

GroundSolve Ltd

Consulting Geotechnical, Engineering Geology
and Environmental Engineers

Job No.

Sheet No.

Rev.

2575.

4/13

Member/Location

Job Title

Bonc wen Mine Shaft Cap

Drg. Ref.

Made by DAS

Date 01/22

Chd. SDI

Revised Design

GroundSolve Ltd carried out a design for the shaft caps at Bonc wen in October 2021.

However due to the availability of suitable plant, the contractor is considering casting the shaft at rockhead rather than constructing a plug and cap at shallower depth.

These calculations are for the shaft at rockhead.

The Designers Risk Register is presented in Appendix C.

Proposed Development
and
Location of Shafts
FIGURE 3



SCALE 1:500 @ A3

The Shafts and Ground Conditions.

There are two shafts on the site namely Shaft 347 and Shaft 348; see following page.

Shaft 347 had an internal diameter of 2.0m and an external diameter of 2.5m.

It was also confirmed that Shaft 348 had the same dimensions; see extracts from report in Appendix A.

The reports by NKC and TerraConsult recorded similar depths to rockhead of 9.80m at Shaft 347 and 10.8m at Shaft 348; see Appendix B.

For the development the ground levels will be changed; see Appendix A

At Shaft 347, the ground level will be reduced by 1.5m.

But at Shaft 348, the ground level will be raised by 1.0m.

∴ Therefore the top of rockhead will be at $10.8 + 1.0 = 11.8$ Say 12m.

2575

4/13

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Shaft Cap Design

The shaft cap shall be designed to CIRIA C758

The minimum cap size will be $2 \times D_{ext}$
 $= 2 \times 2.5 = 5.0m$

The minimum cap thickness shall be
 $500mm > 450mm \therefore O.K.$

The overburden pressure =

$$(12.0 - 0.5) \times 18 = 207 \text{ kN/m}^2$$

Weight of cap = $0.5 \times 24 = 12 \text{ kN/m}^2$.

Since the shafts are in non-vehicle areas
then apply surcharge of 2 kN/m^2 .

(Note: error in original calcs - highway
loading applied).

Apply FOS to permanent loads = 1.4

$$\therefore (207 + 12) = 219 \times 1.4 = 306.6 \text{ kN/m}^2$$

Include the variable load = 2 kN/m^2 .

$$\therefore \text{total load} = 308.6 \text{ kN/m}^2$$

2575

5/13

Member/Location

Job Title

Bone wei Mine Shaft Cap

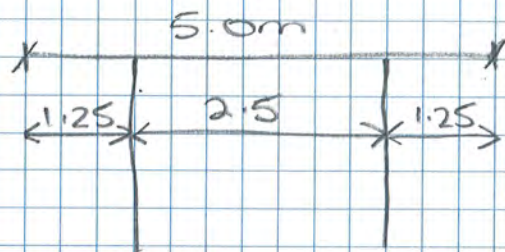
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Date Jan 22

Chd. SDI

Now calculate the effective span.



$$\therefore \text{Effective span} = \frac{1.25}{2} + 2.5 + \frac{1.25}{2}$$

(Leff)

$$= 3.75\text{m}$$

CIRIA C758 cl. 14.7.6 states the effective span must be at least $1.5 \times \text{external dia.}$
 $= (1.5 \times 2.5) = 3.75\text{m} \therefore \text{O.K.}$

Now calculate bending moments and shear forces.

$$\text{Ult Bm} = \frac{wL^2}{8} = \frac{308.6 \times 3.75^2}{8}$$
$$= 542.46 \text{ kNm/m run}$$

Now calculate shear forces at the support

$$W_{\text{ult}} = W \times L_{\text{eff}}$$
$$= 308.6 \times 3.75$$
$$= 1157.25 \text{ kN/m}$$

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and Environmental Engineers

Job No.

Sheet No.

Rev.

2575

6/13

Member/Location

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from Moseley & Bungey (Design of
Reinforced Concrete) Chpt 8.

$$\text{Shear } V_{sd} = \frac{1157.25}{2} \left(\frac{(3.75/2) - (0.5 \times 1.25)}{(3.75/2)} \right)$$

$$= 578.625 \times 0.666$$

$$= 385.36 \text{ kN/m run.}$$

The cover Required will be 75mm.
Due to the high forces us C40/50 concrete

Project Bonc Wen				Job no. 2575	
Calcs for Mine Shaft Cap at Rockhead				Start page no./Revision 7	
Calcs by DAS	Calcs date 20/01/2022	Checked by MJS	Checked date 21/01/2022	Approved by DAS	Approved date 21/01/2022

RC SLAB DESIGN (BS8110:PART1:1997)

TEDDS calculation version 1.0.04

TWO WAY SPANNING SLAB DEFINITION – SIMPLY SUPPORTED

Overall depth of slab $h = 500$ mm

Outer sagging steel

Cover to outer tension reinforcement resisting sagging $c_{sag} = 75$ mm

Trial bar diameter $D_{tryx} = 32$ mm

Depth to outer tension steel (resisting sagging)

$$d_x = h - c_{sag} - D_{tryx}/2 = 409 \text{ mm}$$

Inner sagging steel

Trial bar diameter $D_{tryy} = 32$ mm

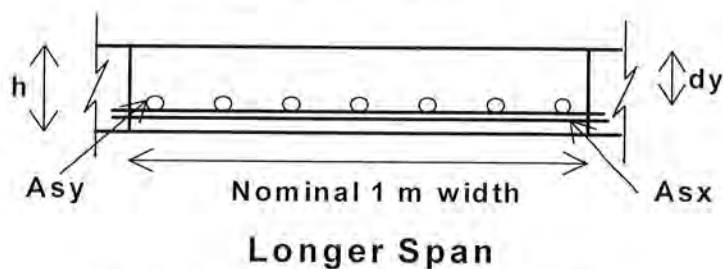
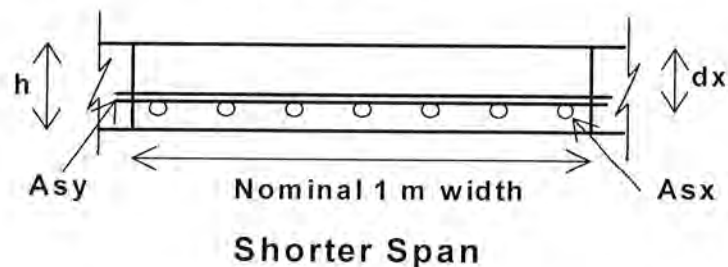
Depth to inner tension steel (resisting sagging)

$$d_y = h - c_{sag} - D_{tryx} - D_{tryy}/2 = 377 \text{ mm}$$

Materials

Characteristic strength of reinforcement $f_y = 500$ N/mm²

Characteristic strength of concrete $f_{cu} = 40$ N/mm²



Two-way spanning slab (simple)

MAXIMUM DESIGN MOMENTS

Length of shorter side of slab $l_x = 3.750$ m

Length of longer side of slab $l_y = 3.750$ m

Design ultimate load per unit area $n_s = 308.6$ kN/m²

Project Bonc Wen				Job no. 2575	
Calcs for Mine Shaft Cap at Rockhead				Start page no./Revision 8	
Calcs by DAS	Calcs date 20/01/2022	Checked by MJS	Checked date 21/01/2022	Approved by DAS	Approved date 21/01/2022

Moment coefficients

$$\alpha_{sx} = (l_y / l_x)^4 / (8 \times (1 + (l_y / l_x)^4)) = 0.063$$

$$\alpha_{sy} = (l_y / l_x)^2 / (8 \times (1 + (l_y / l_x)^4)) = 0.063$$

Maximum moments per unit width - simply supported slabs

$$m_{sx} = \alpha_{sx} \times n_s \times l_x^2 = 271.2 \text{ kNm/m}$$

$$m_{sy} = \alpha_{sy} \times n_s \times l_x^2 = 271.2 \text{ kNm/m}$$

CONCRETE SLAB DESIGN – SAGGING – OUTER LAYER OF STEEL (CL 3.5.4)

Design sagging moment (per m width of slab) $m_{sx} = 271.2 \text{ kNm/m}$

Moment Redistribution Factor $\beta_{bx} = 1.0$

Area of reinforcement required

$$K_x = \text{abs}(m_{sx}) / (d_x^2 \times f_{cu}) = 0.041$$

$$K'_x = \min(0.156, (0.402 \times (\beta_{bx} - 0.4)) - (0.18 \times (\beta_{bx} - 0.4)^2)) = 0.156$$

Outer compression steel not required to resist sagging

Slab requiring outer tension steel only - bars (sagging)

$$z_x = \min((0.95 \times d_x), (d_x \times (0.5 + \sqrt{(0.25 - K_x/0.9)}))) = 389 \text{ mm}$$

$$\text{Neutral axis depth } x_x = (d_x - z_x) / 0.45 = 45 \text{ mm}$$

Area of tension steel required

$$A_{sx_req} = \text{abs}(m_{sx}) / (1/\gamma_{ms} \times f_y \times z_x) = 1606 \text{ mm}^2/\text{m}$$

Tension steel

Provide 32 dia bars @ 225 centres outer tension steel resisting sagging

$$A_{sx_prov} = A_{sx} = 3570 \text{ mm}^2/\text{m}$$

Area of outer tension steel provided sufficient to resist sagging

Concrete Slab Design - Sagging - Inner layer of steel (cl. 3.5.4)

Design sagging moment (per m width of slab) $m_{sy} = 271.2 \text{ kNm/m}$

Moment Redistribution Factor $\beta_{by} = 1.0$

Area of reinforcement required

$$K_y = \text{abs}(m_{sy}) / (d_y^2 \times f_{cu}) = 0.048$$

$$K'_y = \min(0.156, (0.402 \times (\beta_{by} - 0.4)) - (0.18 \times (\beta_{by} - 0.4)^2)) = 0.156$$

Inner compression steel not required to resist sagging

Slab requiring inner tension steel only - bars (sagging)

$$z_y = \min((0.95 \times d_y), (d_y \times (0.5 + \sqrt{(0.25 - K_y/0.9)}))) = 356 \text{ mm}$$

$$\text{Neutral axis depth } x_y = (d_y - z_y) / 0.45 = 47 \text{ mm}$$

 GroundSolve Ltd Unit 1 Well House Barns Chester Road, Bretton Flintshire	Project			Job no.		
	Bonc Wen			2575		
	Calcs for			Start page no./Revision		
	Mine Shaft Cap at Rockhead			9		
	Calcs by	Calcs date	Checked by	Checked date	Approved by	Approved date
	DAS	20/01/2022	MJS	21/01/2022	DAS	21/01/2022

Area of tension steel required

$$A_{sy_req} = \text{abs}(m_{sy}) / (1/\gamma_{ms} \times f_y \times z_y) = 1753 \text{ mm}^2/\text{m}$$

Tension steel

Provide 32 dia bars @ 225 centres inner tension steel resisting sagging

$$A_{sy_prov} = A_{sy} = 3570 \text{ mm}^2/\text{m}$$

Area of inner tension steel provided sufficient to resist sagging

Check min and max areas of steel resisting sagging

Total area of concrete $A_c = h = 500000 \text{ mm}^2/\text{m}$

Minimum % reinforcement $k = 0.13 \%$

$$A_{st_min} = k \times A_c = 650 \text{ mm}^2/\text{m}$$

$$A_{st_max} = 4 \% \times A_c = 20000 \text{ mm}^2/\text{m}$$

Steel defined:

Outer steel resisting sagging $A_{sx_prov} = 3570 \text{ mm}^2/\text{m}$

Area of outer steel provided (sagging) OK

Inner steel resisting sagging $A_{sy_prov} = 3570 \text{ mm}^2/\text{m}$

Area of inner steel provided (sagging) OK

SHEAR RESISTANCE OF CONCRETE SLABS (CL 3.5.5)

Outer tension steel resisting sagging moments

Depth to tension steel from compression face $d_x = 409 \text{ mm}$

Area of tension reinforcement provided (per m width of slab) $A_{sx_prov} = 3570 \text{ mm}^2/\text{m}$

Design ultimate shear force (per m width of slab) $V_x = 385 \text{ kN/m}$

Characteristic strength of concrete $f_{cu} = 40 \text{ N/mm}^2$

Applied shear stress

$$v_x = V_x / d_x = 0.94 \text{ N/mm}^2$$

Check shear stress to clause 3.5.5.2

$$v_{allowable} = \min((0.8 \text{ N}^{1/2}/\text{mm}) \times \sqrt{f_{cu}}, 5 \text{ N/mm}^2) = 5.00 \text{ N/mm}^2$$

Shear stress - OK

Shear stresses to clause 3.5.5.3

Design shear stress

$$f_{cu_ratio} = \text{if } (f_{cu} > 40 \text{ N/mm}^2, 40/25, f_{cu}/(25 \text{ N/mm}^2)) = 1.600$$

$$v_{cx} = 0.79 \text{ N/mm}^2 \times \min(3, 100 \times A_{sx_prov} / d_x)^{1/3} \times \max(0.67, (400 \text{ mm} / d_x)^{1/4}) / 1.25 \times f_{cu_ratio}^{1/3}$$

$$v_{cx} = 0.70 \text{ N/mm}^2$$

Applied shear stress

$$v_x = 0.94 \text{ N/mm}^2$$

Shear reinforcement required

Project Bonc Wen				Job no. 2575	
Calcs for Mine Shaft Cap at Rockhead				Start page no /Revision 10	
Calcs by DAS	Calcs date 20/01/2022	Checked by MJS	Checked date 21/01/2022	Approved by DAS	Approved date 21/01/2022

If shear reinforcement is required (outer tension steel resisting sagging)

Table 3.16 - Note 1, advises that shear reinforcement is not used in slabs less than 200mm thick.

It is assumed that reinforcement provided by bent up bars is not considered.

The shear stress component resisted by shear reinforcement

$$v_{svx} = \max (abs(v_x) - v_{cx}, 0.4 \text{ N/mm}^2) = 0.40 \text{ N/mm}^2$$

Reinforcement Requirements

Characteristic strength of shear reinforcement $f_{yv} = 500 \text{ N/mm}^2$

$$A_{svx_to_sv_reqd} = (1 \text{ m}) \times v_{svx} / (1/\gamma_{ms} \times f_{yv}) = 0.920 \text{ mm}$$

Define Links Provided

Link diameter $L_{dlink} = 8 \text{ mm}$

Link spacing (parallel to span) $s_{vx} = 225 \text{ mm}$

Link leg spacing (perp to span) $s_{vx_perp} = 225 \text{ mm}$

$$A_{svx_to_sv_provided} = 1 \text{ m} \times \pi \times L_{dlink}^2 / (4 \times s_{vx_perp} \times s_{vx}) = 0.993 \text{ mm}$$

Area of links sufficient

SHEAR RESISTANCE OF CONCRETE SLABS (CL 3.5.5)

Inner tension steel resisting sagging moments

Depth to tension steel from compression face $d_y = 377 \text{ mm}$

Area of tension reinforcement provided (per m width of slab) $A_{sy_prov} = 3570 \text{ mm}^2/\text{m}$

Design ultimate shear force (per m width of slab) $V_y = 385 \text{ kN/m}$

Characteristic strength of concrete $f_{cu} = 40 \text{ N/mm}^2$

Applied shear stress

$$v_y = V_y / d_y = 1.02 \text{ N/mm}^2$$

Check shear stress to clause 3.5.5.2

$$v_{allowable} = \min ((0.8 \text{ N}^{1/2}/\text{mm}) \times \sqrt{f_{cu}}, 5 \text{ N/mm}^2) = 5.00 \text{ N/mm}^2$$

Shear stress - OK

Shear stresses to clause 3.5.5.3

Design shear stress

$$f_{cu_ratio} = \text{if } (f_{cu} > 40 \text{ N/mm}^2, 40/25, f_{cu}/(25 \text{ N/mm}^2)) = 1.600$$

$$v_{cy} = 0.79 \text{ N/mm}^2 \times \min(3, 100 \times A_{sy_prov} / d_y)^{1/3} \times \max(0.67, (400 \text{ mm}) / d_y)^{1/4} / 1.25 \times f_{cu_ratio}^{1/3}$$

$$v_{cy} = 0.74 \text{ N/mm}^2$$

Applied shear stress

$$v_y = 1.02 \text{ N/mm}^2$$

Shear reinforcement required

If shear reinforcement is required (inner tension steel resisting sagging)

Project Bonc Wen				Job no. 2575	
Calcs for Mine Shaft Cap at Rockhead				Start page no./Revision 11	
Calcs by DAS	Calcs date 20/01/2022	Checked by MJS	Checked date 21/01/2022	Approved by DAS	Approved date 21/01/2022

Table 3.17 - Note 1, advises that shear reinforcement is not used in slabs less than 200mm thick.

It is assumed that reinforcement provided by bent up bars is not considered.

The shear stress component resisted by shear reinforcement

$$v_{svy} = \max (abs(v_y) - v_{cy}, 0.4 \text{ N/mm}^2) = 0.40 \text{ N/mm}^2$$

Reinforcement Requirements

Characteristic strength of shear reinforcement $f_{yv} = 500 \text{ N/mm}^2$

$$A_{svy_to_sv_reqd} = (1 \text{ m}) \times v_{svy} / (1/\gamma_{ms} \times f_{yv}) = 0.920 \text{ mm}$$

Define Links Provided

Link diameter $L_{diay} = 8 \text{ mm}$

Link spacing (parallel to span) $s_{vy} = 225 \text{ mm}$

Link leg spacing (perp to span) $s_{vy_perp} = 225 \text{ mm}$

$$A_{svy_to_sv_provided} = 1 \text{ m} \times \pi \times L_{diay}^2 / (4 \times s_{vy_perp} \times s_{vy}) = 0.993 \text{ mm}$$

Area of links sufficient

CONCRETE SLAB DEFLECTION CHECK (CL 3.5.7)

Slab span length $l_k = 3.750 \text{ m}$

Design ultimate moment in shorter span per m width $m_{sx} = 271 \text{ kNm/m}$

Depth to outer tension steel $d_x = 409 \text{ mm}$

Tension steel

Area of outer tension reinforcement provided $A_{sx_prov} = 3570 \text{ mm}^2/\text{m}$

Area of tension reinforcement required $A_{sx_req} = 1606 \text{ mm}^2/\text{m}$

Moment Redistribution Factor $\beta_{bx} = 1.00$

Modification Factors

Basic span / effective depth ratio (Table 3.9) $ratio_{span_depth} = 20$

The modification factor for spans in excess of 10m (ref. cl 3.4.6.4) has not been included.

$$f_s = 2 \times f_y \times A_{sx_req} / (3 \times A_{sx_prov} \times \beta_{bx}) = 149.9 \text{ N/mm}^2$$

$$factor_{tens} = \min (2, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + m_{sx} / d_x^2))) = 1.631$$

Calculate Maximum Span

This is a simplified approach and further attention should be given where special circumstances exist. Refer to clauses 3.4.6.4 and 3.4.6.7.

$$\text{Maximum span } l_{max} = ratio_{span_depth} \times factor_{tens} \times d_x = 13.34 \text{ m}$$

Check the actual beam span

$$\text{Actual span/depth ratio } l_x / d_x = 9.17$$

$$\text{Span depth limit } ratio_{span_depth} \times factor_{tens} = 32.62$$

Span/Depth ratio check satisfied

Project Bonc Wen				Job no. 2575	
Calcs for Mine Shaft Cap at Rockhead				Start page no./Revision 12	
Calcs by DAS	Calcs date 20/01/2022	Checked by MJS	Checked date 21/01/2022	Approved by DAS	Approved date 21/01/2022

CHECK OF NOMINAL COVER (SAGGING) – (BS8110:PT 1, TABLE 3.4)Slab thickness $h = 500$ mmEffective depth to bottom outer tension reinforcement $d_x = 409.0$ mmDiameter of tension reinforcement $D_x = 32$ mmDiameter of links $L_{dix} = 8$ mm

Cover to outer tension reinforcement

$$C_{tenx} = h - d_x - D_x / 2 = 75.0 \text{ mm}$$

Nominal cover to links steel

$$C_{nomx} = C_{tenx} - L_{dix} = 67.0 \text{ mm}$$

Permissible minimum nominal cover to all reinforcement (Table 3.4)

$$C_{min} = 50 \text{ mm}$$

Cover over steel resisting sagging OK

2575

13/13

Member/Location

Job Title

Bone Wen Mine Shaft Cap

Drg. Ref.

Made by DAS

Date

01/22, Chd. Sol

Summary

The cap shall be:

- 5m x 5m x 0.5m deep
- Founded at rockhead
- Bottom Reinforcement: 32mm bars at 225mm c/c in both directions
- Top reinforcement: A393 mesh
- Shear links: 8mm links

Link spacing (parallel to span) = 225mm

Link leg spacing (perp to span) = 225mm

- Strength of reinforcement = 500 N/mm^2
- Cover to reinforcement = 75mm
- Concrete strength = C40/50
- Maximum aggregate size = 20mm
- 1 No set of cubes (4 cubes) to be taken and tested at 3 day, 7 day and 28 day age

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Job No.

Sheet No.

Rev.

Member/Location

Job Title

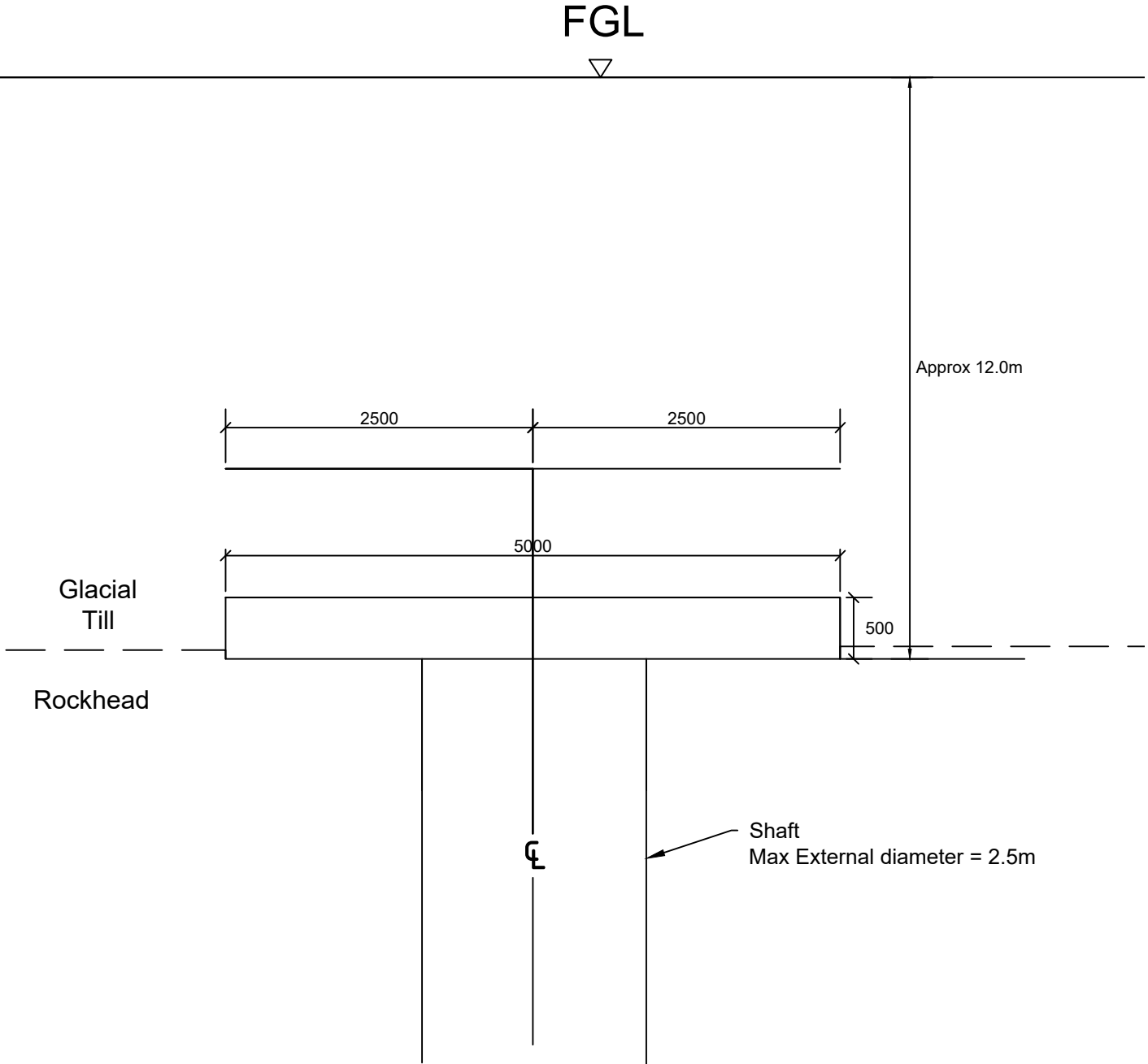
Drg. Ref.

Made by

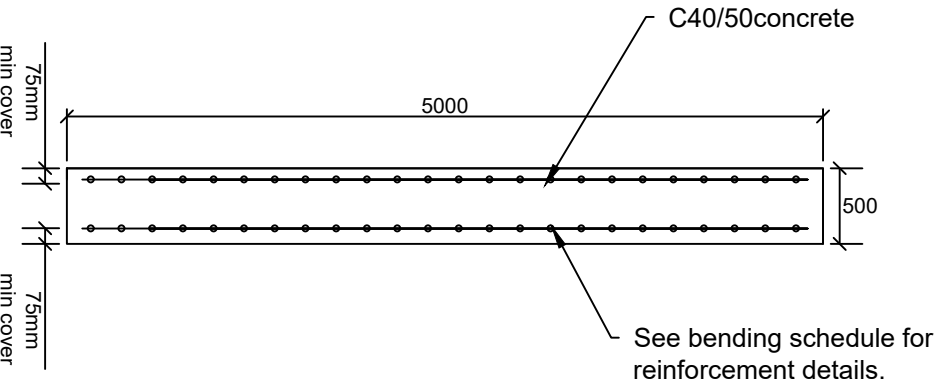
Date

Chd.

DRAWINGS



Section
(NTS)



Cap Detail
1:50 @ A3

Notes

1. The contractor shall form a safe excavation to construct the shaft cap. A temporary works design will be required for the shoring.
2. Gas monitoring shall be undertaken during the excavation of the cap.
3. A 500mm thick cap shall be founded on bedrock, which comprises orange sandstone and grey mudstone.
4. The cap shall be 5000 x 5000mm in area.
5. The reinforcement is detailed on Drawing No. 2575/CD/002 Rev C1.
6. The minimum steel grade shall be 500N/mm².
7. The concrete grade shall be a minimum of C40/50.
8. The reinforcement shall have a minimum of 75mm cover.
9. 1 No. set (4 cubes) shall be taken and tested at 3 day, 7 day and 28 day age.
10. No plug or grouting of the shaft is required.
11. The material above the shaft shall be constructed from site won material compacted in accordance with a suitable earthworks specification.

C1	Original Drawing	26/01/22
Revision	Description	Date

GroundSolve Ltd

Consulting Geotechnical, Engineering Geology and Environmental Engineers

Unit 1, Charter Court
Well House Barns
Chester Road Bretton
Flintshire CH4 0DH

Bonc Wen

Shaft Cap

Drawing Scale	Drawn By	Approved By
Various	ALB	DAS
Drawing Status	Date of Issue	
CONSTRUCTION	26/01/22	
Drawing No	Revision	
2575/CD/001	C1	

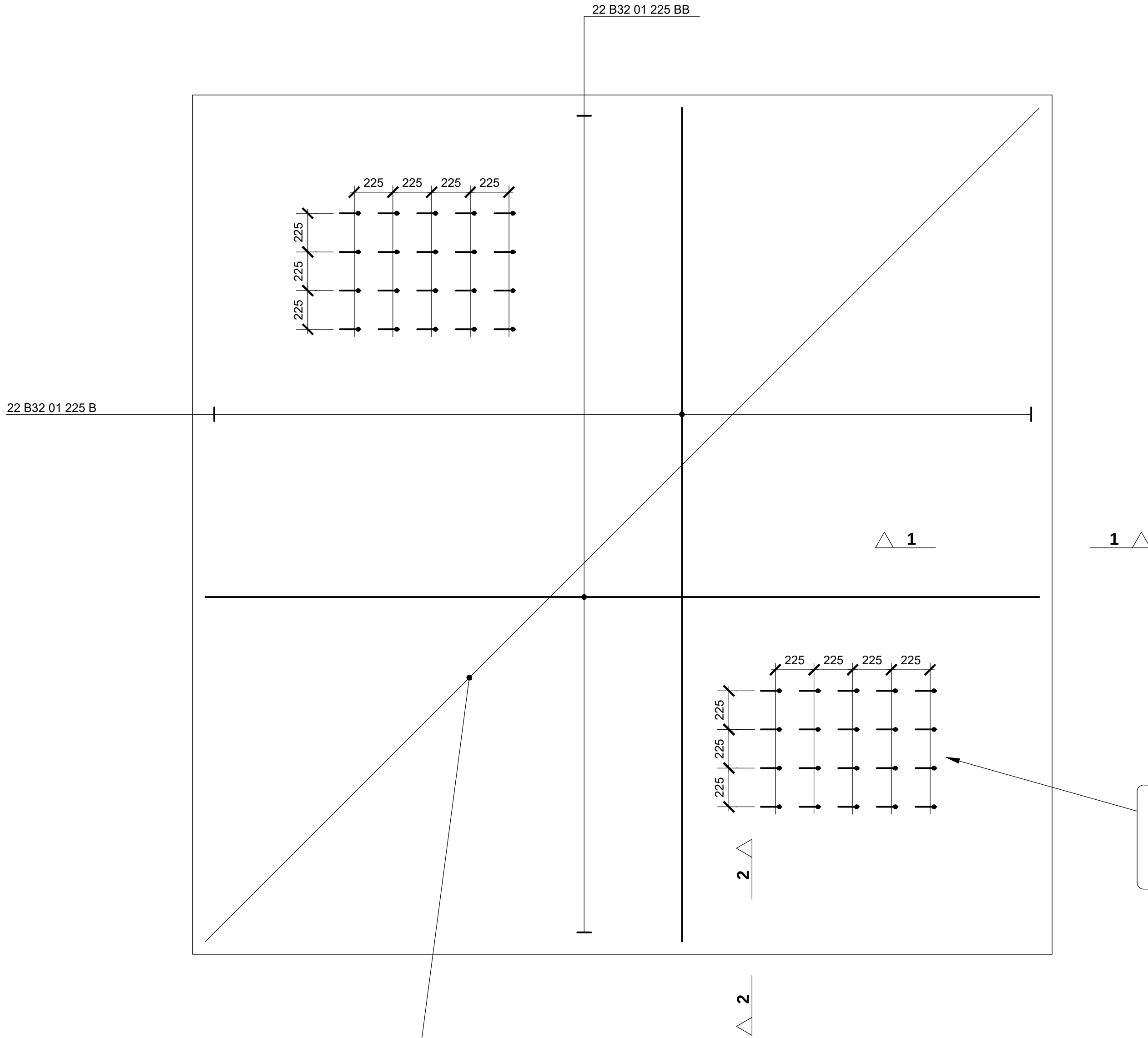
Date (+ Initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	A	R	C	Further Action	by	Status
mjs 01/22	Collapse of the shaft	Collapse of the shaft during the construction of the mat	No personnel shall be allowed over or near the shaft, as it has the potential to collapse.			✓	If ground movements are observed, then work should cease immediately, and the Designer and Coal Authority should be informed immediately.	Contractor	Active
mjs 01/22	Obstructions at ground level from previous buildings	Not possible to construct temporary works to required depth	Excavations to glacial till to be undertaken, with excavator positioned away from the shaft.			✓	Appropriate RAMS to be produced by contractor and reviewed prior to start of the temporary works	Contractor	Active
mjs 01/22	Potential for gas	Overcome by gas whilst working in the excavation/Explosions	Gas monitoring shall be undertaken by the contractor.			✓	Gas monitoring alarm levels to be agreed with designer prior to works starting.	Contractor	Active
mjs 01/22	Cap must be founded at rock head. Cap only designed for maximum 12m depth.	Variation in rockhead elevation.	May be necessary to deepen temporary works excavation and redesign cap.			✓	The formation should be inspected, and the designer should be informed if rock head is deeper than anticipated.	Contractor	Active
mjs 01/22	Stability of the excavation to form the cap	Collapse of the excavation	The side slopes for the upper section must be battered back at a safe angle. Personnel entering the excavation must be kept to a minimum, and where possible reinforcement should be lifted into position by crane. The sheet piled excavation must be subject to detailed design.			✓	Temporary works must be considered and designed by the contractor, in advance of the works.	Contractor	Active

Designers Risk Register

Notes

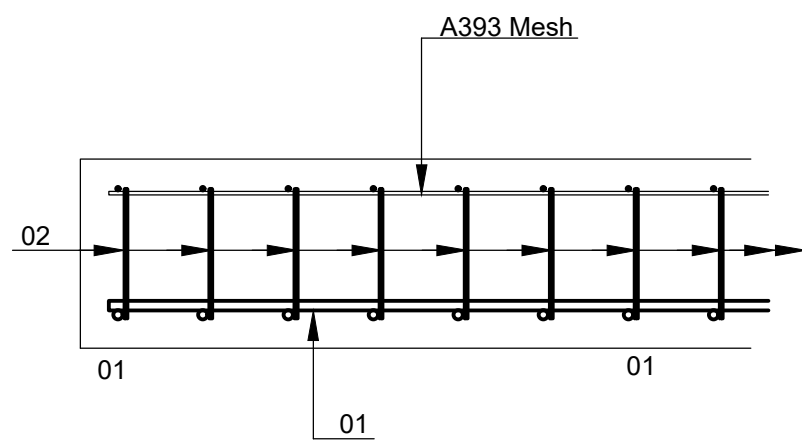
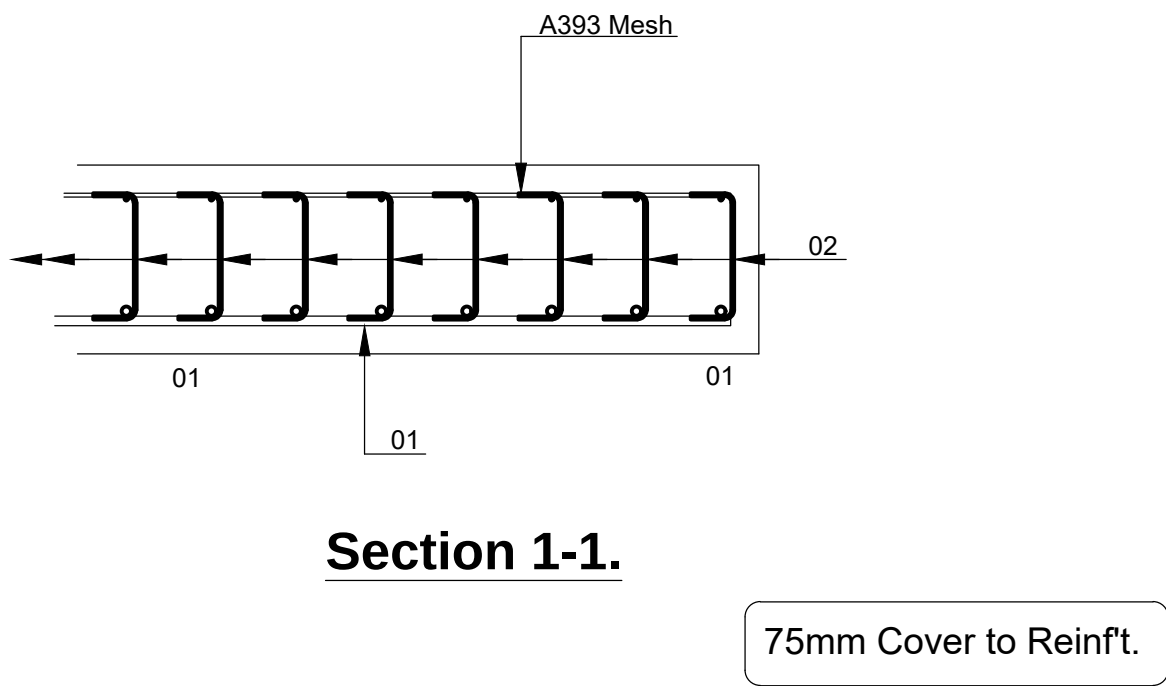
UB - U Bar.
TT - Top Outer Layer
BB - Bottom Outer Layer

Lap Lengths - B10 - 500
 B12 - 600



31.0 Sq.Metres of Mesh to B.S.
Ref. No. A393 with Flying Ends.
Placed in Top of Slab at 75mm Cover.
400mm Min. Laps.
Area Includes Allowance for Cutting.

484 B8 02 225 Links
Links to be Placed at 225 Pitch
In Both Directions Over Whole
Slab As Shown on Sections.



Plan on Mine Shaft Capping Slab.

C1	Issue For Construction	26/02/22
Revision	Description	Date

GroundSolve Ltd
Consulting Geotechnical, Engineering Geology
and Environmental Engineers

Unit 1, Charter Court
Well House Barrs
Chester Road Bretton
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Tel: 01244 661361
Fax: 01244 661289

Job Title

Bonc Wen

Drawing Title

Reinforcement Details
Mine Shaft Cap

Drawing Scale 1:20 @ A1	Drawn By J.McD.	Approved By D.S.
Drawing Status Construction	Date of Issue 26/02/22	
Drawing No 2575-CD-002	Revision C1	

[illegible]

* Specified in multiples of 5 mm.

† Specified in multiples of 25 mm.

Bending Schedule							Job No.		Drawing No.		Page No.		Rev.	
									2575-CD-002		2 of 2		C1	
							Revision		C2		C3		C4	
Bonc Wen							Originator/Date: JMcD 02/22							
Mine Shaft Capping Slab							Chd. by/Date: JMcD 02/22							
Member	Bar mark	Type and size	No. of mbrs.	No. of bars in each	Total no.	Length of each bar ↑ mm	Shape Code	A * mm	B * mm	C * mm	D * mm	E/R * mm	Rev. letter	
Slab Mesh														
31 Sq. Metres of Mesh to B.S. Reference No. A393 with Flying Ends														
Area Includes Allowances for Cutting.														

* Specified in multiples of 5 mm.

† Specified in multiples of 25 mm.

Drawing Weightings				Job No.		Rev. C1	
				Drawing No. 2575-CD-002			
Bonc Wen							
Mine Shaft Capping Slab							
Type & Size		Straight (Kg)		Bent (Kg)		Total (Kg)	
B8		0		105		105	
B32		1347		0		1347	
Total		1347		105		1452	

Drawing Weightings				Job No.		Rev. C1
				Drawing No. 2575-CD-002		
Bonc Wen						
Mine Shaft Capping Slab						
Mesh Type		Area (sq. m.)		Weight (Kg)		
A393		31		191		
Total		31		191		

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Appendix A .
Relevant Extracts
from report .

3.0 PROPOSED DEVELOPMENT

NWHA propose to build houses on a plot of land off Bonc Wen in Rhosllanerchrugog, near Wrexham. The development comprises three (two storey) blocks of apartments (Blocks A, B and B (M)), with associated gardens and car parking.

The current development layout is presented in Figure 3, with a typical elevation through one of the blocks presented below:



Typical Elevation

It is also understood that a cut/fill operating is proposed for the development. This shows that in the vicinity of the shafts, around Shaft 348 it is proposed to raise the ground level by around 1m. Whilst in the vicinity of Shaft 347 the ground will be lowered by up to 1.50m.

Foundation loads are not known at this stage, but based on experience of similar developments, foundation loads will be around 50 to 75kN/m run, with floor slab loadings not exceeding 5kN/m².

The following recommendations are based on the above assumptions, and should therefore be reviewed, and if necessary revised during the detailed design.

PV Voids remain in Workings

Only minor voidage was encountered in the boreholes. However, as discussed above the potential for old roadways beneath the site cannot be discounted, which were typically around 2m high and 2m wide.

PI Voids become unstable

Therefore, the potential for voids to become unstable has to be considered. The ground conditions above the coal seam comprise weak mudstones. However, of the seven boreholes drilled into the bedrock, none proved any upward migration of voids from the workings.

PR Rock cover insufficient to prevent migration of rock

H/T ratios of between 2.60 and 6.4 were recorded above the old workings. Consequently, the risk of upward migration of any residual voidage reaching surface is considered to be low to medium, assuming there was no superficial cover.

PD Drift cover insufficient to prevent migration to surface

However, the drift and made ground at this site are between 9.80 and 15.05m thick, so would also have a significant ameliorating effect on upward migration of any voidage.

The depth to workings would ensure that if any collapse into main roadways did start, they would be unable to migrate to surface, as there would be sufficient material to “choke” any potential collapse.

Consequently, when taking the depth of the superficial into account this would reduce the risks to very low.

Mine Shafts

Shaft 347

This shaft is some 13m away from Block A, with the glacial till proven at 2.50 depth and rockhead at 9.80m depth. It was proven to have an ID of 2.0m, and an OD estimated to be 2.50m.

The liner for this shaft was proven to start at the top of the glacial till. Should this shaft collapse, it is likely that the initial collapse would be in the made ground, which given an angle of draw of 45°, give a crown hole at surface of 7.50m, and some 10.5m from the building. This would not threaten Block A and would then allow any emergency work to be undertaken.

The shaft is considered likely to be lined throughout the glacial till down to bedrock, and would therefore remain stable, as shown by its stiff nature. However, in the unlikely event it should collapse to bedrock then given a 45° draw, would result in a crown hole some 22.10m diameter and some 3m from the building.

Therefore, even should the shaft collapse entirely to bedrock it is unlikely that the building will be affected.

Shaft 348

This shaft had the same dimensions as shaft 347, however, the masonry liner extended almost to surface. The glacial till was encountered at a depth of 2.40m, with the bedrock at 10.8m.

Block A is 10m away from the shaft, although there is a nearby cycle store.

Should this shaft collapse, it is likely that the initial collapse would be in the made ground, which given an angle of draw of 45°, would give a crown hole at surface of 7.50m, and some 7.5m from the building, which again would not threaten the building and would then allow any emergency work to be undertaken.

The shaft is considered likely to be lined throughout the glacial till down to bedrock, and would therefore remain stable. However, in the unlikely event it should collapse to bedrock then given a 45° draw, would result in a crown hole some 24.10m diameter, and some 2.20m from the building.



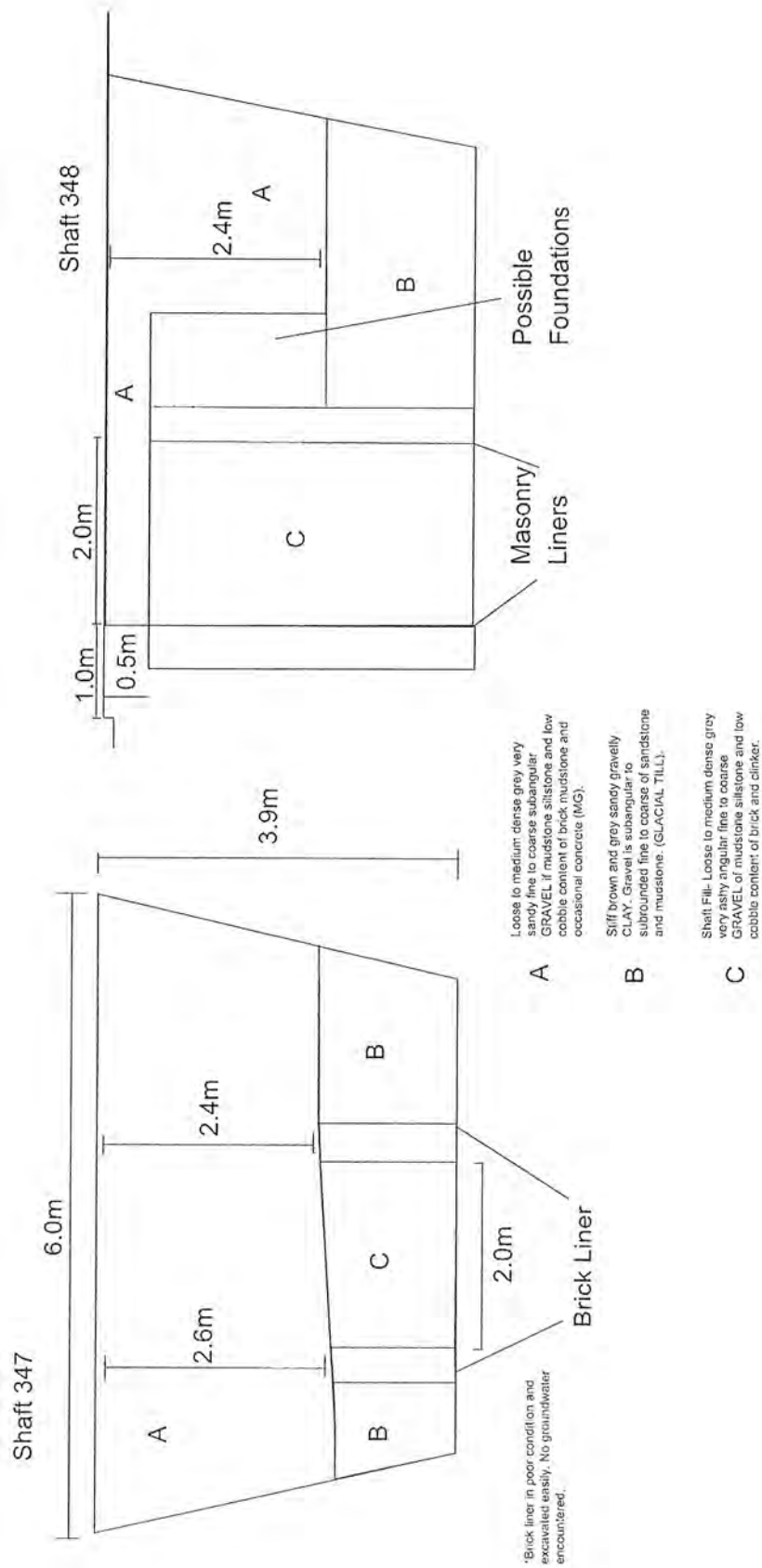
Crane and Grab

The shaft should be excavated for a depth of 2D below rock head, I, e, 5m below 10m giving a depth of 15m.

The shaft should then be inspected either by drone, or man entry following confirmation that mine gas is not an issue. This is not likely to be an issue after the shaft drilling by Nkc. The sides of the shaft in the rock should then be cleaned using a power washer to ensure the rock is clean.

The shaft should then be backfilled with mass concrete to the top of the glacial till, which will require around 61m³ of concrete. The volume of concrete can be reduced by adding “rock plums” to the concrete.

The shaft should then be capped at a depth of around 2.50m at the top of the stiff glacial till. The shaft cap will need to be 5m by 5m, and around 500mm thick (subject to detailed design).



SCALE 1:50 @ A3

Shaft Cross Sections

FIGURE 5

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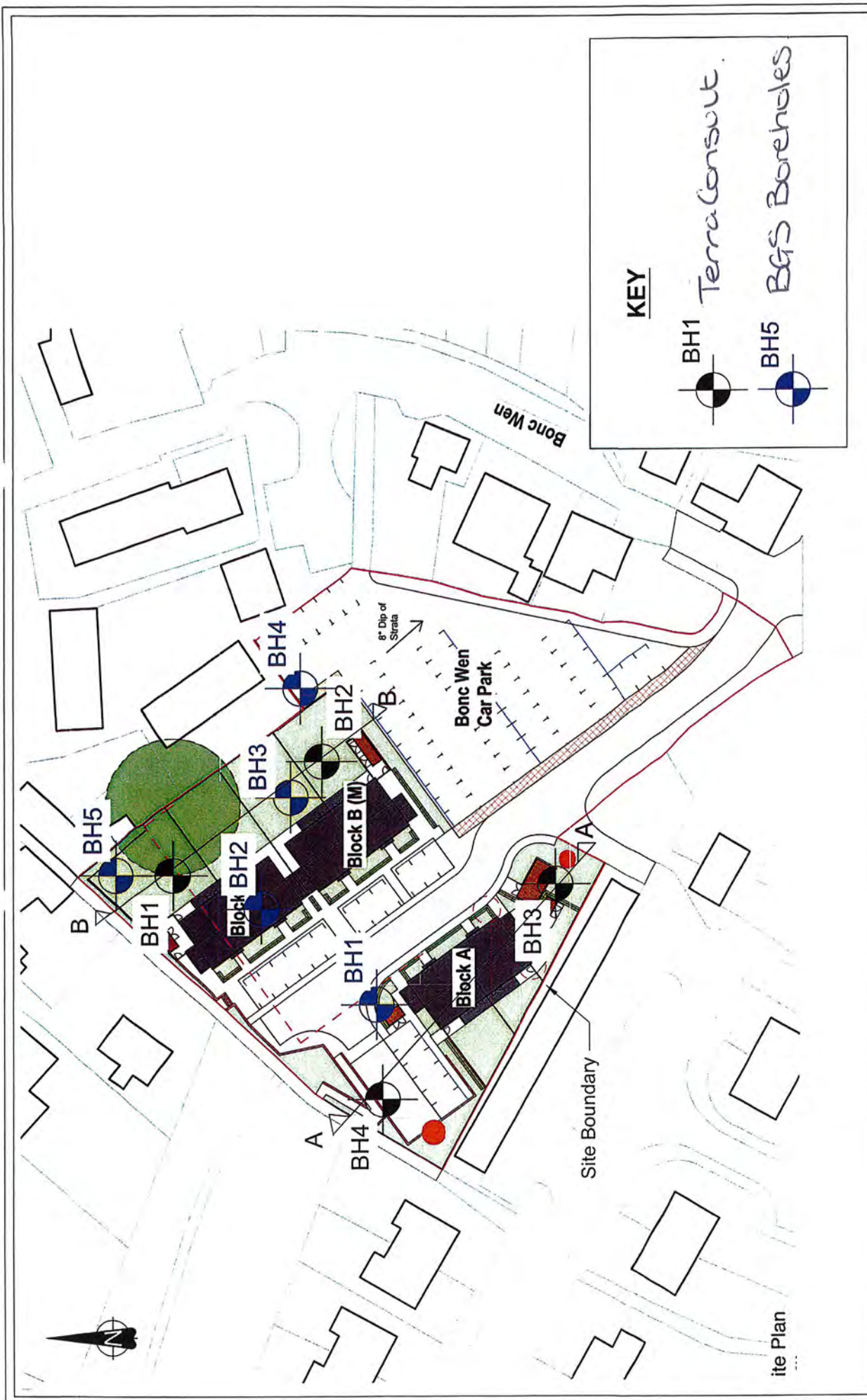
Drg. Ref.

Made by

Date

Chd.

Appendix B
Borehole logs.



SCALE 1:500 @ A3

A-A, B-B- See Figure 6

Location of boreholes

FIGURE 4

Personnel:
 Drilled by: Equipment & methods:
 Logged by: Plant: Dando/Cornacchio005
 Checked by: Method: Light cable percussion
 Flush: Water SPT Hammer details:

Hole diameter & casing depths:
 Dia (mm): to: Casing depth:
 7.50
 18.00

Coordinates & level:
 UK National Grid
 328991.20mE 346353.54mN
 *

Dates:
 Start: 19/02/2015
 End: 27/02/2015
 Backfilled: 27/02/2015

Backfill/ Well Inst.	Water- stages	Legend	Level (Thickness)	Stratum Description	Progress, Casing & Water Data		Samples & In Situ Testing			
					Date Casing	Time Water	Depth Core run	Type & No.	Results	
			(2.70)	Very stiff grey brown sandy slightly gravelly friable CLAY. Gravel is fine-coarse, sandstone, mudstone and coal			10.00 Dry 10.59 - 10.99	D18 U6	110 blows	
			11.90 (0.30)	Extremely weak completely weathered orange and white fine-medium grained SANDSTONE.	7.50	Dry	12.00 - 12.34 12.00	S SU	100 (12,11/21,42,37 for 40mm)	
			12.20 (1.00)	Extremely weak highly weathered gray MUDSTONE.			12.50	D20		
			13.20 (0.65)	Extremely weak grey weathered thinly laminated MUDSTONE. Bedding is clayey, deconstructed with brown pebble pebbles	7.50	Dry	13.00 - 13.10 13.00	S S10	100 (25 for 40mm/100 for 55mm)	
			13.85 (0.65)	Medium strong to strong light grey and grey thickly laminated fine-medium SANDSTONE with occasional fracture zones. Discontinuity sets - Bedding is 90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical, orange, clean, planar, smooth			13.20 - 14.20	100 11 0		
			14.50 (1.20)	Medium strong dark grey silty thickly laminated MUDSTONE. Discontinuity sets - Bedding is 90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical, orange, clean, planar, smooth			14.20 - 14.80	129 41 24		
			15.70 (0.70)	Medium strong light grey and dark grey SILTSTONE with slump structures. Discontinuity sets - Bedding is 85-90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical to 20degrees, orange, clean, planar, smooth			14.80 - 16.40	92 25 7		
			16.40 (1.50)	Weak grey slightly weathered laminated MUDSTONE with zones recovered as clay and gravel. Discontinuity sets - Bedding is 90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical, orange, clean, planar, smooth			16.40 - 17.90	100 23 8		
			17.90 (0.60)	No returns - Possible worked Coal Seam			17.90 - 18.50	0 0 0		
			18.50 (1.50)	Extremely weak grey weathered MUDSTONE with zones recovered as clay and clayey Gravel			18.50 - 19.50	100 0 0		
							19.50 - 19.90	100 0 0		
Continued next sheet					Casing Date	Water Time	Core run Depth	ICH SCR R/O	Results	
Instrumentation details: ID: Type: Diam: Remarks: P101 P201					General remarks: 17.90 to 10.50m Loss of returns / flush - cased to 18m			Groundwater entries: Struck: Yes/no; Rate of Drop: (20 mins) follow: sealed: No Groundwater Encountered		Chiselling: From: to: Duration (min): Took:
AGS Notes: For explanation of symbols and abbreviations see key sheet. All depths are reduced levels in metres Log Issue: Scale: 1:50 (at TerraConsult, www.terraconsult.co.uk)					Project: Bonc Wen, Rhosllanerchrugog Project No: SRL-164 Client: Datrys Design Engineering					

Personnel: Drilled by: Logged by: Checked by:	Equipment & methods: Plant: Dando/Comacchio30S Method: Light cable percussion Flush: Water	Hole diameter & casing depths: Dia (mm): to: Casing depth: 7.50 18.00	Coordinates & level: UK National Grid 328991.20mE 346353.54mN	Dates: Start: 10/02/2015 End: 27/02/2015 Backfilled: 27/02/2015
---	--	---	--	---

Backfill/ Wall Inst	Water sinks	Legend	Level (Thickness)	Depth (m)	Stratum Description	Progress, Casing & Water Data		Rotary Coring		
						Date Casing	Time Water	Depth Core run	TCH SCH RCD	Results
			20.00 (0.50)		Black blighty COAL - bedding 90degrees to core axis					
			20.50 (0.20)		Soft grey CLAY - SEATEARTH			19.90 - 21.40	93 0 0	
			20.70 (0.33)		Black blighty COAL					
			21.03 (0.37)		Soft becoming stiff grey CLAY - SEATEARTH					
			21.40 (0.40)		Black blighty COAL					
			21.80 (1.10)		Firm becoming stiff grey/brown CLAY - SEATEARTH			21.40 - 22.90	87 0 0	
			22.90		Exploratory hole ends at 22.90 m					

Instrumentation details:
ID: Type: Diam: Remarks:
P101
P201

General remarks:
17.00 to 18.50m Loss of returns / flush - cased to 18m

Casing Data	Water Time	Core run Depth	TCH SCH RCD	Results
Groundwater onsets: Struck: Flow to: Flow of: Depth (20 mins) follow sealed: No Groundwater Encountered				

Notes: For explanation of symbols and abbreviations see key sheet.
All depths are reduced to sea level.
Log Issue:
Scale: 1:50 (c) TerraConsult www.terraconsult.co.uk

Project: Bone Wen, Rhosllanerchrugog
Project No: SRL-164
Client: Datrys Design Engineering

TerraConsult		Borehole Log		Borehole no: BH04		Sheet 1 of 3					
Personnel: Drilled by: Logged by: Checked by:		Equipment & methods: Plant: Dando/Comacchio305 Method: Light cable percussion Finish: Water SPT Hammer details:		Hole diameter & casing depths: Dia (mm): 100 Casing depth: 9.20 17.50		Coordinates & level: UK National Grid 32081.56mE 346377.90mN Dates: Start: 16/02/2015 End: 23/02/2015 Backfilled: 25/02/2015					
Backfill Well Inst.	Water surface	Legend	Level Depth (Thickness)	Stratum Description	Progress, Casing & Water Data		Samples & In Situ Testing				
					Date Casing	Time Water	Depth	Type & No.	Results		
			(0.40)	MADE GROUND: Brick and concrete demolition material			0.20	ES1			
			0.40	MADE GROUND: Brown fine-coarse GRAVEL of sandstone, coal, brick with sandy clay pockets			0.50	ES2			
			(0.30)	MADE GROUND: Gray/dark grey sandy slightly gravelly CLAY. Gravel is fine-coarse, sub-angular, brick, clinker, glass, sandstone			1.00	ES3			
			(1.30)		Dry	1.20 - 1.65	U1	28 blows			
			2.00	MADE GROUND: Grey and orange slightly clayey slightly sandy fine-coarse flat, sub-angular Midstone GRAVEL.			1.70	Dry	1.90 - 2.35	S S1	N=9 (1,2,2,2,3,2)
			(1.10)		Dry	2.40 - 2.85	U2	51 blows			
			3.10	MADE GROUND: Firm orange brown slightly sandy slightly gravelly CLAY. Gravel is fine-medium sub-angular, clinker, coal, sandstone			2.90	Dry	3.10 - 3.55	D5 ES5 S S2	N=10 (2,2,2,3,2,3)
			(0.50)		Dry	3.60 - 4.05	U3	60 blows			
			3.60	Stiff brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse, sub-angular, sub-rounded, sandstone, occasional coal			4.00		4.10	ES6 U6	
					Dry	4.30 - 4.75	S S3	N=13 (2,3,3,4,3,3)			
					Dry	4.80 - 5.25	U4	75 blows			
						5.30	D7				
					Dry	5.50 - 5.95	S S4	N=17 (2,3,4,5,4,4)			
					Dry	6.00 - 6.45	U5	110 blows			
						6.50	D8				
		Dry	6.70 - 7.15	S S5	N=24 (2,5,5,5,7,7)						
		Dry	7.20 - 7.65	U6	100 blows						
			7.60	D9							
		Dry	7.90 - 8.35	S S6	N=23 (2,4,5,6,6,6)						
		Dry	8.40 - 8.85	U7	100 blows						
			8.90	D10							
		Dry	9.10 - 9.55	S S7	N=22 (2,3,5,5,6,6)						
		Dry	9.60 - 10.05	U8	160 blows						
Continued next sheet				Casing Date	Water Time	Depth	Type & No.	Results			
Instrumentation details: ID: Type: Diam: Remarks: P101 P201				General remarks: 15.00 to 15.30m Complete loss of fluid - cased to 15.30m		Groundwater entries: Struck: 15.00 to 15.30m Depth (20 mins) follow: 15.30m No Groundwater Encountered		Chiselling: From: to Duration (min): Tool:			
Project: Bone Wen, Rhoslanerchrugog Project No: SRL-164 Client: Datrys Design Engineering											

Personnel:
 Drilled by: Equipment & methods:
 Logged by: Plant: Dando/Comacchio305
 Checked by: Method: Light cable percussion
 Flush: Water SPT Hammer details:

Hole diameter & casing depths:
 Dia (mm): to: Casing depth:
 9.20
 17.50

Coordinates & level:
 UK National Grid
 328861.55mE 346377.90mN

Dates:
 Start: 10/02/2015
 End: 23/02/2015
 Backfilled: 25/02/2015

Backfill/ Well Inst		Water- strikes	Legend	Level (Thickness)	Depth	Stratum Description	Progress, Casing & Water Data		Samples & In Situ Testing		
							Date Casing	Time Water	Depth Core (m)	Type & No.	Results
					10.10	Extremely weak orange fine-medium grained SANDSTONE	9.20	00	10.00	011	100 (21.5 for 15mm/46.54 for 50mm)
				(0.40)	Weak weathered orange brown thinly laminated fine to medium SANDSTONE. Bedding is 70degrees, clayey, rough. Jointing is sub-vertical, clayey			10.10 - 10.30	100S		
				10.53				10.10	0		
				(0.17)	10.70	Extremely weak slightly weathered brown clayey MUDSTONE			10.10 - 10.70	0	
						Extremely weak grey slightly weathered thinly laminated MUDSTONE. Discontinuity sets - bedding is 85-90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical, clean, smooth, planar			10.70 - 12.20	99	
				(0.50)	11.60					0	
						Very weak grey slightly weathered thinly laminated MUDSTONE. Discontinuity sets - bedding is 85-90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical, clean, smooth, planar					
				(1.33)		12.20m - 12.70m: highly fractured Mudstone			12.20 - 12.70	100	
										0	
					12.93	Extremely weak grey slightly weathered thinly laminated MUDSTONE with clayey fracture zones. Discontinuity sets - bedding is 85-90degrees to core axis, clean, smooth, planar. Jointing is sub-vertical, clean, smooth, planar			12.70 - 14.00	92	
										6	
									14.00 - 14.50	110	
						14.50m: with occasional brown strong Siltstone pebbles				24	
				(3.67)					14.50 - 15.50	95	
										22	
									15.50 - 17.00	83	
										0	
					16.60	Extremely weak black clayey carbonaceous MUDSTONE with COAL					
				(0.40)					17.00 - 17.50	80	
				(0.10)	17.10	Soft brown CLAY - SEATEARTH I				0	
				(0.20)	17.30	Black bright COAL				0	
						Soft brown CLAY - SEATEARTH I			17.50 - 17.90	75	
				(0.30)	17.60					0	
						Extremely weak grey MUDSTONE					
				(0.30)	17.90						
						Black bright COAL					
				(0.35)					17.90 - 19.40	100	
					18.25	Extremely weak grey highly weathered friable clayey MUDSTONE - SEATEARTH				0	
									19.40 - 20.20	125	
										0	

Personnel:
 Drilled by:
 Logged by:
 Checked by:

Equipment & methods:
 Plant: Dando/Comacchio305
 Method: Light cable percussion
 Fluid: Water SPT Hammer details:

Hole diameter & casing depths:
 Dia (mm): to: Casing depth:
 9.20
 17.50

Coordinates & level:
 UK National Grid
 328961.99mE 346377.99mN

Dates:
 Start: 16/02/2015
 End: 23/02/2015
 Backfilled: 25/02/2015

Backfill/ Well Inst	Water- surface	Legend	Level (Thickness)	Depth	Stratum Description	Progress, Casing & Water Data		Rotary Coring			Results
						Date Casing	Time Water	Depth Core (m)	YCR SCR RCD	II	
				20.20 (0.70)	Extremely weak grey highly weathered friable clayey MUDSTONE - SEATEARTII Weak grey slightly weathered laminated MUDSTONE with zones recovered as clay. Discontinuity sets - Bedding is 90 degrees to core axis, clean, smooth, planar.				00 14 0		
				20.90 (1.27)	Extremely weak grey weathered friable clayey MUDSTONE			20.20 - 21.70			
				22.17 (0.33)	Black bright COAL			21.70 - 22.60	100 0 0		
				22.50 (0.10)	Black carbonaceous clayey friable MUDSTONE						
				22.60 (1.50)	No returns - Possible worked Coal Seam			22.60 - 24.10	0 0 0		
				24.10	Exploratory hole ends at 24.10 m						
Instrumentation details:						Casing Date	Water Time	Core Depth	YCR SCR RCD	II	Results
General remarks:						Groundwater entries:			Chiselling:		
15.00 to 15.30m Complete loss of fluid - cased to 15.3m						Struck: Rose to: Rate of: Depth:			From: to: Duration (min): Tool:		
101 201						(20 mins) inflow: sealed			No Groundwater Encountered		



Notes: For information of symbols and
 abbreviations see key sheet
 All depths are reduced to sea level

Log Issue:
 Scale: 1:50 (c) TerraConsult www.terraconsult.co.uk

Project: Bone Wen, Rhosllanecrugog
 Project No: SRL-164
 Client: Datrys Design Engineering

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Date

Chd.

Appendix C
Designers Risk Register

Hazard Risk Register

Register reference 001 Rev A

Project Bonc Wen

Job number

2575

Package/Topic Reinforced Concrete Cap

Design stage

Detailed Design – 10m Deep cap

Remember: Avoid – Reduce – Control and communicate relevant information to others (CDM Regulation 13)

Date (+ initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	A	R	C	Further Action	by	Status	
									Active/closed	
mjs 01/22	Collapse of the shaft	Collapse of the shaft during the construction of the mat	No personnel shall be allowed over or near the shaft, as it has the potential to collapse.			✓	If ground movements are observed, then work should cease immediately, and the Designer and Coal Authority should be informed immediately.	Contractor	Active	
mjs 01/22	Obstructions at ground level from previous buildings	Not possible to construct temporary works to required depth	Excavations to glacial till to be undertaken, with excavator positioned away from the shaft.			✓	Appropriate RAMS to be produced by contractor and reviewed prior to start of the temporary works	Contractor	Active	
mjs 01/22	Potential for gas	Overcome by gas whilst working in the excavation/Explosions	Gas monitoring shall be undertaken by the contractor.			✓	Gas monitoring alarm levels to be agreed with designer prior to works starting.	Contractor	Active	
mjs 01/22	Cap must be founded at rock head. Cap only designed for maximum 12m depth.	Variation in rockhead elevation.	May be necessary to deepen temporary works excavation and redesign cap.			✓	The formation should be inspected, and the designer should be informed if rock head is deeper than anticipated.	Contractor	Active	
mjs 01/22	Stability of the excavation to form the cap	Collapse of the excavation	The side slopes for the upper section must be battered back at a safe angle. Personnel entering the excavation must be kept to a minimum, and where possible			✓	Temporary works must be considered and designed by the contractor, in advance of the works.	Contractor	Active	

Unit 1 Well House Barns
Chester Road
Bretton
Flintshire CH4 0DH

Job Number:2575

Project	Bonc Wen	Job number	2575
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Package/Topic	Reinforced Concrete Cap	Design stage	Detailed Design – 10m Deep cap
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Remember: Avoid – Reduce – Control and communicate relevant information to others (CDM Regulation 13)										
Date (+ initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	A	R	C	Further Action	by	Status	
									Active	Closed
			reinforcement should be lifted into position by crane. The sheet piled excavation must be subject to detailed design.							