BIS Biscuit Flat Land System

Area: 104.2 km^2

Landscape: Poorly drained dune corridor plains on the landward side of the Woakwine Range, north west of Hatherleigh. Calcarenite rises are intermingled with the plains.

Annual rainfall: 695 – 745 mm average

Geology: Lacustrine deposits of the Pleistocene Padthaway Formation.

Main soils:

- **N3** (14%) Wet soil (non to moderately saline) (Sodosolic-Calcarosolic-Dermosolic Hydrosol)
- **C5** (12%) Gradational dark clay loam (Calcic-Hypercalcic Brown-Grey-Black Dermosol-Calcarosol)
- **B7** (10%) Shallow sand over clay on calcrete (sandy Petrocalcic Sodosol-Chromosol)
- **B2** (9%) Shallow calcareous loam on calcrete (Petrocalcic Calcarosol-Rudosol)
- **A7** (8%) Calcareous clay loam on marl (Marly Calcarosol)

Minor soils:

- **G3** (7%) Thick sand over clay (sandy Brown-Red Chromosol-Sodosol)
- **N1** (7%) Peaty soil (Organosol)
- **B3** (6%) (Shallow sandy loam on calcrete (Petrocalcic Red Tenosol-Kandosol-Rudosol)

Summary: Wet, dark clayey soils are predominant. The main limitations are waterlogging and poor drainage. The small areas with better-drained soils are very shallow over calcrete and stony, with low water holding capacity and are not suitable for crops such as root crops.

Soil Landscape Unit summary: Biscuit Flat Land System (BIS)

SLU	% of area	Component	Main soils	Prop#	Notes
MAB	0.2	Rise	B3RR	D	**MAB** Gently undulating calcreted former beach ridge with stony, very shallow red and brown loamy over red clay soils. >50% bare calcrete. **MAC** Undulating as above. Main soils: Shallow sandy loam on calcrete - **B3** and Rock or exposed calcrete – **RR**.
MAC	0.2	Rise	B3RR	D	
M-B	0.2	Stony rise	B3RR	V	As above but <50% bare calcrete. **M-B** Gently undulating rises.10-20% swales with shallow loam over poorly structured brown clay, or red clay on calcrete. Main soils: ***Rises:*** Shallow sandy loam on calcrete - **B3** and Rock or exposed calcrete – **RR**. ***Swales:*** Sand over friable brown clay on calcrete - **B7** and Shallow sandy loam over red-brown clay on calcrete - **B6**.
		Swale	B7B6	L	
MEB	0.3	Stony rise	B3	V	Gently sloping calcarenite rises with shallow sand over calcrete soils. 10-20% dunes with water repellent, deep siliceous sands. Main soils: ***Stony rises:*** Shallow sandy loam on calcrete - **B3**. ***Dunes:*** Highly leached sand - **I1** and Bleached siliceous sand - **H3**.
		Dune	I1H3	L	

MHB	0.1	Dune	H3	E	Gently sloping calcarenite ridge with 30-60% deep bleached siliceous sands on dunes. 30-60% shallow sand over calcrete and bare calcrete. Main soils: ***Dunes:*** Bleached siliceous sand - **H3**. ***Stony ranges:*** Shallow sandy loam on calcrete - **B3** and Rock or exposed calcrete – **RR**.
		Stony range	B3RR	E	
MRB	0.3	Rise	B6B4B3	D	Gently undulating calcreted former beach ridges with shallow sandy loam to clay loam mostly over red clay on calcrete, but also shallow sandy loam on calcrete. Main soils: Shallow sandy loam over red-brown clay on calcrete - **B6**, Shallow red loam on limestone - **B4** and Shallow sandy loam on calcrete - **B3**.
MXM	0.3	Rise	RRB3	V	Undulating calcarenite rises with mostly bare calcrete or very shallow sandy loam on calcrete soils. 10-20% swamps with wet loamy and peat soils. Main soils: ***Rises:*** Rock or exposed calcrete – **RR** and Shallow sandy loam on calcrete - **B3**. ***Swamps:*** Wet clay loam - **N3** and Peaty soil – **N1**.
		Swamp	N3N1	L	
NAA	4.0	Plain	B8B3B6	D	Plains with mostly shallow sand or sandy loam over calcrete, often with red clay subsoils. 10-30% of soils are shallow sandy loam over poorly structured brown clay, or deep bleached sands. Main soils: Shallow sand on calcrete - **B8**, Shallow loam on calcrete - **B3** and Shallow sandy loam over red-brown clay on calcrete - **B6**.
NBA	0.3	Plain	B2B5	D	Plains thin calcareous loam or dark clay loam on dark clay over calcrete. 10-30% shallow sand over calcrete and shallow clay loam over dark clay on calcrete. Main soils: Shallow calcareous loam on calcrete - **B2** and Shallow dark clay loam on limestone - **B5**.
NDA	3.9	Plain	B7G3	D	Inter-dune corridor plains with shallow yellow or grey Sodosols. **NDA** Plains with shallow sand over dark brown clay on calcrete; and deep sand over brown clay. 10-30% shallow sand, often calcareous, over calcrete. **NDO** Plains with shallow sandy loam over poorly structured brown clay on calcrete; 20-30% sandy rises with deep sand, often over coffee rock and/or brown clay; 10-20% stony rises with loam and sandy loam, mostly over red clay, on calcreted calcarenite. **NDP** Plains and sandy rises as above; <10% swamps with wet sandy loam over, often poorly structured, clay soils and shallow equivalents on calcrete. Main soils: ***Plains:*** Sand over friable brown clay on calcrete - **B7** and Thick sand over clay - **G3**. ***Sandy rises:*** Wet highly leached sand - **I2** and Thick sand over clay - **G3**. ***Stony rises:*** Shallow sandy loam over red-brown clay on calcrete - **B6** and Shallow sandy loam on calcrete - **B3**. ***Swamps:*** Wet clay loam - **N3**, Thick sand over clay - **G3** and Sand over friable brown clay on calcrete - **B7**.
NDO	10.2	Plain	B7	V	
		Sandy rise	I2G3	C	
		Stony rise	B6B3	L	
NDP	1.6	Plain	B7	V	
		Sandy rise	I2G3	C	
		Swamp	N3G3 B7	M	
NJA	8.9	Plain	A7C5	D	Plains with deep clayey mostly calcareous dark grey soils over marl or dark calcareous clay; 10-30% shallow black or grey cracking clay or calcareous loam, on calcrete. Main soils: Calcareous clay loam on marl - **A7** and Gradational dark clay loam – **C5**.
NjC	1.2	Plain	B7	D	**NjC** Plains with shallow sand, mostly over poorly structured brown clay on calcrete.10-30% clay loam over dark brown clay on calcrete. <10% stony rises with shallow loam on
		Stony rise	B3	M	
NjI	1.0	Stony plain	B7	V	

		Swamp	N3	L	calcrete.
NjS	0.7	Plain	G3	V	**NjI** Stony plains as above with 10-20% swamps with wet loam over dark clay and shallow black clay loam on calcrete soils. **NjS** Plains with deep sand over clay soils; 10-20% sandy rises with deep moderately drained sands, mostly over coffee rock/brown clay. Main soils: ***Plains:*** Sand over friable brown clay on calcrete - **B7**. ***Sandy rises:*** Wet highly leached sand - **I2**, Thick sand over clay - **G3** and Bleached siliceous sand - **H3**. ***Stony rises:*** Shallow sandy loam on calcrete - **B3**. ***Swamps:*** Wet clay loam - **N3**.
		Sandy rise	I2G3H3	L	
		Swamp	N3	L	
NKJ	20.5	Plain	C5A7	E	Corridor plains with mostly deep Calcarosols and Dermosols. 30-60% plains with deep clay loam to clay over dark grey clay; and calcareous clay over grey calcareous clay. 30-60% swamps with wet deep, dark clay loam to clay over dark clay soils, minor peats. <10% stony rises with shallow loam, often calcareous, over calcrete. Main soils: ***Plains:*** Gradational dark clay loam – **C5** and Calcareous clay loam on marl - **A7**. ***Swamps:*** Wet clay loam - **N3** and Gradational dark clay loam – **C5**. ***Stony rises:*** Shallow sandy loam on calcrete - **B3** and Shallow calcareous loam on calcrete - **B2**.
		Swamp	N3C5	E	
		Stony rise	B3B2	M	
NlI	1.6	Stony plain	B5E1	V	Corridor plains with shallow grey or black Dermosols and Calcarosols. **NlI** Stony plains with mostly shallow black cracking clay over calcrete, co-dominant with deep equivalents. 10-20% swamps with wet, black cracking clays and clay loam over dark clay soils. **NlM** Plains as above with 20-30% stony rises with shallow calcareous clay or clay loam, often over dark clay on calcrete. Main soils: ***Plains:*** Shallow dark clay loam on limestone - **B5** and Black cracking clay - **E1**. ***Stony rises:*** Shallow calcareous loam on calcrete - **B2** and Shallow dark clay loam on limestone - **B5**. ***Swamps:*** Wet clay loam - **N3**, Black cracking clay - **E1** and Deep friable gradational clay loam - **M2**.
		Swamp	N3E1 M2	L	
		Stony rise	B2B5	M	
NlM	7.6	Plain	B5E1	V	
		Stony rise	B2B5	C	
NMA	4.1	Plain	G3F2	D	Plains with deep sand or loam over sodic brown clay soils. Main soils: Thick sand over clay - **G3** and Sandy loam over poorly structured brown or dark clay - **F2**.
NTD	1.0	Plain	G3	D	Plains with deep sand over brown clay soils. <10% sandy rises with deep strongly water repellent, acid sand, with 10-30% shallow sandy loam over red clay on calcreted calcarenite. Main soils: ***Plains:*** Thick sand over clay - **G3.** ***Sandy rises:*** Highly leached sand - **I1** and Bleached siliceous sand - **H3**.
		Sandy rise	I1H3	M	
NUP	2.7	Plain	G3B7	V	Plains with mostly deep, acidic sand over brown clay; and shallow sandy loam over poorly structured brown clay on calcrete. 10-20% sandy rises with deep strongly water repellent, acid sand. <10% swamps with deep wet grey and brown clay soils. Main soils: ***Plains:*** Thick sand over clay - **G3** and Sand over friable brown clay on calcrete - **B7**. ***Sandy rises:*** Bleached siliceous sand - **H3** and Highly leached sand - **I1**.
		Sandy rise	H3I1	L	
		Swamp	N3E3	M	

					Swamps: Wet clay loam - **N3** and Brown or grey cracking clay - **E3**.
NxJ	2.0	Plain	B5B2	V	Corridor plains with shallow calcareous soils on calcrete in association with shallow non-calcareous clay-loams and peaty soils. **NxJ** Plains with shallow dark clay loam over clay on calcrete; and shallow calcareous clay loam on calcrete, soils. 20-30% swamps with wet dark clay loams, mostly over dark clay soils, co-dominant with alkaline peats. <10% stony rises with very shallow loam over calcrete soils. **NxM** Lacustrine/lagoonal plains as above; 20-30% lunettes with very shallow loam over calcrete soils. **NxU** As above, 20-30% lunettes as above; 20-30% swamps with wet dark organic clay loams and alkaline peats over dark clay soils. Main soils: ***Plains:*** Shallow dark clay loam on limestone - **B5** and Shallow calcareous loam on calcrete - **B2**. ***Stony rises:*** Shallow sandy loam on calcrete - **B3**. ***Swamps:*** Wet clay loam - **N3**, Peaty soil – **N1** and Deep friable gradational clay loam - **M2**. ***Lunettes:*** Shallow sandy loam on calcrete - **B3**.
		Swamp	N3N1 M2	C	
		Stony rise	B3	M	
NxM	5.3	Swampy plain	B5B2	V	
		Lunette	B3	C	
NxU	2.4	Plain	B5B2	E	
		Lunette	B3	C	
		Swamp	N3N1 M2	C	
Xc-	0.6	Lunette	B2B3	D	Lunettes with shallow, mostly calcareous loam, on calcrete. Main soils: Shallow calcareous loam on calcrete - **B2** and Shallow sandy loam on calcrete - **B3**.
Xd-	0.2	Lunette	B2B5	D	Lunettes with shallow, mostly calcareous clay loam, often over dark clay, on calcrete. Main soils: Shallow calcareous loam on calcrete - **B2** and Shallow dark clay loam on limestone - **B5**.
XRC	1.0	Swamp	N3	D	**XRC** Swamps with wet dark, cracking clay soils with minor peats. **XRf** Swamps as above, with 10-20% stony rises with shallow dark clay loam grading to clay on calcrete. Main soils: ***Swamps:*** Wet clay loam - **N3**. ***Stony rises:*** Shallow dark clay loam on limestone - **B5** and Shallow calcareous loam on calcrete - **B2**.
XRf	0.3	Swamp	N3	V	
		Stony rise	B5B2	L	
XtA	6.2	Plain	N3	D	**XtA** Swampy plains with mostly wet, deep dark clay loam and peat over dark clay or marl. **XtC** Peat swamps. **Xtf** Swamps with shallow, often wet, clay loam grading to clay on calcrete. Minor peat soils. 20-30% rises with shallow calcareous loam or siliceous sand over calcrete. Main soils: ***Swamps:*** Peaty soil – **N1**, Shallow dark clay loam on limestone - **B5** and Wet clay loam - **N3**. ***Stony rises:*** Shallow calcareous loam on calcrete - **B2** and Shallow sandy loam on calcrete - **B3**.
XtC	0.5	Swamp	N1	D	
Xtf	4.1	Swamp	B5N3	V	
		Rise	B2B3	C	
XuC	0.8	Swamp	N3	D	**XuC** Swamps with non-peaty wet soils **Xuf** Swamps as above; 20-30% stony rises with shallow often calcareous, grey clay loam, often over dark grey clay, on calcrete. Main soils: ***Swamps:*** Wet clay loam - **N3**. ***Stony rises:*** Shallow calcareous loam on calcrete - **B2**, Shallow sandy loam on calcrete - **B3** and Shallow dark clay loam on limestone - **B5**.
Xuf	0.1	Swamp	N3	V	
		Stony rise	B2B3B5	C	
XxC	3.5	Swamp	N1N3 WW	D	**XxC** Swamps with deep acid peats, organic loam over clay, or water filled. **Xxe** Swamps as above; 20-30% lunettes with shallow loam, occasionally over red clay, on calcrete.
Xxe	1.3	Swamp	N1N3 WW	V	

		Lunette	B3	C	**Xxf** Swamps as above; 10-20% stony rises with shallow calcareous clay loams, or siliceous sand, over calcrete or shallow dark clay loam on dark clay on calcrete. Main soils: ***Swamps:*** Peaty soil – **N1** and Wet clay loam - **N3**. ***Stony rises:*** Shallow calcareous loam on calcrete - **B2**, Shallow sandy loam on calcrete - **B3** and Shallow dark clay loam on limestone - **B5**. ***Lunettes:*** Shallow sandy loam on calcrete - **B3**.
Xxf	0.6	Swamp	N1N3 WW	V	
		Stony rise	B2B3 B5	L	

PROPORTION codes assigned to Soil Landscape Unit (SLU) components:

- D Dominant in extent (>90% of SLU)
- V Very extensive in extent (60–90% of SLU)
- E Extensive in extent (30–60% of SLU)
- C Common in extent (20–30% of SLU)
- L Limited in extent (10–20% of SLU)
- M Minor in extent (<10% of SLU)

Detailed soil profile descriptions:

A7 Calcareous clay loam on marl (Marly Calcarosol)
Dark calcareous clay with a marly subsoil (often saline in Upper SE). Often with shells and a peaty surface.

B2 Shallow calcareous sandy loam on calcrete (Petrocalcic Calcarosol)
Up to 40 cm calcareous loamy sand to sandy loam with variable calcrete rubble overlying calcreted calcarenite - rises.

B3 Shallow sandy loam on calcrete (Petrocalcic Rudosol)
Medium thickness non calcareous sandy loam, often having a slight clay increase with depth, over calcreted calcarenite shallower than 50 cm - rises.

B5 Shallow dark clay loam on limestone (Petrocalcic, Black Dermosol)
Black clay loam to light clay over calcreted limestone at shallow depth, grading to highly calcareous clay - flats.

B6 Shallow sandy loam over red-brown clay on calcrete (Petrocalcic, Red Kandosol)
Medium thickness sandy loam with slight ironstone gravel overlying a weakly structured reddish brown sandy clay on calcarenite within 50 cm - rises.

B7 Shallow sand over sandy clay on calcrete (Petrocalcic, Brown Chromosol)
Medium thickness sand overlying brown friable sandy clay to clay on limestone or calcreted sandy clay within 50 cm - flats.

B8 Shallow sand on calcrete (Petrocalcic, Bleached-Leptic Tenosol)
Thick bleached sand over calcreted calcarenite within 50 cm - rises.

C5 Gradational dark clay loam (Calcic-Hypercalcic Brown-Grey-Black Dermosol-Calcarosol)
Dark clay loam over abundant 'soft lime'. >10% carbonate is the cut off between this and M2 soils.

E1 Black cracking clay (Black Vertosol)

E3 Brown or grey cracking clay (Brown-Grey Vertosol)

F2 Sandy loam over poorly structured brown or dark clay (Brown-Dark Sodosol-Chromosol)
Topsoil <30 cm over a poorly structured subsoil. Loamy, often sandy loam, to clay loamy texture contrast soil with a sodic/dispersive/poorly structured brown clayey subsoil. Often sandy loam, usually with a bleached horizon, and thin topsoil over a poorly structured B.

G3 Thick sand over clay (Hypercalcic, Brown Sodosol / Chromosol)
Thick bleached sand with an organically darkened surface abruptly overlying a massive to coarsely structured brown to reddish yellow sandy clay to clay, calcareous with depth - rises.

H3 Deep bleached sand (Basic, Arenic, Bleached-Orthic Tenosol)
Grey sand over a very thick bleached sand grading to yellow sand continuing below 100 cm.

I1 Highly leached sand (Fragic, Pipey, Aeric Podosol)
Grey sand with a very thick bleached A2 layer, over dark brown and yellow massive soft to semi-hard clayey sand (coffee rock), grading to softer yellow and brown sand to sandy clay loam from about 80 cm.

I2 Wet highly leached sand (Fragic, Humic, Aquic Podosol)
Grey sand with a thick bleached A2 horizon, overlying a thin to thick layer of coffee rock, grading to pale brown sand sharply overlying a grey, brown and yellow mottled sandy clay loam to light clay.

M2 Deep friable gradational clay loam (Red-Brown-Grey-Black Dermosol)
Deep well structured red clay loamy soil.

N1 Peat (Organosol)
Peaty soil

N3 Seasonally waterlogged, non-to-marginally saline equivalents of associated soils listed above, viz.:
N3c Wet **G3**
N3d Wet **B5**
N3e Wet **B7**

RR Bare rock

WW Water

Further information: DEWNR Soil and Land Program