Supplement 1 to the 3rd Edition of the Soil Data Entry Handbook

for the NSW Soil And Land Information System (SALIS)

The Salinity Soil Data Card

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General acknowledgments are contained in the *Soil Data Entry Handbook* (Milford *et al.* 2001).

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1 INTRODUCTION

1.1 Preamble

This document describes the additional additions and changes released as part of the Salinity Soil Data Card, introduced in September 2002. It supplements the *Soil Data Entry Handbook*, 3rd edition (Milford *et al.* 2001). Only those attributes specific to the Salinity Soil Data Card are described here. This supplement should be used together with the *Handbook*, in which the rest of the fields on the Salinity Soil Data Card are described.

1.2 Standards and References

In keeping with Australian standards for scientific terminology in soil science, terms and definitions found in this handbook follow:

RC McDonald, RF Isbell, JG Speight, J Walker and MS Hopkins 1990, *Australian Soil and Land Survey Field Handbook* (2nd edn), Inkata Press, Melbourne, Vic., Aust.

We acknowledge permission granted by the copyright owners to use these definitions.

For ease of use, definitions of values are generally not sourced within the text. Other than Macdonald *et al*. (1990) as noted, additional sources include:

Bates, RL and Jackson, JA (eds) 1984, *Dictionary of Geological Terms*, 3rd edn, Doubleday, New York, USA.

Gary, M, MacAfee, R and Wolf, CL (eds) 1972, *Glossary of Geology*, American Geological Inst., Washington DC, USA.

Moore, WG 1988, *The Penguin Dictionary of Geography*, 7th edn, Penguin, London, UK.

Morse, RJ, Atkinson, G and Craze, B 1982, *Soil Data Card Handbook*, Soil Conservation Service of NSW Technical Handbook No. 4, Sydney, NSW, Aust.

Abraham SM and Abraham NA 1996, *Soil Data System Site and Profile Information Handbook*, NSW Dept of Land and Water Conservation, Sydney, NSW, Aust.

Information related to use of electromagnetic induction instruments in field assessment of soil salinity is taken from:

Bennett, D, George, R and Ryder, A 1995, *Soil salinity assessment using the EM38: Field operating instructions and data interpretation*, Dept of Agriculture Miscellaneous Publication 4/95, Perth, WA, Aust.

McNeill, JD 1980, *Electromagnetic Terrain Conductivity Measurement at Low Induction Numbers*, Technical Note TN-6

The following publication contains a complete list of referenced work (**3 References**) and describes the non-unique attributes and values on the Salinity Soil Data Card:

Milford, HB, McGaw, AJE and Nixon, KJ (eds) 2001, *Soil Data Entry Handbook*, 3rd edn, NSW Dept of Land and Water Conservation, Sydney, NSW, Aust.

1.3 Explanation of Text Format

The text of this document is formatted into five different styles:

- Base font is used for general descriptions and explanations.
- Database terms such as ATTRIBUTE appear in SMALL CAPITALS, as do characteristics of attributes, e.g., size, type.
- Feature names are set in **BOLD CAPITALS**.
- The attributes of each feature are printed in **boldface**.
- The values of an attribute are printed in *italics* with a definition in smaller type following where necessary.

1.4 The Salinity Soil Data Card

This card appears as purple text on white, two pages (a double-sided A4 page) with the 'Salt Action' logo at top right of the first page. The card was designed for observation-level data collection by Salinity Team members from the NSW Department of Land and Water Conservation and NSW Agriculture, but may be used by other field officers wishing to record measurements of salinity on a site-by-site basis. This Card includes a number of salinity-specific attributes and a more limited selection of other soil and land attributes than the other two-page Soil Data Cards.

1.5 Measuring Soil Salinity through Electromagnetic (EM) Induction

Soil salinity that occurs across large areas can be assessed with reduced amounts of soil sampling through the use of portable instruments that measure soil electrical conductivity. This allows the extent and severity of areas of different conductivity to be quickly and reliably delineated. The conductivity of the soil is measured through its electromagnetic induction, and so the instruments used are commonly known as EM meters or EMI meters. EM meters measure the *apparent soil electrical conductivity* (ECa). If a significant correlation is found between soil salinity and ECa, the measurements can be converted to other results (such as ECe, the *electrical conductivity of a soil saturation extract*) by calibration for soil type.

Table 1 lists the characteristics of four EM meters commonly used in Australia, all of which are manufactured by the Canadian company Geonics. Uniform halfspacing is a theoretical concept stating that in a uniform conductive material the EM meters will read to the depths stated in the table. Coil spacing is the distance between the current flows. Both of these concepts are described more fully in McNeill (1980).

Table 1 Configuration and nominal depths for Geonics EMI meters for a uniform halfspace (McNeill 1980)

			Depth (m) for a uniform halfspace	
Instrument	**Frequency**	**Coil Spacing (m)**	**Horizontal Dipole (Em_h)**	**Vertical Dipole (EM_v)**
EM 38	14.6kHz	1.0	0.75	1.5
EM 31	9.8kHz	3.7	3.0	6.0
EM 34	6.4kHz	10.0	7.5	15.0
	1.6kHz	20.0	15.0	30.0
	0.4kHz	40.0	30.0	60.0
EM 39	39.0kHz	0.5	Lowered down boreholes for continuous reading, radial distance = 0.9 m	

The following are some basic considerations for operation of these instruments (specifically the EM38) as described by Bennett *et al.* (1995). (For other meters, users should refer to the appropriate instruction manual).

- Before use, the instrument should be checked and zeroed to ensure that it is measuring correctly. This will remove a source of substantial potential error from your measurements.
- Salinity is usually the primary factor influencing the ECa of a soil—however, other factors may also affect the reading, including:
  - Heavy clay soils, which may be more conductive than less clayey soils with the same salinity;
  - Low soil moisture, which inhibits electrical conductivity;
  - Low soil temperature, which also inhibits electrical conductivity (ECa results are generally corrected, as are laboratory EC tests, to a soil temperature of 25^0C)
- Regular calibration of the EM meter with the results from on-site soil sampling is recommended, particularly when readings are to be related to performance of crops or pastures across a range of soil types.
- The presence in the soil of significant electromagnetic anomalies, such as large boulders (especially those containing high amounts of iron) or ferric or lateritic pans, may produce irregular readings.
- Sodic soils may produce high conductivity readings but are not necessarily saline (although they may indicate where previous soil salinity has occurred) and may not affect plant growth.

2 EXPLANATION OF TERMS AND ATTRIBUTES

2.1 Site Field Notes

2.1.1 Land Use Veg. Species

This notes field allows the surveyor to record the names of vegetation species typical of the land use carried out in the **general area** as well as their condition.

2.1.2 Salt Outbreak Veg. Species

This notes field allows the surveyor to record the names of vegetation species present at any surface outbreak of salinity that may occur at the **site** as well as their condition.

2.2 Salinity

2.2.1 Salt Outbreak Mapping

3-DIGIT NUMBER, 1 VALUE ONLY

This field allows the surveyor to record a Salt Outbreak Mapping class for the **site**.

Reference List of VALUES

013	*Non-saline wet site*	The site is affected by high groundwater or a localised perched watertable. No evidence of salt-tolerant vegetation species is observed at the site, although species tolerant of permanently or seasonally moist conditions are observed. In localities where dryland salinity is already an acknowledged problem, these sites have the potential to become saline over time
014	*Confirmed sub-surface store of salt*	No surface expression of salinity is observed at the site. The presence of sub-surface salt is confirmed by electromagnetic induction survey and soil sampling.
015	*Early phase of dryland salinity outbreak with salt-tolerant plant species present*	Salt-tolerant vegetation occupies most of the site and can include *Typhus spp.* (cumbungi), *Juncus acutus* (spiny rush), *Cynodon dactylon* (couch) and *Hordeum marinum* (sea barley grass). Bare patches of ground up to 1 m^2 in size occupying up to 25% of the total surface area of the site occur in small, discrete patches. Salt crystals can be observed on the bare surfaces at certain times. Salt sensitive vegetation species are entirely absent or restricted to slightly raised areas within the overall site.
025	*Dryland salinity outbreak affected by low to moderate levels of sheet erosion.*	The site is affected by high, saline groundwater. Salt-tolerant vegetation occupies most of the site and can include *Typhus* spp. (cumbungi), *Juncus acutus* (spiny rush), *Cynodon dactylon* (couch) and *Hordeum marinum* (sea barley grass). Bare patches of ground up to 1 m^2 in size and occupying up to 25% of the total surface area of the site occur in small, discrete patches. Salt crystals can be observed on the bare surfaces at certain times. Salt sensitive vegetation species are entirely absent or restricted to slightly raised areas within the overall site.
045	*Dryland salinity outbreak affected by severe to extreme rates of rill and sheet erosion.*	Site affected by high, saline groundwater. The site is almost completely bare of vegetation, including most salt-tolerant species. Salt crystals can be observed on the bare surfaces at certain times. Salt-tolerant vegetation species are usually restricted to slightly raised areas within the overall site.
055	*Minor gully erosion: salt discharges within gully floor or from banks of gully.*	Minor gully erosion is classified as isolated, discontinuous linear gullies, confined to primary or minor drainage lines.
065	*Moderate gully erosion: salt discharges within gully floor or from banks of gully.*	Moderate gully erosion is classified as continuous linear gullies, confined to primary or minor drainage lines.
075	*Severe gully erosion: salt discharges within gully floor or from banks of gully.*	Severe gully erosion is classified as discontinuous or continuous gullies, branching into minor drainage lines or multiple branching within primary drainage lines.
085	*Extreme gully erosion: salt discharges within gully floor or from banks of gully.*	Extreme gully erosion is classified as discontinuous or continuous multiple branching gullies or sub-parallel gullies in dispersible soils.
115	*Early phase of salinity development caused by irrigation practices with salt-tolerant plant species present*	Site affected by high, saline groundwater caused by irrigation practices. Salt-tolerant vegetation occupies most of the site and can include *Typhus* spp. (cumbungi), *Juncus acutus* (spiny rush), *Cynodon dactylon* (couch), *Hordeum marinum* (sea barley grass) or *Trifolium fragiferum* (strawberry clover). Salt sensitive vegetation species are entirely absent or restricted to slightly raised areas within the overall site. No more than 5% of the total area of the site is bare of vegetation.
125	*Salinity site caused by irrigation practices and associated with low to moderate levels of sheet erosion.*	Site affected by high, saline groundwater caused by irrigation practices. Salt-tolerant vegetation occupies most of the site and can include *Typhus* spp. (cumbungi), *Juncus acutus* (spiny rush), *Cynodon dactylon* (couch), *Hordeum marinum* (sea barley grass). Bare patches of ground up to 1 m^2 in size and occupying up to 25% of the total surface area of the site occur in small, discrete patches. Salt crystals can be observed on the bare surfaces at certain times. Salt sensitive vegetation species are entirely absent or restricted to slightly raised areas within the overall site.
145	*Salinity site caused by irrigation practices and associated with*	Site affected by high, saline groundwater caused by irrigation practices. The site is almost completely bare of vegetation, including most salt-tolerant species. Salt crystals

	severe to extreme rates of rill and sheet erosion	can be observed on the bare surfaces at certain times. Salt-tolerant vegetation species are usually restricted to slightly raised areas within the overall site.
215	*Soil salinity due to marine influences.*	Includes areas of mangroves, brackish coastal swamps.

2.3 EM Measurements

The Salinity Soil Data Card allows the surveyor to record up to two electromagnetic induction measurements at the **site**.

2.3.1 Type

2-DIGIT NUMBER, 1 VALUE ONLY

This field allows the surveyor to record the identifying number of the EM instrument being used for the first set of measurements. To add additional types of meters to the list of values, please contact the SALIS administrator.

Reference List of VALUES

31 *Geonics EM31*

34 *Geonics EM34*

38 *Geonics EM38*

39 *Geonics EM39*

2.3.2 Horiz.

3-DIGIT NUMBER, 1 VALUE ONLY

Record the electromagnetic reading in millisiemens per m (mS/s) with the EM instrument on or very close to the ground surface in horizontal dipole mode (i.e., with the flat sides of the instrument facing vertically).

2.3.3 Vert.

3-DIGIT NUMBER, 1 VALUE ONLY

Record the vertical electromagnetic reading in millisiemens per m (mS/m) with the EM instrument on or very close to the ground surface in vertical dipole mode (i.e., with the flat sides of the instrument facing horizontally).

2.4 Electrical Conductivity (EC)

2.4.1 Measurement Units

CHOICE, 1 VALUE ONLY, ESSENTIAL IF EC VALUES RECORDED

In this field, the surveyor must record the units in which the electrical conductivity (EC) results recorded in the **EC** fields have been measured.

2.4.2 EC

DECIMAL TO 1 SIGNIFICANT FIGURE, 1 VALUE ONLY PER LAYER

The salinity of each layer can be measured by mixing a small sample of soil with distilled water and testing it using a properly calibrated EC meter. The result should be recorded in either decisiemens (dS) or millisiemens (mS), depending on the value selected in the **MEASUREMENT UNITS** field. Decisiemens (dS) is the international standard unit for these measurements so its use is preferred.