Subject: **CVRCD Mobilized Salinity Assessment Survey Example**

Project: Turf Grass Field Survey
Date: 03/02/00
Location: Coachella Valley

1. Survey Data

EM-38 horizontal and vertical survey readings were collected at 721 survey locations across 14 distinct transects within this field. EM-38 vertical signal readings ranged from 0.36 dS/m to 1.52 dS/m, with a median level of 0.78 dS/m. EM-38 horizontal signal readings ranged from 0.44 dS/m to 1.79 dS/m, with a median level of 0.87 dS/m. The vertical / horizontal signal correlation was very low (r = 0.566).

Maps of the vertical and horizontal spatial signal patterns are shown in figures 1.1 and 1.2, respectively. Both maps show strong, but rapidly changing spatial structure. The low level of vertical / horizontal signal correlation suggested that (1) the soil salinity levels across much of the survey area might be rather low, and (2) other soil physical variables (texture, water content, bulk density, etc.) might be significantly influencing the EM signal data.

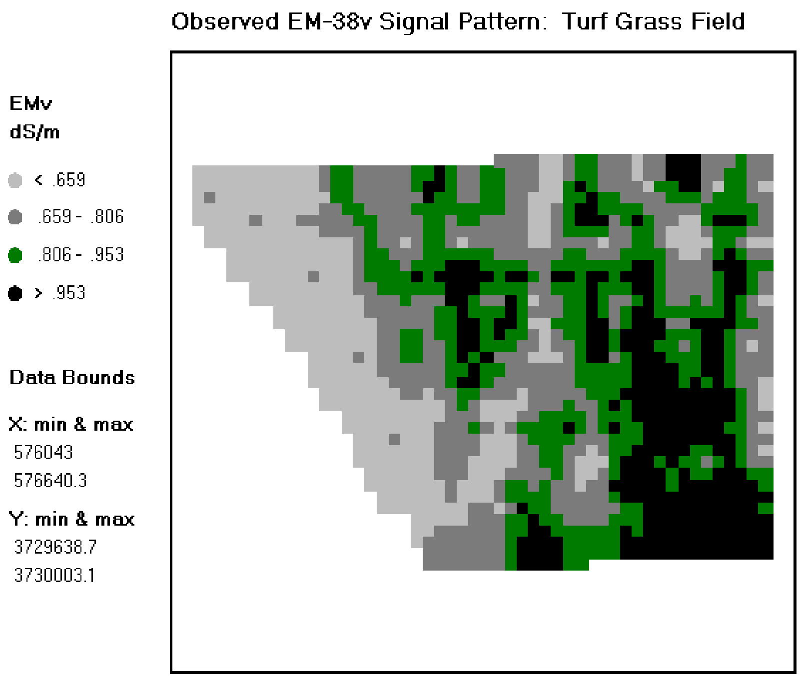

Figure 1.1 Spatial map of EM-38 vertical signal data.

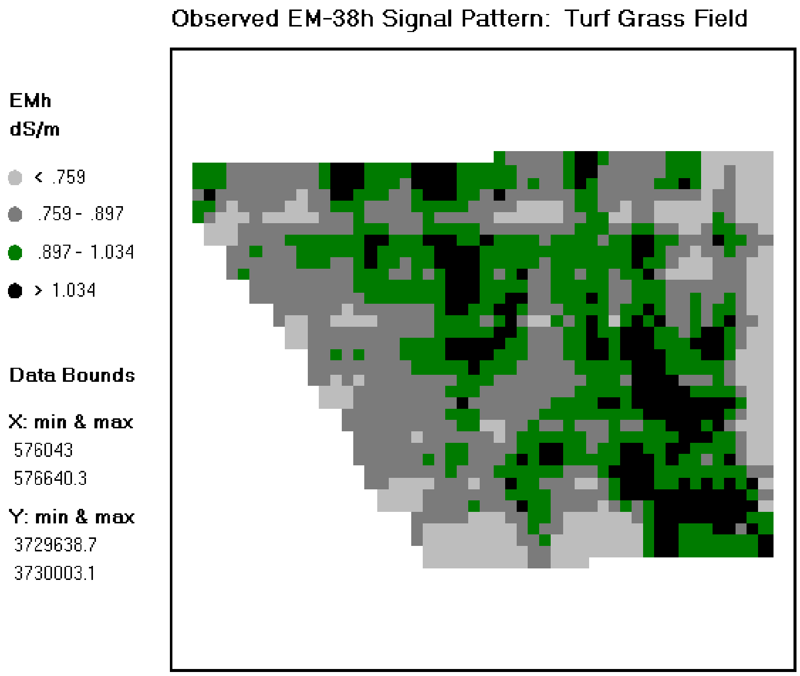

Figure 1.2 Spatial map of EM-38 horizontal signal data.

2. Soil Sample Data

The ESAP-95 software package was used to process the EM survey data and generate the soil sampling plan. Twelve (12) optimal sampling locations were identified, based on the EM survey data. The original intention was to collect 1.5 inch sample cores down to a depth of 4 feet. However, due to the high compaction level of the soil, the maximum sampling depth obtained at any site was 24 inches, and the average sampling depth was only 16.75 inches. Hence, only 0-12 inch soil sample data was obtained across all 12 sites. (The penetration depths of the cores from five sites were deep enough to allow for the collection of 12-24 inch depth samples; this data is discussed in more detail in section 5). In addition to these 12 sites, one additional 24 inch core was collected from a large, dead area about 100 meters from the south-east corner of the field. This latter data is also discussed in more detail in section 5.

Some basic summary statistics pertaining to the analyzed laboratory soil samples are shown on the following page.

	Soil variable	mean	std.dev	min	max
(physical)	SP (%)	34.3	4.37	28.5	40.3
	Vol h2o (ratio)	0.147	0.041	0.071	0.207
	h2o | FC (%)	57.5	16.2	31.8	85.2
(chemical)	ECe (dS/m)	3.92	3.18	0.92	12.29
	SAR (ratio)	5.94	4.55	1.58	17.65
	Boron (ppm)	0.76	0.65	0.247	2.497
(other)	core depth (in)	16.75	4.83	10.5	24.0

Note that the core depth data simply reflects how deep the sampling push probe was able to penetrate into the soil. There were two cases where the probe failed to penetrate 12 inches (site 455, 11 inches, and site 644, 10.5 inches). In these two cases the acquired sample was analyzed as though it was a 0-12 inch sample.

A preliminary data analysis showed that there was reasonably high correlation between the log transformed salinity and SAR levels (r = 0.778). Additionally, very strong correlation was observed between the log transformed salinity and boron levels (r = 0.936). These data correlation structures are shown in figures 2.1, and 2.2, respectively. The correlations between log salinity and the various soil physical properties were rather low. The SP and log salinity were only moderately correlated (r=0.562), and the log salinity levels appeared uncorrelated with either the volumetric water content or water content relative to field capacity data (r = 0.253 and r = 0.038, respectively).

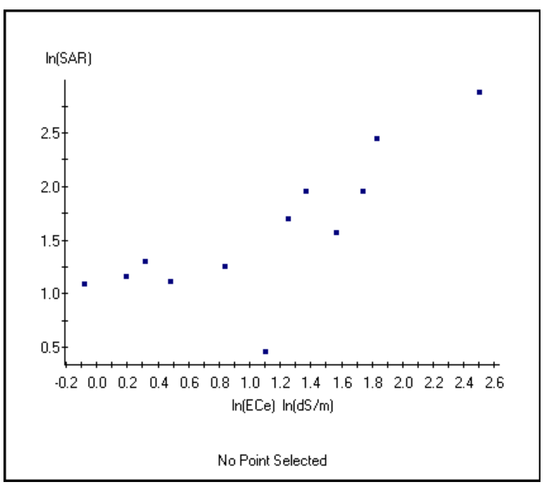

Figure 2.1 ECe / SAR correlation structure (log scale).

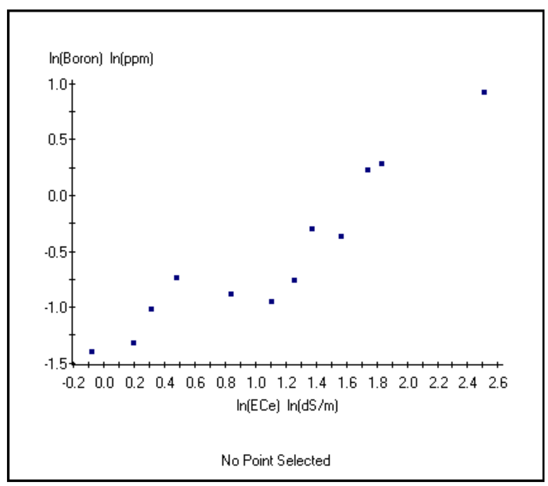

Figure 2.2 ECe / boron correlation structure (log scale).

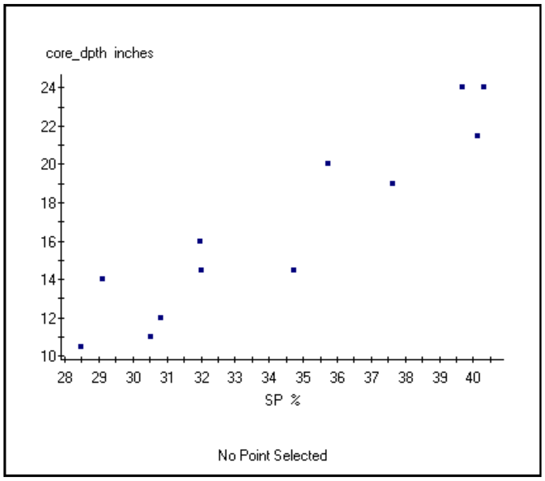

Figure 2.3 SP / core penetration depth correlation structure.

Due to the difficulty encountered when pushing the soil sampling core into the soil, it is thought that this field might be suffering from at least some degree of compaction. However, the correlation between the core penetration depth and the SP level was found to be very high (r = 0.936), suggesting that the inability to insert the sampling core to a uniform depth was simply caused by variations in the soil particle size distribution (rather than variable rates of compaction across the field). This correlation structure (between the core depth and SP) is shown in figure 2.3 above.

3. Soil Chemical Maps

The raw correlations between the measured average EM conductivity and ECe, SAR, and boron levels were reasonable, ranging from about 0.65 to 0.81. These correlations improved substantially after the EM signal data was adjusted using the ESAP-95 spatial regression modeling procedure. The final predicted correlations between the trend-adjusted EM conductivity data and soil chemical levels were as follows:

Soil Chemical Variable	Model R^2	CV%	Corr(Obs,Prd)
ECe (dS/m)	0.958	21.5	0.979
SAR	0.902	26.4	0.950
Boron (ppm)	0.953	20.8	0.976

These statistics confirm that the spatial EM signal data from this survey could be converted into predicted soil chemical information with a high degree of accuracy.

Prediction summary statistics for each soil chemical variable are shown below. These statistics refer to the 0-12 inch sampling depth, and include both the predicted median levels for the entire field and range interval estimates (i.e., the percent area of the field containing soil chemical levels within the given ranges).

ECe (dS/m)	median:	2.43
	95% CI:	2.03 to 2.91
	Range:	% Area
	< 2.0:	40.4
	2.0 to 4.0:	36.1
	4.0 to 6.0:	12.7
	> 6.0:	10.8
SAR	median:	4.29
	95% CI:	3.55 to 5.18
	Range:	% Area
	< 3.0:	28.2
	3.0 to 6.0:	45.4
	6.0 to 9.0:	15.2
	> 9.0:	11.2
Boron (ppm)	median:	0.51
	95% CI:	0.43 to 0.60
	Range:	% Area
	< 0.5	53.7
	0.5 to 1.0	33.5
	1.0 to 1.5	7.5
	> 1.5	5.3

Plots of the observed versus predicted ECe, SAR, and boron levels are shown in figures 3.1, 3.2, and 3.3, respectively.

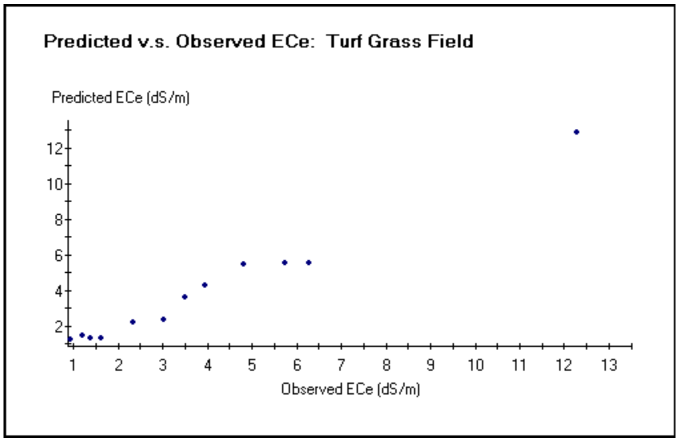

Figure 3.1 Observed v.s. predicted ECe.

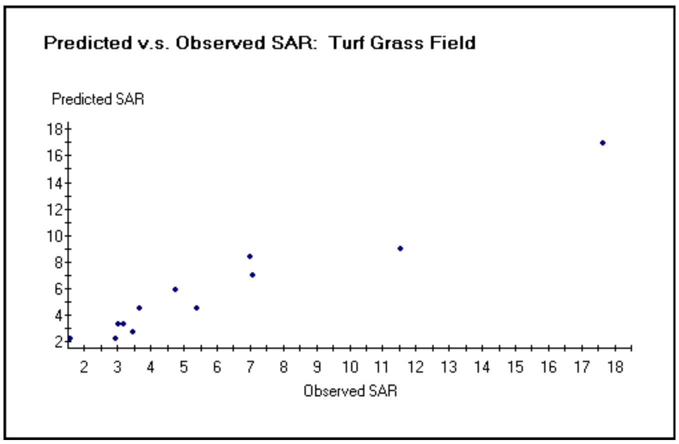

Figure 3.2 Observed v.s. predicted SAR.

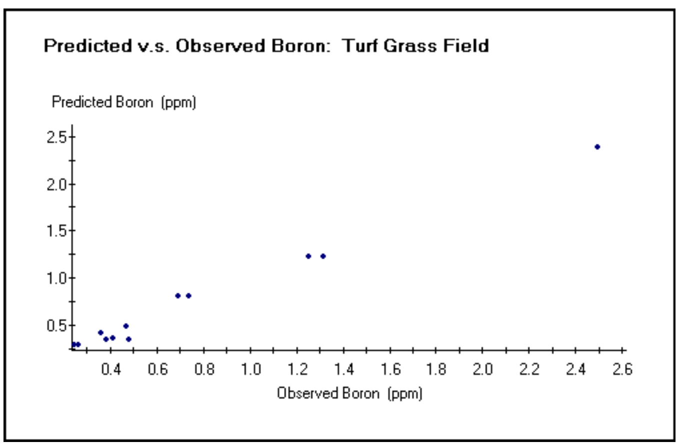

Figure 3.3 Observed v.s. predicted boron.

Maps of the predicted spatial ECe, SAR, and boron levels are shown in figures 3.4, 3.5, and 3.6, respectively. The ECe map displayed in figure 3.4 suggests that there is some build-up of near surface salinity along the southern edge of the field, as well as in the north-west corner. The SAR and boron maps both suggest that the highest SAR and boron concentrations also tend to occur along the southern edge of the field.

In general, the salinity and SAR levels in this field should not be especially limiting to turf grass development. The estimated yield loss for Bermuda Grass due to this estimated salinity pattern is only 2.7%. Additionally, most turf grass varieties are reasonably tolerant of moderate soil boron levels, and the boron levels in this field are very low. It is possible that the combined effect of the elevated ECe, SAR, and boron levels in the south-east corner of the field might account for the loss of the turf grass in this area. However, it is difficult to justify the degree of yield loss (which was observed to be between 5% to 10% during the actual survey process) based solely on these predicted soil chemical levels.

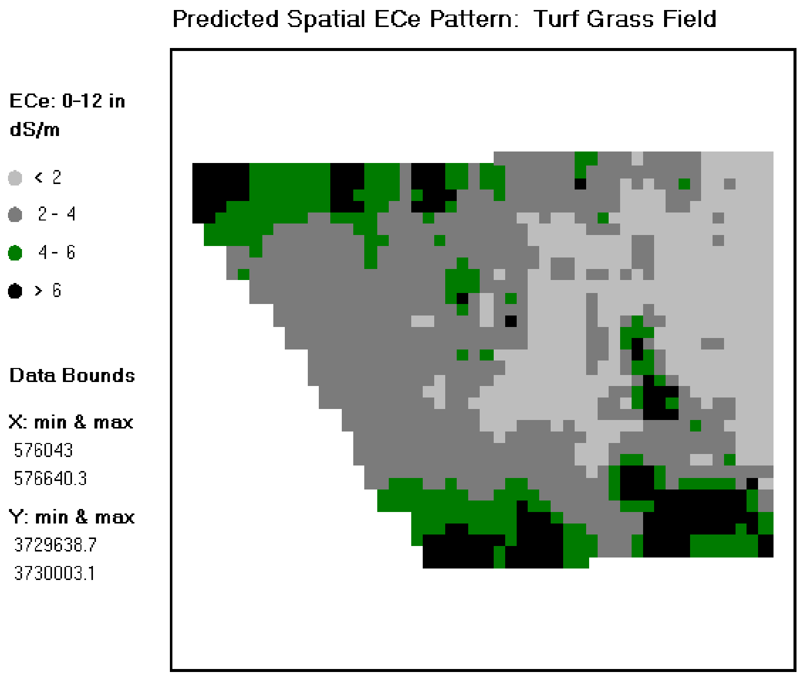

Figure 3.4 Predicted spatial ECe pattern.

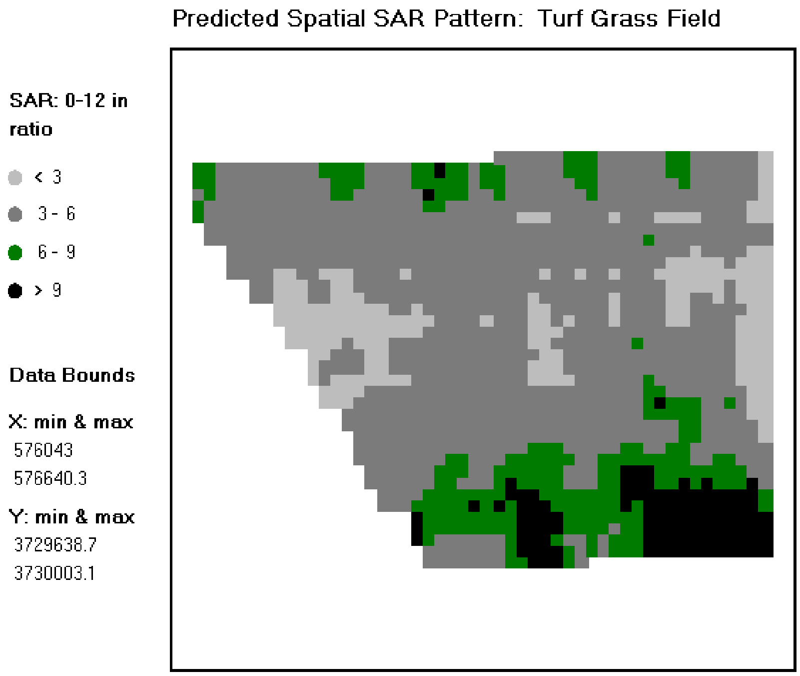

Figure 3.5 Predicted spatial SAR pattern.

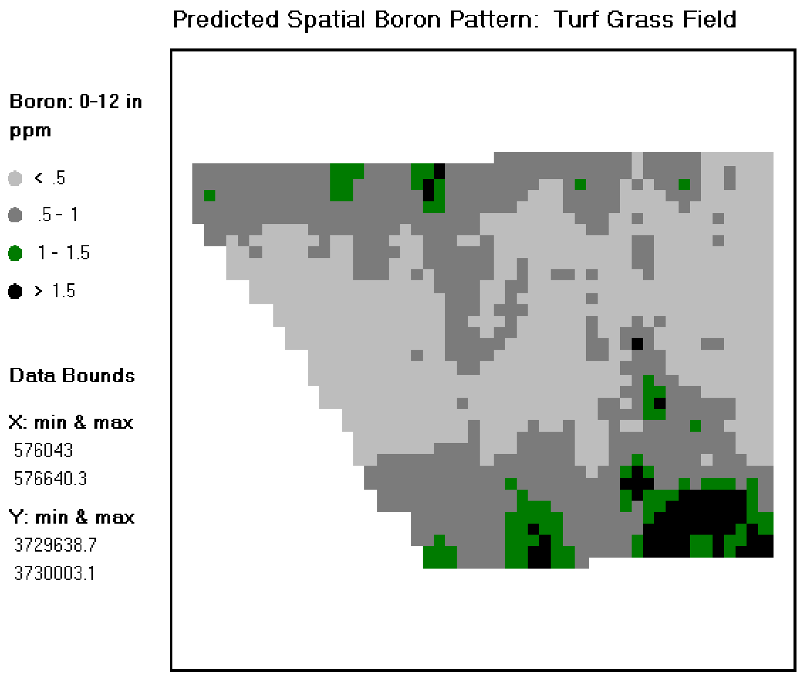

Figure 3.6 Predicted spatial boron pattern.

4. Soil Physical (SP) Map

Although the salinity levels did not correlate especially well with soil texture (SP), it was still possible to estimate the spatial SP pattern in this field, due to the presence of a strong spatial trend in the texture levels. Based on the ESAP-95 spatial regression modeling procedure, the final predicted correlation between the trend-adjusted EM conductivity data and soil SP levels was r = 0.938 (the regression model produced an R^2 value of 0.880 and a root mean square estimate of 2.05). Based on this model, the predicted mean SP level within this field was 33.9 %, with a 95% confidence interval of (32.4%, 35.5%). Nearly all of the field was predicted to have SP levels between 30% to 40%.

Figure 4.1 shows the predicted spatial SP map for this field. A strong parabolic trend in soil texture is clearly evident; most of the course texture sand is located in the north-east corner of the field, while the fine textured sand is located along the south and west edges of the field. In general, one would expect the course textured sand to drain quicker, and hence possibly require somewhat more frequent irrigation. However, the course textured sand should also leach better.

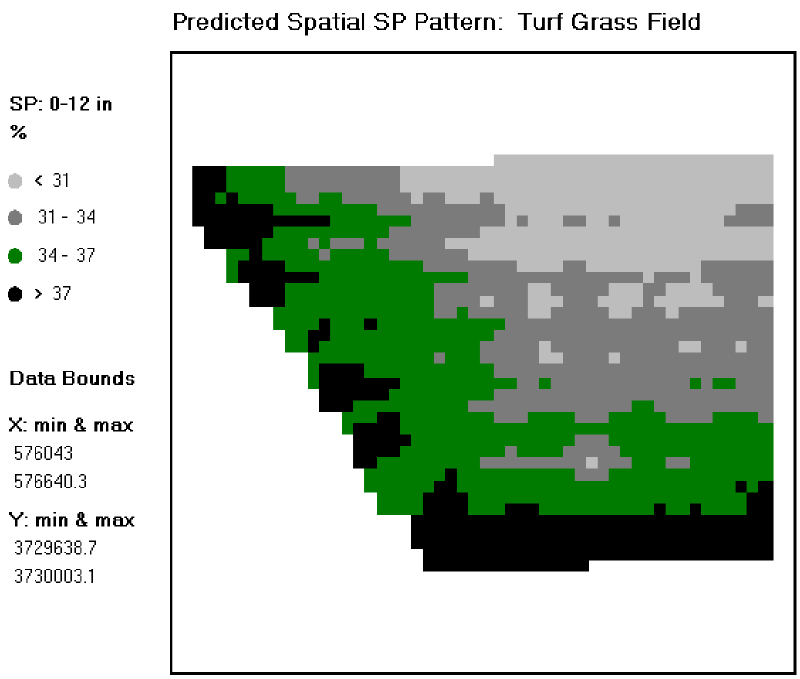

Figure 4.1 Predicted spatial SP pattern.

5. Additional Observations

As previously noted, it was impossible to produce any soil chemical prediction maps for the 12-24 inch sampling depth due to insufficient soil samples. However, soil samples from this depth were acquired at 5 of the 12 sample sites, in addition to the selected dead-spot. Note that in all six cases, these cores were acquired from the southern half of the field (i.e., where the higher SP levels allowed the sample core to penetrate to at least 19 inches below the soil surface). This 12-24 inch ECe data is shown below, along with the corresponding salinity data from the 0-12 inch depth (for comparison purposes).

Site	0-12 ECe (dS/m)	12-24 ECe (dS/m)
dead spot	12.05	7.26
14	5.73	2.97
41	12.29	3.45
84	3.95	1.09
107	6.29	4.76
263	2.33	1.61

Two facts are clearly evident from this data. First, in all cases the 0-12 inch ECe levels are considerably higher than the corresponding 12-24 inch samples. This implies that the salinity profile is inverted, which in turn implies that either (a) the drainage in this field is inadequate, and hence upward water movement is occurring, or (b) there is an insufficient amount of water being applied to this field to maintain an effective leaching fraction.

Second, the 0-12 inch salinity level associated with the dead-spot sample is nearly as high as the highest regular 0-12 inch sample (site 41), and also has by far the highest 12-24 inch ECe level. This would suggest that the salinity may indeed be a controlling factor with respect to the turf grass development. One possibile scenerio that these levels would be high enough to kill the turf grass, given either deficit irrigation practices or the presence of a localized shallow, saline water table.

6. Recommendations

The inverted salinity profiles suggest that this field may be experiencing either insufficient irrigation to maintain a reasonable leaching fraction, or suffering from a localized shallow, saline water table. While the ECe and SAR levels by themselves do not appear to be high enough to be especially limiting, the combination of these levels in conjunction with a significant water stress may very well be the cause of the localized turf grass yield losses.

Additional soil sampling needs to be undertaken (to identify the primary cause of the inverted salinity profile shapes) in order formulate an adequate reclamation strategy.

[*end of assessment report*]

Survey completed:	March 2000
Lead Investigator(s):	S. Lesch & D. Ackley
Recommendation(s):	reserved (pending further investigation)