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Measured Water Losses of Lateral A in Hidalgo County Irrigation District No. 2

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Rio Grande Basin Initiative
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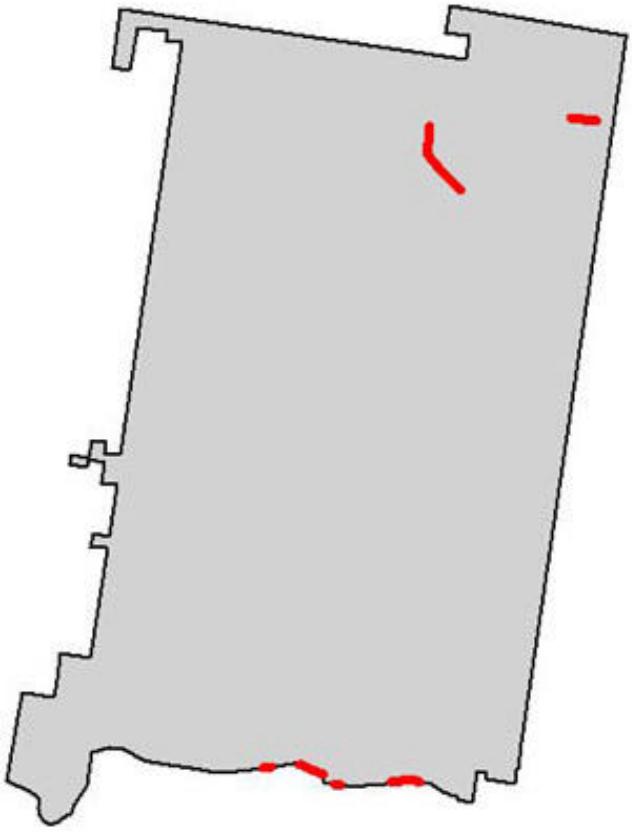
MEASURED WATER LOSSES

OF LATERAL A

IN HIDALGO COUNTY IRRIGATION DISTRICT NO. 2[1]



by

Eric Leigh and Guy Fipps, P.E. [2]

April 1, 2003

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Measured Water Losses in Lateral A of Hidalgo County Irrigation District No. 2

Summary

Seepage and loss rate tests were conducted in Hidalgo County Irrigation District No. 2 (HCID2) on four segments of Lateral A during September 2002 and January 2003. Table 1 summarizes the results of this study. Also given in Table 1 are the results of two additional loss rate tests conducted during regional planning projects in the late 1990's. Table 2 gives the measured loss rate of each test in four commonly used methods for characterizing water loss in canals. The annual water loss amounts given in Tables 1 and 2 are based on a in-service life of 365 days.

Lateral A is a concrete-lined canal location at the southern area of HCID2 running parallel just south of Military Hwy 281 (Figure 3) approximately 38,242 ft (7.24 miles) long and 18 feet in width. Maximum operating depths range from 4 to 6.5 ft and with a normal operating range of 2.7 to 6.0 ft.

Table 1. Seepage Loss Test Results for Lateral A and the Wisconsin canal of HCID2. All segments are concrete-lined.

Test	Segment	Soil	Top Width (ft)	Length (ft)	Seepage Rate (gal/ft^2/day)	Total Loss in Canal (ac-ft/mile) per day	per year
1	Lateral A-9 (Stewart Rd)	silty clay	18.0	735.0	1.17	0.31	111.20
2	Lateral A-7 (I Rd)	silty clay	15.5	806.0	1.38	0.40	145.50
3	Lateral A-8 (West Stewart Rd)	silty clay	15	2603	1.88	0.45	163.48
4	Lateral A-11 (Wildlife)	silty clay	19	2944	1.98	0.62	227.14
**RM-1	AL15 & AL16	clay loam	11.5	6463	2.43	0.42	152.77
**P2-1	Wisconsin	sandy clay loam	19.0	2557	2.77	0.80	293.40

**Results of tests conducted as part of regional water planning studies known as the "Region M Study" (RM) and Phase II Study (P2) during 1998 - 2000. These tests are not reported further in this report; see http://dms.tamu.edu for additional information.

Table 2. Measured losses of Lateral A given in 4 commonly used methods for characterizing water loss from canals					
Test	**$ft^3/ft^2/hour$**	**ft/day**	**inches/day**	**$gal/ft^2/day$**	**acre-ft/mile/year**
1 (Stewart Rd)	0.007	0.18	2.10	1.17	111.2
2 (I Rd)	0.008	0.25	3.06	1.38	145.5
3 (W. Stewart Rd)	0.010	0.34	4.02	1.88	163.4
4 (Wildlife)	0.011	0.32	3.82	1.98	227.14

Materials and Methods

Loss rates were determined in four segments of Lateral A as shown in Figure 1. The ponding method was used. In this method, the two ends of a canal segment are closed or sealed with earthen dams (Fig. 2). Once sealed, water elevations were taken for at least 48 hours. One to three continuous-stage level recorders (Fig. 3) were used to supplement the 3 locations where stage levels were recorded manually. Canal dimensions and water span were also surveyed.

The canal segments of Tests 1 and 2 contained no valves or gates within the canal and measured the seepage loss rates, while the segments of Tests 3 and 4 contain valves and gates and measured the total loss rates with such structures.

While pools of standing water existed along the canal levees and in drainage ditches of all the test segments, only Test segment 3 had visible leaks originating from two turnout gates. Groundwater levels were also recorded and surveyed adjacent to the canal test sites.

Soil samples were taken at two locations:

a) Canal embankment (levee) samples were taken of the approximately 10 ft from the canal, 2 feet below the surface.
b) Natural surrounding soil samples were taken at depths of approximately 6, 7 and 10 feet.

Figure 19 shows a soil series map of this portion of the district.

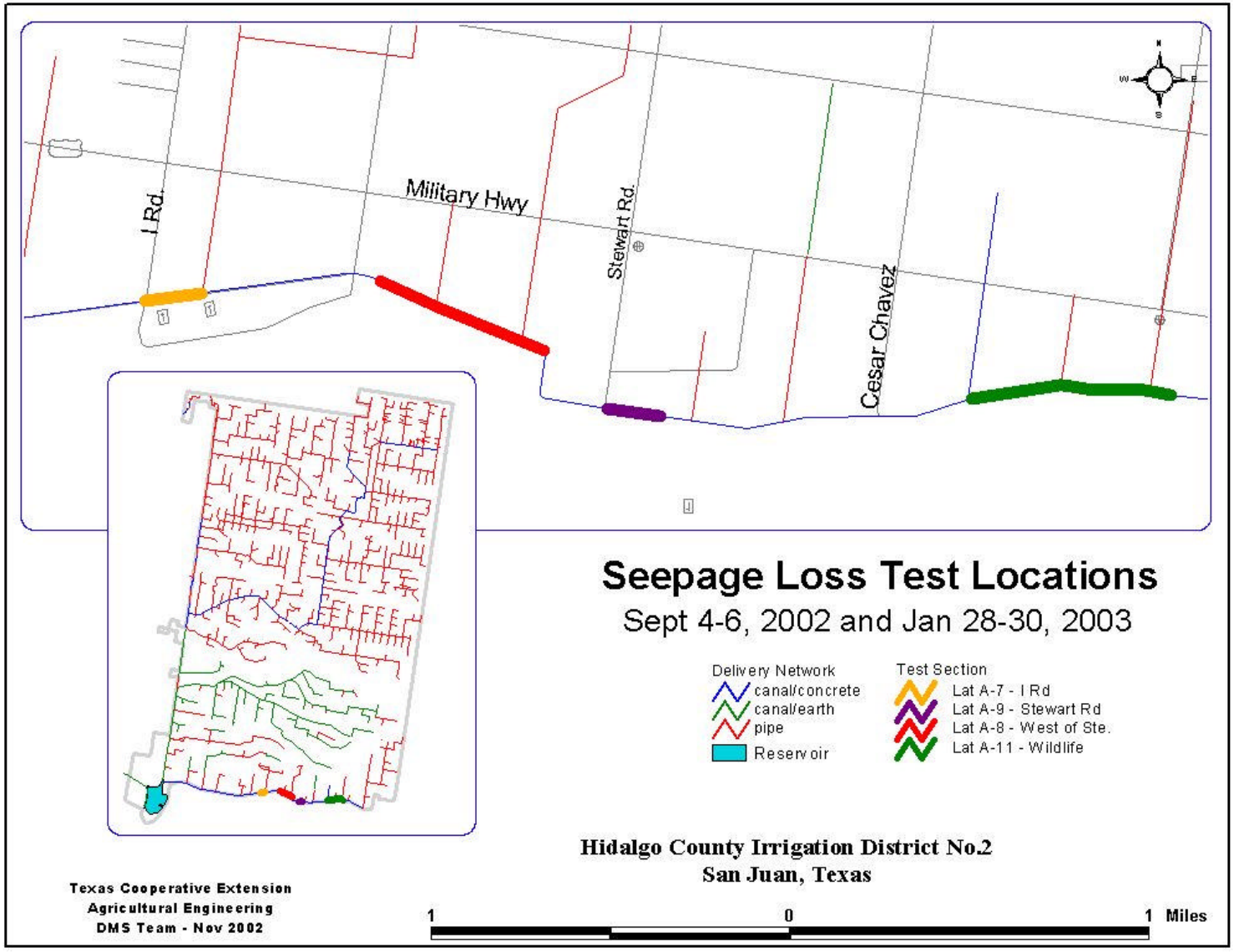

Figure 1: Map showing the locations of water loss tests conducted on Lateral A.

Figure 2: Earthen dam constructed on Lateral A - Stewart Rd.

Figure 3: Continuous-stage level recorders on Lateral A - Stewart Rd.

Test 1 – Steward Rd

Table 3. Data for Test 1: Lateral A-9, Stewart Rd.

District:	Hidalgo County Irrigation District No.2	**Test ID:**	Lat A - Stewart Rd
Canal:	Lateral A – 9	**Lining Type:**	Concrete
Top Width:	18 feet	**Date:**	Sept 4 – 6, 2002
Test Length:	735 feet	**Start Time:**	12:30 am
Total Depth:	3.9 feet	**Finish Time:**	12:33 pm

Location: East of Stewart Rd, south of Military Hwy (281).

Staff Gage Readings

	Date	SG1		SG2		SG3	
		Readings	**Time**	**Readings**	**Time**	**Readings**	**Time**
1	4-Sept	2.74	12:32	2.74	12:31	2.84	12:30
2		2.74	13:38	2.72	13:43	2.84	13:44
3		2.74	14:38	2.70	14:40	2.82	14:43
4		2.72	15:36	2.68	15:38	2.82	15:40
5		2.72	16:30	2.68	16:32	2.80	16:34
6	5-Sept	2.58	08:57	2.54	08:59	2.67	09:00
7		2.56	11:59	2.52	12:01	2.65	12:03
8		2.54	15:06	2.50	15:06	2.62	15:07
9	6-Sept	2.42	09:51	2.40	09:53	2.50	09:55
10		2.40	12:33	2.38	12:30	2.49	12:31

Figure 4: Large crack in the canal lining and aquatic vegetation growing from the bottom of the canal (lateral A - Stewart Rd)

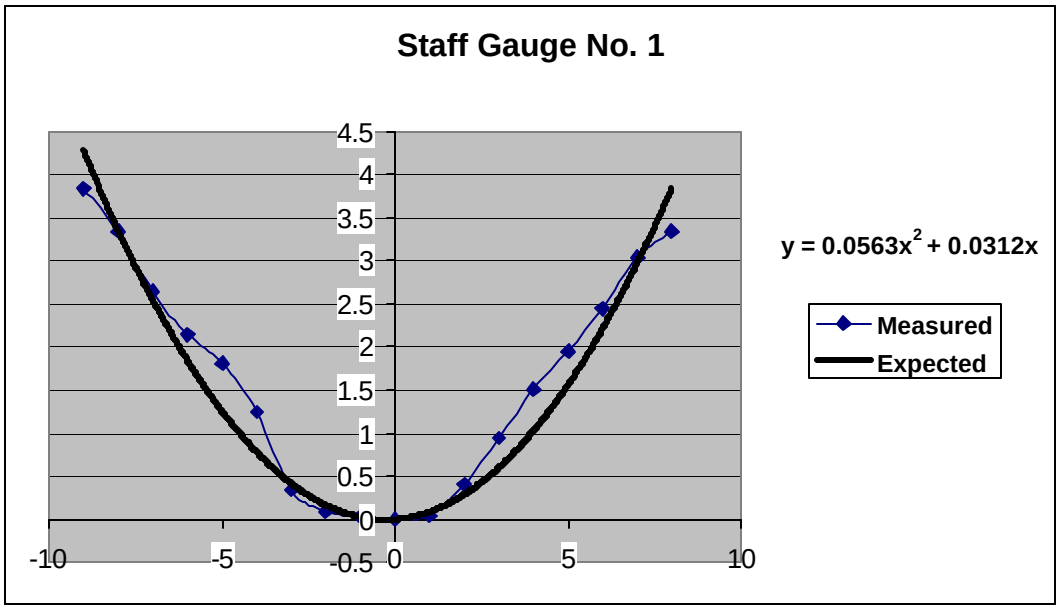

Figure 5: Cross-section of Staff Gauge 1 of lateral A - Stewart Rd.

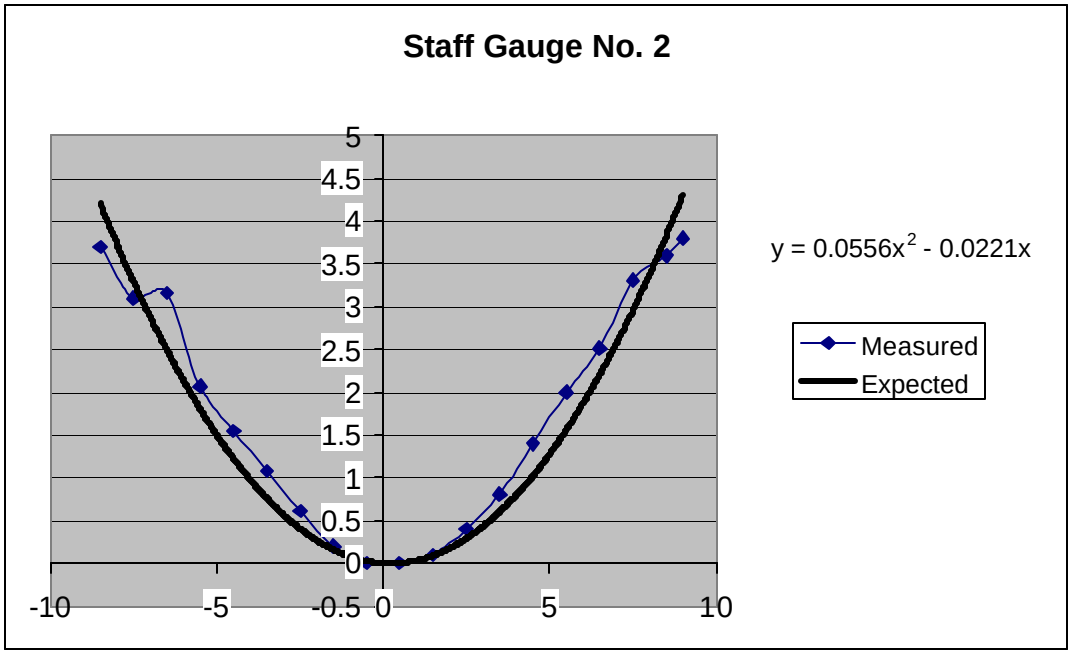

Figure 6: Cross-section of Staff Gauge 2 of lateral A - Stewart Rd.

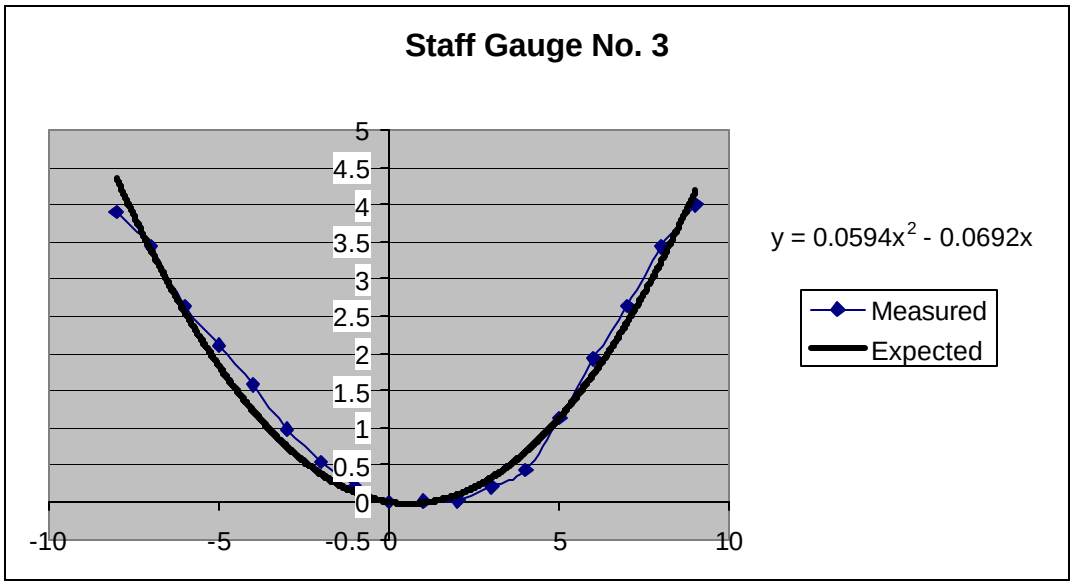

Figure 7: Cross-section of Staff Gauge 3 of lateral A - Stewart Rd.

Figure 8: Cracking of lateral A - Stewart just down stream of the test section.

Test 2 – I Road

Table 4. Data for Test 2 - Lateral A-7, I Rd.

District:	Hidalgo County Irrigation District No.2	**Test ID:**	Lat A - 'I' Rd
Canal:	Lateral A – 7	**Lining Type:**	Concrete
Top Width:	15.5 feet	**Date:**	Sept 4 – 6, 2002
Test Length:	806 feet	**Start Time:**	15:24
Total Depth:	5.44 feet	**Finish Time:**	13:57
Location: East of 'I' Rd, south of Military Hwy (281).			

Staff Gage Readings

	Date	SG1		SG2		SG3	
		Readings	**Time**	**Readings**	**Time**	**Readings**	**Time**
1	4-Sept	3.00	15:24	2.17	15:25	2.83	15:27
2		2.98	16:20	2.13	16:21	2.79	16:22
3		2.96	17:20	2.13	17:20	2.79	17:23
4	5-Sept	2.74	09:10	1.92	09:15	2.79	09:13
5		2.70	12:13	1.88	12:12	2.77	12:11
6		2.66	15:14	1.83	15:13	2.75	15:12
7	6-Sept	2.46	09:39	1.63	09:40	2.54	09:42
8		2.40	13:57	1.63	13:39	2.50	13:47

Figure 9: Continuous stage level recorders on Lateral A – I Rd.

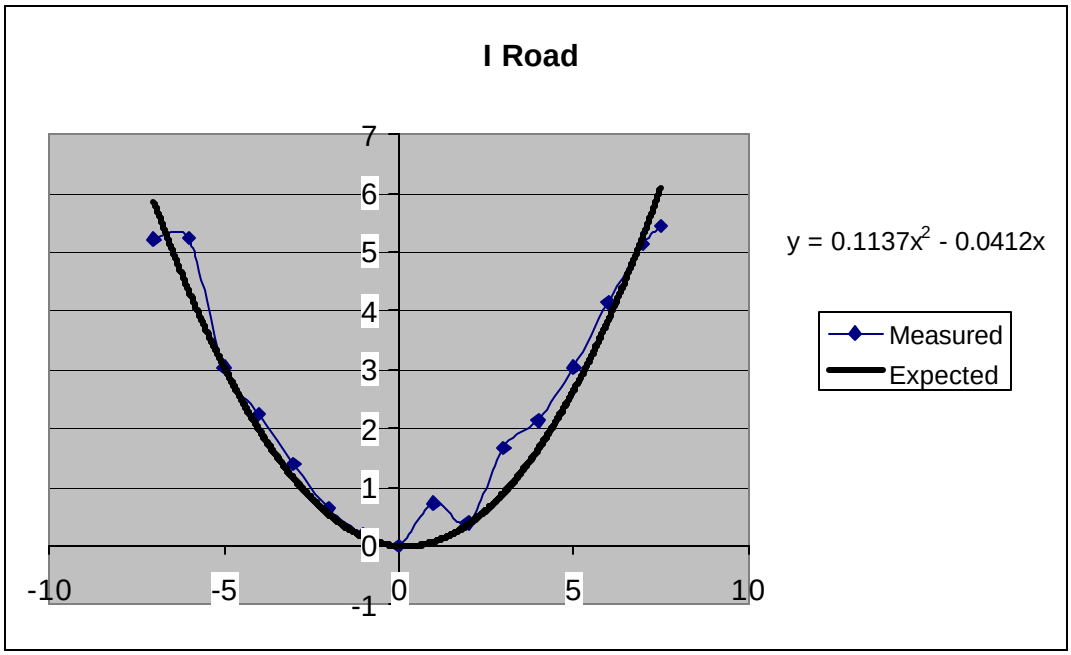

Figure 10: Lateral A - I Rd cross-section

Figure 11: Large amounts aquatic vegetation growing next to lateral A - I Rd.

Test 3 – West of Steward Road

Table 5. Test (3) Information for Lateral A-8 (West of Stewart Rd..)

District:	Hidalgo County Irrigation District No.2	**Test ID:**	Lat A – West of Ste
Canal:	Lateral A – 8	**Lining Type:**	Concrete
Top Width:	15 feet	**Date:**	January 28-30, 2003
Test Length:	2603 feet	**Start Time:**	13:58
Total Depth:	5 feet	**Finish Time:**	13:55
Location: West of Stewart Rd, south of Military Hwy (281).			

Staff Gage Readings

	Date	SG1		SG2		SG3	
		Readings	**Time**	**Readings**	**Time**	**Readings**	**Time**
1	28-Jan	2.55	13:58	2.50	14:03	2.22	14:04
2		2.52	15:46	2.49	15:41	2.22	15:37
3		2.50	17:21	2.46	17:19	2.18	17:17
4	29-Jan	2.22	09:55	2.18	09:51	1.90	09:48
5		2.20	12:01	2.16	11:59	1.88	11:57
6		2.18	13:06	2.14	13:04	1.86	13:02
7	30-Jan	1.92	09:42	1.88	09:45	1.59	09:41
8		1.90	11:56	1.86	11:59	1.57	12:00
9		1.88	13:55	1.83	13:54	1.55	13:58

Figure 12: Lateral A – West of Stewart Rd.

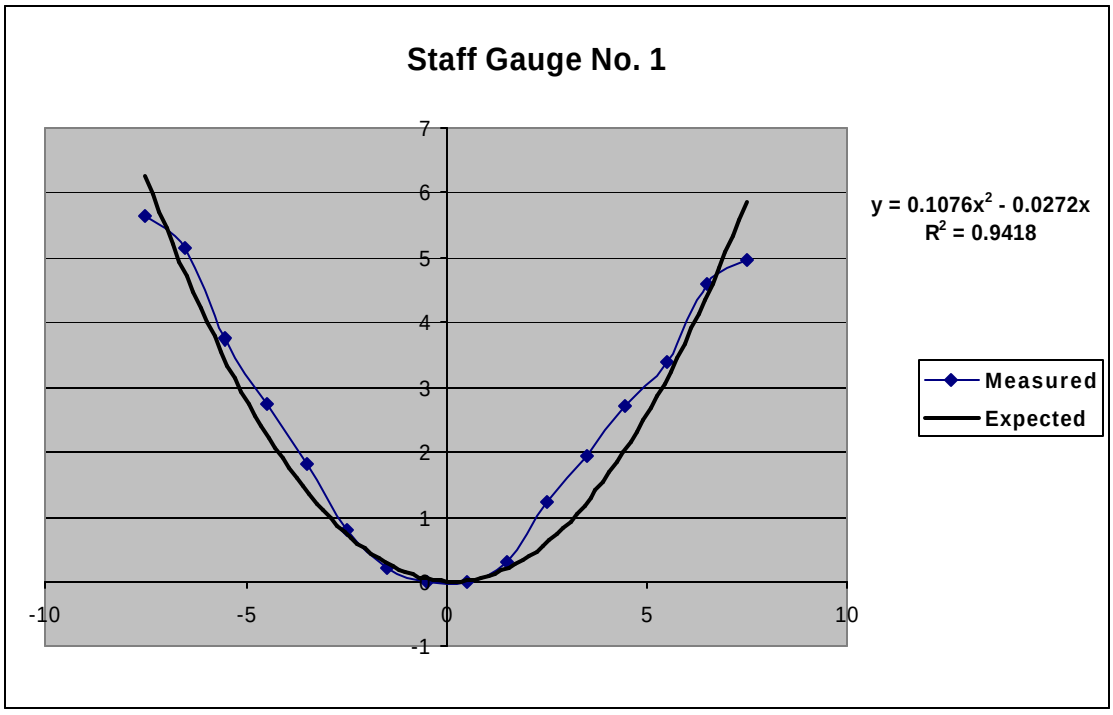

Figure 13: Cross-section of Staff Gauge 1 of lateral A – West of Stewart Rd.

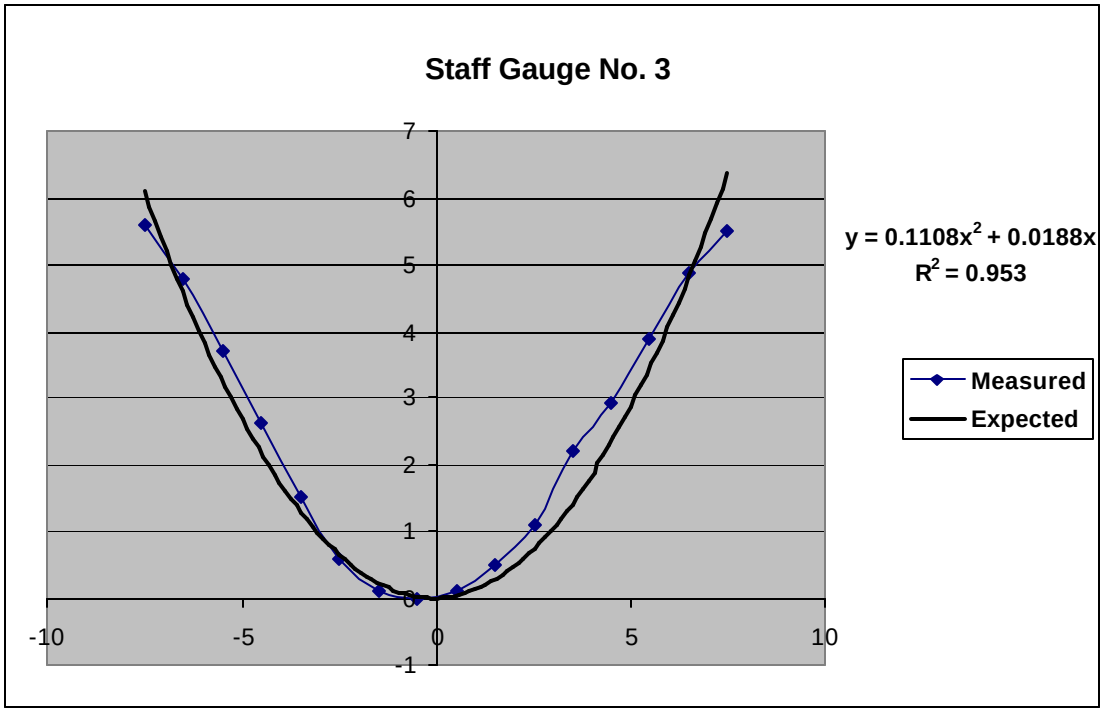

Figure 14: Cross-section of Staff Gauge 3 of lateral A – West of Stewart Rd.

Test 4 - Wildlife

Table 6. Data for Test 4 - for Lateral A-11, Wildlife

District:	Hidalgo County Irrigation District No.2	**Test ID:**	Lat A - Wildlife
Canal:	Lateral A – 11	**Lining Type:**	Concrete
Top Width:	19 feet (avg)	**Date:**	January 28-30, 2003
Test Length:	2944 feet	**Start Time:**	15:24
Total Depth:	4.5 feet	**Finish Time:**	14:26

Location: South of Military Hwy (281), West of Santa Anna Wildlife Refugee

Staff Gage Readings

	Date	SG1			SG3	
		Readings	**Time**		**Readings**	**Time**
1	28-Jan	3.05	15:24		3.13	15:55
2		3.00	17:29		3.10	17:31
3		2.98	18:21		3.08	18:19
4	29-Jan	2.74	10:13		2.84	10:08
5		2.71	11:48		2.80	11:46
6		2.70	13:15		2.80	13:17
7	30-Jan	2.46	09:35		2.56	09:33
8		2.44	12:07		2.54	12:09
9		2.42	14:24		2.52	14:26

Figure 15: Lateral A - Wildlife

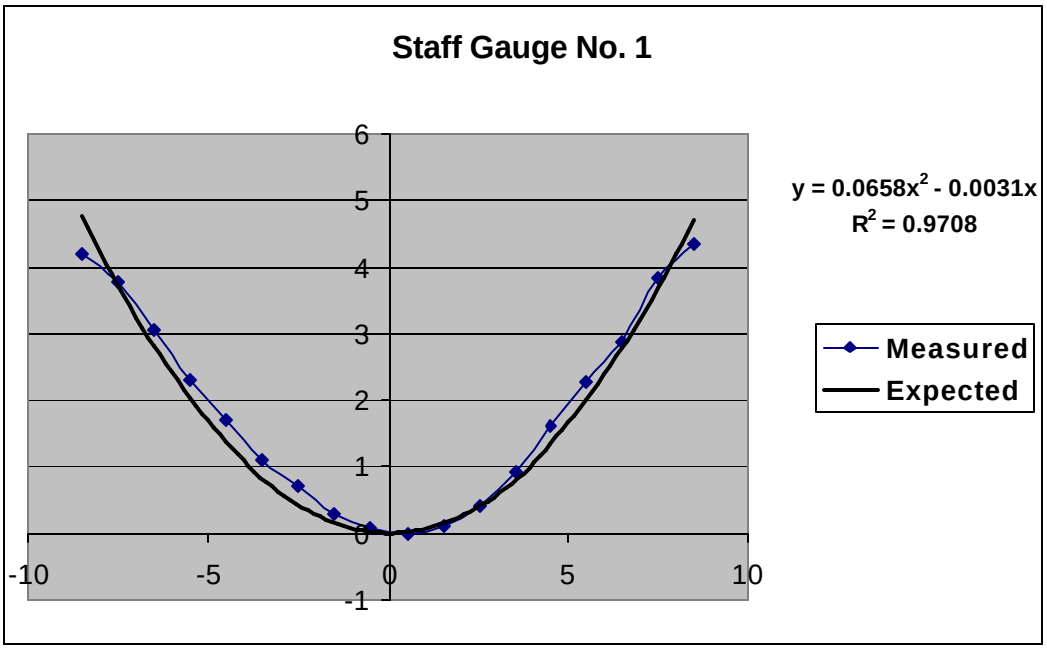

Figure 16: Cross-section of Staff Gauge 1 of lateral A - Wildlife

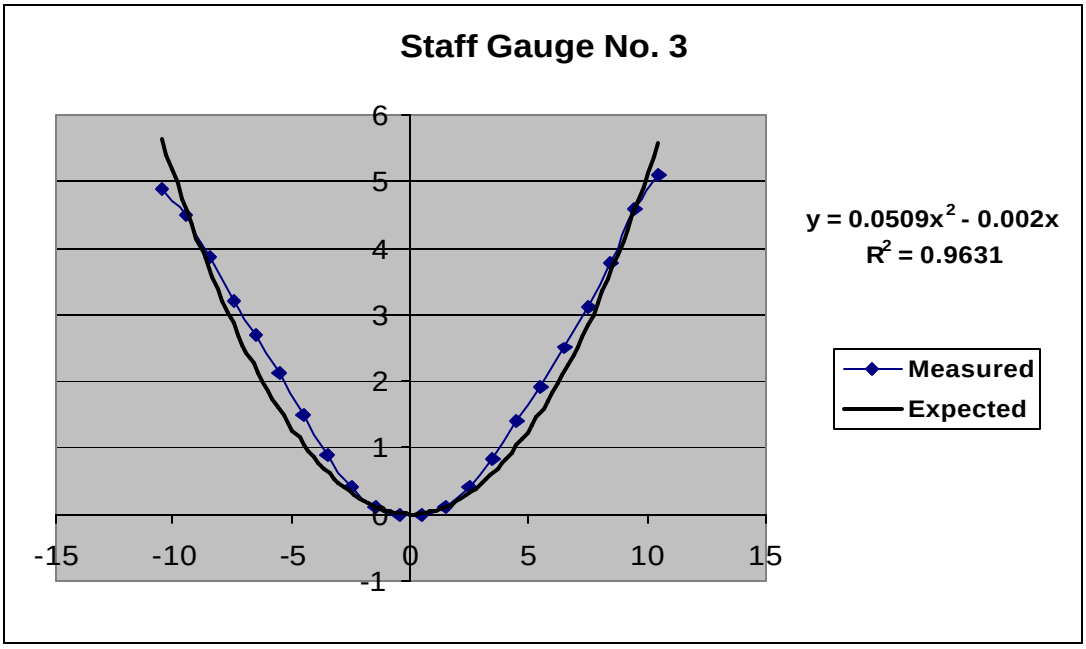

Figure 17: Cross-section of Staff Gauge 3 of lateral A - Wildlife

Groundwater Measurements

Table 7. Canal and groundwater elevations (feet)		
Test Section	**M**	**N**
Lat. A – Stewart Rd	9.93	8.31
Lat.A – I Rd	8.75	6.3

M) Groundwater level elevation from to natural ground from (Figure 18).
N) Canal water level elevation from natural ground (figure 18).

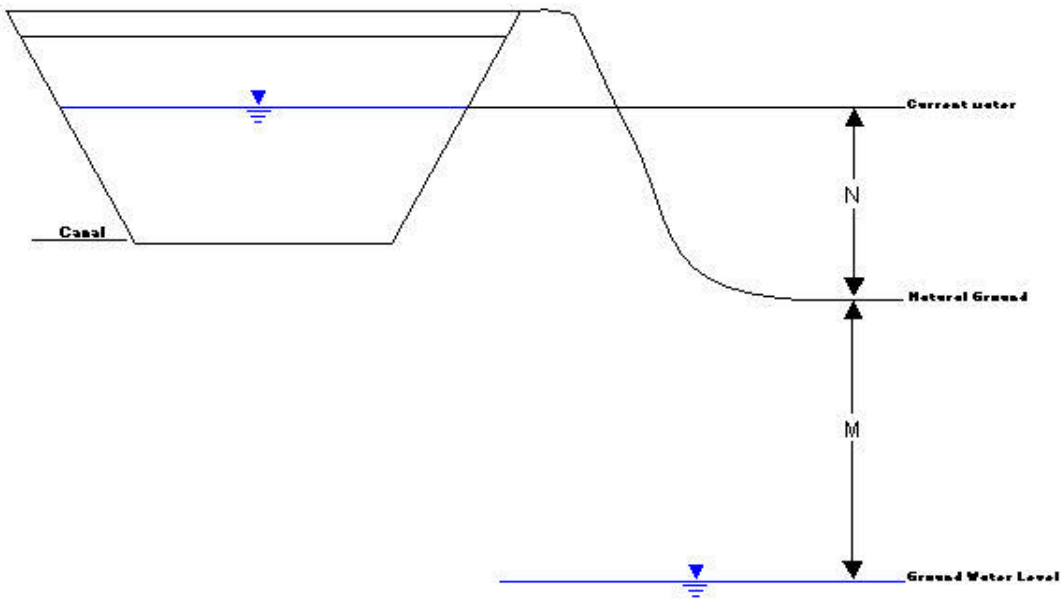

Figure 18: Groundwater measurement diagram.

Soil Descriptions

General Soil Series

9 – Harlingen-Runn-Reynosa: Deep, very slowly, slowly, and moderately permeable soils that typically have a grayish brown clay, silty clay, or silty clay loam surface layer.

2 – Rio Grande-Matamoros: Deep, moderate and slowly permeable soils that typically have a light brownish gray brown silt loam or silty clay surface layer.

Detailed Soil Units

Table 8. Soil Series Key Codes and Permeability Ranges.

Soil Unit	**Permeability In\hr**
07 – Cameron silty clay	0.2 – 6.0
19 – Harlingen clay	< 0.06
55 – Reynosa silty clay loam	0.6 – 2.0
64 – Runn silty clay	0.06 – 0.6

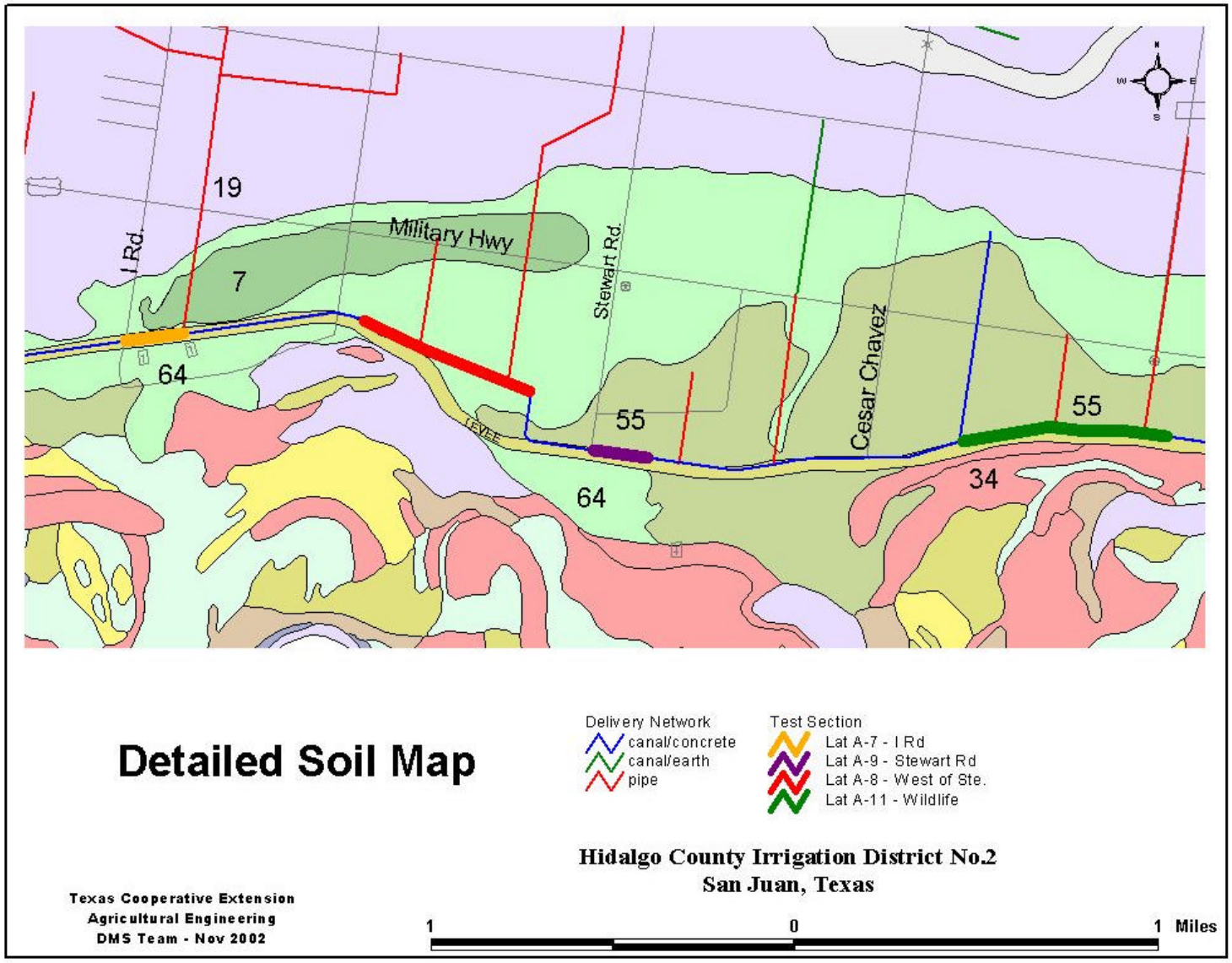

Figure 19: Detailed Soil Series with soil sampling locations (see table 8).

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 11 and 12.

Table 9. 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
Plactic[4]	0.08-3.74
Concrete[4]	0.06-3.22
Gunite[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 10. 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).

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