

above the base of the peat. The undrained condition would correspond for example to the effect of sudden loading of the peat.

A FoS less than 1.5 was recorded in the area of about ch. 89,690. The calculated FoS for load condition (2) was 1.3. This corresponds to a notably low value of undrained strength (1kPa) at 1m bgl. The strength used in the analysis (1kPa) is notably low and possibly not representative of the peat conditions.

Given the apparent low strength in this area further ground investigation should be carried out prior to construction to confirm the peat conditions.

Where low peat strengths exist then construction controls should be exercised in this area, particularly loading of the peat should be avoided.

Drained Analysis

An infinite slope analysis was carried to determine the FoS against peat instability along the pipeline route between South of Sruwaddacon Bay and L-1202 for the drained condition. This analysis includes an assessment of peat stability assuming failure occurs just above the base of the peat. The drained condition would correspond for example to concentrated water ingress into the base of the peat from an intense rainfall event.

The effective stress parameters used were ϕ' of 25° and c' of 2 kPa, see Appendix C.

Results of analysis show that all FoS's are greater than 1.5. This assessment shows that the peat between the South of Sruwaddacon Bay and L-1202 section of the proposed onshore pipeline has an adequate FoS for the drained or long term condition which from experience would be considered the case as there are no signs of rainfall induced failures of the peat within the area.

5.5.2 Failure within the Mineral Soil below the Peat

Undrained Analysis

An infinite slope analysis was carried to determine the FoS against sliding instability within the mineral soil below the peat along the pipeline route between South of Sruwaddacon Bay and L-1202 for the undrained condition. This analysis includes an assessment of the stability 0.1m below the peat-mineral interface within the mineral soil. The undrained condition would correspond for example to the effect of sudden loading of the peat.

The total stress parameters used for the mineral soil was assumed to be c_u of 15kPa which is assumed a worst case based on an undrained shear strength of less than 20kPa.

Results of analysis show that all FoS were greater than 1.5.

This assessment shows that the mineral soil along South of Sruwaddacon Bay to L-1202 section of the proposed onshore pipeline has an adequate FoS for the undrained or short term condition.

Drained Analysis

An infinite slope analysis was carried to determine the FoS against sliding within the mineral soil below the peat along the pipeline route between South of Sruwaddacon Bay to L-1202 for the drained condition. This analysis includes an assessment of the stability 0.1m below the peat-mineral interface within the mineral soil. The drained condition would correspond for example to concentrated water ingress into the base of the peat from an intense rainfall event.

The effective stress parameters used for the mineral soil was assumed to be; ϕ' of 30° and c' of 1 kPa.

Results of analysis show that all FoS were greater than 1.5.

This assessment shows that the mineral soil between South of Sruwaddacon Bay and L-1202 section of the proposed onshore pipeline has an adequate FoS for the drained or long term condition.

5.6 L-1202 to Terminal Site

5.6.1 Failure within the Basal Zone of the Peat

Undrained Analysis

An infinite slope analysis was carried out to determine the FoS against peat instability along proposed onshore pipeline route between L-1202 and terminal site for the undrained condition. This analysis includes an assessment of peat stability assuming failure occurs just above the base of the peat. The undrained condition would correspond for example to the effect of sudden loading of the peat.

A FoS less than 1.5 was recorded in the area of about ch. 96,690. The calculated FoS for load condition (2) was 1.0 This corresponds to a notably low value of undrained strength (2kPa) with a slight increase in the slope inclination at this location. The strength used in the analysis (2kPa) is notably low and possibly not representative of the peat conditions.

Given the apparent low strength in this area further ground investigation should be carried out prior to construction to confirm the peat conditions.

Where low peat strengths exist then construction controls should be exercised in this area, particularly loading of the peat should be avoided.

This assessment shows that the peat between the L-1202 and terminal site section of the pipeline has an adequate FoS for the undrained or short term condition.

Drained Analysis

An infinite slope analysis was carried to determine the FoS against peat instability along the pipeline route between L-1202 and the terminal for the drained condition. This analysis

includes an assessment of peat stability assuming failure occurs just above the base of the peat. The drained condition would correspond for example to concentrated water ingress into the base of the peat from an intense rainfall event.

The effective stress parameters used were ϕ' of 25° and c' of 2 kPa, see Appendix C.

Results of analysis show that all FoS's are greater than 1.5. This assessment shows that the peat along between the L-1202 and terminal section of the proposed onshore pipeline has an adequate FoS for the drained or long term condition which from experience would be considered the case as there are no signs of rainfall induced failures of the peat within the area.

5.6.2 Failure within the Mineral Soil below the Peat

Undrained Analysis

An infinite slope analysis was carried to determine the FoS against sliding instability within the mineral soil below the peat along the pipeline route between L-1202 and the terminal for the undrained condition. This analysis includes an assessment of the stability 0.1m below the peat-mineral interface within the mineral soil. The undrained condition would correspond for example to the effect of sudden loading of the peat.

The total stress parameters used for the mineral soil was assumed to be c_u of 15kPa which is assumed a worst case based on an undrained shear strength of less than 20kPa.

Results of analysis show that all FoS's are greater than 1.5. This assessment shows that the mineral soil along the L-1202 to the terminal section of the proposed onshore pipeline has an adequate FoS for the undrained or short term condition.

Drained Analysis

An infinite slope analysis was carried to determine the FoS against sliding within the mineral soil below the peat along the pipeline route from the L-1202 and the terminal for the drained condition. This analysis includes an assessment of the stability 0.1m below the peat-mineral interface within the mineral soil. The drained condition would correspond for example to concentrated water ingress into the base of the peat from an intense rainfall event.

The effective stress parameters used for the mineral soil was assumed to be; ϕ' of 30° and c' of 1 kPa.

Results of analysis show that all FoS were greater than 1.5. This assessment shows that the mineral soil along the L-1202 and the terminal section of the proposed onshore pipeline has an adequate FoS for the drained or long term condition.

This assessment shows that the mineral soil along the Rossport (Commonage) section of the proposed onshore pipeline has an adequate FoS for the drained or long term condition.

6 SUMMARY OF FINDINGS

The findings of the assessment of peat stability assessment report for the proposed onshore pipeline route from the landfall at Glengad Headland to the Bellanaboy gas terminal site are as follows.

- (1) An assessment of the peat stability along the proposed onshore pipeline route was carried out and included the following: walkover survey of the route and production of geomorphological plans, review of ground investigation and interpretation of ground conditions, and quantitative assessment of peat stability.
- (2) The proposed onshore pipeline route is approximately 9.2km long, from the landfall at Glengad Headland to the terminal. The onshore pipeline crosses approximately 5.7km of deeper peatland, with peat depths ranging from 0.25 to 5m. Altogether about 60% of the route is within peat land.
- (3) The three sections where the proposed pipeline crosses over peat land are Rossport (Commonage) (ch. 85,960 to ch. 88,600), South of Sruwaddacon Bay to L-1202 (ch. 89,500 to ch. 91,000), and L-1202 to Terminal Site (ch. 91,000 to 92,560).
- (4) The general geology along the route and the depth of peat is shown on Drawings 864_05_005 to 010. The deepest peat is recorded within the Rossport (Commonage), where peat is up to 5m deep.
- (5) The walkover survey of the pipeline route was carried out to identify salient ground conditions, in particular evidence of peat instability that may pose a potential risk to the pipeline route. The findings of the walkover survey of the route identified no apparent signs of peat instability that would pose a risk to the pipeline route.
- (6) A stability assessment of the route was carried out using an infinite slope approach to model the stability of natural peat slopes. The stability analysis examined the following potential failure models:
 - (a) Potential failure in the peat within the basal zone of the peat (total stress and effective stress condition), and
 - (b) Potential failure in the mineral soil just below the peat-mineral interface (total and effective stress condition).
- (7) The stability analysis examined two load cases namely (1) no applied loading and (2) 10kN/m² applied loading.
- (8) The results of the stability analysis (for all potential failure models) showed that the natural peat slopes along the proposed pipeline route have an acceptable Factor of Safety (FoS) of 1.5 or greater in accordance with relevant standards (BS 6031:1981 and Eurocode 7) where the peat is not loaded.
- (9) In the case where the peat is loaded by 10kPa the FoS was less than 1.5 for undrained failure within the basal zone of the peat at two locations (ch. 87,220 and 89,690).

- (10) The localised areas where the FoS was low corresponded to locations where there were particularly low undrained strength values (1 and 2kPa) recorded from the insitu hand vanes.
- (a) At about ch. 87,220 in Rossport (Commonage) the undrained FoS is 1.3. This corresponds to a notably low value of undrained strength (1kPa) and is located close to a series of shallow bog pools. Given the increasing slope inclination to the east of this location, it is considered that this area represents an increased risk of peat instability.
 - (b) At about ch. 89,690 South of Sruwaddacon Bay results of analysis show that the FoS is 1.3. This corresponds to an area of relatively intact peat, where the peat strength is 1kPa at 1m bgl. The strength used in the analysis (1kPa) is notably low and possibly not representative of the peat conditions.
 - (c) At about ch. 96,690 on the approach to the terminal results of analysis show that the FoS is 1.0 for load condition (2). This corresponds to a notably low value of undrained strength (2kPa) with a slight increase in the slope inclination at this location. The strength used in the analysis (2kPa) is notably low and possibly not representative of the peat conditions. A stone road has already been safely constructed in this area.
- (11) In general the high FoS calculated for the proposed pipeline route would indicate that there is limited potential for instability of the natural peat slopes. The high FoS for the route would correspond to the findings of the walkover survey of the route which identified no apparent signs of peat failure.
- (12) Findings of the walkover survey of the route identified the following critical areas with respect to peat stability:
- (a) Areas of machine cut peat within the commonage. There are extensive areas of machine cut peat (for example ch 86,250 to 86,600, ch 87,300 to 87,450). The use of stone road construction method will mitigate against any significant peat failure risk; though temporary excavations in cut areas may need to be supported to avoid local collapse of excavation.
 - (b) Areas of wet/weak peat. There is a series of shallow bog pools within an area of relatively intact peat (ch 87,200 to 87,300). This area has notably weak and deep peat and its location at the crest of a slope represents an area of greater risk.
 - (c) Areas of deep peat. Around ch 88,100 there is an area of significantly deep peat (up to 5m deep). This area likely has a significant thickness of weak amorphous peat at depth.
- (13) Extensive ground investigations have been carried out along the route though investigation has been limited in some areas due to access difficulties. Using the investigation data the stability assessment has shown that the natural peat slopes have a satisfactory FoS. Notwithstanding the above, it is recommended that prior to

construction confirmatory ground conditions is carried out in selected areas to re-confirm the ground conditions as follows:

- (a) Insitu vane tests (using mechanical vane) and undisturbed sampling for associated laboratory testing in peat to establish strength and general characteristics.
- (b) Insitu tests and undisturbed sampling for associated laboratory testing in underlying mineral soil to establish strength and general characteristics.
- (c) Particular locations for investigation are within Rossport (Commonage) as a whole and particularly within machine cut peat areas (for example ch 86,250 to 86,600, ch 87,300 to 87,450), in the vicinity of the series of shallow bog pools (ch 87,200 to 87,300) and the area of deep peat around ch 88,100.

(14) In conclusion

- (a) The walkover survey of the pipeline route, carried out to identify salient ground conditions and in particular evidence of peat instability, identified no evidence of peat failure that would pose a risk to the pipeline route.
- (b) Results of a stability analysis showed that the natural peat slopes along the proposed pipeline route have an acceptable FoS. The high calculated FoS for the route corresponds to the findings of the walkover survey of the route which identified no evidence of peat failure.
- (c) Several localised areas of weaker peat were identified along the route. These areas are not considered to represent a significant risk to the pipeline construction, particularly taking into account the use of a stone road construction method in the peat.
- (d) Taking into account the findings of the walkover survey, the results of the stability assessment and the proposed stone road construction method it is considered that the pipeline can be safely constructed along the proposed pipeline route.

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FIGURES

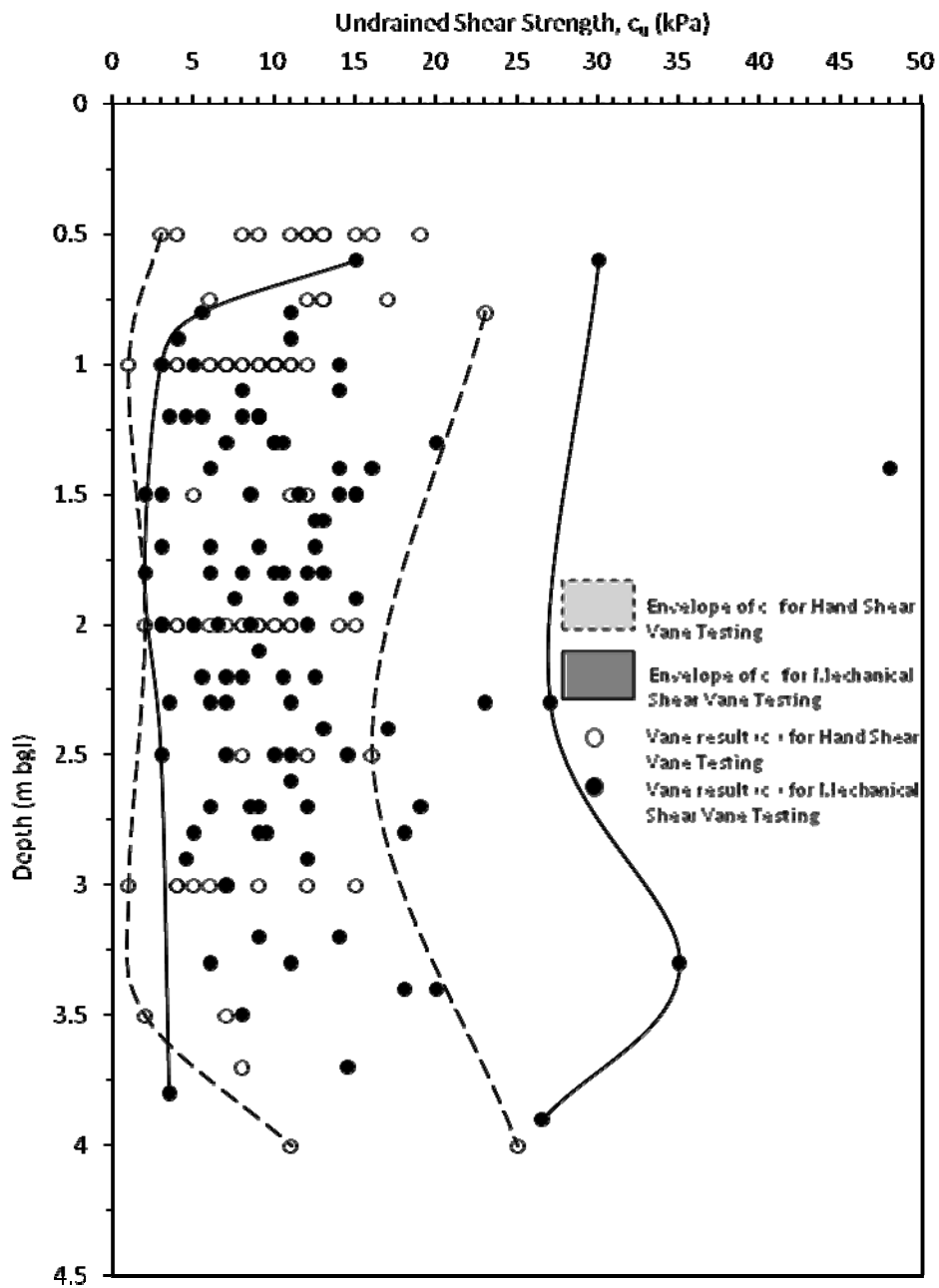


Figure 1 Comparison of Undrained Shear Strength (c_u) for Peat with Depth for Hand and Mechanical Shear Vanes

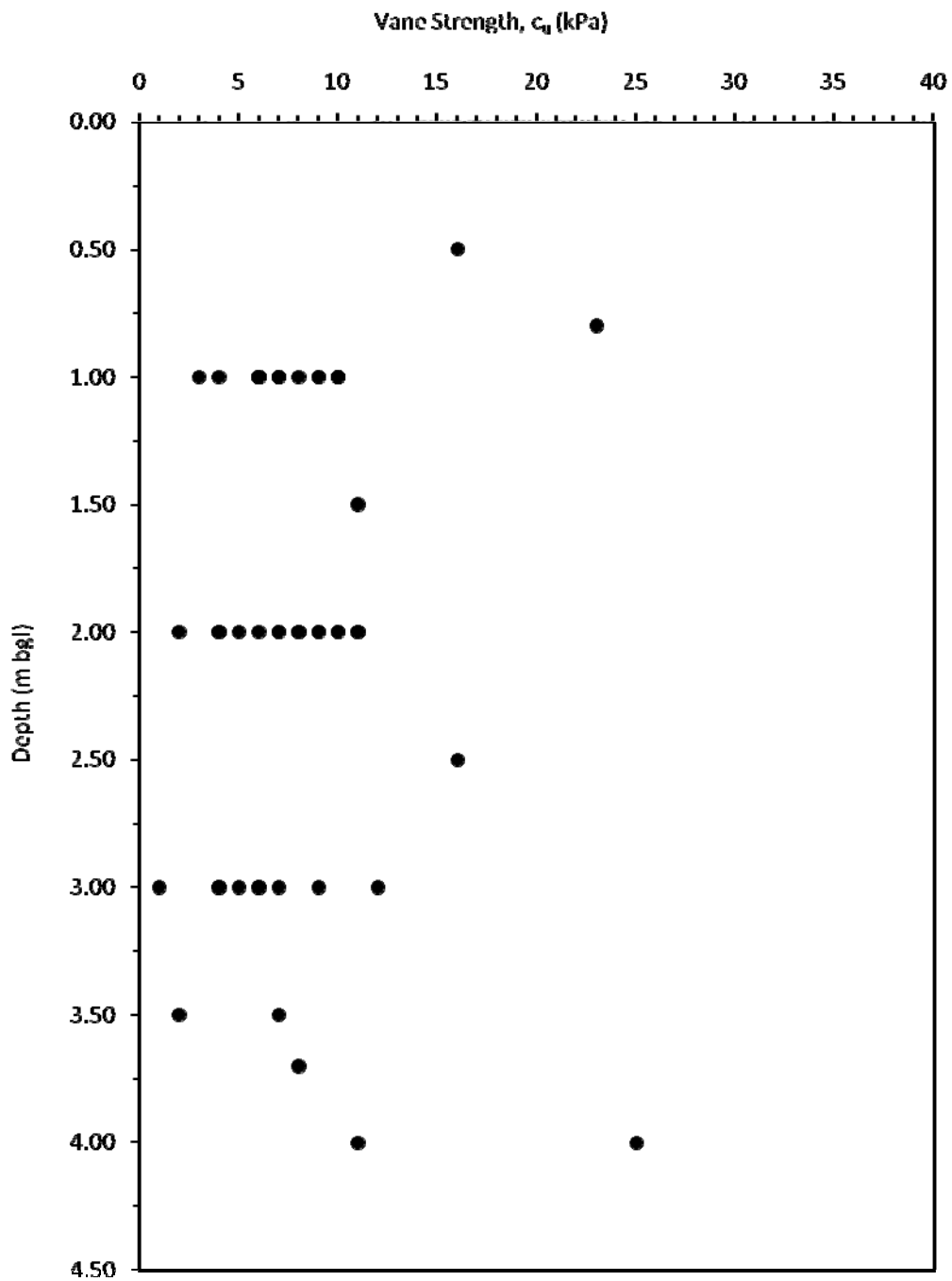


Figure 2 Shear Vane Strength (c_u) for Peat with Depth, Rossport (Commonage)

Note

- (1) Results based on insitu tests using SL810 hand vane with 33mm diameter vane
- (2) Vane results are not corrected for plasticity.

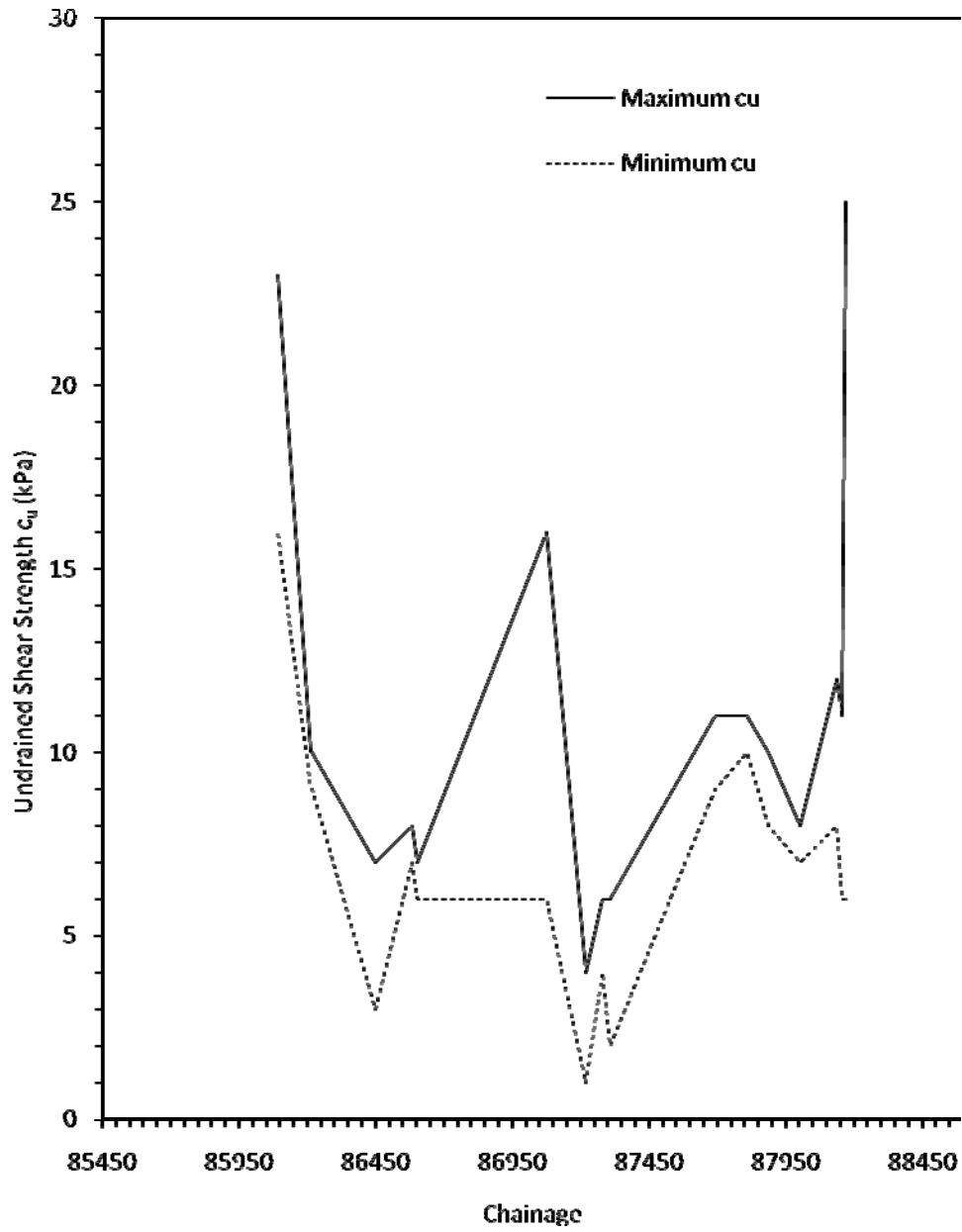


Figure 3 Shear Vane Strength (c_u) for Peat with Depth against Chainage along Pipeline Route at Rossport (Commonage)

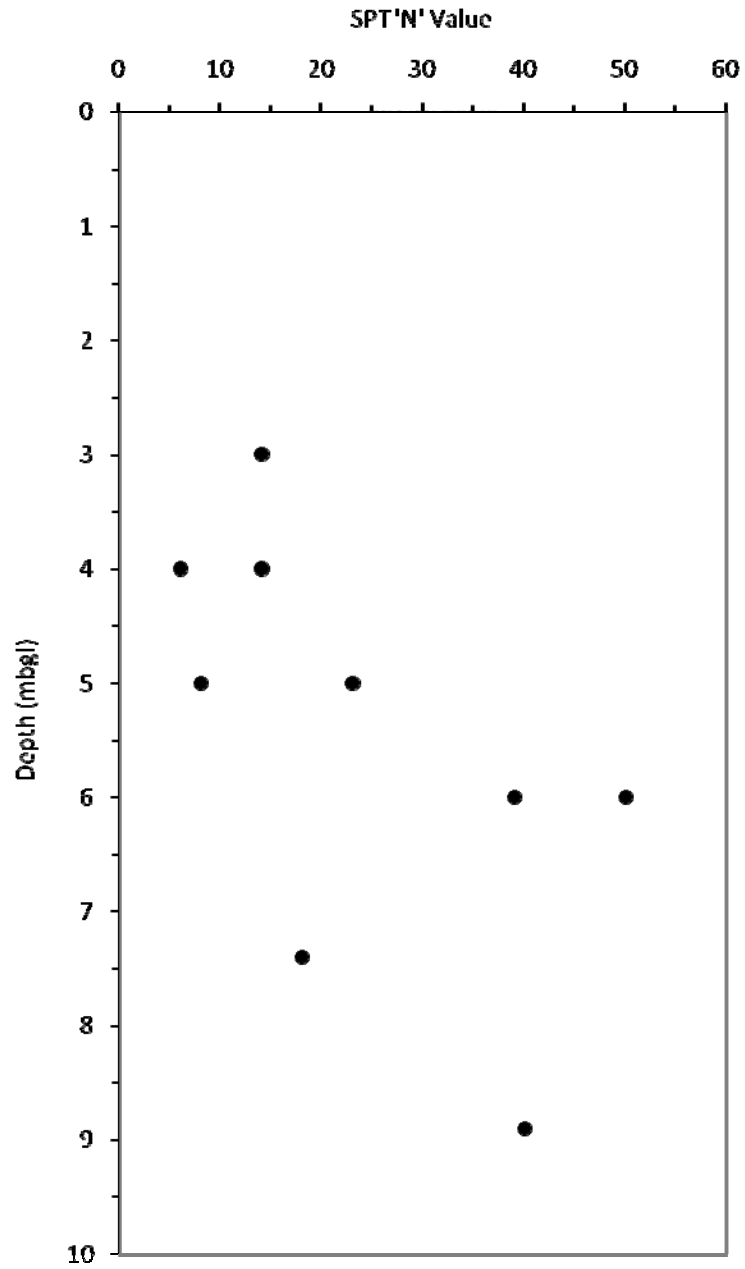


Figure 4 SPT 'N' Value versus Depth for Mineral Soil below Peat, South of Sruwaddacon Bay to L-1202

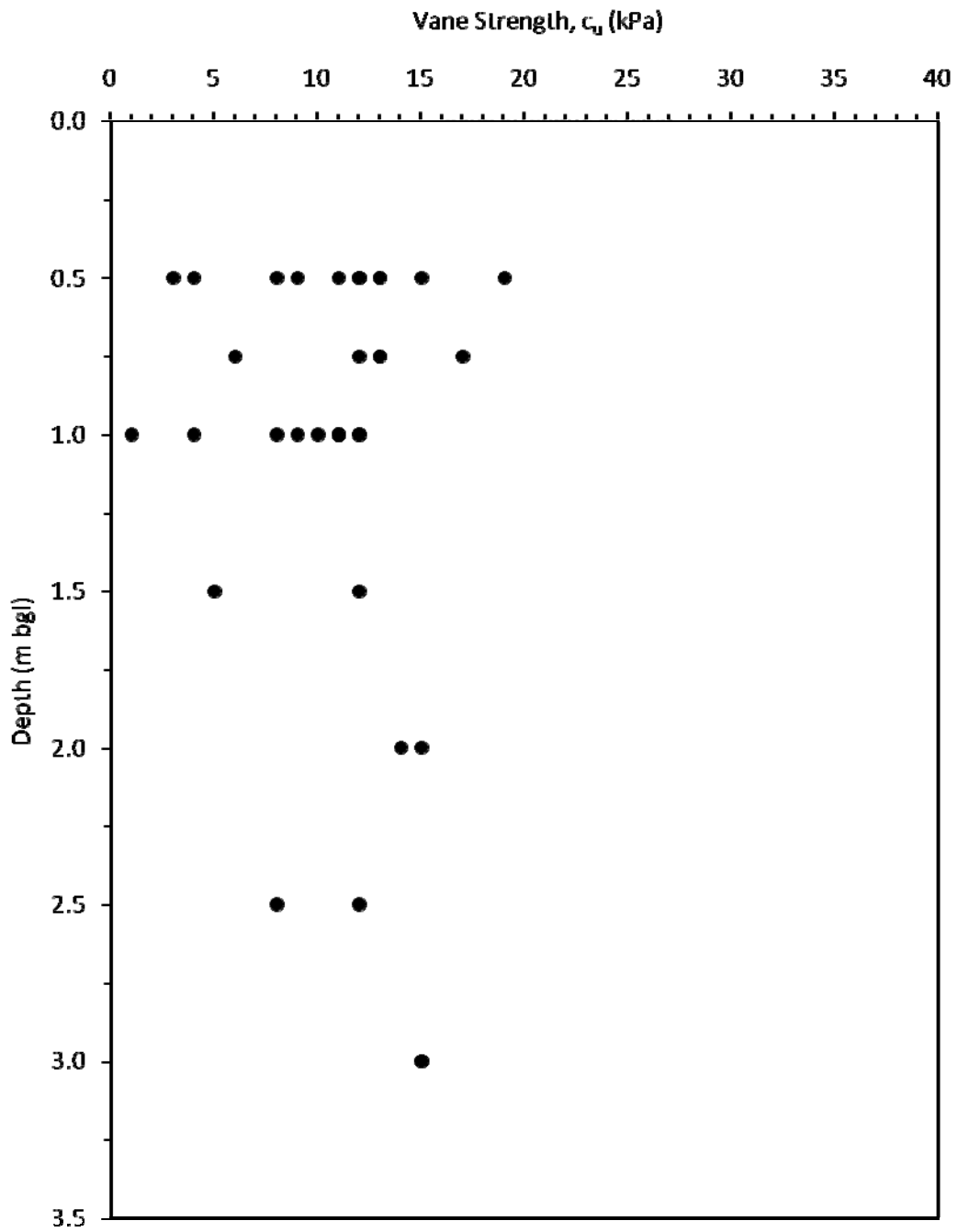


Figure 5 Shear Vane Strength (c_u) for Peat with Depth, South of Sruwaddacon Bay to L-1202

Note

- (1) Results based on insitu tests using SL810 hand vane with 33mm diameter vane
- (2) Vane results are not corrected for plasticity.

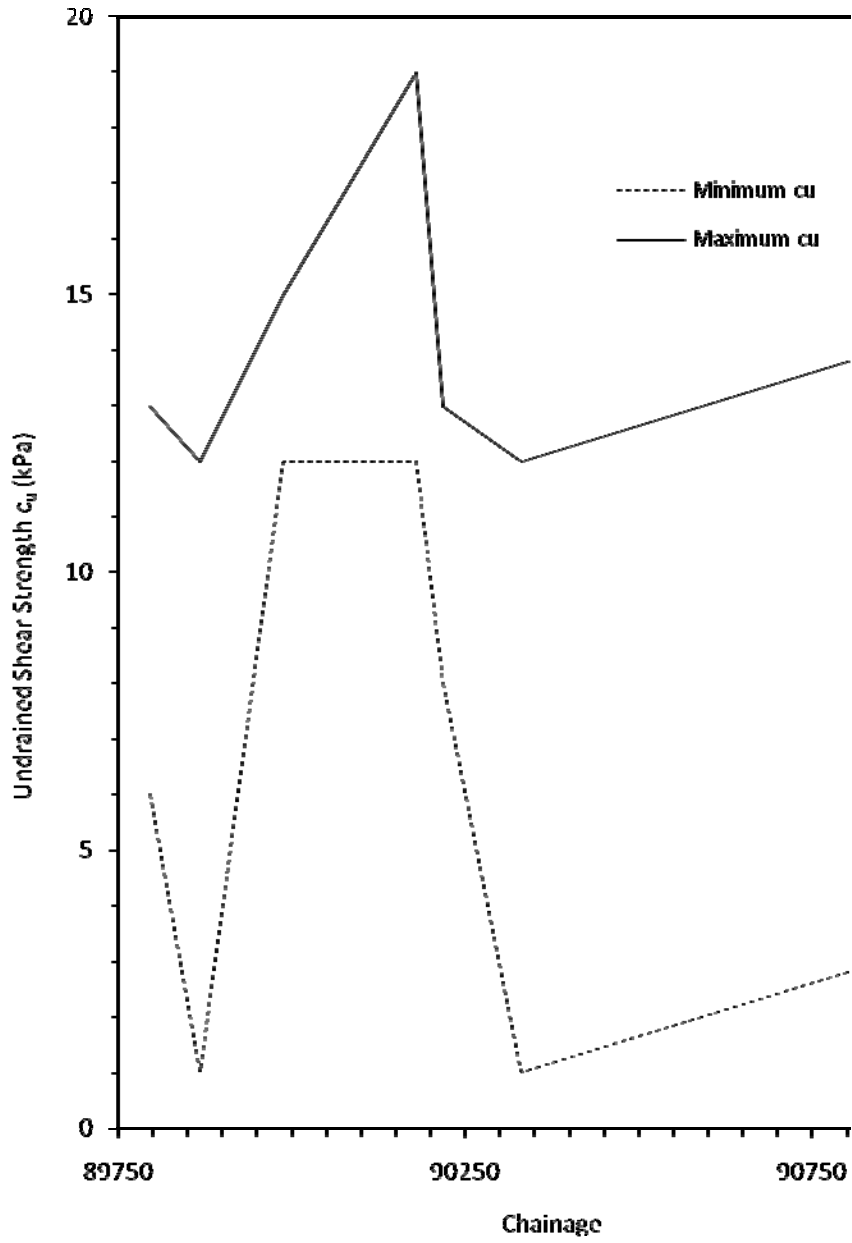


Figure 6 Shear Vane Strength (c_u) for Peat with Depth against Chainage along Pipeline Route, South of Sruwaddacon Bay to L-1202

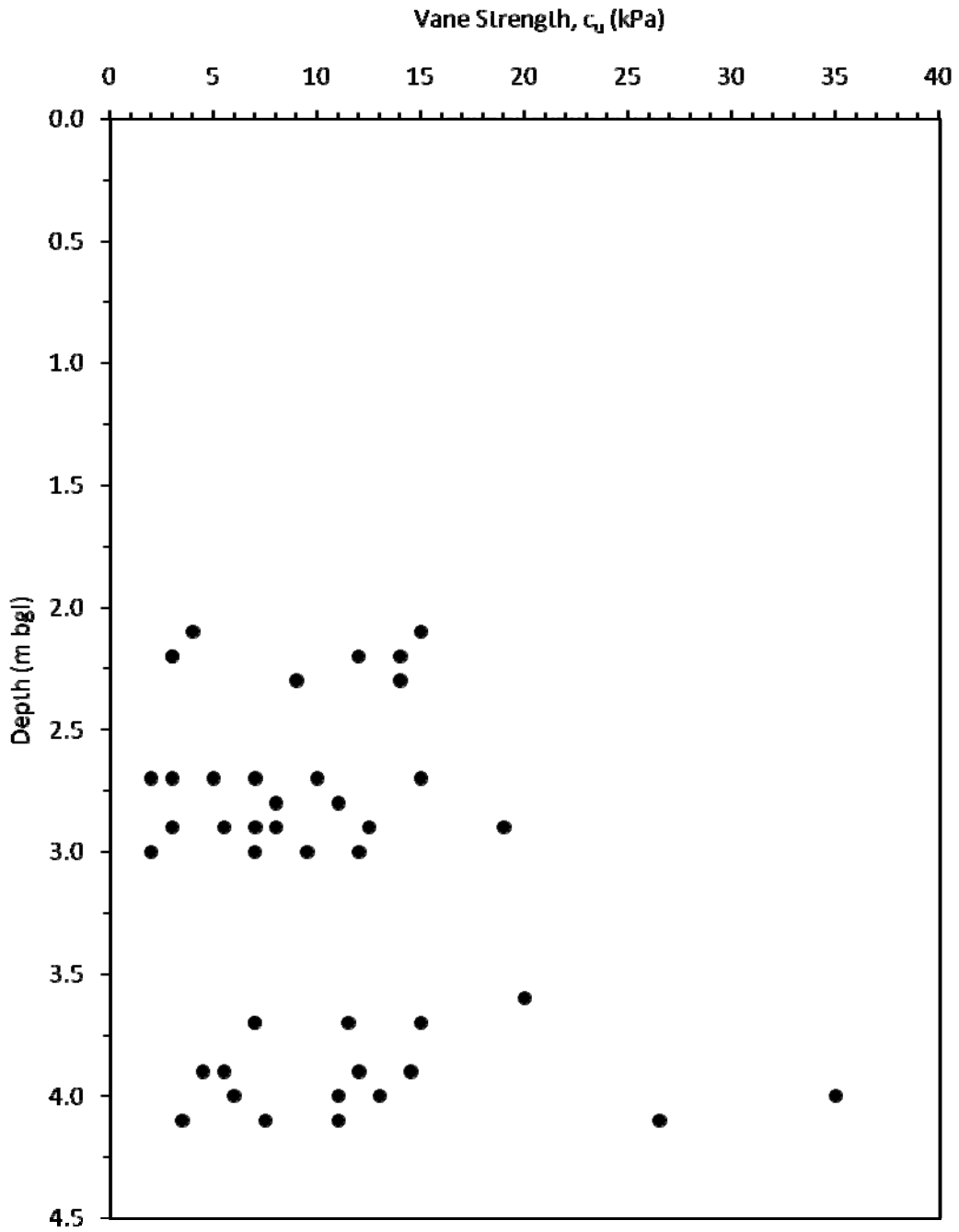


Figure 7 Shear Vane Strength (c_u) for Peat with Depth, L-1202 to Terminal Site

Note

- (1) Results based on tests using Geonor H-10 mechanical vane with 65mm diameter
- (2) Vane results are not corrected for plasticity.

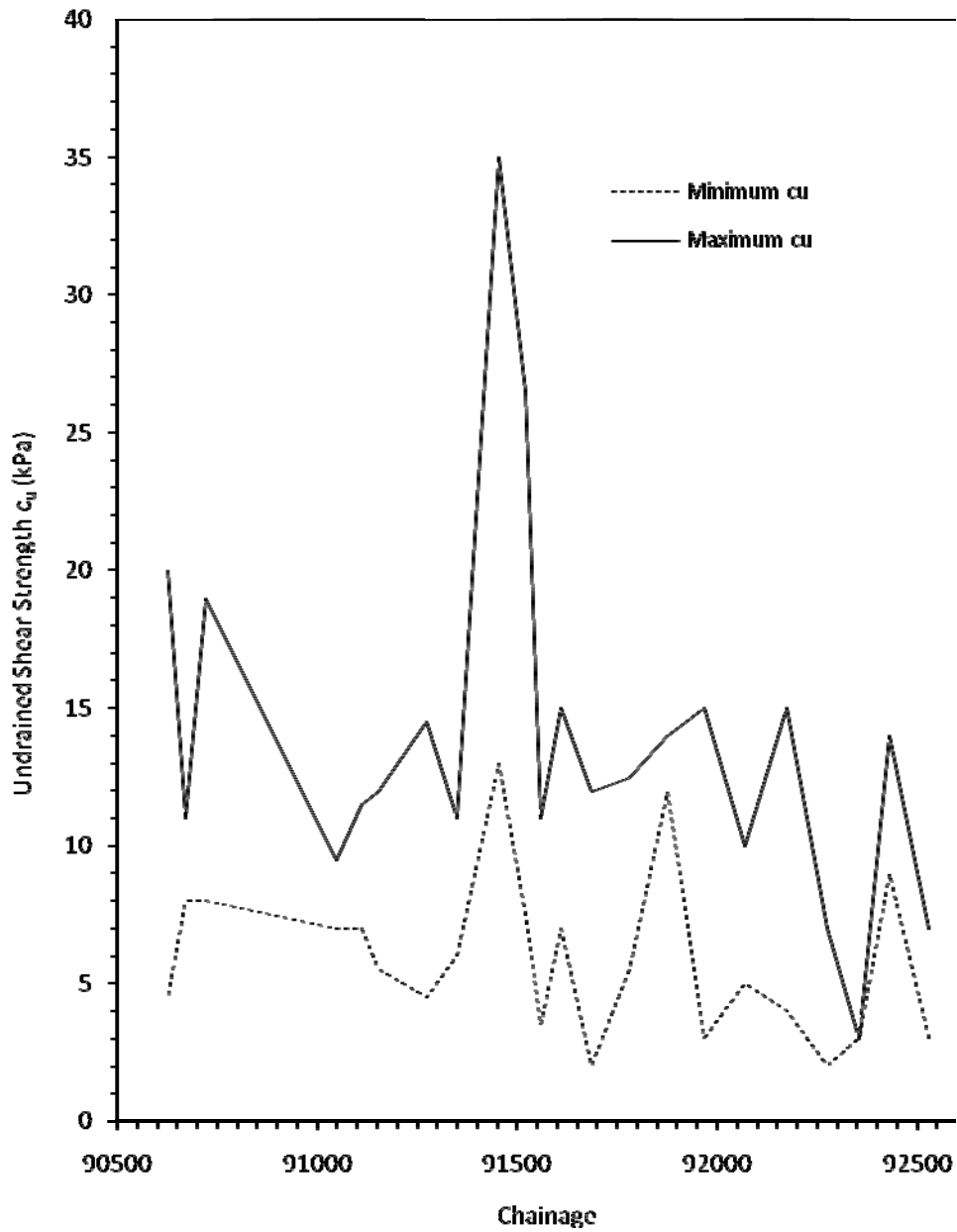


Figure 8 Shear Vane Strength (c_u) for Peat with Depth against Chainage along Pipeline Route between L-1202 and Terminal Site

APPENDIX A
FINDINGS OF GEOMORPHOLOGICAL SURVEY

Table A1 Section 1 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
83.400	84.065	1°	Uniform slope with undulations to the north	At landfall area: 0-0.5m peaty topsoil 0.5 – 2.5m firm brown very sandy gravelly silt with some to much angular cobbles 2.5- 3m Very dense brown gravelly angular to sub rounded mixed lithology cobbles. Gravels showing localised foliation. Variable rockhead from >1.6m to 3m at landfall. Strong light brown to grey medium grained psammite/semi pellicite extensively fractured and locally weathered. 3 sets of sub vertical fractures spacing commonly <100mm. Sub horizontal fractures spacing commonly <300mm Sand underlies part of the route.	Surface run off and several large ditches	Grazing land	Peaty topsoil	1.1 1.2 1.3



Table A2 Section 2 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
84.065	84.250	Shallow <1°	Shallow beach terrace on foreshore of bay.	-	Tidal zone	Grass	None	2.1
84.250	84.445		Low tidal zone					
84.445	84.470	Shallow <2°	Shallow beach terrace on foreshore of bay	Occasional bedrock exposures with sand gravel and angular cobbles and boulders	Tidal zone	Tidal	None	

Table A3 Section 3 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
84.470	84.480	Locally steep to sub-vertical	Locally steep (2-2.5m) soil rock cliff	0 – 2m weathered rock and till 2 – 2.5m intact rock		Scrub	None	3.1
84.480	84.510	11 to 21°	Uniform slope	0 – 0.5m peaty topsoil >0.5m firm brown gravelly sandy silt with occasional cobbles	Surface runoff	Grazing land	Peaty topsoil	3.2
84.510	84.800	2 to 5°	Headland with convex slope to cliff face	0 – 0.5m peaty topsoil +0.5m firm brown gravelly sandy silt with occasional cobbles Rock at shallow depth. Vertical/sub vertical moderate to closely spaced joints predominate.	Surface runoff/ditches	Grazing land	Peaty topsoil	3.3
84.800	85.640	4 to 5°	Uniform slope with minor shallow depressions	0 – 0.5m peaty topsoil occasionally slightly sandy, gravelly silt. >0.5m firm to stiff reddish brown gravelly silty sand. Localised layers of cobbles. Localised slumping of bank and erosion caves or pipes at base of slope Rock not exposed in foreshore cliff	Surface runoff. Occasional water filled ditches running downslope and discharging on beach	Grazing land	Peaty topsoil	3.4 3.5
85.640	85.815	4 to 5°	Uniform slope	0 – 0.2m peaty topsoil	Surface runoff	Grazing land	Peaty topsoil	3.6
85.815	85.960	3°	Uniform slope	0 – 0.4m peaty topsoil 0.4 – 1.3m soft to firm light brown sandy, gravelly silt.	Surface runoff/ditches. Localised ground water	Grazing land. Localised marshy	Peaty topsoil	

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
85.960	86.250	1.5 to 3°	Uniform slope becoming slightly concave. Localised irregular surfaces common	0 – >3m Peat becoming thicker to east	Surface runoff/ditches flowing northeast. Shallow standing water in irregular surface and flat lying areas	Peat commonage with localised areas of cut peat commonly < 1m deep. Locally marshy. Grazing	Depth: 0.7m in west becoming +3m in east Drainage: Surface runoff into ditches flowing northeast. Well drained in west. Shallow standing water in irregular surfaces and flat lying areas. Ground waterlogged to east. Land use: Domestic peat cutting and limited grazing. Condition: Fibrous and relatively firm to the west becoming soft and wetter to the east.	4.1

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
86.250	86.600	0 to 2°	Saddle slope with ridge/watershed 100m to the south	0 – >3.6m Peat	Surface runoff/ditches flowing northeast. Shallow standing water in irregular surface and flat lying areas	Peat commonage with extensive areas of machine cut and localised areas of cut peat. Locally marshy. Grazing	<p>Depth: 2m at ridge to south. +3.6m to north reducing to 3.3m eastwards</p> <p>Drainage: Ditches in central area flowing northeast. Ground waterlogged to north in flat lying areas and where peat levels reduced by cutting/grazing.</p> <p>Land use: Extensive areas of peat cut by machine and localised areas of steep sided peat banks (commonly < 1m high) where peat has been removed.</p> <p>Condition: Peat has been extensively cut along the proposed pipeline route. Machine cut centres 0.5 to 1m with areas of multiple cross cutting. Depth of cuts approx 1m and cuts commonly water filled. Quaking of bog common along proposed route.</p>	<p>4.2</p> <p>4.3</p> <p>4.4</p> <p>4.5</p>

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
86.600	87.050	0 to 3°	Raised ground 50m to south forming flat top east/west trending hill	0 – 2.6m peat becoming thicker to north and reducing to 1m thick to south + 2.6m firm greenish/brown sandy gravely silt. Mineral soil exposures to south where peat removed by cutting. Ancient tree roots and cobbles exposed on excavated surfaces	Surface runoff/ditches flowing north. Shallow standing water in irregular surfaces and flat lying areas	Peat commonage with extensive areas of machine cut and localised areas of cut peat. Locally marshy. Grazing	Depth: 1m at hill to south. Up to 2.6m to north, east and west of hill. Drainage: Ditches generally flowing north. Ground waterlogged in localised areas where peat levels reduced by cutting/grazing and in flat lying areas. Land use: Extensive areas of peat cut by machine and localised areas of steep sided peat banks (commonly < 1m high) where peat has been removed. Condition: Peat has been extensively cut along the proposed pipeline route. Machine cut centres 0.5 to 1m with areas of multiple cross cutting common. Depth of cuts approx 1m and cuts commonly water filled.	4.6 4.7 4.8 4.9 4.10

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
87.050	87.400	0.5 to 2°	Central ridge of a east-west trending hill with gentle slopes to the north, south and east	0 – >3.1m peat becoming thicker to the north and east	At eastern end series of shallow bog pools unconnected at surface located. Surface runoff. Ground waterlogged where peat machine cut	Peat commonage with localised areas of machine cut peat. Locally wet. Localised shallow pools of standing water. Grazing. Power lines crossing proposed pipeline route	Depth: 2.6m in west to +3.1m in east Drainage: General surface runoff. Localised shallow pools of standing water, commonly < 3m diameter located predominantly south of the proposed pipeline at eastern end. Standing water where peat has been machine cut north of proposed pipeline. Land use: Localised areas of peat cut by machine. Power lines including poles crossing proposed route at eastern end of survey. Condition: Peat has been locally machine cut to the north and south of the proposed pipeline. It is possible that the shallow water pools are a result of construction operations to install the power lines (?). Generally the condition of the peat is wetter and weaker eastwards becoming soft and quaking underfoot.	

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
87.400	87.550	2 to 3° (est)	Uniform slope with slight convexity	Peat - depths not proven	In cut peat areas surface runoff with ditches draining to the roadside drainage to the east Ground waterlogged where peat machine cut	Peat commonage with extensive areas of cut peat and localised areas of machine cut peat.	Depth: not proven Drainage: Surface runoff with ditches draining to the north east in hand cut peat areas. Localised areas of standing water in blocked ditches Land use: Extensive areas of cut peat to adjacent road with localised areas of machine cut peat to the west. Areas of steep sided peat banks (about 1m high) where peat has been removed. Condition: Peat has been extensively cut beside road with localised area of machine cut to the west. Peat becoming softer to the west were machine cut	

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
87.550	87.940	0.5°	Uniform slope to north east with gentle ridge to south	0 –0.75m peat in the west with upper 0.5 to 0.6m firm and fibrous. > 0.6m peat becoming softer and more amorphous in the west 0 – 1.8m peat in the east	Surface runoff with ditches draining to the north east in cut peat areas	Peat commonage with extensive areas of cut peat and localised areas of machine cut peat. Grazing	Depth: 0.75m in the west, 1.8m in the east Drainage: Surface runoff with ditches draining to the north east in hand cut peat areas. Localised areas of standing water in blocked ditches Land use: Extensive areas of cut peat to the west with localised areas of machine cut peat to the east. Areas of steep sided peat banks (commonly < 1m high) where peat has been removed. Condition: Peat has been extensively cut to the northwest with localised area of machine cut to the southeast. Peat becoming softer to the southeast	4.11

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
87.940	88.030	1°	Poorly defined shallow valley perpendicular to proposed pipeline sloping northeast	1.8 – 5 peat. Peat surface becoming hummocky and wetter to the southeast	Surface runoff forming discrete multi-directional channels within the surface vegetation/peat culminating in a sink hole approx 20m northeast of the proposed pipeline route	Peat commonage. Grazing	Depth: 1.8m in the west, 5m in the east Drainage: Surface runoff forming discrete multi-directional channels within the surface vegetation culminating in a sink-hole approx 10m northeast of the proposed pipeline route. Ground water within sinkhole flowing northeast. No spring/uprising water present. Land use: Grazing Condition: Peat becoming wet and soft especially in drainage surface channels. Where the peat is becoming hummocky to the southeast the raised sections of peat are firm and fibrous	

Table A4 Section 4 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
88.030	88.270	0.5 to 2.5°	Gentle slope with discrete ridge towards northern end. Slope increasing to south	0 – 5m peat to north. Hummocky 0 – 1.5m peat to south within cuts with ancient tree roots	Surface runoff. Ditches to the south	Peat commonage. Areas of hand cut peat to the south. Grazing	Depth: 5m to the north. 1.5m to the south Drainage: Surface runoff forming discrete surface channels to the north. Surface runoff and ditches in areas of hand cut peat in the south Land use: Peat commonage. Areas of cut peat to the south forming peat banks >1m high adjacent to road. Peat has been locally machine cut to the northeast. Grazing. Condition: Peat becoming firmer, less hummocky although undulating to the south	
88.270	88.600	2.5 to 4.5°	Uniform slope becoming steeper to the south near foreshore	0 – 0.3m peaty topsoil commonly between and adjacent to peat hummocks. Peat depth is variable and is up to several metres. 0.3 – 0.5m firm reddish brown slightly sandy, slightly gravelly silt +0.5m firm light grey silty gravelly sand with sub-rounded to sub-angular cobbles	Surface runoff and drainage ditches/streams along field boundaries	Peat commonage. Grazing	Depth: 0.5m to several metres south side of the road. Drainage: Surface runoff, channels and drainage ditches/streams along field boundaries Land use: Peat commonage. Cut peat and grazing Condition: Peat forming isolated hummocks. Peat firm and fibrous at coast.	4.12 4.13



Table A5 Section 5 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
88.600	88.630	3°	Uniform slope beach with slightly raised 5 to 6m terrace	0 – 0.15m topsoil >0.15m gravelly silty sand many/ occasional cobbles	Tidal zone	Tidal	None	5.1
88.630	88.470		Low tidal zone					
89.470	89.500	3 to 3.5°	Uniform slope beach with slightly raised 5-8m wide spit and irregular to hummocky paleo-terrace to the south	Paleo terrace: 0 – 0.15m topsoil 0.15 – 0.6m firm dark to light brown organic sandy slightly gravelly silt with typically 10mm laminations of sand and fine gravel with occasional tree roots. Estuarine sediments: Soft silty sand with occasional shells and cobbles becoming sandy gravel with cobbles at 5m from terrace. Spit materials: Sandy gravel with many cobbles and few boulders forming 20m long x 8m wide spit feature adjacent to the west side of the proposed pipeline	Tidal zone	Tidal	None	5.1

Table A6 Section 6 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
89.500	89.510	Locally steep to sub-vertical	Locally steep 2 – 2.4m soil peat cliff	0 – 2.1m soft to firm dark brown fibrous peat with lower 0.3m amorphous peat. Tree roots at 1.8m 2.1 – 2.4m firm brown silt with rootlets.	Erosion drains occasionally cutting through cliff face		Peat locally eroded at cliff face due to surface runoff channels	6.1 6.2
89.510	89.950	2 to 4.5°	Uniform slope becoming steeper eastwards	0 – 2.1m soft to firm dark brown fibrous peat	Surface runoff. Single ditch along field boundary	Grassland/grazing	Depth: 2.1m at foreshore and upslope, reducing to 0.8m eastwards. Drainage: Surface drainage, occasional ditch. Land use: Grazing. Area of cut peat to the south Condition: Peat generally soft to firm, extensively hummocky and undulating (likely due to over grazing) with dendritic water channels forming in between hummocks.	6.3

Table A6 Section 6 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
89.950	90.040	4.5 to 6.5°	Sloping down eastwards and increasing at break of slope.	0 – 1.1m soft to firm dark brown fibrous peat. Localised cultivation. Tree roots at base of peat common. >1.1m firm to stiff brown very sandy gravelly silt with angular to sub rounded cobbles.	Surface runoff. Single ditch cross-cutting proposed pipeline.	Extensive areas of cut peat. Grazing. Grasslands	Depth: 1.1m reducing eastwards to 0.5m. Extensive areas where peat removed by cutting. Drainage: Surface runoff. Single drainage ditch perpendicular to proposed pipeline. Land use: Some cut peat. Grazing to the east Condition: Peat soft to firm. Eastwards peat likely to have been reclaimed for agriculture.	6.4 6.5
90.040	90.050	Sub-vertical to sub horizontal	Locally steep soil and man-made rubble wall adjoining flat man-made stone/rubble track	0 – 0.7m rubble wall 0.7 – 1.3m firm light brown very sandy gravelly silt	Surface runoff	Access	None	6.6
90.050	90.090	Sub horizontal	Flat lying river crossing with low terraces	Sandy gravel with extensive cobbles.	Surface runoff		None	6.6
90.090	90.100	Sub vertical to sub horizontal	Locally steep soil bank adjoining flat man made stone/rubble track	0 – 0.2m soft to firm dark brown peaty topsoil 0.2 - 1.2m firm dark to light brown slightly organic sandy gravelly silt with occasional cobbles	Surface runoff. Erosion feature on bank channelling runoff	Access	None	

Table A6 Section 6 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
90.100	90.180	4.5 to 8.5°	Uniform to convex slope	0 to 1.5 m soft to firm dark brown fibrous silty peat. Likely reclaimed.	Surface runoff. Localised channelling	Grazing. Grasslands. Reeds	Depth: 0.2 to 1.5m – onwads Drainage: Surface runoff. Localised channelling Land use: Grazing Condition: Peat likely to have been reclaimed for agriculture	6.7
90.180	90.220	4°	Slightly convex slope	0 – 2m soft to firm fibrous peat	Surface runoff. Ditches to east, west and north	Domestic cut peat	Depth: 2m to the east, 1.5m to the west Drainage. Ground waterlogged where peat excavated. General surface runoff northwards into ditches. Land use: Domestic cut peat. Condition: Peat cut in bays with narrow banks of intact peat in between. Intact peat uneven and area where peat excavated undulating and waterlogged	
90.220	90.380	2.5 to 3.5°	Generally uniform slope. Slightly convex and raised to the west	0 – 3.5m soft to firm peat	Surface runoff. Ditch at boundary to east	Grazing. Grasslands	Depth: +3.1m to the south and northeast. 2.7m to the northwest Drainage: Surface runoff with discrete shallow water channels northwards and minor valley Land use: Grazing Condition: Intact peat slightly undulating and uneven	

Table A6 Section 6 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
90.380	91.100	0.5 to 1°	Generally gentle slope to north with very slight N-S trending depression and stream in west	0 – 3.3m soft to firm fibrous peat	Drainage ditches trending NW SE generally at 3.5m centres and occasional NE-SW trending ditches along access tracks and firebreaks	Forestry land with dense mature trees to the west young trees and harvested areas to the east and north	Depth: 1.2m to the west, 3.3m to the east. Drainage: Forestry drainage ditches generally spaced at 3.5m centres with water flow to the west. Ditches along firebreaks and tracks flowing N to NE Land use: Forestry Condition: Peat extensively vegetated and generally well drained at surface	

Table A7 Section 7 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
91.100	91.210	0.5 to 1°	Initially gentle slope reducing as approaching ridge line	0 – >3.8m soft to firm brown to dark brown peat	Drainage ditches NE-SW trending ditches along access track/break	Edge of forestry land overgrown with scrub and bushes	Depth: 3.2m to the northeast, >3.8m at the ridge line Drainage: Forestry drainage ditches spaced along access track draining northeast Land use: Forestry Condition: Peat vegetated and drained at surface	
91.210	91.470	0.5 to 1°	Gentle slope south increasing southwards	0 – >3.7m soft to firm brown to dark brown peat	Drainage ditches E-W 3 to 6m spacing. N-S trending ditches along access track	Forestry land with mature trees to the west and young trees to the east	Depth: >3.7m to the south, 3.7m to the north Drainage: Forestry drainage ditches spaced at 3 to 6m with drainage west. N-S trending ditches along access track draining south Land use: Forestry Condition: Peat extensively vegetated and generally well drained at surface	7.1

Table A7 Section 7 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
91.470	91.500	2 to 4°	Slightly concave slope	0 – >3.4m soft to firm dark brown peat	Drainage ditches E-W trending 3 to 6m spacing. N-S trending ditches along access track	Forestry land with mature trees to the west and east	Depth: >3.4m Drainage: Forestry drainage ditches spaced at 3 to 6m with drainage west. N-S trending ditches along access track draining south Land use: Forestry Condition: Peat extensively vegetated and generally well drained at surface	7.2
91.500	91.530	0 to locally 8° near stream bank	'U' shaped meandering stream valley with irregular slopes	0 – 3.6m soft to firm dark brown silty peat. Silty gravely sand in stream bed	Drainage ditches and surface runoff into stream	Stream valley bordering forestry land	Depth: 2.3m to the east, 3.6m to the west Drainage: Drainage ditches and surface runoff into westward flowing stream Land use: Forestry Condition: Peat soft and waterlogged adjacent to stream	
91.530	91.560	1°	Gentle slope north	0 – 3.6m soft to firm dark brown peat	Drainage ditches E-W trending 3 to 6m spacing. Occasional NW-SE and N – S trending ditches crosscutting	Forestry land with sparse young trees	Depth: +3m to east and west. Drainage: Forestry drainage ditches E-W trending 3 to 6m spacing. Occasional NW-SE and N – S trending ditches crosscutting and flowing north. Land use: Forestry with firebreaks Condition: Peat soft to firm drained at surface by ditches	



Table A7 Section 7 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
91.560	91.920	3°	Uniform slope to the north-north west.	0 - 3.7m soft to firm brown to dark brown peat with upper 0.6m fibrous	Drainage ditches E-W trending commonly 15m spacing. N-S trending ditch adjacent to area of stacked peat approx 20m east of access track. Surface runoff along access track	Forestry land with dense mature trees to east and west of access track/firebreak	Depth: 3.7m to the south and 3.1m north reducing to 3.1m in central areas. Drainage: Forestry drainage ditches E-W trending commonly 15m spacing. N-S trending ditch adjacent to area of stacked peat approx 20 east of access track. Land use: Forestry with firebreaks Excavated peat stacked <1m high between 12 and 20m wide on east side of 12m wide access track Condition: Peat soft to firm fibrous over top 0.6m. Well drained by surface ditches	

Table A7 Section 7 - Geomorphological Summary of Proposed Onshore Pipeline Route (see Notes at end)

Approximate Chainage		Slope (degs)	Morphology	General Soil and Rock Conditions	Drainage	General Land Use/Land Cover	Peat Conditions	Photo
To	From							
91.920	92.400	1 to 2°	Uniform slope to the north-north west.	0 - >3.1m soft to firm brown to dark brown peat with upper 0.6m fibrous	Drainage ditches E-W trending commonly 15m spacing. N-S trending ditch adjacent to area of stacked peat approx 20m east of access track. Surface runoff along access track	Forestry land with dense mature trees to east and northwest of access track/firebreak and sparse young trees to the southwest	Depth: +3.1m to the north, 3.1m to the southwest typically 2.6m to the south east and in central areas. Drainage: Forestry drainage ditches E-W trending commonly 15m spacing. N-S trending ditch commencing approx 130m from southern end adjacent to area of stacked peat approx 20 east of access track. Localised waterlogged ground to the south east. Land use: Forestry with firebreaks Excavated peat stacked <1m high between 12 and 20m wide on east side of 12m wide access track and excavated peat stacked <1m high 5m wide on west side of track. Condition: Peat soft to firm fibrous over top 0.6m. Generally well drained by surface ditches	7.3
92.400	92.560		Within terminal site					