

1.0 REMEDIATION STRATEGY

The remediation strategy should be read in accordance with the latest revision of CoDa Structures' Phase 2 Engineering and Environmental Assessment Report, CoDA Structures' drawing 7861/003 and CoDA Structures' Project Specification for Earthworks.

1.01 The Site

The site is located to the west of Mount Vernon Road and lies approximately 1.0 mile to the south of Barnsley Town Centre.

The Ordnance Survey co-ordinates for the centre of the site are 434960mE, 404750mN.

The site is approximately 2.7 hectares in area.

The site can be accessed from Mount Vernon Road

The site was a former NHS hospital. The hospital buildings were recently demolished.

The general fall of the site is to the southeast.

1.02 Objectives of the Remediation Works:

The objective of remediation scheme is to improve any contaminated land into ground suitable for use for residential use with home grown produce.

1.03 Geology:

The site is underlain by the Woolley Edge Rock Formation (Sandstone). Drift deposits are unlikely to be present at the surface.

1.04 Ground Conditions:

The following typical ground conditions were encountered on the site in the CoDA Structures' trial pit investigation:-

Strata	Location						
	TP1	TP2	TP3	TP4	TP5	TP6	TP7
Approx. Ground Level (m AOD)	158.45	158.50	158.50	19.00	158.35	158.50	158.50
Topsoil	0.00 – 0.15m	-	-	-	-	-	0.00 – 0.20m
Made Ground	0.15 – 1.00m	0.00 – 0.50m	0.00 – 2.40m	0.00 – 0.65m	0.00 – 1.70m	0.00 – 0.08m	0.20 – 0.80m
Sand	1.00 – 1.70m (sand, gravel and cobbles)	-	-	-	-	0.08 – 0.90m (sand)	-
Sandstone	1.70 – 2.40m (moderately weak to strong, slightly weathered)	0.50 – 0.75m (strong, slightly weathered to fresh)	2.40 – 3.30m (moderately weak to strong, fresh)	0.65 – 0.90m (strong, becoming very strong, fresh)	1.70 – 2.00m (strong and very strong, fresh)	0.90 – 1.60m (very strong with open fractures)	0.80 – 1.50m (strong with open fractures)

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	weathered to fresh)						
Stability	Pit walls stable whilst open	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Partial collapse of pit walls	Partial collapse of pit walls in made ground

Strata	Location						
	TP8	TP9	TP10	TP11	TP12	TP13	TP14
Approx. Ground Level (m AOD)	157.00	157.90	157.90	In hollow left by demolition-	157.90	157.20	155.70
Topsoil	-	-	-	-	-	-	-
Made Ground	0.00 – 1.65m	0.00 – 0.70m	0.00 – 0.10m	0.00 – 0.70m	0.00 – 0.03m	0.00 – 0.25m	0.00 – 2.65m
Sand	-	-	-	-	0.03 – 0.75m (sand, gravel, cobbles, possible made ground)		
Sandstone	1.65 – 2.20m (moderately weak to strong, slightly weathered to fresh)	0.70 – 1.30m (moderately weak to strong with possible crown hole feature)	0.10 – 0.30m (very strong, fresh)	0.70 – 0.75m (very strong, fresh)	0.75 – 1.00m (moderately weak)	0.25 – 0.40m (moderately weak, slightly weathered)	2.65m (strong, fresh)
					1.00 – 1.20m (strong)	0.40 – 1.10m (moderately weak to strong with fracture zone)	
Stability	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Pit walls stable whilst open	Continual collapse of pit walls	Partial collapse of pit walls in made ground	Pit walls stable whilst open	Major collapse of pit walls

Strata	Location						
	TP15	TP16	TP17	TP18	TP19	TP20	TP22
Approx. Ground Level (m AOD)	156.80	157.30	157.30	154.00	154.30	157.30	154.30
Topsoil	-	-	-	-	-	-	-
Made Ground	0.00 – 2.00m	0.00 – 0.75m	0.00 – 1.30m	0.00 – 2.20m	0.00 – 1.40m	0.00 – 0.80m	0.00 – 1.50m
Sand	-	0.75 – 0.90m (sand)	1.30 – 1.45m (sand, gravel and cobbles)	-	-	0.80 – 1.10m (sand)	-
Sandstone	2.00 – 3.10m (strong with open fractures)	0.90 – 2.10m (moderate weak to strong, fresh with open joint fractures)	1.45 – 1.70m (very strong with open fractures)	-	1.40 – 2.00m (strong, highly to moderately weathered)	1.10 – 1.40m (strong, fresh)	1.50 – 1.55m (strong, fresh)
					2.00 – 2.20m (strong, fresh)		
Stability	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Sudden, major collapse of pit walls	Partial collapse pit walls in made ground	Partial collapse of pit walls in made ground of	Partial collapse of pit walls in made ground

Strata	Location				
	TP23	TP24	TP25	TP26	TP27
Approx. Ground Level (m AOD)	145.50	156.00	154.30	153.75	150.35
Topsoil	-	0.00 – 0.40m	-	0.00 – 0.15m	-
Made Ground	0.00 – 0.30m	0.40 – 2.20m	0.00 – 1.10m	0.15 – 1.70m	0.00 – 1.60m
Sand	-	-	-	1.70 – 1.90m (sand and cobbles, possible made	-

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				ground)	
Sandstone	0.30 – 0.70m (strong, fresh)	2.20 – 2.30m (strong, fresh)	1.10 – 1.30m (strong, fresh)	1.90m?	1.60m (strong)
Stability	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Partial collapse of pit walls in made ground	Major collapse of pit walls	Partial collapse of pit walls in made ground

Topsoil was encountered in trial pits TP1, TP7, TP24 and TP26.

The made ground encountered on the site generally comprised of sand, sandstone gravel and cobbles, concrete gravel and fragments and occasional topsoil, plastic fragments, metal fragments, wood fragments, floor tile, tarmac fragments, brick fragments, ash cement bond asbestos and slate fragments.

A faint hydrocarbon odour was observed in TP8 at 1.60m.

The following ground conditions were encountered in the ARP and CoDA Structures' rotary borehole investigation:-

Borehole R01	
Strata	Thickness (m)
Made Ground	5.70
Sandstone	1.40
Mudstone	5.10
Coal	1.20
Mudstone	12.70
Coal	0.70
Mudstone	3.20
Drilled Depth	30.00

Borehole R02	
Strata	Thickness (m)
Made Ground	0.80
Sandstone	12.30
Mudstone	5.40
Coal	1.00
Mudstone	1.50
Drilled Depth	21.00

Borehole R03	
Strata	Thickness (m)
Made Ground	0.80
Sandstone	12.90
Mudstone	6.00
Coal	1.10
Mudstone	1.20
Drilled Depth	22.00
Borehole R04	
Strata	Thickness (m)
Made Ground	1.60

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Sandstone	11.60
Mudstone	6.40
Coal	1.00
Mudstone	1.40
Drilled Depth	22.00

Borehole R05	
Strata	Thickness (m)
Topsoil	0.20
Made Ground	0.60
Sandstone	9.30
Mudstone	6.60
Coal	1.00
Mudstone	1.30
Drilled Depth	19.00

Borehole R06	
Strata	Thickness (m)
Made Ground	1.10
Sandstone	8.50
Mudstone	7.80
Coal	1.10
Mudstone	11.50
Drilled Depth	30.00

Borehole R07	
Strata	Thickness (m)
Made Ground	1.40
Sandstone	12.00
Mudstone	6.20
Coal	1.00
Mudstone	1.40
Drilled Depth	22.00

Borehole R08	
Strata	Thickness (m)
Topsoil	0.20
Made Ground	1.10
Sandstone	13.40
Mudstone	6.60
Coal	1.00
Mudstone	1.70
Drilled Depth	24.00

Borehole R09	
Strata	Thickness (m)
Made Ground	5.80

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Sandstone	3.90
Mudstone	4.00
Coal	1.00
Mudstone	5.30
Drilled Depth	20.00

Borehole R10	
Strata	Thickness (m)
Made Ground	0.40
Sandstone	4.80
Mudstone/Siltstone	7.80
Coal	0.80
Mudstone	3.00
Siltstone	0.80
Mudstone	5.80
Mudstone/Siltstone	4.70
Siltstone/Mudstone	1.90
Drilled Depth	30.00

Borehole R11	
Strata	Thickness (m)
Made Ground	1.00
Sandstone	3.50
Siltstone	3.30
Siltstone/Mudstone	1.70
Mudstone	4.00
Mudstone/Coal	1.00
Mudstone	2.60
Siltstone	2.90
Drilled Depth	20.00

Borehole R12	
Strata	Thickness (m)
Made Ground	0.60
Sandstone	10.40
Siltstone/Mudstone	7.00
Mudstone	1.00
Siltstone/Mudstone	1.00
Drilled Depth	20.00

1.05 Groundwater:

Groundwater was not encountered in the ARP window sampling borehole investigation.

Groundwater was not encountered in the ARP hand dug trial pit investigation.

Groundwater was not encountered during the CoDA Structures' trial pit investigation.

Groundwater was not encountered in the ARP or CoDA Structures' rotary borehole investigation.

Groundwater was not encountered during the gas monitoring in ARP window sampling boreholes WS2, WS5, WS8 and WS13.

1.06 Contamination Encountered (Summary):

When compared with the proposed Assessment Criteria in relation to residential use with home grown produce no determinants with levels in excess of Assessment Criteria were encountered in the topsoil on the site.

When compared with the proposed Assessment Criteria in relation to residential use with home grown produce, the following determinants with levels in excess of Assessment Criteria were encountered in the made ground on the site:-

Lead	2 No.	WS15 TP14	0.90 – 1.10m 1.70m	380 mg/kg 220 mg/kg
Benzo (a) Pyrene	3 No.	WS17 TP14 TP22	0.30 – 0.50m 0.60m 0.60m	80 mg/kg 6.0 mg/kg 4.3 mg/kg
Benzo (a) Anthracene	1 No.	WS17	0.30 – 0.50m	74.0 mg/kg
Chrysene	1 No.	WS17	0.30 – 0.50m	69.0 mg/kg
Benzo (b) Fluoranthene	3 No.	WS17 TP14 TP22	0.30 – 0.50m 0.60m 0.60m	57.0 mg/kg 6.1 mg/kg 4.7 mg/kg
Indeno (1,2,3-cd) Pyrene	1 No.	WS17	0.30 – 0.50m	53.0 mg/kg
Di-benzo (a,h) Anthracene	4 No.	WS17 TP14 TP14 TP22	0.30 – 0.50m 0.60m 1.70m 0.60m	8.7 mg/kg 0.99 mg/kg 0.27 mg/kg 0.61 mg/kg
Asbestos	1 No.	TP14	1.70m	Chrysotile

In view of the above there is a significant pollution linkage present on the site in relation to Lead, Benzo (a) Anthracene, Benzo (a) Pyrene, Benzo (b) Fluoranthene, Chrysene, Indeno (1,2,3-cd) Pyrene and Di-benzo (a,h) Anthracene in the made ground on the site.

The presence of asbestos in TP14 is not of concern to end users as it was encountered at 1.70m below ground level. However, there should be vigilance with regard to possible asbestos based material during the construction works.

When compared with the proposed Assessment Criteria in relation to residential use with home grown produce no determinants with levels in excess of Assessment Criteria were encountered in the natural ground on the site.

1.07 Controlled Waters:

Following the remediation works local to WS17, the levels of contamination encountered on the site are not considered to pose a significant risk to controlled waters.

1.08 Remediation Works:

- Disconnect and/or divert any live services on the site.
- Grub out all vegetation and remove from site. Any vegetation to be retained, should be adequately protected from the works.
- Inspect the site for hazardous materials visible on the surface, remove from site together with any fly tipping and rubbish to a suitably licensed tip, using approved methods and a suitably licensed contractor.
- After the initial site strip (ie removal on any vegetation or slurried surface material) the formation is to be inspected. The depth of the site strip is expected to be approximately 0.1m. Following the site inspection, and if deemed necessary, the area will be cordoned off, and soil sampling and chemical testing undertaken. No further works will be carried on site until this is undertaken. Following receipt of test results and associated risk assessment, should the proposed remediation works need to be varied this will be advised to the Local Authority in writing, together with associated correspondence and risk assessments, as appropriate.
Prior to the implementation of any changes to the Remediation Strategy on site they will need to be agreed in writing by the Local Authority.
- During general excavation works on the site, if any suspected contamination is encountered works should cease and CoDA Structures should be informed so an inspection can take place. Following the site inspection, and if deemed necessary, the area will be cordoned off, and soil sampling and chemical testing undertaken. No further works will be carried on site until this is undertaken. Following receipt of test results and associated risk assessment, should the proposed remediation works need to be varied this will be advised to the Local Authority in writing, together with associated correspondence and risk assessments, as appropriate.
Prior to the implementation of any changes to the Remediation Strategy on site they will need to be agreed in writing by the Local Authority.
- The made ground local to WS17 will be initially excavated to a depth of 0.6m below finished level or to natural ground and removed from site to a suitably licensed tip. The base and sides of this excavation will be tested (6No samples, one from each side of the excavation and two from the base) for speciated PAH to confirm the elevated PAH levels in this area of the site have reduced to those generally encountered in this area of the site. If any samples show levels similar to those encountered in the sample tested from WS17 then further material will be removed and the sides and base of the resulting further excavation will be sampled and re-tested for speciated PAH. A 0.6m minimum inert capping will then be provided in this area. The inert capping should be

laid on a layer of Terram 1000 and the upper 0.15m of the cap should be topsoil. All materials making up the cap will be validated as described in Section 1.17. The Assessment criteria for the material used will need to be in accordance with the table in Section 1.17.

- The made ground in the area of WS15, WS17, TP14 and TP22, where in garden areas should be capped with 0.6m of inert materials. The made ground local to these plots will be excavated to a depth of 0.6m below finished level or to natural ground and the material will be removed from site to a suitably licensed tip to facilitate the 0.6m capping material. Once garden areas are prepared for the capping layer the sides of the resulting excavation will be sampled and re-tested for speciated PAH and lead to confirm the extent of the proposed inert capping is adequate. A minimum of six sample locations are proposed. Alternatively, the made ground in each garden can be sampled and tested to establish whether a capping layer is required. The test results will be assessed against the Assessment Criteria adopted in the Phase 2 Engineering & Environmental Assessment test results and a risk assessment will be undertaken. If any samples fail then further material will be removed in that area (ie the extent of the capping area will be extended) and the side of the resulting further excavation will be sampled and re-tested for speciated PAH to confirm the extent of the proposed inert capping is adequate. Once the capping area is finalised the inert capping material should be placed on a layer of Terram 1000 and the upper 0.15m of the cap should be topsoil.
All materials making up the cap will be validated as described in Section 1.17. The Assessment criteria for the material used will need to be in accordance with the table in Section 1.17.
- The specification for water pipes on the development will be agreed with Yorkshire Water (YW). A risk assessment form will be submitted to Yorkshire Water.
- All service trenches should be backfilled with clean inert materials.
- The remediation activities on the site should be conducted under a Material Management Plan implemented under the Definition of Waste: Development Industry Code of Practise (CL:AIRE 2011).
- Any imported engineering fill material should be compacted in accordance with the Dpt. Highways Specification.
- Guidance should be sought from the local Waste Management Regulation Office regarding the disposal of soils from the site.

1.09 **Radon:**

No radon protection measures are required on the development.

1.10 Landfill Gas (Summary):

A summary of the monitoring results from the ARP report are shown in the table below.

Monitoring Point	Gas concentrations recorded (% v/v)		Flow rates recorded (litre/hour)
	Methane	Carbon Dioxide	
WS2	0.0	0.0 – 2.0	0.0
WS5	0.0	0.5 – 2.5	0.0
WS8	0.0	0.0 – 1.5	0.0
WS13	0.0	0.0	0.0

ND: None detected

Site Gas Regime:

Where Flow rates are shown as 0.0 a default value of 0.1 litres/hour has been used, representing the limit of detection of the measuring equipment.

The gas monitoring data has been appraised in order to assess the potential gas emission rate from the soils beneath the site.

Borehole gas screening values (GSV) for both methane and carbon dioxide have been calculated for each borehole and are shown in the table below.

Borehole No.:	Gas Screening Value – Methane (litre/hour)	Gas Screening Value – Carbon Dioxide (litre/hour)
WS2	0.0	0.0020
WS5	0.0	0.0025
WS8	0.0	0.0015
WS13	0.0	0.0000

Based on the maximum recorded concentrations of methane the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the GSVs obtained for methane the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the maximum recorded concentrations of carbon dioxide to date the site is categorised in accordance with the NHBC 'traffic light system' as Green.

Based on the GSVs obtained for carbon dioxide the site is categorised in accordance with the NHBC 'traffic light system' as Green.

1.11 Drawings and Specifications:

The remediation works are detailed on drawing 7861/003.

The works should be undertaken in conjunction with CoDA Structures Specification

for Earthworks.

1.12 **Phasing & Programme of Works:**

The phasing of the development is to be advised by the client.

Due to the nature of the remediation works proposed on the site (localised soil removal and capping) these will be undertaken towards the end of each build phase when the plots are effectively complete and the external areas are being formed.

1.13 **Consents, Agreements and Licenses:**

- Planning approval.
- An approved Material Management Plan implemented under the Definition of Waste: Development Industry Code of Practise (CL:AIRE 2011) will be required for the site.
- Licensed 'Waste' carriers to be used.
- Material to be disposed at suitably licensed tips (tip tickets, waste transfer notes and consignment notes to be obtained).

1.14 **Material records:**

Detailed records of all materials imported onto and taken off site should be kept. This includes Waste Transfer Notes for non-hazardous waste, Consignment Notes for hazardous wastes, delivery notes and chemical analysis certificates.

1.15 **Site management procedures to protect site neighbours, environment and amenity during works:**

- A detailed method statement is to be prepared by the earthworks sub-contractor.

1.16 **Details of how any necessary variations from the approved remediation statement, arising during the course of the works, will be dealt with:**

- If ground conditions or contamination are encountered by the contractor which are significantly different to those encountered during the ground investigation the works should be ceased and CoDA Structures informed.
- Following a site inspection, and if deemed necessary, the works in the immediate vicinity of the problem area will be cordoned off, and additional sampling and chemical testing undertaken.
- Following receipt of test results and associated risk assessment, should the proposed remediation works need to be varied this will be advised to the Local Authority in writing, together with associated correspondence and risk assessments, as appropriate. No further works will be carried on site until this is undertaken.

- Prior to the implementation of any changes to the Remediation Strategy on site They will need to be agreed in writing by the Local Authority.

1.17 **Details of how the works will be validated to ensure the remediation objectives have been met:**

General

- Waste transfer notes, consignment notes and tip tickets are to be obtained for all materials imported onto the site and disposed of off-site.
- Contaminated soils removal will be verified by sampling and testing of the sides and base of any such excavations. As a minimum 6No samples will be taken (one from each side of the excavation and two from the base). The testing should be for the compound(s) in relation to which the remediation is required namely PAH compounds.

The validation of the imported material should be in accordance with the YALPAG document Verification Requirements for Cover Systems.

Prior to importation on to site, chemical test analysis will be obtained on all materials proposed for use in garden and landscape areas as follows:-

- Crushed natural stone (hardcore) will be validated by visual inspection.
- Prior to importation onto site, chemical test analysis will be obtained on all material proposed for use in garden and landscape areas at a frequency of:

Topsoil and natural ground, from greenfield sites, 1 per 250m³ of material used with a minimum of 3 tests in total.

Material from previously developed sites and site won material 1 per 100m³ of material used with a minimum of 6 tests in total.

- The soils chemical testing to be undertaken on imported topsoil or imported natural ground as capping material from greenfield sites as a minimum should comprise:

Arsenic	Mercury	Nickel	Asbestos
Cadmium	Selenium	Zinc	PAH (speciated)
Chromium III	Boron (ws)	Sulphate (ws)	
Lead	Copper	pH	

- The soils chemical testing to be undertaken on imported capping material from previously developed sites as a minimum should comprise:

Arsenic	Nickel	Sulphate (ws)	TPH (speciated)
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Cadmium	Selenium	Zinc	PAH (speciated)
Chromium III	Boron (ws)	Phenols	Sulphide
Lead	Copper	pH	Cyanide
Mercury	Asbestos		

- The soils chemical testing to be undertaken on site won materials should comprise:

Arsenic	Nickel	Sulphate (ws)	TPH (speciated)
Cadmium	Selenium	Zinc	PAH (speciated)
Chromium III	Boron (ws)	Chromium V	VOC's
Lead	Copper	pH	SVOC's
Mercury	Asbestos		

- The criteria to which chemical analysis will be compared and not exceed for both capping material and validation of material removal and extent of capping is the site Assessment Criteria for residential use with home grown produce used in the Phase 2 Engineering & Environmental Assessment as follows:-

Determinant	Max Concentration
Heavy Metal / Metalloids	
Arsenic	37 mg/kg
Cadmium	22 mg/kg
Chromium (III)	910 mg/kg
Chromium (VI)	21 mg/kg
Lead	200 mg/kg
Mercury	40 mg/kg
Nickel	180 mg/kg
Selenium	250 mg/kg
Boron	290 mg/kg
Copper	2400 mg/kg
Zinc	3700 mg/kg
PAH 16EPA	
Acenaphthene	210 mg/kg
Acenaphthylene	170 mg/kg
Anthracene	2400 mg/kg
Benzo (a) Anthracene	7.2 mg/kg
Benzo (a) pyrene	2.1 mg/kg
Benzo (b) fluoranthene	2.6 mg/kg
Benzo (k) fluoranthene	77 mg/kg
Benzo (g, h, i) perylene	320 mg/kg
Chrysene	15 mg/kg
Di-benzo (a, h) anthracene	0.24 mg/kg
Indeno (1, 2, 3-cd) pyrene	27 mg/kg
Fluoranthene	280 mg/kg
Fluorene	170 mg/kg
Napthalene	2.3 mg/kg
Phenanthrene	95 mg/kg
Pyrene	620 mg/kg
Others	
pH	<5
Sulphate	500 mg/l
Asbestos	Non detected
Sulphide	250 mg/lg
Phenolics	
Phenol	280 mg/kg
General Inorganics	
Cyanide (free)	36 mg/kg
Aliphatic Hydrocarbons	
TPH Aliphatic > EC5-6	42 mg/kg
TPH Aliphatic > EC6-8	100 mg/kg

TPH Aliphatic > EC8-10	27 mg/kg
TPH Aliphatic > EC10-12	130 mg/kg
TPH Aliphatic > EC12-16	1100 mg/kg
TPH Aliphatic > EC16-35	65000 mg/kg
TPH Aliphatic > C35-44	65000 mg/kg
TPH Aromatic > EC5-7	70 mg/kg
TPH Aromatic > EC7-8	130 mg/kg
TPH Aromatic > EC8-10	34 mg/kg
TPH Aromatic > EC10-12	74 mg/kg
TPH Aromatic > EC12-16	140 mg/kg
TPH Aromatic > EC16-21	260 mg/kg
TPH Aromatic > EC 21-35	1100 mg/kg
TPH Aromatic > EC35-44	1100 mg/kg
Benzene	0.87 mg/kg
Toluene	130 mg/kg
Ethylbenzene	47 mg/kg
o - Xylene	45.2 mg/kg
m - Xylene	59 mg/kg
p - Xylene	56 mg/kg
SVOC's	Below test detection limits except PAH compounds which are to be as above.
VOC's	Below test detection limits

- The following photographs should be taken during the works:-
 - During the excavation of soils for removal for the placing of capping or to remove contaminated soils from site.
 - At the completion of the excavation works.
 - Following placing of the Terram layer.
 - During placing of capping materials including topsoil.
 - On completion of the works.

- Placed depth of capping will be verified by random trial pits once the material is insitu at a frequency of 1 in 3 gardens. Logs of each validation pit are to be made together with a record photograph. The location of the validation trial pits are to be recorded on drawing 7861/003.

- A completion report with record photographs will be prepared for the site by CoDA Structures.

APPENDICES:

- CoDA Structures Phase 2 Engineering & Environmental assessment.
- CoDA Structures drawing 7861/003.
- CoDA Structures Specification for Earthworks.
- YALPAG document Verification Requirements for Cover Systems.



Signed:
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