

Seepage Loss Test Results in Cameron County Irrigation District No. 2

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Prepared for:
Cameron County Irrigation District No. 2

April 2011

Texas Water Resources Institute Technical Report No. 375
Texas A&M University System
College Station, Texas 77843-2118

SEEPAGE LOSS TEST RESULTS IN CAMERON COUNTY IRRIGATION DISTRICT NO.2

Rio Grande Basin Initiative
Irrigation Technology Center
Texas Water Resources Institute
Texas AgriLife Extension Service

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December 18, 2002

¹ A portion of this study was funded by Texas Cooperative Extension through the Rio Grande Basin Initiative administered by the Texas Water Resources Institute of the Texas A&M University System with funds provided through a grant from Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under Agreement No. 2001-001-45049-01149.

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Summary

This report summarizes seepage loss tests conducted in Cameron County Irrigation District No. 2 (CCID2) on five canal segments located as shown on the right.

The results are summarized in Table 1 for the 5 tests conducted during Summer 2002 and a test performed previously in the district.

The locations of these tests are shown in more detailed on the attached map. Canals 23, 27, 33 and 35 are unlined canals supplied by main canal B. These canals run from main canal B east crossing Center Line Road and Brown Tract Road. Canal 55 is an unlined canal located 5 miles due north from canal 35 off of Brown Tract Road. Maximum operating depths range from 3 to 5 ft. Typically in this region, the normal operating depth is about 6 inches to a foot of the maximum.

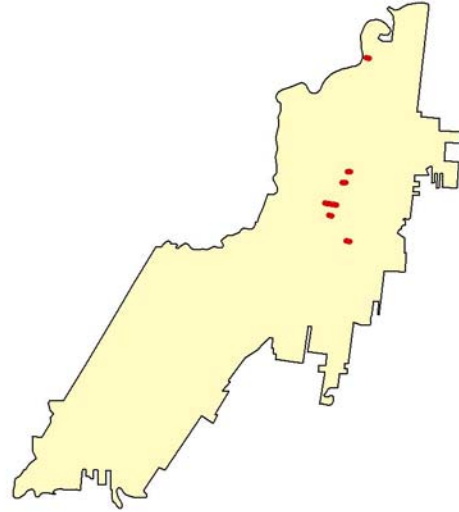


Table 1: Seepage Loss Test Results for the project area described above of CCID2. All segments are earth-lined.

| Test # | Segment | Soil Type | Top Width (ft) | Length (ft) | Ave Loss Seepage Rate (gal/ft ² /day) | Total Loss in Canal (ac-ft/mile) per day per year | |
|--------|----------|----------------------|----------------|-------------|--|--|--------|
| 1 | Canal 23 | fine sandy clay loam | 20 | 640 | 1.443 | 0.5178 | 188.99 |
| 2 | Canal 27 | clay loam | 16 | 600 | 0.643 | 0.1872 | 68.33 |
| 3 | Canal 33 | fine sandy clay loam | 18 | 740 | 1.674 | 0.5159 | 188.31 |
| 4 | Canal 35 | fine sandy clay loam | 17 | 600 | 0.419 | 0.1297 | 47.35 |
| 5 | Canal 55 | clay loam | 18.5 | 500 | 1.239 | 0.4276 | 156.09 |
| **RM 1 | Canal 29 | clay loam | 29 | 2530 | 1.27 | 0.5901 | 215.40 |

**Corrected test calculations for RM-1 (Region M Study – see <http://dms.tamu.edu>). This test is not discussed further in this report.

TEST METHOD

Loss rates were determined using the ponding method. In this method, the two ends of a canal segment are closed or sealed with earthen dams (Fig. 1), as are any valves or gates located in the test segment. Changes in water levels are recorded for at least 48 hours. One to three continuous-stage level recorders (Fig. 2) were used to supplement the 3 locations where stage levels were recorded manually. During the tests, canal dimensions and water span were also record and surveyed.



Figure 1. Earthen dam constructed on canal 55.

Soil Sampling and Groundwater Level Measurement

Two soil samples were taken of the canal embankment (or levee) and one in a field adjacent to the canal. One canal embankment (levee) sample was from inside the canal at or below the normal operating water level, and the other at a location approximately 10 ft from the edge of the canal and 2 feet below the surface. Natural surrounding soil samples were taken in fields adjacent to the test area down to 12 foot of depth. In these tests, shallow groundwater was not found within 12 feet of the soil surface.

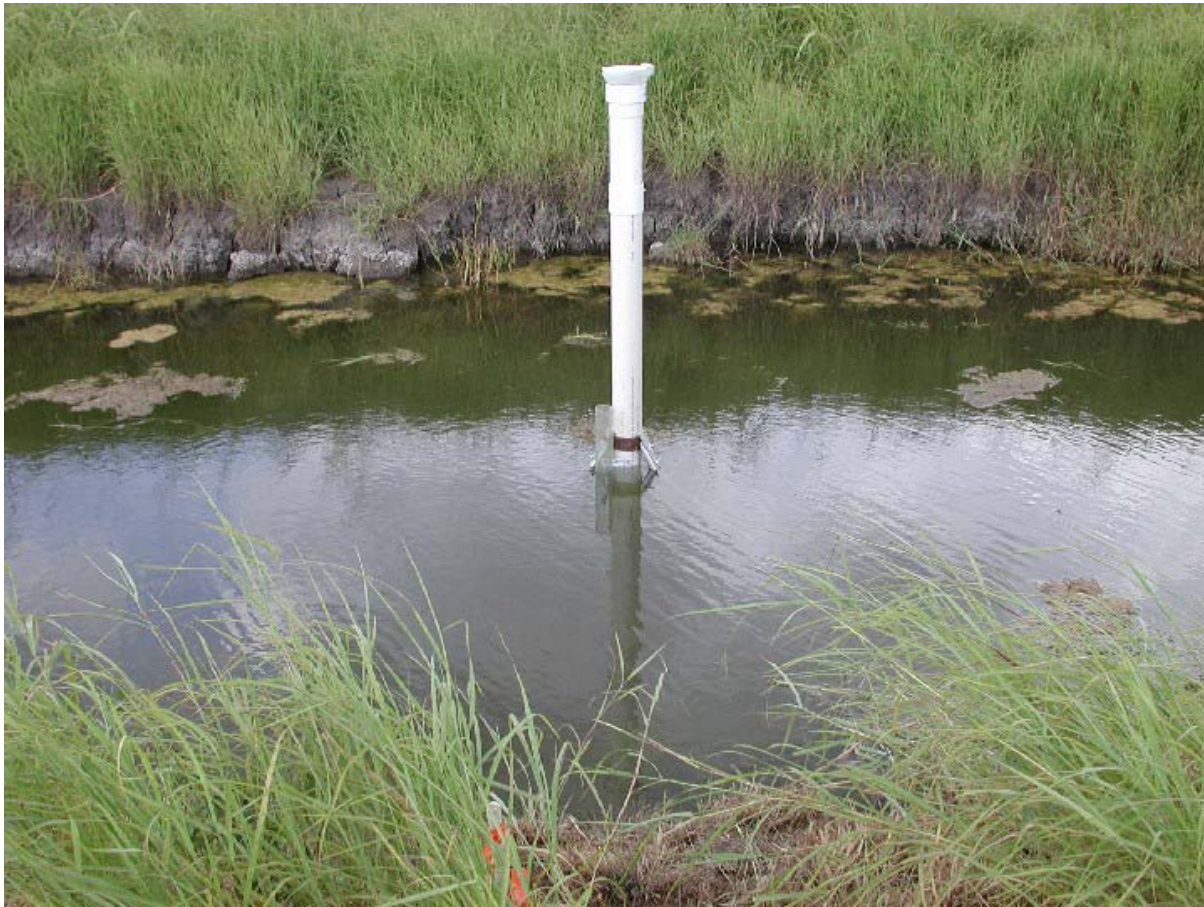


Figure 2. Continuous-stage level recorders on canal 55.

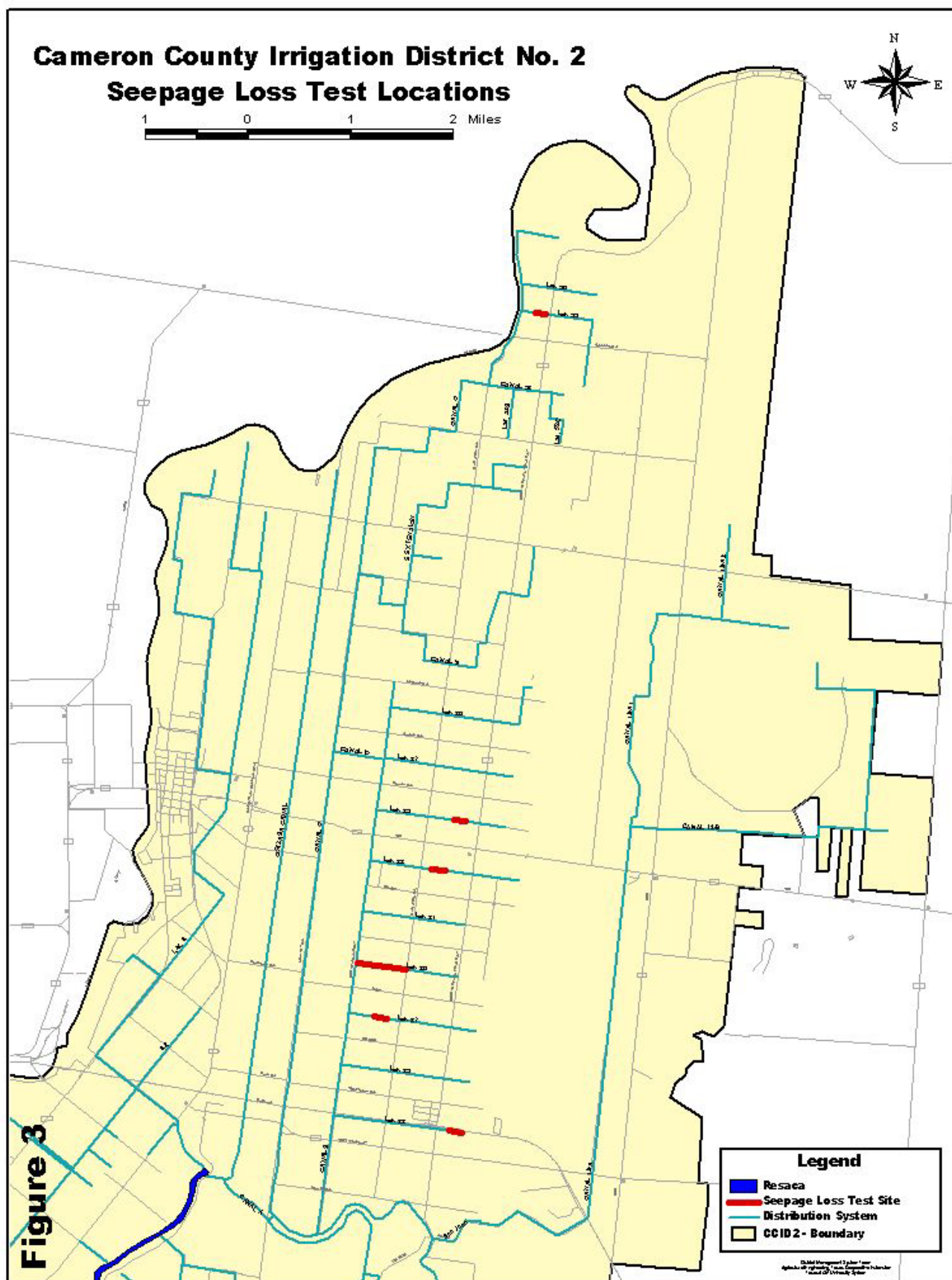


Figure 3 Test site location.

DETAILED TEST RESULTS

Tables 4 – 11 provide additional details on the test results and other information collected. For each canal, two tables are provided. The first table gives canal dimensions, testing dates and time, and stage level measurements. The second table gives the loss rated in 5 methods commonly used to characterize water loss in canals. Note: annual water loss rates assume that the canal is in service 365 days per year.

For each test segment, a chart is provided showing the measured canal profile compared to the expected canal profile. The expected profile was developed by fitting an equation to the measured data as shown.

| Table 2. Test Information for Canal 23 | | | | | | | |
|--|--------|--------------------------------------|-------|------------|---------------------|------------|--------------------|
| District: | | Cameron County Irrigation District 2 | | | Test ID: | | Canal 23 |
| Canal: | | Canal 23 | | | Lining Type: | | Earth |
| Top Width: | | 20 ft | | | Date: | | June 18 – 20, 2002 |
| Test Length: | | 640 ft | | | Start Time: | | 18:51 |
| Total Depth: | | 3.5 ft | | | Finish Time: | | 14:01 |
| Location: East of Brown Tract Rd, end of section. | | | | | | | |
| Staff Gage Readings | | | | | | | |
| Date | | SG1 | | SG2 | | SG3 | |
| | | Reading | Time | Reading | Time | Reading | Time |
| 1 | 18-Jun | 2.40 | 18:56 | 2.38 | 18:54 | 2.00 | 18:51 |
| 2 | 19-Jun | 2.21 | 13:27 | 2.25 | 13:24 | 1.97 | 13:20 |
| 3 | | 2.17 | 16:07 | 2.24 | 16:05 | 1.94 | 16:03 |
| 4 | | 2.16 | 18:54 | 2.21 | 18:52 | 1.91 | 18:50 |
| 5 | 20-Jun | 1.79 | 10:55 | 2.07 | 10:56 | 1.79 | 10:58 |
| 6 | | 1.77 | 13:58 | 2.04 | 14:00 | 1.77 | 14:01 |

| Table 3. Average Unit Area Loss Rate for Canal 23. | | | | | | |
|--|--------|------------|--------------------------|-----------|-------------------|-----------|
| ft ³ /ft ² /hour | ft/day | inches/day | gal/ft ² /day | | acre-ft/mile/year | |
| | | | avg. | std. dev. | avg. | std. dev. |
| 0.0080 | 0.193 | 2.31 | 1.443 | 0.730 | 188.99 | 95.426 |

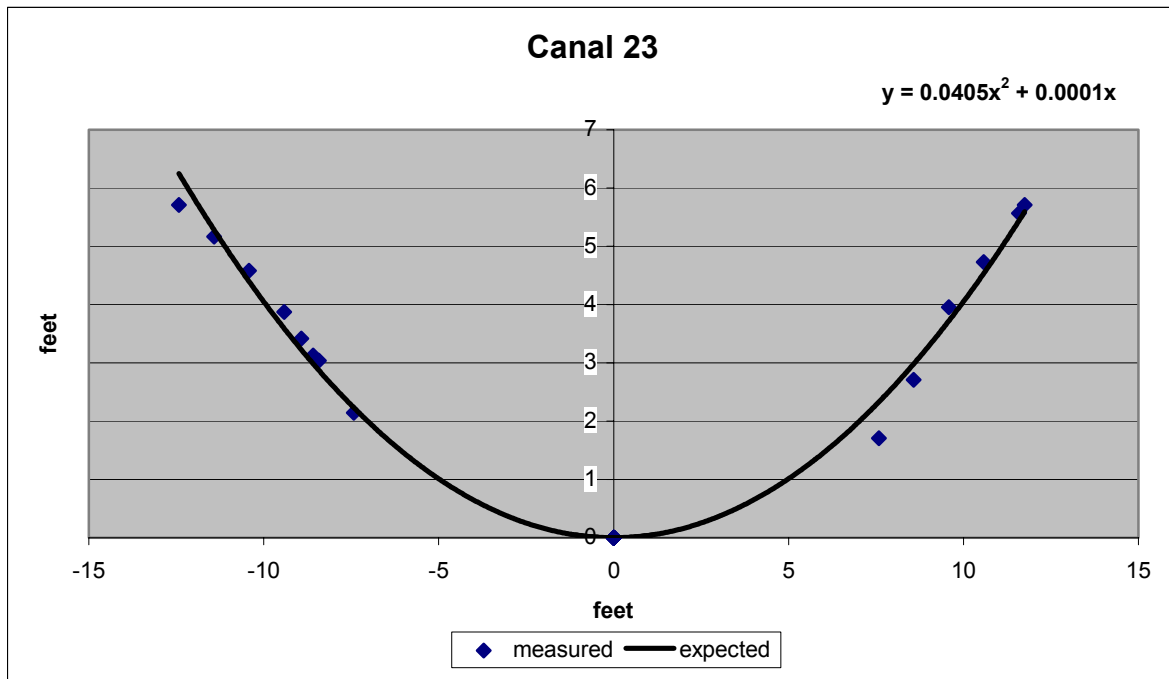


Figure 4. Cross-section of canal 23.



Figure 5. Canal 23

Table 4. Test Information for Canal 27

| | | | | | | | | | | | |
|--|--------------------------------------|---------------------|------------------|------------|-------|------------|-------|------------|-------|------------|-------|
| District: | Cameron County Irrigation District 2 | Test ID: | Canal 27 | | | | | | | | |
| Canal: | Canal 27 | Lining Type: | Earth | | | | | | | | |
| Top Width: | 16 ft | Date: | June 5 – 7, 2002 | | | | | | | | |
| Test Length: | 600 ft | Start Time: | 15:03 | | | | | | | | |
| Total Depth: | 2.5 ft | Finish Time: | 09:26 | | | | | | | | |
| Location: East of Canal B and west of Center Line Rd. | | | | | | | | | | | |
| Staff Gage Readings | | | | | | | | | | | |
| Date | | SG1 | | SG2 | | SG3 | | SG4 | | SG5 | |
| | | Reading | Time | Reading | Time | Reading | Time | Reading | Time | Reading | Time |
| 1 | 5-Jun | 1.427 | 15:16 | 1.417 | 15:09 | 1.828 | 15:07 | 2.250 | 15:20 | 2.104 | 15:03 |
| 2 | | 1.406 | 16:16 | 1.438 | 16:20 | 1.813 | 16:22 | 2.250 | 16:28 | 2.146 | 16:25 |
| 3 | 6-Jun | 1.333 | 10:03 | 1.375 | 09:58 | 1.719 | 10:14 | 2.167 | 10:09 | 2.042 | 10:12 |
| 4 | | 1.328 | 11:56 | 1.390 | 11:53 | 1.719 | 11:57 | 2.167 | 11:59 | 2.042 | 11:48 |
| 5 | | 1.323 | 14:52 | 1.375 | 14:50 | 1.708 | 14:48 | 2.156 | 14:46 | 2.031 | 14:41 |
| 6 | | 1.307 | 16:44 | 1.333 | 16:41 | 1.688 | 16:39 | 2.146 | 16:37 | 2.042 | 16:35 |
| 7 | 7-Jun | 1.250 | 09:18 | 1.25 | 09:20 | 1.635 | 09:21 | 2.073 | 09:26 | 1.958 | 09:24 |
| | | | | | | | | | | | |

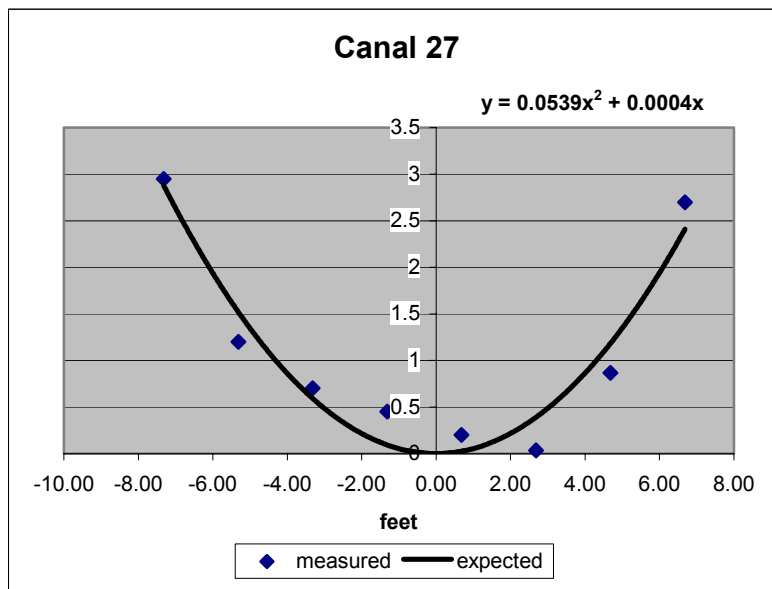


Figure 6. Cross-section of canal 27.

Table 5. Average Unit Area Loss Rate for Canal 27.

| ft ³ /ft ² /hour | ft/day | inches/day | gal/ft ² /day | | acre-ft/mile/year | |
|--|--------|------------|--------------------------|-----------|-------------------|-----------|
| | | | avg. | std. dev. | avg. | std. dev. |
| 0.00358 | 0.0860 | 1.03 | 0.643 | 0.065 | 68.331 | 6.873 |

Table 6. Test Information for Canal 33

| | | | | | | | |
|--|--------------------------------------|---------------------|------------------|------------|-------|------------|-------|
| District: | Cameron County Irrigation District 2 | Test ID: | Canal 33 | | | | |
| Canal: | Canal 33 | Lining Type: | Earth | | | | |
| Top Width: | 18 ft | Date: | June 5 – 7, 2002 | | | | |
| Test Length: | 740 ft | Start Time: | 17:01 | | | | |
| Total Depth: | 5 ft | Finish Time: | 10:45 | | | | |
| Location: East of Center Line Rd. and west of Brown Tract Rd. South of 106. | | | | | | | |
| Staff Gage Readings | | | | | | | |
| Date | | SG1 | | SG2 | | SG3 | |
| | | Readings | Time | Readings | Time | Readings | Time |
| 1 | 5-Jun | 1.396 | 17:01 | 2.708 | 17:05 | 1.771 | 17:07 |
| 2 | 6-Jun | 1.198 | 10:23 | 2.500 | 10:25 | 1.635 | 10:28 |
| 3 | | 1.115 | 13:54 | 2.458 | 13:55 | 1.542 | 13:58 |
| 4 | | 0.958 | 16:06 | 1.531 | 16:10 | 2.458 | 16:12 |
| 5 | 7-Jun | 0.979 | 10:42 | 2.271 | 10:44 | 1.333 | 10:45 |
| | | | | | | | |

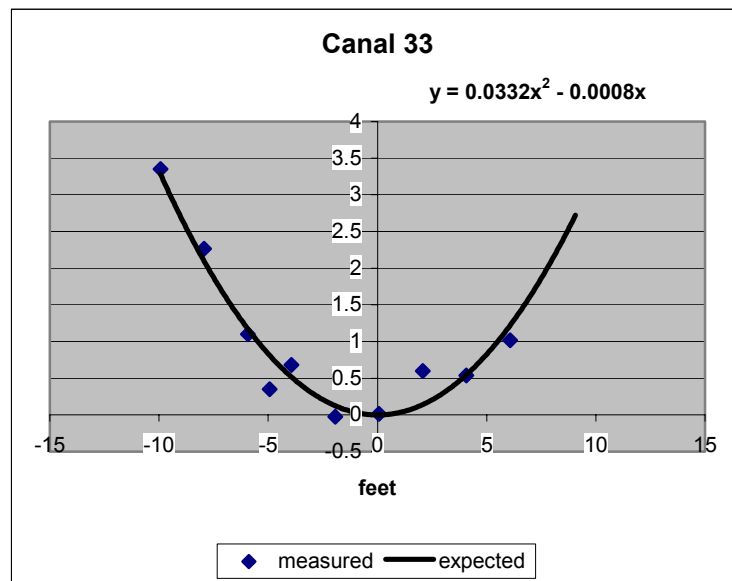


Figure 7. Cross-section for canal 33

Table 7. Average Unit Area Loss Rate for Canal 33.

| ft ³ /ft ² /hour | ft/day | inches/day | gal/ft ² /day | | acre-ft/mile/year | |
|--|--------|------------|--------------------------|-----------|-------------------|-----------|
| | | | avg. | std. dev. | avg. | std. dev. |
| 0.00932 | 0.223 | 2.68 | 1.674 | 0.042 | 188.31 | 4.678 |

| Table 8. Test Information for Canal 35 | | | | | | | |
|--|--------|--------------------------------------|-------|---------------------|-------|--------------------|-------|
| District: | | Cameron County Irrigation District 2 | | Test ID: | | Canal 35 | |
| Canal: | | Canal 35 | | Lining Type: | | Earth | |
| Top Width: | | 17 ft | | Date: | | June 19 – 21, 2002 | |
| Test Length: | | 600 ft | | Start Time: | | 19:22 | |
| Total Depth: | | 3.5 ft | | Finish Time: | | 09:36 | |
| Location: East of Center Line Rd. and west of Brown Tract Rd. North of 106. | | | | | | | |
| Staff Gage Readings | | | | | | | |
| Date | | SG1 | | SG2 | | SG3 | |
| | | Readings | Time | Readings | Time | Readings | Time |
| 1 | 19-Jun | 2.46 | 19:25 | 2.49 | 19:22 | 3.09 | 19:23 |
| 2 | 20-Jun | 2.42 | 10:36 | 2.48 | 10:38 | 3.04 | 10:39 |
| 3 | | 2.40 | 13:46 | 2.46 | 13:44 | 3.02 | 13:42 |
| 4 | | 2.40 | 15:11 | 2.46 | 15:10 | 3.02 | 15:08 |
| 5 | | 2.40 | 17:46 | 2.44 | 17:46 | 3.02 | 17:42 |
| 6 | | 2.40 | 18:50 | 2.44 | 18:52 | 3.02 | 18:53 |
| 7 | 21-Jun | 2.36 | 09:39 | 2.40 | 09:37 | 2.98 | 09:36 |

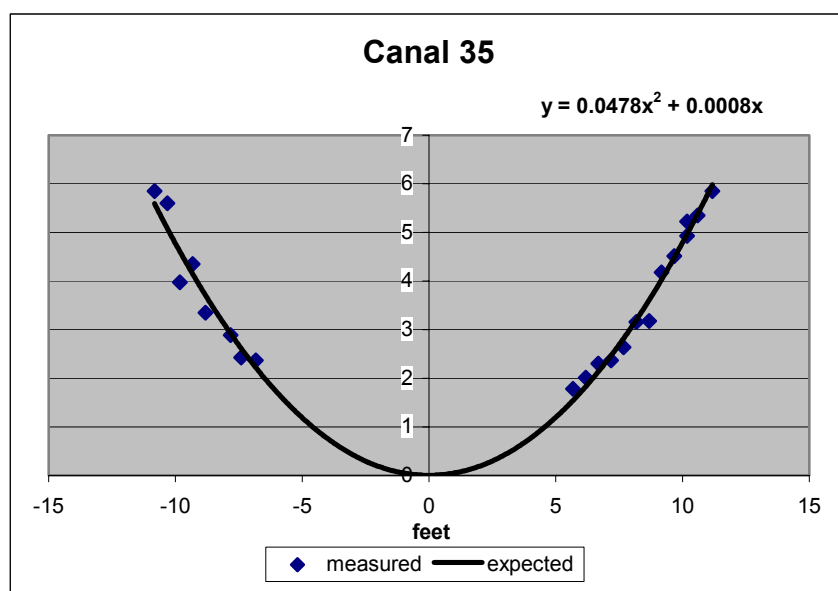


Figure 8. Cross-section of canal 35

| Table 9. Average Unit Area Loss Rate for Canal 35. | | | | | | |
|--|--------|------------|--------------------------|-----------|-------------------|-----------|
| ft ³ /ft ² /hour | ft/day | inches/day | gal/ft ² /day | | acre-ft/mile/year | |
| | | | avg. | std. dev. | avg. | std. dev. |
| 0.00233 | 0.056 | 0.67 | 0.419 | 0.042 | 47.345 | 4.721 |



Figure 9. Canal 35

Table 10. Test Information for Canal 55

| | | | |
|---|--------------------------------------|---------------------|----------------|
| District: | Cameron County Irrigation District 2 | Test ID: | Canal 55 |
| Canal: | Canal 55 | Lining Type: | Earth |
| Top Width: | 18.5 ft | Date: | August 7, 2002 |
| Test Length: | 500 ft | Start Time: | 09:52 |
| Total Depth: | 4.5 ft | Finish Time: | 15:16 |
| Location: West of Brown Tract Rd. and north of Johnson Rd. | | | |
| Staff Gage Readings | | | |
| | Date | Readings | Time |
| 1 | 7-Aug | 3.22 | 09:52 |
| 2 | | 3.20 | 10:57 |
| 3 | | 3.20 | 11:54 |
| 4 | | 3.18 | 15:16 |

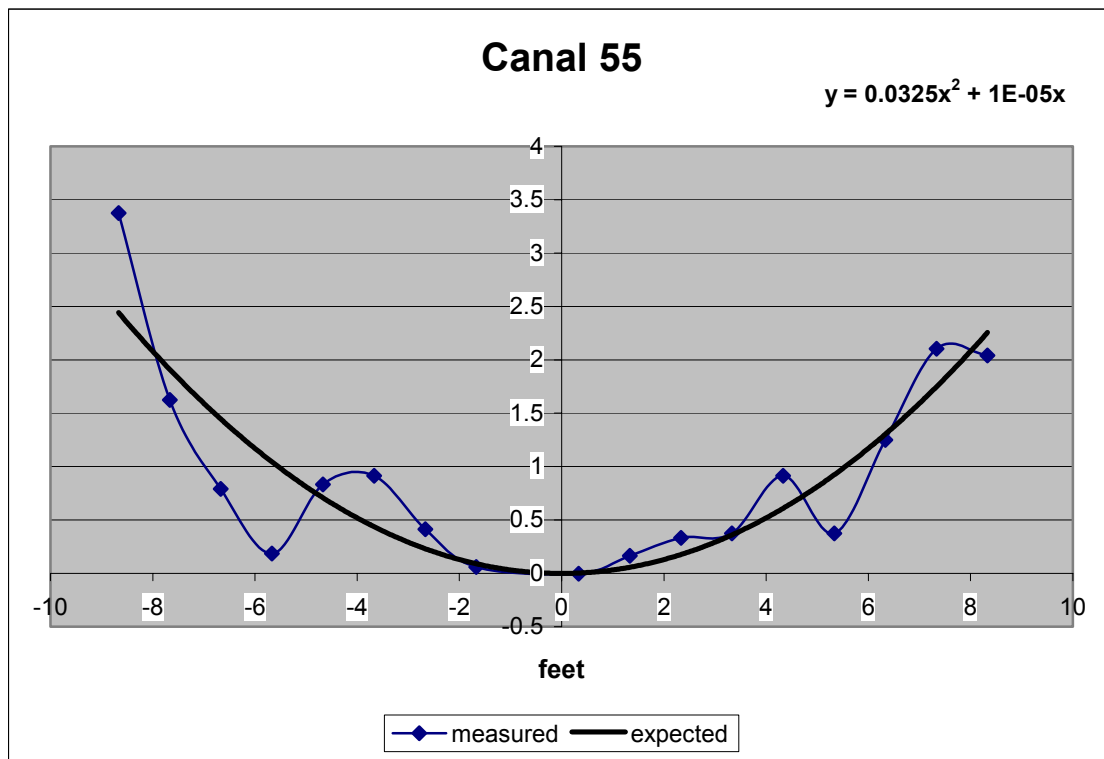


Figure 10. Cross-section of canal 55



Figure 11. Canal 55

| Table 11. Average Unit Area Loss Rate for canal 55. | | | | |
|---|---------------|-------------------|-------------------------------|--------------------------|
| ft³/ft²/hour | ft/day | inches/day | gal/ft²/day | acre-ft/mile/year |
| 0.0069 | 0.166 | 1.99 | 1.239 | 156.089 |

Literature Review

Very little information has been reported in scientific literature on canal seepage and reduction from district rehabilitation projects. All the data that we have found for seepage rates versus lining type are given in Tables 12 and 13.

| Table 12. Canal seepage rate reported in published studies. | |
|---|---|
| Lining/soil type | Seepage rate (gal/ft ² /day) |
| Unlined ¹ | 2.21-26.4 |
| Portland cement ² | 0.52 |
| Compacted earth ² | 0.52 |
| Brick masonry lined ³ | 2.23 |
| Earthen unlined ³ | 11.34 |
| Concrete ⁴ | 0.74 - 4.0 |
| Plastic ⁴ | 0.08-3.74 |
| Concrete ⁴ | 0.06-3.22 |
| Gunit ⁴ | 0.06-0.94 |
| Compacted earth ⁴ | 0.07-0.6 |
| Clay ⁴ | 0.37-2.99 |
| Loam ⁴ | 4.49-7.48 |
| Sand ⁴ | 4.0-19.45 |

¹ DeMaggio (1990).

² U.S. Bureau of Reclamation (1963).

³ Nayak, et al. (1996).

⁴ Nofziger (1979).

| Table 13. Canal seepage rates reported for the Lower Rio Grande Valley. | |
|---|--|
| Soil Type | Seepage Loss Rate (gal/ft ² /day) |
| clay | 1.5 |
| silty clay loam | 2.24 |
| clay loam | 2.99 |
| silt loam earth | 4.49 |
| loam | 7.48 |
| fine sandy loam | 9.35 |
| Sandy loam | 11.22 |

Source: Texas Board of Water Engineers (1946).

Soil Descriptions³

General Soil Series

7 – Lyford-Raymondville-Lozano association: Nearly level, well drained and moderately well drained sandy clay loams, clay loams, and fine sandy loams.

9 – Willacy-Raymondville association: Nearly level to gently sloping, well drained and moderately well drained sandy loams and clay loams.

13 – Mercedes association: Level to gently sloping, moderately well drained clays.

| Table 14: Detailed Soil Units / Permeability | |
|--|--------------------|
| Soil Unit ⁴ | Permeability In/hr |
| RE – Raymondville clay loam | 0.20 – 0.63 |
| LY – Lyford sandy clay loam | 0.63 – 2.0 |
| LR – Lozano fine sandy loam | 2.0 – 6.3 |



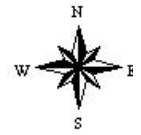
Figure 12. Canal levee soil profile on canal 23.

³ Soil Surveys of Cameron County, USDA, SCS, TAES (1979)

⁴ See Detailed Soil Map (Figure 13).

Detailed Soils Series

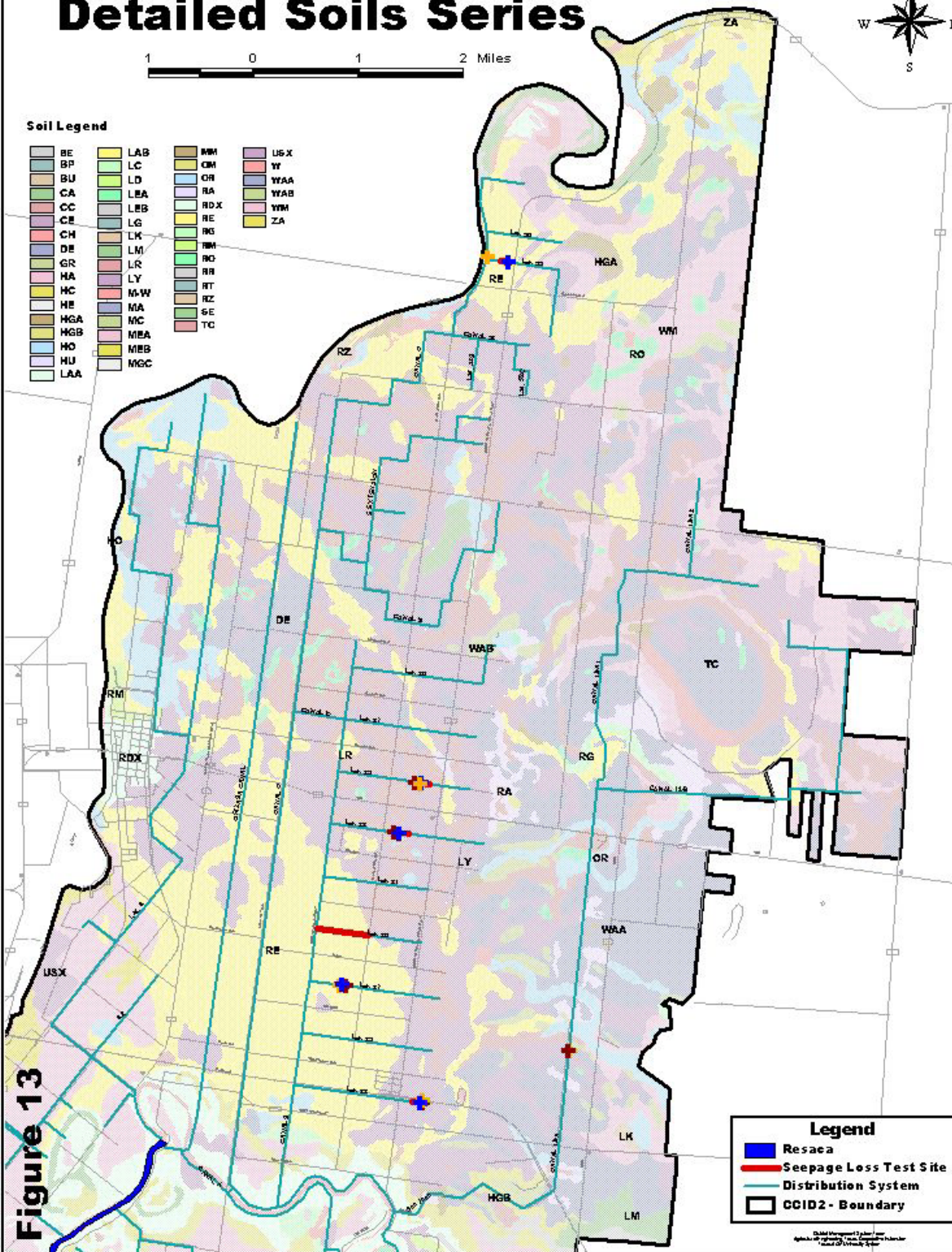
1 0 1 2 Miles



Soil Legend

| | | | |
|-----|-----|----|-----|
| BE | LAB | RM | USX |
| BP | LC | RM | W |
| BU | LD | RM | WAA |
| CA | LEA | RM | WAB |
| CC | LEB | RM | WM |
| CE | LG | RM | ZA |
| CH | LK | RM | |
| DE | LM | RM | |
| GR | LR | RM | |
| HA | LY | RM | |
| HC | MW | RM | |
| HE | MA | RM | |
| HGA | MC | RM | |
| HGB | MEA | RM | |
| HO | MIB | RM | |
| HU | MGC | RM | |
| LAA | | RM | |

Figure 13



Acknowledgements

DMS TEAM

Support provided by the DMS (District Management System) team of:

Martin Barroso, Extension Agricultural Technician
 Noemi Perez, Extension Agricultural Technician
 Gabriel Ortega, Extension Assistant
 Bryan Treese, Extension Assistant (former)
 Daniel Wishard, Student Worker
 Brock Faulkner, Student Worker

CAMERON COUNTY IRRIGATION DISTRICT NO.2

Helpful planning and assistance in canal ponding tests was provided by the District office and field personnel, and canal riders.

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This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under Agreement No.2010-45049-20713 and Agreement No. 2010-34461-20677. For program information, see <http://riogrande.tamu.edu>.