LAND RESOURCES OF

THE LOWER BURDEKIN RIVER DELTA:

NORTH BURDEKIN AND

SOUTH BURDEKIN WATER BOARD AREAS,

NORTH QUEENSLAND

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NOVEMBER 2003

FINAL REPORT: PROJECT 23

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SUMMARY

Local industry stakeholders identified the lack of adequate soils mapping information, as a very high priority in the "Draft Community Based Natural Resource Management Strategy for the Burdekin-Bowen Floodplain Sub-region."

This project has provided a comprehensive database of the soil types of the Burdekin Delta. Soil mapping of approximately 68000 hectares, comprising 43000 hectares in the North Burdekin Water Board, and 23000 hectares in the South Burdekin Water Board, has been completed. Forty-seven soil types have been identified. The maps and databases produced as a result of the project will be provided to stakeholders to help them make informed management decisions about the sustainable use of land and water resources in the Burdekin Delta.

The data collected will provide information essential to the sustainable management of the regions groundwater resources by providing soil and permeability information for the Burdekin Delta groundwater model, and the development of best practice irrigation practices guidelines. The identification and mapping of Acid Sulfate Soils and Good Quality Agricultural Land will greatly assist stakeholders with local and sub-regional planning.

1. INTRODUCTION

1.1 Background

The Burdekin Delta is a major irrigation area administered by the North Burdekin Water Board (NBWB) and the South Burdekin Water Board (SBWB). The area grows more than 35000 ha of irrigated sugarcane and other crops (Bristow *et al* 2000). It is centred on the towns of Ayr, Home Hill and Brandon, and is approximately 90 kilometres southeast of Townsville in north Queensland (See Figure 1). The area of the NBWB and SBWB comprises a total of 75975 hectares.

The Water Boards are Statutory Authorities constituted under the "Water Act 2000." Their role is to replenish the sub-artesian water supplies, in order to increase the quantity and improve the quality of the supply available, for irrigation, domestic, stock and industrial purposes by utilising part of the flow of the Burdekin River. This is achieved through the use of electric pumping plants to divert river water to suitable recharge areas through a series of natural and artificial channels.

Since the completion of the Burdekin Falls Dam in 1987, there has been a significant increase in the number of farms relying on open water from distribution channels (McMahon et al 2000). This has resulted in a change in the management of the water resources by the Water Boards. The irrigation system is now considered as one of conjunctive use of both surface and groundwater supplies. It was recognised that an evaluation of the results of this change, and the long-term protection of the large groundwater system from saltwater intrusion, needed to be undertaken.

1.2 Purpose and extent of the project

The Burdekin Delta Groundwater Model (Arunakumaren *et al* 2001) was developed to simulate the behaviour of the Burdekin Delta groundwater system. The model allows for the evaluation of water management strategies to ensure that irrigation use in the Delta area is sustainable.

The groundwater system within the Burdekin Delta sediments is considered to be unconfined and is therefore open to recharge from the surface. Recharge is determined by assessing the amount of input to the groundwater system via rainfall, channel seepage, percolation through artificial recharge pits, and through irrigation return flows. An estimate of the amount of recharge that occurs through the soil profile is an important input for the model. However, at the time of model construction, there was no detailed soil and permeability information available for the Burdekin Delta area.

In order to obtain this data, the Lower Burdekin Landcare Association Incorporated made successful applications to the Rural Water Use Efficiency Initiative (RWUEI), and the National Heritage Trust (NHT), for funding of a 3-year project, titled "Burdekin Delta Soils – A Basis for Sustainable Planning". Two of the main objectives of the project were the production of a detailed soil map of the Burdekin Delta; and a database of soils infiltration, chemical and physical characteristics for the various soils, from which inputs into the groundwater model could be calculated.

The stated objectives of the RWUEI project proposal are as follows:

1. Provide a database of soils infiltration, chemical and physical characteristics for input into the Burdekin Delta groundwater model.
2. Provide industry stakeholders with GIS maps for strategic planning and development guidelines.
3. Identify areas of Acid Sulfate Soils.
4. Define the boundaries of Good Quality Agricultural Land.
5. Provide the RWUE extension program with information to formulate best practice irrigation guidelines in consultation with growers and industry stakeholders.

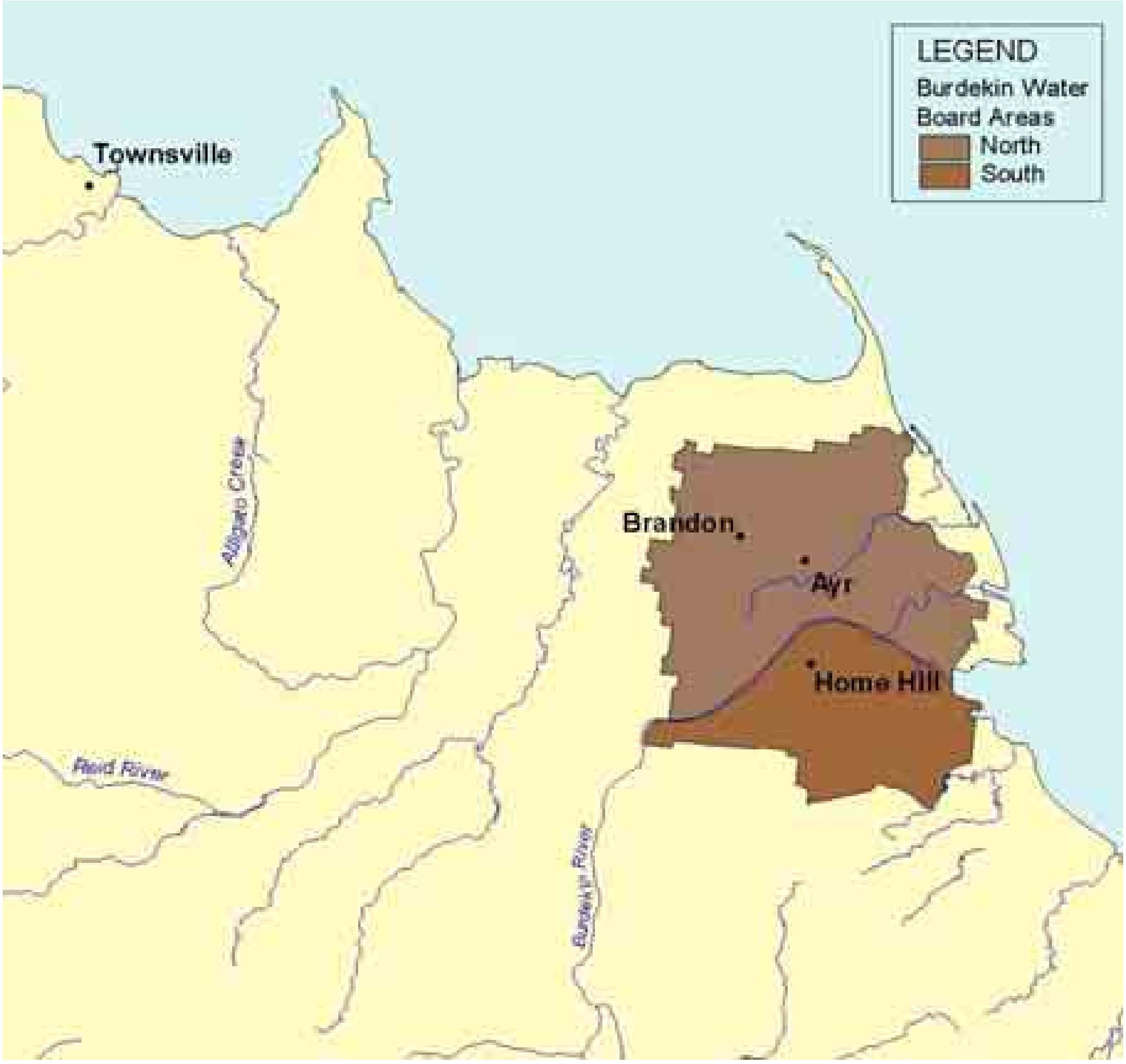

Figure 1. Locality Plan of the North and South Burdekin Water Boards

2. SOIL MAPPING METHODOLOGY

2.1 Introduction

The collection of good land resource information and making it available to "stakeholders" should assist them to make informed management decisions to ensure the appropriate utilisation of soil types in the Burdekin Delta. The results of soils mapping, the identification of Acid Sulfate Soils and the identification of Good Quality Agricultural Land are some of the key components of this good land resource information.

Prior to the Burdekin Delta Soils project, Christian et al (1953) and McClurg (1986) detailed the only available land resource information for the area.

During the initial soil investigations for the groundwater model (see Section 3.2 Methodology), there was some "grower suspicion" as to the intended use of the soils information (Enderlin 2000). With the subsequent soil mapping associated with this project, the emphasis has focused more on the information being for a range of land management and planning uses, and not necessarily the groundwater model.

In determining soil survey methodology and the estimation of sites required, reference was made to the Australian Soil and Land Survey Handbook, Guidelines for Conducting Surveys (Gunn *et al* 1988). Following consultation with stakeholders, it was determined that a medium-intensity (1:50 000) soil survey would be undertaken of the area, which represents a site intensity of 1 site description per 25 - 50 hectares. This scale of mapping was a compromise, when compared with other soil surveys in the Lower Burdekin area, and was mainly due to limitations of time/budget and available resources. It would, however, provide a level of land resource information suitable to address the objectives of the project.

The Free Survey method has been used where "ground observations are irregularly located according to the surveyor's judgement (Steur 1961)." Sites were described on standard description sheets, and in accordance with the methodology in the Australian Soil and Land Survey Field Handbook Second Edition (McDonald *et al* 1998). The field observations will then be compiled into the SALI Site component of the Soil and Land Information (SALI) database of Natural Resources & Mines.

2.2 Soil Types and Mapping Units

Enderlin (2000) conducted initial soil sampling across the area associated with preliminary investigations for the Burdekin Delta groundwater model. Three hundred and fifty two (352) sites were described and sampled to approximately 1.5 metres. Profile information collected at each site included, depth, and field textures of the various soil layers (horizons). A soil type description, based on this sampling, was also determined for each site. These sites were used as part of the reference-making phase of the survey, and formed the basis for the detailed Landscape Unit/Soil Type descriptions used in the soil survey.

Five Landscape Units have been identified:

1. **Landscape Unit B:** Current alluvium associated with the Burdekin River and major distributary channels;
2. **Landscape Unit C:** Current alluvium associated with minor distributary channels;
3. **Landscape Unit R:** Relict alluvium associated with large low-lying flats;
4. **Landscape Unit M:** Current marine plains; and
5. **Landscape Unit H:** Hills and mountains.

Within these landscape units, forty-seven soil types have been identified, along with phases and miscellaneous units. The depth to sandy layers is one of the main soil attributes used to separate the soil types, as this was deemed to be an important soil characteristic for irrigation.

The nomenclature of soil types was similar to the alphanumeric code used by Thompson and Reid (1982) for soil profile classes, with minor modification for the Burdekin Delta, to avoid confusion. Each soil type was identified by a textual code:

- a letter for the landscape unit;
- the appropriate subdivision of the dominant Primary Profile Form (Northcote 1979); and
- a letter for each separate soil type within the landscape unit and primary profile form subdivision.

For example, soil type **BUfc,**

- "B" denotes landscape unit B (Current alluvium associated with the Burdekin River and major distributary channels);
- "Uf" indicates a subdivision of the primary profile form (in this case a Uniform fine textured non-cracking clay); and
- "c" separates this soil type from other Uniform fine textured (non-cracking) soil types within landscape unit B.

See Appendix 1 for the Key for the Recognition of Soil Types, used during the field mapping. This "Key" was continually updated as new soils, or variations in current soils, were observed. Where the soil type has affiliation with, or could be correlated to a similar soil type from previous soil and land resource surveys in the Burdekin River Irrigation Area (BRIA), the BRIA soil type has been highlighted in bold in the soil type description eg BUca **(BRIA – 6Ucc).**

3. APPLICATION OF SOILS MAPPING TO GROUNDWATER MODEL

3.1 Introduction

As detailed soil and permeability information was not available for the Burdekin Delta at the time of initial model construction, the major objectives for the project were to first map the soils of the Burdekin Delta area, and then secondly provide a database of soils infiltration, chemical and physical characteristics for the various soil types, which would then be inputted into the ground water model.

This information was required so that the amount of recharge that occurs through the soil profile via rainfall and irrigation application could be estimated.

3.2 Methodology

Following completion of the main objective ie. soils mapping, the next major challenge was to provide a database of soils infiltration, chemical and physical characteristics. Thirteen profiles were sampled in the NBWB area, and five profiles sampled in the SBWB area for detailed chemical and physical analyses. These profiles represented the major soil types in the two Water Board areas.

The size, complexity and variability of the overall soils mapping project has made the determination of soil infiltration extremely difficult during this project due to:

- Massive profile disturbance due to levelling, cut and filling activities by landholders to expose, or vary the depth to sandy layers, or incorporate heavier layers in an effort to seal the sandy soils from deep drainage leakage under furrow irrigation;
- The variability in quality of groundwater and surface water and their effects on particle size and surface sealing;
- The variability in application rates between landholders on the same soil type;
- The use of gypsum in some areas by landholders on the same soil type;
- The effects of compaction on infiltration, or, inducing compaction on some soils to reduce infiltration;
- Understanding particle size distribution throughout the profile, and inconsistencies associated with field soil textures and laboratory analyses of particle size;
- Differences in “cultural practices” on similar soil types.

Due to these problems, the determination of soil infiltration in this report has been limited to:

- Assessing the results of the SALF software package (Carlin and Truong 1999) using the appropriate chemical and physical inputs from the analysed representative profiles collected during the survey;
- Extrapolating the results to similar soil types which were not analysed;
- Extrapolating analysed representative profiles from other land resource surveys in the Burdekin River Irrigation Area (BRIA) to similar soil types which were not analysed;
- Extrapolating physical and hydraulic properties from field sites established by the Lower Burdekin Initiative (LBI) throughout the Burdekin Delta, which are representative of the major soil recharge zones (Eldridge 2000).

The 13 analysed profiles from the NBWB area, and extrapolation of results from the SALF model to similar soil types, has mainly been used for the determination of soil infiltration for most of the Burdekin Delta area. The remaining five profiles sampled in the SBWB area are currently undergoing laboratory chemical and physical analyses, and results incorporated when they become available.

3.3 Use of SALF model for Deep Drainage Estimates

3.3.1 Soil and Irrigation Criteria for SALF model

The Salinity And Leaching Fraction (SALF) software package was considered for estimation of leaching fraction. Two models SALFPREDICT and SALFCALC exist within the package.

1. SALFPREDICT is used to predict the effects of irrigation on root zone salinity, leaching fraction and plant salinity response, based on soil properties and salt balance.

2. SALFCALC is used to analyse salinity data. SALFCALC is used to convert raw data to measures of salinity that have direct relationships with plant yield data and soil leaching processes. Leaching fraction and relative yield are estimated.

The SALFPREDICT program was used. This program calculated the leaching fraction (proportion of input water draining below the root zone) at the bottom of the active root zone depth, which is assumed to be 0.9m. The root zone is approximately the same as used in the groundwater model.

The program requires the following inputs:

- ESP – this is the value for exchangeable sodium (milli-equivalents/100grams of soil) at a depth of 0.9m in the soil profile, and is **NOT** Exchangeable Sodium Percentage, which is calculated by the program.
- Clay% - the value entered is the clay content in g/100g of soil from a particle size analysis.
- CEC – the value entered is the cation exchange capacity of the soil (milli-equivalents/100g of soil).
- ADMC – air dry moisture content is required to convert the CEC values to oven dry in order to determine the CEC/clay ratio (CCR).
- Linear correction (refer SALFPREDICT model).
- Depth of rainfall (mm) – is the average annual rainfall mm/year.
- EC – electrical conductivity (EC) is a measure of the salt content of the irrigation water source.
- Irrigation depth – the depth of application of irrigation water applied in mm/year.
- Crop name – the list of plants comes from the list for which quantative plant salt tolerance data is available (Shaw et al 1987).

Predicted leaching fraction was calculated then, by the equation of Shaw and Thorburn (1985a). To ensure consistency in data inputs between the equation and the SALFPREDICT model, the same “irrigation criteria” was used.

- EC of irrigation water (0.25dS/m) was taken as the average Burdekin River water at Clare Weir (Ahern et al 1988);
- An average rainfall of 900mm/year (Ayr) was used for the purpose of this paper;
- The EC of rainfall is assumed to be equal to 0.03dS/m;
- An irrigation regime of 1000mm/year, representing the higher water use in the Burdekin region, was imposed on the annual rainfall figure.

3.3.2 Use of SALFPREDICT to calculate Deep Drainage

Predicted deep drainage loss has previously been calculated for Burdekin soils (Ahern et al 1988). These estimates are mostly for soils within the Burdekin River Irrigation Area (BRIA), which is generally located to the south west of the Delta area. However, a minor number of soil profiles from a small area within the Delta, Ayr Research Station (McClurg 1986), are also calculated within this existing data.

In order to evaluate and calibrate SALFPREDICT for the Burdekin Delta Soils project, trial runs were undertaken using existing chemical data from analysed profiles in the BRIA to compare results from SALFPREDICT with the predicted deep drainage losses outlined in Ahern et al (1988). This was to determine if both calculated results were similar or not, or to "groundtruth" the model results. The trial runs also included changing the EC of the irrigation water to better reflect the EC of the groundwater being used in the water board area.

The results of the trial runs caused some concern, as there were occasions when the SALFPREDICT model gave vastly different deep drainage values when compared to those of Ahern et al (1988). Some results also indicated Leaching Error Fraction >1. A review of the model, limitations of the model, and the original relationships to develop the model were undertaken, and involved further investigations into the original research publications.

The basis of the SALFPREDICT model is detailed in Shaw and Thorburn (1985a) and Shaw and Thorburn (1985b), while limitations of the model are discussed in Carlin and Truong (1999).

The main limitation, for this project, appears to be the range of rainfall values from which the original model relationships were derived, being 200 to 2000mm. Calculations of leaching fraction outside this range, or close to these values, could be in error. The prediction of leaching fraction under irrigation used the calculation "Irrigation plus Rainfall" to determine depth of input water.

In the Burdekin Delta area, it is common for rates of irrigation application to be 15-30 megalitres per hectare (1500 – 3000mm). When added to average annual rainfall, the depth of input water far exceeded the limitations of the SALFPREDICT model, hence this could explain the discrepancies. It was decided that the original irrigation regime of 1000mm/yr (Ahern et al 1988), to enable an estimate of leaching fraction for Burdekin Delta soils. As the model allows for a linear relationship, it was possible to use a simple extrapolation of the calculated leaching fraction to allow for the higher irrigation rates used in the Burdekin Delta. For the purpose of interpreting results for this project, Leaching Fraction, rather than deep drainage (mm/yr) may also be the preferred measure for extrapolating the results from the model to similar soil types.

3.3.3 Development of Deep Drainage Units

The next step was to extrapolate the leaching fraction data to soils with similar physical and chemical properties. To ensure accuracy of the extrapolation, a validation process was used to assess the leaching fraction and deep drainage data against the physical and chemical properties, and to determine "atypical" data, which was generally not considered accurate or included within estimates of deep drainage for this report. Part of the validation process included the use of deep drainage data (% Irrigation and Rainfall), collected from the field sites established by the LBI throughout the Burdekin Delta. Using the grid coordinates (AMG) for each site (Charlesworth pers. comm.) it was possible to locate the field sites by soil type. It was however necessary to even validate these deep drainage estimates by comparing actual irrigation plus rainfall against crop water requirement, to ensure deep drainage wasn't being under/over estimated.

Table 1 summarises the leaching fraction, deep drainage (SALFPREDICT), and extrapolated deep drainage (mm/yr) calculated for 13 of the analysed profiles in the Burdekin Delta area.

The next process was to extrapolate the results to soil types with similar soil descriptors (eg soil depth and field texture), physical and chemical characteristics, and therefore similar leaching fractions. The process also included extrapolating results from soil types in the BRIA to similar soil types in the Burdekin Delta area where no extrapolation could be made using the previous method. The final step in this process was to also make some assessment of the leaching fractions. Arbitrary subdivisions of leaching fraction and soil types, based on likely effects of long term use of furrow irrigation on the particular soil types were established. While the leaching fractions have been determined using the SALFPREDICT model, the naming nomenclature i.e. Marginal, is based on author's assumptions about deep drainage. Table 2 details these processes.

The concept of Soil Management Groups has previously been used in soil/land resource surveys in the BRIA (Donnollan 1991). However, the Burdekin Delta is located in the Dry Tropics, and given the dominance and reliance on water, both surface and groundwater, for irrigated sugar cane production, it is suggested that the concept of Water Management Groups may be the preferred option for the groundwater model, rather than soil management groups. A Water Management Group essentially would a soil type or group of soil types with similar leaching fraction, although may not necessarily be similar from a soil management perspective. Table 3 summarizes the Water Management Groups.

Table 1: Leaching fraction, deep drainage (SALFPREDICT), and extrapolated deep drainage (mm/yr) calculated for thirteen of the analysed profiles, Burdekin Delta area.

Site Number	**Soil Type**	**Metres East**	**Metres North**	**Leaching Fraction**	**Deep drain SALF PREDICT**	**Extrapolated Deep drain 15Ml Irrigation**	**Extrapolated Deep drain 20Ml Irrigation**	**Extrapolated Deep drain 30Ml Irrigation**
369	BUmb	544840	7838640	0.34	638	816	986	1326
1225	BUfb	538255	7827725	0.82	1551	1968	2378	3198
198	BUfa	536760	7836875	0.37	709	888	1073	1443
755	RUgc	535970	7835635	0.49	930	1176	1421	1916
877	BUma	551640	7827670	0.30	578	720	870	1170
589	RDya	545169	7844610	0.01	24	25	29	39
800	BUga	535520	7839705	0.02	38	48	58	78
209	BUfc	546480	7839150	0.26	491	624	754	1014
276	RUgd	539105	7835787	0.04	82	96	116	156
1142	BUfc	536240	7830460	0.12	224	288	348	468
689	RUgb	535930	7840690	0.03	60	72	87	117
1186	BUca	534265	7828685	0.36	691	864	1044	1404
265	BUfe	551450	7828705	0.05	92	120	145	195

Table 2: Extrapolation of Burdekin Delta Soil Types, Burdekin Delta groundwater model.

Group	**Leaching Fraction (LF)**	**Deep Drainage mm (SALF Predict)**	**Soil Type (Survey code* - Site No.)**	**Dominant Soil/Chem Features 0 - 0.9m**
Negligible	**0.01-0.06**			
	0.01	14	6Dyg (IMC-S03)	Clay loam 0-0.12m; medium clay 0.12-0.52m; light clay 0.52-0.90m. Strongly sodic (ESP 44 at 0.2-0.3m). EC high (1.7 dS/m) at 0.2-0.3m to very high (5.2 dS/m) at 0.8-0.9m. Chloride high (1620mg/kg) to very high (2730 mg/kg). Gypsum crystals. **Extrapolate with CDbb.** Data is oven dry, use 0 value for ADMC in SALF. Atypical to other BRIA 6Dyg's, but salt levels more indicative of this area.
	0.01	19	6Dyg (NHC-S108)	Clay loam fine sandy 0-0.18m. Medium clay 0.18-0.9m. Strongly sodic (ESP 18-56) at 0.2-0.9m. **Extrapolate with CDbb.** Data is oven dry, use 0 value for ADMC in SALF.
	0.01	25	RDya (589)	Clay loam fine sandy 0-0.18m; medium clay 0.18-0.9m. Strongly sodic ESP 20 at 0.2-0.3m. EC high (1.04mS/cm) at 0.5-0.6m. Chloride high (807mg/kg) at 0.5-0.6m. Acid sulfate soil site, possible marine influence on salt levels? **Extrapolate with 3Dya.**
			CDbb	Clay loam fine sandy 0.12-0.25m, bleached. Light medium/medium clay to 1.0-1.10m. Alkaline at and below 0.6m. **Extrapolated from RDya/6Dyg.**
	0.02	41	6Dyg2 (HTS-S9)	Sandy loam 0-0.21m. Medium clay 0.21-0.9m. Strongly sodic (ESP 38-68) at 0.2-0.9m. **Extrapolate with CDbb.** Data is oven dry, use 0 value for ADMC in SALF.
	0.02	48	BUga (800)	Medium clay to 0.9m. Sodic (ESP 9 at 0.2-0.3m) to strongly sodic (ESP 22 at 0.8-0.9m). Clay % low in upper profile low for medium clay. EC very low (0.04mS/cm) to low (0.29mS/cm). Chloride very low (14mg/kg) to low (131mg/kg).
	0.03	60	RUgb (689)	Medium clay to 0-0.6m. Light medium clay to 0.6-0.9m. Sodic (ESP 9 at 0.1-0.2m) to strongly sodic (ESP 17-24) throughout profile. EC high (1.45mS/cm) at 0.3m. Chloride high (598mg/kg) at 0.3m.
	0.04	82	RUgd (276)	Medium clay to 0-0.9m. Sodic (ESP 7-14) throughout profile. EC low (0.19-0.31mS/cm) throughout profile. Chloride very low throughout profile.
	0.05	92	BUfe (265)	Silty clay to 0-0.9m. Strongly sodic (ESP 13-16) throughout profile. EC low (0.20-0.35mS/cm) throughout profile, accept for surface which is medium (0.55mS/cm). Chloride is medium (329-552 mg/kg) in upper 0.6m of profile.
	0.06	121	4Dyf (IMC-S11)	Sandy loam 0-0.35m. Light clay 0.35-0.82m. Light medium clay 0.82-0.9m. Strongly sodic (ESP 20-64) at 0.5-0.9m. **Correlate with HDyc?.** Data is oven dry, use 0 value for ADMC in SALF.
	0.1	181	6Dyg (HTN-S23)	Clay loam fine sandy 0-0.2m. Medium clay 0.2-0.9m. Sodic (ESP 9-10) at 0.5-0.9m. **Extrapolate with CDbb.** Data is oven dry, use 0 value for ADMC in SALF. Atypical from other 6Dyg's?
			MDya	Bleached clay loam to 0.12m. Mottled medium clay to 0.9m. Strongly alkaline at or below 0.6m. **Extrapolated from RDya/Ruff?**
			MUfa	Silty clay to 0.2m. Mottled grey clay to 0.9m. **Extrapolated from RDya/Ruff?**
			RUgbS (1431)	SBWB. Should be "saltier version" of site 689.
			RUff	Light/light medium clay to 0.1-0.2m. Mottled light medium/medium clay to 0.9m. **Extrapolated from profile descriptions.**
			RUfe	Fine sandy to light medium clay, bleached, to 0.1-0.3m. Fine sandy to medium clay to 0.7-1.5m. Mottled sand to clay loam fine sandy to 1.5. **Extrapolated from profile descriptions.**

Table 2: Extrapolation of Burdekin Delta Soil Types, Burdekin Delta groundwater model.

Group	**Leaching Fraction (LF)**	**Deep Drainage mm (SALF Predict)**	**Soil Type (Survey code* - Site No.)**	**Dominant Soil/Chem Features 0 - 0.9m**
Slight	0.12-0.26			**General for Group 2. This group mostly "clay textures" to 0.9m. S04 atypical from textures.**
	0.12	224	BUfc (1142)	Light medium clay 0-0.9m. Non-sodic (ESP 3-4) throughout profile. EC very low (0.05-0.08mS/cm) throughout profile. Chloride very low (7-17mg/kg) throughout profile. Fine sand/Silt/Clay ratio = 1/3. Black subsoil?
			BUfb	Fine sandy light/light medium clay to 0.2-0.6m. Fine sandy light/light medium clay to 0.6-1.1m, over fine sand/fine sandy loam. **Extrapolated from BUfc.**
	0.12	235	Katoora (ARS - SO5)	**Extrapolate with BDba.** Sandy clay loam 0-0.1m. Light clay 0.1-0.8m. Sandy loam 0.9-0.9m. Weakly sodic ESP 10 at 0.9m. EC very low (0.02-0.04mg/kg) throughout profile. Chloride very low 0.01mg/kg) throughout profile**.**
	0.13	256	McDesme (ARS - SO2)	**Extrapolate with BUfc.** Silty clay 0-0.28m. Light medium clay 0.28-0.5m. Fine sandy clay 0.5-0.9m. Non-sodic (ESP 1.5-4.5) throughout profile. Chloride very low 0.01-0.03.
	0.17	322	Mirrigan (ARS - SO4)	**Extrapolate with BUma.** Sandy clay loam to 0.3m. Coarse sand 0.3-0.5m. Sand 0.5-0.9m. Coarse sand dominant. Hydraulic head (wetting front) effect due to dominance of coarse sand? Non-sodic throughout profile? Too low?
	0.26	491	BUfc (209)	Fine sandy clay to 0-0.9m. Sodic (ESP 6-7) throughout profile. Fine sand dominant. Clay % very low for fine sandy clay (13-16% clay). Brown subsoil?
			BDya	Clay loam, bleached to 0.2-0.4m. Mottled medium clay to 0.4-0.8m, over sandy clay loam to light medium clay. Generally neutral. **Extrapolated from profile description**.

Table 2: Extrapolation of Burdekin Delta Soil Types, Burdekin Delta groundwater model.

Group	**Leaching Fraction (LF)**	**Deep Drainage mm (SALF Predict)**	**Soil Type (Survey code* - Site No.)**	**Dominant Soil/Chem Features 0 - 0.9m**
Moderate	**0.29-0.40**			**General for Group 3. This group non-sodic and generally lighter textures down the profile.**
	0.29	556	4Dyl (IMC-S10)	Sandy loam 0-0.3m. Light clay 0.3-0.9m. Non-sodic (ESP 1.3-3.8) throughout profile. Data is oven dry, use 0 value for ADMC in SALF.
	0.3	578	BUma (877)	Clay loam fine sandy 0-0.3m. Fine sandy loam 0.3-0.7m. Loamy sand 0.7-0.9m. Non-sodic (ESP <3) throughout profile. Fine sand dominant.
	0.33	630	6Dyd (BRL-S59)	Sandy clay loam 0-0.4m. Clay loam sandy 0.4-0.45m. Medium heavy clay 0.45-0.9m. Non-sodic (ESP <4) throughout profile. **Extrapolate with CDba**, but 6Dbc better fit? Data is oven dry, use 0 value for ADMC in SALF.
	0.34	638	BUmb (369)	Clay loam fine sandy to 0.9m. Non-sodic (ESP 3-4) throughout profile. Coarse sand/Fine sand co-dominant.
	0.36	691	BUca (1186)	Fine sandy loam to 0.9m. Non-sodic (ESP 3) throughout profile. Coarse sand dominant. Hydraulic head (wetting front) effect due to dominance of coarse sand? LF thought too low?, but some BRIA 6Uc's are similar.
	0.37	709	BUfa (198)	Light medium clay to 0.9m. Non-sodic (ESP 3-4) throughout profile. Fine sand/Silt/Clay ratio =1/3
	0.4	768	Maidavale (ARS-S06)	**Extrapolate with BGnb.** Clay loam fine sandy 0-0.2m; fine sandy clay 0.2-0.5m; loam fine sandy 0.5-0.9m. Fine sand dominant. Clay % too low (15-19%) for fine sandy clay.
			BUfd	Fine sandy light /light medium clay to 0.2-0.6m, over fine sand to fine sandy loam. **Extrapolated from BUfa.**
			CUfa	Fine sandy clay to 0.2-0.6m, over fine sandy clay/light medium clay to 0.7-1.1m, over layered sand to clay loam fine sandy. **Extrapolated from BUfa.**
			CUfb	Fine sandy clay/light medium clay to 0.4-0.6m, over fine sandy clay/light medium clay. Fits better with BUfc (slight)? However, reddish-brown colours suggest better drainage?
			CUfc	Fine sandy clay/light clay to 0.3-0.6m, over fine sandy clay/light medium clay to 0.8-1.4m, over loamy fine sand to clay loam fine sandy. Alkaline to strongly alkaline below 0.6-0.9m. **Extrapolated from BUfa.** Better with BUfe, alkaline SRT?
			CUma	Sandy clay loam to clay loam to 0.3-0.4m, over layered clayey sand to to clay loam fine sandy. **Extrapolated from BUma.**
			CUmb	Sandy clay loam to clay loam fine sandy to 0.3-0.6m, over clay loam fine sandy. **Extrapolated from BUmb.**
			BGna	Sandy clay loam to clay loam fine sandy to 0.2-0.6m, over fine sandy light/light medium clay. **Extrapolated from Maidavale?**
			BGnb	Sandy clay loam to clay loam fine sandy to 0.2-0.5m, over fine sandy light clay to 0.75-1.2m, over fine sand to fine sandy loam. **Extrapolated from Maidavale?**
			CGna	Fine sandy loam to clay loam fine sandy to 0.2-0.5m, over fine sandy clay loam to light clay to 0.8-1.1m, over sand to fine sandy clay. Neutral SRT to strongly alkaline below 0.9-1.2m. **Extrapolated from BGna.**

Table 2: Extrapolation of Burdekin Delta Soil Types, Burdekin Delta groundwater model.

Group	**Leaching Fraction (LF)**	**Deep Drainage mm (SALF Predict)**	**Soil Type (Survey code* - Site No.)**	**Dominant Soil/Chem Features 0 - 0.9m**
Marginal	**0.49-0.52**			**General for Group 4. This group atypical? Disregard from final estimates?**
	0.49	930	RUgc (755)	Medium clay to 0-0.4m. Light medium clay 0.4-0.9m. Non-sodic (ESP <3) throughout profile. Fine sand/Silt/Clay ratio =1/3. This site neiutral SRT, but should still be lower LF?
	0.5	948	6Dyd (BRL-S49)	Loam fine sandy 0-0.4m. Medium clay 0.4-0.9m. Non-sodic (ESP <2) throughout profile. **Extrapolate with CDba,** but 6Dbc better fit? Data is oven dry, use 0 value for ADMC in SALF.
	0.51	964	Ayrees (ARS - SO1)	**Extrapolate with BUfc.** Light medium clay 0-0.18m. Medium clay 0.18-0.30. Light medium clay 0.3-0.9m. This prior swamp. Virgin site for irrigation? No effects from chemistry of irrigation water? Therefore better drained? Compare with BUfc irrigated sites. Non-sodic (ESP 1.3-1.7) throughout profile.
	0.52	982	6Dra (BRL-S50)	Sandy loam to clay loam sandy 0-0.45m. Medium clay 0.45-0.9m. **Correlate with CDra**. Data is oven dry, use 0 value for ADMC in SALF.
			CDba	Clay loam fine sandy to 0.3-0.6m, over light medium clay to 0.9m. **Extrapolated from 6Dra.** 6Dbf (HTN-S15) atypical, too high? Better here?
			CDra	Fine sandy loam to sandy clay loam to 0.3-0.5m, over snady clay to 0.7-1.00m, over loamy sand to fine sandy loam. **Extrapolated from 6Dra.** 6Dbf (HTN-S15) atypical, too high? Better here?
			BDba	Sandy clay loam/clay loam fine sandy to 0.3-0.6m, over fine sandy light/light medium clay to 0.6-1.2m, over sand to fine sandy loam. **Extrapolated from CDba/CDra.**
			BGnc	Sandy clay loam to clay loam fine sandy to 0.2-0.5m, over sandy clay loam to clay loam sandy to 0.5-1.1m, over fine sand to fine sandy loam. **Extrapolated from profile description**.

Table 2: Extrapolation of Burdekin Delta Soil Types, Burdekin Delta groundwater model.

Group	**Leaching Fraction (LF)**	**Deep Drainage mm (SALF Predict)**	**Soil Type (Survey code* - Site No.)**	**Dominant Soil/Chem Features 0 - 0.9m**
Severe	**>0.6**			**General for Group 5. This group atypical? Disregard from final estimates?**
	0.64	1218	6Ucc (BSA-15)	Sandy clay loam 0-0.3m. Sandy loam 0.3-0.9m. Non-sodic (ESP <2) throughout profile. **Extrapolate with BUca/b**. Data is oven dry, use 0 value for ADMC in SALF.
	0.67	1281	5Dra (NLH-S19)	Light clay 0-0.20m. Atypical? Light medium clay 0.20-0.25m. Heavy clay 0.25-0.60m. Medium heavy clay 0.60-0.90m. Non-sodic (ESP <1) throughout profile. Data is oven dry, use 0 value for ADMC in SALF.
	0.72	1377	6Ucc (BSA-26)	Sandy loam 0-0.85m. Loamy coarse sand 0.85-0.9m. **Extrapolate with BUca/b**. Data is oven dry, use 0 value for ADMC in SALF.
	0.77	1468	Jarvisfield (ARS-SO3)	**Extrapolate with BUmb?** Clay loam fine sandy to 0-0.5m. Sandy clay loam 0.5-0.9m. Fine sand dominant. Non-sodic (ESP 1.8-2.4) throughout profile. Atypical? Research station site. No effects from chemistry of irrigation water? Therefore better drained? Compare with site 369.
	0.81	1539	6Dbc (BRL-S35)	Loam fine sandy 0-0.2m. Light medium clay 0.2-0.7m. Light sandy clay loam 0.7-0.9m. Non-sodic (ESP <1) throughout profile. **Extrapolate with CDba.** This site too high? Data is oven dry, use 0 value for ADMC in SALF.
	0.82	1551	BUfb (1225)	Light medium clay 0-0.42m. Sandy clay 0.42-0.9m. Fine sand dominant throughout profile. Clay% too low (15-19%) for LMC. Non-sodic (ESP 3) throughout profile. Atypical?
	0.89	1696	6Uma (HTN-S14)	Fine sandy loam 0-0.2m Loam fine sandy 0.2-0.9m. Sodic surface? (ESP 12). Non-sodic (ESP <1) throughout profile. **Extrapolate with BUmd**. Data is oven dry, use 0 value for ADMC in SALF.
	0.94	1786	5Dye (IMC-S3)	Clay loam 0-0.22m. Light medium clay 0.22-0.55m. Medium clay 0.55-0.80m. Light medium clay 0.8-0.9m. Non-sodic (ESP <1) throughout profile. Data is oven dry, use 0 value for ADMC in SALF.
	0.99	1881	6Dbf (HTN-S15)	Clay loam fine sandy 0-0.30m. Fine sandy light medium clay 0.3-0.9m. **Extrapolate with CDba**. Data is oven dry, use 0 value for ADMC in SALF.
			MUca	Sand to sandy loam to 0.2-0.3m, over fine sand to fine sandy loam. **Extrapolated from BUc/RUc/6Uc.**
			MUcb	Fine sandy loam to 0.3-0.5m, over fine sandy loam to fine sandy clay loam. **Extrapolated from BUc/RUc/6Uc.**
			RUca	Sand to sandy loam to 0.7-1.2m, over sand to sandy loam. **Extrapolated from BUc/MUc/6Uc.**
			BUca	Sand to fine sandy loam to 0.2-0.3m, over sand to fine sandy loam. **Extrapolated from MUc/RUc/6Uc.**
			BUcb	Sand to fine sandy loam to 0.4-0.8m over sand to fine sandy loam. **Extrapolated from MUc/RUc/6Uc.**
			BUmd	Loam to clay loam fine sandy to 0.2-0.5m, over loam to clay loam fine sandy to 1.2m. Textures suggest lower?

Notes:

Survey code*

IMC	Inkerman Central
NHC	Northcote
HTS	Haughton South
HTN	Haughton North
ARS	Ayr Research Station
BRL	Burdekin River Left Bank
BSA	Burdekin Southern Area
NLH	Leichhardt Downs

Table 3: Summary of Water Management Groups in the Burdekin Delta area.

Water Management Group	**Range Leaching Fraction (LF)**	**Soil Types (Burdekin Delta)**
Negligible	0.01 - 0.06	RDya; RUgb; RUgd; BUga; BUfe; CDbb; RUgc; RUga; BUfe; MDya; MUfa; RUgbS; RUff; RUfe
Slight	0.12 - 0.26	BUfb; BUfc; BDya
Moderate	0.29 - 0.40	BUfa; BUfd; BUmb; BUma; CUfa; CUfb; CUfc; CUma; CUmb; BGna; BGnb; CGna
Marginal	0.49-0.52	CDra; CDba; BDba; BGnc
Severe	>0.6	MUca; MUcb; RUca; BUca; BUcb; BUmd

4. ACID SULFATE SOILS MAPPING

4.1 Introduction

Acid sulfate soils (ASS) occur predominantly on coastal lowlands with elevations generally below 5m Australian Height Datum (AHD). When these lowlands are disturbed or drained, toxic quantities of acid (sulfuric), aluminium, iron and heavy metals may contaminate land and adjacent waterways. Following significant rainfall, such contamination may cause red spot disease in fish and destroy aquatic flora and fauna, including highly visible fish kills (Ahern *et al* 1998).

Christianos (1999) detailed the only ASS mapping for the Lower Burdekin Coastal Plains, prior to the commencement of this project. This mapping delineated areas below 5 metres AHD, and followed the Queensland Acid Sulfate Soil Investigation Team (QASSIT) recommendation at that time (Ahern *et al* 1998), where areas below 5 metres AHD should be investigated for ASS prior to commencement of any drainage or excavation or disturbance below the watertable or alteration of local hydrology of lands or watercourses. This delineation of the 5-metre contour line was to be used in lieu of any detailed ASS mapping. The 5m contour line was delineated using colour 1:25 000 Topographic Image Maps for the area (Department of Natural Resources 1997). The accuracy of the 5m was ± 2.5 metres. The accuracy has been improved by using data obtained as part of the Digital Elevation Model (DEM) developed for the groundwater model.

4.2 Field survey methodology

In December 2001, preliminary ASS sampling was undertaken on a limited number of sites to provide an overview of the area, and the potential severity of ASS in the Burdekin Delta area. In determining possible sites for sampling, use was made bore strata logs associated with groundwater observation bores (NR&M Groundwater Database). A “word search” was undertaken on the database for “ASS indicators” such as “marine/mangrove/shells”. While these descriptive terms used by drillers may not be to a particular standard, the terminology is considered adequate for the purpose of identifying possible sites with layers of ASS.

The search identified approximately 40 possible sites in the area matching these criteria. The search was then further refined, by eliminating possible sites where the “ASS indicator” was below 5 metres of the surface, as this was the excavation limit of the sampling equipment available.

In the initial reference phase of the soils mapping, obvious areas of “marine or estuarine sediments” were mapped out using aerial photographic interpretation (API). These areas included tidal creeks and flats, mangroves and salt flats. These areas are now mapped as Landscape Unit “M” (Current Marine Plains).

During the soils mapping fieldwork, two soil types were identified with jarosite, an ASS indicator (See photo 1), within the depth of standard field sampling i.e. 1.5 metres. The two soil types are of “Relict Alluvial” origin (Landscape Unit R), being grey cracking and grey non-cracking clays (RUga and RUff). Areas of these two soil types that have been mapped during this study, mainly occurring to the north of Alva Beach Road, were targeted to further refine the ASS mapping, and identified possible sites for further detailed sampling and analyses.

Eight sites were selected for detailed soil descriptions and sampling for chemical analyses. Five sites were sampled in the NBWB area, and three sites sampled in the SBWB area. Soil profiles were sampled using a trailer-mounted vacuum vibro-corer (“Vibrocorer”) sampling rig (See Photo 2).

Photo 1. Jarosite, an ASS indicator, is a yellow-coloured mottle that is commonly seen in actual acid sulfate soils.

4.3 Field sampling procedures

The field sampling procedures, as set out in the guidelines of Ahern *et al* (1998) were closely followed to ensure reliability and uniformity of field and laboratory testing.

The soil profiles were described using the nomenclature of McDonald et al (1990). Soil profile properties described include horizon depth, colour (Oyama and Takehara 1967), mottles (including jarosite), texture, coarse fragments (eg. shell) and pH. Soil field pH tests were recorded at 0.25m intervals, firstly on a 1:5 soil water paste (pH_F), and secondly after reaction with 30% hydrogen peroxide (pH_{FOX}). A significant depression in pH after reaction with the peroxide is a good field indicator of the presence of Potential Acid Sulfate Soil PASS (Malcolm et al 2002).

It must be noted that the field pH tests as an indicator of ASS should be used with caution and should always be supported with the appropriate laboratory analyses as per the Queensland Department of Natural Resources and Mines' (NR&M) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland (*Ahern *et al* 1998).

Photo 2. Trailer-mounted vacuum vibro-corer (“Vibrocorer”) sampling rig.

One hundred and eight (108) samples were selected from the eight soil profiles. Samples for laboratory analyses were placed in sealed plastic bags and refrigerated immediately using portable car fridge/freezers. Upon returning to the office, the samples were frozen and sent overnight courier to the Natural Resource Sciences at Indooroopilly, where they were ground and analysed according to the standards set out in Ahern *et al* (1998).

The field and chemical data was then interpreted in consultation with QASSIT (K. Watling pers. comm.) Brisbane. The data indicated that sediments containing Actual Acid Sulfate Soil (ASS) and Potential Acid Sulfate Soil (PASS) were found at variable depths below natural surface from all eight profiles sampled. More detailed interpretation will be provided in a future Land Resources Report (Natural Resources and Mines). A map of Acid Sulfate Soils will be published according to the standard legends and map codes, recently established by QASSIT, to ensure consistency and presentation of ASS maps, throughout Queensland.

The results of this preliminary sampling confirmed that in the general project area, there is a very strong likelihood of ASS below 5 metres elevation. Samples for ASS should be taken for laboratory analyses and interpretation from any proposed works involving deep excavation to depths below 5mAHD, drainage or lowering of groundwater. Sampling and interpretation should be according to the latest QASSIT Guidelines and State Planning Policy (SPP 2/02).

5. IDENTIFICATION OF GOOD QUALITY AGRICULTURAL LAND

5.1 Introduction

The implementation of State Planning Policy 1/92: Development and the Conservation of Agricultural required Local and State Governments to be aware of the location and extent of GQAL.

The identification of GQAL is necessary so that provisions for the protection of this land can be included in strategic plans, development control plans (DCP's) and other elements of planning schemes (DPI/DHLGP 1993).

Good Quality Agricultural Land (GQAL) is land, which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources (DPI/DHLGP 1993). In this context, agricultural land is defined as land used for crop or animal production, but excluding intensive animal uses such as feedlots, piggeries, poultry farms and plant nurseries based on either hydroponics or imported growth media (DPI/DHLGP 1993).

GQAL is determined following an assessment of the suitability of the land for specified agricultural land uses. Agricultural land suitability is a rating of the ability of the land to maintain a reasonable level of productivity.

Four classes of agricultural land are defined in the SPP 1/92 and associated guidelines for the purposes of identifying GQAL:

- Class A. Crop land.
- Class B. Limited crop land.
- Class C. Pasture land.
- Class D. Non-agricultural land.

General descriptions of the four classes can be found in Appendix 1.

5.2 Methodology

While the field mapping of soils is now completed, the digital soils mapping information is still undergoing data validation checks. In addition, in order to classify the agricultural land suitability, a land suitability classification process needs to be established in conjunction with some of the stakeholders (eg BSES).

It is proposed that a modified version of the Land Suitability Classification for Irrigation in the Burdekin River Irrigation Area (Donnollan and Day 1986) be used as a basis for establishing a classification process to determine the land suitability of the Burdekin Delta Soils. Following this, land will be assigned an Agricultural Land Classification according to the definitions in *Planning Guidelines for the Identification of Good Quality Agricultural Land* (DPI/DHLGP 1993). A map showing GQAL will be produced, for use the various stakeholders, especially local government, who are currently finalising there strategic plan for the Burdekin Shire.

5.3 Results and Discussion

When the data validation of the soils mapping is completed, priority will be given to finalising the land suitability classification process so that the identification of GQAL can be undertaken.

The limitation of the map identifying GQAL is the scale of the soils mapping from which the assessment is based on. The mapping scale of 1:50 000 is suitable only for broad scale planning, and should only be used as a guide, and not used at the property level.

It is not acceptable for maps published at a broad scale to be enlarged for detailed development assessments, as the level of accuracy is limited to the intensity of data collection for the published map i.e. at the scale of this project (1:50 000 scale), areas mapped as GQAL may be rejected by local Council on the basis of the inaccuracy of the broad scale mapping, in which case a detailed site assessment would be undertaken. Further on-site assessment of the GQAL status of individual parcels of land will still be required for the assessment process of development applications.

6. BEST PRACTICE IRRIGATION GUIDELINES

6.1 Introduction

Following concerns expressed by canegrowers in the Burdekin regarding rising groundwater and salinity, the Department of Primary Industries (DPI) instigated action to investigate and develop Best-On-Farm Water Management Practices (Bass and Cloonan 1996).

The purposes of that project were to:

1. Improve landholder awareness of water use to maximise cane production while minimising the likelihood of salinity and changes in the groundwater balance.

2. Facilitate the development of soil and water management practices on a range of soils in the Burdekin.

The outcomes were:

1. Landholder awareness of the relationships between salinity, on-farm water use and groundwater, and practices to best manage them.

2. A range of "best practices" which reflect the vast array of individual farm/er conditions.

3. Development of an extension model based on the value of indigenous knowledge; equality between government and farmers; and the examination of underlying assumptions in relation to water management by both Government and farmers.

4. Identification of issues for future research and extension.

In the early stages of the Best-On-Farm Water Management Practices project, discussions were held with Bureau of Sugar Experiment Stations (BSES), to update them on the project, and to determine their current and future research and extension activities.

Following this discussion, it was agreed that *growers in the Burdekin Delta area would not be included in the project.* This was due to the significant ill feeling at that time towards the Water Resources section of the DPI in that area due to rumours that Water Resources was going to put meters on their groundwater pumps and charge them for this supply (Bass and Cloonan 1996).

One of the objectives of this project was to therefore provide the Rural Water Use Efficiency Initiative (RWUEI) extension program with information to formulate, in consultation with growers and industry stakeholders, best practice irrigation guidelines for the Burdekin Delta area.

6.2 Identification of issues for Guidelines

Bass and Cloonan (1996) stated that best on farm soil and water management practices were dependent on many issues, with the major issues being:

1. Economic sustainability;
2. Environmental sustainability;
3. Availability of water supply;
4. Soil types;
5. Farm layout/shape (topography); and
6. Individual growers' needs and expectations.

While growers in the BRIA identified these issues, it is felt that there would be some similarity for growers in the Burdekin Delta area. In the early stages of the project, discussions were held with P. Sutherland (BSES/RWUEI Coordinator) to determine BSES issues and needs for the Delta Soils Mapping project.

It was identified that one of the most important factors for water use efficiency and irrigation management in the Burdekin Delta was the identification of very sandy soils, or where sandy soils occur within approximately 30cms of the surface (Benson, BSES, pers. comm.). These highly permeable areas not only have a significant impact on groundwater recharge, but also are equally important from a water management perspective due to the large volumes of irrigation water required to successfully grow a crop.

The identification of a considerable number of soil types was becoming an issue for irrigation management. It was determined that the grouping of soil types into Soil Management Groups, based on similarities of soil properties, was a preferred option. This assisted with the initial development of guidelines for the major soil types.

6.3 Best Practice Irrigation Guidelines

Draft Guidelines have been developed for a range of soils with high infiltration rate as identified by preliminary soils map and calculation of leaching fraction for the various soil types. The main strategy is to overcome the most severe infiltration rates associated with cultivated highly permeable soils on the Delta. The RWUEI has demonstrated the use of the flow coefficient- 1l/sec/100m of furrow length to reduce deep drainage losses and improve irrigation efficiency. When used in combination with Surge irrigation and, on suitable soils, alternate furrow irrigation efficiencies improve from 30% to 57% depending on the soil and the salinity of the irrigation water used (P Sutherland pers comm.). To date around 1000ha of highly permeable soil has been treated saving around 7000ML per annum as well as reducing the limitations to growth associated with over irrigation.

A Draft map of “Water Management Groups” has been produced and provided to the RWUEI extension program to determine the suitability of such a map, or whether Soil Management Groups is preferred, or if there is a need for both maps.

Leaching Fraction can be greatly influenced by the salinity of the soil profile and/or quality of the irrigation water. After the project had commenced, discussion was held with BSES as to the need for some salinity assessment to be undertaken as part of the project. This was undertaken using Electrical Conductivity (EC) of the soil profile at each site in the mapping project. This provided “point source data”, as Australian Map Grid (AMG) coordinates are taken at each site. Using a Geographic Information System (GIS), broad-scale soil salinity maps will be produced. The maps will be used as part of assessing relationships between soil salinity and groundwater quality. This will be particularly important for irrigation guidelines, as the quality of irrigation water, both surface and groundwater, can be a critical factor in soil/water management strategies eg. Surface sealing. This information will be further discussed, and validated, with the “grower groups” in the area that have been established by BSES.

To date, approximately 800 profiles have been sampled at 30cm increments to an average depth of 1.5 metres. Samples have been dried at 40° C, ground to <2mm size, and analysed according to the soil EC methodology detailed in Rayment and Higginson (1992). The site locality data (grid coordinates) for each site has been provided to BSES for follow-up activities involving EM38 readings and calibration with EC data at each site. The production of soil salinity maps has not yet commenced, as entry of the EC data into the Soil And Land Information (SALI) database for the project is still being undertaken.

7. COMMUNITY BASED STRATEGIC PLANNING AND DEVELOPMENT

7.1 Introduction

At the commencement of the Burdekin Delta Soils project, the long-term objectives were to fulfil or progress priority issues identified in regional and subregional natural resource management strategies covering the project area, being:

- Natural Resource Management Regional Strategy (BDTG)
- Natural Resource Management Sub-regional Strategy (BBIFMAC)

At the local level, the Lower Burdekin Landcare Association Incorporated (LBLAI) is responsible for undertaking strategic planning of particular areas for the overall environmental betterment of the Burdekin Shire area.

7.2 Natural Resource Management Regional Strategy (BDTG)

7.2.1 Origin and Development of the Strategy

The Burdekin Dry Tropics Group (BDTG) is a community based regional strategy group concerned with natural resource management in the Burdekin Dry Tropics Region (BDTG 2000).

The Burdekin Dry Tropics has five distinct subregions that are defined by using a combination of bioregional provinces, catchment divides, local government boundaries, land use, climate and ecological characteristics. The sub-regions are:

- Burdekin Rangelands (BRIG)

- Burdekin Bowen Floodplains (BBIFMAC)

- Townsville Thuringowa Coastal Plains (NaREF)

- Belyando – Suttor Implementation Group (BSIG)

- Desert Uplands Build-Up and Development Strategy Committee (DUBDSC)

In 1997/98 three of the subregions began developing community based natural resource management plans with NHT funding. The subregional strategies were completed in 2000. Two received interim endorsement, from the Queensland Landcare Catchment Management Council (LCMC). These plans identify the key natural resource management issues, priorities and actions that are particular to each subregion.

7.3 Natural Resource Management Subregional Strategy (BBFIMAC)

7.3.1 Origin and Development of the Strategy

In 1997, the Lower Burdekin Landcare Association Incorporated (LBLAI) received advice from the Australian Natural Heritage Trust (NHT) that in future, Landcare and natural resource management projects would only be funded where they are seen to have links to priorities identified in regional strategic plans. This provided impetus for the LBLAI to seek funding to initiate the development of a natural resource management strategy for the lower Burdekin. In consultation with Australian Centre for Tropical Freshwater Research (ACTFR), a successful NHT funding proposal was developed, which included the employment of a project officer from ACTFR. Nominations of representatives from a range of industry, community and government agency bodies were sought by the LBLAI. In early 1998, the Burdekin – Bowen Floodplain Management Advisory Committee (BBIFMAC) was formed, to guide the development and support the implementation of a community based natural resource management strategy for the Burdekin – Bowen Sub-regional area.

Following a 2-year consultation process involving community, industry and government agency stakeholders, a Draft Strategy (BIFMAC 2000) was released in September 2000. An analysis of the natural resource management issues identified during the consultation process indicated that issues could be generally classified into three main areas, being:

1. Water Management
2. Nature Conservation
3. Sustainable Land Use and Development

7.3.2 Natural Resource Management Strategies

The Burdekin Delta Soils project addresses several key high priority strategies identified in the document. In particular it will fulfil or progress the following issues and actions:

- Water Management (Irrigation issues) – Key strategies 2 and 6.

Key Strategy 2. Promote and support the adoption of improved irrigation water use efficiency (WUE) as Best Management Practice (BMP).

This is being achieved in conjunction with the soils data being collected for the Burdekin groundwater model. From the database of soils infiltration, soil physical and chemical characteristics, leaching fraction for the various soil types have been calculated or extrapolated from soil types with similar soil properties (Tables 1 and 2). Table 3 shows the soil types grouped into five broad functional categories based on water management groups. A Draft Permeability map of the Burdekin Delta area has been prepared for the WUE program.

Key Strategy 6. Delineate soils and landform areas where development for irrigated agriculture would present unacceptable salinisation risks.

A soils map (map scale 1:50 000), is currently being produced. Using the soils mapping and site description data collected during the field survey, a land suitability map for irrigated agriculture will be produced. This map will indicate areas where land is assessed as suitable, marginal or unsuitable for irrigated agriculture. Following this, a map indicating Good Quality Agricultural Land (GQAL) will be produced for the Burdekin Delta area of the sub-region. These maps will be provided to BBIFMAC and other industry stakeholders for formulating strategic planning and development guidelines.

- Water Management (Groundwater issues) – Key strategies 1 and 4.

Key Strategy 1. Establish studies and collect data to develop a predictive groundwater model to support sustainable management of lower Burdekin groundwater aquifers.

This has been achieved by firstly completing soils mapping of unmapped areas within the Burdekin Delta (NBWB and SBWB only). Secondly, a database of soils infiltration, soil physical and chemical characteristics has been established from which calculations and extrapolations of Leaching Fraction (Carlin and Truong 1999) have been determined.

Key Strategy 4. Ensure groundwater use remains within sustainable yield limits of aquifers within the Sub-region.
Soils data collected during the soils mapping has contributed to the progress of the Burdekin delta Groundwater model.

- Sustainable Land Use and Development (Production Sustainability issues) – Key strategy 2.

Key Strategy 2. Develop and implement action plans to address water management sustainability risks.

Soils data collected during the soils mapping has contributed to the progress of the Burdekin Delta Groundwater model in both the North Burdekin and South Burdekin Water Board areas.

- Sustainable Land Use and Development (Sustainable Development issues) – Key strategy 1.

Key Strategy 1. Develop comprehensive mapped natural resource inventories for the Sub-region and make available to the community, industry and government agencies.

Soils, Acid Sulfate Soils and GQAL maps are being produced for the Burdekin delta area, and will be made available to the community, industry and government agencies.

7.4 Lower Burdekin Landcare Association Incorporated (LBLAI)

Within Australia, the Landcare movement has demonstrated the importance of farming effective relationships between the community, industry and government to effectively address environmental degradation and sustainable natural resource management needs.

The LBLAI, through their theme of “Working in the local community to achieve sustainable land use”, has shown great initiative in successfully applying for NHT and RWUEI funding for this project.

The soil mapping, including the mapping of ASS, the refinement of the Burdekin Delta groundwater model using soil infiltration data collected from the project and the development of best practice irrigation guidelines will provide a sound basis for LBLAI, in conjunction with stakeholders, to produce strategic planning principles and development guidelines for the Burdekin Delta area. The recommendations contained in this report will also assist in determining priorities for future research projects.

8. CONCLUSIONS AND FURTHER RECOMMENDATIONS

The provision of a detailed soils map for the Burdekin delta area is a major achievement, in that it is a significant sugar cane producing area, which until the completion of this project, had no detailed soils information on which to base sound land/water management recommendations. The soils information produced from the mapping project will be used as a basis for future land/water management research, and also for use in regional planning and development.

More detailed soils mapping will be required for Property Management Planning, and Land and Water Management Plans.

The soils mapping, along with the database of soils infiltration, chemical and physical characteristics, provide sound information for input into the Burdekin Delta Groundwater Model. The establishment of trial sites by the Lower Burdekin Initiative has provided some qualitative data as to deep drainage/leaching fraction on some Burdekin Delta soils.

However, given the complexity of soils in the area, particularly the NBWB area, there is still a need for further field validation of the deep drainage/leaching fraction of the soils so as to further refine the model, and particularly take into consideration the variability in groundwater quality and higher application rates of irrigation water, which, due to the limitations of the SALF model, this project has only partly addressed.

Acid Sulfate Soils have been identified and mapped for the Burdekin Delta area. However, due to the limitations of the scale of the soil mapping, some areas identified are too small to be shown on the soils map. There has also been limited sampling for chemical analyses and interpretations of Acid Sulfate Soils.

More identification, detailed soil mapping, and chemical analyses of Acid Sulfate Soils are required.

The project, in whole, has addressed and identified several issues associated with local and sub-regional planning strategies. It will be necessary for the local community, associated agencies and stakeholders to ensure that these issues are a key focus for future projects.

The Lower Burdekin Landcare Association Incorporated, and the Burdekin Bowen Integrated Floodplain Management Advisory Committee need to be lead agencies in the ongoing extension and commitment, to ensure that these issues continue to be identified for future projects, and ongoing local planning strategies and sub-regional strategies.

9. ACKNOWLEDGEMENTS

There are many people the authors would like to extend their heartfelt thanks, in completing this project in the space of 2 ½ years:

- The Lower Burdekin Landcare Association Inc. for successfully gaining funding for this project;
- Natural Heritage Trust (NHT) for providing salary funding for 2 years of the project;
- Rural Water Use Efficiency Initiative (RWUEI) for providing vehicle funding for 3 years of the project and salary funding for 1 year of the project;
- Christine Juergensen, Technical Officer employed on the project, provided field and office technical support during her time on the project;
- Peter Sutherland and Gary Ham, BSES, for technical assistance and comments on the project and various reports, and undertaking the laboratory analysis for Electrical Conductivity (EC) on sampled profiles.
- Merv Pyott (Chairman, Lower Burdekin Landcare Association Inc), Les Searle (Project Manager, Burdekin Delta Soils Project) and Eleanor Betteridge (Treasurer, Lower Burdekin Landcare Association Inc) for their technical support and enthusiasm;
- Officers of Natural Resources and Mines, Ayr and Mareeba, who provided technical support with the field mapping and undertaking the laboratory analysis for Electrical Conductivity (EC) on sampled profiles, provided helpful advice on soil technical issues;
- Neil Enderlin (NR&M), for providing copies of the site descriptions used in the initial investigations for the groundwater model;
- Anybody who has been forgotten, our apologies, but also our thanks; and finally,
- The Christianos family, who often bore the brunt of some frustration associated with the project in the later stages, I thank them for their patience and understanding.

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APPENDIX 1

KEY FOR THE RECOGNITION OF SOIL TYPES,

BURDEKIN DELTA SOILS

Notes:

Soil type was identified by a textual code:

- a letter for the landscape unit;
- the appropriate subdivision of the dominant Primary Profile Form (Northcote 1979); and
- a letter for each separate soil type within the landscape unit and primary profile form subdivision.

For example, soil type **BUfc,**

- "B" denotes landscape unit B (Current alluvium associated with the Burdekin River and major distributary channels);
- "Uf" indicates a subdivision of the primary profile form (in this case a Uniform fine textured non-cracking clay); and
- "c" separates this soil type from other Uniform fine textured (non-cracking) soil types within landscape unit B.

Where the soil type has affiliation with, or could be correlated to a similar soil type from previous soil and land resource surveys in the Burdekin River Irrigation Area (BRIA), the BRIA soil type has been highlighted in bold in the soil type description eg BUca **(BRIA – 6Ucc).**

KEY FOR THE RECOGNITION OF SOIL TYPES,

BURDEKIN DELTA SOILS

LANDSCAPE UNIT B: CURRENT ALLUVIUM ASSOCIATED WITH MAJOR DISTRIBUTARY CHANNELS (BURDEKIN RIVER, KALAMIA, PLANTATION AND SHEEPSTATION CREEKS)

A. Channel Bench, Scroll, Scroll Plain

B. Sandy to sandy loam texture to 1.5 m.

C. Dark A horizon < 0.35m **(BRIA – 6Ucc).** BUca

C. Dark A horizon > 0.35m **(BRIA – 6Ucc).** BUcb

B. Light to light-medium clay surface texture.

C. Uniform non-cracking clay, massive to weak structure throughout, over brown yellow-brown sandy[1] D horizon at 0.5 – 1.0 m. BUfa

C. Black to grey, weakly to strongly cracking clay, usually gravely. BUga

A. Levee or Floodout

B. Sand to Sandy loam texture to 1.5 m.

C. Dark A horizon < 0.35 m **(BRIA – 6Ucc).** BUca

C. Dark A horizon > 0.35 m **(BRIA – 6Ucc).** BUcb

B. Sandy clay loam to clay loam surface texture (Um PPF).*

C. Brown to yellow-brown sandy D horizon < 0.5 m. BUma

C. Brown to yellow-brown sandy D horizon 0.5 – 1.2 m. BUmb

C. Brown to yellow-brown sandy D horizon (if present) >1.2 m **(BRIA 6Uma).** BUmd

B. Duplex soil with sandy clay loam to clay loam surface texture.

C. Neutral throughout with red-brown subsoil, yellow-brown sandy D horizon <1.2m. BDba

C. Black to grey subsoil, neutral, occasionally bleached, or alkaline. BDya

LANDSCAPE UNIT B: CURRENT ALLUVIUM ASSOCIATED WITH MAJOR DISTRIBUTARY CHANNEL (BURDEKIN RIVER, KALAMIA, PLANTATION AND SHEEPSTATION CREEKS)

A. Levee or Floodout (continued)

- *B. Loam to clay loam surface texture (Gn PPF)**.*
  - C. Brown to yellow-brown sandy clay loam to clay loam B horizon, massive to weakly structured subsoil. BGnc
- *B. Light to light-medium clay surface texture (Uf PPF).*
  - C. Uniform non-cracking clay, massive to weak structure throughout, over brown to yellow-brown sandy D horizon 0.5 – 1.0 m. BUfa
  - C. Brown to yellow-brown sandy D horizon 0.2 – 0.6 m. BUfd
  - C. Brown to yellow-brown sandy D horizon 0.6 – 1.1 m. BUfb
  - C. Brown to yellow-brown sandy D horizon (if present) >1.20 m. BUfc

A. Backplain

- *B. Loam to clay loam surface texture (Gn PPF).*
  - C. Brown to yellow-brown sandy D horizon 0.75-1.2 m. BGnb
  - C. Brown to yellow-brown sandy D horizon (if present) > 1.2 m. **(BRIA 6Gnd).** BGna
- *B. Light to light-medium clay surface texture (Uf PPF)*
  - C. Strongly alkaline pH >8.5 before 1.5m (often salty at depth?). Close to a cracking clay classification (Ug) **(BRIA 6Ufb,c).** BUfe
  - C. Brown to yellow-brown sandy D horizon at 0.2 - 0.6 m. BUfd
  - C. Brown to yellow-brown sandy D horizon at 0.6-1.1 m **(BRIA 6Ufd).** BUfb
  - C. Brown to yellow-brown sandy D horizon (if present) > 1.2 m BUfc

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Notes:

[1] Sandy D horizon is defined as sand to sandy loam (whether coarse, medium or fine) texture. (These horizons may contain some fine to coarse gravels).

*** Soil texture is within Um Principle Profile Form (Northcote 1979).**

**** Soil texture is within Gn Principle Profile Form (Northcote 1979).**

***** Soil texture is within Uf Principle Profile Form (Northcote 1979).**

LANDSCAPE UNIT C: CURRENT ALLUVIUM ASSOCIATED WITH MINOR STREAM CHANNELS (WARREN’S GULLY, SANDY CREEK)

B. Uniform sandy soils (Uc)	
C. Neutral brown sand to sandy loam to 1.2 – 1.5m, over reddish-brown sand to clay loam fine sandy to 1.5m.	CUca
B. Uniform loamy soils (Um)	
C. Sandy clay loam to clay loam, over layered D horizons <0.5m.	CUma
C. Sandy clay loam to clay loam, over layered D horizons >0.9m.	CUmb
B. Uniform non-cracking clay (Uf PPF)	
C. Brown to reddish-brown, fine sandy to light medium clay, over brown to orange layered sand to clay loam D horizons from 0.7 – 1.1m, neutral SRT.	CUfa
C. Brown to reddish-brown, fine sandy to light medium clay, over brown to reddish-brown sand to fine sandy loam D horizons (if present) >1.2m, neutral SRT.	CUfb
C. Brown to reddish-brown, fine sandy to light medium clay, over brown to orange loamy fine sand to clay loam D horizons from 0.8 - 1.4m, alkaline below 0.6 – 0.9m.	CUfc
B. Gradational soils (Gn)	
C. Neutral to alkaline, brown gradational soil over brown sand to fine sandy clay D horizons from 0.8 – 1.1m (BRIA 6Gnd?).	CGna
B. Duplex soils (Db or Dr)	
C. 0.3 – 0.5m clay loam fine sandy A horizon, over brown light medium clay B horizon to 0.9 – 1.4m, over brown to orange sand to fine sandy clay D horizon to 1.5m, neutral SRT. **(BRIA 6Dbf).**	CDba
C. 0.12 – 0.25m clay loam fine sandy, bleached, A horizon, over grey to yellowish-brown light medium to medium clay B horizon to 1.00 – 1.10m, over yellowish-brown fine sand to fine sandy clay D horizon. Strongly alkaline at and below 0.6m. Carbonate, and occasionally gypsum, present from 0.5 – 0.6m **(BRIA 6Dyg).**	CDbb
C. 0.3 – 0.5m fine sandy loam to sandy clay loam A horizon, over massive to moderately structured reddish-brown sandy clay B horizon to 0.7-1.00m, over dull-brown to orange loamy sand to fine sandy loam D horizon, neutral SRT **(BRIA 6Dra).**	CDra

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Notes:

[+] SRT Soil Reaction Trend (Northcote 1979).

LANDSCAPE UNIT R: RELICT ALLUVIUM ASSOCIATED WITH LARGE, LOW LYING FLATS (OFTEN BORDERING CURRENT TIDAL FLATS)

A. Narrow raised sandy ridges (not directly connected to current Burdekin River alluvium, prior streams?, not relict beach ridges)

B. Sandy soils (Uc PPF).

C. Sand to sandy loam texture? RUca

A. Low lying alluvial plains, swamps

B. Grey non-cracking clay

C. Strongly mottled and generally wet below 0.9 – 1.5 m.
Overlies PASS/ASS layers by 1.5 m.
Soil profile often contains gypsum crystals **(BRIA – 2Ugj).** RUff

C. Not strongly mottled and without gypsum or PASS/ASS layers before 1.5 m. RUfe

B. Grey cracking clay (slickensides usually evident in upper B horizon).

C. Brown to yellow-brown sandy D horizon by 1.5 m. RUgc

C. PASS/ ASS layers < 1.50 m **(BRIA – 2Ugj).** RUga

C. No sandy D horizon or PASS/ ASS layers by 1.50 m **(BRIA 2Ug/3Ug?).**

D. High pH >8.5 by 0.6m. RUgb

D. Neutral SRT, or high pH >8.5 at or below 0.9m. RUgd

A. Slightly Elevated Flats

B. Grey to black, mottled, alkaline duplex soil

C. <0.20m loamy A horizon **(BRIA 3Dya?).** RDya

LANDSCAPE UNIT M: CURRENT TIDAL FLATS (INCLUDES AREAS ABOVE CURRENT HIGH WATER LEVEL; MAY BE COLONISED BY MANGROVES AND / OR SALTWATER COUCH)

A. Rellict Beach Ridge

C. Yellow-brown uniform sand and/or shallow loam to 1.5m (Uc or Um). **MUca**

C. Red to red-brown uniform sand and/or to loam to 1.5 m (Uc, Gn PPF). **MUcb**

A. Tidal Flats

C. Soil described as Grey Sodosol/Hydrosol. **MDya**

C. Grey, mottled, non-cracking clay, usually over PASS/ASS before 1.5m. **MUfa**

C. Saline Flats. Obvious tidal influences. eg. Wetness, mangroves, salt water couch. **SF**

LANDSCAPE UNIT H: HILLS / MOUNTAINS (SOIL PROFILES USUALLY OVER BC/C HORIZONS BY 1.50 m)(need to include/redefine BRIA LU4 and LU5)

A. Hillcrests, Upper and Mid Slope

B. Uniform sand (Uc PPF)

C. A horizon not bleached **(BRIA 4Ucb).** HUca

B. Gradational soil (GnPPF)

C. Red subsoil **(BRIA 4Gnb).** HGna

B. Duplex soil (Dy, Db or Dr PPF)

C. Red subsoil **(BRIA 5Dra).** HDra

C. Yellow-brown subsoil **(BRIA 4Dyl, 5Dya).** HDya

A. Mid to Lower Slopes, Pediments and Footslopes

B. Uniform sand (Uc PPF)

C. Bleached A horizon **(BRIA 4Ucc).** HUcb

B. Gradational or duplex soil with acid to neutral SRT

C. 0.3 – 0.9m sandy to loamy A horizon, over grey to brown weakly mottled B horizon, over mottled loam to clayey D horizon or decomposing rock below 0.8 – 1.5m **(BRIA 4Dyd,f).** HDye

B. Gradational or duplex soil with alkaline SRT

C. <0.3m sandy to loamy bleached A horizon over grey to brown B horizon. Usually strongly alkaline at 0.3 - 0.6m. **(BRIA 4Dyg,h, 5Dyc,d).** HDyc

C. >0.3m sandy to loamy bleached A horizon over grey to brown B horizon. Usually strongly alkaline below 0.6m **(BRIA 4Dye,j).** HDyf

C. 0.15 – 0.35m loamy A horizon, occasionally bleached over yellow-brown B horizon. Alkaline at or below 0.9m **(BRIA 5Dyb,e).** HDyb

A. Any slope position (due to changes in underlying geology)

B. Weakly to strongly cracking clay

C. Strongly cracking black clay **(BRIA 5Uga).** HUga

C. Weakly cracking to non cracking grey clay **(BRIA 5Ugb).** HUgb

APPENDIX 2

GENERAL DESCRIPTIONS OF THE AGRICULTURAL LAND CLASSES: GOOD QUALITY AGRICULTURAL LAND

CLASS	DESCRIPTION
Class A	**Crop land: -** Land suitable for current and potential crops with limitations to production which range from none to moderate levels.
Class B	**Limited crop land: -** Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
Class C	**Pasture land: -** Land suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance.
Class D	**Non-agricultural land: -** Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.