METROLINK

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A19.11 Hydrogeological Review for Tara Street and Swords Central

Client	**Jacobs**
Project	**3216 - Metrolink**
Subject	**Technical Note – Hydrogeological review for Tara Street and Swords Central Metrolink Stations**

1. Introduction

Minerex Environmental were appointed to provide a hydrogeological review for the proposed Tara Street and Swords Central Metrolink Stations. The specifics of the brief and scope for the review are presented in Appendix A.

2. Tara Street Station

Minerex have previously dewatered two construction sites (denoted Minerex Site A and Site B - Appendix B) in proximity to the proposed Tara Street Metrolink Station. Minerex Site A is located approximately 40m east of the proposed Tara Street Station. Minerex Site B is located approximately 80m West of the proposed station.

Site A

A cross section for Site A is presented in Appendix C. The groundwater level was recorded at 0.6 mOD while bedrock was encountered, on average, at approximately -3.1 mOD. The natural ground was primarily comprised of gravels (dark grey, silty and sandy) with areas of sand (dark grey, clayey, gravelly, silty, fine to coarse). The required excavation level was -3.7 mOD. The site was surrounded by a continuous secant piled wall.

Site B

A cross section for Site B is presented in Appendix D. The static water level measured in Site B (approx. 0.5 mOD) was consistent with measurements from Site A. The targeted dewatering depth was approx. -3 mOD. The site was not surrounded by a secant pile wall.

Dewatering

The dewatering works managed by Minerex at Site A lasted for a 32-week period. The average pumping rate over this period was 0.67 l/s with weekly average pumping rates ranging from 0.3 to 1 l/s. Pictures of the excavation are presented in Appendix E. As shown in Appendix E (and also visible in Appendix C), the site was excavated to below the bedrock surface. As dewatering at a rate of less than 1 l/s was sufficient to keep the site dry, this could be inferred as a conservative measure of vertical (base up) groundwater ingress.

Apparent in Appendix E are several leaks and seepages through the secant pile wall at the reported groundwater level. Failures in the secant wall result in significantly higher inflows.

At Site B, the absence of secant pile wall necessitated high pumping rates in order to dewater the site to the requisite level. For the duration of the dewatering phase (approx. 6 months), the average discharge flow rate was 9 l/s, however a max flow rate of 22 l /s was required for periods. Photographs of the excavation are shown in Appendix F. Apparent is the extent and highly productive nature of the gravels and cobble bed. Significant ingress (pictured – Appendix F) was encountered in the South-West corner of the excavation. It must be noted that the main excavation was approximately 500m^2 in area and only partially penetrated the gravel. Hence, greater flows would be expected from a deeper excavation at this location.

Dewatering excavations such as these requires telemetric monitoring and an automated alarm system to ensure continuous pumping is maintained and to ensure that all discharged water is compliant with the pertinent discharge licence limits. Weekly sampling is also required. The application for this licence(s)

should be considered well in advance of any works to ensure a suitable and sustainable discharge point is established. Options for discharge include discharge to foul sewer (incurring a cost) and/or recharge to groundwater/surface water. All options have been successfully implemented by Minerex.

Note, this assessment does not consider potential contamination issues in the made ground to be excavated as part of the station box construction. Such contamination could pose complexities for dewatering discharges. In order to comply with water quality limits outlined in a discharge licence Minerex commonly implement water treatment works for the removal of suspended solids, hydrocarbons as well as pH adjustment.

Groundwater flow & Tidal effects

Groundwater flow direction is anticipated to flow northwards towards the River Liffey with tidal influences likely.

Minerex Environmental have previously investigated the influence of tidal effects on the groundwater levels within construction sites located on the quays in Dublin City Centre. Water levels were monitored in two wells (DW3 and DW9 – Appendix G) on a construction site at Sir John Rogerson's Quay using water level divers for a period of 5 months. The highest range of tidal variance was 1.3m in DW3 and 0.79m in DW9. Tidal influences would be expected to be more pronounced in the gravel overburden if hydraulically connected to the river.

The proximity of the proposed station box to the Stein River and Gallows River (Ref. 1) which are presumably culverted near this located should be noted. Care should be taken to identify their location, course and depth.

Conclusions & Recommendations

1. Minerex experience is that the overburden surrounding the proposed Tara St. Station can be very productive.

2. Groundwater ingress is fundamentally controlled by the completeness and integrity of the secant pile wall and position with respect to bedrock.

3. Vertical ingress from the Limestone bedrock adjacent to the proposed site was <1.0 l/s. This is consistent with Minerex's experience in Dublin City Centre. Greater levels of ingress have, however, been observed on construction sites where bedrock faults are encountered.

4. The tidal influence on groundwater levels in the area has been observed to be in the order of 1m. It is recommended that water level sensors (divers) are installed for a one-week period to ascertain tidal influences on the site.

5. A suitable dewatering plan (including discharge/recharge point, telemetric monitoring and treatment system) is required.

6. Hydrogeological modelling would be required to ascertain the full extent of any barrier effect. Barrier effects are discussed further in Section 4.

3. Swords Central

The underlying Malahide Formation is described as argillaceous bioclastic limestone and shale. The associated aquifer is classed as only locally important with bedrock which is moderately productive in local zones. In contrast to the Tara St. Station the Swords Central Station will be constructed entirely within the horizon of Boulder Clay. As described in Ref.2, the black boulder clay at the proposed location is very stiff, dark grey, slightly sandy clay, with some gravel and cobbles. It is typically 36m thick. Locally, there are intercalations of silt/gravel lenses and big boulders up to 5 m thick. It is stated as having a high compositional variability even over short distances. The overburden here is described as an aquitard.

Dewatering

In contrast to the proposed Tara Street Station, Minerex Environmental do not have specific experience dewatering in proximity to the proposed Swords Central Station. However, Minerex do have experience dewatering sites (see Minerex Sites C and D – Appendix H) within the city where excavations are situated primarily within boulder clay and, hence, comparisons can be drawn.

Typically, such sites require low pumping rates to keep the excavations dry during the construction phase. Minerex Site C (see photos – Appendix I) was excavated to a depth of -5 mOD (9 m below ground level). Note, a piled secant wall surrounded the site. For the duration of the Minerex dewatering works (approximately 15 months) the average weekly dewatering pumping rate was 320 m^3 per week (or approximately 0.5 l/s).

The methods for dewatering excavations within boulder clay are often distinct from the advanced dewatering strategies as the bored wells normally utilised in productive gravel aquifers would be ineffective in the poorly permeable boulder clay. Effective dewatering can be completed using flow channels to concentrate flow towards abstraction sumps. This can lead to high levels of suspended solids that require treatment prior to discharge. It should be noted that the use of large quantities of lean mix concrete caused elevated pH levels in the abstracted water and hence a pH reduction treatment system was required before final discharge.

Where basement excavations are entirely within the boulder clay horizon, it is Minerex's experience that historical site investigation boreholes can provide a potential pathway for the ingress of groundwater. This was encountered at Minerex Site D (Appendix J). This can be particularly problematic where the borehole penetrates the boulder clay and enters into the more productive underlying gravels creating an artesian effect. The boreholes required sealing with bentonite to prevent ingress. This may be pertinent at the Swords Central Station due to the proximity of RC122 and its location within the station line.

Groundwater Flow

While the local topography is shallow the assumed groundwater flow direction is likely towards the North or North-East. A detailed digital elevation model and further site investigations would be required to confirm localised groundwater flow. It should be noted that the proposed Swords Central Station location is in proximity to the Gaybrook Stream which drains the Barrysparks area and flows westwards towards the Malahide Estuary SAC and SPA. Hence, in order to protect the habitat and species the hydrological regime and connectivity with the Gaybrook Stream should be considered.

While it is envisaged that less water will be encountered during the excavation of the station box at Swords Central compared to the Tara St Station, the poorly permeable nature of the boulder clay would inhibit the equalisation of groundwater levels of either side of the station box.

Conclusions & Recommendations

1. It is recommended that water level sensors (divers) are installed for a one-week period to ascertain tidal influences on the site.
2. Due to the reported aquitard nature of the boulder clay the overburden inflows are likely to be low.
3. A suitable dewatering plan (including discharge/recharge point, telemetric monitoring and treatment system) is required.
4. Care should be taken to identify any historical boreholes or old site investigation boreholes that may contribute to inflows.
5. Hydrogeological modelling would be required to ascertain the full extent of any barrier effect. See Section 4.

4. Barrier Effect Mitigation

As concluded with the respect to the Tara St. and Swords Central Stations, hydrogeological modelling would be required to ascertain the full extent of any barrier effect. A conceptual strategy to mitigate against any barrier effect surrounding a station box is presented in Appendix K. The strategy proposes the use of wells on both the upgradient and down gradient sides (with respect to groundwater flow) of the station box. The wells provide a conduit for groundwater flow beneath the station box structure. The specific design of the wells will be dictated by the local geological conditions. This is consistent with the approach developed by Idom (Ref.2) for the Bogota Metro Line.

References

Sweeney, C (2017) The Rivers of Dublin - New Revised Edition. Irish Academic Press.	Ref. 1
Jacobs IDOM Metrolink. (2020) Geotechnical Design Report ML1-JAI-GEO-ROUT_XX-RP-Y-00004 (2020)	Ref. 2

Appendix A

MINEREX WORK ITEMS

Minerex Doc. Ref: 3216-008.ppt.

Minerex Environmental

From: Hallissey, Ronan/DUB <Ronan.Hallissey@jacobs.com>
Sent: Thursday 10 September 2020 16:32
To: Cecil Shine | Minerex <Cecil.shine@minerex.ie>
Cc: O'Shaughnessy, Maria <Maria.OShaughnessy@Jacobs.com>; Dooney, Andrew <Andrew.Dooney@jacobs.com>; Cowie, Neil/UKS <Neil.Cowie@jacobs.com>; Kevin Brennan <kbrennan@idom.com>
Subject: 3216 - MetroLink Work

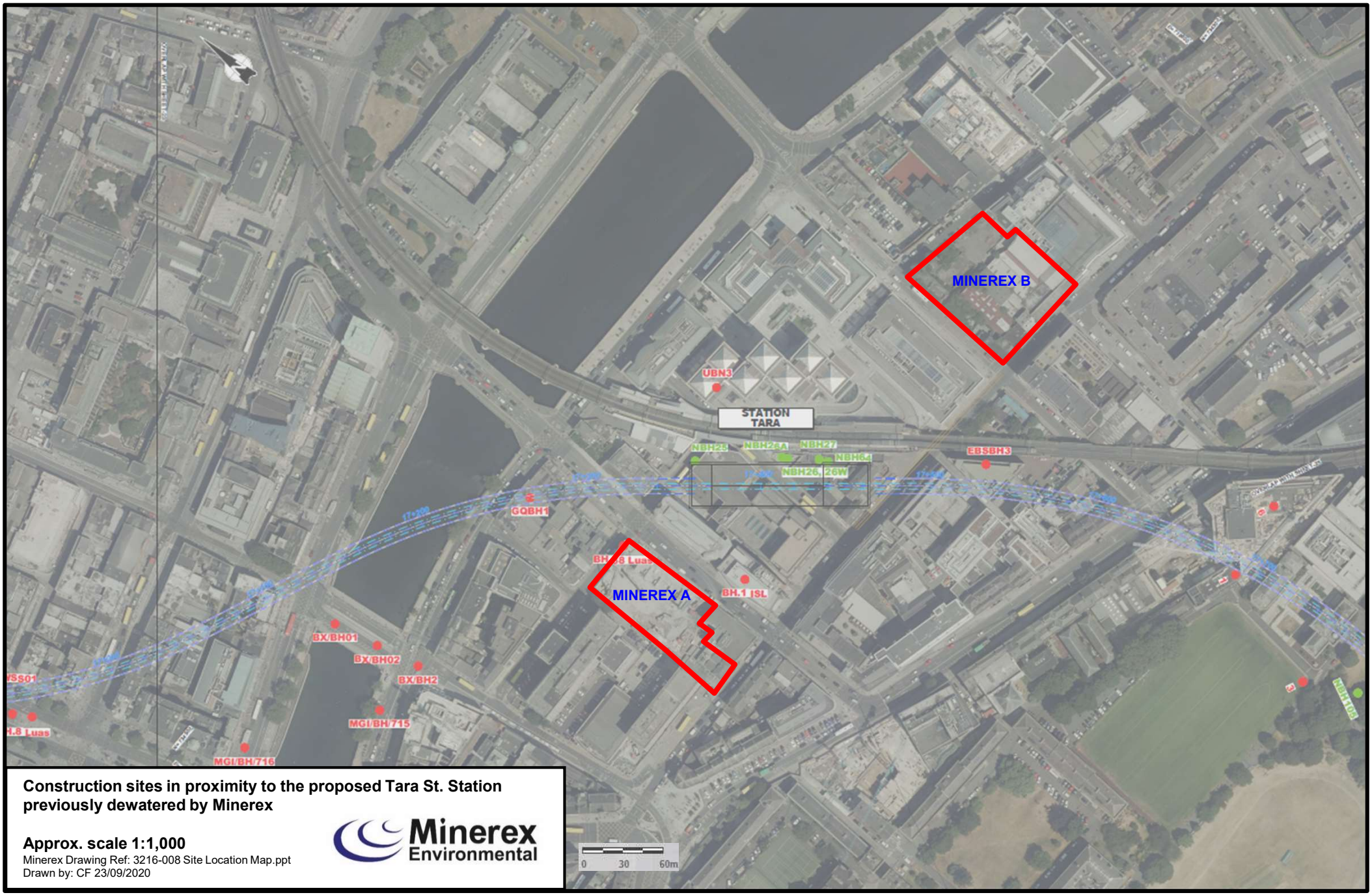
Cecil,

As discussed in our meeting on 2/9/20, I would appreciate it if you could progress with the following work in line with the fee proposal submitted by email on 1/9/20.

1. ***Tara Street:*** Review the proposed station design for this location and using data on your system:
    a. Provide a summary of the hydrogeological (aquifer characteristics) and geotechnical conditions at this site including with regard to likely tidal effects;
    b. Define local groundwater flow directions and patterns in the area and potential disruption due to the location of the station box in a city centre setting; and
    c. Identify if groundwater ingress to the station box excavation would occur during construction (d-walls construction activity), having regard to data and your understanding of the hydrogeological conditions in the area; inflow potential should consider both likely lateral and vertical (i.e. base up) ingress of groundwater and anticipated volumes where possible.

2. ***Swords Central:*** Review the proposed station design for this location and using data on your systems:
    a. Provide a summary of the hydrogeological (aquifer characteristics) and geotechnical conditions at this site including with regard to likely tidal effects with distance;
    b. Define local and regional groundwater flow directions and patterns in the area and potential disruption due to the location of the station box and cut section;
    c. Identify if groundwater ingress to the station box excavation would occur during construction (secant pile construction activity), having regard to data and your understanding of the hydrogeological conditions in the area; inflow potential should consider both likely lateral and vertical (i.e. base up) ingress of groundwater and anticipated volumes where possible.

Appendix B



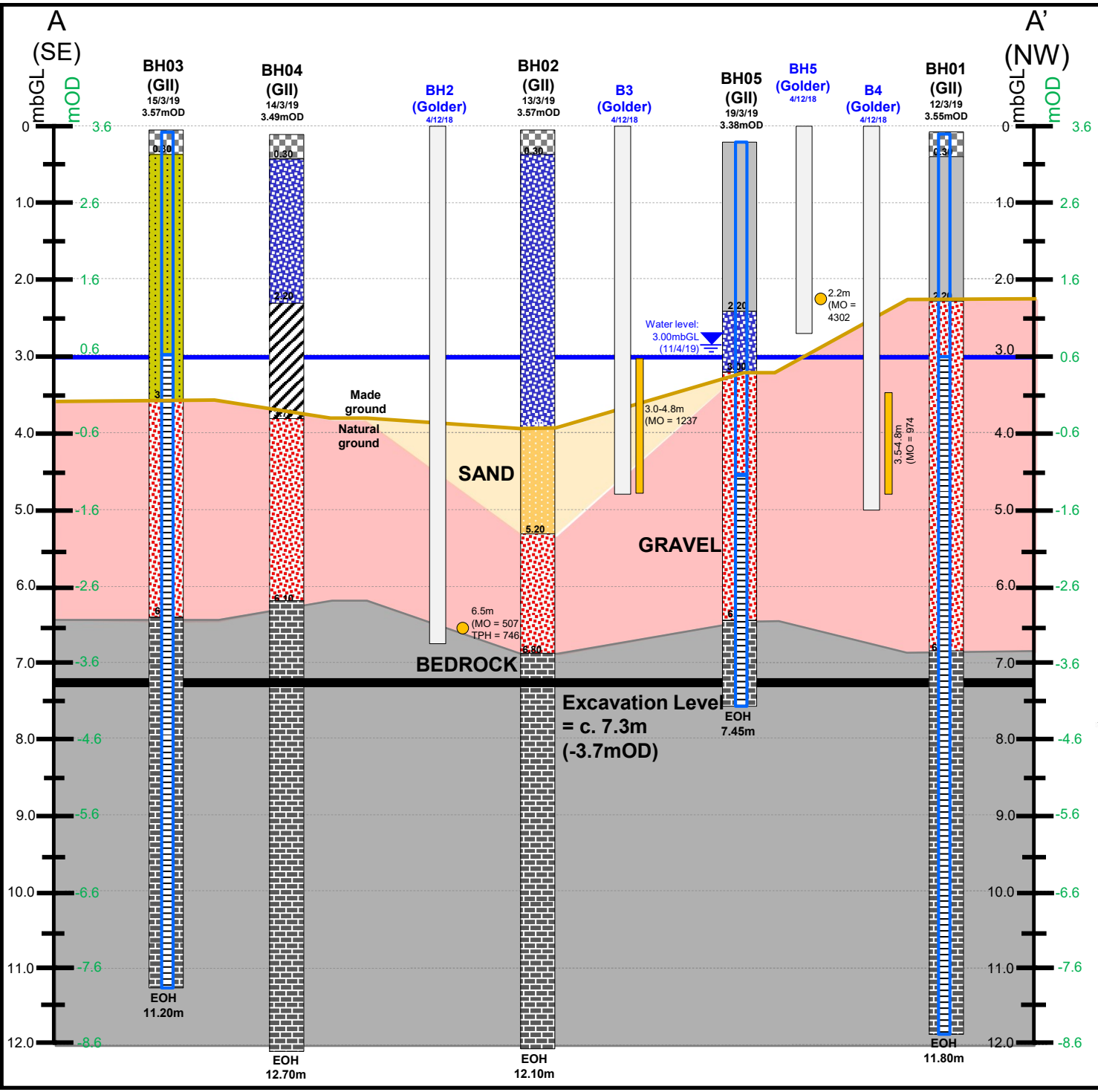
Construction sites in proximity to the proposed Tara St. Station previously dewatered by Minerex

Approx. scale 1:1,000

Minerex Drawing Ref: 3216-008 Site Location Map.ppt
Drawn by: CF 23/09/2020

Minerex Environmental

Appendix C



MINEREX SITE A

Minerex Drawing Ref: 3083-008.
Drawn by: CS & JC 10/06/19

Minerex Environmental

LAYERS LEGEND

NON-NATURAL / MADE GROUND

1. **CONCRETE**
2. Returns of concrete and red bricks
3. **GRAVEL –** Dark brown, silty & sandy, red brick & concrete
4. **SAND –** Brown, silty & gravelly, red brick and concrete fragments

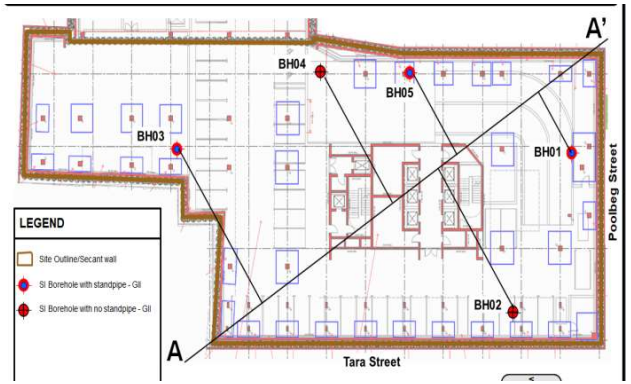
NATURAL GROUND

5. **GRAVEL –** Dark Grey, silty and sandy
6. **SAND –** Dark Grey, clayey, gravelly, silty, fine to coarse
7. **BEDROCK (Limestone) –** Dark Grey

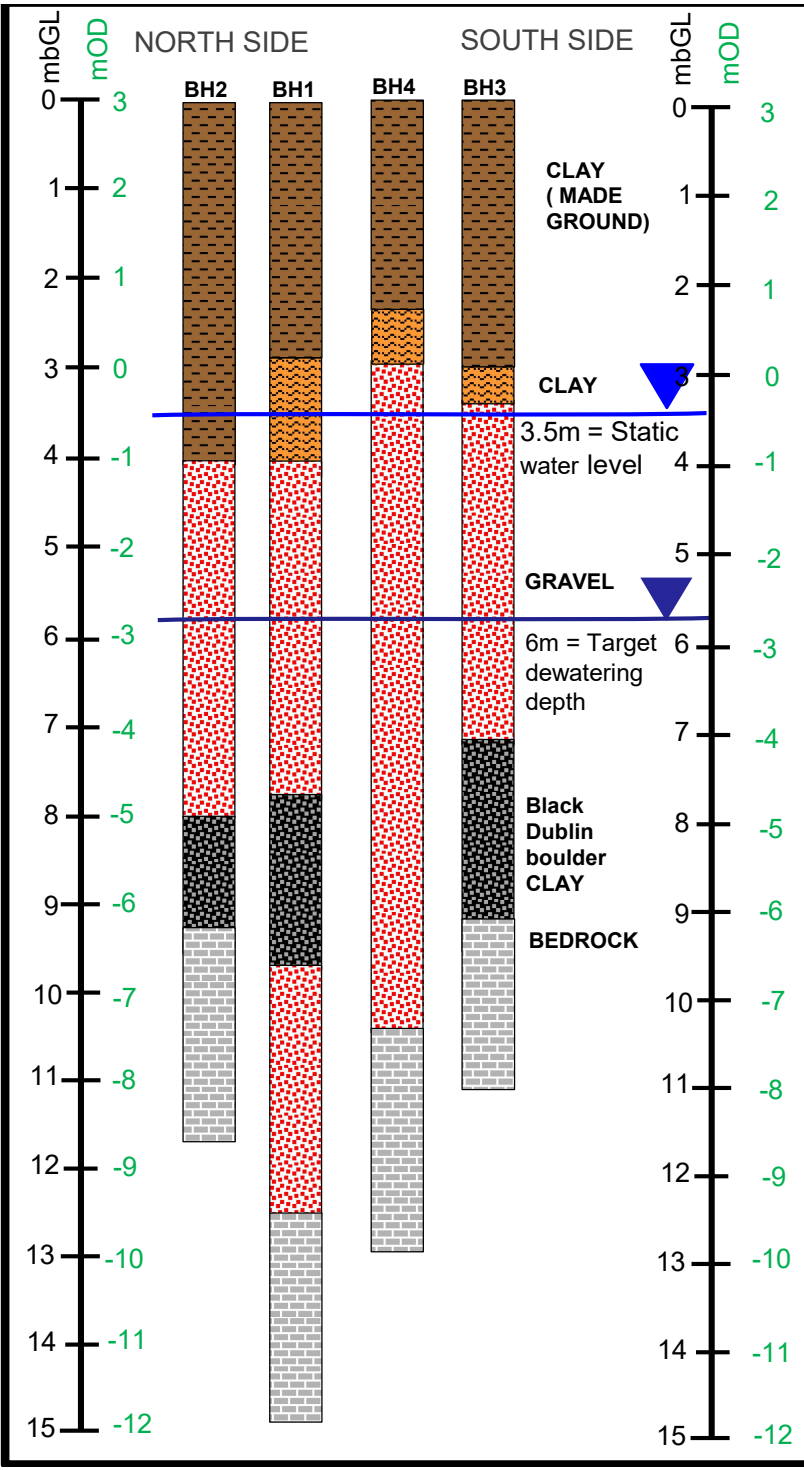
No recovery

Slotted standpipe

Plain standpipe



Appendix D



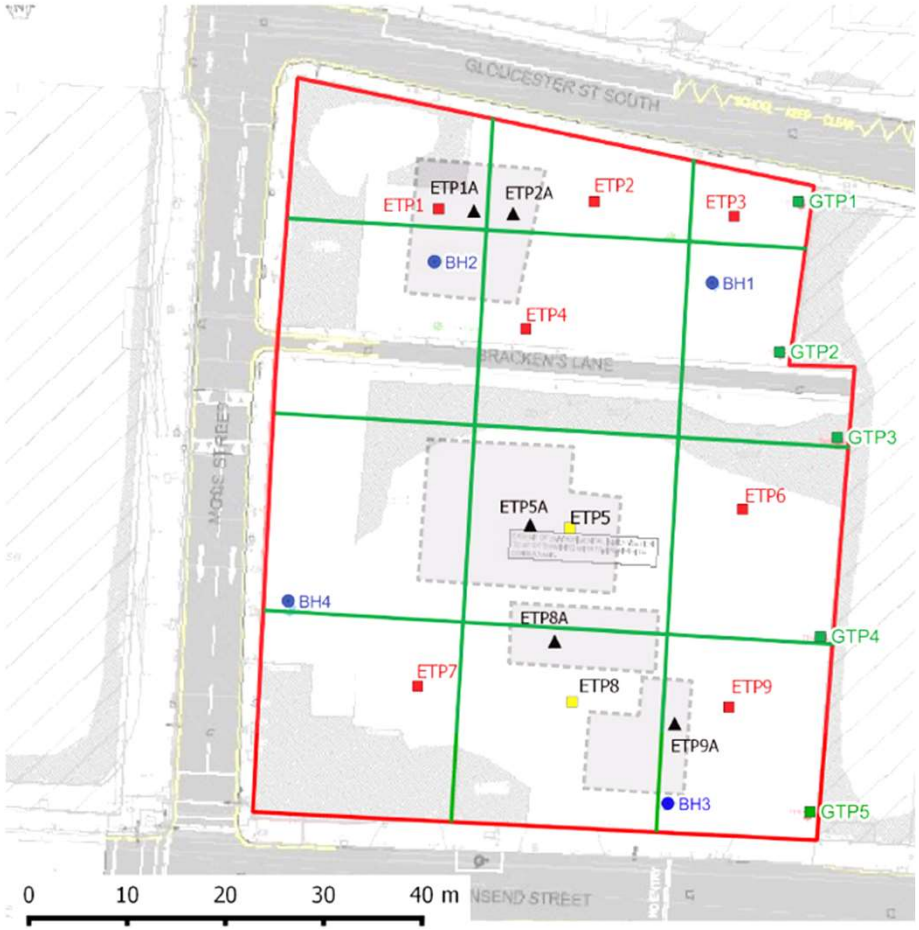
LAYERS LEGEND

1. CLAY (MADE GROUND)
2. CLAY
3. GRAVEL
4. SAND
5. BEDROCK (Limestone) – Dark Grey

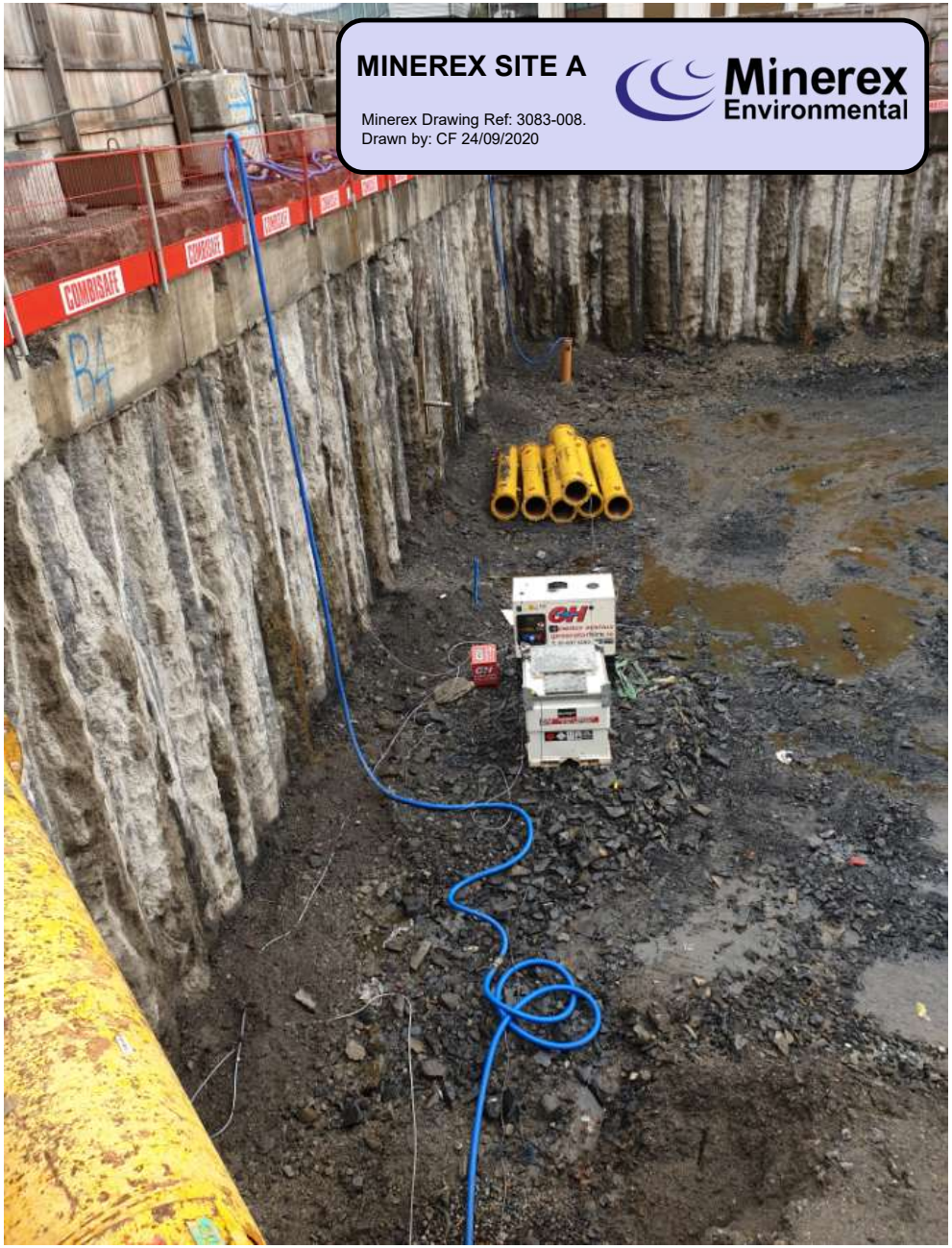
MINEREX SITE B

Minerex Doc. Ref: 3061-008.ppt.
Drawn by: CF 24/09/2020

Minerex Environmental



Appendix E



MINEREX SITE A

Minerex Drawing Ref: 3083-008.
Drawn by: CF 24/09/2020

Minerex Environmental

Appendix F

MINEREX SITE B

Minerex Doc. Ref: 3061-008.ppt. Drawn by: CF 24/09/2020

Appendix G

Groundwater tidal influence data @ Sir John Rogerson's Quay

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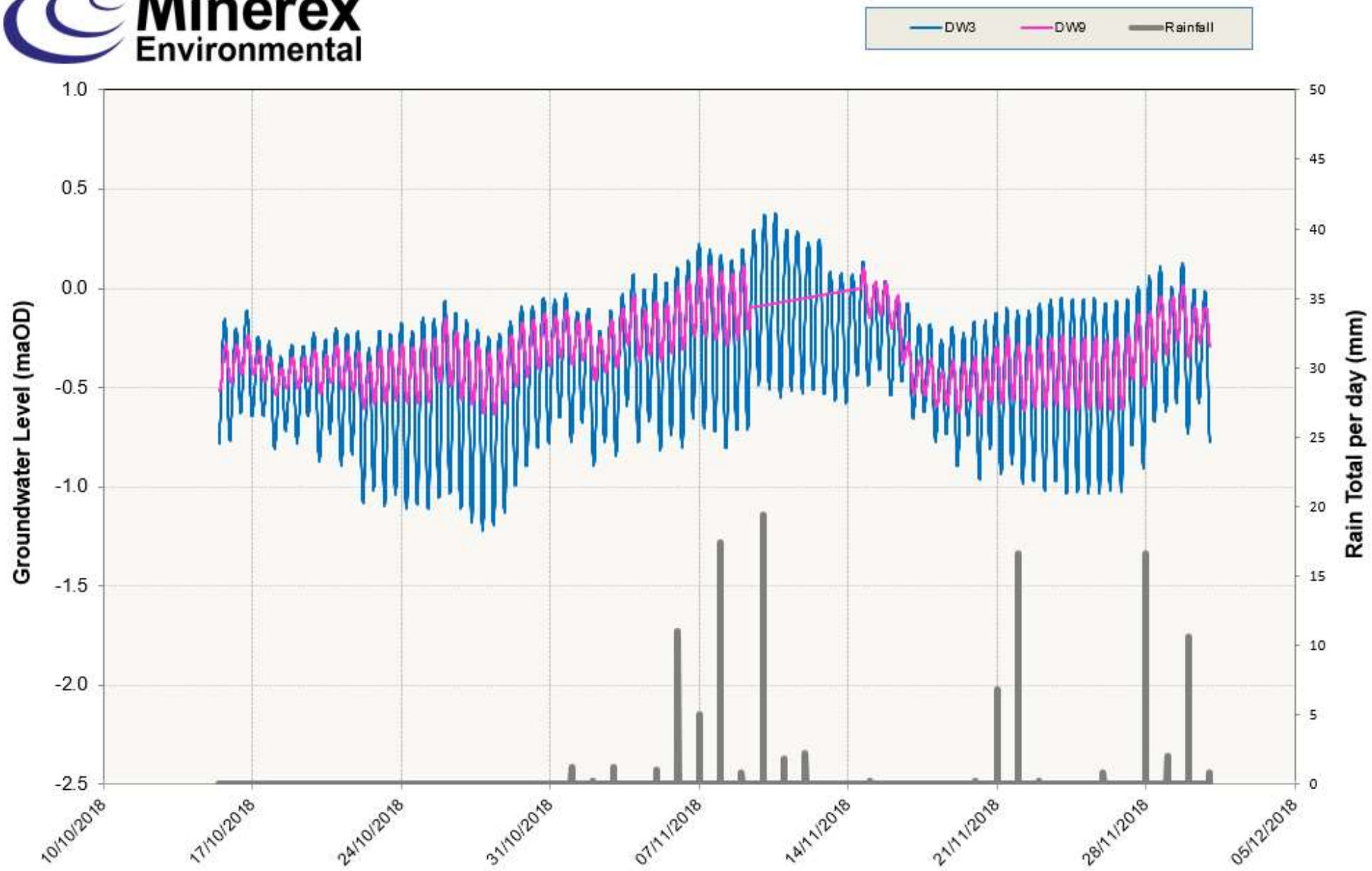
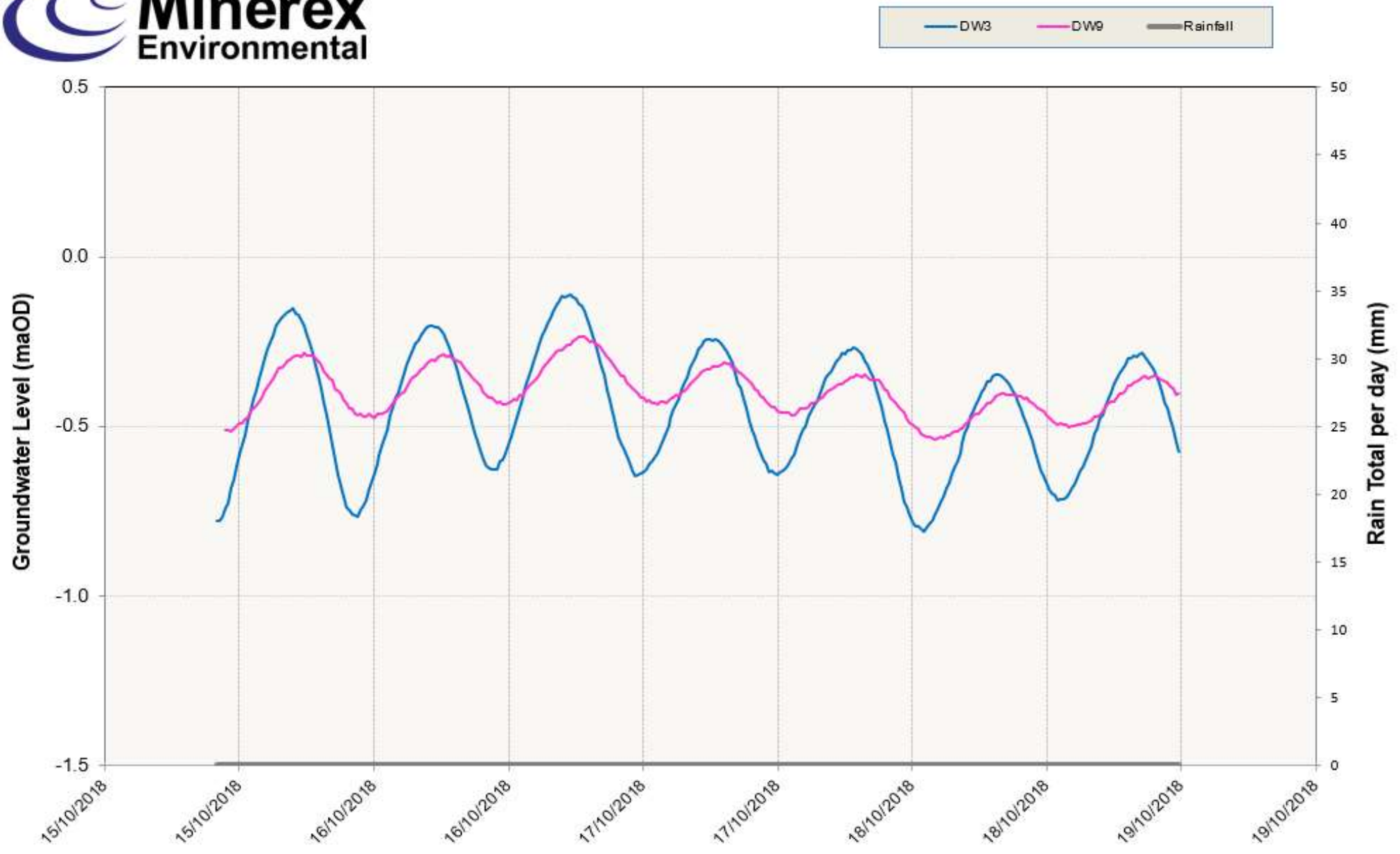


Groundwater tidal influence data @ Sir John Rogerson's Quay

Minerex Environmental



Appendix H

Construction sites situated within boulder clay overburden previously dewatered by Minerex

Approx. scale 1:8,000

Minerex Drawing Ref: 3216-008 Site Location Map.ppt
Drawn by: CF 23/09/2020

Minerex Environmental

Appendix I

Site C: Dewatering excavations in boulder clay

Minerex Drawing Ref: 3083-008.
Drawn by: CF 24/09/2020

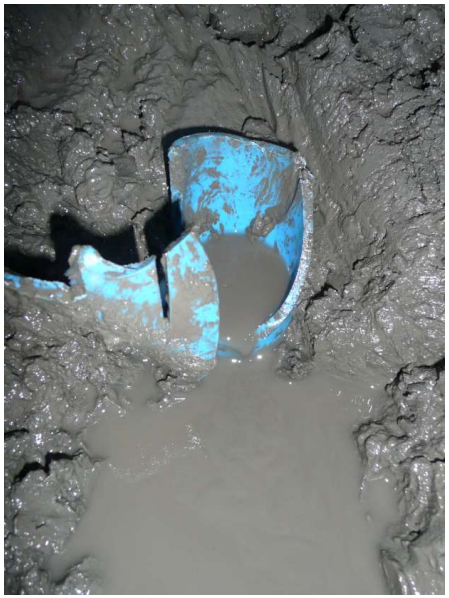
Minerex Environmental

Appendix J

Site D: Groundwater ingress through S.I boreholes

Minerex Drawing Ref: 3083-008.
Drawn by: CF 24/09/2020

Minerex Environmental



Appendix K

Conceptual approach to mitigate barrier effect

Minerex Environmental

Minerex Doc. Ref: 3216-008.ppt. Drawn by: CF & CS 07/10/2020