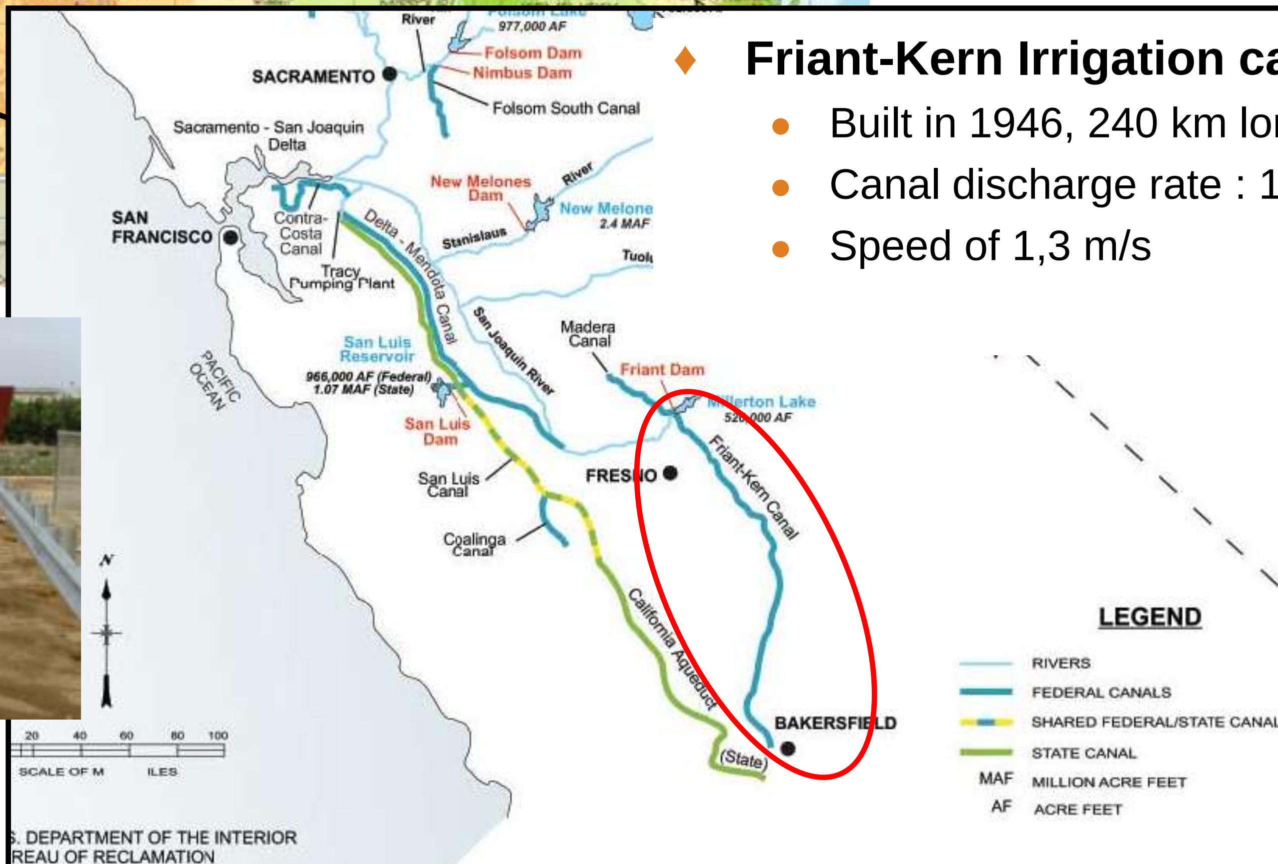
Lime Treatment of Soils
The Friant-Kern Canal experience

G. Herrier *Lhoist R&D*
E. Berger *Lhoist North America*
S. Bonelli *Irstea*

ICSE-6 2012



♦ Friant-Kern Irrigation canal

- Built in 1946, 240 km long
- Canal discharge rate : 100 m^3/s
- Speed of 1,3 m/s

♦ Earth and concrete-lined blankets

- 87 km of the canal built with Porterville clays (montmorillonitic clayey soil)
- Below water level : volumic expansion, lowering density and strength
- Above water : shrinkage, cracks, loss of shear strength and slidings

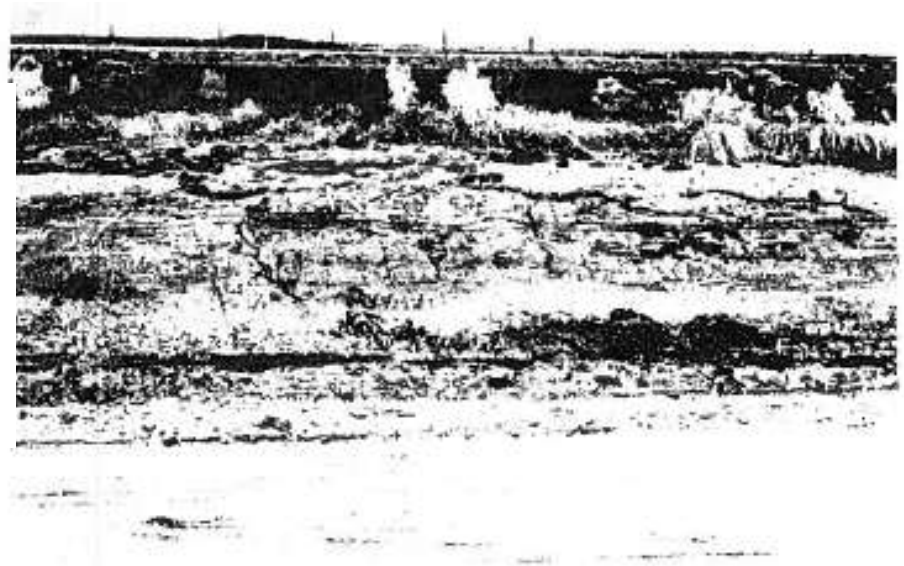
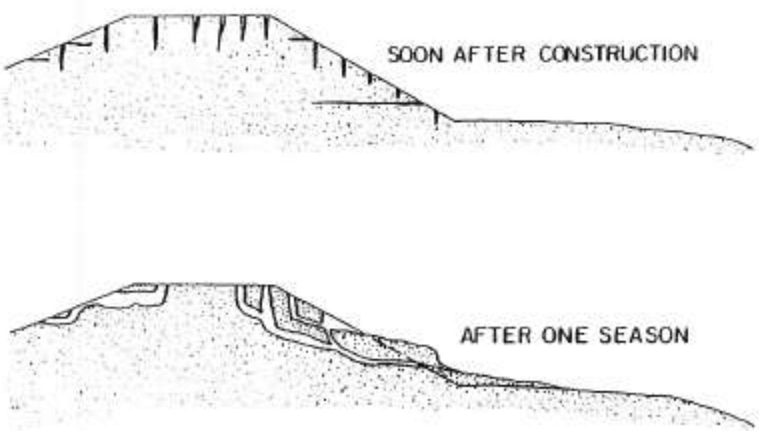
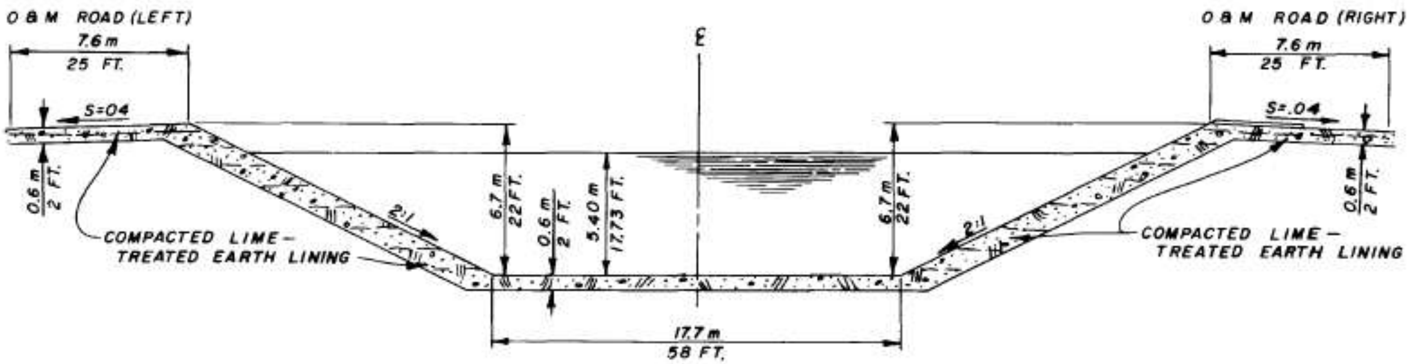


Fig. 2 Typical slide failure, Friant Kern Canal

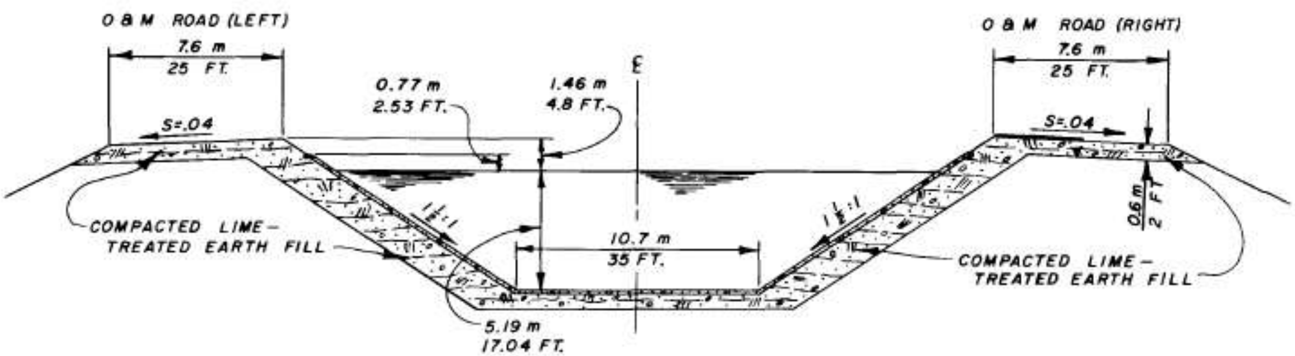


♦ Decisions of US Bureau of reclamation for renovation

- Problem of availability of suitable soils for replacement of failed soils
- Replacement by rock or gravel not satisfactory
- 70's : Decision for lime treatment for restoration of damaged zones
- Purpose : stabilize slopes only



TYPICAL EARTH REHABILITATION SECTION



TYPICAL CONCRETE LINED REHABILITATION SECTION

- **First operations : 1972**
  - Lime dosage according lab study :
    4 % granular quicklime (CaO)
  - PI reduction : 47 to 12
  - Shrinkage limit increase : from 7 to 26 %
  - Increase of compressive strength x20

- **Construction procedure**
  - Moving the failed material from the banks
  - Partial lime treament of sticky soil to facilitate excavation
  - Material moved to the canal bottom for lime spreading and mixing steps
  - Mellowing overnight before placement

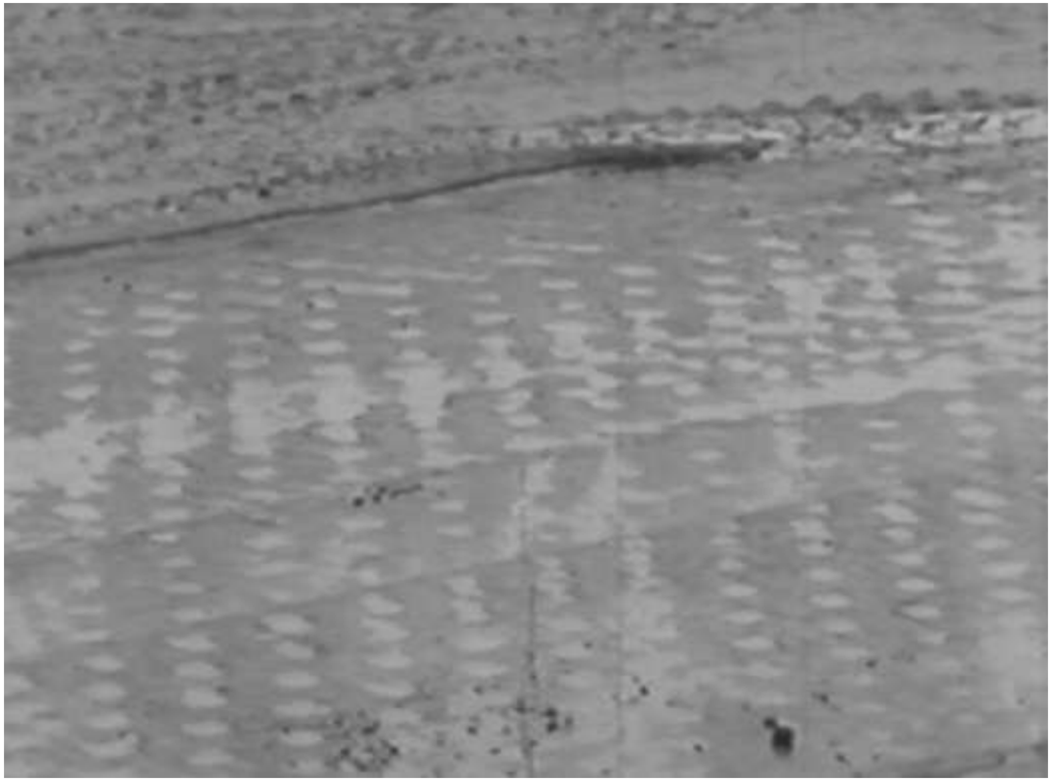
- **Placement and compaction**
  - 30 to 40 cm lifts on the banks
  - Compaction with a vibrating sheepfoot roller, « yo-yo » fashion

- **Next projects (1975-77 and 1983-84) : changes**
  - Placement of the lime-treated material in horizontal lifts, « stair-step » construction
  - Bank slope trimmed
  - Mixing step in adjacent areas (flexibility of the solution)

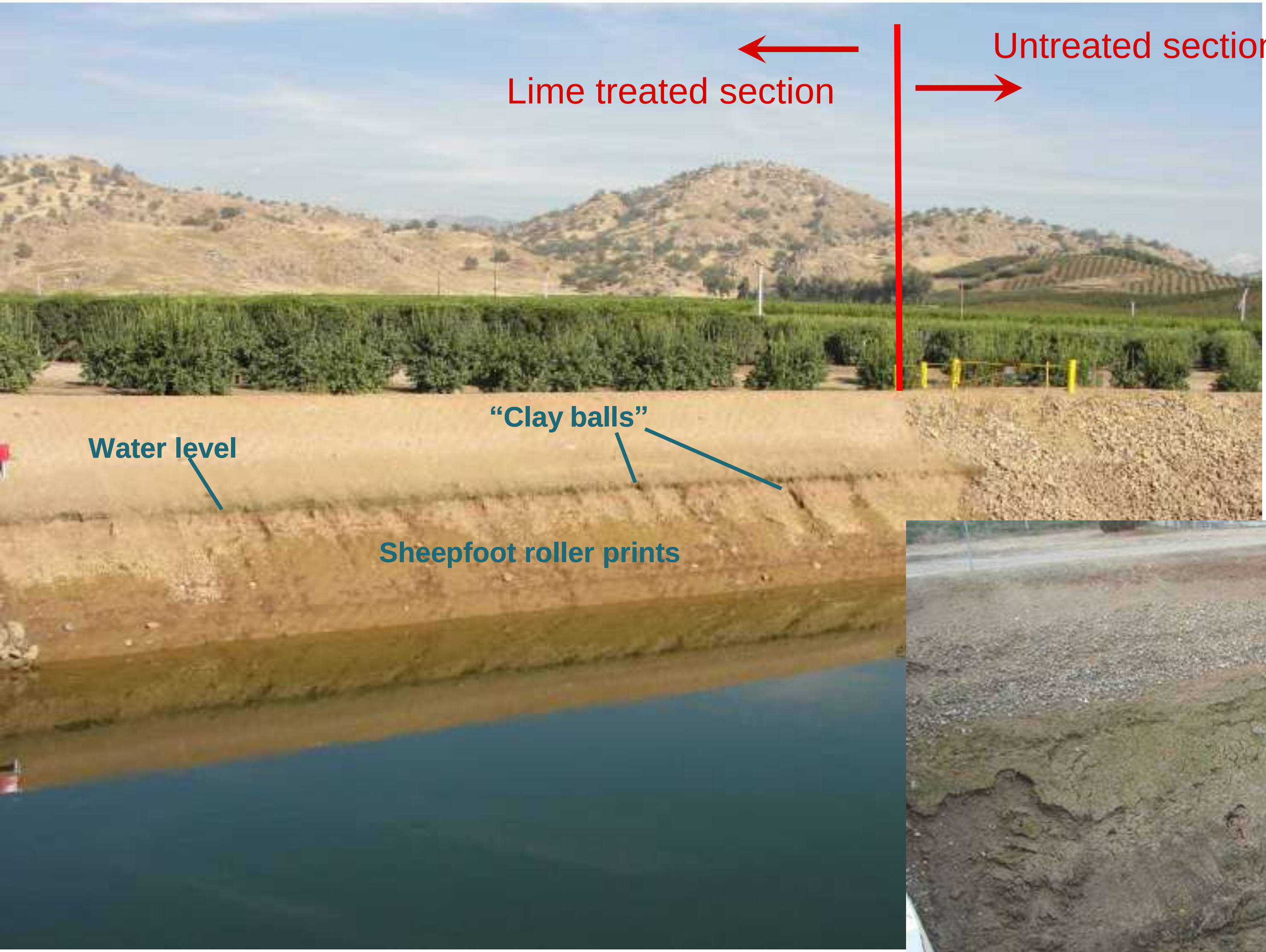
♦ Feedback and performance of lime-treated sections

- After 1 year irrigation : sheepfoot rollers imprints still visible
- No new slips or slides since the renovation works
- Rc on cored specimens : 2.2 MPa (after 1 month) to 3.4 MPa (after 1 year)

Fig. 8a Sheepsfoot imprints after 10 months



Lhoist



Untreated section

♦ Testimonials

- Lime treatment induces **no need for additional material**, flattening of slopes…
- After 1 year service, unprotected lime-treated lining did not suffer from **erosion**
- gravel belt judged unnecessary (60 000 $ **cost savings**)
- Lime-treated sections, initially to be recovered with concrete panels, stayed unprotected without erosion or unstability
- Lime stabilized linings needs the **less maintenance**
- No measurements of other properties (permeability), but indirects signs of waterthighting

♦ Other testimonials of lime applications

- Mississippi River Levees
- Earth dams
- Case of dispersive soils
- French structures, to be investigated

Country	Amount of hydrated lime	Type of test	Curing	Problem	Structure type and location where treated soils placed	Remarks	Reference
New South Wales, Australia	0.5%	Small scale dam model investigation	Not provided	Tunneling failure due to dispersion	Upstream face of the embankment	Recommended to compact the soil to 80% of max. dry density	Rosewell 1977
Canada	1%	Pinhole test	Not provided	Erosion of sensitive marine clay	Dyke's foundation	Reported that lime acted as cementing agent	Dascal and Hurtubise 1977
New Mexico	4%	Pinhole test	Minimum of 4-day curing	Internal erosion of dispersive soils	Fractured sandstone foundation of Los Esteros dam	Recommended to cure soil-lime mix in loose state at near OMC* before the placement and compaction	McDaniel and Decker 1979
Mississippi, USA	2-3%	Laboratory dispersion test	Minimum of 2-day curing	Surface erosion	Slopes of dams	Recommended to cure soil-lime mix in loose state before the compaction	Perry 1977

Lhoist

Thank you for your attention !

gontran.herrier@lhoist.com
eric.berger@lhoist.com
didier.lesueur@lhoist.com