Aitken Rowe
GEOTECHNICAL ENGINEERING

Geotechnical Engineering
Environmental Consultancy
Soil Concrete Aggregate Testing
NATA Accredited Laboratories

ABN 53 058 315 138 ACN 058 315 138

28 August 2023 Reg. No.: GS23-218

Terramia Farming Co. Pty Ltd
PO Box 348
Hanwood, NSW 2680

Attention: Mr. Sabastian Schimizzi

Dear Sir,

LIMITED GEOTECHNICAL INVESTIGATION – PROPOSED AQUACULTURE DAMS, FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

Further to your request in response to our quotation Q23-296, dated 7 June 2023, we carried out a limited geotechnical field investigation at the proposed site for the proposed construction of four (4) aquaculture dams at Farm 1961, No. 251 Stacy Road, Kooba, NSW.

The purpose of the investigation was to determine the nature of the subsurface soils and groundwater conditions by augering, testing and sampling across the proposed site. Based upon the information obtained, comments and recommendations for the suitability of the construction of the dams are to be made. **It should be noted that as per the client's request only one (1) borehole was drilled at the location of each aquaculture dam which is considered a limited investigation.**

1.0 SITE DESCRIPTION

The proposed aquaculture dams site is located at DP 751721, Lot 54, Farm 1961, No. 251 Stacy Road, Kooba, NSW which is located approximately 18.5km south-east of the town of Griffith, NSW (refer to attached site locality plan). The subject site of the proposed four (4) aquaculture dam sites is located directly south of the existing storage dam located directly south of Stacy Road (refer to attached borehole location plan).

The site was noted to be generally flat and covered with vegetation at the time of the investigation. It should also be noted that the site has been previously used for cropping with the surface generally cultivated with furrows across the site surface as noted at the time of the investigation.

2.0 INVESTIGATION PROCEDURE

2.1 Fieldwork

The fieldwork was carried out on 18 July 2023 by our experienced Geotechnician of Aitken Rowe Testing Laboratories Pty Ltd from Griffith, NSW, who nominated the sampling and prepared engineering logs of the boreholes. The borehole logs with explanatory note are herewith attached.

The fieldwork for the investigation consisted of the logging and sampling of four (4) boreholes, BH1 to BH4 across the proposed dam sites (one borehole at each dam location). The boreholes were augered with our trailer-mounted drilling rig to the depths of 4.5m at the locations as shown in the attached borehole location plan with small and Bulk samples recovered at various depths from the boreholes for relevant laboratory testing.

2.2 Laboratory Testing

To confirm and evaluate the results of the fieldwork, laboratory tests were carried out on the representative samples of the subsoil obtained from the boreholes. The relevant laboratory testing included Particle Size Distribution (PSD) test, hydrometer test, Atterberg Limit test, Field Moisture Content (FMC) determination test, Standard Maximum Dry Density (SMDD) test, permeability test and dispersion (Emerson Class) test on the recovered samples, which were undertaken at our NATA accredited testing laboratory in Griffith, NSW.

The samples for permeability tests were compacted at 95% of SMDD and at nearest 100% of Standard Optimum Moisture Content (SOMC). The laboratory test reports for Particle Size Distribution, Atterberg Limit, FMC, SMDD, SOMC, permeability and dispersion tests are herewith attached. The test results for FMC and SOMC are incorporated in the respective borehole logs.

3.0 SUBSURFACE CONDITIONS

The borehole investigation revealed that the subsurface soil profile where the boreholes were drilled generally consisted of topsoil to 0.25m to 0.3m overlying natural alluvial material comprising low plasticity clayey silt (in BH3 and BH4 only) and high plasticity clay and silty clay, extending to the borehole termination depth at 4.5m in BH1 to BH4 (refer to attached borehole logs).

The moisture condition of the underlying natural alluvial material was generally greater than plastic limit throughout the silt-based and clay-based profile in all boreholes drilled at the time of the investigation. Seepage was encountered within the investigated depth during the course of the drilling at the depths of 2.2m to 3.1m in BH2 and 2.3m to 3.2m in BH3 with the remaining boreholes (BH1 & BH4) found dry at the completion of drilling. It should also be noted that variations to the water table level could fluctuate with changes to the season, temperature and rainfall.

The borehole logs with explanatory note are herewith attached.

4.0 DISCUSSIONS & COMMENTS

4.1 Soil Properties

The laboratory tests carried out on the underlying silt-based material recovered from BH4 indicated that the material generally contains 23% sand, 43% silt and 34% clay content with Plasticity Index (PI) of 27% on the sample tested. The material is generally classified as "ML – Clayey SILT; low plasticity, with fine to coarse sand" in accordance with "AS1726 - 2017 Geotechnical Site Investigations".

The permeability test carried out on the same silt-based material recovered from BH4 indicates the permeability of $4x10^{-10}$ m/sec on low plasticity clayey silt, which was compacted at 95% of SMDD at nearest 100% of SOMC. The dispersion (Emerson Class) tests carried out on the same silt-based sample from BH4 showed "Emerson Class 1" and therefore considered generally "potentially highly dispersive".

The laboratory tests carried out on the underlying clay-based material recovered from BH1 and BH2 indicated that the material generally contains 9 to 16% sand, 24 to 40% silt and 44 to 67% clay content with Plasticity Index (PI) ranging from 41 to 53% on the samples tested. The material is generally classified as "CH – CLAY; high plasticity, trace sand" and "CH – Silty CLAY; high plasticity, with fine to coarse sand" in accordance with "AS1726 -2017 Geotechnical Site Investigations".

The permeability test carried out on the selected clay-based material recovered from BH1 indicate the permeability of $2x10^{-10}$ m/sec on high plasticity clay, which was compacted at 95% of SMDD at nearest 100% of SOMC. The dispersion (Emerson Class) tests carried out on the same silt-based sample from BH1 showed "Emerson Class 5" and therefore considered generally "potentially slighty dispersive".

4.2 Dam Excavation & Preparation

It is noted that the proposed excavation for the proposed dams across the site is approximately 2.5m below the existing site level. Based on the subsurface type and condition encountered in the boreholes drilled (BH1 to BH4) and **assuming similar soil profile across the site of the proposed aquaculture dam sites,** the proposed aquaculture dams can be built at the subject site **provided some treatment of the material with strict compaction control at the floor and sides of the aquaculture dams are undertaken.**

Citing the occurrence of alluvial silt-based and clay-based material throughout the investigation depth in the boreholes drilled at the proposed aquaculture dam site locations at the subject site, the excavation depth may be taken to the proposed design depth of 2.5m below existing surface level. It is anticipated that the excavation would be within mainly silt-based and clay-based materials. It is therefore assessed that all the required earthworks should be capable of being performed by conventional earthmoving plant such as scrapers, dozers, rollers and backhoes or excavators.

It should be noted that the placement of clay liner or plastic liner may be required at the nominated excavation depth if low plasticity clayey silt material is encountered. It should be noted that low plasticity clayey silt was encountered at the depth of 1.7m to 2.4m in BH3 and 1.8m to 2.7m in BH4 below the existing surface level.

It should also be noted that seepage was encountered from 2.2m to 3.1m in BH2 and 2.3m to 3.2m in BH3 below the existing surface level at the time of the investigation. **It is anticipated that construction difficulties due to seepage may be experienced during the construction. It is therefore recommended to limit the excavation depth at 1.5m across the subject site if feasible. It should also be noted that variations to the water table level could fluctuate with changes to the season, temperature and rainfall as discussed above.**

The maximum batters of 1H: 1V are recommended for the excavation within the silt-based and clay-based materials. After excavation to the nominated depth in the proposed aquaculture dam areas, the excavation would generally expose a subgrade comprising low plasticity clayey silt and high plasticity silty clay and clay at the proposed floor and sides of the proposed aquaculture dams. **Therefore, it is highly recommended that the clay-based material at the bottom and sides of the proposed aquaculture dam be scarified to a depth of at least 250mm and re-compacted in such a way that it achieves at least 100% of Standard Maximum Dry Density (SMDD) at -2 to 0% Standard Optimum Moisture Content (SOMC) in every 150 to 200mm thick compacted layers.**

However, if the proposed aquaculture dam is to be taken to the proposed depth of 2.5m below existing surface level and citing the occurrence of silt-based material as stated above, it is highly recommended to remove the low plasticity silt-based material where exposed on the sides and floor of the excavation to a minimum depth of 0.6m as required. Approved clay liner material shall then be replaced to a minimum thickness of 0.6m perpendicular to the final excavated surface.

The careful selection of the material for the clay liner is vital to ensure that there is no gravel incorporated in the liner. It is anticipated that the natural clay-based materials encountered across the site may be used provided they are compacted to a minimum of 100% of SMDD in maximum 150mm thick compacted layers. The relative compaction of the fill placement should be confirmed by a NATA accredited testing laboratory to ensure it is compacted accordingly.

The overall performance of the clay liner is influenced by the construction performance of the contractor, degree of compaction, and conditioning of the correct moisture in the material at the time of construction. The permeability of the clay liner should be less than 1.0×10^{-9} m/sec to have a minimum seepage loss.

The clay liner utilizing the clay materials as discussed above, shall be placed and compacted as specified below:

- The exposed natural material should be scarified to a depth of about 200mm at both sides and floor of the aquaculture dam; moisture conditioned to within -2 to 0% of SOMC

and compacted to a minimum of 100% of SMDD once excavation is taken to the required depth.

- Any soft or heave areas, if detected during the process, should be excavated down at least 0.5m and backfilled with appropriate approved materials compacted in 150mm thick layers to the minimum equivalent density of 100% of SMDD.
- Any area of exposed subgrade which exhibits shrinkage cracking and does not require recompaction, should be watered and rolled until the shrinkage cracks do not reappear. During this undertaking, care should be exercised to ensure the surface does not become soft.
- Once exposed surface is treated as specified above, the clay materials for liner shall be placed in horizontal layers, compacted in 150mm thick layers to the equivalent density of 100% of SMDD at a moisture content within the range of -2 to 0% of SOMC. Care shall be taken in the placement of compacted materials to avoid laminations occurring between compacted layers. Compacted surfaces shall not be allowed to dry and crack before placing subsequent layers. If this should occur, then all dried clays shall be stripped off and replaced or alternatively, scarified and conditioned to the recommended moisture condition before placing the next layer. To prevent such laminations from occurring between compacted layers, each subsequent layer shall be compacted and kneaded into the underlying layer using a sheepsfoot roller.
- The batter incorporating with clay liner should not be steeper than 1V:2H (1 Vertical to 2 Horizontal).
- The clays are liable to crack if they are subject to drying and wetting and to prevent this, they may be covered with about 200 mm of topsoil or sand-based materials. The topsoil is generally non-dispersive and acts as a protective filter zone and it could minimize interaction of water with clay materials as part of the dispersive action. An adequate cover of topsoil will also promote grass cover and prevents internal clay materials from drying out and cracking during dry circles. The topsoil should be sown with grass, which generally protects the embankment from erosion.

Alternatively, any other type of liner material, such as plastic liner, geosynthetic clay liner, bentonite (soil mixed or blanket) or polymer may be used provided it is approved by the relevant authority and properly designed. If plastic lining is adopted where silt-based material is encountered, it is recommended to place a minimum 300mm of clay liner below plastic lining.

4.3 Embankment Construction

It is anticipated that the new embankment would be built using high plasticity clay-based material. It is assumed that the maximum height of the embankment above natural surface would be no greater than 3.0m and the maximum fetch would be less than 300m and the total water depth would be maximum 5.0m with 1.0m maximum above natural surface. Based on these design criteria and using the clay material encountered on site, we recommend the followings for the embankment construction:

- All topsoil and fill material, if any, shall be stripped in the foundation area of the embankment. The stripping depth for the topsoil is noted to be about 0.25m to 0.3m (refer to attached borehole logs).
- Proof roll the exposed subgrade to detect any soft or heaving areas.
- Any wet, soft or heave areas, if detected, should be excavated down at least 0.5m and backfilled with appropriate approved excavated materials compacted in 150mm thick layers to the minimum equivalent density of 100% of SMDD at a moisture content within the range of –2% to 0% of SOMC.
- Any area of exposed subgrade, which exhibits shrinkage cracking and does not require recompaction, should be watered and rolled until the shrinkage cracks do not reappear. During this undertaking, care should be exercised to ensure the surface does not become soft.
- Cut-off trench excavation should be extended at least 500mm into the impervious clay material and the side batters of 1V: 1H (one vertical to one horizontal) may be adopted. It should be noted that cut-off trench placement may not be required if the dam is lined with the lining material.
- Once the foundation subgrade is prepared, medium to high and high plasticity site won clay material shall be placed in horizontal layers and compacted in 150mm thickness to the equivalent density of 98% to 100% of SMDD at a moisture content within the range of -2% to 0% of SOMC.
- The compaction of the inside batter of the embankment extending to the top of the outside batter, should be strictly controlled in such a way that it achieves relative compaction of at least 100% of SMDD.
- If the embankment inside batter is to be protected by applying and mixing with hydrated lime or gypsum, then a minimum of 98% of SMDD at OMC between -2% and 0% for the entire embankment may be adopted.
- The compaction of outside batter shall be compacted not less than 98% of SMDD at moisture content within the range of -2% to 0% of SOMC.
- Low plasticity clayey silt material from the site may be used on the outside batter of the embankment and compacted at 100% of SMDD at moisture content within the range of -2% to 0% of SOMC.
- Sand-based material, if encountered, should not be used for the embankment construction.
- A topsoil layer or less reactive, such as sandy silty clay/clayey sand material and non-dispersive soil layer of at least 200mm thick should be placed on the inside batter, which also serves to reduce surface erosion and prevent cracking. The crest and outside batter should also be protected with a topsoil layer or less reactive and non-dispersive soil layer.
- Care shall be taken in the placement of compacted materials to avoid laminations occurring between compacted layers.
- Embankment using above clay material should have a maximum batter of 2.5H: 1V for the upstream (inside batter) and 2.0H: 1V for the downstream (outside batter).

- A minimum crest width of 2.5m is recommended.
- A minimum freeboard of 0.8m is recommended.

The compaction with correct moisture content would also provide structural stability to the embankment and reduces the potential seepage losses due to the tendency of the dispersion of the materials. Care shall be exercised to ensure that the moisture is conditioned accordingly as discussed above.

It would be essential to maintain drainage of the site area during any earthworks to prevent rainfall from adversely affecting the material such that they become unsuitable for direct re-use.

Some settlements may occur from the consolidation of the founding material and therefore the designer is recommended to take appropriate design consideration to maintain the settlement within tolerable limit.

The silt-based and clay-based materials are assessed to be moderately to highly reactive and therefore they are liable to crack if they are subjected to drying and wetting. Similarly, the application of lime into the clay-based materials, if adopted, may develop shrinkage cracks when they are subjected to drying and wetting. Therefore, there is the potential for embankment slope and crest to develop tension cracks. In the long term, these tension cracks will subject to open and close due to drying and wetting cycles, resulting in fretting of the embankment slope and crest and consequently slope stability failure.

It is therefore required to ensure that the inner and outer face of the embankment and crest are given adequate protection. It is therefore recommended that the outer face and crest be covered with topsoil or less reactive materials, such as sandy silty clay/clayey sand material to a minimum thickness of 200mm, measured perpendicular to the slope upon the completion of the embankment. The topsoil is generally non-dispersive and acts as a protective filter zone and it could minimize interaction of water with clay materials as part of the dispersive action. An adequate cover of topsoil will also promote grass cover and prevents internal clay materials from drying out and cracking during dry circles. The topsoil should be sown with grass, which generally protects the embankment from erosion.

When topdressing an embankment, care shall be taken to achieve an even crest and batter finish, free of irregularities and tyre marks etc. Runoff water concentrating in these areas can result in rilling, which can expose the underlying clays and lead to more serious erosion problem. The embankment should be fenced off from stock to prevent grass cover being eaten, and to prevent the formation of deep cattle pads, which promotes scouring. It is also important to carry out regular inspection and maintenance to ensure topsoil cover is maintained. Some form of protection is recommended to prevent surface run-off into the aquaculture dam.

5.0 GENERAL COMMENT

It should be noted that the comments and recommendations given in this report are based on a limited geotechnical investigation carried out and assumption that similar subsurface profile across all the proposed dam sites therefore care and caution should be exercised during the construction to ensure similar soil profiles exists across the site.

The degree of compaction should be verified by a NATA accredited testing authority to ensure that it achieves the minimum required density in the placement of clay-based material and construction of embankment. Failure in undertaking strict controlled compaction during the construction would eventually result in the collapse of the embankment and consequently face seepage problems.

Verification is also required that the clay-based material is being placed in 200mm thick compacted layers for the embankment and there is no lamination occurring between clay-based layers. Remoulding of the clay-based material is most important during the placement and compaction of the clay-based material to ensure a low isotropic permeability.

In designing the aquaculture dams, the designer should try to minimize the number of pipes through the embankments, as it is difficult to get adequate compaction around the pipes. Backfilling around the pipes is particularly susceptible to piping failure if poorly compacted. Reinforced concrete cut-off walls at suitable intervals, should be provided around the pipe, and particularly concentrated in the inner face half of the embankment.

The excavations for pipe installations should not be left open for long periods allowing the exposed clay-based material to dry and develop shrinkage cracks. The excavation through the completed embankment creates a point of weakness, which may result in failure. After the pipe is in place, care must be taken to ensure that the excavation trench is backfilled with selected clay-based materials and compacted thoroughly as specified above. Care must also be taken to ensure the required degree of compaction is achieved below the midline of the pipe. This normally involves the use of handheld compaction equipment. As the embankment is to be constructed from a dispersive soil, lime stabilisation around the pipe shall be considered.

It is recommended that the clay-based material be compacted using a vibrating sheepsfoot roller or tamping roller. Rubber tyred or steel drum rollers are not recommended, as they tend to create horizontal laminations between layers. Care shall be taken in the preparation of the embankment foundation and the placement of compacted materials to avoid laminations occurring between compacted layers as discussed above.

Occasionally, the subsurface soil conditions between the completed boreholes may be found different (or may be interpreted to be different) from those expected. This can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact us.

Should you have any queries, please do contact us.

Yours truly,

Jarrod Gornall
Senior Geotechnical Engineer

Tin Maung
Principal Geotechnical Engineer

Attachments:

- Addendum
- Site Locality Plan
- Plan showing Borehole Locations
- Borehole logs with explanatory note
- Laboratory test reports

ADDENDUM

LIMITS OF INVESTIGATION

The recommendations made in this report are based on the assumption that the test results are representative of the overall subsurface conditions. However, it should be noted that even under optimum circumstances, actual conditions in some parts of the building site may differ from those said to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal all that is hidden by earth, rock and time.

The client should also be aware that our recommendations refer only to our test site locations and the ground level at the time of testing.

The recommendations in this report are based on the following: -

a) The information gained from our investigation.
b) The present "state of the art" in testing and design.
c) The building type and site treatment conveyed to us by the client.
d) Historical information.

Should the client or their agent have omitted to supply us with the correct relevant information, or make significant changes to the building type and/or building envelope, our report may not take responsibility for any consequences and we reserve the right to make an additional charge if more testing is necessary.

Not withstanding the recommendations made in this report, we also recommend that whenever footings are close to any excavations or easements, that consideration should be given to deepening the footings.

Unless otherwise stated in our commission, any dimensions or slope direction and magnitude should not be used for any building costing calculations and/or positioning. Any sketch supplied should be considered as only an approximate pictorial evidence of our work.

Aitken Rowe Testing Laboratories Pty Ltd

Registration Number: GS23-218

Client: TERRAMIA FARMING CO PTY LTD – HANWOOD, NSW
Project: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS
FARM 1961 No. 251 STACY ROAD, KOOBA, NSW
SITE LOCATION PLAN

Aitken Rowe Testing Laboratories Pty Ltd

Registration Number: GS23-218

Client: TERRAMIA FARMING CO PTY LTD – HANWOOD, NSW

Project: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS
FARM 1961 No. 251 STACY ROAD, KOOBA, NSW
BOREHOLE LOCATION PLAN

AITKEN ROWE TESTING LABORATORIES PTY LTD

Borehole No.: **1**
Sheet No.: 1 of 1

Ground Level: Existing
Method: Auger Drilling with TC Bit

Date: ***18/07/2023***
GPS N: ***6187503***
E: ***0415476***

USCS Symbol	Description	Depth (m)	Moisture Condition	Consistency/ Rel. Density	Sample Type	Sample No.	Lab. Test L.S % -425µm	Remarks & Field Records
CH	TOPSOIL: CLAY; high plasticity, trace sand, mottled orange dark brown grey		MC>PL	S				NATURAL
CH	CLAY; high plasticity, trace sand, mottled grey brown	0.5		St.	D	1A		@OMC to 1% >OMC
CH	CLAY; high plasticity, trace sand, cream brown	1.0		St.-VSt	D	1B		@OMC
CH	CLAY; high plasticity, trace sand, yellow grey	1.5		VSt.	D	1C		FMC = 24.6% SOMC = 22.2% 2% >OMC
CH	CLAY; high plasticity, trace sand, grey	2.0 2.5 3.0						
CH	CLAY; high plasticity, trace sand, mottled cream grey	3.5			D	1D		FMC = 24.3 1-2% <OMC
	End of Borehole (BH1) @ 4.5m	4.0 4.5 5.0 5.5 6.0						

Registration No.: GS23-218

Location: Limited Geotechnical Investigation - Proposed Aquaculture Dams, Farm 1961, No. 251 Stacy Road, Kooba, NSW

Client: Terramia Farming Co Pty Ltd - Hanwood, NSW

Logged By: JAG

Scale: As shown

Dry on completion

AITKEN ROWE TESTING LABORATORIES PTY LTD

Borehole No.: **2**
Sheet No.: 1 of 1

Ground Level: Existing
Method: Auger Drilling with TC Bit

Date: ***18/07/2023***
GPS N: ***6187594***
E: ***0415491***

USCS Symbol	Description	Depth (m)	Moisture Condition	Consistency/ Rel. Density	Sample Type	Sample No.	Lab. Test L.S % -425µm	Remarks & Field Records
CH	TOPSOIL: CLAY; high plasticity, trace sand, mottled orange dark brown grey		MC>PL	S				NATURAL
CH	CLAY; high plasticity, trace sand, mottled grey brown	0.5		St.	D	2A		@OMC
CH	CLAY; high plasticity, trace sand, cream brown	1.0 1.5		VSt.	D	2B		@OMC - 1% >OMC
CH	Silty CLAY; high plasticity, with fine to coarse sand, yellow grey	2.0 2.5			D	2C		Slight seepage @ 2.2m to 3.1m
CH	Silty CLAY; high plasticity, with fine to coarse sand, grey	3.0			D	2D		FMC = 26.3
CH	CLAY; high plasticity, trace sand, mottled cream grey	3.5 4.0 4.5						End of seepage
	End of Borehole (BH2) @ 4.5m	5.0 5.5 6.0						

Registration No.: GS23-218

Location: Limited Geotechnical Investigation - Proposed Aquaculture Dams, Farm 1961, No. 251 Stacy Road, Kooba, NSW

Client: Terramia Farming Co Pty Ltd - Hanwood, NSW

Logged By: JAG

Scale: As shown

Slight seepage @ 2.2m to 3.1m

AITKEN ROWE TESTING LABORATORIES PTY LTD

Borehole No.: **3**
Sheet No.: 1 of 1

Ground Level: Existing
Method: Auger Drilling with TC Bit

Date: ***18/07/2023***
GPS N: ***6187675***
E: ***0415503***

USCS Symbol	Description	Depth (m)	Moisture Condition	Consistency/ Rel. Density	Sample Type	Sample No.	Lab. Test L.S % -425µm	Remarks & Field Records
CH	TOPSOIL: CLAY; high plasticity, trace sand, mottled orange dark brown grey		MC>PL	St.-VSt				NATURAL
CH	CLAY; high plasticity, trace sand, mottled grey brown	0.5		VSt.	D	3A		@OMC
		1.0						
CH	CLAY; high plasticity, trace sand, cream brown				D	3B		
		1.5						
ML	Clayey SILT; low plasticity, with fine to coarse sand, mottled yellow grey							
		2.0			D	3C		
								← Slight seepage @2.3m to 3.2m
CH	Silty CLAY; high plasticity, trace sand, grey	2.5			D	3D		
		3.0						
CH	CLAY; high plasticity, trace sand, mottled cream grey							← End of seepage
		3.5			D	3E		
		4.0						
		4.5						
	End of Borehole (BH3) @ 4.5m							
		5.0						
		5.5						
		6.0						

Registration No.: GS23-218

Location: Limited Geotechnical Investigation - Proposed Aquaculture Dams, Farm 1961, No. 251 Stacy Road, Kooba, NSW

Client: Terramia Farming Co Pty Ltd - Hanwood, NSW

Logged By: JAG

Scale: As shown

Slight seepage @2.3m to 3.2m

AITKEN ROWE TESTING LABORATORIES PTY LTD

Borehole No.: **4**
Sheet No.: 1 of 1

Ground Level: Existing
Method: Auger Drilling with TC Bit

Date: ***18/07/2023***
GPS N: ***6187758***
E: ***0415513***

USCS Symbol	Description	Depth (m)	Moisture Condition	Consistency/ Rel. Density	Sample Type	Sample No.	Lab. Test L.S % -425µm	Remarks & Field Records
CH	TOPSOIL: CLAY; high plasticity, trace sand, mottled orange dark brown grey		MC>PL	S				NATURAL
				St.-VSt				
CH	CLAY; high plasticity, trace sand, mottled grey brown	0.5		VSt				
CH	CLAY; high plasticity, trace sand, grey brown	1.0			D	4A		
		1.5						
ML	Clayey SILT; low plasticity, with fine to coarse sand, mottled yellow grey	2.0			D	4B		FMC = 22.5% SOMC = 20.1% 2% <OMC
		2.5						
CH	Silty CLAY; high plasticity, trace sand, grey	3.0						
CH	CLAY; high plasticity, trace sand, mottled cream grey	3.5						
		4.0						
		4.5						
	End of Borehole (BH4) @4.5m	5.0						
		5.5						
		6.0						

Registration No.: GS23-218

Location: Limited Geotechnical Investigation - Proposed Aquaculture Dams, Farm 1961, No. 251 Stacy Road, Kooba, NSW

Client: Terramia Farming Co Pty Ltd - Hanwood, NSW

Logged By: JAG

Scale: As shown

Dry on completion

AITKEN ROWE TESTING LABORATORIES PTY LTD

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record	▼	Standing water level. Time delay following completion of drilling may be shown.
	▶	Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	D	Disturbed bag sample taken between the depths indicated by lines.
	U	Undisturbed 50mm diameter tube sample taken between the depths indicated by lines
Field Tests	4, 7, 10 N=17	Standard Penetration Test (S.P.T.) performed between depths indicated by lines. Individual figures show blows per 150mm penetration driven by SPT hammer.
	5 7 3	Dynamic Cone Penetration Test performed between depths indicated by lines. Individual figures show blows per 100mm penetration for 60 degree solid cone driven by 9 kg hammer.
Moisture Condition (Silt or Clay based)	MC<PL	Moisture content estimated to be less than plastic limit.
	MC=PL	Moisture content estimated to be approx. equal to plastic limit.
	MC>PL	Moisture content estimated to be greater than plastic limit.
Moisture Condition (Gravel or Sand based)	D	DRY – runs freely through fingers.
	M	MOIST – does not run freely but no free water visible on soil surface.
	W	WET – free water visible on soil surface.
Consistency (Silt or Clay based)	VS	VERY SOFT – unconfined compressive strength less than 25kPa.
	S	SOFT – unconfined compressive strength 25-50 kPa.
	F	FIRM – unconfined compressive strength 50-100kPa.
	St.	STIFF – unconfined compressive strength 100-200kPa.
	VSt.	VERY STIFF – unconfined compressive strength 200-400kPa.
	H	HARD – unconfined compressive strength greater than 400kPa.

Relative Density (Gravel or Sand based)		Description	Density Index Range %	'N' Value Range Blows/300mm
	VL	VERY LOOSE	<15	0-5
	L	LOOSE	15-35	6-10
	MD	MEDIUM DENSE	35-65	11-30
	D	DENSE	65-85	31-60
	VD	VERY DENSE	>85	>60

Hand Penetrometer Readings	300 250 280	Numbers indicate individual test results in kPa on representative undisturbed material.
Laboratory Test	L.S. %	Linear Shrinkage (As per TfNSW Method T113)
	M.C. %	Field Moisture Content (As per Australian Standard AS1289.2.1.1 or TfNSW Method T120)
	Iss	Shrink-Swell Index (As per Australian Standard AS1289.7.1.1)

Piezometer Construction	Fill		Piezometer	
		Bentonite		Solid Pipe
		Washed Fine Graded Gravel		Slotted Screen

Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Tungsten Carbide wing bit.

AITKEN ROWE Testing Laboratories Pty Ltd

ARTL Griffith: 17b Battista Street, Griffith NSW 2680

*

PAGE 1 OF 1

TEST REPORT: GEOTECHNICAL INVESTIGATION - SOIL ANALYSIS

CLIENT : TERRAMIA FARMING CO PTY LTD - HANWOOD, NSW

JOB DESCRIPTION : LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS
FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

SAMPLED BY: ARTL
DATE SAMPLED: 18/07/2023
DATE SUBMITTED: 18/07/2023
SAMPLING METHOD: AS1289.1.2.1
SAMPLING CLAUSE: 6.5.3
DATES TESTED: 20-31/07/2023
ORDER No.: *

MATERIAL SOURCE : IN-SITU BOREHOLES
MATERIAL TYPE : REFER TO BOREHOLE LOGS
PROPOSED USE : DESIGN

REGISTRATION No : R28 **GS23-218**

		SAMPLE NUMBER :	1C	1D	2D	4B	*	*
		SAMPLING LOCATION :	BH1	BH1	BH2	BH4	*	*
		DEPTHS BETWEEN WHICH SAMPLES TAKEN (mm) :	1600-2500	3300-3500	2700-2900	1800-2700	*	*
TESTS	TEST ELEMENT		*	*	*	*	*	*
AS1289.3.6.1		PASS 75.0mm SIEVE %	*	*	*	*	*	*
		PASS 53.0mm SIEVE %	*	*	*	*	*	*
		PASS 37.5mm SIEVE %	*	*	*	*	*	*
		PASS 26.5mm SIEVE %	*	*	*	*	*	*
		PASS 19.0mm SIEVE %	*	*	*	*	*	*
		PASS 13.2mm SIEVE %	*	*	*	*	*	*
		PASS 9.50mm SIEVE %	*	*	*	*	*	*
		PASS 6.70mm SIEVE %	*	*	*	*	*	*
		PASS 4.75mm SIEVE %	*	*	*	*	*	*
		PASS 2.36mm SIEVE %	100	100	100	100	*	*
AS1141.19	WHOLE SAMPLE	PASS 425 µm SIEVE %	*	*	*	*	*	*
		PASS 75 µm SIEVE %	*	*	*	*	*	*
		LESS THAN 13.5 µm %	*	*	*	*	*	*
AS1141.19	-2.36mm	PASS 425 µm SIEVE %	*	*	*	*	*	*
		PASS 75 µm SIEVE %	*	*	*	*	*	*
		LESS THAN 13.5 µm %	*	*	*	*	*	*
		OBSERVATIONS	*	*	*	*	*	*
AS1289.3.1.2		LIQUID LIMIT %	58	64	53	42	*	*
AS1289.3.2.1		PLASTIC LIMIT %	13	11	12	15	*	*
AS1289.3.3.1		PLASTICITY INDEX	45	53	41	27	*	*
		PREPARATION METHOD	AS1289.1.1-5.3	AS1289.1.1-5.3	AS1289.1.1-5.3	AS1289.1.1-5.3	*	*
AS1289.5.1.1		STANDARD MAX. DRY DENSITY t/m^3	1.66	*	*	1.72	*	*
(NOT DRY PREPPED)		OPTIMUM MOISTURE CONTENT %	22.2	*	*	20.1	*	*
		OVERSIZE MATERIAL % RETAINED ON 19.0mm	0	*	*	0	*	*
		LL METHOD OF CURING TIME DETERMINATION	VISUAL	*	*	VISUAL	*	*
		CURING DURATION HOURS	194	*	*	194	*	*
AS1289.2.1.1		FIELD MOISTURE CONTENT %	24.6	24.3	26.3	22.5	*	*
AS1289.3.8.1		EMERSON CLASS	5	*	1	*	*	*
(AIR DRIED)		TYPE OF WATER	DISTILLED	*	DISTILLED	*	*	*

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing.

ACCREDITATION NUMBER: 4679

*
*
*
All samples are oven dried and dry sieved during prep. unless otherwise stated

APPROVED SIGNATORY : ..... DATE: 28/08/2023

Jarrod Gornall

AITKEN ROWE TESTING LABORATORIES PTY LTD

ARTL Wagga: 4/2 Riedell Street, Wagga Wagga NSW 2650

SAMPLE No.: 1C

TEST REPORT - GRADING/HYDROMETER

SAMPLED BY: ARTL

DATE SAMPLED: 18/07/2023

CLIENT: TERRAMIA FARMING CO PTY LTD - HANWOOD, NSW

DATE SUBMITTED: 18/07/2023

TEST METHOD: AS1289.3.6.3
AS1289.3.6.1

JOB DESCRIPTION: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS

TEST HOLE: BH1

DEPTH (mm): 1600-2500

TEST DATES: 28-03/8/2023

LOCATION: FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

HYDROMETER TYPE: BULB

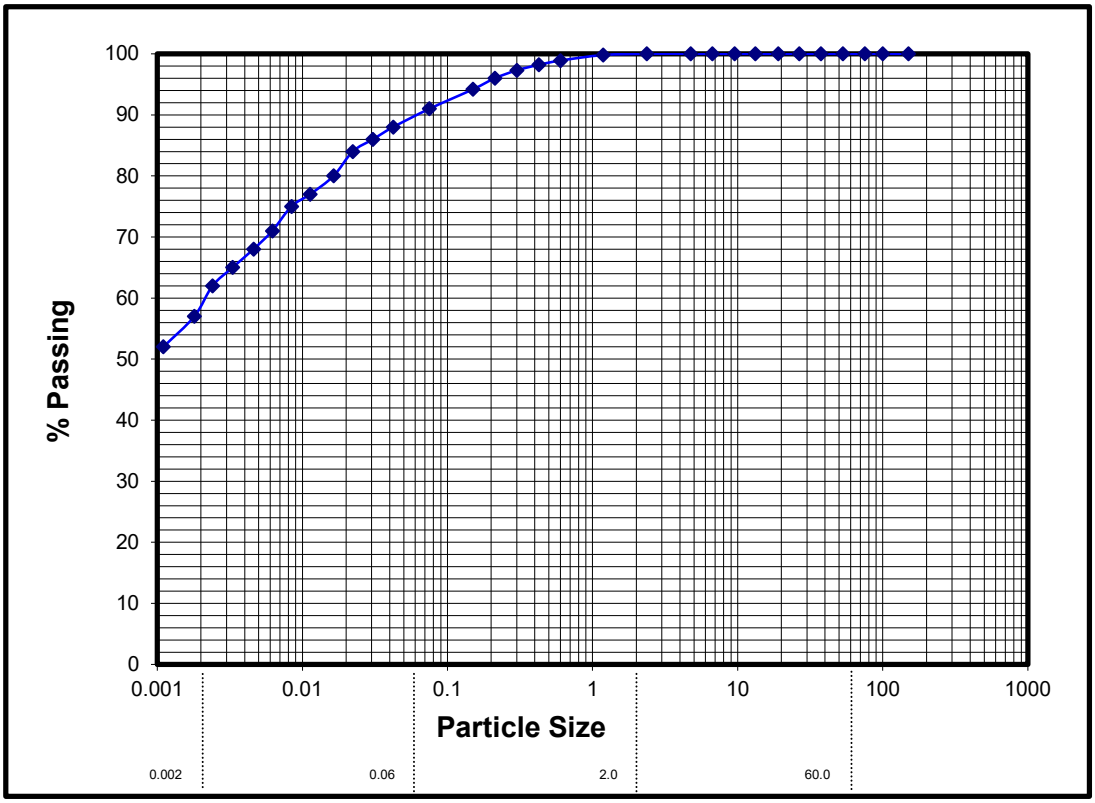
REGISTRATION No.: R36 **GS23-218**

METHOD OF DISPERSION

i). AGENT ☒
ii). MIXER ☒
iii). HYDROMETER ☒
CALIBRATED IN g/l

PERCENTAGE LOSS IN PRETREATMENT: NIL

SOIL CLASSIFICATION: CLAY; high plasticity, trace fine to coarse sand



Particle Size (mm)	% Passing
150	100
100	100
75	100
53	100
37.5	100
26.5	100
19	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	99.8
0.6	98.9
0.425	98.2
0.3	97.3
0.212	96
0.15	94.2
0.075	91
0.06	87.2
0.02	81.3
0.006	70.4
0.002	57.9

CLAY	SILT		29%	SAND		13%	GRAVEL		0%	COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
58%	12%	11%	6%	7%	4%	2%	0%	0%	0%	0%

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing.

ACCREDITATION NUMBER: 4679

APPROVED SIGNATORY Peter Forbes-Taber

DATE: 21/08/2023

AITKEN ROWE TESTING LABORATORIES PTY LTD

ARTL Wagga: 4/2 Riedell Street, Wagga Wagga NSW 2650

SAMPLE No.: 1D

TEST REPORT - GRADING/HYDROMETER

SAMPLED BY: ARTL

DATE SAMPLED: 18/07/2023

CLIENT: TERRAMIA FARMING CO PTY LTD - HANWOOD, NSW

DATE SUBMITTED: 18/07/2023

TEST METHOD: AS1289.3.6.3
AS1289.3.6.1

JOB DESCRIPTION: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS

TEST HOLE: BH1

DEPTH (mm): 3300-3500

TEST DATES: 28-03/8/2023

LOCATION: FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

HYDROMETER TYPE: BULB

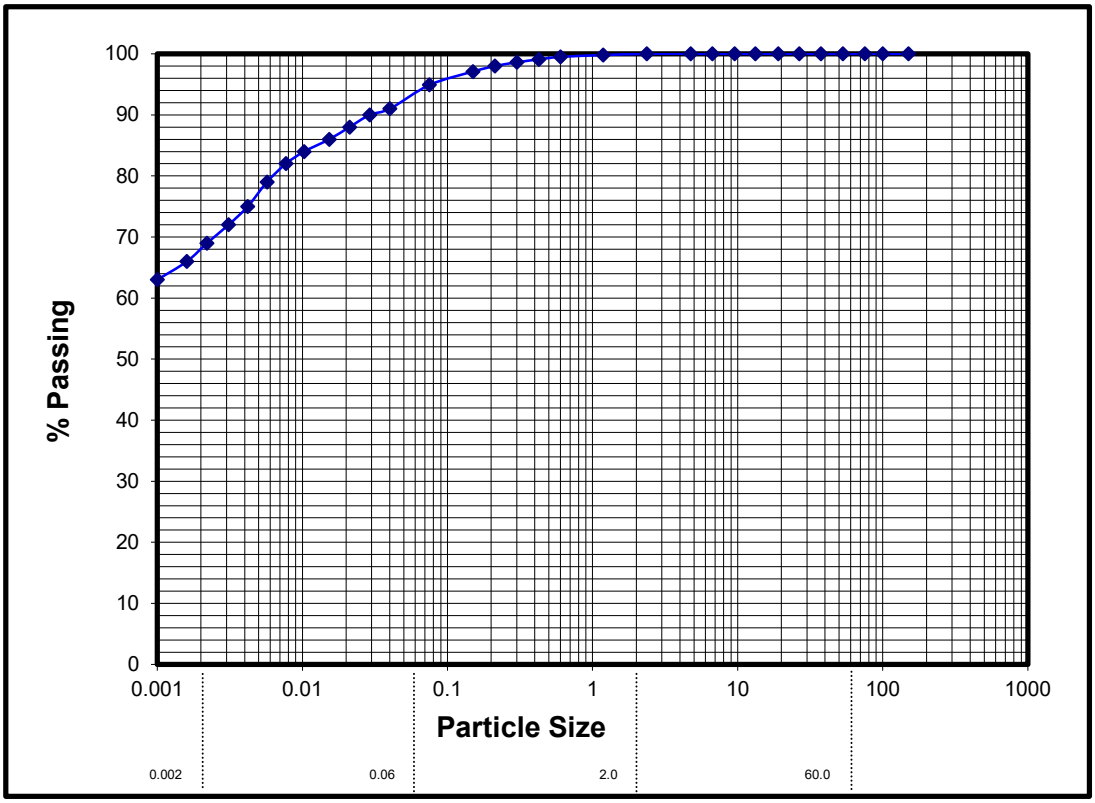
REGISTRATION No.: R36 **GS23-218**

METHOD OF DISPERSION

i). AGENT ☒
ii). MIXER ☒
iii). HYDROMETER ☒
CALIBRATED IN g/l

PERCENTAGE LOSS IN PRETREATMENT: NIL

SOIL CLASSIFICATION: CLAY; high plasticity, trace sand



Particle Size (mm)	% Passing
150	100
100	100
75	100
53	100
37.5	100
26.5	100
19	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	99.8
0.6	99.5
0.425	99.1
0.3	98.6
0.212	98
0.15	97.1
0.075	94.9
0.06	91.2
0.02	87.0
0.006	78.8
0.002	67.4

CLAY	SILT		24%	SAND		9%	GRAVEL		0%	COBBLES
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
67%	11%	8%	4%	5%	3%	1%	0%	0%	0%	0%

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing.

ACCREDITATION NUMBER: 4679

APPROVED SIGNATORY Peter Forbes-Taber

DATE: 21/08/2023

AITKEN ROWE TESTING LABORATORIES PTY LTD

ARTL Wagga: 4/2 Riedell Street, Wagga Wagga NSW 2650

SAMPLE No.: 2D

TEST REPORT - GRADING/HYDROMETER

SAMPLED BY: ARTL

DATE SAMPLED: 18/07/2023

CLIENT: TERRAMIA FARMING CO PTY LTD - HANWOOD, NSW

DATE SUBMITTED: 18/07/2023

TEST METHOD: AS1289.3.6.3
AS1289.3.6.1

JOB DESCRIPTION: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS

TEST HOLE: BH2

DEPTH (mm): 2700-2900

TEST DATES: 28-03/8/2023

LOCATION: FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

HYDROMETER TYPE: BULB

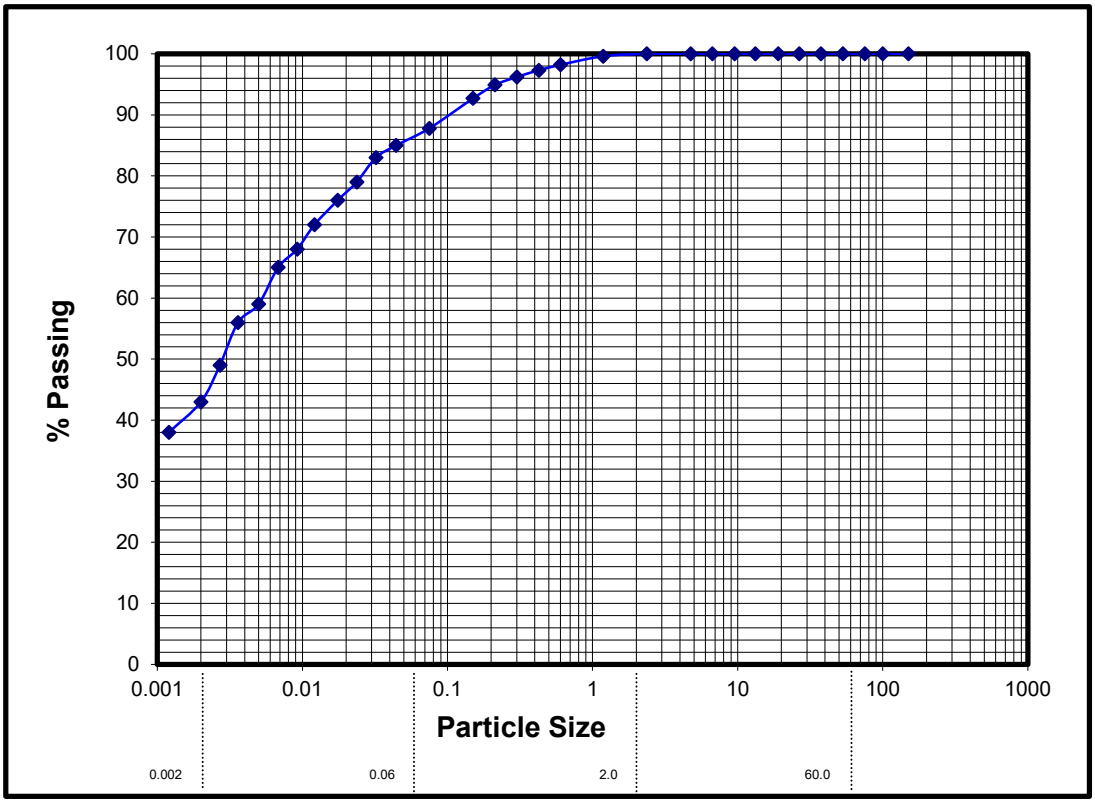
REGISTRATION No.: R36 **GS23-218**

METHOD OF DISPERSION

i). AGENT ☒
ii). MIXER ☒
iii). HYDROMETER ☒
CALIBRATED IN g/l

PERCENTAGE LOSS IN PRETREATMENT: NIL

SOIL CLASSIFICATION: Silty CLAY; high plasticity, with fine to coarse sand



Particle Size (mm)	% Passing
150	100
100	100
75	100
53	100
37.5	100
26.5	100
19	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	99.6
0.6	98.2
0.425	97.3
0.3	96.2
0.212	94.9
0.15	92.7
0.075	87.8
0.06	83.8
0.02	76.0
0.006	60.9
0.002	43.8

CLAY	SILT			40%	SAND			16%	GRAVEL			0%	COBBLES
	FINE	MEDIUM	COARSE		FINE	MEDIUM	COARSE		FINE	MEDIUM	COARSE		
44%	17%	15%	8%		8%	5%	2%		0%	0%	0%		0%

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing.

ACCREDITATION NUMBER: 4679

APPROVED SIGNATORY Peter Forbes-Taber

DATE: 21/08/2023

AITKEN ROWE TESTING LABORATORIES PTY LTD

ARTL Wagga: 4/2 Riedell Street, Wagga Wagga NSW 2650

SAMPLE No.: 4B

TEST REPORT - GRADING/HYDROMETER

SAMPLED BY: ARTL

DATE SAMPLED: 18/07/2023

CLIENT: TERRAMIA FARMING CO PTY LTD - HANWOOD, NSW

DATE SUBMITTED: 18/07/2023

TEST METHOD: AS1289.3.6.3
AS1289.3.6.1

JOB DESCRIPTION: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS

TEST HOLE: BH4

DEPTH (mm): 1800-2700

TEST DATES: 28-03/8/2023

LOCATION: FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

HYDROMETER TYPE: BULB

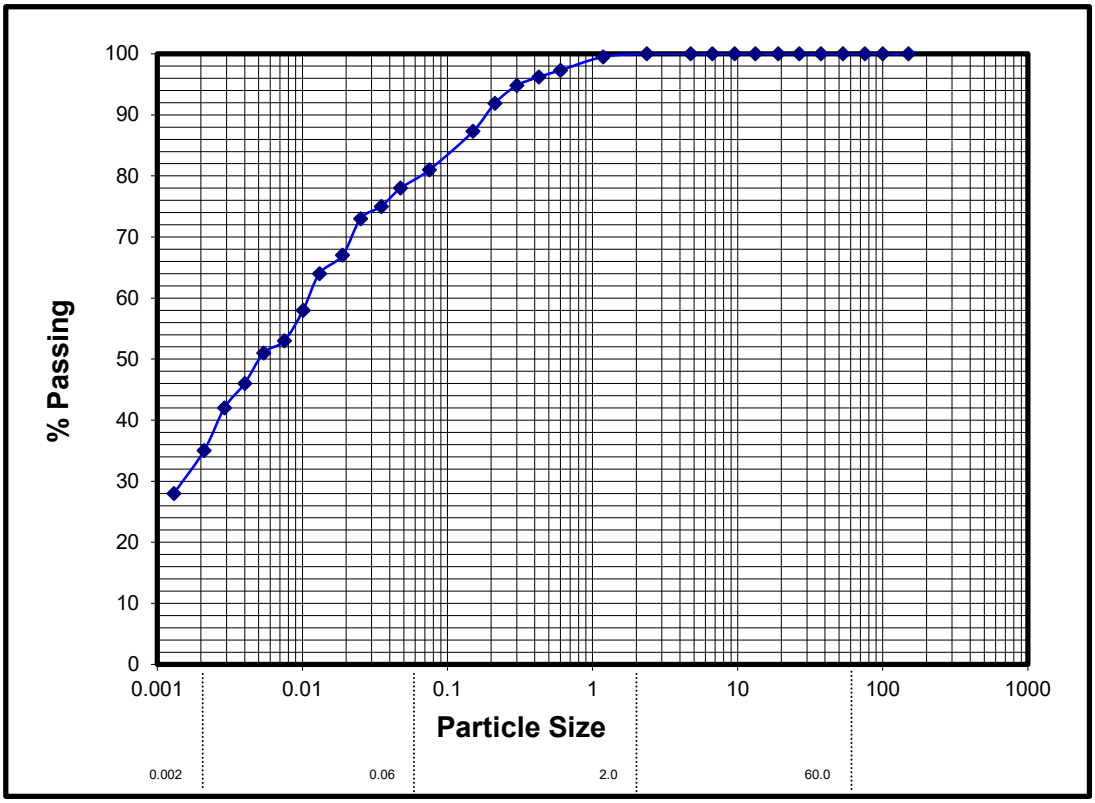
REGISTRATION No.: R36 **GS23-218**

METHOD OF DISPERSION

i). AGENT ☒
ii). MIXER ☒
iii). HYDROMETER ☒
CALIBRATED IN g/l

PERCENTAGE LOSS IN PRETREATMENT: NIL

SOIL CLASSIFICATION: Clayey SILT; low plasticity, with fine to coarse sand



Particle Size (mm)	% Passing
150	100
100	100
75	100
53	100
37.5	100
26.5	100
19	100
13.2	100
9.5	100
6.7	100
4.75	100
2.36	100
1.18	99.5
0.6	97.3
0.425	96.2
0.3	94.8
0.212	91.9
0.15	87.3
0.075	81
0.06	76.8
0.02	66.3
0.006	50.0
0.002	34.2

CLAY	SILT			43%	SAND			23%	GRAVEL			0%	COBBLES
	FINE	MEDIUM	COARSE		FINE	MEDIUM	COARSE		FINE	MEDIUM	COARSE		
34%	16%	16%	10%		11%	9%	4%		0%	0%	0%		0%

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025 - Testing.

ACCREDITATION NUMBER: 4679

APPROVED SIGNATORY Peter Forbes-Taber

DATE: 21/08/2023

Aitken Rowe Testing Laboratories Pty Ltd

ARTL Griffith: 17b Battista Street, Griffith NSW 2680

PERMEABILITY / DISPERSION REPORT

CLIENT: TERRAMIA FARMING CO PTY LTD - HANWOOD, NSW
PROJECT: LIMITED GEOTECHNICAL INVESTIGATION
PROPOSED AQUACULTURE DAMS
FARM 1961, No. 251 STACY ROAD, KOOBA, NSW

MATERIAL TYPE: REFER TO BOREHOLE LOGS
SOURCE OF MATERIAL: IN-SITU BOREHOLES
PORTION OF STRUCTURE: PROPOSED DAM FLOOR & EMBANKMENTS
SURCHARGES ADDED: 2.65
PRESSURE APPLIED: 3KPa
% RETAINED ON NOMINAL SIEVE: NIL
NOMINAL SIEVE SIZE: -19.0mm

PAGE 1 OF 1
SAMPLED BY: ARTL
DATE SAMPLED: 18/07/2023
DATE SUBMITTED: 18/07/2023
TEST DATE/S: 31/07/23-1/08/23
ORDER No.: *
TEST METHODS: AS1289.6.7.2
AS1289.5.1.1
AS1289.2.1.1
*
REGISTRATION No: R23 **GS23-218**

SAMPLE No.	TEST PIT No.	DEPTH (mm)	MAX. DRY DENSITY (t/m^3)	OPTIMUM MOISTURE (%)	DRY DENSITY OF SPECIMEN (t/m^3)	MOULDING MOISTURE (%)	ACTUAL % OF MDD	PERMEABILITY m / sec AS1289.6.7.2	EMERSON CLASS AS1289.3.8.1
1C	BH1	1600-2500	1.66	22.2	1.58	22.0	95	$2x10^{-10}$	5
4B	BH4	1800-2700	1.72	20.1	1.64	20.1	95	$4x10^{-10}$	1
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*

REMARKS: *

*

APPROVED SIGNATORY: .....
Jarrod Gornall

DATE: 28/08/2023