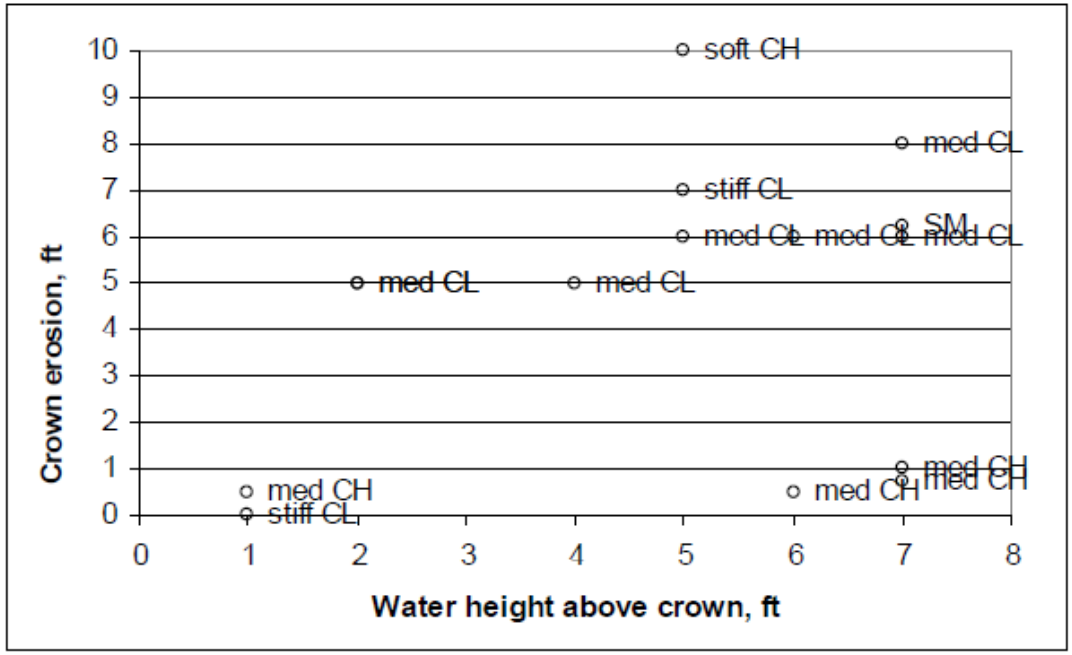


Figure 109. Scour depths versus surge/wave loading from soil borings and LIDAR data plotted from Table 4 levee surface soil stiffness (strength) and soil type are labeled. Note that medium-strength fat clay (med CH) had the least amount of erosion as the hydraulic loading increased.

Source: IPET Report, Volume V "The Performance – Levees and Floodwalls" – U.S. Army Corps of Engineers.

New Orleans is Armoring Levees at “Critical Areas”

Turf reinforcement mat

Source: http://www.mvn.usace.army.mil/Missions/HSDRRS/Armoring.aspx.

Armorflex® mat

Source: http://www.conteches.com/Products/Erosion-Control/Hard-Armor/ArmorFlex

Overtopping Challenges/Approaches

- Urban Riverine Levees have preferred, armored overtopping locations at downstream end.
- Local Sponsors will always try to save the town; preferred overtopping sections are often sandbagged.
- The “new” first overtopping location then becomes random.
- In a hurricane levee system there is no predictable overtopping location, as the surge’s peak can be in virtually any location. The location may be impacted by topography, currents, offshore channel depth, channel geometry, wind direction, etc.
- New Orleans is still wrestling with armoring for the inevitable overtopping events to come. Economics of armoring everywhere is a major challenge.

Final Thoughts

- An overtopping event that is short in duration may allow the levee to survive without being breached.
- A shorter levee may have a higher likelihood of surviving without a breach because there is less initial overtopping energy. However there is also a far smaller levee cross-section to be eroded away after initiation.
- Wind-driven waves impart greater stress on the turf than static overtopping.
- Good turf with a well established, substantial root system will always provide better erosion resistance than poor turf, but test results suggest there is high variability with different types of grass.
- Long grass would appear to be more erosion resistant than short grass.
- Slope changes and “nick” points are high rate of erosion locations.
- Stiff clay is more erosion resistant than soft clay, which is better than sand, which is better than silt.
- Armored turf seems to hold great promise in extending overtopping survivability.

Thank You!

Special thanks to Scott Shewbridge and Tim O'Leary
for providing suggestions, information and content.

Emergency Management

US Army Corps of Engineers
BUILDING STRONG®

USACE Assistance During Emergency Operations

Don Walker

Emergency Operations Manager

District Emergency Management & Security Branch

Louisville District, USACE

U.S.ARMY

USACE Mission Statement

Provide vital public engineering services in peace and war to strengthen our Nation's security, energize the economy, and *reduce risks from disasters*.

Reduce risks from disasters.

- **Prepare for (Preparedness)**
- **Respond to (Response)**
- **Recover from (Recovery)**
- **Mitigate for (Mitigation)**

Disaster Management Cycle

District Emergency Response

EP 500-1-28 (dtd 31 Jan 11) assigns the primary responsibility to LRL response and planning activities for both the Commonwealth of Kentucky and the State of Indiana.

EP 500-1-28 further assigns the responsibility for the coordinate and develop Catastrophic Disaster Response Planning (CDRP) for high impact, low probability events.

USACE Authorities for Civil Emergency & Contingencies

PL 84-99 - FC&CE

Under PL 84-99, the Chief of Engineers, acting for the Secretary of the Army, is authorized to undertake activities including disaster preparedness, Advance Measures, emergency operations (Flood Response and Post Flood Response), rehabilitation of flood control works threatened or destroyed by flood, protection or repair of federally authorized shore protective works threatened or damaged by coastal storm, and provisions of emergency water due to drought or contaminated source.

Types USACE Assistance

Two (2) types of USACE Assistance available to local sponsors for Flood Fighting:

- **Technical Assistance**
- **Direct Assistance**

Technical Assistance

Can include the following:

- **Evaluation of project**
- **Recommendations of actions**
- **Review of emergency plans (pre-event)**

Direct Assistance

Can include the following:

- **Direct Material Support**
- **Emergency Contracting**
- **Advance Measures**
- **Rescue Operations**
- **Manage Flood Fight Operations**

USACE Assistance Facts

Flood Fight assistance is intended to be temporary and emergency measures only.

USACE Flood Fight Assistance is *100% federally funded*.

Removal or upgrade of all emergency measures is a local responsibility.

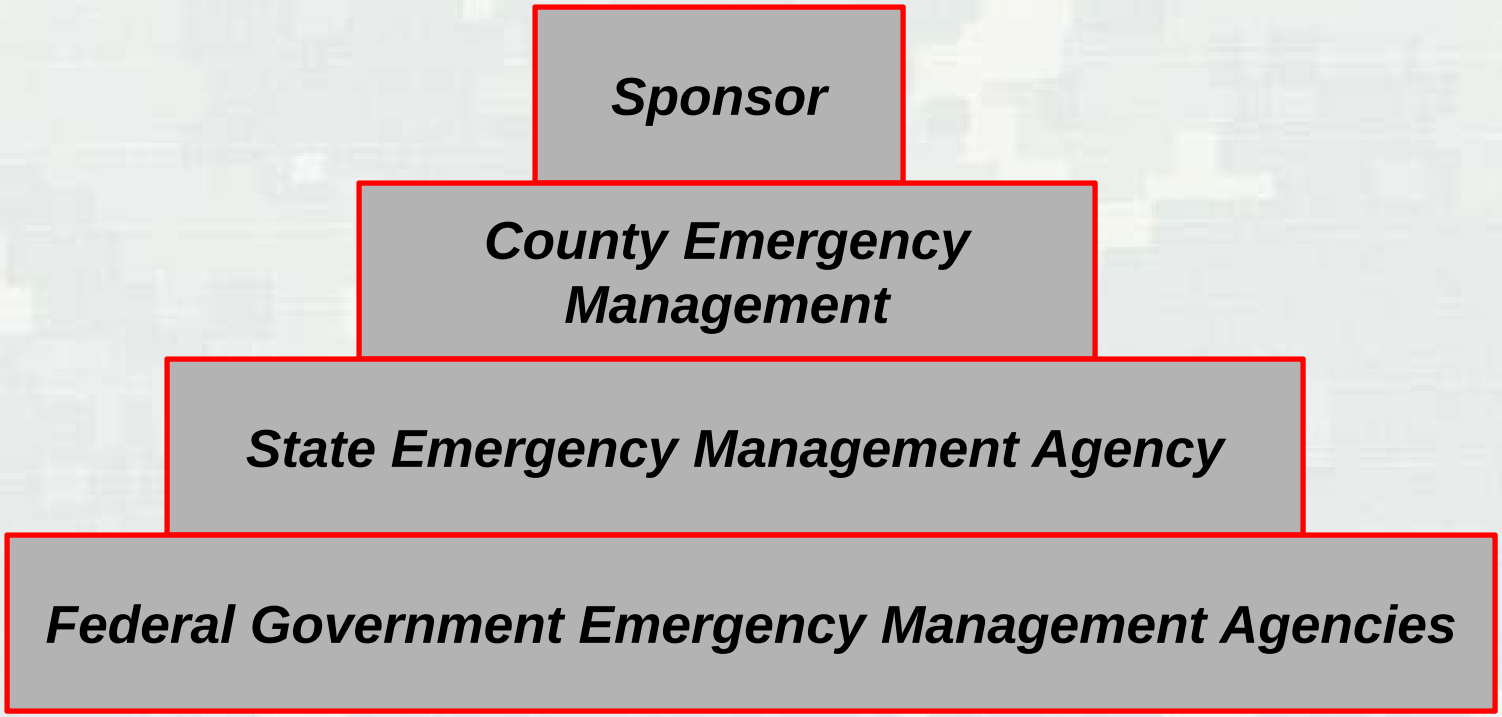
Deliberate Levee Breach – Must be coordinated with USACE.

Assistance Criteria

The following criteria must be met before assistance can be rendered:

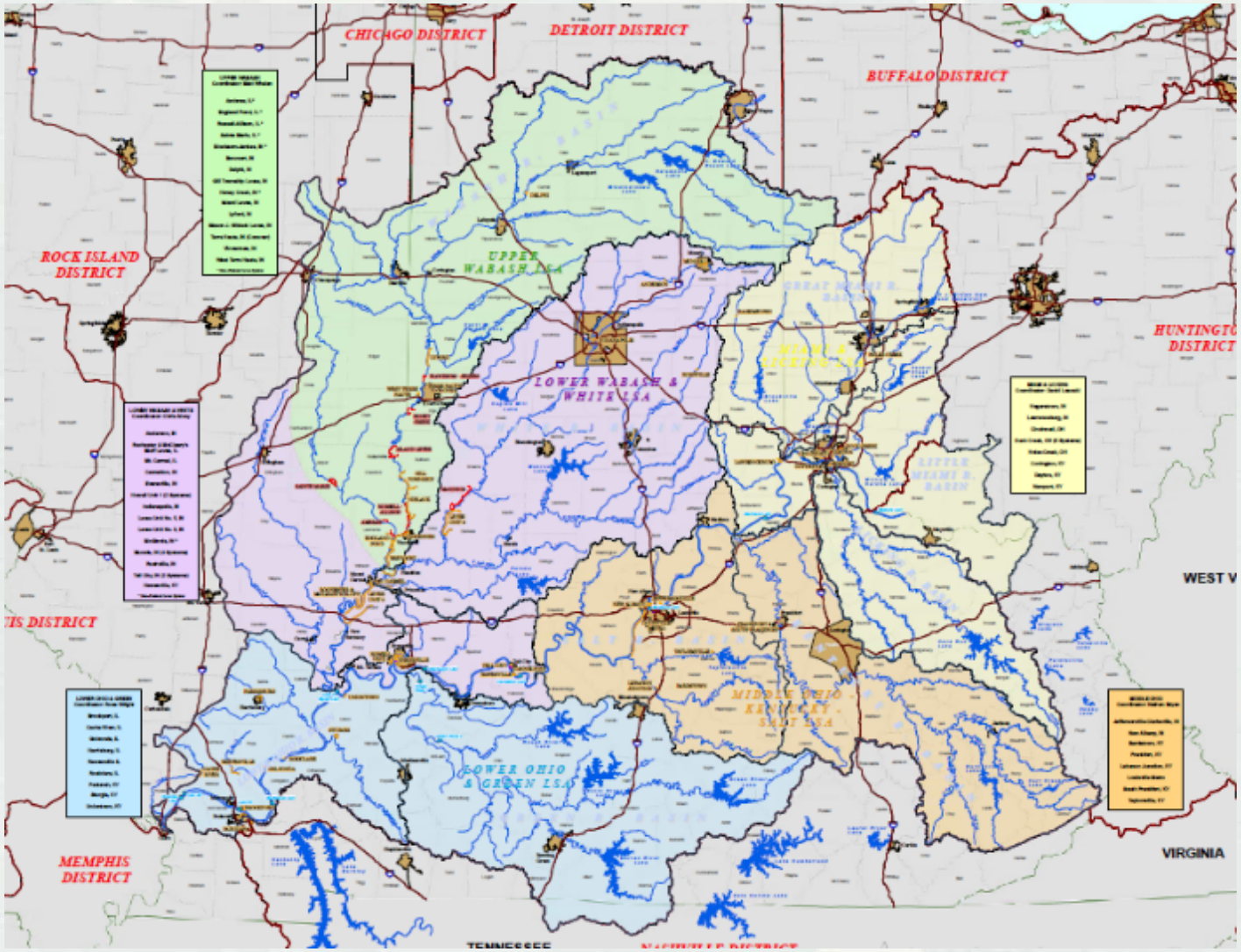
- **Declaration of Emergency – USACE District Commander**
- **Rivers *at or above* flood stage**
- **Local & State resources are fully employed**
- **Locals have requested assistance through State**

Assistance Relationships

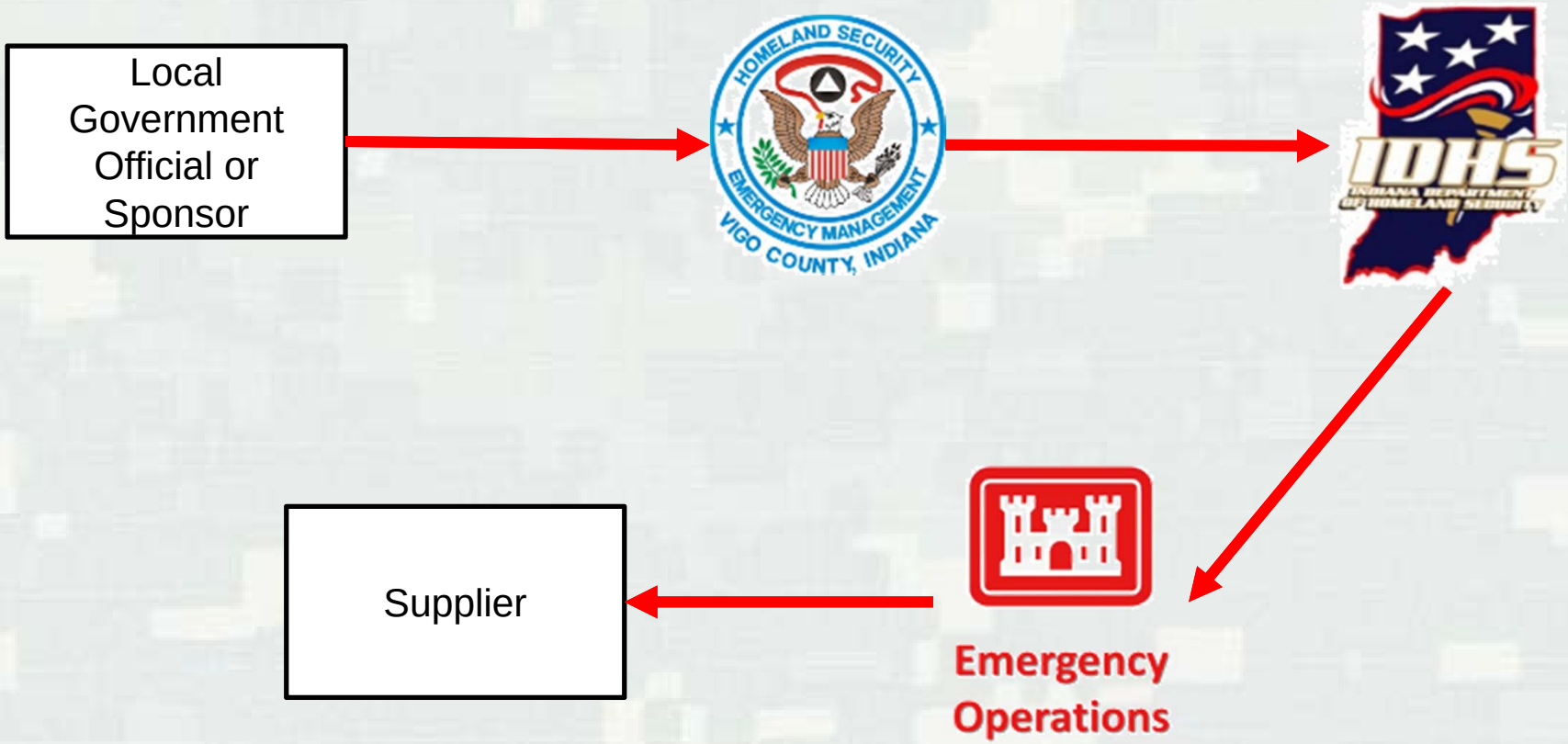


The Federal support is supplemental to the State.

Assistance Relationships



Assistance Request - Formal



Communication Chain

Material Support Items

- Sandbags – 5 M
- Gabion Baskets – 20K
- Big Bags – 2K
- Poly – 2K rolls
- Pumps +/- 125

Some Items can be shipped to you.

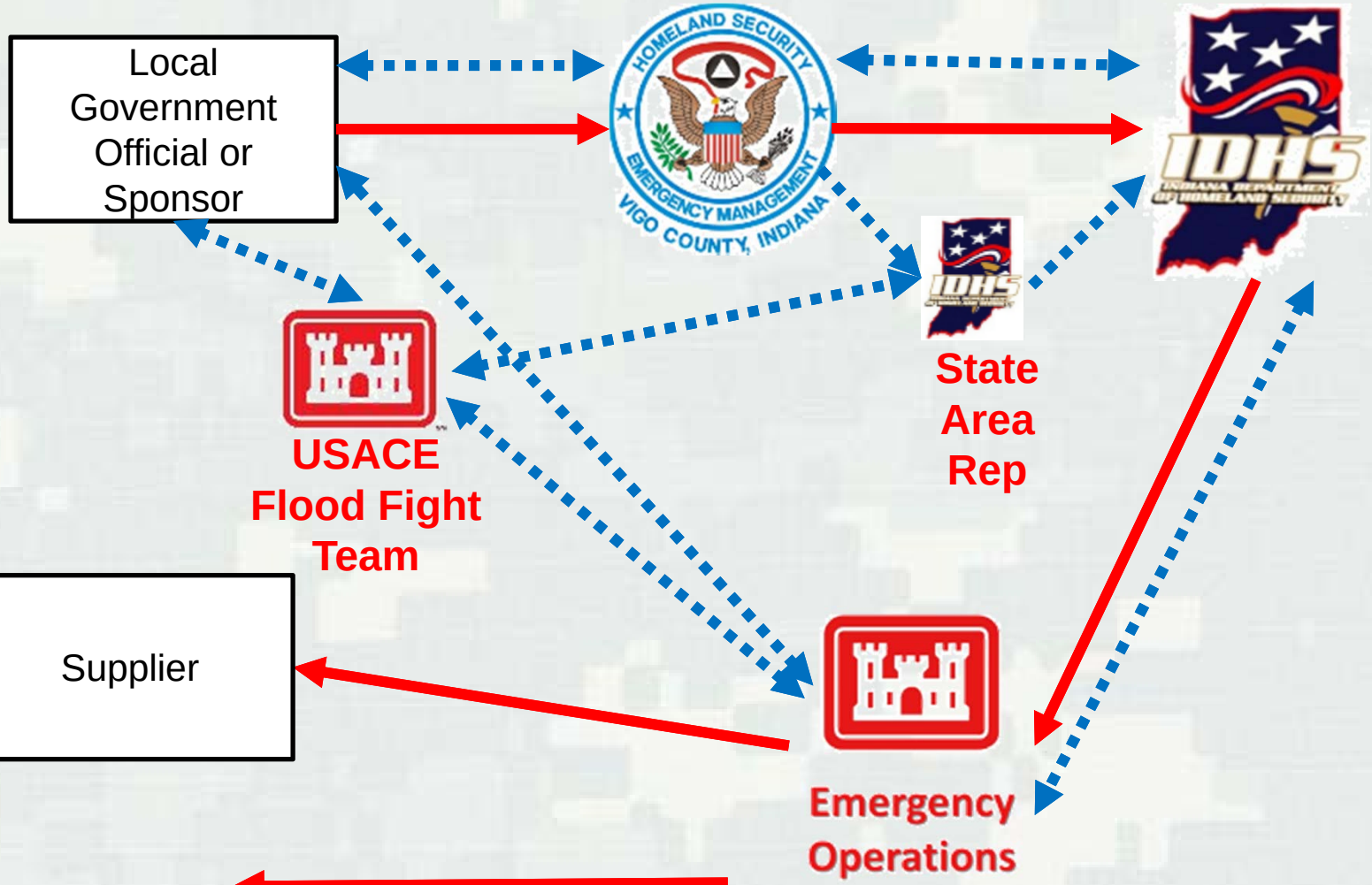
Sandbag Request

Sandbag Request	Sandbag Request
Amount Requested	
Description of issue occurring	
Pick up orDelivery	
Requester Information	**Requester Information**
Contact name	
Contact title	
Organization	
County	
District	
Phone	
Fax	
Email	
Delivery Information	**Delivery Information**
Contact name	
Contact title	
Organization	
Site 24-hour phone	
Alternate phone	
Site fax	
Site name	
Site Street Address	
Site City	
Site State	
Site ZIP	
Site Geographic coordinates	
Latitude	
Longitude	

Pump Request

Pump Request	Pump Request
Size of Area to Pump, Surface length (ft) Surface width (ft) Depth (ft)	
Movement Depth (ft)	
Description Provide a brief description of the situation and the amount of water you need to pump.	
Recommended pump size (GPM)	
Length of intake (ft)	
Length of discharge (ft)	
Requester Information	**Requester Information**
Contact name	
Contact title	
Organization	
County	
District	
Phone	
Fax	
Email	
Delivery Information	**Delivery Information**
Contact name	
Contact title	
Organization	
Site 24-hour phone	
Alternate phone	
Site fax	
Site name	
Site Street Address	
Site City	
Site State	
Site ZIP	
Site Geographic coordinates	
Latitude	
Longitude	

Assistance Request - Informal



Communication Chain

Informal Chain Chain

U.S.ARMY

BUILDING STRONG®

How to Obtain USACE Assistance

Ensure the criteria are met.

Contact your local EMA/County Emergency Manager.

Relay all contact information:

Needed Items/Issue(s)

Sandbag Request	Sandbag Request
Amount Requested	
Description of issue occurring	
Pick up orDelivery	
Requester Information	**Requester Information**
Contact name	
Contact title	
Organization	
County	
District	
Phone	
Fax	
Email	
Delivery Information	**Delivery Information**
Contact name	
Contact title	
Organization	
Site 24-hour phone	
Alternate phone	
Site fax	
Site name	
Site Street Address	
Site City	
Site State	
Site ZIP	
Site Geographic coordinates	
Latitude	
Longitude	

After The Flood

USACE Rehabilitation Assistance

When does the USACE consider the Flood over?

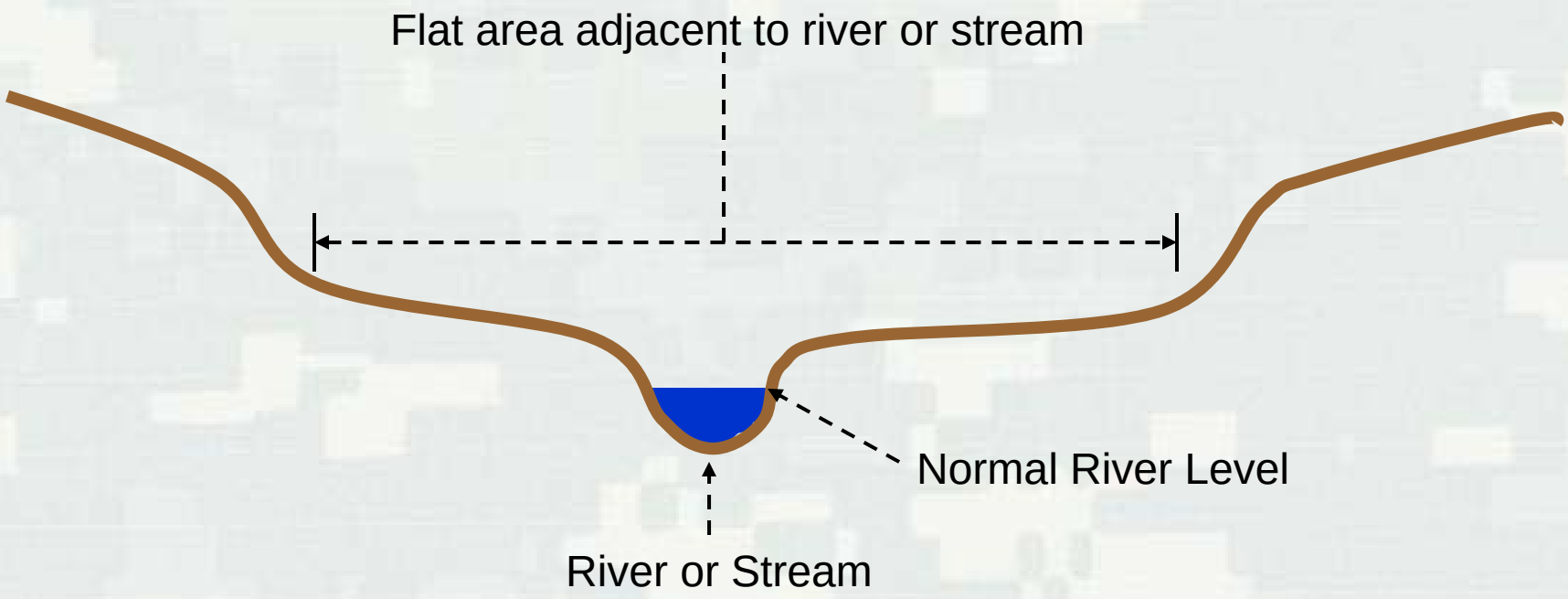
When the water recedes to "Bank Full"

Why is this important?

30 days after this date (Bank Full date), Sponsors must have their request for assistance to USACE, under P.L. 84-99.

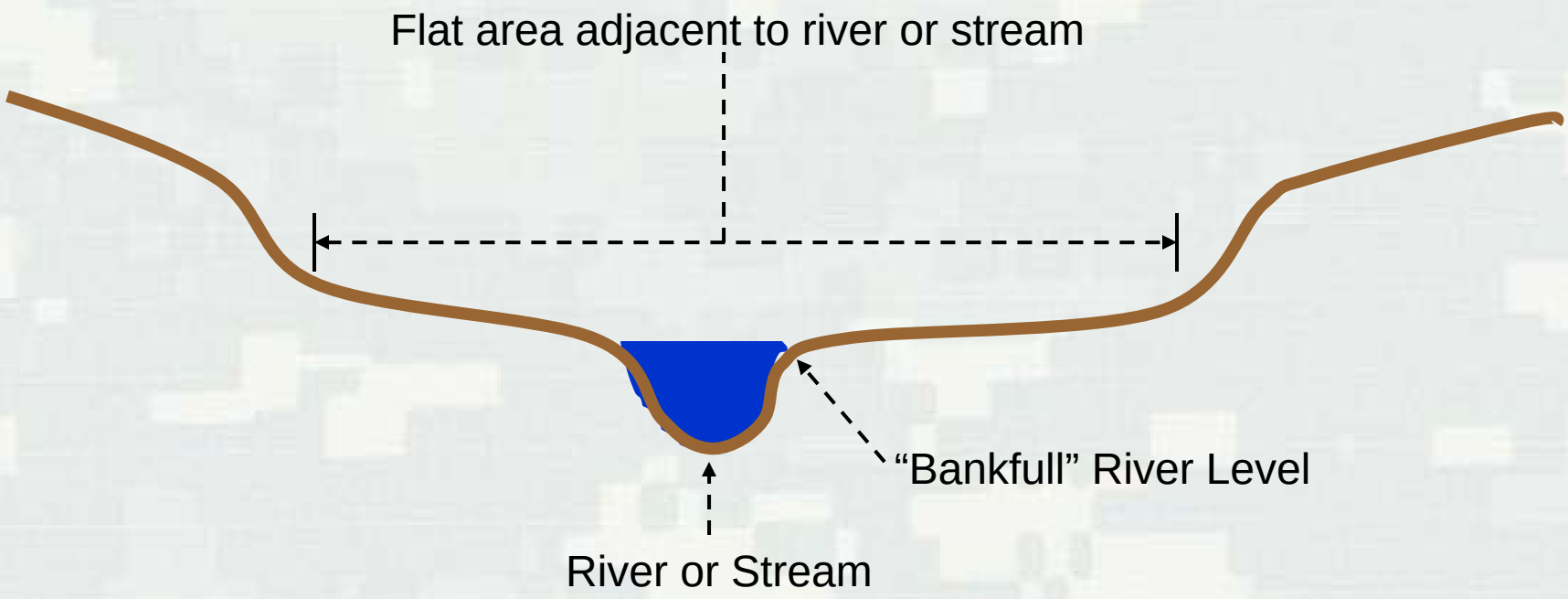
River Conditions

Normal River



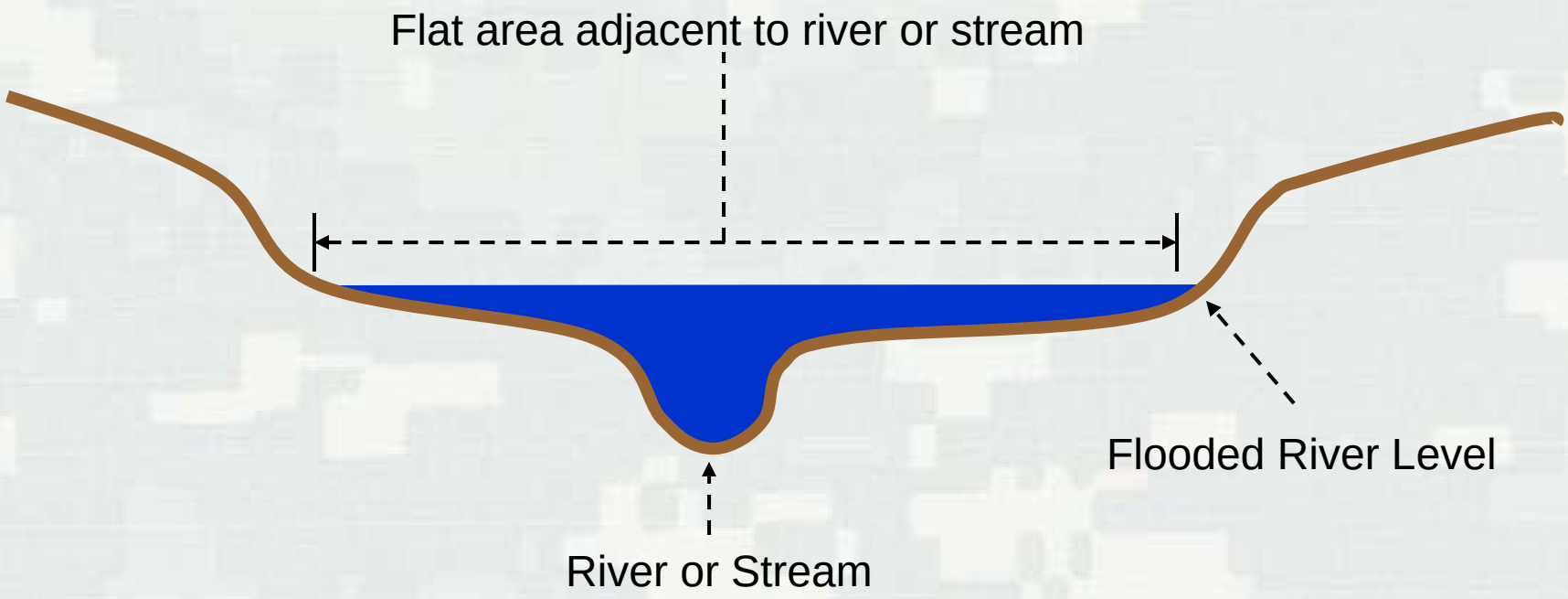
River Conditions

Bankfull River



River Conditions

Flooded River



Sponsors Actions After the Event

Return all unused supplies.

Return any borrowed equipment.

Inspect your levee.

Record any damage.

Update your records.

USACE Actions After the Event

The USACE District will issue the "Notice to Public Sponsors" to declare damages to Levee Works under P.L. 84-99.

The deadline for submitting the request assistance will be stated in the notice and will be for 30 days after the river has receded back to "Bank Full".

Once the request for assistance has been received the "Project Information Report" (PIR) process begins.

Flood Fight School

Mission

To ensure that local sponsors and Government officials know and understand the USACE capabilities, authorities and responsibilities as they pertain the local assistance during flood fighting operations both within the District's Area of Operation (AOR).

Goals

- Promote the proper use and knowledge of flood fighting techniques.
- Ensure a general understanding of the flood fighting mission of the USACE.
- Ensure the local officials and sponsors are aware of the assistance the USACE can provide during high water operations.
- Promote better planning efforts of the local sponsor and local governments for flooding response.
- Promote better communications at all level of the flood response operation.
- Present a more active response posture of the USACE to the public.
- Promote a better understand of the USACE among both local sponsor and local governments.
- The USACE to become a better community partner by taking a more active role in preparedness, response and recovery planning an assistance with both the local and state level partners.

Concept

- 6 to 8 hours of instruction.
- Sponsors, Emergency Managers and other Elected Officials.
- Hands-on & Classroom Instruction
- Interactive
- Zero cost for students
- Conducted in the Local Area

FY 16 Classes

- National Incident Management System (NIMS) Introduction, Informal vs Formal Communications, Organization
- Vocabulary, Common Language
- Flood Control and Coastal Emergency (FC&CE) (Public Law 84-99)
- Hazard & Vulnerability Analysis
- Emergency Action Plan (EAP) (Template)
- Operational References
- USACE Supplies & Timing
- Levee Safety Program Process, Permit, Levee Safety Action Classification, Inspection Policies
- How to Flood Fight: Techniques & Materials

- *State WebEOC – taught by State Rep.*

FY 17 Additional Classes

- Evacuation Planning
- After the Flood Fight
- Drought Issues

Course Scheduled

March 9, 2016
Harrison County Govt. Center
245 Atwood Street, Corydon, IN 47112
POC: Doug Cooke / dcooke@dhs.in.gov

May 17, 2016
Parkview Wabash Hospital
710 North East Street, Wabash, IN 46992
POC: Rick Dolsen / rdolsen@dhs.in.gov

July 8, 2016
Putnam County Emergency Ops Center (EOC)
600 W. CR 225 South, Greencastle, IN 46135
POC: Jerry Sears / jsears@dhs.in.gov

To Schedule

Indiana POC:

Doug Cooke

dcooke@dhs.in.gov

(317) 605-2804

Kentucky POC

Terry Varney

terry.l.varney@us.army.mil

(502) 607-5733

QUESTIONS