



# **Upper Brownsville Geotechnical Site Investigation Update**

**International Boundary and Water Commission**  
**United States Section**  
Engineering Services Division

**May 13, 2015**



# International Boundary and Water Commission

## Engineering Services Division

# Timeline of Events

- **Nov 2013:** Levee height was raised and widened by 2 to 3 feet.
- **Mar 2014:** Rapid drawdown in Rio Grande water surface elevations of between 5 to 7 feet.
- **Mar 2014:** Levee cracks appeared downstream of Gateway International Bridge in Brownsville, Texas.
- **May 2014:** USIBWC contacted USACE to perform geotechnical study.
- **June 2014:** USIBWC entered into an interagency agreement with USACE.
- **July 2014:** USACE conducted preliminary site inspection.
- **August 2014:** Cone-penetrometer tests taken.
- **September to October 2014:** Borings drilled and inclinometers installed.
- **October 2014 through December 2014:** Cross-sections developed.
- **December 2014 to March 2015 :** Development / Completion of Final Site Investigation Report that includes three remediation options.
- **March 2015 to Present:** Review and selection of remediation option.
- 2 Currently developing design package for remediation option.



# International Boundary and Water Commission

Engineering Services Division

## Levee Cracking

Cracks at levee toe



Cracking and settlement at top of levee

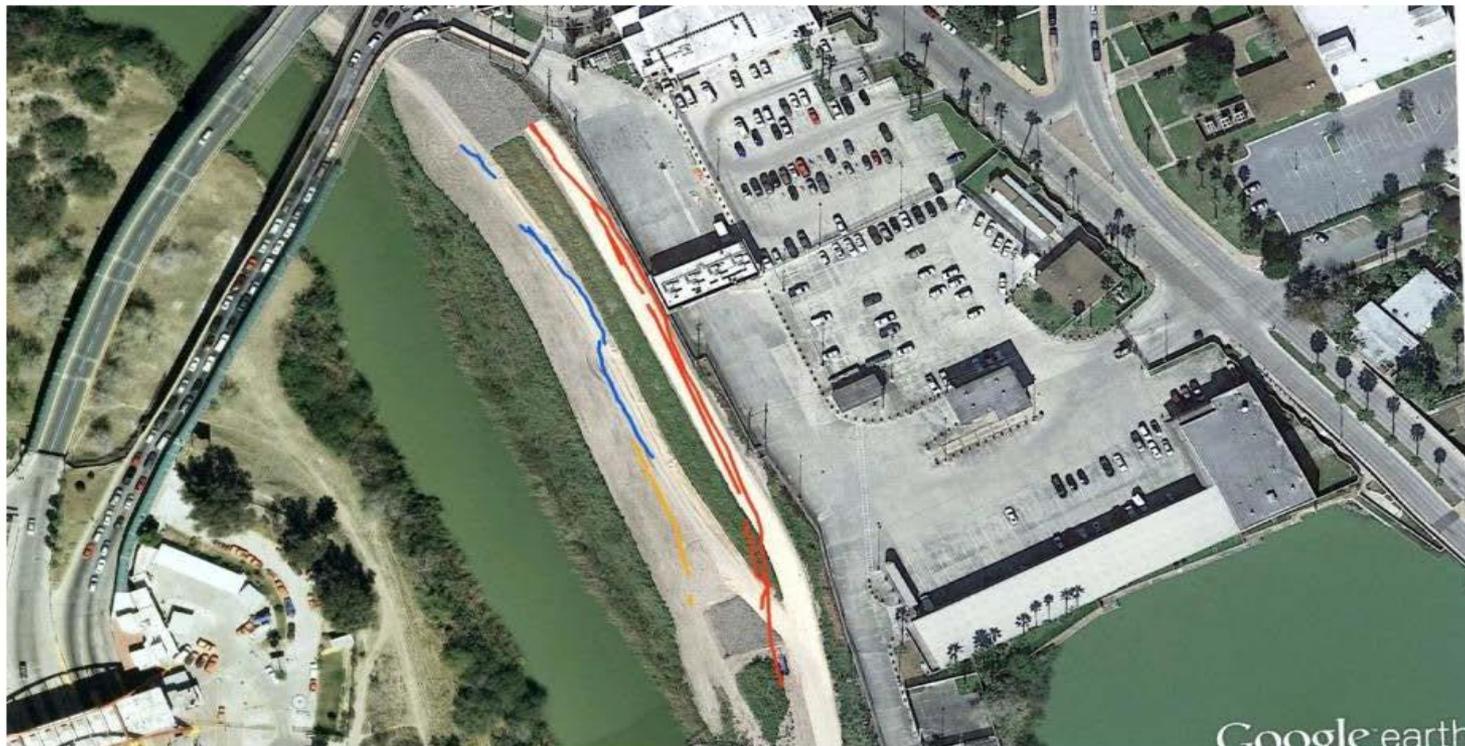




# International Boundary and Water Commission Engineering Services Division

## Levee Cracking adjacent to Gateway International Bridge

Three Major Crack Sets – 1 July 2014







# International Boundary and Water Commission

## Engineering Services Division

# Approach

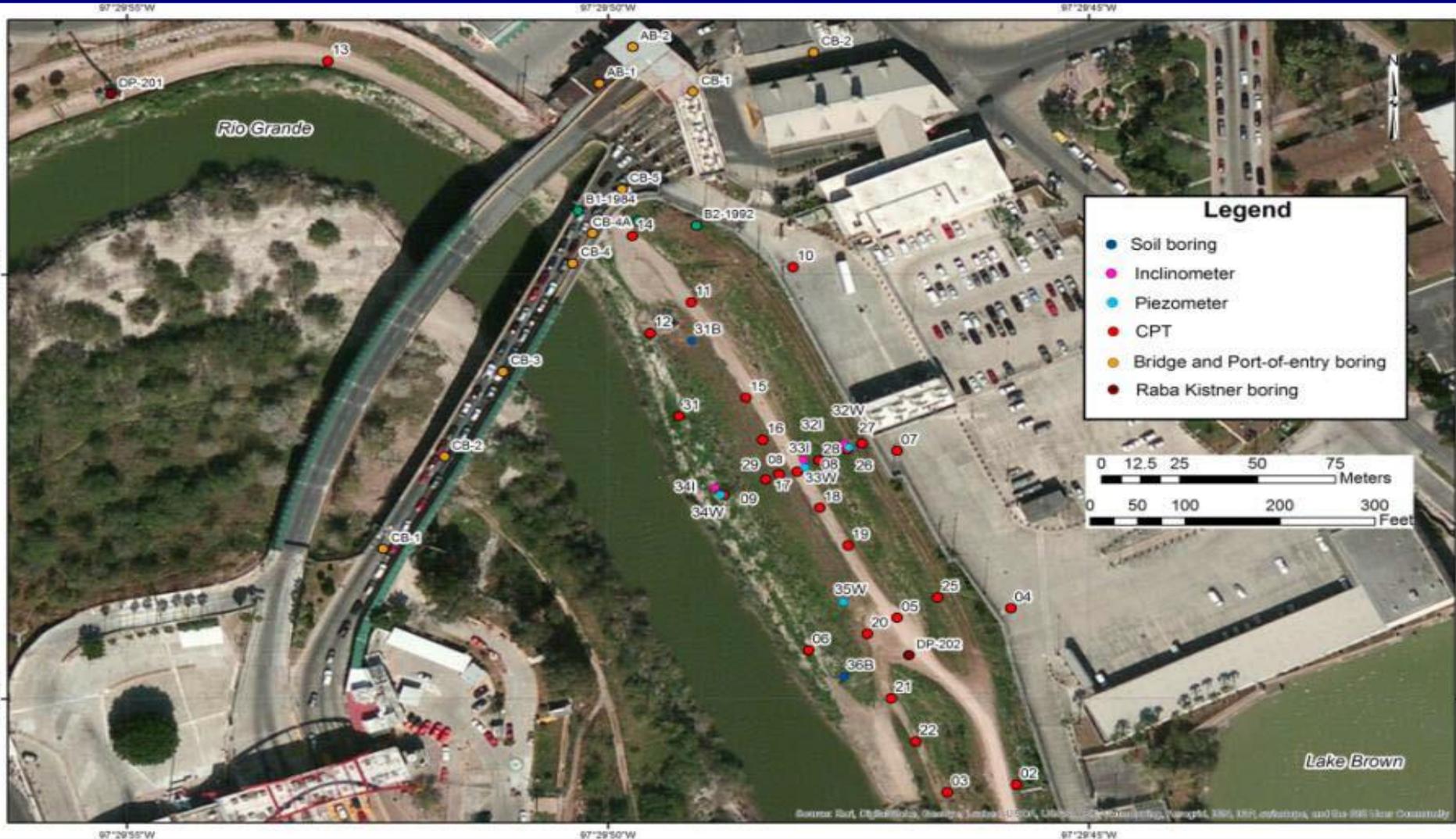
- Conduct a geotechnical investigation of the levee reach to identify source leading to cracking
  - Field investigation **(July – Nov 2014, completed)**
    - Perform preliminary site visit
    - Cone Penetration Tests (CPT)
    - Soil borings
    - Slope movement monitoring
    - Waterborne geophysical survey
  - Laboratory analyses **(Nov 2014 – Dec 2014, completed)**
    - Geotechnical index properties
  - Historic assessment **(July – September 2014, completed)**
  - Slope stability modeling **(Completed)**
  - Technical report **(Delivery date: May 28, 2015 or sooner)**



# International Boundary and Water Commission

## Engineering Services Division

# Collected Boring Data





# International Boundary and Water Commission

## Engineering Services Division

# Soil Borings /Monitoring Equipment



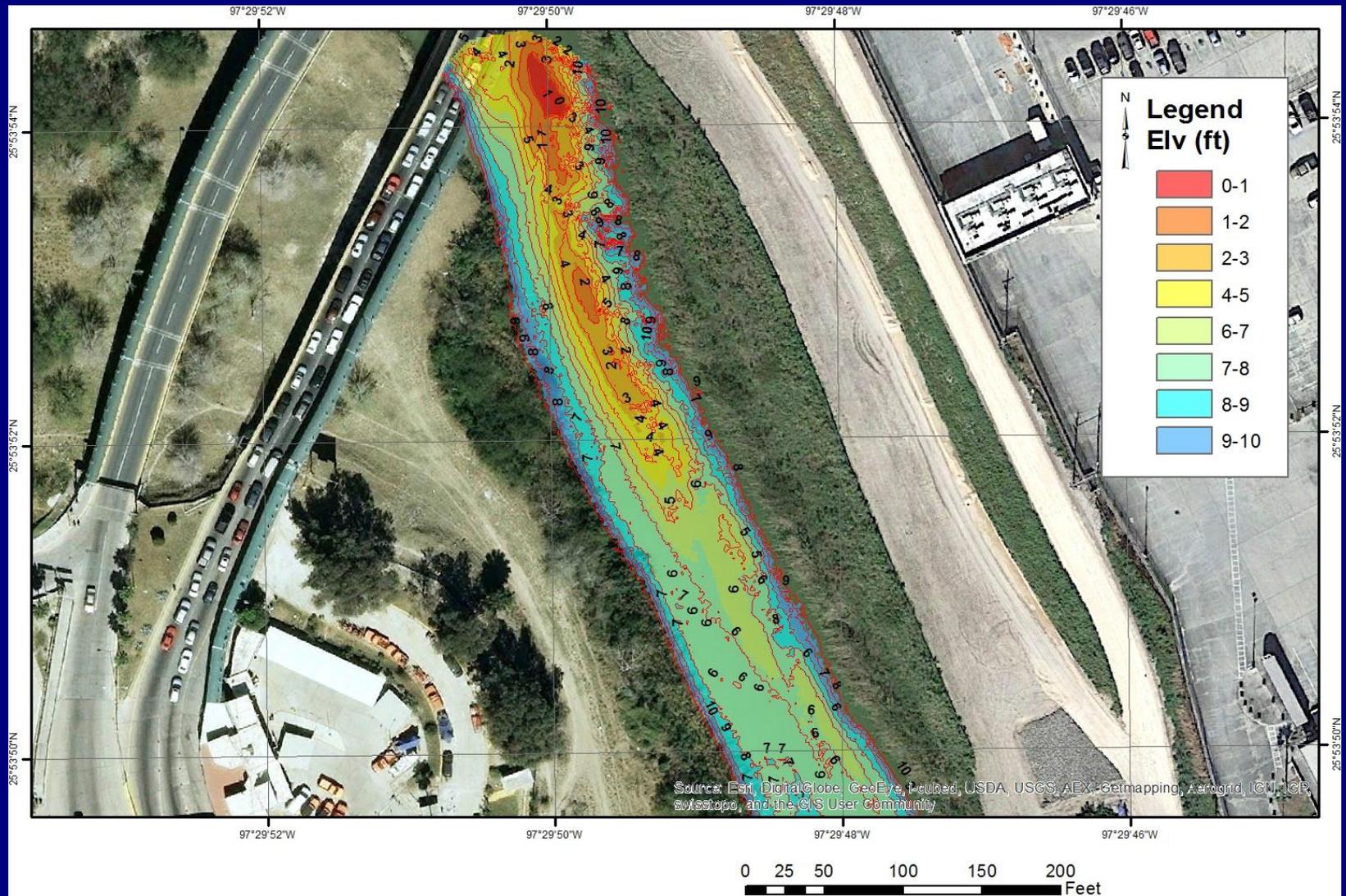
- Laboratory tests
  - Particle-size analysis
  - Void ratio, porosity, degree of saturation
  - Liquid limit, plastic limit, plasticity index
  - Soil compaction
  - Un-compressive strength test
  - Tri-axial compressive strength test
  - Pore pressure measurements





# International Boundary and Water Commission Engineering Services Division

## Channel Bathymetry

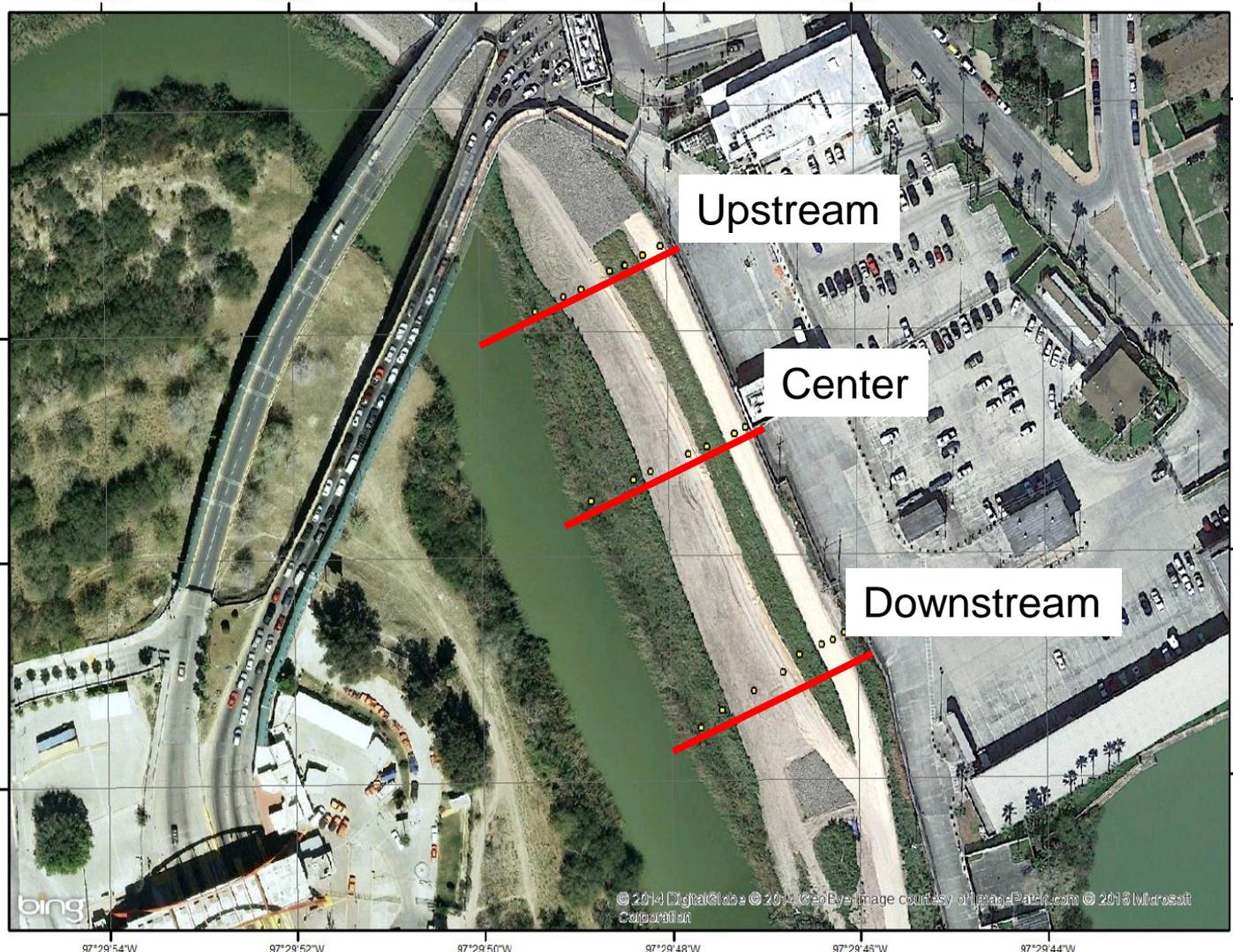




# International Boundary and Water Commission

## Engineering Services Division

# Elevation Monitoring



- Requires total station survey for accuracy needed to determine movements.



# International Boundary and Water Commission

## Engineering Services Division

### Slope movement monitoring

- Three methods of monitoring:
  - Monthly surveys
  - Inclinometers
  - Piezometers
- The results show there has been little to no movement from August 2014 to Present Day.

**Movement from Aug 26 to Sept 9 (Total Station)**





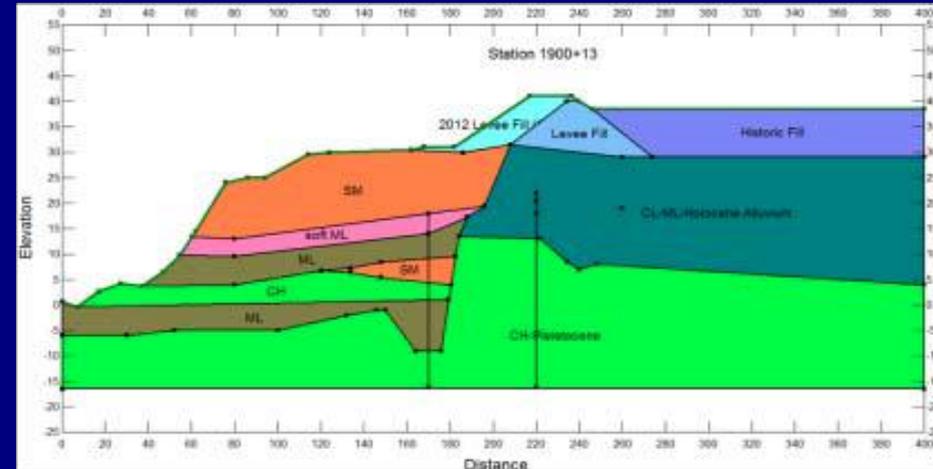
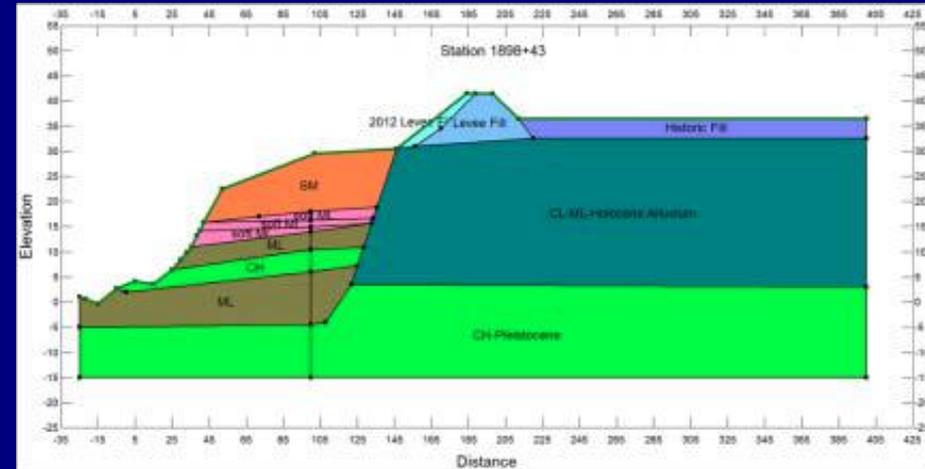
# International Boundary and Water Commission

## Engineering Services Division

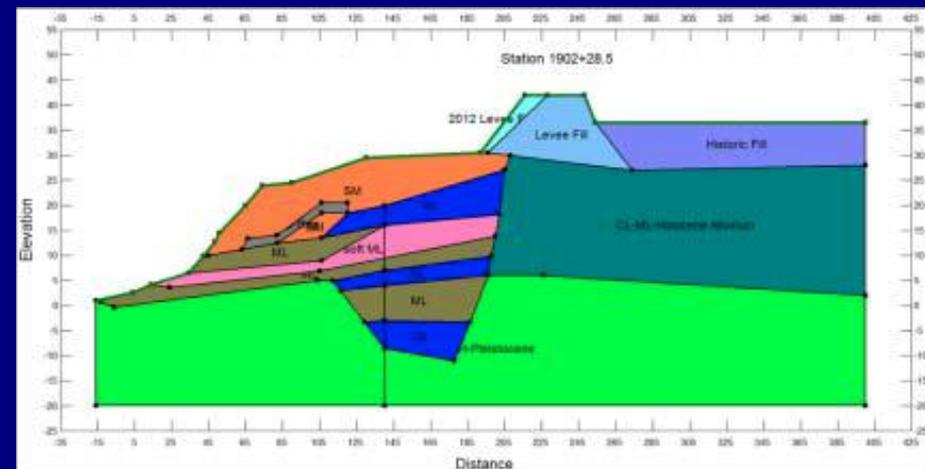
# Numerical Modeling Sections

### Cross Section 111

### Cross Section 211



### Cross Section 311



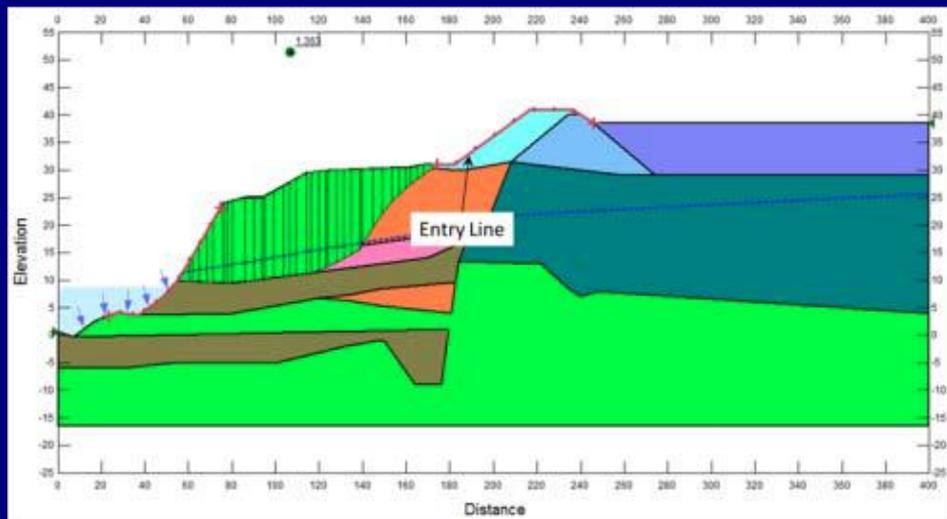
*Three sections analyzed:*  
Coincide with instrumentation  
Piezometers, Inclometers, and  
Survey monuments.



# International Boundary and Water Commission

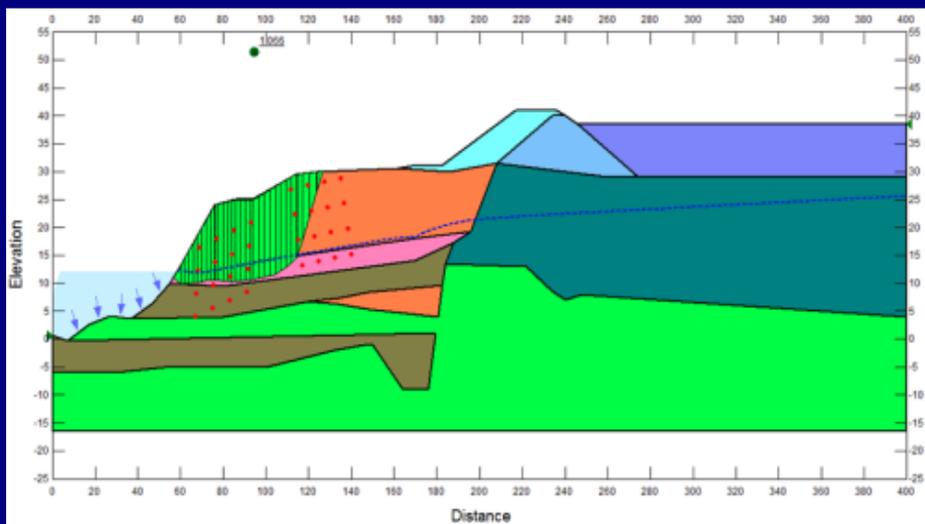
## Engineering Services Division

# Numerical Modeling Results (Cross Section 111)



- Infiltration surface at Station 1900+13, riverbank movement.

- Station 1900+13 with weak zone shear strength at 215 pcf.





# International Boundary and Water Commission

## Engineering Services Division

# Contributing Factors



- A series of rapid river drawdown events, combined with the local geologic conditions, led to the partial slope slide.
- Steep riverbank slopes combined with a deep scour pool in the bendway contribute to the sliding through this reach.
- Progressive/creep-type sliding is the probable mechanism that caused the cracking.
- Lake Brown's water elevation adversely impacts the stability of the levee.



# Remediation Alternatives

- **Alternative I:** Re-grade the bank to a 1V:5H slope with appropriately sized riprap protection from the edge of the access road to below the elevation of the softer material (long term, >5yrs)
- **Alternative II:** Install a sheetpile wall behind the existing riverbank to reinforce the soft alluvial sediments (long term, >5yrs)
- **Alternative III:** Improve the soil strength at the toe of the levee using soil mixing, installing either a continuous wall or panels to improve the shear strength and rigidity of the foundation materials (long term, >5yrs)
- **Alternative IV:** Monitor existing conditions and maintain stable river elevations. Avoid rapid drawdown events (short term, 3-5 yrs)

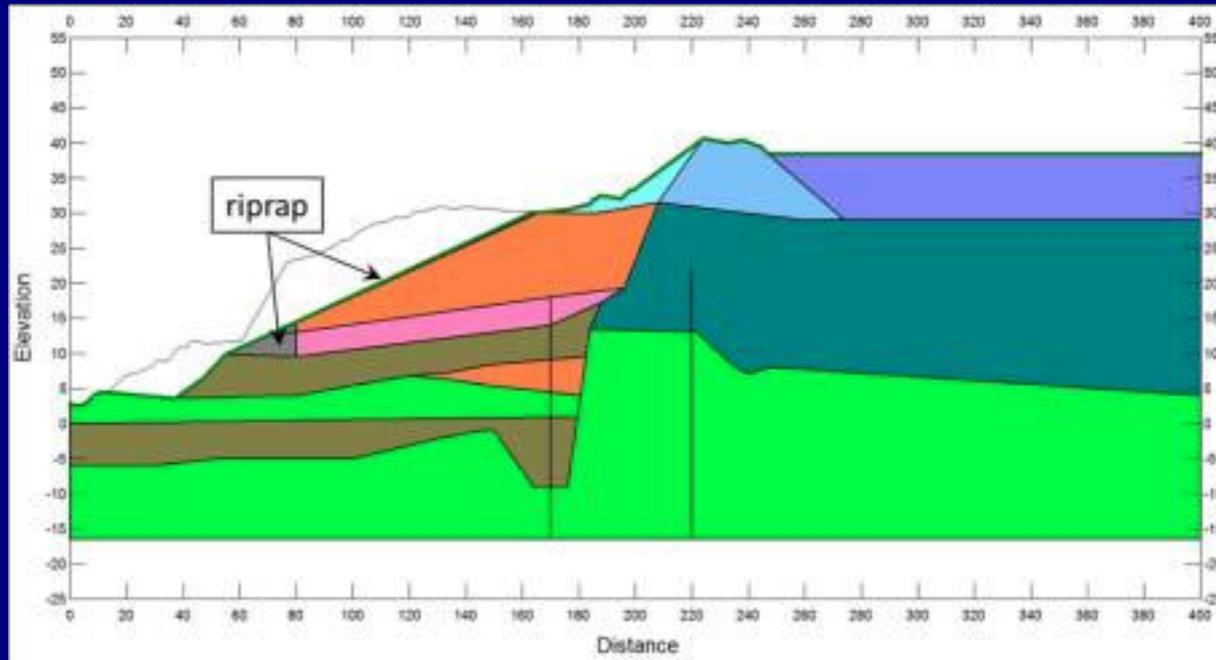


# International Boundary and Water Commission

## Engineering Services Division

# Remediation Alternative Analysis

## Alternative I: Re-grade Bank & Place Rock Riprap



Analysis	Steady State Low (7.77 ft)	Steady State High (14.31 ft)	Rapid Drawdown (14.31 ft. to 7.77 ft.)	Hydrograph (transient analysis)
Pre-instability	1.26	1.10	1.00	1.02
Post-instability	1.16	1.17	1.00	1.15
Alt. I	1.24	1.22	1.20	1.56
Alt. II	1.62	1.55	1.34	1.64
Alt. III	1.56	1.67	2.19	2.32



# Conclusions

- The investigation determined that rapid drawdown of the Rio Grande and local geologic conditions caused cracking of a 800 linear foot segment of Rio Grande flood control levee.
- The cracks pose no immediate flood risk and are considered safe under conditions similar to the 2010 flood.
- The USIBWC has performed a Cost to Benefit Analysis of the remediation options offered by the USACE and has chosen to:
  - Short Term: Continue to monitor the area conditions by using the installed USACE monitoring equipment.
  - Long Term: Proceed with implementing Alternative I to stabilize the river bank.
- USIBWC is in the process of issuing a design contract for the Alternative I repair option. Once design is completed, USIBWC will solicit the construction project.



Ramon F. Navarro

Contracting Officers Representative /  
Civil Engineer

Weslaco Field Office  
(956) 564-2991

**International Boundary and Water Commission**  
**United States Section**  
Engineering Services Division

**Construction Projects Inquiries**

Isela Canava  
Lead Civil Engineer  
(915) 832-4748