



Former Labour Exchange Geotechnical Design Report

Hale Construction

Date: 12 December 2018

Doc ref: LEM-HYD-XX-XX-RP-G-1002

DOCUMENT CONTROL SHEET

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Client	Hale Construction	
Project name	Former Labour Exchange	
Title	Geotechnical Design Report	
BIM reference	LEM-HYD-XX-XX-RP-G-1002	
Project reference	C-07197-C	
Date	12/12/2018	

Document Production Record		
Status and Revision	S2 P1	Name
Prepared by	Mark Lynn	
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Approved by	Robert Hooker	

Document Revision Record			
Status	Revision	Date	Revision Details
S2	P1	12/12/2018	For Approval

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Preamble

In August 2018, Hydrock was commissioned by Hale Construction to prepare a Geotechnical Design Report (GDR) for Former Labour Exchange. The scope of works to which Hydrock have been appointed is indicated in email dated 28th August 2018. The proposed development consists of replacing the cut slope back to its pre-development state. Approximate National Grid co-ordinates for the centre of the development site are 305080E, 206700N.

A ground investigation was undertaken at the site by Hydrock and the findings are presented in the report, 'Former Labour Exchange – Geotechnical Interpretive Report on Ground Investigation' prepared for Hale Construction, reference LEM-HYD-XX-GI-RP-G-1000-S2-P1, dated July 2018. The data within this report has been used as the basis for the geotechnical design presented herein.

The GDR has been prepared for Hale Construction for the purposes of replacing the cut material and returning the site to a similar slope profile prior to development.

BS EN ISO 1997: Section 2 advocates the use of geotechnical categorization of the proposed structures to establish the design requirements. For the purposes of the GDR the proposed earthworks associated with the, including embankments, cuttings and the placement of fill, have been determined to be Category 2.

1. INTRODUCTION

1.1 Project History

In November 2017, Hydrock Consultants Limited (Hydrock) was commissioned by Hale Construction Ltd to undertake a ground investigation at the former Labour Exchange building site adjacent to Pen-y-Darren Road in Merthyr Tydfil.

The site covers approximately 0.7 ha and currently comprises a soil nailed cut slope and associated terraced platform, Hale Construction site cabins and a partially completed four story apartment building located toward the south-western boundary of the site.

The proposed development was initially designed to comprise twelve detached residential houses with associated gardens and a block of flats toward the southern boundary of the site. A road was designed to access the twelve properties from the rear and this involved the development of a soil nailed slope.

The original development as described within the Geotechnical Interpretative Report issued by Hydrock on the 9 July 2018 has been adversely affected by the part-construction of a soil nailed cut slope which forms the western boundary of the site. Subsequent localised stability issues have been experienced at the site and including sloughing/voiding of material between and behind the soil nail bearing plates resulting in multiple nail tendon exposures and bulging of the retention geotextile (Maccaferri MacMat R – Geomat and double twisted steel mesh).

The original proposal shows the road level as 194mAOD with a soil nailed cut slope above it; however, the most current topographical survey shows the level as approximately 198mAOD, i.e. up to 4 meters above this level. Hydrock has been informed that the proposed development of the site was abandoned by the sub-contractor due to significant shallow failures within the cut slope face between the soil nail heads. This instability has been attributed to unexpected ground conditions which resulted in the washing out of soils due to perched water saturation of multiple granular lenses exposed by the cut slope. Correspondence between parties at the time suggests that ground conditions experienced during soil nailing were not expected by the designer however Hydrock would note that a robust design should have considered drainage of the slope as well as a robust facing system designed to work in conjunction with the reinforced slope to prevent erosion and degradation of the exposed surfaces between the nail head plates.

Inclinometer results obtained from the initial Hydrock site investigation (November 2017) and the extent of the cut at the toe of the slope raised concerns about the overall global stability of the soil nailed slope. Additional monitoring boreholes were installed at the site during a second round of investigation in April 2018 and showed no trend with regard to cumulative deflection. The two rounds of site investigation were used to compile the Geotechnical Interpretative Report (GIR) on Ground Investigation that was issued in July 2018. The soil parameters and ground model formulated during the production of the GIR are considered sufficient in the writing of this GDR.

1.2 Objectives

The GDR has been prepared for Hale Construction Limited for the purposes of preparing the site and undertaking the associated earthworks, slope reinstatement, retaining wall construction and drainage construction. This GDR will form the basis of the design work requirement to restore the slope back to a stable permanent condition.

1.3 Available Information

The following third-party reports have been provided to Hydrock by Hale Construction Limited for use in the preparation of previous reports:

- Mike Williams Surveys, May 2017. Topographical Survey Former Labour Exchange, Merthyr reference J1622;
- Tweedie Evans Consulting Ltd, April 2014. Preliminary Geo-Environmental and Geotechnical Assessment Report;
- Soil Nail Design with Associated Temporary Works Design Report for the site issued by Groundsolve Ltd on 16 October 2016;

Hydrock has prepared the following historical reports for Hale Construction and they should read in conjunction with this report:

- Hydrock January 2018 Ground Investigation Factual Report for Former Labour Exchange, Merthyr Tydfil LEM-HYD-XX-GI-RP-G-1000-S2-P1
- Hydrock July 2018 Geotechnical Interpretive Report on Ground Investigation Former Labour Exchange LEM-HYD-XX-GI-RP-G-1001-S2-P1

2. SLOPE ASSESSMENT

2.1 General Comment

The original slope prior to soil nailing was recorded at various gradients ranging between 14-29 degrees for the lower half of the slope and 10-34 degrees for the upper half of the slope. The entire slope, prior to earthworks, was highly vegetated with large mature trees and dense low-level bramble and scrub. Hydrock has been informed by Hale Construction that the original retaining wall and concrete foundation was removed during the enabling works. The following report presents a re-design of the wall to the previous alignment.

The current slope comprises an upper cut slope that ranges between 17 and 30 degrees, this progresses into the soil nailed section of slope which varies from 45 to 70 degrees and ranges in height from approximately 3m to 6.5m. This soil nailed cut slope drops onto an upper platform (carriageway level) which is currently situated at approximately 198m AOD approximately four metres above the proposed finished level (now abandoned). The site then slopes down again to the main site compound and haul road at between 24 and 35 degrees and this section of slope is approximately 6m to 7.5m in height and exhibits minor shallow failures due to localised over-steepening of slopes during enabling works.

2.2 Approach

The site was sub-divided into nine current cut section profiles. Optimised proposed ground profiles were superimposed over current profiles incorporating constraints arising from the drainage design proposals and two sections were selected as Section 4-4' and 5-5'. The location and dimensions of the proposed toe retaining wall were included in each profile for accuracy. The analysis uses the soil parameters and soil types as defined in the Geotechnical Interpretative Report issued by Hydrock in July 2018 and are summarised in Table 2.1 below:

Table 2.1: Strata Encountered (Boreholes located at +207mAOD and +198mAOD are included for comparison)

Stratum	Brief Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)	SPT N-Values
Made Ground	Soft and stiff, light brown sandy and silty gravelly CLAY containing clinker, fused coal ash and red brick.	0.00	0.70 - 2.50 (+198mAOD) 5.50 - 6.00 (+207mAOD)	0.70 - 2.50 & 5.50 - 6.00	1-16
Upper Glacial Till (fine grained)	Soft, firm and stiff orangish brown mottled light brown sandy gravelly CLAY and SILT/clayey GRAVEL.	1.40 - 2.80 (+198mAOD) 5.50 - 6.00 (+207mAOD)	5.50 - 9.50 (+198mAOD) 11.00 - 11.50 (+207mAOD)	4.10 - 6.70 & 5.50	0->50
Lower Glacial Till (coarse grained)	Cobbles and boulders of siltstone recovered as sub-rounded cobble sized fragments and subangular to sub-rounded gravel.	5.00 - 7.60 (+198mAOD) 11.00 - 11.50 (+207mAOD)	9.00 - 11.50 (+198mAOD) 17.50 - 18.50(+207mAOD)	4.00 - 3.90 & 6.50 - 7.00	22->50
SW Coal Measure	Very stiff dark grey gravelly SILT and strong greyish blue SILTSTONE recovered as coarse gravel and sub angular cobble fragments	9.00 - 11.50 (+198mAOD) 17.50 - 18.50 (+207mAOD)	10.72 - 13.00 (+198mAOD) >20.00 - >21.50 (+207mAOD)	1.72 - 1.50* 2.50 - 3.00*	45->50

The appropriated soil parameters are summarised in Table 2.2:

Table 2.2: Summary of Soil Parameters and Characteristic Values

Soil Parameters	Units	Symbol	Made Ground	Upper Glacial Till (UGT)	Lower Glacial Till (LGT)	Engineered Fill
Unit Weight of unsaturated soil	kN/m ³	γ	15	20	20	20
Unit weight of saturated soil	kN/m ³	γ_{sat}	18	20	22.5	20
Undrained Shear Strength	kPa	c_u	50	85	N/A	N/A
Angle of Internal Friction (ϕ')	Degrees	ϕ	27	30	35	Varies See Appendix A
Effective Cohesion	kPa	$c' k$	0	0	0	0

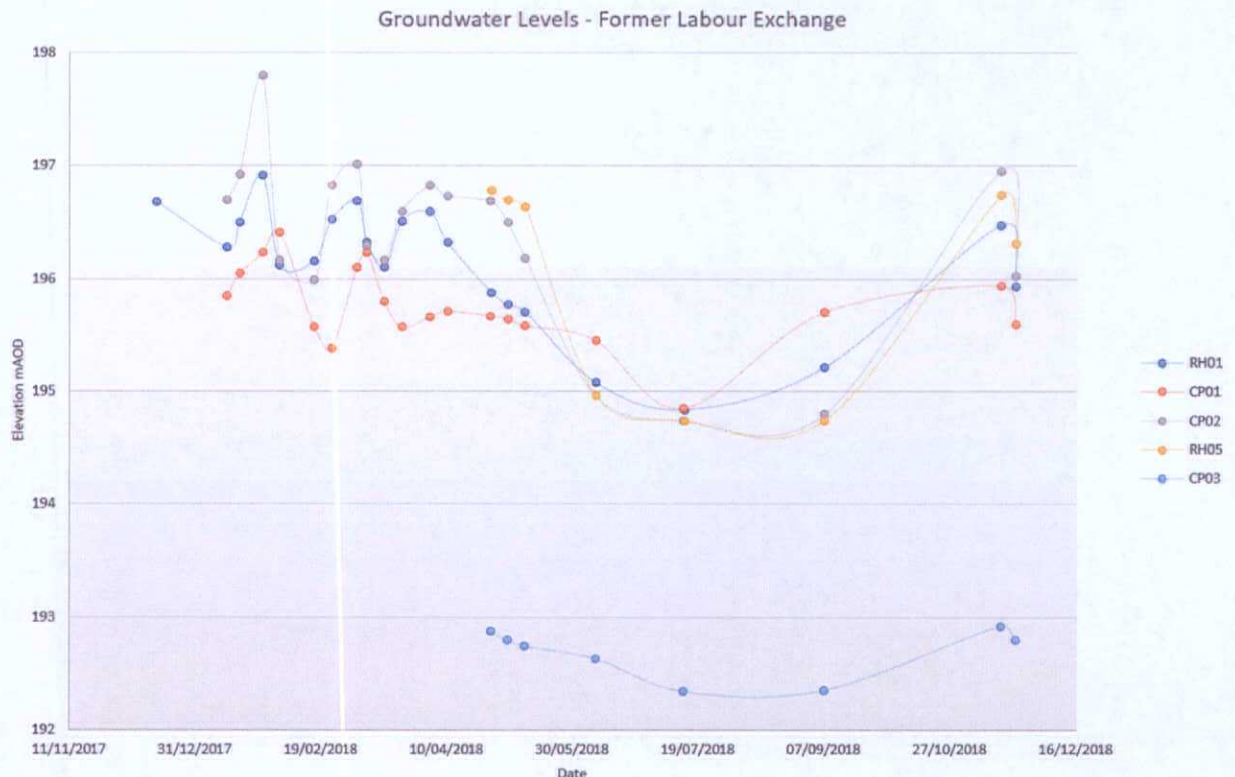
2.3 Groundwater

On-going monitoring shows a steady increase in groundwater levels at each borehole installation across the site between July and September 2018. It is likely to continue to rise to levels recorded during the initial stages of monitoring in January 2017 and to respond significantly to prolonged periods of heavy rainfall. See Figure 2.3 below for a summary of groundwater monitoring to date.

The groundwater regime for the site is complex, the groundwater is present within the upper Glacial Till and the more granular lower Glacial Till horizon. Additionally, localised perched water permeates through granular lenses within the upper cut/soil nailed slope. The final drainage solution should be designed to prevent the engineered fill component from becoming inundated by groundwater. If attenuation of the collected waters is necessary prior to discharge, then the attenuation solution should be robust, such that leakage is minimised.

For the slope analysis, groundwater has been modelled in the most relevant scenarios. This includes a worst-case scenario with groundwater entering the fill component.

Figure 2.3: Summary of groundwater monitoring levels



2.4 Existing Soil Nails

The effect of soil nails within the upper cut slope has not been included in the slope assessment as their head works will no longer be accessible following the earthworks. The current proposal is for the soil nails to be left in place during and post earthworks and for the retained cut slope to be buried by the engineered fill component hence the global stability assessment of the whole slope is conservative as the soil nails will provide a significant additional factor of safety to the upper slope.

2.5 Design Critical Cross Section Review

A design critical cross section (Section 4-4') was identified based on slope gradient and used in the assessment.

A toe retaining wall has been designed for the geometry at each intersection (i.e. 1-9).

Two benches, both 1.5 metres in width, have been designed mid-way along the slope and at the toe of the slope (as per Drawing LEM-HYD-XX-DR-C-0600 – Appendix C and Drawing LEM-HYD-XX-GI-DR-G-1008 – Appendix A) to provide a flat area around the proposed drainage access covers to the drainage systems access chamber.

2.5.1 Section 4-4'

The original slope profile at cross section 4-4' shows slope angles that vary between 22 degrees (1:2.5) and 34 degrees (1:1.5). The height of the proposed retaining wall in this section will be 1.6 metres in height.

The designed slope profile has been optimised to accommodate benches for the drainage and this has resulted in a slope angle of 25 degrees for the lower slope and 29 degrees for the upper slope. This is geometrically more onerous than section 3-3' which has resulted in a lower slope angle of 26 degrees and an upper slope angle of 26 degrees.

2.6 Slope Assessment Conclusions

The long-term global stability of the slope is primarily dependent on a combination of both the soil properties and the groundwater regime. Using conservative soil parameters and assuming a functioning drainage system, to obtain an acceptable utilisation for the slope the Made Ground beneath the existing platform/proposed carriageway will need to be removed. The two drains designed to service the toe of the existing cut slope and the mid-slope will be excavated within the Upper Glacial Till horizon.

Assuming it's not plausible for the lower slope drainage measures to fail, the slope assessment suggests that failure of the upper drainage is not critical to the overall global stability of the slope.

Hydrock has subdivided the entire slope into four zones based on the slope assessment results, namely Zone A, B, C and D with appropriate minimum phi angles designated to each zone for imported engineered fill component.

The phi angle of the imported Class 6N Engineered Fill has been optimised to reduce import volumes and to value engineer the final solution. Final slope angles for the entire site should not exceed gradients outlined in Table 2.4. Please refer to Drawing no. LEM-HYD-XX-GI-DR-G-1008 (Appendix A) for optimised slope angles for sections 1-1' through 9-9'.

Table 2.4 shows the minimum shear strength parameters for each of the zones of the slope and provides the likely material classification specification.

Table 2.4: Recommended phi (ϕ) angle and slope gradients versus Engineered Fill Zone designation

Fill Zone Area Designation	Section Lines	Approximate Slope Gradients (degrees from horizontal plane)	Recommended Minimum (ϕ') Phi Angle for Imported Fill	Recommended Material Classification
A	1-1'	16	35 degrees	Class 6N
	2-2'	21-22		
B	3-3'	26	45 degrees	Class 6N
	4-4'	25-29		
C	5-5'	21-22	35 degrees	Class 6N
	6-6'	14-15		
	7-7'	13		
D	8-8'	9	25 degrees	Class 6N or site won material with a minimum undrained shear strength of 50kPa
	9-9'	9		

Note: **Bold** figures represent the design critical section

It may be possible to reuse site won material from the removal of Made Ground at carriageway level, drainage trench and retaining wall excavations to fill a proportion of the fill requirement in zone D. A minimum undrained shear strength of 50kPa is a minimum requirement for re-use.

Based on the slope assessment, a Class 6N selected well graded granular fill as defined by Table 6/1 Acceptable Earthworks Materials (Volume 1 Specification for Highways Works – Series 600 Earthworks) will be appropriate as imported fill. Please see Appendix E for further details.

Compaction requirements and further detail will form part of the Earthworks Specification Report.

Please refer to Appendix A Drawing No. LEM-HYD-XX-GI-DR-G-1008 for details of the zoning, designated Class 6N Engineered Fill ϕ' and Appendix D for the slope assessment output.

This report does not include detailed recommendations for landscaping or seeding/tree planting works within the finished profile however discussions between Hydrock and the landscape architect (Fiona Cloke Associates) have resulted in a preliminary general arrangement for shrubs, trees (slopes <25 degrees) and seeded areas (>25 degrees) using biodegradable erosion protection measures and taking the earthworks constraints into account. Further detail is to be provided within the architect's design report.

3. NOTE REGARDING DRAINAGE DESIGN

The drainage design can be subdivided generally into three main requirements;

3.1 Slope Drainage (On-Site)

3.1.1 *Drainage Blanket*

The design shows a flexible drainage blanket attached to the soil nailed cut slope in sections and pinned into the slope crest such as ABG Deckdrain Geocomposite or similar approved with an additional earthwork-facing bonded geotextile layer. The geotextile will collect groundwater emanating from the slope and channel the flow into the upper toe drain. The Maccaferri Mat-Mac R reinforcing between the existing soil nails may have to be removed during the installation. The geo-composite can be cut, rebonded and fixed to the slope between the nail heads.

3.2 Collector Drainage (On Site)

3.2.1 *Upper Toe Drain*

The upper toe drain is to be excavated to a depth of 0.75 meters below the current platform level at approximately 198mAOD at the toe of the soil nailed cut slope. The drain is to be composed of 225mm diameter perforated pipe placed within a 0.75 x 0.75-meter-wide stone filled trench and run the entire length of the slope. The drain will be tied into the geo-composite running down the face of the slope.

Five junctions formed using lockable non-entry access chambers located along the length of the drain at 10-25-meter centers will allow access to the buried junctions, these will need to be extended from the current platform level to the proposed finished engineered fill level.

3.2.2 *Toe Carrier Drains*

Carrier drains collect water from the toe drains and run perpendicular to the general slope profile. They connect to the upper toe drain at the junction locations to the attenuation system at the bottom of the slope. These drains will be excavated to the appropriate depth to maintain an adequate fall to the lower toe drain and over-sized attenuation pipe at the toe of the profile.

3.2.3 *Lower (Mid Slope) Toe Drain*

The lower toe drain is located further down the slope profile. This drain is also to be composed of 225mm diameter perforated pipe located 2 meters below current ground level within a 0.75m wide stone filled trench extending to final formation level along the entire length of the slope.

A further five junctions formed using lockable non-entry access chambers located along the length of the drain at 10-25-meter centers will allow access to the buried junctions, these too will need to be extended from the current platform level to the proposed finished engineered fill level. A 1.5-meter-wide berm has been modelled within the slope profile to accommodate the access cover.

3.2.4 *Over-sized Attenuation Pipe*

The over-sized attenuation pipe will be located directly behind the proposed toe retaining wall and is connected to both toe drains at each proposed manhole location. The pipe is composed of 900mm diameter plastic pipe split into sections at manhole locations to account for the slope angle running east-west across the site. The pipe will be designed to attenuate flow generated by the slope achieved

with integrated weir walls and vortex flow controls situated within five of the proposed manholes. A 1.5-meter-wide horizontal berm has been modelled within the slope profile to accommodate the manhole cover.

3.2.5 Existing Land-Drain Pipe

The existing temporary land-drain collects surface water from the adjacent Merthyr Tydfil Football Club 3G pitch soak-away system and will be replaced with a new structured wall pipe and connected to the final manhole as per the Toe Carrier Drain arrangement. This flow is kept fully independent of the slope drainage system until the final manhole.

3.2.6 Surface Water Land Drainage

Shallow surface water drainage is to be provided across the finished slope. This is to take the form of a herringbone arrangement comprising 150mm collector drainage laid up the slope and 100mm diameter collector pipes (half perforated) forming the herringbone pattern. The pipes are to be in 450 x 450mm box trenches and filled with clean free draining aggregate and wrapped with geotextile. These land drains are to discharge in to the access chambers associated with the toe drains and attenuation pipe.

3.3 Drainage and Attenuation Strategy (Off-Site)

The objective is to ensure that the final discharge rate from the slope land drainage system is reduced such that it does not pose a flood risk to the following:

- The slope site itself;
- Off-site areas (promenade and the adjacent residential development);
- Within Pen-y-darren Road and the neighboring properties;
- Within the receiving Nant-y-Morlais watercourse channel at High Street.

The proposal is to provide a reasonable maximum amount of piped attenuation storage within the site; in order to reduce the final discharge rate into the receiving off-site drainage system.

3.3.1 Existing Flows

The existing water discharges originating from the slope site and into the existing drainage system are: deep and shallow ground water flows and an existing land drainage pipe originating from the football club land.

These flows cannot be quantified to any useful degree, unlike flows from rainfall events or land drainage surface runoff.

At present those flows are happening, but in an uncontrolled manner down the slope and onto the promenade and road. Any provision for flow rate reduction and attenuation storage is beneficial compared to the current situation.

The existing surface water drain in Pen-y-darren Road is a 225mm diameter pipe with an approximate capacity of 90l/s based on its 5m fall from Pen-y-darren Road to High Street (1:23). It is estimated that 60% of this flow volume is already utilized by highway runoff and other flows totaling 4000m³.

The allowable discharge from the previously consented residential development was 9l/s (8.6l/s), so this should remain the initial target for the slope drainage discharge.

This excludes the existing land drain flow that originates from land outside the slope site which is assumed to be around 3l/s.

3.3.2 *Proposed Flows*

It is anticipated that no additional new drainage will be required off site as the generated flow will be attenuated to a rate that matches that of the previously proposed housing development at the site.

The proposed piped attenuation system considers reasonable assumptions in inflow rates and reasonably sized flow controls devices (to avoid blockage risk). The predicted peak discharge rate is 9l/s, which will need to be proved through hydraulic modelling during the detailed design stage.

Including the existing land drain flow that originates from land outside the slope site (assumed 3l/s) the predicted total controlled discharge rate is 12l/s.

In summary, the target is to reduce the final discharge rates to a more reliable, consistent and lower level than the current uncontrolled overland flows. The existing uncontrolled discharges through the slope and on to Penyarden road will cease.

Please refer to Appendix C and Drawing LEM-HYD-XX-XX-DR-C-0003 for detail regarding the drainage design works proposed for the site.

4. NOTE REGARDING EARTHWORKS SPECIFICATION

4.1 General Information

The following Annex is a note regarding the Earthworks Specification only. Please refer to the Earthworks Specification in Appendix E for detail.

4.2 Material Type and Stability

It is anticipated that the remaining soils on-site will be unsuitable for re-use during the proposed earthworks. It is anticipated that to achieve the proposed slope angles imported fill be the following:

- **Class 6N Selected Well Graded Imported Granular Fill for Zones A, B, C and D.**

It may be possible to use site won soils from drainage trench and retaining wall excavations to achieve the shallow proposed slope angles within Zone D. Hydrock suggest that this material will be a combination of:

- **Class 6N Selected Well Graded Imported Granular Fill and/or Class 1 General Granular Fill and/or Class 2 Cohesive General Fill with a characteristic minimum undrained shear strength of 50kPa.**

4.3 Cut/Fill Analysis

Please refer to Drawing LEM-HYD-XX-GI-DR-G-1018 for the estimated cut/fill volumes and associated surface level data calculated for the site.

4.4 Summary of Source Testing Requirements for Imported Fill

For detailed source testing requirements please refer to Appendix E Hydrock Report LEM-HYD-XX-XX-RP-G-1002

4.5 Summary of In-situ Testing Requirements for Imported Fill

For detailed in-situ testing requirements please refer to Appendix E Hydrock Report LEM-HYD-XX-XX-RP-G-1002

4.6 General Benching Requirements

It is recommended that to prevent shallow localised failures and to ensure adequate compaction, shallow benching beyond the crest of the soil nailed slope is carried out to help key the engineered fill into the slope as it thins out at this point in the fill profile.

Benching is recommended where possible throughout the current slope profile to assist with stability. Please refer to Appendix A Drawing LEM-HYD-XX-GI-DR-G-1012 (Section 4-4') and LEM-HYD-XX-GI-DR-G-1013 (Section 5-5') for further detail.

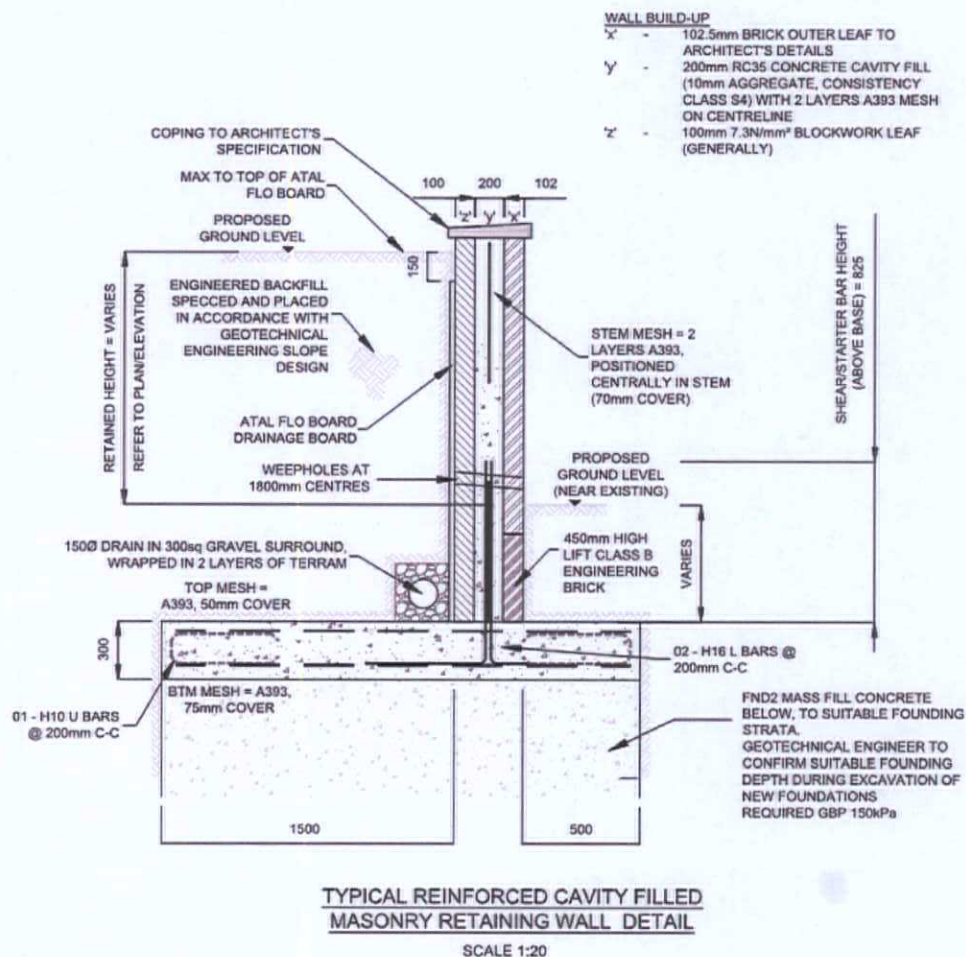
5. NOTE REGARDING RETAINING STRUCTURES

5.1 Toe of Slope

The historic toe retaining structure was removed during the initial earthworks which took place in 2016. The initial topographic survey carried out by Alpine Land Surveyors as Drawing No. PONTM 001/A (issued January 2013) was overlaid with the topographic survey carried out by Mike Williams Land and Engineering Surveys as Drawing LEM-HYD-XX-GI-DR-G-P1-J1622 (issued May 2017) to ascertain levels and volumes removed from the site.

The position of the proposed retaining wall is approximately as previously constructed however the height of the wall has been adjusted to optimise and provide permanently stable slope angles for the imported engineered fill component.

Figure 5.1: General arrangement for the twin-skin masonry retaining toe wall (from preliminary Hydrock drawing S942 Rev.A)



To provide sufficient space behind the retaining wall to accommodate a 900mm diameter attenuation pipe and associated manhole chamber, the retaining wall has been designed as a reinforced cavity filled structure. The reinforced base of the retaining wall has been designed to be a nominal 300mm in thickness however a suitable formation level for the concrete over-pour will need to be confirmed by a

geotechnical engineer on-site during excavations as this level will vary along the length of the wall. The retaining wall has been designed to accommodate the 900mm diameter attenuation pipe within the retained engineered fill component.

A geotechnical engineer must be present during the excavations for the new retaining wall along its entire length. The concrete over-pour to formation level should extend to a minimum of 300mm into the SW Coal Measures.

Groundwater flows may be present within retaining wall excavations and, if encountered, sump pumping is recommended to keep the base of the trenches dry during concrete pours. Trench boxing may also be required should the final formation levels need to be over deepened.

Please refer to Appendix B and Appendix A (Drawing LEM-HYD-XX-GI-DR-G-1008) for retaining wall dimensions applicable to each cut profile from 1-9. Dimensions associated with the retaining wall will vary along its length and the provided detail refers to dimensions at the specific cut profile location only.

5.2 Adjacent Courtyard Retaining Structures

A historic stone wall and King-Post retaining structure divides the site from the adjacent historic Labour Exchange property. This building and facade have been subsequently redeveloped into residential flats and a courtyard area is proposed. A King-Post retaining wall has been constructed in front of the old stone wall to protect residents and this will be tied into the toe retaining wall referenced above.

The proposed finished levels of the engineered fill at cut section 1-1' have been designed to finish behind the King-Post sections at a gradient of no more than 1:3 or approximately 16 degrees from the horizontal. There is scope to reduce the slope angle if necessary.

5.3 Retaining Wall Founding Level

The founding level for the retaining wall will vary along its length. It is critical to the long-term stability of the slope that a qualified geotechnical engineer is present during all associated excavations to confirm a suitable formation level before the mass fill concrete base is poured.

5.4 Historic Gateway Path to Merthyr Football Club

A gate and path existed to the north-eastern end of the original retaining wall, this allowed members of the public access via the site to the football stadium. Hydrock has been informed that the pathway is no longer required. The retaining wall is now designed to tie in to the existing red-brick faced wall at this boundary location.

6. INSTRUMENTATION AND MONITORING

6.1 In-situ Monitoring

Hydrock recommends that the inclinometer in RH02 and the groundwater standpipe in RH01 are retained and monitored at regular intervals during the earthworks program. The behaviour of the general groundwater regime and any movement attributed to the fill works can be recorded and combined with the weekly summary reports for inclusion in the Health and Safety file.

7. UNCERTAINTIES AND LIMITATIONS

7.1 Site-specific comments

The scheduled groundwater monitoring is complete however Hydrock would recommend that the inclinometer installed within RH02 and groundwater installation within RH01 should continue to be monitored especially during the installation of the flexible drainage blanket.

Groundwater monitoring during the earthworks program would allow Hydrock to record any fluctuations in the groundwater regime and allow an opportunity to refine the ground-model if necessary.

The location of both boreholes lies outside of the site boundary and will not be affected by the proposed earthworks. Any significant cumulative deflection beyond the agreed threshold (10mm in A or B axis) during works should trigger a pause and risk assessment of the program to ensure the safety of groundworkers at the site.

A geotechnical engineer must be present during the excavations for the new retaining wall along its entire length. The concrete over-pour to formation level should extend to a minimum of 300mm into the SW Coal Measures.

Groundwater flows may be present within retaining wall excavations and, if encountered, sump pumping is recommended to keep the base of the trenches dry during concrete pours. Trench boxing may also be required should the final formation levels need to be over deepened.

Groundworks should allow for a 1.5-meter exclusion zone from the boundary fence at the crest of the cut slope.

7.2 General Comments

Hydrock Consultants Limited (Hydrock) has prepared this report in accordance with the instructions of Hale Construction Ltd (the Client), by email dated 28 August 2018 under the terms of appointment for Hydrock. Hydrock shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared and provided.

This report details the findings of work carried out in 2017 and 2018. The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, all potential environmental constraints or liabilities associated with the site may not have been revealed.

Hydrock has used reasonable skill, care and diligence in the design of the investigation of the site. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

Groundwater findings described are only representative of the dates on which they were made and levels may vary.

Information provided by third parties has been used in good faith and is taken at face value; however, Hydrock cannot guarantee its accuracy or completeness.

Where the existing reports prepared by others have been provided by the Client, it is assumed that these have been either commissioned by the Client, or can be assigned to the Client, and can be relied upon by Hydrock. Should this not be the case Hydrock should be informed immediately as additional work may be required. Hydrock is not responsible for any factual errors or omissions in the supplied data, or for the opinions and recommendations of others. It is possible that the conditions described may have since changed through natural processes or recent activities.

The work has been carried out in general accordance with recognised best practice. The various methodologies used are referenced in **Error! Reference source not found..** Unless otherwise stated, no assessment has been made for the presence of radioactive substances or unexploded ordnance. Where the phrase 'suitable for use' is used in this report, it is in keeping with the terminology used in planning control and does not imply any specific warranty or guarantee offered by Hydrock.

Unless otherwise stated, at the time of this investigation the future routes of water supply pipes had not been established. This investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling and chemical testing may be required at a later date once the routes of the supply pipes are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

Whilst the preliminary risk assessment process has identified potential risks to construction workers,

Please note that notwithstanding any site observations concerning the presence or otherwise of archaeological sites, asbestos-containing materials or invasive weeds, this report does not constitute a formal survey of these potential hazards and specialist advice should be sought.

Any site boundary line depicted on plans does not imply legal ownership of land.

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Appendix A Geotechnical Design Drawings

Appendix B Structural Design Drawings and Calculations

Appendix C Civil Engineering Drawings

Appendix D Slope Stability Assessment Output

Appendix E Earthworks Specification

Appendix F Topographical Survey Information

