HOCHTIEF UK CONSTRUCTION

SNOWDONIA VISUAL IMPACT PROVISION PROJECT

SHAFT CONSTRUCTION (GARTH)

C0233-HUK-GES-AS-PL-W-0001

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Revision	Date	Prepared	Checked	Approved	Reason for Issue
P01	23/03/2023	MGE	DGM	LBR	For Information
P02	22/05/2023	MGE	DGM	LBR	Section 5 updated

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1.0 Shaft Design Evolution

The Launch-shaft at Garth has been reduced in depth, from a 25m deep circular shaft (with underground mined addits) to a 13m deep rectangular temporary shaft. This has eliminated the need for extensive ground-improvement grouting and reduced the need for concrete, shotcrete and underground excavations.

The shallow rectangular launch-shaft 69m x 8.5m wide will be constructed with a concrete headwall and temporary sheetpiles (AZ48-700) along three sides. A permanent concrete base-slab will be constructed approximately 10m below ground level.

The shaft design change is shown schematically in Figure 1 below. The red rectangle is the revised shaft outline overlaid on the original deep circular shaft design.

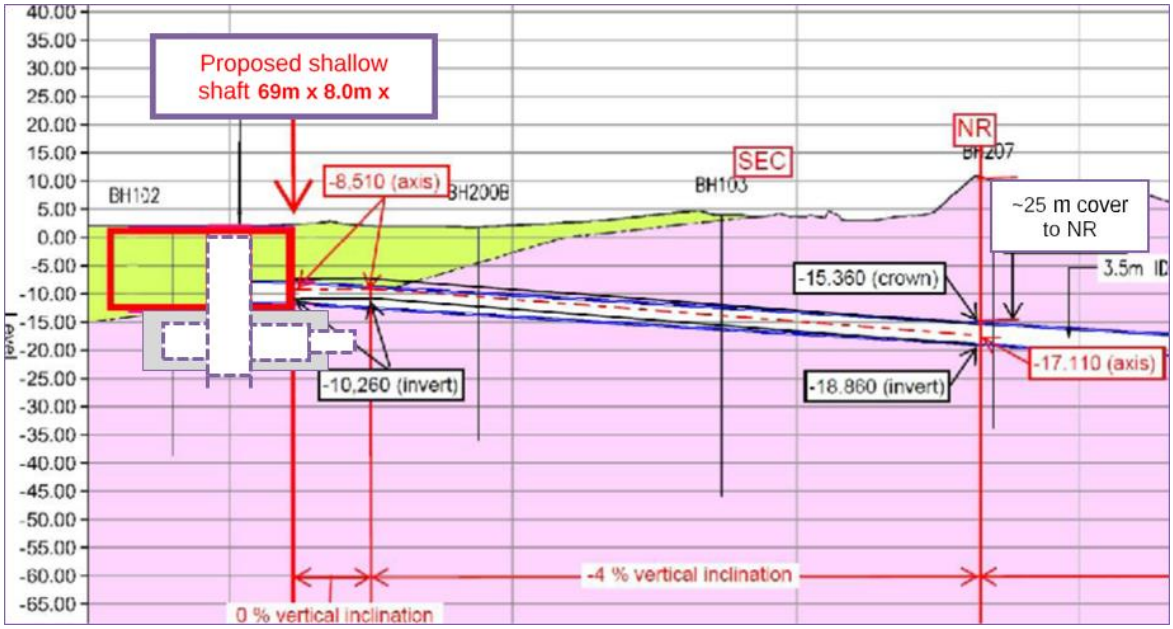

Figure 1 Tunnel Vertical Alignment

2.0 Brief Method Statement

The rectangular shaft will be aligned on the tunnel route.

A concrete headwall made from nine 1.2m diameter concrete secant piles and a grout block will be created for the TBM to cut through. The concrete piles will be 18 m long. They will extend approximately 3m above existing ground level for flood protection reasons and 15m into the ground. The concrete secant-piles will be constructed using full length temporary steel casings which will contain the liquid concrete while it hardens. The secant pile wall in the vicinity of the TBM opening will be supplemented by a grout block extending 4m from the face of the secant piles. The grout block will be 10m deep and extend the width of the secant pile wall.

The three remaining shaft sides will be made from 18m long steel sheetpiles. The sheet pile wall will extend approximately 3m above existing ground level for flood protection reasons and will extend 15m into the ground. These will be installed through the Alluvium into the Mudstone by pre-drilling (auger) and vibro-block. Percussion driving will not be used because it is too noisy.

By inserting the sheetpiles into the mudstone in a pre-augered socket very little groundwater is expected to flow into the shaft. Sheetpiles joints will be sealed with a clutch-sealant (WADIT-type or similar) to prevent seepage through sheet pile joints.

After installing the sheetpiles and the launch-shaft's perimeter is closed a pump-test will be carried out to confirm the pit is sufficiently watertight and that residual seepage is acceptable. If the pump-test shows unacceptable inflow of water into the shaft then sealing grout will be injected at sheet pile toe and/or along clutches of the piles to seal the shaft.

Once the shaft is suitably sealed then the material within the shaft walls will be excavated. Once excavated to formation level a concrete base slab will be constructed.

The base-slab has not been designed to be fully water tight. Some pressure relief valves will be incorporated into the base slab to release excess hydrostatic water pressure at the bottom of the shaft. Mudstone at the bottom of the excavation will be treated by injection to keep groundwater flow into the shaft to a minimum expected to be between 80 - 110m3/day.

3.0 Garth Shaft Construction Materials

	Use	Material	Quantity	Specifications	Method of use	Contact with soil / gndwater	Programme
1	Secant pile wall	Concrete. **(note 1&2)**	**250 m^3**	Male pile:C32/40 Female pile:C8/10 Head wall (soft) piles: to be 66% concrete + 33% bentonite	Bored piles insitu concreted	**Y**	Start 07.2023 End 08.2023
2	Ground improvement TBM launch	Grout **(note 3)**	**240 m^3**	Ultra Fine Cement	Jet Grouting (Injections) from above ground.	**Y**	Start 08.2023 End 09.2023
3	Sheet piles Temp. extracted after 26-30 months	Steel **(note 4)**	**3564 m^2**	S240 GP rolled steel sheet piles.	Installed using vibrohammer or similar method.	**Y**	Start 06.2023 End 09.2023
4	Sheet piles joint seal	Swelling tape or equivalent **(note 5)**	**108 m^2**	Clutch Sealant 6 Corner joints of the sheet piles 6 x 18 m = 108 m	Applied in site of the sheet piles.	**N**	Start 06.2023 End 09.2023
5	Base slab	Concrete **(note 1)**	**490 m^2**	C28/35 An area of approximately 7m x 70m will be in direct contact with the ground	Base slab insitu concreted.	**Y**	Start 10.2023 End 01.2024

Notes.

1. The concrete will be supplied by TG Concrete and Cambrian Services
2. The Berkbent CGB bentonite is manufactured by Tolsa Gp.
3. The ground improvement grouts will be supplied by Zublin AG UK
4. The steel sheet piles will be manufactured by ArcelorMittal
5. The steel sheet piles will be sealed with Akila or Wadit products

4.0 Estimated water abstraction during shaft construction

The construction of the shaft's secant wall and grout block will displace some groundwater. This displaced water will be collected and pumped to a treatment plant to neutralise the pH and remove settleable solids. The volume of groundwater displaced is assumed to be equal to the volume of the secant piles. The estimated daily volume of water abstracted as a consequence of this work is assumed to be up to 40m^3/day. The treated water will be discharged off site in accordance with NRW requirements.

One wall of the rectangular Garth shaft will be formed by a secant pile wall and associated grout block and the other three walls will be made of steel sheet piles. Once the four shaft walls have been installed and sealed a groundwater pumping test will be undertaken using a test borehole in the shaft. The aim of the pumping test is to demonstrate that the shaft walls are sufficiently well sealed prior to excavation. The maximum volume of groundwater expected to be pumped from the shaft during the pumping test is 100m^3/day. If the volume of groundwater pumped during the test approaches this volume further grouting will be undertaken to further seal the shaft walls until the pumping test abstracts less than 60m^3 /day. Once the pumping test demonstrates that the shaft is sufficiently well sealed then shaft excavation will begin.

During the three month excavation of the Garth shaft the water ingress requiring dewatering is expected to range between 200 - 500m3/day. Although shaft walls are inserted into the competent mudstone some water will enter the construction works through faults and fissures. Once completed the concrete slab in the base of the shaft will not be water tight but will have pressure relief valves built into it.

It is expected that the groundwater flowing into the shaft via the base slab's pressure relief valves will range between 300-450m3/day. Sealing grouts will be injected into the underlying mudstone to reduce the groundwater flows into the shaft via the slab. It is expected that the groundwater flowing into the shaft via the base slab's pressure relief valves will range between 80-110 m3 /day once moderated by injections of sealing grout. Therefore the peak groundwater flow into the shaft is expected to be during the initial excavation and reduce during the TBM drive.

Most of the Garth shaft will be removed on completion of the tunnel leaving a smaller footprint permanent shaft that will be made water tight on completion. The water seepage into the permananet structure comprising both shafts and the tunnel is expected to be up to 5 m3/day. The seepage water will be continuously pumped from the Cilfor shaft to maintain dry conditions in the tunnel.

5.0 Garth Shaft Construction Programme Summary