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Department of the Environment, Climate and Communications
Geoscience Regulation Office

Boliden – Tara Mine In-Rush Event Assessment

October 2022

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Geoscience Regulation Office

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October 2022

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Disclaimer

The Department of the Environment, Climate and Communications (DECC) Geoscience Regulation Office (GSRO) in the Republic of Ireland, Meath County Council and the Irish Environmental Protection Agency have provided information and jointly funded the work undertaken in the compilation of this report.

The report is based on information and data provided in the main by Boliden Tara Mines, with secondary information from the GSRO, Meath County Council and the Environmental Protection Agency. The information exchange with Boliden Tara Mines was facilitated by the GSRO.

WAI has, in preparing this report exercised due care in the evaluation of such information to ensure our conclusions and statements are consistent with the level of information provided.

The information and data contained in this report, provided by the mine, is reproduced in good faith by WAI. WAI has made assumptions, recommendations and conclusions based on the information and data received from the mine, however WAI cannot verify the accuracy or completeness of that information and data and therefore cannot be held responsible for any liability, damages or loss incurred by any party who use any assumptions, recommendations or conclusions provided by WAI using such information or data.

Executive Summary

On the 20 November 2021, a return air raise vent (RAR) pilot hole broke through, as planned into the Tara Deep Exploration Drive (TRDEX), an exploration tunnel driven from the South West Extension (SWEX) area of Tara Boliden's Navan mine which connects to the Tara Deep exploration area. The pilot hole immediately began discharging water which over the course of the next few days dramatically increased in flow rate and began flooding the tunnel and underground workings. The hole was eventually plugged on 2nd December 2021 by which time an estimated 412,000 m^3 of groundwater had accumulated in underground relief storage ponds in the Navan mine and had inundated a number of pumps and working areas. The inrush event was unexpected and caused a shut-down of operations and initiated an incident inquiry.

Prior to the inrush event, from records back to March 2020, local residents in Robinstown and Shambo had reported their concerns that water levels in their residential boreholes were declining. In late summer 2021, this condition was reported to have worsened and the number of reports of wells drying up became a matter of referral for both the Environmental Protection Agency (EPA), the local Meath County Council and the Geoscience Regulation Office (GSRO). Prior to and during this time, Boliden's sub-surface activities comprised underground tunnelling of the TRDEX, controlling groundwater inflows into the tunnel which were varying at different stages depending on fractures and uncontrolled seeps encountered and progressing the RAR pilot hole. The potential relationship between Boliden's sub-surface activities and resident's groundwater levels is examined in this review.

The purpose of this study is to assess the hydrogeology of the site and what most plausibly caused the inrush event and the potential connection (if any) with the Robinstown and Shambo community wells. A number of Robinstown and Shambo community wells showed a distinct response to the inrush in November 2021 and the plugging of the RAR in December. Another aspect of this review is to assess and make recommendations for better monitoring or surveillance that could be deployed in future for the Tara Deep exploration area.

The findings of this work are that the limestone aquifer, previously thought to be relatively 'tight' i.e. of low transmissivity and controllable by interventions such as grouting, demonstrates much higher transmissivity than expected. Particularly in the upper 400m where information suggests a system of well-connected, transmissive fractures extends vertically and laterally. At depths from 400m to approximately 1000m below ground level where the TRDEX tunnel and base of the RAR are situated, the limestone aquifer becomes more competent, more stratified but is still capable of moderate flow and transmissivity as evidenced by the TRDEX inflows and other geophysical factors. The transmissivity (the ability to transmit water through rock) of the area appears to be much higher compared to the Tara Navan and SWEX mine areas. The reasons for this are unclear and require further study, it may be related to increased limestone thickness, presence of minor faults and poor rock quality extending to at least 400m depth, or other factors related to this site's structural geological setting and a more 'open' stress system. Some borehole sites showed competent 'tight' rock throughout whilst others showed poor ground and evidence of weathering and enhanced permeability to significant depths. Hydrogeological effects created by the intersection of fault

systems may affect the transmissivity of the limestone and create a substantial number of minor fault splays and discontinuities which may also convey water.

Reviewing the previous hydrogeological work undertaken to support the planning application for the RAR pilot hole, it is clear the original conceptualisation was not sufficiently precautionary. The previous work placed a high level of reliance on grouting one cavity zone that was informed by loss of circulation of drilling fluids, which occurred earlier when a geotechnical borehole was drilled adjacent to the RAR site, and observations of fracture connection over 300m+ distances between boreholes. These observations should have been treated as warning signs that the RAR pilot hole could encounter a more pervasive fracture system in the UDL, that there would be connection to upper large stores of water within the weathered UDL sequence and that multiple inflow zones were likely to be present.

During drier periods, such as occurred in summer 2021 some of the most vulnerable boreholes and wells – those that are relatively shallow, will have been experiencing lower water levels through lack of recharge. The removal of several thousand cubic metres a day of groundwater from the TRDEX throughout the summer period when no recharge was occurring (i.e. replenishment of aquifer storage) could have worsened this condition. There is clear evidence that the RAR inrush affected the community wells with water levels dropping c.20m at the outset of the inrush and rebounding when the RAR was plugged. This demonstrates that hydraulic connection can be established over several kilometres in this system. The TRDEX at elevations between 700 and 900m is located in less transmissive limestone but, by virtue of its continued inflow from 2020 into 2021 is also connected to other, recharging groundwater zones. The TRDEX inflows could have induced a reduction in water level which would have been enough to have reduced levels near to or below pump intakes. The exact drawdown value for each property cannot be determined with accuracy but analytical calculations, taking into account the limestone properties at a bulk scale, suggest it is plausible for an average drawdown of approximately 2m to occur across the affected area. This hides the likely variability where some properties and boreholes would be affected greater or less than others. The complete drying of some wells could have been a combination of the dewatering effect from the mine, shallow vulnerability, and reduced, dry weather recharge acting in unison. The chronology of the reported lowered community water levels has been correlated with the timing of the main episodes of inflow into the the TRDEX tunnel.

The inrush event created conditions that were akin to a large scale 'pumping test'. This provided sufficient data to analyse the hydrogeologic connection between the TRDEX tunnel and the Shambo/ Robinstown area. Hydraulic connection between the sites was empirically proven by the inrush event. A number of wells in the Shambo/ Robinstown area showed a distinct response to the inrush. When the drawdown behaviour of the inrush was analysed and hydraulic parameters derived, a predicted drawdown of up to 2m at Shambo and Robinstown was calculated for the inflow rates recorded. This relates reasonably well to the drawdowns reported in the summer of 2021 when complaints of drying wells were registered. The loss of water from the November-December 2021 inrush caused a much more distinct dewatering of the system and more wide-spread impact. The majority of inflow for the November 2021 inrush came from a number of discreet conduits which were fed by an inter-connected network of joints, discontinuities and small-scale fractures which extended to Shambo and Robinstown. Whether a similar interconnected system exists at the level of the TRDEX tunnel is not

possible to definitively prove with the data available but the lines of evidence suggest this is plausible, albeit at a more subdued condition.

The implications of this are significant for future monitoring, regulation and groundwater resource sustainability. This report concludes it is plausible that drawdowns caused by TRDEX tunnelling in Summer 2021 exacerbated the seasonal drying of some wells at that time. This report includes outline recommendations for further monitoring and risk assessment to improve characterisation of hydrogeological conditions at the Tara Deep orebody and support future surveillance.

1 Introduction

The Department of the Environment, Climate and Communications (DECC) Geoscience Regulation Office (GSRO) in the Republic of Ireland, Meath County Council and the Irish Environmental Protection Agency (EPA) have provided information and jointly funded the work undertaken in the compilation of this report.

Wardell Armstrong International (WAI) was commissioned in January 2022 to undertake an independent hydrogeological review of the Boliden Tara Deep Deposit and surrounding area. The objectives were to:

- Review and appraise the conceptual hydrogeological model of the mine for the Tara Deep Area,
- Assess the monitoring regime being undertaken for the Tara Deep Area,
- Review the most likely causes of the recent (November 2021) in-rush of water into the mine, and
- Try and determine whether there is a linkage or not between the mining activities and the drop in groundwater levels in the nearby Robinstown - Shambo area. Reduced water levels were recorded since at least early summer 2021. Conversely, the assessment also needs to consider if there is a natural explanation for this or some other 'hydrological' reason.

To undertake this review, WAI has undertaken the following scope of work:

- Prepare information requests and over multiple rounds of correspondence, facilitated by GSRO, refine the level of collected data and understanding of the relevant circumstances.
- With the support of GSRO's team of geoscientists, compile and review the relevant data.
- The chronology of the inflow events and related works such as tunnelling have been assessed and interpreted. The hydrogeological data has been used to develop a hydrogeological 'conceptualisation', or in other words, a description of how groundwater behaves in the area and its likely interaction with the Tara Deep works.
- To test whether the conceptualisation is valid, some simple analytical 'models' or predictive calculations have been used to gauge whether 'effects' for example drawdown from the inrush event or TRDEX tunnelling could theoretically extend as far as the observations that were recorded in monitoring wells and community boreholes; and
- Appraise the linkage between the mine site and the Robinstown - Shambo area and review the suitability of the monitoring program undertaken. The conceptualisation and review of the monitoring program are interrelated as they both inform each other. In other words, hydrogeological understanding is only as good as the data on which it is based.

Data reviewed to support this assessment has been provided primarily by Boliden Tara Mines DAC, Meath County Council, the EPA and the DECC via the GSRO. The data has been reviewed and checked and where necessary the raw (uninterpreted) data has been used to compile this assessment. Additional anecdotal data has been incorporated from the *Shambo and District Water Action Group.* A video conference meeting was held in May 2022 between the study team (WAI) and representatives of the Water Action Group. A further video conference meeting was held in September 2022 between the study team (WAI) and representatives of Boliden Mines.

A full inventory of the data reviewed is listed in Appendix A.

2 Site Setting

2.1 Hydrology and Terrain

The Tara Deep exploration area is located in a generally flat to undulating topographic area of the eastern Boyne catchment, ranging from c. 60-70 m elevation. The area is northwest of the River Boyne in the centre of County Meath and has an overall slight northeast topographic gradient meaning drainage is to the south. Land-use comprises agricultural fields, local access roads, dwellings and the M3 motorway located approximately 300m north of the site.

Local drainage comprises a series of local ditches and field drains joining the Clady, River Blackwater and River Boyne to the south near Robinstown. The River Boyne is the most significant surface water feature in the region. The River Blackwater catchment drains the area of the existing Navan mine workings to the east where the Blackwater flows into the River Boyne in Navan. The Robinstown area is within the lower reach of the Clady catchment which drains to the east into the River Boyne catchment. The Tara Deep and Shambo areas are within sub-catchments of the River Boyne which generally drain to the east into the River Boyne which has an elevation of c. 40 m above ordnance datum (AOD). Figure 2.1 presents an overview of the sub-catchment drainage to the River Boyne.

The local areas - Shambo and Robinstown are 2.7 km and 3.6 km respectively due south of the Return Air Raise (RAR) site which was the cause of the inrush event causing flooding of the underground mine. The water supply in these areas is from a combination of predominantly private abstraction boreholes with limited reticulated mains water supply. A large proportion of residences and properties have their own boreholes and are reliant on their own supply. Private water supplies are used for drinking water, domestic purposes and agriculture including livestock watering and horticulture. Residents have to commission and maintain their own supplies including borehole works, well screens, headwork installations, pumps and pipework and treatment systems to render the water safe for domestic and livestock use.

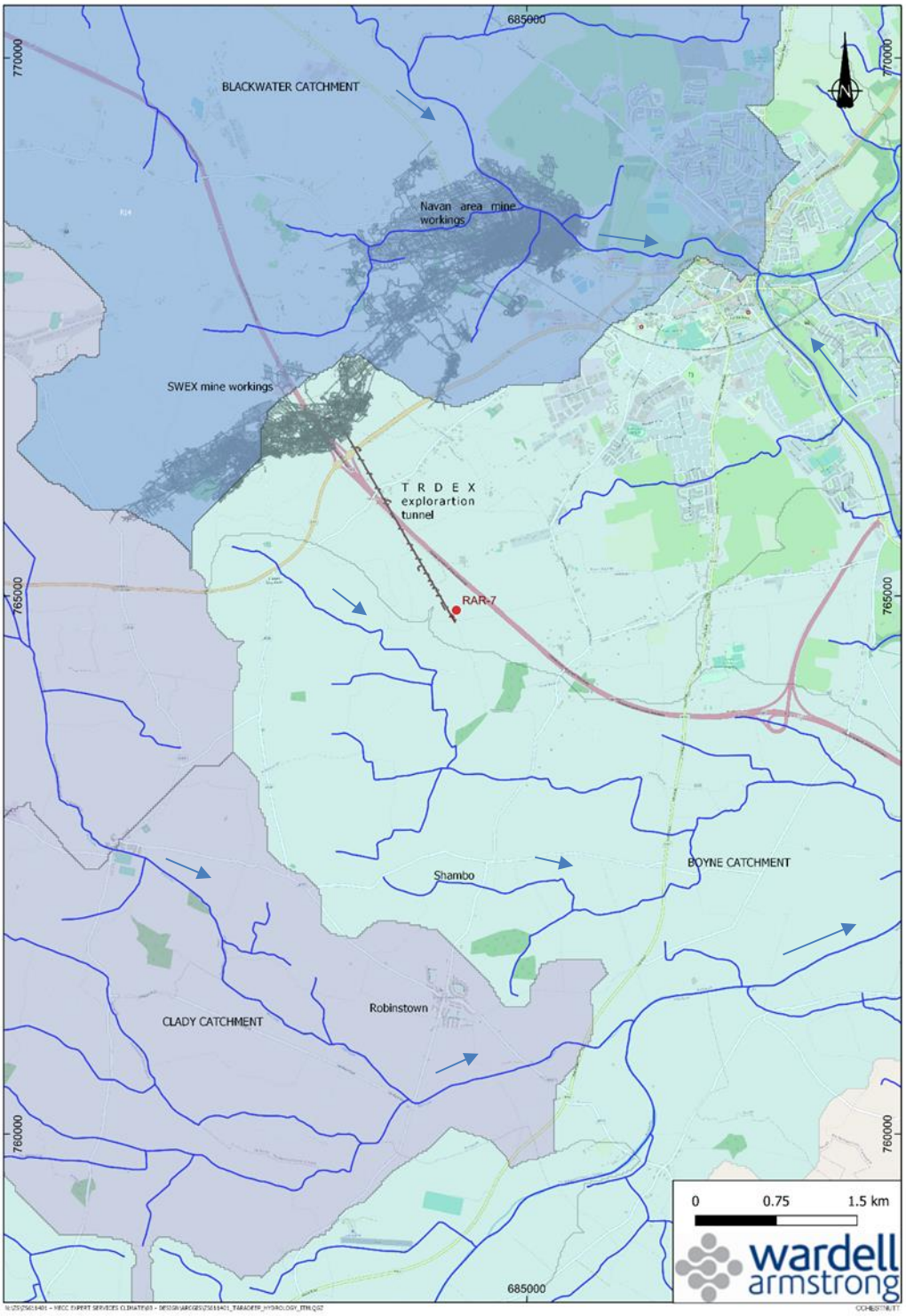


Figure 2.1: Local Hydrology Showing Sub-Catchments of the Clady (purple), Blackwater (dark blue) and Boyne (light blue).

The mean annual rainfall for 1971 to 2021 from the Randalstown meteorological station, Co. Meath, was 860 mm/yr. The median annual rainfall for the same period was 837 mm/yr. The monthly average rainfall is presented in Figure 2.2. Months with the highest average rainfall are October to January ranging from 86 mm/month to 82 mm/month respectively. The driest months are April and May with an average of 54mm/month and 59 mm/month respectively. It is notable how uniform rainfall is, on average, throughout the year. From a hydrogeological perspective, the significance of rainfall depth is strongly modified by other processes such as as the prevailing temperature and humidity (affecting evaporation and the 'effectiveness' of rainfall to infiltrate into soil) and soil 'dryness' (which affects its storage capacity and the ability to transmit moisture through to the underlying groundwater systems).

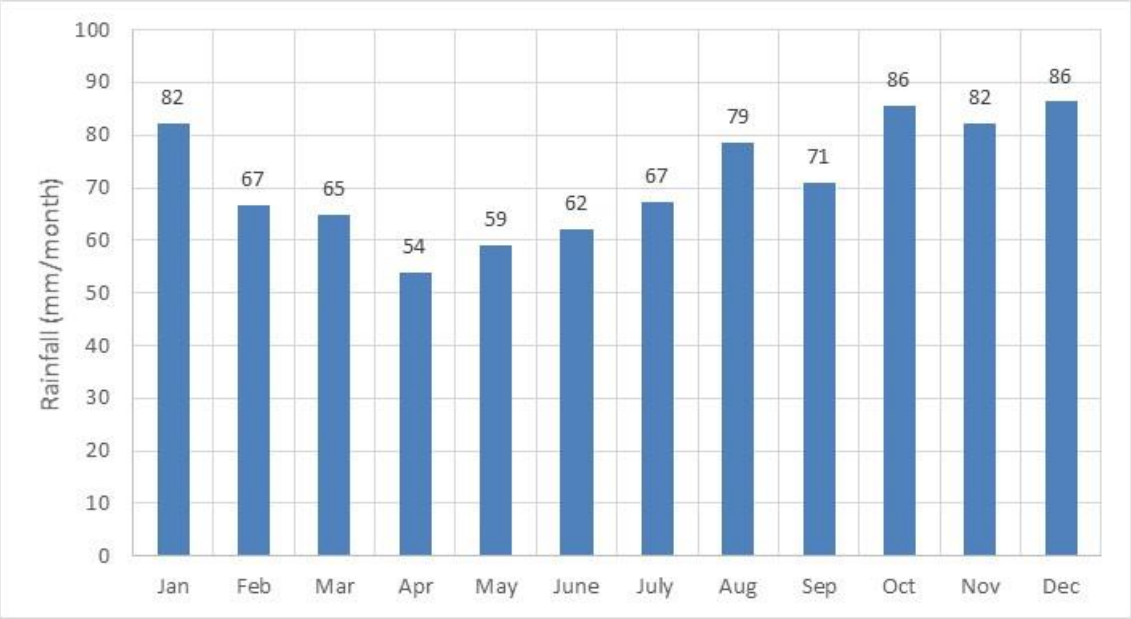


Figure 2.2: Average Monthly Rainfall (1971 to 2021) from Randalstown, Co. Meath

These 'recharge' processes that control how much water is transmitted to depth are affected by antecedent i.e. preceding soil conditions that exert a form of water balance in the soil zone. These processes are examined in more detail in the following sections of the report to review how they may have affected groundwater levels during the 2020 – 2021 period.

Further analysis of the rainfall in the period 2020-2021 is provided in subsequent rainfall monitoring sections.

2.2 Tara Mine

The existing operational mine in the Navan/ South West Extension (SWEX) area is the largest Zinc mine in Europe. The mine processed 2.1Mtonnes of ore in 2021[1], and for contextual purposes is a regionally important operation, with significant economic influence and an employer of more than 580 people in the local area.

[1] Pg 110, Annual and Sustainability Report 2021, Boliden, 2022

There is no current mining in the Tara Deep area, only planned exploration activities and enabling works. The deposit is estimated to be a 28 Mtonnes Inferred Mineral Resource[1] as of December 2021 and is regulated under Boliden Tara Mines prospecting licence (PL4502) which comprises 48.7 km^2 area of dominantly flat agricultural land. PL4502 was issued in 2015 and covers the same area as retired licences PL1489R and PL1661R. A prospecting licence has been issued to Boliden Tara Mines for this area since 1970[2] .

The Tara Deep Exploration Tunnel (TRDEX) connects the SWEX area of the existing mine workings to the new Tara Deep development area. The tunnel provides the only access route to the Tara Deep exploration area and is wholly underground. Two ventilation shafts called Return Air Raises (RAR 6 and 7) are planned at Hanlonstown, Navan. The RARs are planned at Irish Grid Reference 284414, 264848 (Easting, Northing) at a point c. 2 km along the TRDEX tunnel from the existing mine workings. The RARs intersect the tunnel at a depth of about 1000m. Figure 2.3 presents a site overview showing the extent of existing mine workings underground, the TRDEX and the RAR7 pilot hole, relative to Shambo and Robinstown. Further information on Tara Deep is provided in Section 4.

[2] Summary Exploration Work Report, Prospecting Licence 4502, Co. Meath, January 2019 to October 2020, Boliden Tara Mines, October 2020

Figure 2.3: Existing Underground Infrastructure, RAR7 Pilot Hole, Shambo and Robinstown.

3 Geology

3.1 Regional Geology

The general geological succession at Meath comprises superficial (near surface) units of glacial till (sometimes referred to as boulder clay) and alluvial sands and gravel underlain by a transition zone where weathered bedrock and sub-soils grade into their parent host rock.

The bedrock sequence begins with dark muddy (or argillaceous) limestones and shales which are formally termed the 'Dinantian Upper Impure Limestone' of Lower Carboniferous age (359 to 324 million years ago). Generally, and throughout this report, this is referred to as the Upper Dark Limestone (UDL) and is generally considered to be separated into an upper weathered unit and a lower more competent, inter-layered unit with shale beds. The UDL is relatively thick and can exceed 1000m depth in some areas. The UDL's thickness, particularly in Tara Deep is increased due to ancient tectonic events which created a series of structural high and low areas. Thickened terraces of limestone are present between intervening blocks with erosion removing limestone from structural highs. Beneath the UDL, there is an unconformable sequence of breccias and mudstone conglomerates, representing a period where the depositional sedimentary process was disrupted, and the underlying rocks were eroded forming a break in the sequence.

The breccia and conglomerates separate the UDL from underlying purer limestones in which the economic mineralisation is located - these are collectively called the "Pale Beds". These units are at a depth in the Tara Deep region of nearly 1400m and are in a sequence of upper calc-arenites and lower shaley limestones (Shaley Pales). This unit is recognised as an aquifer and is the main source of inflow into the Navan mine. Hitherto the inrush event the UDL had not been regarded as a major water-bearing sequence. This is discussed in greater depth in the following hydrogeology section. The stratigraphy is shown in Figure 3.1.

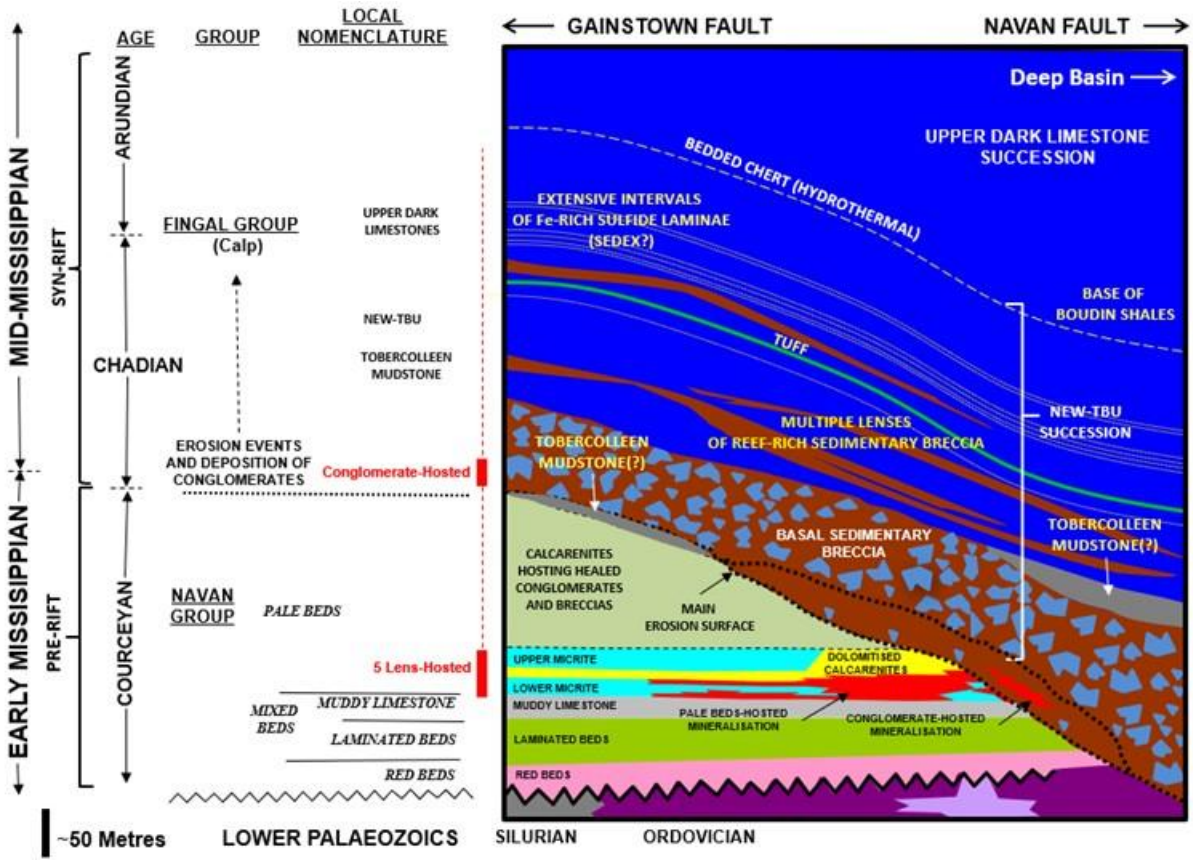


Figure 3.1: Stratigraphy of the Tara Deep Ore Body (Source: Piteau Associates, 2021, adapted from Ashton et al., 1992 and Anderson et al., 1998)[3]

The RAR7 development and TRDEX exploration tunnel are both wholly within the UDL unit. Borehole logs from two wells nearby to the RAR7 summarise the site-specific geology:

- Borehole N02176 drilled in 2012 near Curraghtown House;
- Borehole N02481 drilled in 2019 as a prior geotechnical test hole for the RAR7 development.

The recorded geological information at these locations indicates the basal sedimentary breccia / conglomerate is not encountered until at least 1446m below ground level. The RAR7 pilot hole reached approximately 1000m depth but a preceding geotechnical test borehole went slightly deeper to 1100m depth, both were wholly within the UDL sequences.

[3] Tara Deep: Further Discussion of Factors Contributing to the Conceptual Hydrogeology Model, Piteau Associates, December 2021

3.2 Site Specific Geology

Geological information from government sources as well as Boliden's surveys, drilling and exploration work has been reviewed. The logs provided[4] are hand-written and it is not confirmed if they are QA/QC'd, the logs record extensive joints, weathering and faulting. A Leapfrog geological model was supplied however, geotechnical data which would describe ground conditions was not included in the dataset. The site-specific geology and hydrogeology of the Tara Deep area, from the provided information is described below.

3.2.1 Superficial glacial deposits

Glacial till is variable in thickness with a general estimate of between 3 to 26m[12] in the area of the Tara Deep exploration area and approximately 10m thick above the RAR7 shaft. Nearer to established river channels, alluvial sequences are more developed while interfluve zones (ridge and valley sides) have reduced thickness and local erosion of superficial sediments. The till deposits (also called *boulder clay*) are derived from glacial reworking of the underlying limestone and can contain isolated lenses of sand and gravel in areas where the glacial deposits are thicker.

Some of the shallowest domestic wells derive their water exclusively from the sand and gravel lenses in the superficial deposits which are limited in extent and generally more vulnerable to drying up and depletion. The till is derived from glacial grinding and reworking of the underlying limestone beds, it is likely to have, at most, a partial or tenuous hydraulic connection with the underlying 'bedrock' . Its original limestone texture is altered (refer to the Meath County Council Consultant's Report[5] , 2022 for a description of till). The normal consensus of Tills or Boulder Clays is that they are low permeability materials. However, the Consultant Report states: "In general, the subsoil in the area of interest is expected to be of high to moderate permeability, with a low likelihood of .. impeded vertical drainage." The report suggests the permeability of the subsoil materials is considered as generally 'Moderate' (GSI, 2021). Findings of a walkover survey, suggest 'SAND' or 'SILT'dominated material according to BS:5930 subsoil classification. A number of glacial deposits along the River Boyne and the Clady River, as well as in parts of Shambo, Balbradagh and Bellewstown Townlands, consist of glaciofluvial sands and gravels derived from limestone. These sands and gravels are sorted and bedded, and highly permeable, and dominate the general area flanking most of the major rivers in central County Meath. Tills may also have a lower permeability, sometimes having a clay or silt texture as well as enclosing the sand and gravel lenses[5]. Where permeable, Till allows water to pass through to recharge underlying limestone and may be hydraulically affected by underdrainage of deeper units.

[4] N02176,N02207, N02413,N02592, N002473,N02570, N02572, N02595,N02610,N02616,N02621, MW7,MW8, Micon Drilling Record,

[5] Hydrogeological Characterisation And Assessment For Proposed Application To Community Grants Scheme As Part Of The Multi-Annual Rural Water Programme, Shambo – Robinstown Locality, Navan, County Meath, Robert Meehan, March 2022.

In late December 2021 and early January 2022 two monitoring wells, TD_MW7 and TD_MW8 were tested at Shambo[6] . These monitoring boreholes were drilled to 40m and 55m depth respectively, encountering mainly angular gravel and sand. The lithology was described in the logs as an upper glacial till underlain by UDL which was logged as chips and clasts. TD_MW7 had a water strike at 14m depth and was reasonably productive in terms of yield, TD_MW8 did not make water during drilling and when tested was found to have low yield. Overburden of boulder clay in other locations (for example borehole N02176) was found to be thin in the order of 6m.

The Meath Council Consultancy Report[4] (2022) report describes as-built borehole construction details, geological unit types and groundwater flow from 70 local community monitoring wells. The report identifies three categories of domestic wells and bores: those developed in upper sub-soils between 0 - 8m depth, those in transition materials between 3 - 11m depth and the remainder in upper bedrock from 13 – 49m depth. One deeper borehole was installed into bedrock at 122m depth.

[6] Productivity Testing of Two Monitoring Wells Identified as TD_MW7 & TD_MW8 For Boliden Tara Mines, Coyle Environmental, February 2022

3.2.2 Weathered Upper Dark Limestone (UDL).

The weathered portion of the UDL extends to several hundred meters depth in some locations, in others it is relatively close to surface. From Rock Quality Determination (RQD) logging and analysis carried out at NO2481 (Boliden, 2019), weakened or poor rock quality (<70%) dominates to 200m depth and is prevalent to at least 400m depth. The RQD analysis includes all discontinuities affecting rock including jointing and fracturing as well as rock matrix deterioration.

The weathered zone of the UDL is often fractured allowing groundwater movement and this zone may contain a relatively large amount of groundwater in storage.

Enhanced weathering in the Tara Deep / RAR area, penetrating in some places to deeper depths than observed at the Navan mine may be associated with underlying structural geology, particularly where thickened units, multiple fault sets and splays and down-thrown zones have created a paleo-extensional stress regime in the overlying rocks causing a tendency for weakening and dilation of the rock fabric and greater circulation of groundwater which enhances the weathering process. This has been documented in the P-fault above the SWEX area of the Navan mine but was not reported in the RAR7 area according to observations from borehole N02481[3]. The log provided for N02413 (the initial proposed location of the RAR but abandoned because of 'severe ground conditions') shows pervasive and near continuous jointing / discontinuities to approximately 776m depth. Logs for N02176 and NO2481 (at the selected RAR site) show more competent conditions. The logging of N02481 differentiates upper shales and cherts to approximately 219 mbgl, thereafter the log is undifferentiated and uses the term 'clean, cherty calc-arenite' to 630mbgl.

The weathered UDL is thought to allow significant groundwater movement and circulation which, in turn allows more dissolution of soluble limestone material and creation of flow-paths. The unit is reported to have higher drainable porosity than the underlying competent UDL. Dissolution and groundwater circulation can continue and become increasingly magnified such that large scale cavities, solution pipes and fissures are formed, a process common in limestones called karstification. There is no evidence that full-scale karstification has occurred at Tara Deep, but there are references in logs (including N02481) to cavity development. At N02481, the selected RAR geotechnical borehole, cavities were recorded at 248.5mbgl and 453.7 mbgl. At N02413 cavities were reported at 177mbgl and 474-480mbgl with reports of weathering throughout.

Thinner beds of limestone and calcareous shales are prone to dissolution and mineral decomposition by the action of circulating groundwater. Soluble minerals are removed leaving weakened residual clays, sandy clays, open or partially infilled fractures and overall increased porosity and permeability. This in turn enables more water to drain and flow through and more dissolution and weathering to occur. In places where this has occurred in the weathered UDL, it is recognised the formation can develop reasonably large primary porosity, karst features and groundwater in storage with significant fracturing and local-scale permeability . It is likely the cavity zones noted in N20481 were large scale water transmitting features (500mm and 10mm respectively).

In the SWEX area it has been observed that de-pressuring of the deeper mine system[7] resulted in water level reductions in the UDL at the base of the weathered zone and particularly in zones of deep weathering underlain by the P-fault. This suggests that there is hydraulic connection between the upper weathered UDL, the deeper competent UDL and depressurisation of the underlying pale beds.

3.2.3 Competent Upper Dark Limestone (UDL)

The model of a neatly layered upper weathered UDL for a few hundred metres underlain by competent UDL is an over-simplification and not representative of what is occurring at Tara Deep. Different logs provide a different picture of the degree of competence and uniformity of the deeper UDL with some logs showing poor ground and weathered conditions extending to 750m depth and others showing more competent material occurring at shallower elevations.

On the basis of the log from geotechnical test borehole N02481, the competent UDL is reported to be over 1100m thick in the RAR7 location. The UDL is a thick depositional sequence with many inter-layered beds including boudinated shales, tuffs (volcanic debris sediments), and sulphidic lenses forming a thick-layered sequence of limestones, shaley limestones and shales. Cavity zones were encountered at 248.5m and 453.7m in N02481, no greater than 0.5m thickness. A possible division between an upper 220 m thick unit was identified based on the presence of 'a bottom marker shale'. Extensive fracturing was observed in N02481 down to c. 450 m [7].

The main UDL comprises a strongly layered sequence of limestone beds, shale horizons and shaley-limestone units. Below the superficial (glacial) deposits, the bedrock geology in N02481 is entirely UDL, consisting predominantly of cemented calcarenites, interbedded shales and mudstones of the UDL formation.

Most of the available drill logs in the area of Tara Deep show a similar sequence at depth (>500m) within the UDL formation described initially as micritic limestone with interbedded shales and chert. Bedding within the UDL sequence is variable but the overall character is alternating beds of thick micritic calc-arenite limestone with frequent shales and occasional tuffs and pyritic mudstones. The thicker beds in the UDL are frequently infilled with carbonate extensional veins which tend to increase the overall competency of the formation.

In the log for N02207, a brecciated area around a fault zone at 451m depth was encountered extending for about 25 and 30m above and below the fault contact. This hole is a significant distance from the RAR site.

In the area of SWEX, the UDL is thought to be strongly layered and forms a general barrier to downward groundwater movement. Many of the thicker beds within the UDL exhibit a well-developed pattern of jointing. However, the joints are usually restricted to individual beds, and do not have the potential for creating vertical hydraulic conduits.

[7] Tara Deep Exploration Drift, Update March 2021, Boliden Tara Mines, 2021

3.2.4 Basal Sedimentary Breccia

The breccia directly underlying the competent UDL comprises a sequence of conglomerate and mudstone layers. Although not encountered at the RAR7 site, it is known from exploration drilling at Tara Deep. The sequence has up to four sedimentary breccias units extending upwards towards the basal parts of the UDL. The UDL units are all generally conformable with the underlying breccia although there is a distinct erosive, unconformable contact between the base of the breccia and the underlying pale beds.

3.2.5 Shaley Pales

Boliden has stated no known Shaley Pales are at the RAR site. No Shaly Pales were intersected in N02413, N02481 or any of the drilling off N02176 which is the nearest hole to the RAR site. Shaley Pales are referenced in the Piteau Reports 2020 and 2021 in the order of 50m. The unit comprises mostly shaley limestone above the main ore sequence. The unit is well developed in the Tara Deep area but less well represented in the SWEX area.

3.2.6 Pale Beds Limestone (PB)

The pale beds which host the mineralisation are thin and estimated to be less than 200m thick in the RAR7 location comprising the main orebody and associated footwall units. This limestone forms the main bedrock groundwater unit in the SWEX area of the Tara Mine. The Pale Beds occur beneath the UDL throughout the entire area. It outcrops over an area of about 13 km² to the northwest of the mining area (Piteau, 2020, Interpreted map, Tara Boliden 1:25,000), partly above the Nevinstown and Liscartan/Rathaldron sub-areas.

3.2.7 Lower Palaeozoic rocks

The basement of Silurian / Ordovician age rocks occurs along faulted contacts on the east side of the mining area.

A summary lithological log in the Tara Deep area from borehole N02176[8] is presented below:

Depth From (m)	Depth To (m)	Unit/Lithology/Feature
0.0	6.0m	Overburden
6.0	1445.7	Upper Dark Limestone
1445.7	1474.0	Close-Packed Conglomerate
1474.0	1571.9	Pale Beds
1571.9	1594.5	Laminated Beds

[8] Drillhole Log N02176, Boliden Tara Mines, April 2012. ING 284232.5, 265105.

Figure 3.2 presents a NW-SE geological conceptual cross section from the SWEX area of mine working into the Tara deep area indicating the key geological units described above, the TRDEX tunnel and the RAR7 pilot hole.

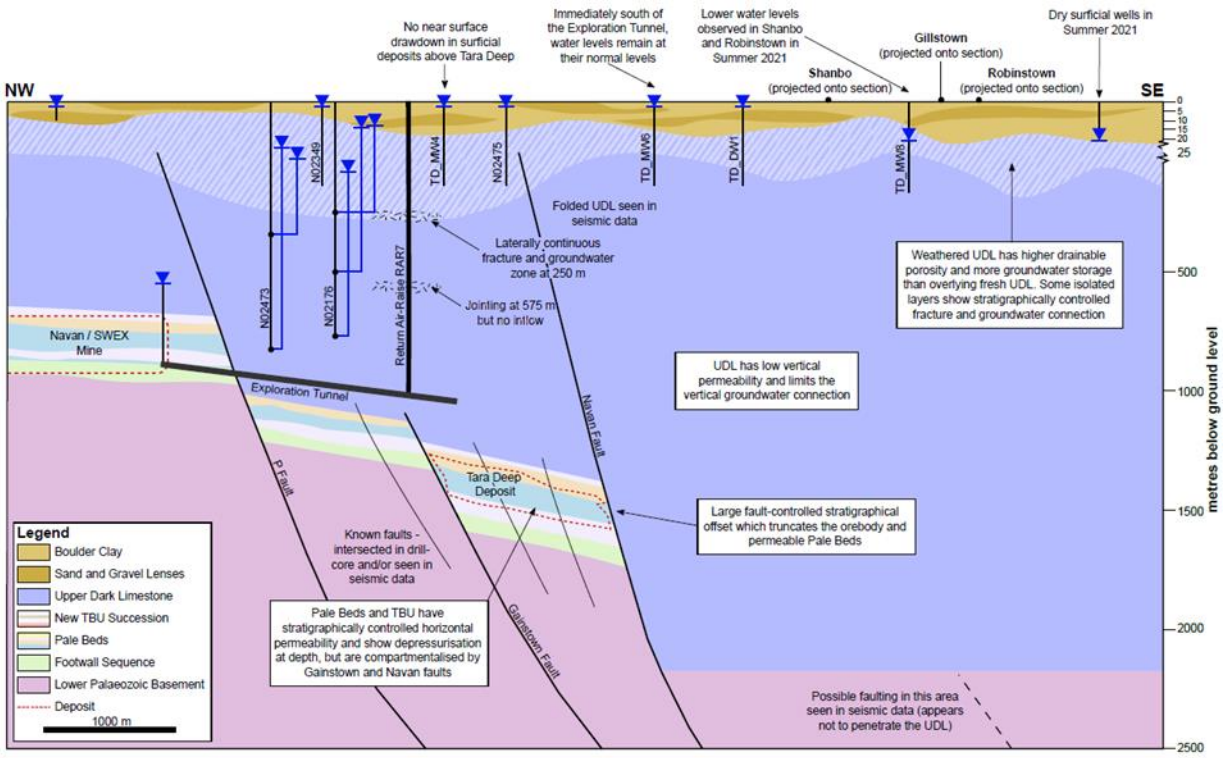


Figure 3.2: NW-SE Geological Conceptual Cross Section (SWEX area to Tara Deep). Source: Pg 12 Piteau Associates, December 2021[3]

3.3 Structural Geology

This section provides a brief overview of salient structural geology factors. Structural geology can have a direct and indirect controlling effect on the way groundwater moves in an area. Faults and rock deformation can create enhanced pathways (conduits) or alternatively barriers to groundwater movement. Effects may be indirect if stress regimes in the rocks induce extension, fracture opening and increased transmissivity or conversely compressional and fracture tightening. Figure 3.3 presents the orientation of the main fault structures in the Tara Deep area.

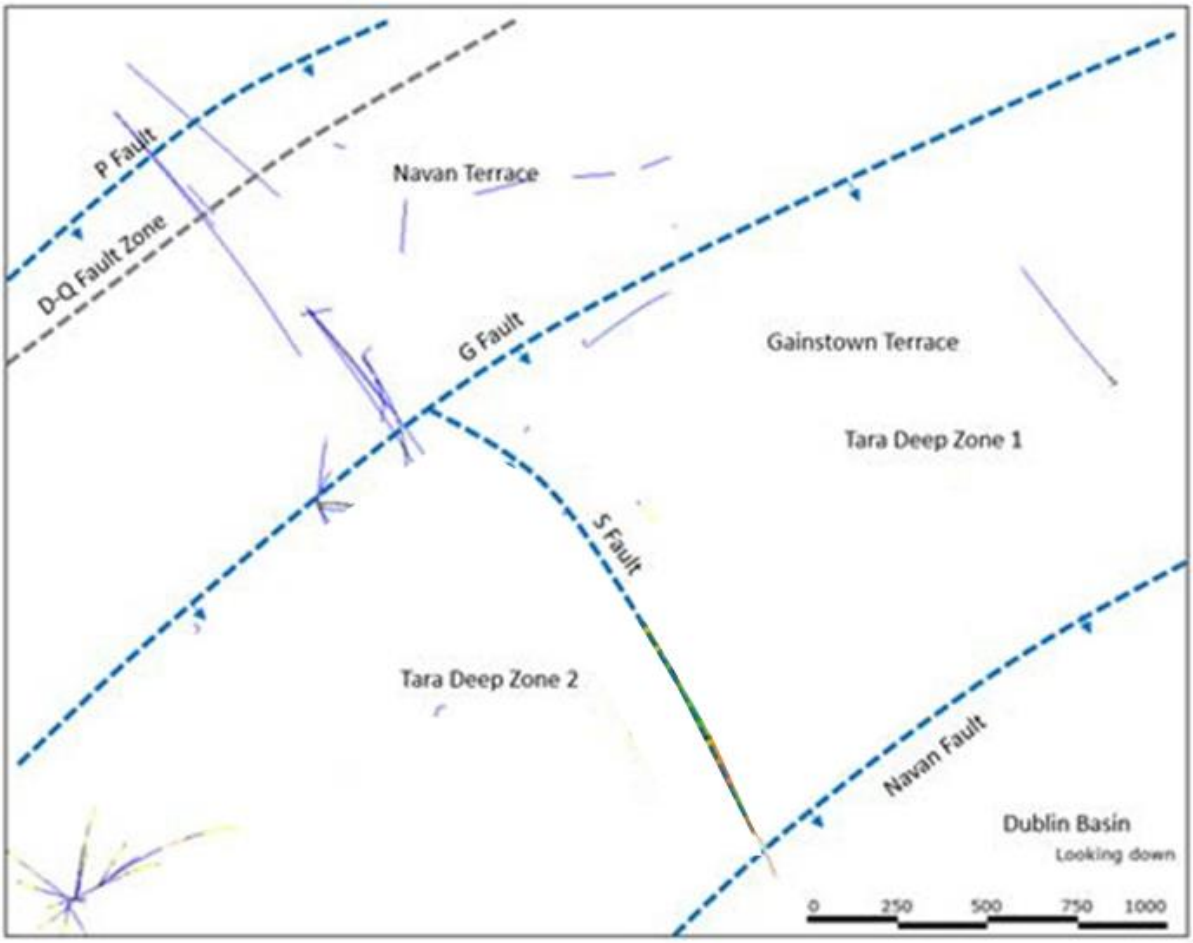


Figure 3.3: Main fault Structures in the Tara Deep area. Source: Piteau Associates, December 2021.[3]

The main faults occur as normal extensional faults near the Tara Deep deposit. These comprise (from North):

- The approximately East-West 'P' fault, with a downthrown section to the south called the Navan terrace
- The approximately East-West 'DQ' fault, with an upthrown section to the south (subordinate to and part of the Navan Terrace)
- The approximately East-West 'G' or 'Gainstown' fault, with a downthrown section to the south called the Gainstown terrace
- A Northwest- Southeast trending fault called the 'S' fault with a downthrow to the west. This fault runs parallel and close to the TRDEX tunnel; and
- The approximately East-West Navan fault, with a downthrown section to the south which effectively truncates the pale bed mineralised zone of the Tara Deep deposit

Only the P and Navan Fault are proven to extend into the overlying UDL. The fault activity is very old (Paleozoic) with fault movement ceasing before the UDL was deposited. A period of inversion is thought to have occurred much later with a compressional regime causing reverse movement along some fault planes.

The main form of the major faults in the area is extensional and at some time created open fracture systems which have been recemented over time. There are some exceptions, the D-Q fault is described by Boliden as a well-documented reverse structure with the upthrown side to the South. The initial extensional period was later reversed by a compressional period. The general conceptualisations developed by Boliden (e.g. Piteau., 2021) present the faults as a series of horst (static blocks) and graben (downthrown terrace) structures. The cross-sectional view of the faults and their effect on truncating bedding units is shown in Figure 3.2.

The faults dip steeply to the south/southeast, with interpreted throws of 900 m (P-Fault) and 500 m (Gainstown Fault). The main terraces in between faults are the Navan Terrace and the Gainstown Terrace (refer to Figure 3.3). The P-Fault and D-Q Fault zones have been traversed by the TRDEX underground exploration tunnel.

A review of the effect of faults on hydrogeology has been conducted in Ireland (Moore and Walsh, 2013) which concluded the major east-west faults (as seen near Tara Deep) tend to be of an older Carboniferous age and have normal (extensional) structures with syn-deformational deposits and are tentatively recognised as barriers to groundwater flow in the perpendicular direction to the fault axis. In effect these faults tend to truncate bedding. Where present, generally younger, north-south (Tertiary or Cenozoic aged) faults are thought[9] to act as potential conduits for groundwater flow along their main axis across Ireland. They may also induce more karstification. The S fault, although orientated generally north-south is thought to be Carboniferous age and not Cenozoic. The nearest Cenozoic aged faults are reported to be several miles north of the site.

This general distinction between fault sets is by no means certain and is further complicated where N-S and E-W faults coincide creating down-thrown blocks. At Tara, it has been speculated that the general arrangement of E-W Carboniferous normal faults has created a series of groundwater compartments with isolated flow in the fault terraces[3].

The larger fault sets e.g. the P and Navan faults include brecciated and fractured zones and may be potential conduits for groundwater flow along some of their strike length whilst also blocking groundwater flow and thus creating compartments perpendicular to the strike or plane of the fault. In the SWEX area, isolated recharge pathways are thought to enable some water to percolate downward through the UDL through the P-fault and vertical stress fractures.

[9] Pg28-33 Groundwater Newsletter Article: Analysis of fracture systems and their impact on flow pathways in Irish bedrock aquifers, ISSN 0790-7753Moore and Walsh, 2013

From Tara Mine's SWEX area it is known that the presence of faults such as the 'P-fault' can cause deformation in the form of stress-release (unloading) to extend upwards above the fault zone creating weakened, jointed zones that enable development of greater transmissivity in the limestone. At Tara Deep, the structures mapped in the Pale Beds do not extend upwards into the UDL, it is unclear if effects from the fault such as extensional strain deformation in the fabric of the rock may be experienced even if no explicit fault is represented. The UDL may be prone to solution cavities developing in zones directly and indirectly affected by deformation. In effect the fault, provides a strong local control on the depth of weathering and groundwater circulation in the upper part of the UDL. The P-Fault was not encountered during the drilling of N02481.

As well as the east-west faults there is a significant northwest-southeast fault - the S fault which creates significantly thickened units of UDL northeast-wards. This thickening of the UDL is apparent in the geophysical cross section and interpretation further discussed in Section 4.3.2. During 2020, the structural geology of the faults was re-assessed. This revealed that the hanging wall of the S-fault has strong evidence of slide structures and comprises a series of blocks of Pale Beds with conglomerates and a melange of Shaley Pales. This is interpreted to represent a series of individual displacement events along the S-fault or slide packages into the hanging wall. However, it is noted that the number and geometry of the fault blocks and this interpretation is determined or ground-truthed by only two drill hole intersections.[10]

It was interpreted that the S fault was a low angle slide however more recent studies suggest fault-induced stratigraphic thickening of the lower part of the New Thin Bedded Unit (NTBU - the name given to the sequence that straddles above and below the unconformity and is related to the Pale beds). Boliden has stated the NTBU lies above the unconformity whereas the Piteau 2021 work identifies the New TBU as straddling the unconformity up to the base of the UDL, this has been deemed an error by Boliden. The increase in thickness of the NTBU across the S-fault suggests that syn-depositional extension of the S-fault occurred during the Carboniferous depositional period which affects the area south of Tara Deep and wider.

The presence of a major slide surface beneath Tara Deep, to the east of the S-fault referred to as the H fault/slide is supported by 2020 interpretation of geophysical work by Dr Dave Coller[10].

Figure 3.4 and Figure 3.5 present the interpreted location of major structures in the vicinity of the existing mine workings and the Tara Deep deposit. Figure 3.5 also presents the locations of seismic geophysical surveys undertaken to characterise the structural geology.

[10] Exploration Work Report, Prospecting Licence 4502, Co. Meath, 2018-2020, Boliden Tara Mines, 2021

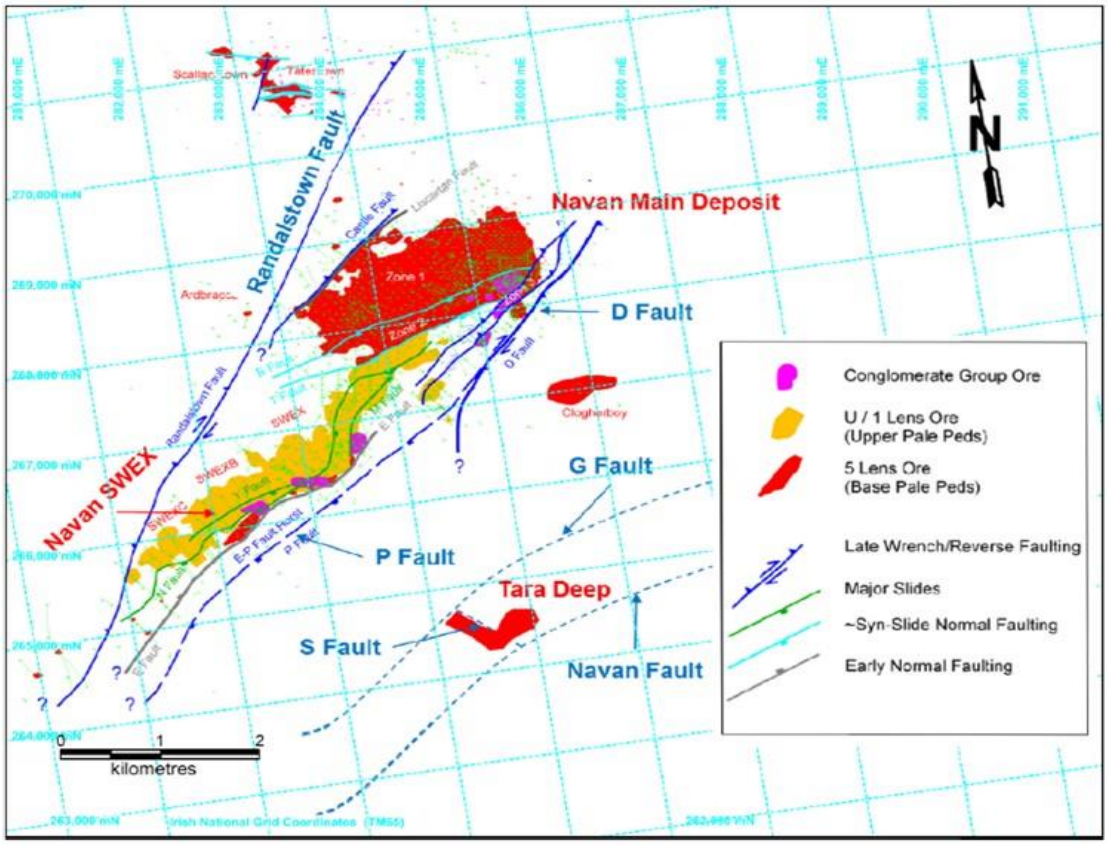


Figure 3.4: Location of Major Structures in the Vicinity of the Existing Mine Workings and the Tara Deep Deposit (Source: Exploration work report 2018-2020, Prospecting Licence 4502, Boliden, 2021[10]

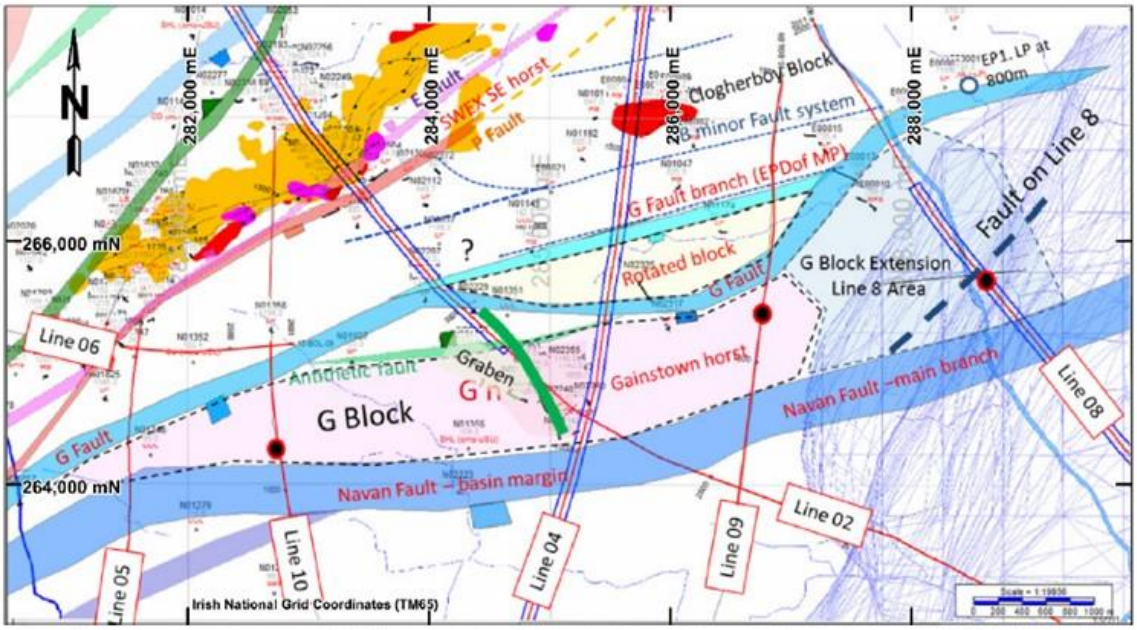


Figure 3.5: Location of Structures Inferred in Tara Deep area. Source: Exploration Work Report 2018-2020, Prospecting Licence 4502, Boliden, 2021 [10]

4 Tara Deep Exploration Activities

4.1 General

The Prospecting Licence (PL) 4502, which includes the Tara Deep area, covers an area of 48.68 km^2, predominantly covered by flat agricultural land as described in the Site Setting. The target prospective unit is the early Carboniferous (Courceyan) Pale Beds which are over 1km deep, below thick Visean Upper Dark Limestones (UDL) of Arundian to Asbian age.

Since 2012, there has been significant exploration in the Tara Deep area, including deep diamond drilling, acquisition of additional 2D seismic data, large loop and down-hole Electromagnetic (EM) and Audio-frequency Magnetotellurics (AMT) surveys[13].

In 2017, Boliden stated that the drilling programme had presented an Inferred Resource at Tara Deep amounting to 10.2Mt grading 8.5% Zn and 1.8% Pb. Additionally, funding was confirmed to explore the Tara Deep area from an underground access tunnel (the TRDEX) from the existing underground mine in the SWEX area workings. Surface exploration results since 2017 has increased the Inferred Resource at Tara Deep to 26.2Mt grading 8.36% Zn and 1.60% Pb (Exploration Plans, PL4502, Navan, Co Meath, Boliden, July 2021). The current Inferred Resource at Tara Deep is reported as 28 Mt[11].

The 2018-2020 exploration report (Boliden, 2021) states that, in addition to the Pale Beds as a host for economic grade sulfide mineralisation, “the S Fault Conglomerate in the common hanging-wall of the G Fault and S Fault contains high-grade mineralisation both of a clastic as well as replacive nature”. Work continues to define the extent of the mineralisation.

4.2 Exploration Drift Tunnel and RAR

An exploration drift tunnel, referred to as the 0860 TRDEX or ‘TRDEX’, was excavated from the existing South West Extension (SWEX) area of mine workings through the UDL in the Tara Deep area from late 2018 (refer to Figure 4.1). Further information on the chronology of the development of the exploration tunnel is in Appendix B. The exploration tunnel starts c. 730 m below ground level (mbgl) within the ‘860 level’ of the SWEX mine workings. The tunnel has a gradient of -14% and is completed at c. 1040 mbgl within the UDL, in the hanging wall of the Tara Deep deposit. The cross-sectional profile of the tunnel is 6.5 m high by 6 m wide. The current length of the tunnel is 2.1 km (as of September 2021) and the total planned finished length of the tunnel is 2.4 km [12].

[11] Pg 110, Annual and Sustainability Report 2021, Boliden, 2022
[12] Tara Deep Exploration Plans, Boliden Tara Mines, July 2021

As the tunnel is 2.1 km from existing infrastructure it requires its own ventilation system from surface. This was planned to be in the form of two Return Air Raises, referred to as RAR 6 and 7. Several geotechnical boreholes were drilled, the first encountering 'severe ground conditions' and was abandoned[13]. The second (N02481) was drilled at the RAR7 site between February and May 2019 to initially evaluate the ground conditions and inform the techniques that would be used for the later pilot hole drilling. The drilling of a 0.381m diameter RAR7 pilot hole began on July 2nd 2021 and concluded on November 25th 2021 which initiated the inrush event into the TRDEX tunnel.

The primary purpose of the tunnel is to provide access and facilitate further underground exploration drilling using directional drilling techniques to better characterise the steeply dipping Tara Deep deposit and upgrade the status of the estimated resource from 'inferred' to 'indicated'. Additionally, the tunnel has enabled test drilling of the Navan Terrace[12].

It should be noted that the RAR7 pilot hole that caused the inrush in November 2021 (0.381m diameter) would eventually need to be converted to a much larger diameter (approximately 4.5m) ventilation shaft by raise-bore (upward reaming techniques). The hydrogeological implications of this full-scale ventilation shaft(s) deserve further consideration outside the scope of this work.

It is understood Boliden's intention is to further extend the development to continue the targeted drilling exploration programme to areas that are inaccessible to drill from the existing tunnel to provide necessary information to improve the mineral resource estimation and feasibility studies[12].

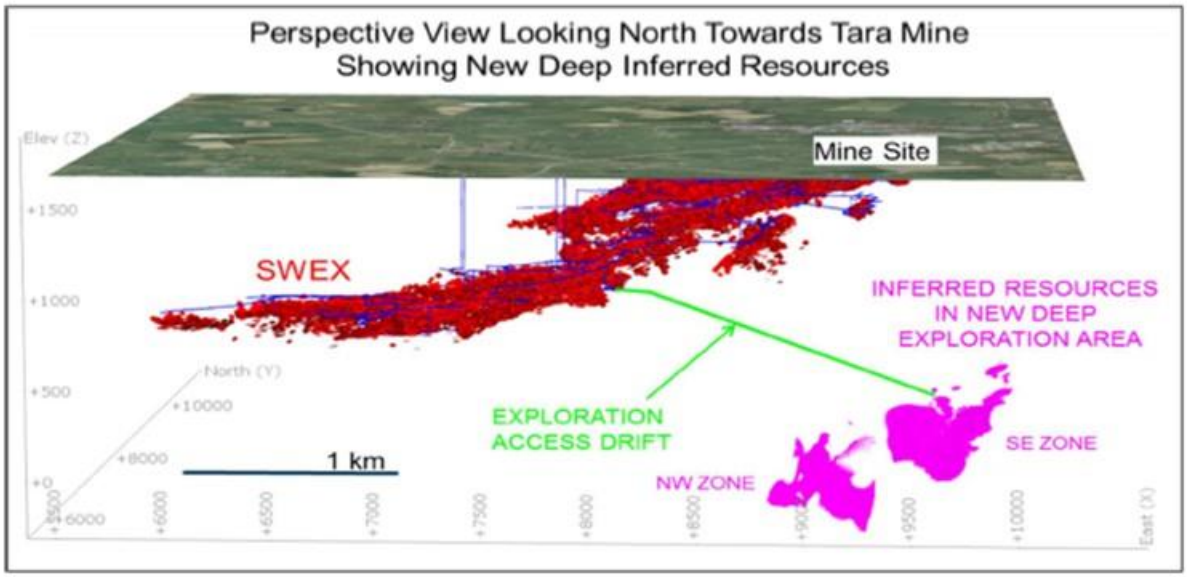


Figure 4.1: 3D Illustration of Relationship Between Tara Mine, Tara Deep Resources and Proposed Access Drift. Source: Exploration Plans, PL4502, Boliden Tara, 2021[12]

[13] Summary Exploration Work Report, Prospecting Licence 4502, Co. Meath, January 2019 to October 2020

4.3 Advance Test Work

4.3.1 Geotechnical

RAR Geotechnics

After the abandonment of borehole N02413 (the initial proposed location of the RAR) due to 'severe ground conditions', the second geotechnical investigation borehole, N02481, was drilled between February and May 2019 to determine an alternative location for the RAR site to connect to the TRDEX exploration tunnel. Upper Dark Limestones (UDL) were encountered for the total borehole depth below the over burden from 10 mbgl to 1100.8 mbgl. Wireline survey work, including calliper, natural gamma, ATV, P and S velocity, fluid conductivity and temperature were completed by Robertson Geologging. The N02481 hole was reported in Boliden Tara's Summary Exploration Work Report[10] to have "revealed extensive fracturing and cavities down to approximately 450m".

The lithological log of the geotechnical exploration hole (N02481) showed two cavity zones: one between 248.5 and 249.0 m depth (0.5 m wide); and one at 453.7 to 453.8 m depth (0.1 m wide). The 248.5 to 249 mbgl zone was the most significant with significant water losses, although overall the site was considered favourable geotechnically.

During drilling, loss of drilling fluid occurred in cavity zone 248.5 to 249.0 m. This cavity zone was cement grouted and subsequent packer testing showed no major flow. However, the grouting was not apparently an easy procedure as it was reported "nearly 50 tonnes of grout were poured in an (*initially first*) unsuccessful attempt to seal the high permeability zone and prevent further water loss".[13]

Packer testing (Piteau, 2019) indicated very little hydraulic conductivity below 450m and the theoretical inflows were restricted to two discrete inflow zones: the most prominent between 243-253mbgl and a second at 572-581 mbgl. The cavity zone at 248.5mbgl was thought to be hydraulically connected over a wide area and therefore likely to support "reasonably sustained" inflows – estimated at the time to be in the range of 12-20 l/s (as suggested from inflows elsewhere at Tara. Hydraulic testing was recommended to better estimate inflows[14]. The interpretation of connection over a reasonably wide area was based on the observation that water levels in Borehole N02176 located approximately 300m lateral distance from borehole N02481 responded to when the 248.5mbgl cavity zone was first encountered and was subsequently grouted.

[14] Tara Deep Exploration Drift, Update March 2021, Boliden, 2021

The lithological log of the geotechnical exploration hole (N02481) showed only two cavity zones: one between 248.5 and 249.0 m depth (0.5 m wide); and one at 453.7 to 453.8 m depth (0.1 m wide).

Fluid return loss also occurred in intervals between 373 – 426m and these zones were cement grouted at various stages and subsequently packer tested. Boliden reported there was no significant loss of drilling fluid at the second cavity zone (453.7 to 453.8 m), so no grouting was required over this interval.

Prior to drilling the RAR7 pilot hole (circa 2 meters from N02481) the identified 248.5-249.0mbgl cavity zone, was attempted to be grouted by a grout curtain installed using 8 holes (4 primary holes and 4 secondary holes) spaced on an 8.5 diameter ring to depths ranging from 215 m to 281 m. During drilling the pilot hole, water loss was encountered at a depth of 266 m. The pilot hole was grouted at a depth of 270 m. After grouting a camera survey was undertaken to ensure this cavity was sealed. Drilling continued and no further significant water loss was reported from this cavity. No water was encountered or reported when drilling through the second cavity zone at 453.7 to 453.8 m.

In 2020, Boliden and Piteau were of the view that the risk of high inflow from the 248mbgl cavity zone had already been mitigated: " .. the upper cavity zone in NO2481. This particular fracture however has already been successfully grouted during drilling of this hole (if untreated there would likely be significant groundwater inflows at this horizon)" (Piteau, 2020). The implication being that grouting the fracture would seal the inflow. The alternative view that 'the fracture' could in fact have been an interconnected network that would not respond well to grouting was not fully assessed, primarily because the prevailing hydrogeological conceptual model at the time gave assurance to the view that all inflows were isolated and discrete and therefore manageable.

The success (or otherwise) of the grouting operation performed by Boliden's specialist subcontractors is unclear. Whilst the initial view that the grouting of N02481 was a success, there remained uncertainty as indicated by recent Piteau and Boliden comments.

The grouting of the 248.5mAOD cavity zone required multiple, sequential grouting interventions. An initial N02481 grouting job performed in 2019 on the geotechnical hole was followed by a grout injection curtain array in 2021 and several episodes of re-grouting during the RAR drilling. It is unclear what was the void/ cavity mechanism and transmissivity that required the sequential grouting interventions and why the effectiveness of the interventions appears to be repeatedly compromised requiring repeat work. The most plausible reason being that 'the cavity' was connected over considerable distance to a network of open conduits.

Following review of the initially provided data, WAI enquired whether the RAR had been pre-grouted prior to drilling. This information Boliden disclosed (May 2022) was: "The pilot hole was grouted at a depth of 270 m. After grouting a camera survey was undertaken to ensure this cavity was sealed. Drilling continued and no further significant water loss was reported from this cavity". This information was used in an earlier draft of the WAI report which progressed on the basis that the main cavity zone had been at least partially sealed. Boliden then stated that "The available evidence (albeit non-definitive) suggests that [grouting the pilot hole] was not successful". In September 2022 Boliden representatives attributed the inflow to grout failure allowing inflow in the cavity zone - the inrush occurred because "the grouting had not been done properly".
It appears that the RAR drilling proceeded with a high level of uncertainty with respect to the grouting performance, although early indications from the geotechnical borehole N02481 were that grouting would be problematic and only partially effective.

TRDEX Geotechnics

Tunnelling commenced in 2019 on the 1100m deep TRDEX and there is a substantial body of accompanying geotechnical records and logging. The main features of relevance to this study are observations of key fractures and wet zones encountered during tunnelling. For example, borehole N02220 identified 'bad ground' at the elevation of the exploration drift and additional probing ahead of the tunnel was recommended in this area. As the TRDEX advanced, inflows and wet zones were encountered[15]:

- Controlled Inflow 1 from Fracture 1 (875m down exploration tunnel). This was intersected by probe holes in August 2019 and allowed to drain into the tunnel to dewater and depressurise the fracture in a controlled manner.
- Inflow 2 in the area between TRDDC1 and TRDDC3 comprised a wet zone in a series of minor flows, drips, and seeps. This together with inflow 1 reached a steady flow rate of 57-65m^3/hour between July 2020 and May 2021.
- Uncontrolled Inflow 3 from Fracture 2 (1920m down exploration tunnel) intersected the tunnel during May 2021 and was poorly defined by probe holes. This inflow is discussed further in the groundwater control section below (Section 4.3.3) because it appears to closely correlate with a time when residents reported water levels dropping in their wells.

Underground probe hole, U30829, intersected high water pressure and poor ground conditions. Several attempts were made to grout and redrill. It was decided to wedge the hole at 364m at the depth where another hole started.

[15] Boliden Communication to GSRO 19.05.2022

Boliden provided an annotated figure (reproduced below) showing water intersections in the TRDEX, see Figure 4.2. The figure has references to other features such as "U31326 500Lpm /2Bar @ 170m" which presumably refer to other inflows not recorded in the reference documents provided. An overall estimate of cumulative water inflow into the TRDEX has been compiled and is described in Section 4.3.3 below.

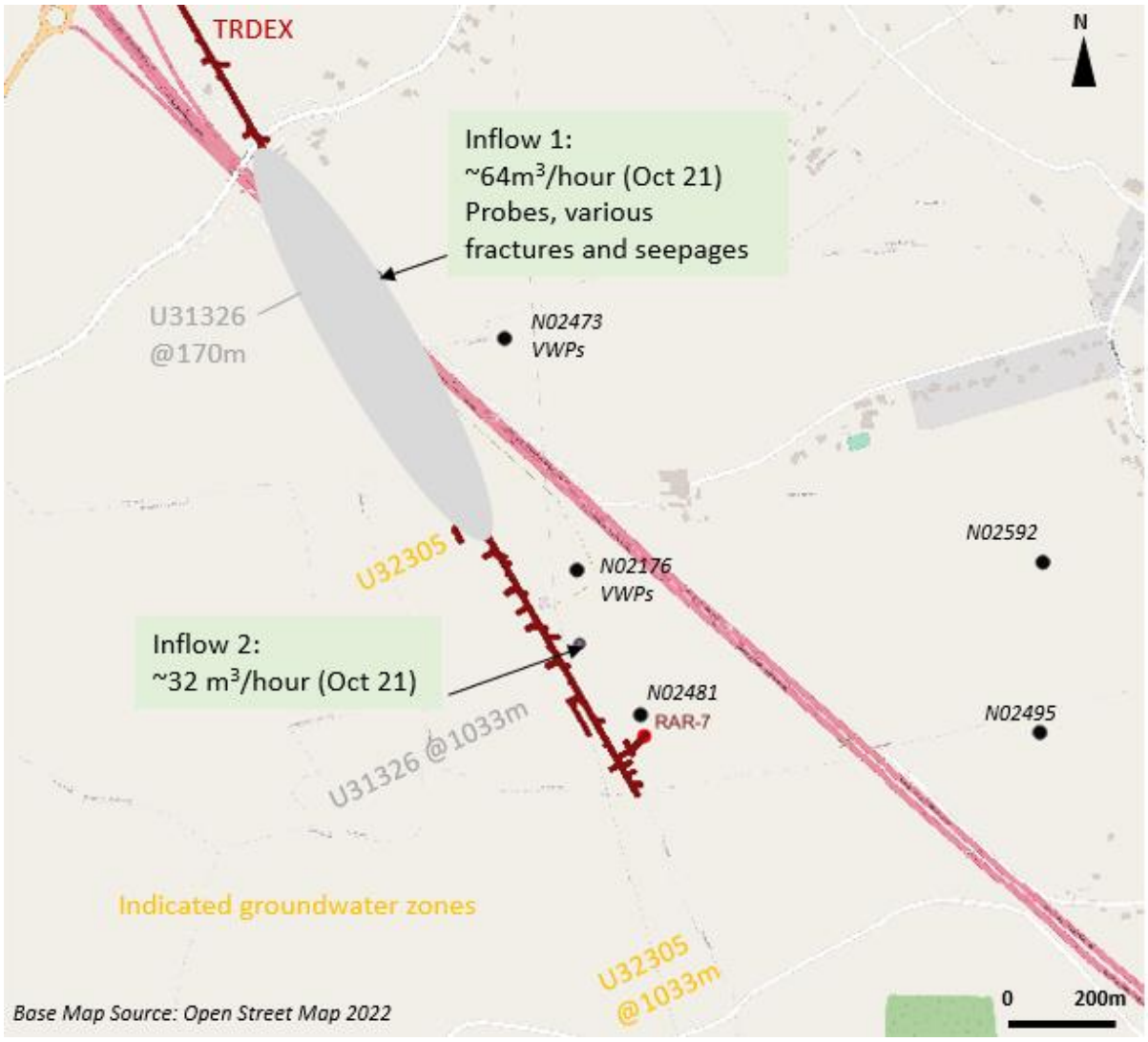


Figure 4.2: Water Bearing areas within Tara Deep exploration Tunnel[16]

4.3.2 Geophysical

A variety of surface and downhole geophysical surveys have been undertaken. In the vicinity of the potential RAR site, initial Electromagnetic (EM) surveying, followed by electrical resistivity tomography (ERT), seismic refraction and drilling of short probe holes to confirm geophysical survey results was completed.

[16] Figure provided by Boliden Tara Mines, May 2022

The second geotechnical investigation borehole, N02481 was surveyed by downhole wireline techniques including calliper, natural gamma, ATV, P and S velocity, fluid conductivity and temperature. These techniques confirmed the cavity zones reported in Section 4.3.1.

Seven seismic profiles were undertaken between 2011 and 2012 by Boliden Tara and reinterpreted in 2020 along with an additional later three further seismic lines, Figure 4.3. The three later seismic survey lines referred to as 15-BOL-08, 15-BOL-09 and 15-BOL-10 were undertaken in 2015. Various inferred geological structures are also presented on this figure. The survey lines 11-BOL-02 (NW-SE) and 12-Bol-04 (NNE-SSW) are particularly relevant as these occur c. 250m to the East and c. 600m to the south of RAR7 pilot hole location (Figure 4.4).

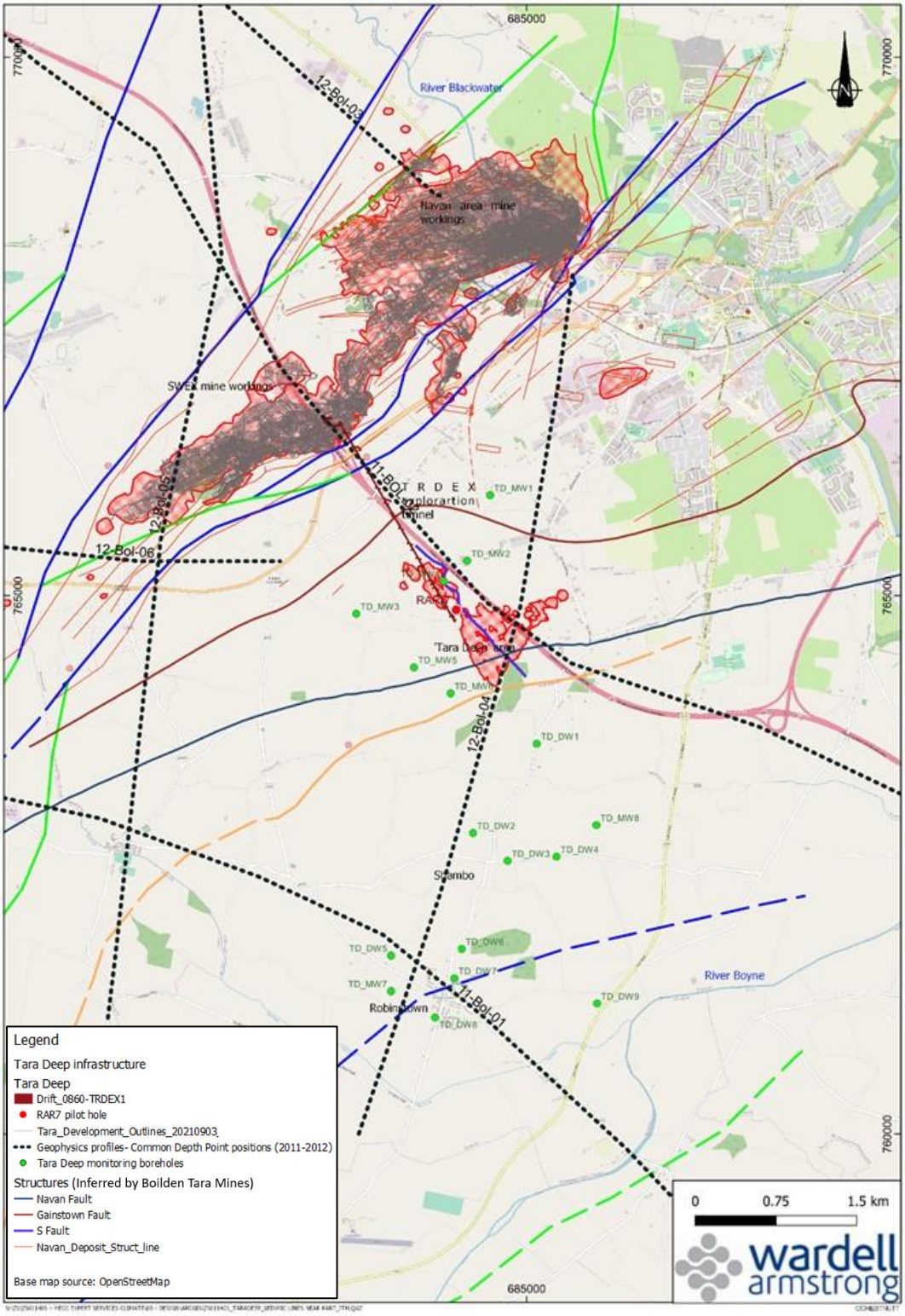


Figure 4.3: Location of Seismic Profiles (Common Depth Point positions) (2011-2012)

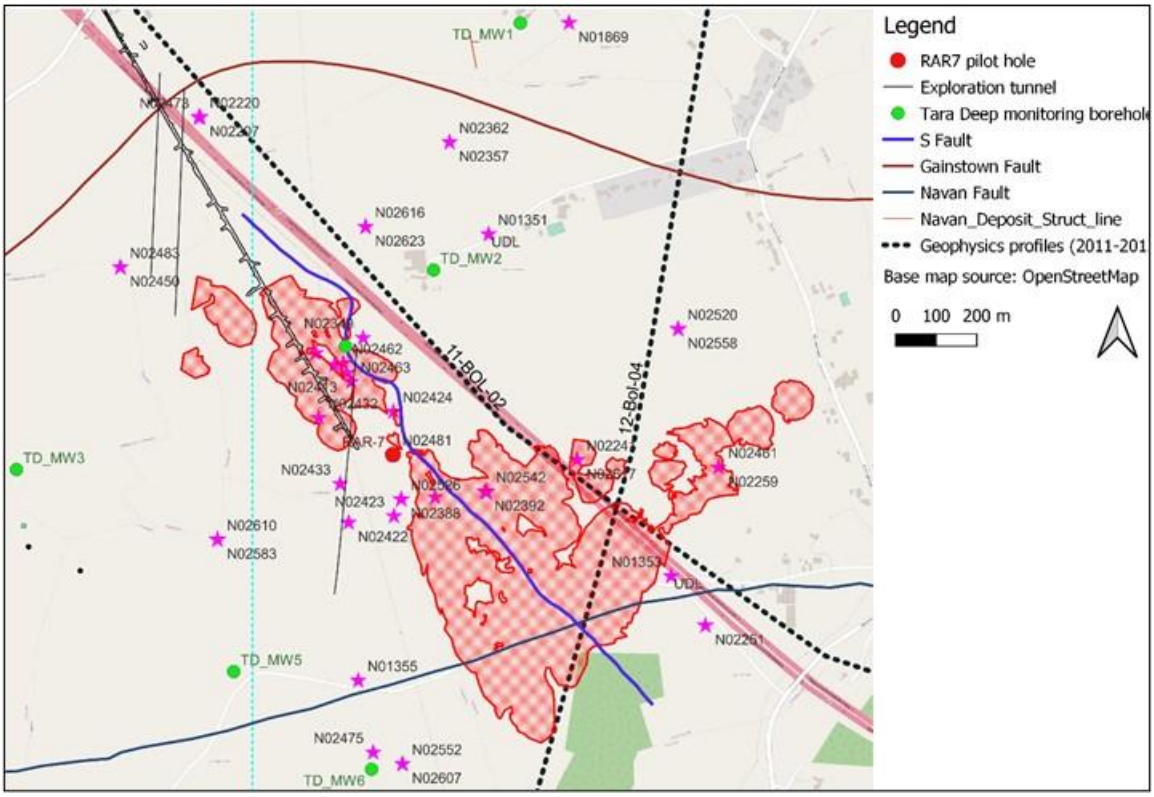


Figure 4.4: Seismic Profiles (Common Depth Point positions) 11-Bol-02 (NW-SE) and 12-Bol-04 (NNE-SSW) in Relation to RAR7

Figure 4.4 shows the RAR7 pilot hole location and groundwater observation locations (green points) and exploration boreholes (pink stars). The inferred locations of the S-fault, Gainstown Fault and Navan fault are also annotated (shapefiles provided by Boliden Tara Mines). Note exploration boreholes (pink stars) are angled holes- location at ground presented only for location orientation.

The 11-Bol-02 survey line provides a well-controlled interpretation of the stratigraphy and structure over a 25 km length from the border of Longford Down, across the SWEX area and across the mineralised zone in Tara Deep area. The key interpretation is the definition of the Gainstown terrace in between the Gainstown and Navan faults as shown on Figure 4.4. The terrace contains internal deformation as described in Section 3.3, namely: "continuation of a major slide surface on the basin margin with a complex faulted complex overlying the basement" and "major slide units or thrusted slices occurring to the east of a local horst (at depth) overlying the basement". The Pale Beds occur in an "Upper Plate" and "Lower Plate" which are both proven to host mineralisation. Drill logs suggest the Lower Plate is downthrown relative to the Upper Plate along an "E-W trending fault which is sub-parallel to the seismic line"[17] and therefore not imaged.

[17] Coller, 2013. Geological Interpretation of 2011 & 2012 Seismic Reflection Survey for the Navan Region, Ireland Internal Report on the Methodologies and Geological Interpretation November 2013

A cross section of part of the 11-Bol-02 survey line across the Gainstown Terrace is presented with the RAR7 pilot hole offset in Figure 4.5. In the seismic survey line, there can be seen delineation of shallower fractures (orange) that apparently extend to surface. The interpreted section also shows the Gainstown Terrace and significant thickening of the UDL associated with the graben structure at depth. The approximate offset location of RAR7 pilot hole is shown relative to the structures. These interpreted sections are from 2013 work and it is understood (from Boliden) later, 2020, drill informed interpretations show significantly less faulting and fracturing in the UDL. However this information was not made available at the time of developing this study.

These fractures may be acting as open conduits and contributing to hydraulic connection between the shallower weathered UDL and the deeper, more competent UDL.

It is noted that the seismic lines have been re-interpreted in 2017 and 2020 for specific purposes related to the geometry of structures at depth relating to the potential mineral prospect of Tara Deep. In 2017 the analysis was related to the presence and interpretation of a rift unconformity and the mapping of the main Navan fault. Full interpretations of the three lines (15-BOL-08, 15-BOL-09 and 15-BOL-10) referenced within the 2017 document were not included in the information provided for review by WAI. In 2020 the re-interpretation was focused on the S-fault. WAI are aware of this work due to its reference within the 2018-2020 Exploration Work Report (Pg 64), however the full geophysicists report of the 2020 reinterpretation was not available to the GSRO and was not provided to WAI for review as part of this study.

The absence of structures within the UDL referred to in later geophysical interpretations is not considered conclusive that they do not exist, rather that they were not relevant to the specific aspects of the structural geology reinterpreted.

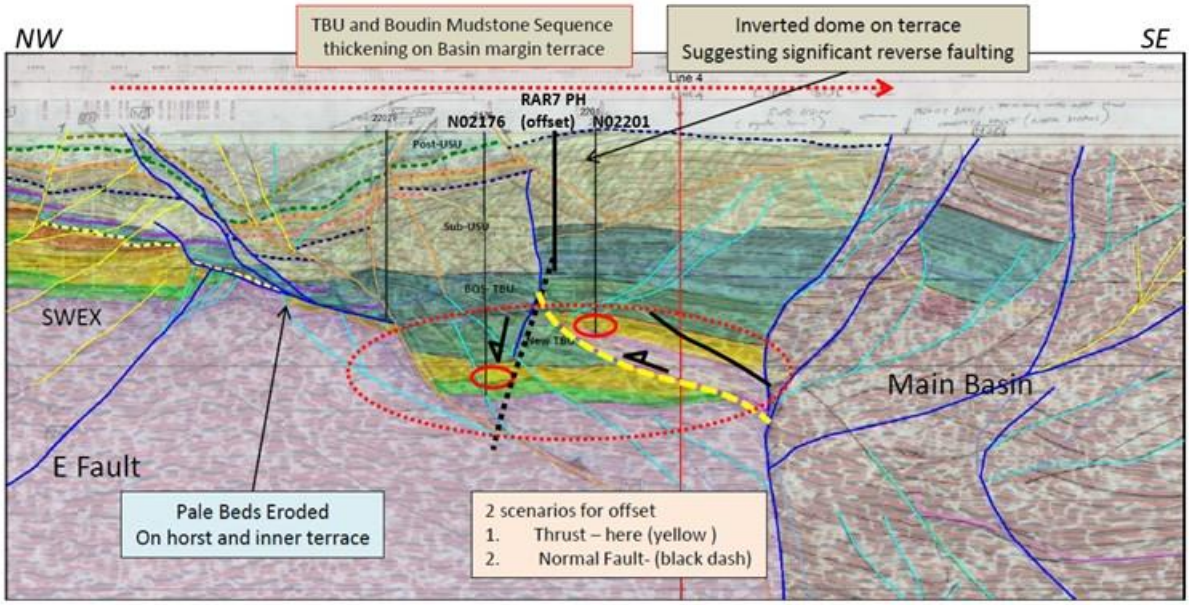


Figure 4.5: Extract of NW-SE Interpreted Seismic Section (11-Bol-02)

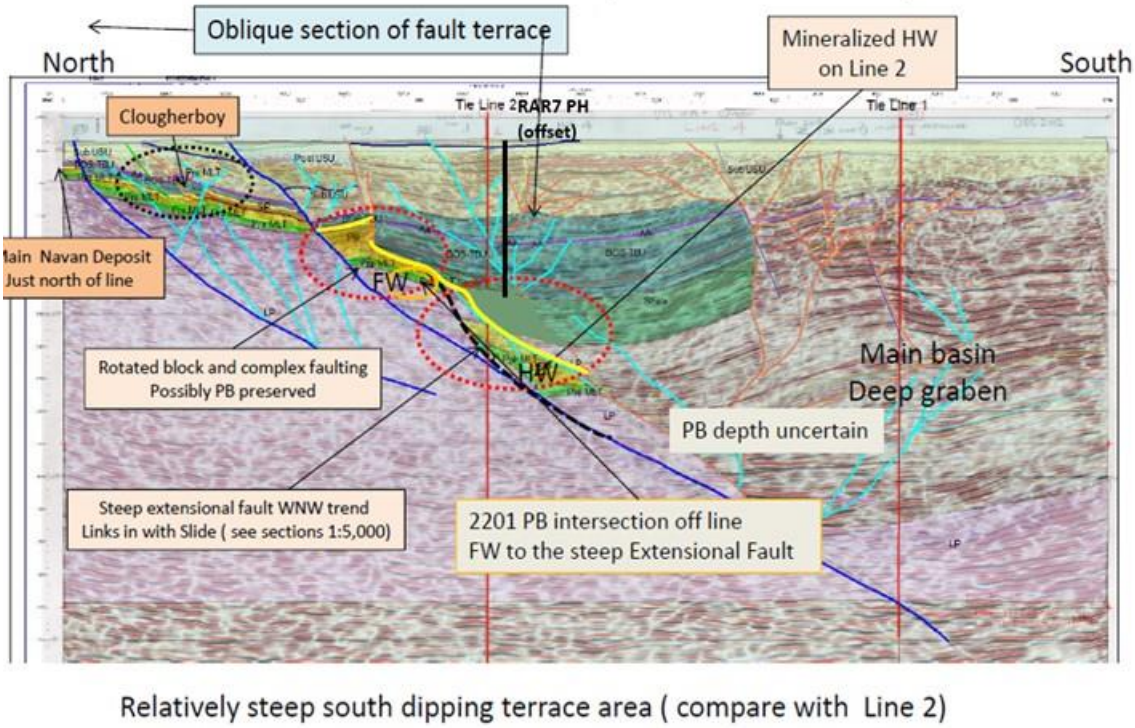


Figure 4.6: Extract of N-S Interpreted Seismic Section (11-Bol 04).

Figure 4.6 presents the structures within the Gainstown Terrace along a N-S seismic survey line illustrating hanging wall and footwall relationships of the WNW structure which displaces the Upper and Lower plate of the Pale Beds (black dashed line). The approximate offset location of the RAR7 pilot hole relative to the structures is shown[18] .

The figure shows the large-scale geometry of the terrace and basin and thickening of the UDL which is accompanied by a change in facies to more shale content in the lower UDL. Steep extensional faults within the WNW orientation are observed in which structure traces extend from near surface to depths of 1000m (blue lines in the vicinity of the offset RAR7 pilot hole. These shallower fractures associated with the extensional displacement between the Lower Plate of the Pale Beds relative to the Upper Plate could be contributing to hydraulic connection from the 'weathered' UDL to the more competent UDL down to, and beyond, 1000m depth.

[18] Adapted from Coller, 2013

4.3.3 Groundwater Control

Before the TRDEX tunnel commenced, an underground borehole (U28093) was drilled along the tunnel route for 615m from the SWEX '950 level'. From this work, no major inflows were expected for the tunnel although 'considerable faulting and veining' was encountered. However, quite soon after tunnelling began, a significant water-bearing structure was intersected at the advance face of the TRDEX during October 2019 (yellow dashed line in Figure 4.7). This required installation of a number of grout curtains to manage inflows which were only partially successful. Further remediation works included a series of short probe holes and water relief holes from the exploration drift (labelled on Figure 4.7). These were left open and enabled more controlled drainage and depressurisation as indicated from Vibrating Wire Piezometer (VWP) data which enabled the exploration drift to re-commence. Vibrating Wire Piezometers (VWPs) are instruments that are permanently installed into boreholes which can continuously record porewater pressure at different depths to monitor changes in groundwater pressure near mine workings.

Test drilling (referred to as cover/probe) drilling was undertaken ahead of the development into the Tara Deep area to characterise the geotechnical, hydrogeological and methane conditions that would likely be encountered by the tunnel advancement. A probe hole (an underground borehole drilled to prove ground conditions in advance of tunnelling) named U28880, 861m deep had a flow rate of 250l/min and 52bar pressure when the hole encountered a water feature and started issuing into the TRDEX tunnel approximately 500 m along the tunnel from the SWEX mine workings (labelled on Figure 4.7.

An underground probe hole from the exploration tunnel (U30829) "intersected significant water hosted by a NNW-trending series of open joints"[12]. The fracture network caused an initial inflow of 1,000l/min (1440m^3/day) and a recorded pressure of 81bar. High pressure cement grouting and two additional ancillary holes were required to locate the structure and control it. Thereafter re-drilling resulted in water flow reduction to 350l/min at 76bar, which was maintained during tunnelling[7].

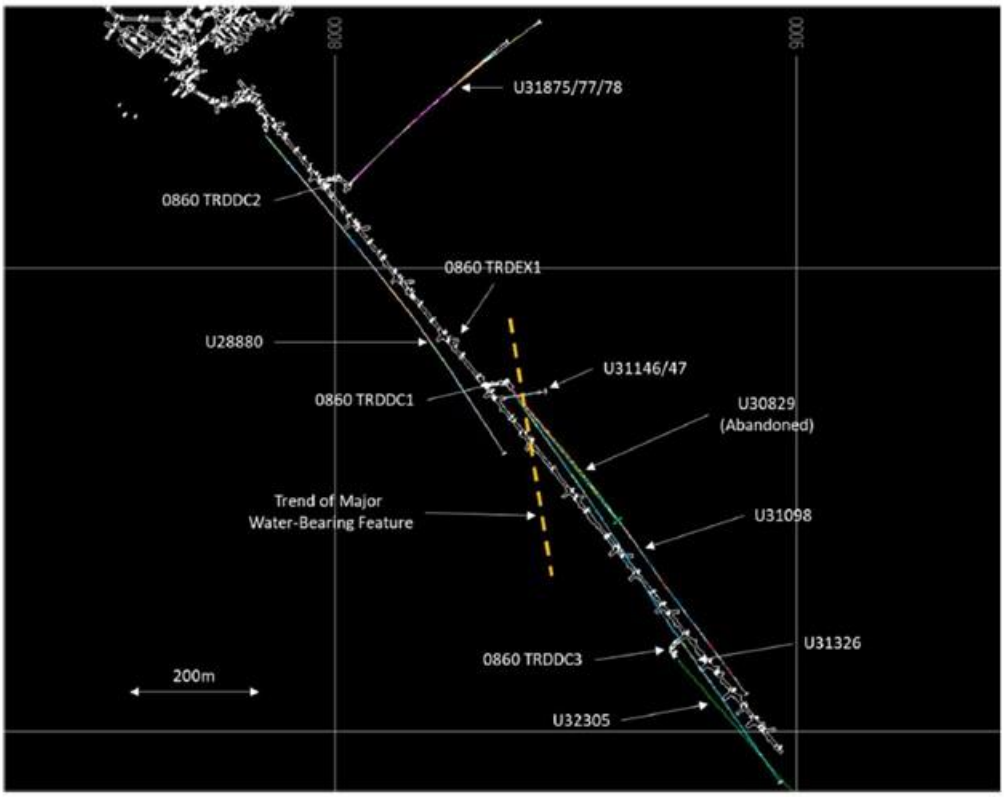


Figure 4.7: Development Plan Tara Deep Access Drift (TRDEX) Source: Tara Deep Exploration Drift, Update March 2021, Boliden Tara Mines, 2021[7]

An averaged water inflow rate for the whole period of the TRDEX tunnelling has been calculated as 2300m^3/day, refer to Figure 4.8.

Boliden has commented[19] that post inrush there is no measurement of groundwater inflow to the Tara Deep exploration tunnel, although it is assumed that inflows and drainage is still occurring. As dewatering of the flood water advances water meters will be installed which will provide accurate flow measurements. In November 2021 (pre pilot hole inrush) the total rate of inflow to the Tara Deep exploration tunnel was circa 101m^3/hour and this cumulative total inflow came from the three areas referred to in Figure 4.2.

[19] Boliden Communication to GSRO 19.05.2022

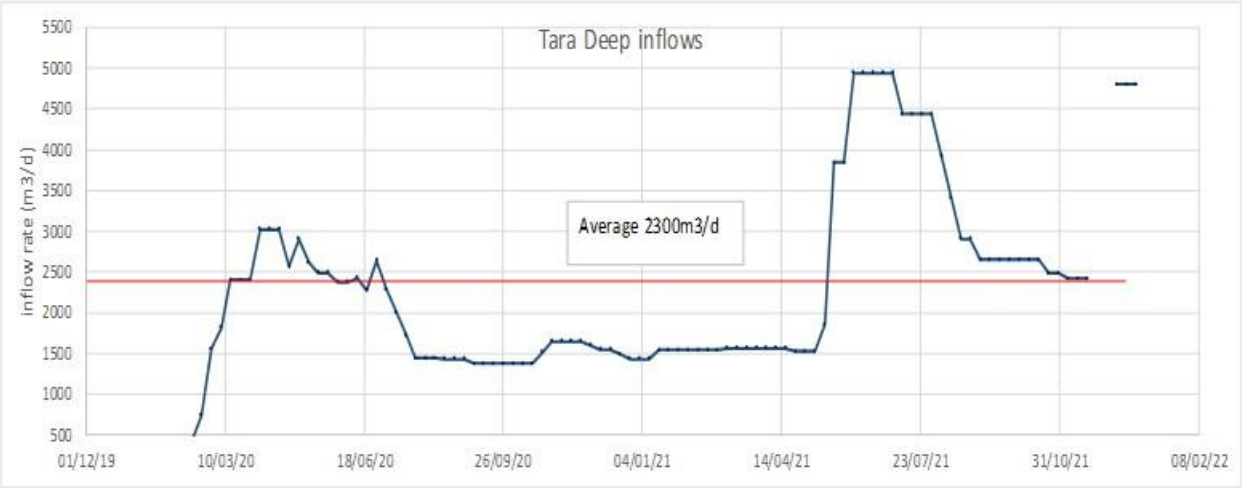


Figure 4.8: TRDEX Tunnel Inflow Rates (2020-2022)

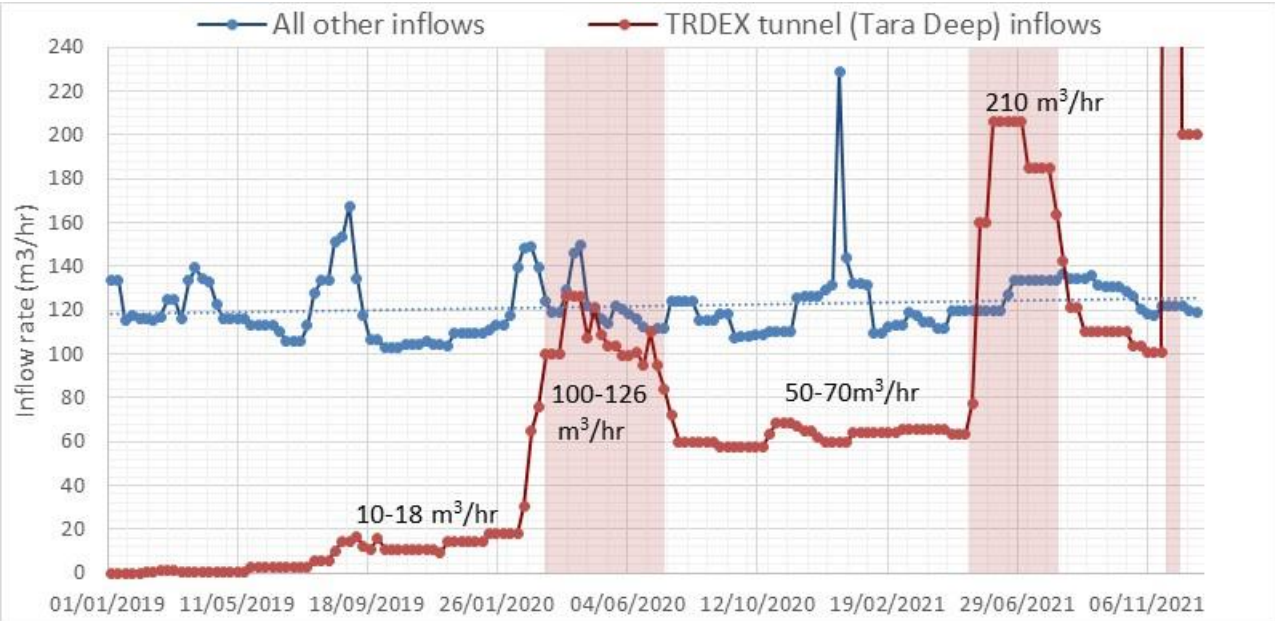


Figure 4.9: TRDEX Tunnel Groundwater Inflows (red) and all other Groundwater Inflows (total) (blue)

Flows are relatively consistent within the existing SWEX and Navan area workings ranging from c. 100-140 m^3/hr with four brief periods when this was exceeded from the beginning of 2019 to end of 2021 (blue line in Figure 4.9). Inflows to the exploration tunnel are significantly higher than those experienced in individual zones in the SWEX mine workings although cumulatively SWEX (including Navan) is on average higher than TRDEX. As the tunnel has progressed, inflows have increased with two notable periods of inflow prior to the in-rush event on November 20th 2021. Inflows to the exploration tunnel were lowest during February 2020 at a rate of c. 18 m^3/hr. Inflows increased to 126 m^3/hr during April 2020 and then reduced to c. 60m^3/hr towards the end of July 2020.

Inflows were relatively stable from August 2020 to May 2021 at 50-70 m^3/h. There was a significant, rapid increase in inflows to c. 206 m^3/hr throughout June 2021. This chronology is potentially significant in relation to the reported loss in groundwater levels in the domestic wells experienced at Robinstown / Shambo.

In summary, advance test-work indicated the potential for significant inflows to occur during the course of tunnelling, significant inflows were experienced requiring corrective action. This is described in more detail in Section 6.1. The key hydrogeological findings from the RAR geotechnical drilling stage and TRDEX tunnelling were:

- 'Severe ground conditions' were encountered down to 800 mbgl in Borehole N02413 and deemed unsuitable for a RAR installation. This hole was abandoned and a new site located. The findings of deep and extensive poor ground with significant water bearing capacity do not seem to have been taken on board in the hydrogeological risk assessment.
- 50 tonnes of grout was injected into a 0.5m cavity zone at 248.5m depth at N02481 which, after treatment was still reported to be flowing and this should have been taken as indicative that grouting intervention was going to face difficulty in sealing a high permeability and connected zone;
- The cavity zone was recognised as being hydraulically connected over a wide area and therefore likely to support "reasonably sustained" inflows;
- The structural geology of the Tara Deep area was identified as being more complex than the Navan and SWEX areas;
- The initial geophysical reviews suggested a system of deep subordinate fractures coming from the main faults and fault splays. Later re-interpretations and drill core data tended to support an alternative view that the system was more closed than previously thought. The presence of open conduits between the shallower weathered UDL and the deeper, more competent UDL was not thought likely based on the hydrogeological model at the time; and
- Difficulties encountered in the central portion of the TRDEX tunnel with water strikes whilst tunnelling requiring underground probe holes (U30829) to try and control "intersected significant water hosted by a NNW-trending series of open joints" which yielded an initial inflow of 1,000l/min (60m^3/hour, 1440m^3/day) and a recorded pressure of 81bar. These inflows, albeit smaller than the overall Navan mine were nonetheless occurring in one decline as opposed to multiple working areas in Navan. This should have been regarded as a higher hydrogeological risk factor than it seemingly was.

5 Description Of The Inrush Event

On the 20th of November 2021 at approximately 03.30am the 0.381m ('15 inch') diameter pilot hole drilled from surface at the RAR7 position broke through into the TRDEX exploration tunnel at a depth below ground of 997 m. The pilot hole intersection immediately released water at an approximate rate of 300m^3/hour, which was monitored and expected to abate on the assumption that a finite store of water would be depleted. On the 21st of November 2021, a decision was made to withdraw the RAR7 drill string which immediately led to a substantially increased rate of water inflow which exceeded the Tara Deep pump capacity. Shortly thereafter the TRDEX exploration tunnel started to flood. The raise bore drill string was re-emplaced which had a temporary effect of reducing inflow.

By the 22nd of November, a 300m section of the tunnel had flooded and the inflow rate had increased to 800m^3/per hour. While some monitoring wells showed 'normal ground water levels' during this time, others were recording significant drawdown. The mine operators began planning for packer and grouting interventions to try and stop the flow. By the 23rd of November the flow had approximately doubled again to 1500m^3/hour and the raise bore drill string was removed to facilitate the plan for inflatable packer plugs to be installed from surface into the hole. On the 24th of November the flow had increased again to 2200m^3/hour and the response plan had been broadened from the initial plugging of the borehole to also include installation of bulkheads and deliberate flooding of the lower SWEX mine to cope with the inflows which started overtopping the tunnel floor level on the 25th of November. The 25th of November saw the first attempt at packer inflation which temporarily worked (7 minutes) and abated the flow but then the drill string broke (including the nitrogen pressure line used for inflating the packers) and the seal failed.

From the 25th of November to the 2nd of December 2021 plans and surveys were developed for a second packer-plugging attempt. During this time (and since the initial onset of the inrush) Boliden deployed major-incident level responses to ensure safety, continued operation of emergency equipment and infrastructure (pump-sets and dewatering systems), water management, monitoring, community, public, workforce and regulatory liaison. The inrush incident was highly dynamic and challenging in terms of management as large-scale underground pump stations became overwhelmed by the inflow and were submerged.

On the 1st of December, the broken drill string was still in place at the base of the RAR7 bore despite efforts to locate it using downhole surveying equipment. An inflatable packer was lowered to a position of 900m depth and secured in place on the 2nd of December 2021 and inflated at 00.30am. Once inflated and stabilised, sand and bentonite were placed on top and then later a grout seal placed which was allowed to cure and the inflow finally stopped.

The chronology defines how inflows significantly increased over several days after the original raise-bore drill string was removed. This suggest some form of wash-out feature may have been present such as a weakly infilled fracture or cavity or even the grouting that was eroded by the force of through-flowing groundwater. This became increasingly active with little to no sign of abatement during the near two weeks before the borehole was plugged. The other aspect is that the source of the inrush, somewhere between 900m depth to surface, had hydraulic connection to a network of transmissive fractures that enabled it to tap into a store of water that continued to provide water for the duration of the inrush. From the spinner tests "The three flow zones comprise two inflow zones at 100m and at between 375 to 415m and a possible outflow zone at 600m" The dynamic spinner test showed "that a region of fissures between 360m and 460m resulted in approximately 73% of the total flow. The remaining 27% of flow entered the borehole at 210, 280 and 610m locations. No fluid movement was recorded below 610m. None of these results correlate with the 248m cavity zone. No explanation for this has been provided. In the absence of which it is concluded that a thicker and more pervasive system of inter-connected fractures is likely to be present.

Following the plugging, Boliden continued works to pump out the accumulated store of water held in the SWEX mine, initially estimated as 633,000m^3, but later re-estimated as 412,000m^3. Dewatering of the flood water commenced on December 13th 2021 with consented discharge to the River Boyne and was still continuing at the time of drafting this (May 2022). The dewatering intends to incrementally draw-down the large volume of water accumulated. Boliden commissioned downhole spinner tests and geophysics surveys on the RAR7 pilot borehole. In liaison with Authorities, the Company agreed to undertake groundwater monitoring across a wide local region area including the Shambo and Robinstown area, using manual measurements and automated instruments as of 25th November 2021. Daily groundwater level measurements commenced in dedicated monitoring and domestic wells and eleven pressure transducers (automated monitoring devices) were installed in local resident's boreholes so as to obtain a high frequency record of groundwater level changes.

Boliden also commissioned SRK - a mining consultancy to investigate the cause of the in-rush event with an objective of determining the most effective future mitigation approach for similar drilling (RAR) work. This study was developed in parallel and independently to the SRK review.

6 Hydrogeology

6.1 Initial Hydrogeological Models

The proposed RAR7 raise-bore was evaluated hydrogeologically as part of planning application submission NA201153 in October 2020. A brief summary of the hydrogeological conceptualisation, developed at the time, prior to the inrush, is outlined below.

6.1.1 General

Much of the hydrogeological understanding of the area was predicted from the SWEX mining area which was known to be largely controlled by a karstic 'channel' feature, at over 150m depth. An underground blanket grouting procedure had been successful in sealing most of the connections. Remaining inflows had been managed by probe and underground dewatering holes. The Pale Beds of the SWEX area were considered the principal aquifer, however no significant interaction with this unit was expected in the TRDEX and RAR7 development works for the Tara Deep deposit. Limited recharge to the Pale Beds in the Tara Deep area was expected due to the absence of the 'channel feature' and the depth of the development over 1km deep. Recharge to the Pale Beds occurs mainly over 13 km^2 of Pale Bed sub-crop to the north-west of Nevinstown and this was considered to be too distant and unlikely to connect to the Tara Deep area. The Pale Beds are not penetrated by the exploration tunnel or the RAR7 pilot hole so were considered less relevant for a potential in-rush event.

The main hydrogeological understanding of the TRDEX and RAR7 was associated with the view that the UDL which the capital works infrastructure would go through was generally low porosity and low transmissivity, with groundwater only associated with rare, localised fault zones, fractures and cavities. However, this view was partly revised when the D-Q fault zone was encountered during excavation of the TRDEX which had a zone of strong shearing with soft shale and gouge which proved to be more transmissive. Development of the TRDEX encountered groundwater during the progress of the tunnel and groundwater control interventions had to be applied.

Boliden recognised that water inflows at Tara Deep could be an issue in their memorandum dated March 31st 2021[20] which was prepared before the RAR7 works:

[20] Tara Deep Exploration Drift, Update March 2021

9. Further planning and a second hole (N02481), was drilled to determine the optimal position of a Return Air Raise that could connect to the Exploration Drift in 2020. The hole revealed extensive fracturing and cavities down to approximately 450m. Wireline surveys (including calliper, natural gamma, ATV, P and S velocity, fluid conductivity and temperature), were completed by Robertson Geologging (Conwy, UK). Subsequent packer testing however showed very little in the way of hydraulic connectivity below 450m and a report by groundwater consultants (Piteau Associates, Shrewsbury, UK). ***The findings of that report are that observations during drilling indicate there would be significant groundwater inflows to a RAR installed at the site of N02481 from the prominent cavity zone between 248.5 and 249.0mbgl. Currently available data indicate that this zone is hydraulically connected over a wide area and is therefore likely to produce reasonably sustained inflows. Pre-grouting of this zone is considered prudent.*** *There is no site specific pre-grouting data available to calculate the inflows from this zone.* ***However, experience elsewhere at Tara would suggest that inflows in the range 12-20 l/s (200-300 gpm) would be likely****. It is possible that testing could be carried out in hole N02176 to provide data to improve this estimate, and to estimate how sustained the inflows would be.*

During the inrush, more than 600 l/s was reported to be inflowing, (Bold italics and underlining added to highlight key section).

Pre-grouting was recommended to mitigate the expected inflows to the RAR7 at the 248mbgl depth. The geotechnical exploration hole (N02481) had showed two main cavity zones: one between 248.5 and 249.0 m depth (0.5 m wide); and one at 453.7 to 453.8 m depth (0.1 m wide). Prior to drilling the RAR7 pilot hole (circa 2 meters from N02481) through the 248.5-249.0 cavity zone, a grout curtain was installed using 8 drill holes (4 primary holes and 4 secondary holes) spaced on an 8.5 diameter ring to depths ranging from 215 m to 281 m. This was done in an attempt to minimise water interaction with the RAR7. As detailed in Section 4.3.1, the pre-grouting required several attempts, and its effectiveness is uncertain.

During drilling the RAR7 pilot hole, water loss was encountered at a depth of 266 m. Further grouting was applied at a depth of 270 m. After grouting a camera survey was undertaken to ensure this cavity zone was sealed. Drilling continued and no further significant water loss was reported from this cavity. Boliden reported that no water was encountered or reported when drilling through the second cavity zone at 453.7 to 453.8 m.

The drillers log for the RAR7[21] identified numerous poor ground conditions in the upper 250m of the RAR7 and in sections below:

- 130m bgl – Remarks of feeling like drilling through air (indicating cavities)
- 220-240mbgl – Remarks regarding 'bad'/ 'messy' drilling conditions
- 253mbgl - Remarks of draining water

[21] Drillcon Scandinavia 'Borrapport Tara Deep' 2021.

At the 453mbgl zone the drillers remark that the rig 'flushed/ unloaded from the pit' implying a complete loss of fluid circulation at this depth. After drilling through the 453mbgl zone the driller's remarks for the remainder of the work are predominantly about losses of fluid and draining down of the pit. The implication being that the hole is almost continuously losing water into the formation.

Superficial water bearing zones at Tara Deep were not anticipated to interact with the drilling works. The thicknesses of the overburden being minor ranging from 3 to 26m, with an average of less than 10m thickness and no apparent continuum between deep groundwater and the superficial units. Approximately 10m of conductor casing was emplaced at surface to enable drill-string operations to take place without surface debris falling into the hole.

6.1.2 2020 Assessment

The hydrogeology of Tara Deep and the RAR7 ventilation shaft development was assessed in July 2020 by Boliden Tara's groundwater consultant (Piteau Associates). The report was submitted to Meath County Council as part of the planning permission application for the RAR7 application and included a review of available geological and hydrogeological information, interpretation and testing of the investigation borehole (N02481) which had been drilled at the RAR7 site between February to May 2019.

The hydrogeological interpretation developed by Boliden's groundwater consultant did not identify risk of an inrush event of the magnitude that occurred in November 2021. The report documented the geology and hydrostratigraphy of the area and noted two cavity zones in competent UDL rock. Both zones were thin (<0.5m) and located at depths 248.5 – 249mbgl, and 453.7 to 453.8 mbgl based on the geotechnical investigation borehole, N02481. The upper cavity zone had resulted in loss of drill fluid circulation requiring remedial grouting at the time of geotechnical drilling. Later on, this zone was targeted for the grout curtain before RAR7 drilling. No grouting was applied at the 453m zone.

The upper cavity zone was also proved (by water returns) to be connected to a nearby borehole (N02176) located 300m to the northeast. Aside from these two zones the rest of the rock encountered was described as tight and competent with no indication of any major fracturing and where shales and mudstones were encountered these had low porosity and permeability.

Boliden's groundwater consultant concluded no adverse impact would occur from the development of the ventilation shafts primarily because the UDL formation was considered strongly layered with limited vertical connection. The issue of dewatering the near surface boulder clays and superficial gravels was dismissed because it was thought only thin superficial with limited permeability would be encountered in the immediate zone of influence. A second issue concerning possible upward connection of pressurised groundwater i.e. from the pale beds aquifer encountered at depth was dismissed because only UDL was expected.

Where fractures would be encountered in the UDL these were interpreted to 'have the potential to create large, short-term groundwater flows' with much of the fracturing known to be located within and towards the base of the weathered zone. The operative word here is assumed to be 'short-term' with rapid depletion of local storage expected to rapidly drain-out but not be connected to large replenishing supply sources (recharge).

In hindsight greater precautionary emphasis should have been given to the likelihood of fracture connection over 300m+ distances and the connection between deeper fractures in the UDL to upper stores of water within the weathered UDL sequence.

The inflows encountered by the TRDEX were not referred to in the RAR application report. At the time of issuing the inflows were on average 60m^3/hour and had not yet risen to the 200m^3/hour inflows that were seen approximately a year later in 2021. The tunnel had encountered inflows at the time of report writing requiring some corrective action but at this stage this was not taken as evidence of problematic inflows at depth. Overall, it was assumed that there was little to no connection between the deeper UDL and the overlying weathered UDL in the area of the planned RAR7 site (Piteau, 2020). This inference was based on selected observations that depressurisation of the tunnel at depth did not cause near-surface draw-down.

It is not known if the report had access to data that showed the vertical distribution of hydraulic heads recorded from wells and monitoring devices installed in boreholes in the superficial unit, the upper weathered UDL and the deeper competent UDL. This data was reported later in the 2021 assessment (after the inrush) and shows a pattern of higher upper heads reducing progressively through deeper units. This distribution suggests in some cases a downward hydraulic gradient and recharge from upper units into lower units. The implication is that there is hydraulic connection from near surface to depth. The 2020 conceptualisation is made without clear reference to hydraulic heads of different levels which seems to be an omission.

Packer tests were undertaken as part of the 2020 investigation of the exploration borehole N02481 located in the area of the proposed RAR7 shafts. The packer tests indicated hydraulic conductivity values range over 4 orders of magnitude, the majority of the UDL having low permeability (for example 10^{-9} m/sec) but at least one 9m section (not identified in the Piteau report) had a hydraulic conductivity of 10^{-5} m/sec which would indicate medium to high hydraulic conductivity.

6.1.3 2021 Assessment

Boliden obtained an updated hydrogeological interpretation from Piteau in early December 2021 whilst the inrush event was occurring.

In this interpretation more description was provided on the fault systems and potential karst properties. The update provides a clearer identification of the upper weathered UDL zone containing continuous fractures, cavity zones (observed in drill holes N02413, N02176 and N02207) and an interpretation that where these occur in the near surface zone (above about 300 m depth) the broken zones may be hydraulically continuous (refer to Figure 6.1).

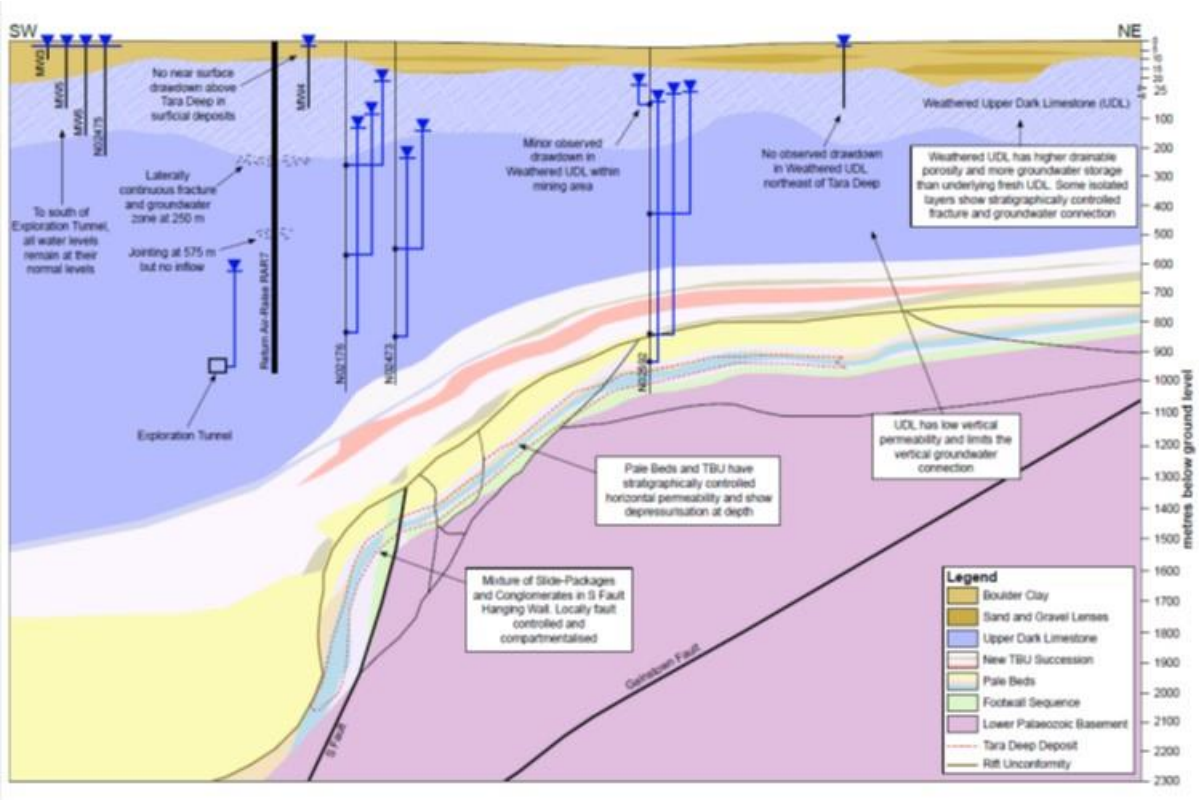


Figure 6.1: SW-NE Hydrogeological Cross Section in Vicinity of Tara Deep. Source: Piteau, 2021[2]

In this update, Piteau identify the hydraulic head of water in the TRDEX tunnel ('Exploration Tunnel' as labelled in Figure 6.1) as being 660m[22] . It is important to differentiate that this hydraulic head is controlled solely by the elevation of the water surface in the SWEX underground sump into which the tunnel and RAR water flowed and decanted. The head reflects the water level in the sump but does not reflect groundwater pore pressure or formation water head. No inferrence about formation water head differentials in different monitoring points can be drawn from this observation.

The hydrogeological cross-section displays a selective sub-set of results for monitoring wells: "to south of Exploration Tunnel, all water levels remain at their normal levels", and makes a similar claim for shallow monitoring wells in the northeast "no observed drawdown in weather UDL northeast of Tara Deep". However, this is not representative of recorded deflections observed in MW1 (north) and MW7 and MW8 and a number of community wells (refer to Section 6.2.2 below).

6.2 Monitoring and Surveillance During Inrush

The magnitude of the inrush event prompted a major deployment of monitoring and additional test-work. The key hydrogeological findings of this are summarised below.

6.2.1 Spinner tests

[22] Confirmed by Piteau in correspondence in September 2022.

6.2.1.1 Static

Static spinner tests were undertaken as part of a suite of downhole surveys including a camera survey, calliper log and Electrical Conductivity (EC) and temperature profiling. The key observations from the static spinner test conducted within the RAR7 pilot hole on 6th and 7th December 2021 by European Geophysical Services are presented in Appendix C.

The static test and its associated geophysical logging indicated that within the RAR7 bore, three flow zones are recorded. The survey work, which was undertaken simultaneously with the plugging of the bore also confirmed other features such as the depth of the lost drill string and the top of the grouted, cemented plug which formed the eventual seal of the RAR7 bore at a thickness of 67m above the packer (833mbgl).

The three flow zones comprise two inflow zones at 100m and at between 375 to 415m and a possible outflow zone at 600m based on downflow records and EC values. Of note, is that none of the spinner tests or geophysical response zones relate to the target 248-249m cavity zone which was the focus of grouting work and has been attributed to be the main source of inflow by Boliden.

The static test results, under non-pumped conditions show downflow occurring in the borehole as water pressures from different vertically arranged inflow horizons equilibrate. A total flow rate of 1.6 – 2.0l/s was measured from 105m down to 610m where flow was observed to exit the borehole. Below 610m, there was no detectable flow. The lack of flow below 610m was also evident in the fluid temperature log which matched the expected geothermal gradient. The summary of the logs is shown in Figure 6.2 below.

The key inflow zone (375-415m) and outflow zone (599-601m) inferred from the geophysical logs are identified in the sections below.

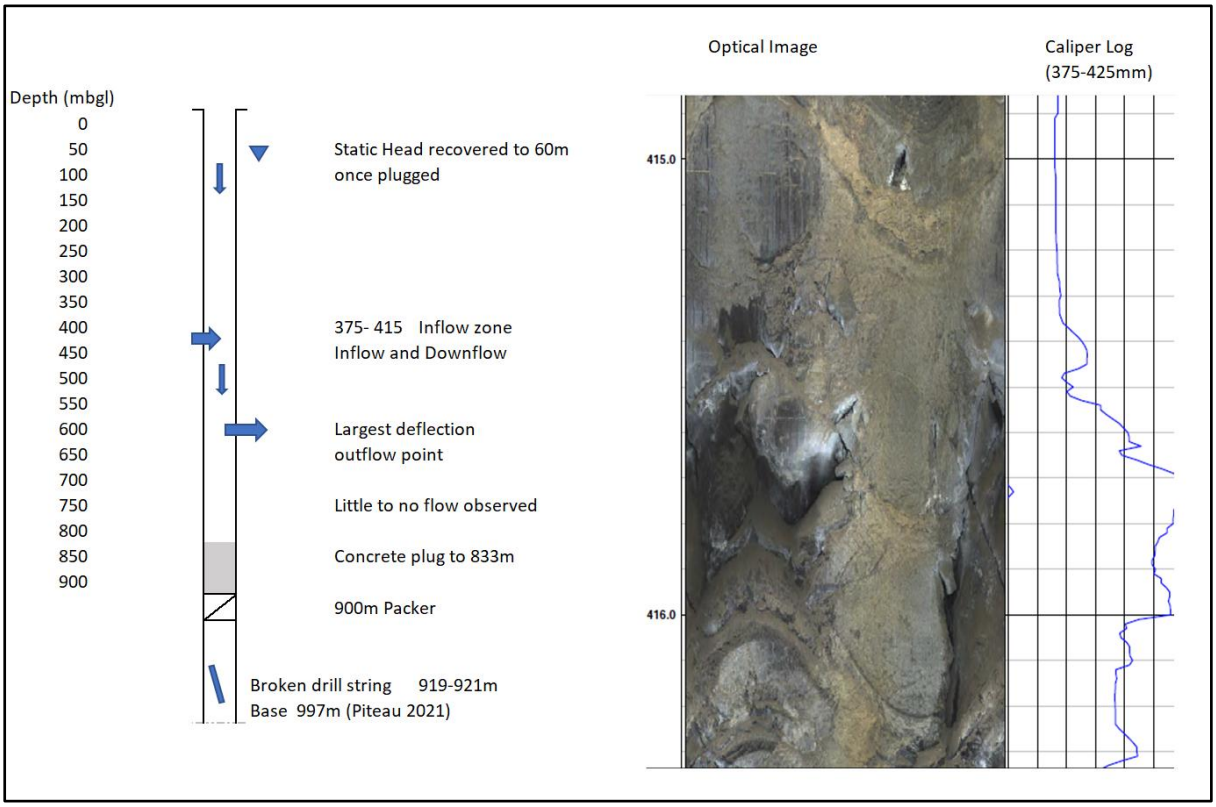


Figure 6.2: A: Flow Zones Observed from the Static Spinner Test, B: Close up of inflow at 415m.

6.2.1.2 Dynamic

A dynamic spinner test, with induced flows of 7 and 15L/sec was completed on 22nd and 23rd February 2022 under the supervision of European Geophysical Services LTD (EGS).

The dynamic test induces a hydraulic gradient within the borehole by pumping out water which more clearly shows flow patterns within the borehole and identifies flow zones. The tool uses an impeller to measure flow rates within the water column of the borehole. Under dynamic testing conditions a log of geophysical parameters such as temperature and EC is recorded in conjunction with the pumping system and impeller logger. During the survey, the elevation of the cemented zone at the base of the RAR7 raise bore was re-measured at 762m following further infill since the last (Static) visit.

The testing indicated under pumped conditions, that a region of fissures between 360m and 460m resulted in approximately 73% of the total flow. The remaining 27% of flow entered the borehole at 210, 280 and 610m locations. No fluid movement was recorded below 610m.

6.2.2 Groundwater monitoring in Tara Deep and surrounding area

Prior to the inrush the Navan mine monitoring programme comprised[23] :

- Daily inspection of underground headings.
- Monthly compilation of underground groundwater inflows (including probe drilling).
- Monthly water table measurement of surface drill holes.
- Monitoring of groundwater pressures in underground holes.
- Bi-annual hydro-geochemical sampling; and
- Professional consultancy from Boliden Tara's consultants.

Following the in-rush event, 17 boreholes within the Tara Deep and Robinstown and Shambo areas were selected to be monitored on a daily basis. These comprise a combination of dedicated monitoring boreholes (TD_MW01 to TD_MW08) and domestic wells (TD_DW01 to TD_DW09). However, the monitoring boreholes tend to be all relatively shallow within either the overburden or the weathered UDL. The deepest monitoring borehole is reported as 120m deep.

There are also 52 monitoring boreholes that are monitored on a monthly basis in the vicinity of the SWEX and Navan mine working areas. These are presented in Appendix E.

Figure 6.3 summarises the locations of these boreholes relative to the RAR7 pilot hole and inferred structural features in the area. Appendix D has more detail of each of the monitoring locations including their distance and orientation relative to RAR7.

Figure 6.4 and Figure 6.5 present the water levels recorded in the monitoring and domestic boreholes from October 2021 to January 2022, including the in-rush event period. Tara Deep water level datasets are presented in Appendix F.

[23] Exploration Plans, PL4502, Navan, Co Meath, Boliden, July 2021

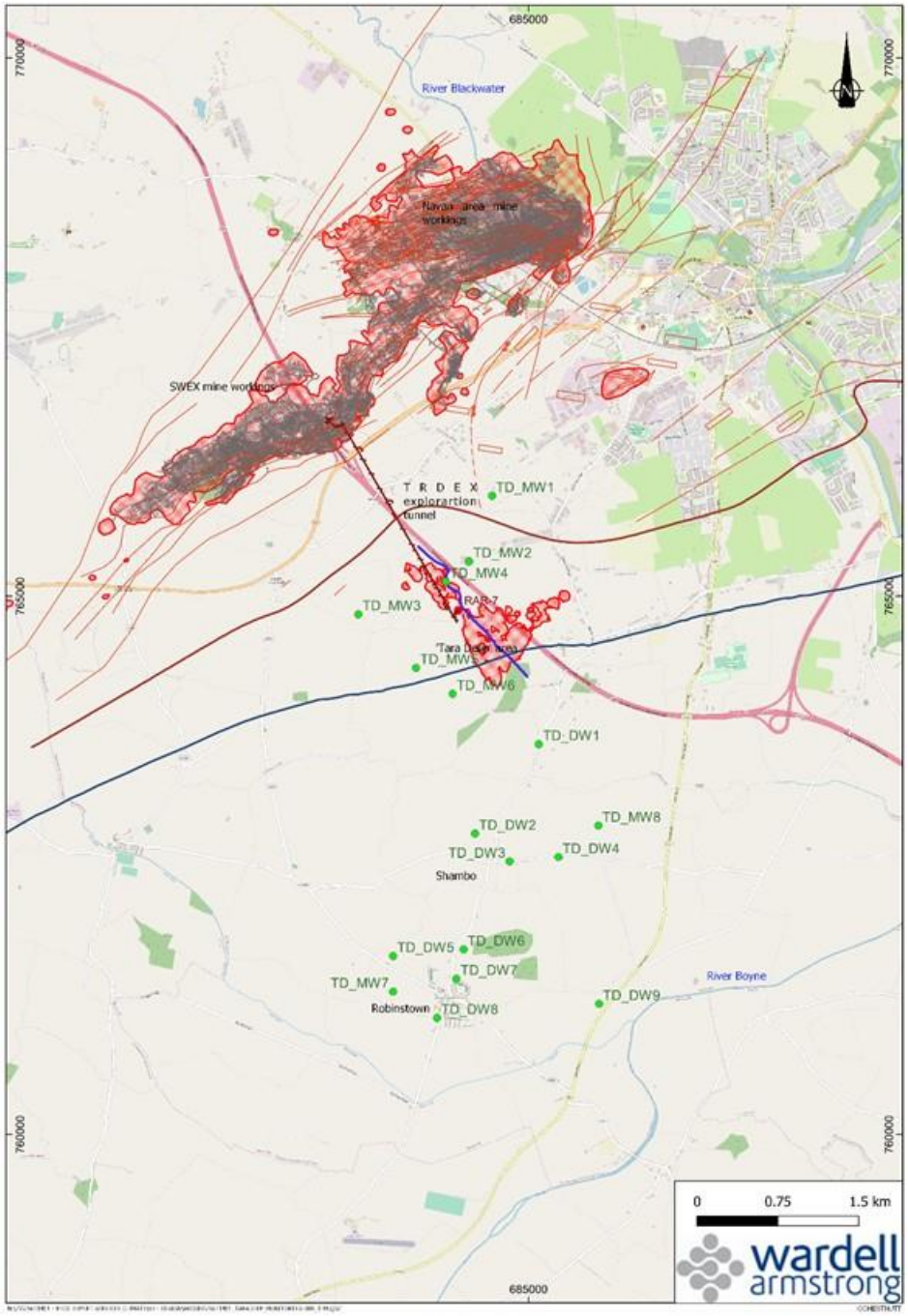


Figure 6.3: Location of the Tara Deep Monitoring Boreholes Relative to the RAR7 Pilot Hole.

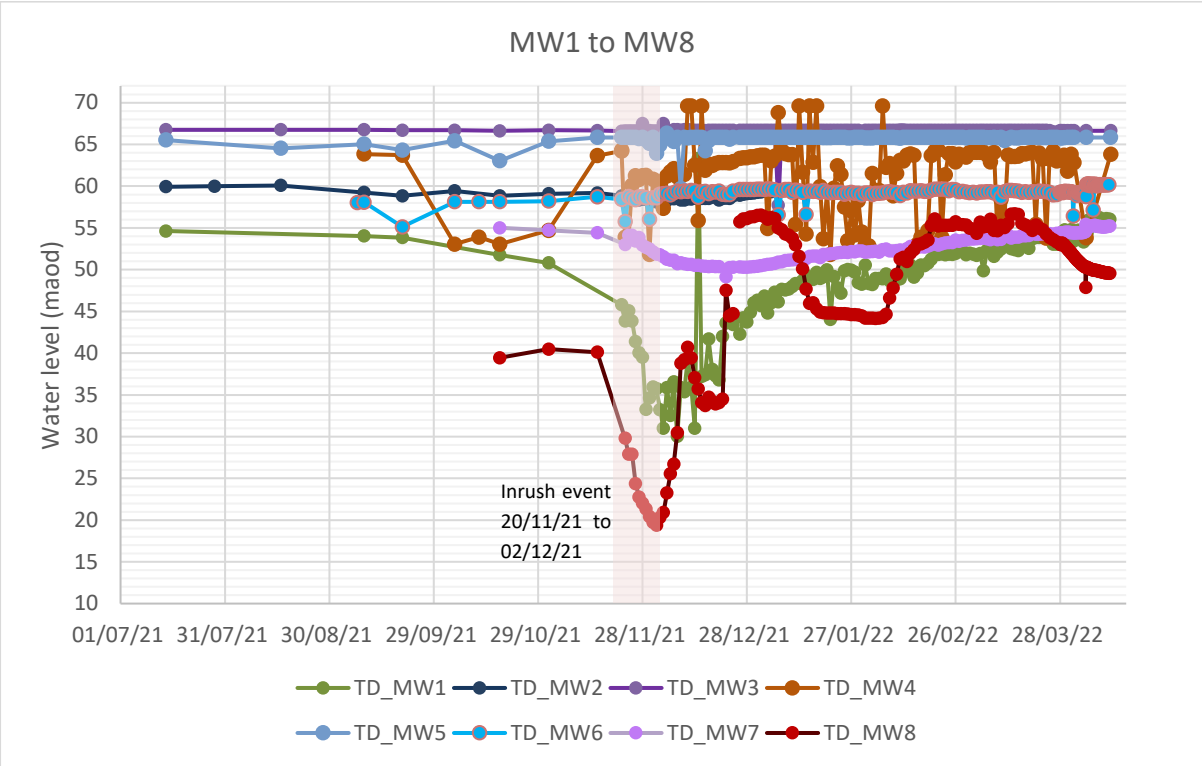


Figure 6.4: Water Levels within Dedicated Monitoring Boreholes Monitored by Boliden Tara Mines (July 2021 to January 2022).

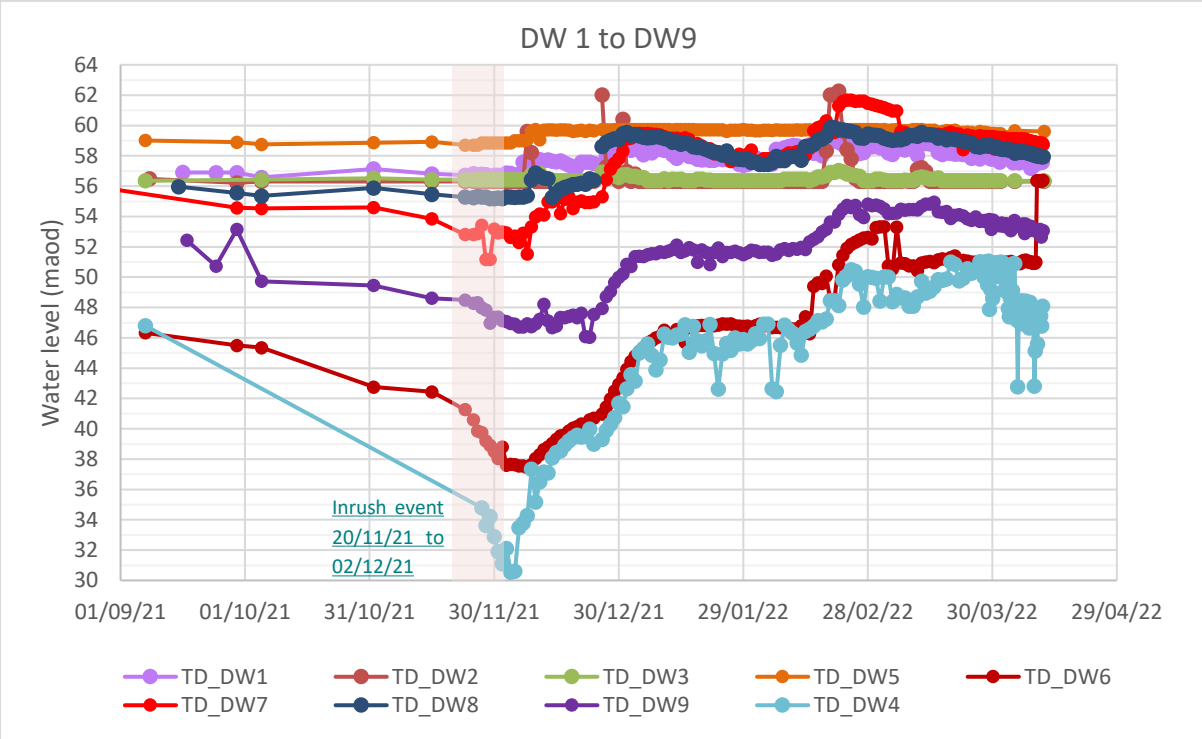


Figure 6.5: Water levels within Domestic Boreholes Monitored by Boliden Tara Mines (October 2021 to January 2022).

Figure 6.7 and Section 7.3 below.

Hydraulic testing was undertaken in monitoring boreholes TD_MW07 and TD_MW08 however this was not informative. No measurements of drawdown over time were reported and only a qualitative estimation of yield and resource was interpreted.

Fortunately, monitoring had been undertaken prior to the inrush event so that a pre-existing baseline was available for comparison. The effect of the quantity of water drained out from the RAR7 bore during the period 20th November to 2nd December 2021 was in effect like a large-scale pumping test, and the monitoring of surrounding boreholes enables a recording of the extent of the 'signal' from the test to be observed. For example, in monitoring point DW9, located 3880m SSE of RAR 7 and south of the Navan fault in the Robinstown area, a distinct response to the inrush was observed, even though this well was a 46m deep domestic installation. The response in the well shows both the drawdown and the recovery stages corresponding to the onset and plugging of the inrush at RAR7.

Both the magnitude of the recorded response and the timing of the response in monitoring wells are analysable. Wells that are connected through fractures and are under 'confined' conditions show an instantaneous hydraulic pressure change, whereas wells that are connected by unconfined 'drainage' take longer to respond depending on the time taken to physically drain fissures and pore space. Generally, all the monitoring wells are in unconfined water bearing units and responses to the inrush (and the subsequent plugging) were delayed by several days, interpreted as a drainable fracture porosity affected by the RAR2 outflow. By comparison the 'VWP' records discussed below, showed an almost immediate response.

The spatial distribution of drawdown associated with the in-rush event, was plotted as a differential water level which shows the change in level compared to baseline conditions before the inrush. Plots were produced at 3-day intervals (Figure 6.6). No obvious spatial trend delineating a dominant groundwater conduit to the RAR7 borehole was interpreted, although a tentative recognition of more drawdown to the north and east was recognised. However, it is recognised that there is likely some bias in the data as there are more observation wells located north and south.

As this is a fractured aquifer system there is not the typical 'cone of depression' that is observed in porous saturated media such as sands and gravels that get dewatered. Instead, the storage depletion and transmission of groundwater via an interconnected fracture network is more linear and zonally isolated. As the water level response in the observation boreholes is determined by the openness and 'connectedness' of fractures, some boreholes closer to RAR7 pilot presented no obvious response to the in-rush event whilst others in the Robinstown and Shambo areas presented drawdowns over 10m.

From the response observed in the monitoring boreholes south of the Navan fault, this E-W structure is not acting as a barrier to flow, at least within the upper c.120m. To review the water level responses in the context of well depths, the monitoring boreholes were categorised into three broad categories;

1) Shallow: 0-20m– the overburden is 0-26 m in vicinity of Tara Deep, averaging c. 10m
2) Intermediate: 20-70m – within 'weathered UDL'?
3) Deeper: 100-120m- within 'weathered UDL'?

The spatial distribution of water level differentials (relative to pre-inrush conditions) is shown graphically for the 3rd December 2021, 13 days since the start of the in-rush, c. 1 day after plugging of RAR7 in Figure 6.6. The analysis is not exact as the distribution of monitoring boreholes introduces a bias into the groundwater contours. The presented contours are illustrative only, within each contour there are variations with some sites not experiencing any drawdown and other experiencing more than the average.

Figure 6.7 shows a more in-depth analysis of the response to the inrush for the shallow, intermediate and deep monitoring borehole categories.

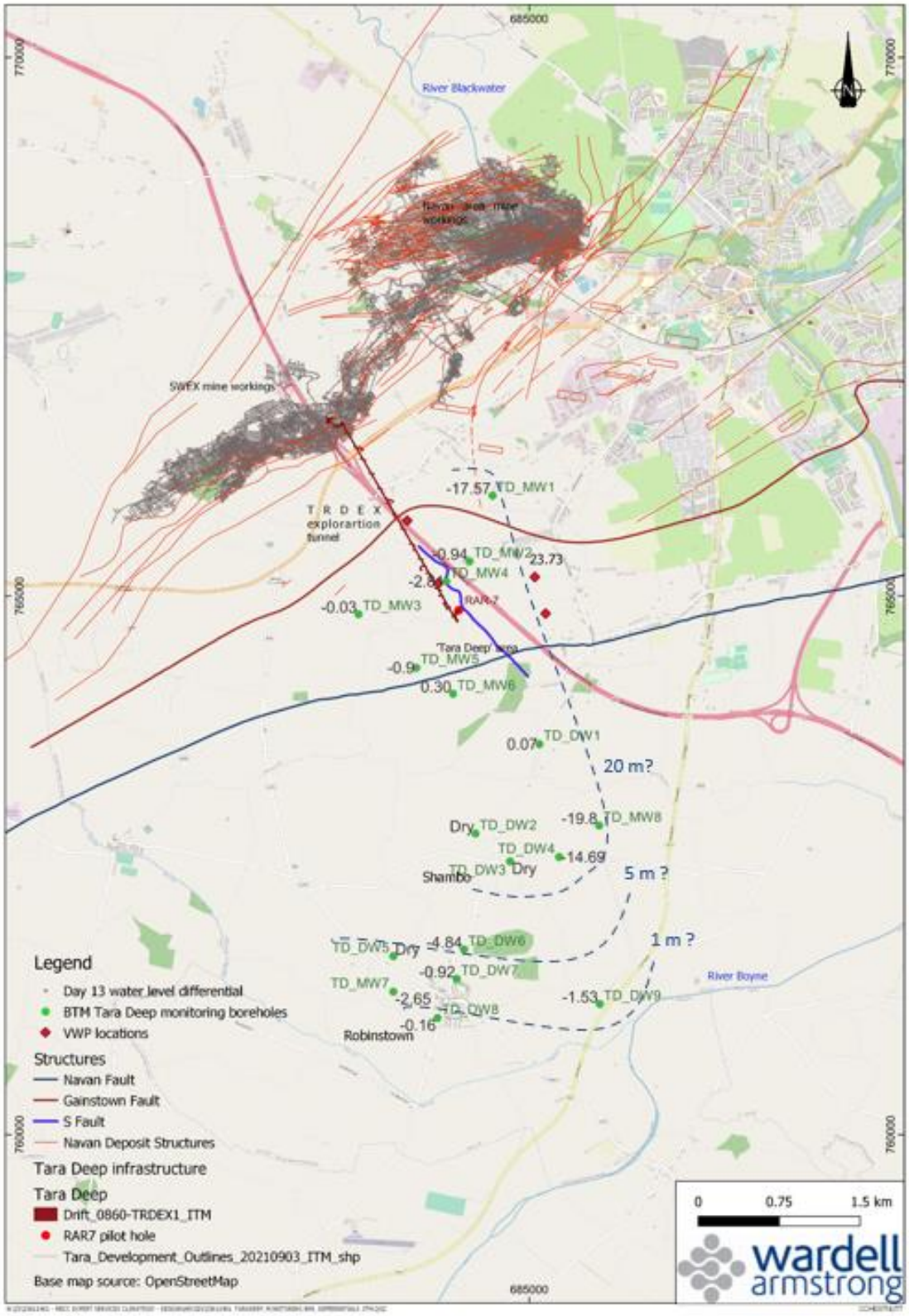
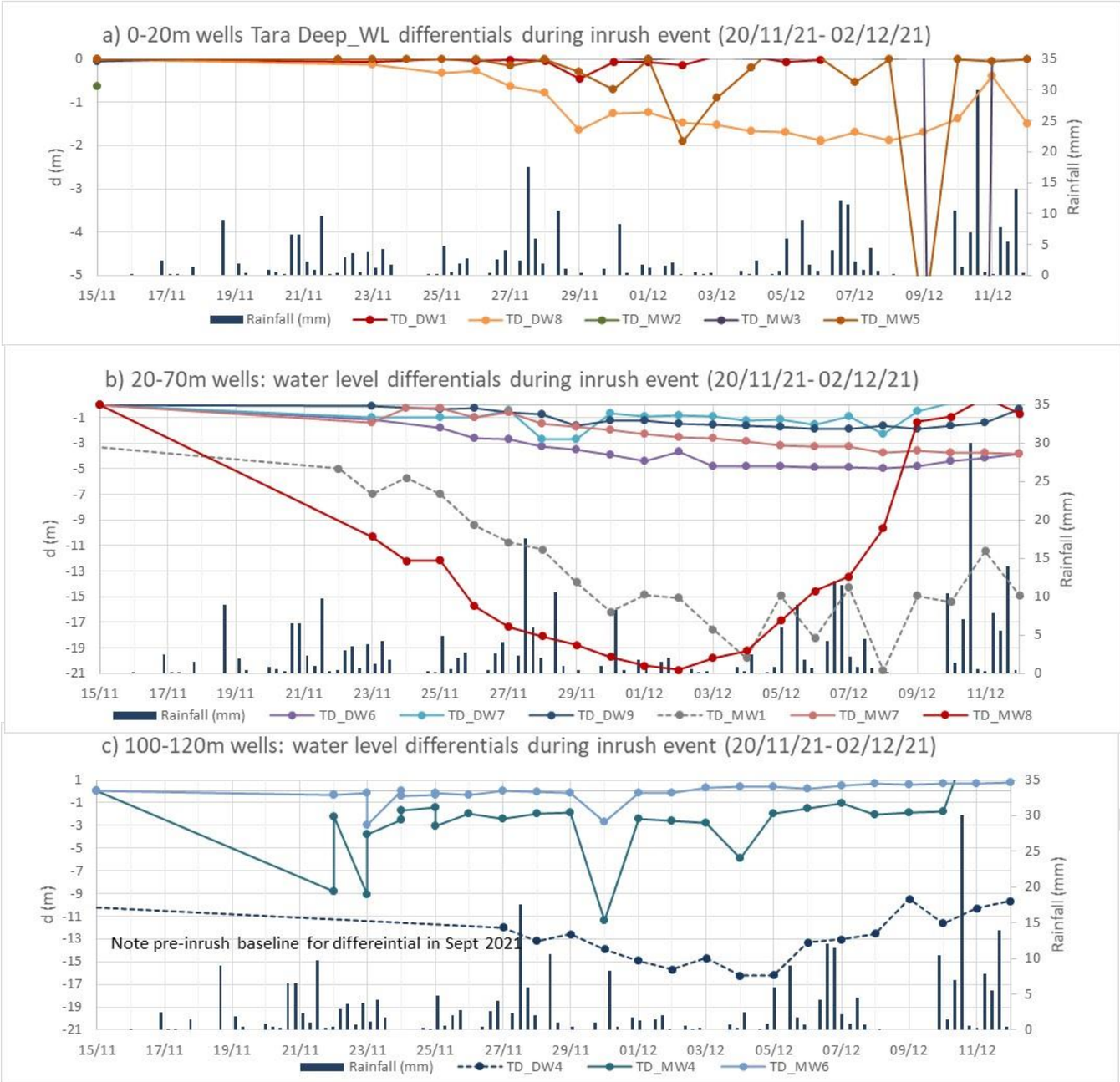


Figure 6.6: Spatial Distribution of Water Level Differentials (relative to pre-inrush conditions) and Schematic Groundwater Contours from 03/12/21



a) Shallower boreholes (0-20m) Observation: Within TD_DW1 and TD_DW5 there was little to no response. There was a lagged response in TD_DW8 with only c. 0.3 m differential on 25/11/21 and 26/11/21, five and six days following the start of inrush (20/11/21). Water level continued to decline until 06/12/21, when it stabilized. This was four days following the plugging of RAR7. Note, TD_DW2 and TD_DW3 were recorded as dry from 05/10/21 and 15/11/21 prior to and throughout the in-rush event.

Interpretation: The boreholes are within the boulder clay and sand gravel alluvial material. Compared to the pre-inrush baseline DW8, and MW5 show signs of drawdown.

b) Intermediate boreholes (20-70m) Observation: TD_MW8 presented the clearest response to the in-rush event and the plugging with a reduction in groundwater level of nearly 21m recorded on 02/12/21 and thereafter recovery. TD_MW1 also showed a marked decline. The other boreholes show a more muted decline (TD_DW6, TD_DW7 and TD_DW9) and partial recovery. TD_MW8 recovered without delay following plugging of RAR7 however all other boreholes observed a lag in recovery. TD_MW7 continued to have declining water levels until 22/12/21, twenty days following the plugging of RAR7PH.

Interpretation: There is a strong positive correlation to the inrush and plugging observed in MW8. Other wells show a decline from the pre-inrush baseline with a lagged (delayed) response in both drawdown and recovery. There would appear to be hydraulic connection between the intercepted fractures of the RAR7 and MW8 (64m deep) although this is nearly 2.4 km to the SSE from RAR7. The smaller, delayed response in the other monitoring wells implies subdued connection. Nonetheless the dewatering of the UDL is having an effect on these intermediate boreholes.

c) Deeper boreholes (100-120m) Observation: There was no clear response in water levels in TD_MW6, 100m deep c. 790 m SSE from RAR7. In TD_MW4, 100m deep, c. 290 m NNW of RAR7, the water level fluctuated with no discernible differential. However, TD_DW4, 120 m deep, c.2470 m SSE showed a discernible response to the in-rush and plugging / recovery.

Interpretation: These monitoring wells are within the upper UDL compared to the full depth of the RAR. The variability in the response at these depths may indicate the way in which some fractures are connected, whilst others aren't. With deeper depth there is less pervasive connection and not always an interaction between fracture sets. TD_MW6 does not respond indicating isolation from the groundwater system that was intersected during the in-rush event.

Figure 6.7 a) to c): Tara Deep Monitoring Borehole Water Level Differentials During and after the in-rush event (20/11/21 to 02/12/21). a) Shallow (0-20m boreholes), b) Intermediate (20-70m boreholes) and c) Deeper (100-120m boreholes).

6.2.3 Community well inventory

Boliden undertook a detailed community well / water resource census over a 5-week period (14/02/2022 to 06/03/2022)[24]. The census comprised a groundwater user survey with details of the location, use, status, well construction and water level of all residences and properties in the area. The census includes comments by the owners regarding the reliability and any perceived changes in the well behaviour.

There are 565 entries into the database with a wide variety of views including:

- 27 responses from residents that identified relatively recent drying of their wells between summer 2021 and the inrush event in November / December 2021 attributing this to Tara.
- 145 positive identifications of wells the majority of which did not report problems or have said that well has gone dry in the past (prior to 2020) or seasonally.
- The remainder of the properties were either uncontactable, wells were not accessible or were on mains supply; and
- Six responses identified poor water quality – typically associated with sedimentation or surface contaminants such as ammonium and two of these responses identified turbidity issues associated with underground blasting.

Of the 27 responses which stated a noticeable recent drying and which had recorded well details, 68% were between 3-7m in depth, with 32% between 32 and 70m depth.

In 2022 a survey was conducted by Meath County Council Consultants to identify the hydrogeological units that were likely to be sustaining the groundwater inflows to 70 local community monitoring wells. The study identified three categories of wells and boreholes installed in the upper sub-soils between 0 - 7.8m depth, transition materials between 2.7 to 11m and upper bedrock from 13.2 – 48.7m with one deeper installation in bedrock (122m). The study made no connection or interpretation with respect to interaction between the mine, the inrush event, and the community wells.

6.2.4 Vibrating Wire Piezometers

Vibrating Wire Piezometers (VWPs) are instruments that are permanently installed and grouted into boreholes which can continuously record porewater pressure at difference depths. The sensors are hydraulically sealed to record porewater pressure only at a particular horizon. In addition to conventional groundwater monitoring, seven VWPs were installed in three boreholes (N02176, N02473 and N02495) to understand groundwater conditions in the vicinity of potential RAR sites. Fortunately, the VWP installations were present and running prior to the inrush incident and provide a good record of response.

[24] Weekly Update Report Week 12 2022, Appendix 4_Baseline Well Survey Findings, Boliden Tara Mines, April 2021

The VWP installation details are:

1) N02176 was installed with three VWPs at 256m, 565m and 837m.
2) N02473 (70 degrees dip) was installed with two VWPs at 958m (planned depth of the tunnel) and at 658m (300m above as a control).
3) N02495 in 'Tara Deep Zone 1' was installed with VWPs at 802m and 903m. (Tara Deep Exploration Drift, Update March 2021, Boliden, 2021).
4) N02592 was more recently installed in August 2021 with VWPs at 907, 831, 427 and 64 mbgl.

Figure 6.8 presents the location of the boreholes installed with VWPs. The plots show the responses observed in the VWP data for the monitoring period (2019 – 2021).

Pore-water pressure changes, at deep and shallow elevations, are discussed below.

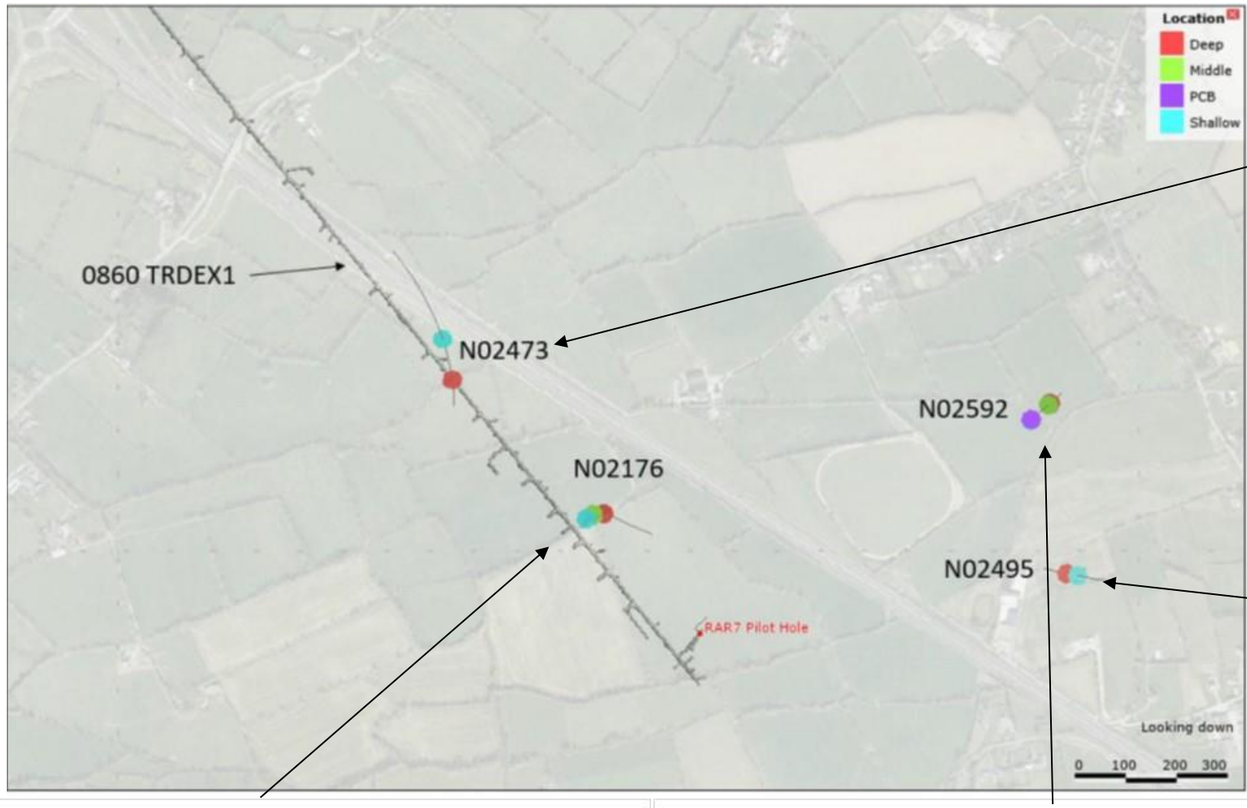
The VWP instrument at borehole N02473, located close to the TRDEX tunnel showed a 500m equivalent head pressure drop in the first week of September 2020 in both the deep and intermediate sensors. The pressure recovered in stages over the next 12 months, with a further pressure drop recorded in mid January 2021. Nothing distinct in terms of TRDEX tunnel inflows was occurring at these times. The pressure drops and recoveries, recorded at both deep and intermediate elevations, exactly mirror each other in terms of magnitude and timing. From early June 2021 the pressure records begin to separate with a 50m hydraulic head developing between the intermediate sensor (with higher head) than the deeper sensor.

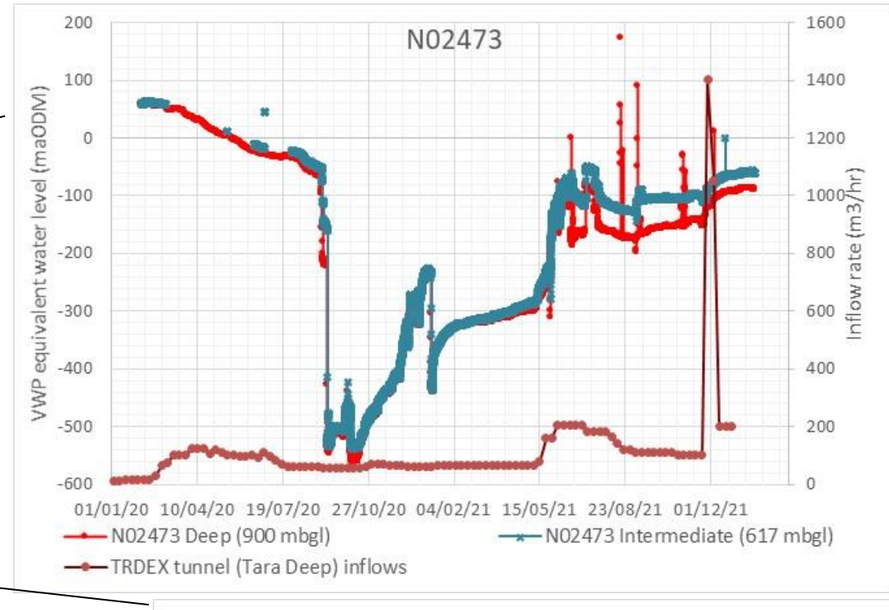
The VWP instruments at boreholes N02176 and N02495 located at the tunnel and approximately 1km east (respectively) both showed a distinct pressure drop response to the inrush event and recovery. This was recorded in both deep and intermediate zones. Instrument NO2176 recorded a pressure drop of nearly 75m whilst N02495 (located 1 km away) showed a pressure drop of about 40m.

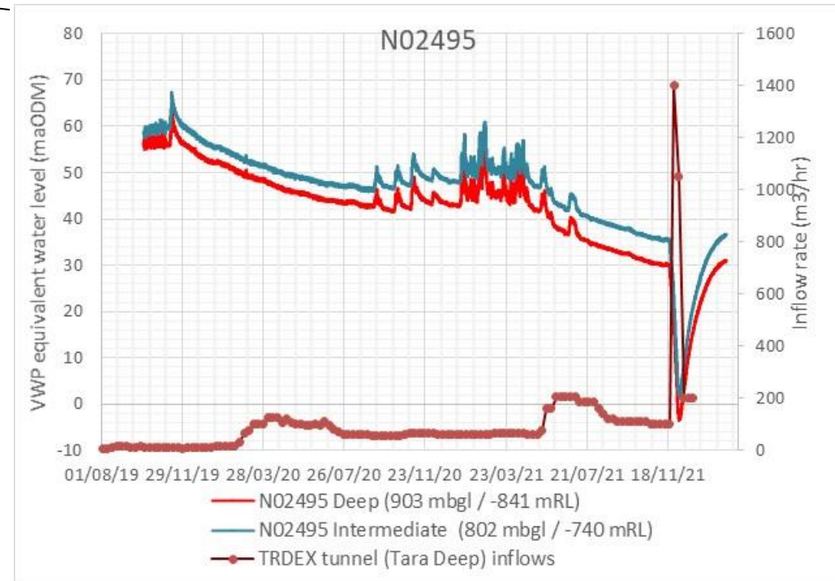
Boliden Tara's groundwater consultant reported in 2022 that "the inflows caused a rapid drop in formation pressure (of about 7,000 kPa) that affected many stratigraphic horizons in the UDL. It is apparent that a pressure response to the pilot hole propagated laterally in individual stratigraphic horizons at discrete depths."

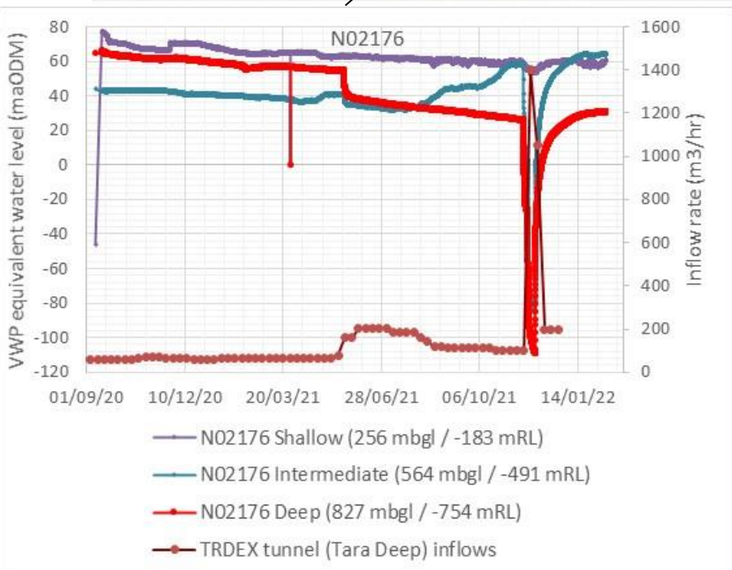
In N02176, the intermediate and deep sensors installed at 565m and 837m also showed a decline in pressure head of 15 and 6 m respectively from January to May 2021, coinciding with advancement of the exploration tunnel. On 07th August 2021 the N02176 sensor at 564 m depth showed the beginning of a stepped rise in pressure which continued until the inrush in November whilst the shallow and deep sensors did not register this and instead showed a steady fall in pressure. During drilling the RAR pilot hole was understood to frequently lose fluid, however there is a break in the activity log from 28th July to the 07th September 2021 at which point the reamer drill bit was at a depth of 271m (i.e close to the 278m cavity zone). The differing trends of the shallow and deep VWP sensors, compared to the intermediate level sensor, indicate some zonal isolation at this point.

In N02495, the VWPs are installed at 802m and 902m depth. Both sensors show the same trend line and timing and a series of mini-pressure disruptions from September 2020 to July 2021 in which both sensors behave identically. Both sensors show a near identical 35 m pressure drop to the inrush event followed by recovery when the RAR was plugged.









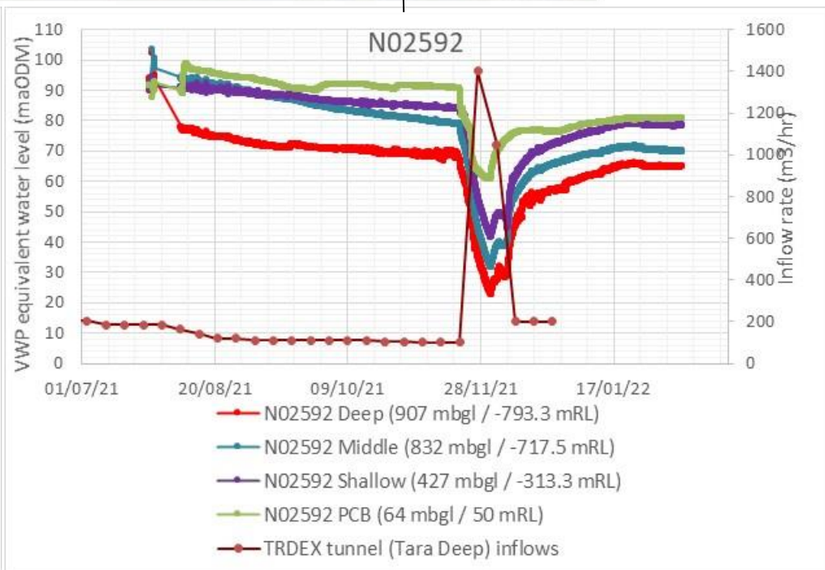


Figure 6.8: Location of VWPs and the Equivalent datum Levels for the VWPs Relative to the TRDEX Tunnel Inflows and in-Rush Event

6.2.5 Hydrochemistry

Groundwater chemical characterisation of inflowing water into the exploration tunnel from between September 2019 to October 2021 has been undertaken. Discrete samples from during the event could not be collected that represent just the RAR inflow and a range of different mine-waters mixed together. Therefore, a diagnostic analysis of the type of inflowing water during the event, and any change in composition is not possible. The flood water from the inrush collected in sumps which contained SWEX water as well and therefore no separate analysis of inflowing water was possible.

Nine water quality samples were collected from fractures and probe holes in the TRDEX exploration tunnel. After analysis this water was determined to be very hard and of a calcium-magnesium bicarbonate type. All samples were fresh with in-situ electrical conductivity ranging from c. 520-750 µS/cm, averaging c.600 Us/cm. Water was neutral and pH ranging from pH 6.6 to 8.5 with an average of 7.4. The freshness of the water possibly implies that this is relatively young water, which is replenished from recharge, however the absence of salinity from chloride and sulphate, which would be expected to emanate from shale horizon in the UDL aquifer is not a totally reliable analysis. The tentative recognition of juvenile water partially suggests there is connectiveness but more analysis and confirmation would be necessary.

Water chemistry was sampled from the RAR7 pilot borehole at the time of the dynamic spinner testing from depths of 250m, 400m and 550m on 23/02/22. The major ion groundwater chemistry from these depths was compared to water chemistry samples taken from the TRDEX prior to the inrush. The post inrush RAR7 samples (blue) plot closely to the pre-inrush TRDEX samples (red) and are interpreted as being the same water type. Minor ion chemistry for Boron, Cadmium, Chromium, Lead, Nickel, Ammoniacal Nitrogen, Nitrogen, Cyanide, Phosphate, Tritium and BOD were all unchanged and generally below detection limit. No shallow groundwater indicators such as nutrients from agriculture (nitrate, phosphate or ammonium) were detected in the water. If clearly discernible agricultural indicators had been connected this would have been taken as positive proof of near surface water connection. Their absence cannot be taken as a strong indication of zonal isolation.

Figure 6.9 presents the water types from the available water quality using a Piper diagram indicating HCO3, Cl + S04 water type is dominant.

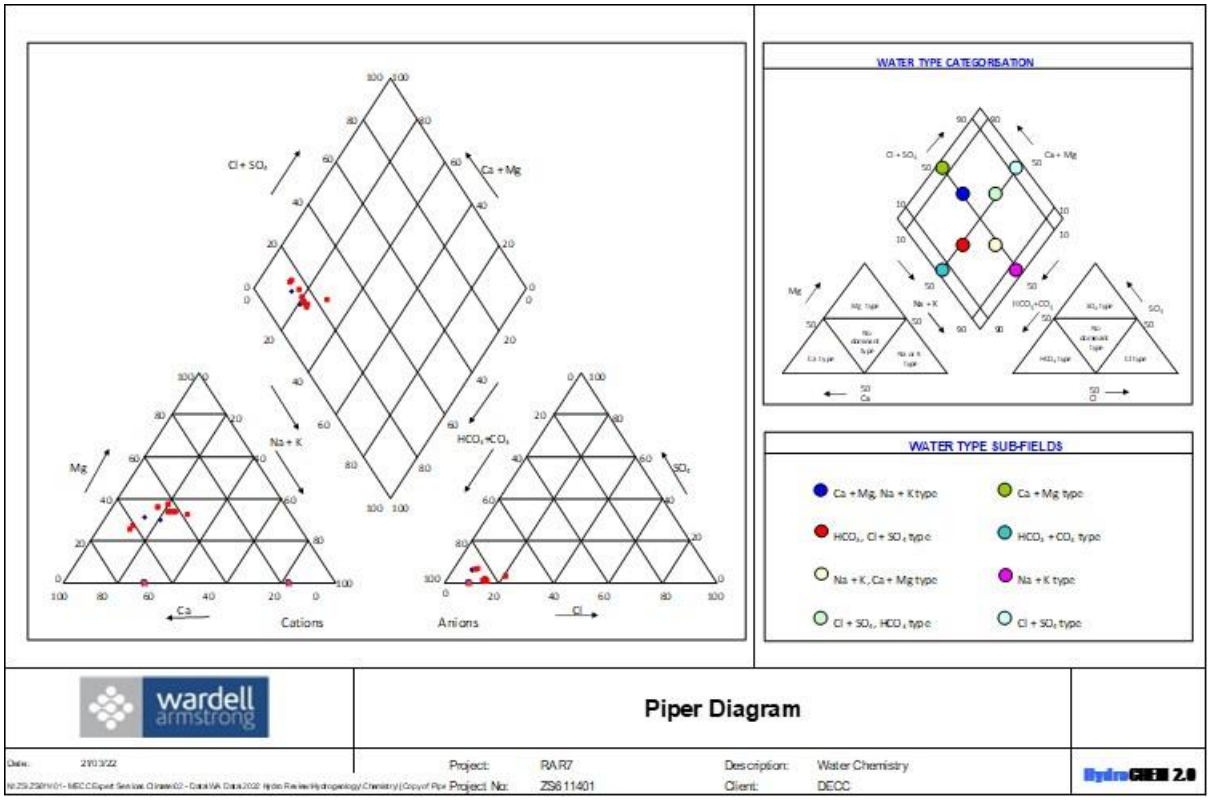


Figure 6.9: Piper Plot of Available Water Quality Results from the TRDEX Tunnel Groundwater Inflows

6.2.6 Hydrology

The River Boyne is the most significant surface water feature in the area, occurring approximately 4km to the SSE of the RAR7 site, draining to the North-East. Hourly discharge and stage data for the River Boyne for 2021 was reviewed, along with a histogram showing daily precipitation. There was no clear response observed in river discharge or stage data over the period of the inrush event.

Figure 6.10 presents the River Boyne discharge and stage alongside daily rainfall throughout 2021 and Figure 6.11 presents the discharge and stage of the River Boyne with precipitation records during November and December 2021.

Flow rates in the rivers started to rise slightly ahead of the plugging due to increased rainfall and no clear signal of drawdown or recovery associated with the inrush is discernible.

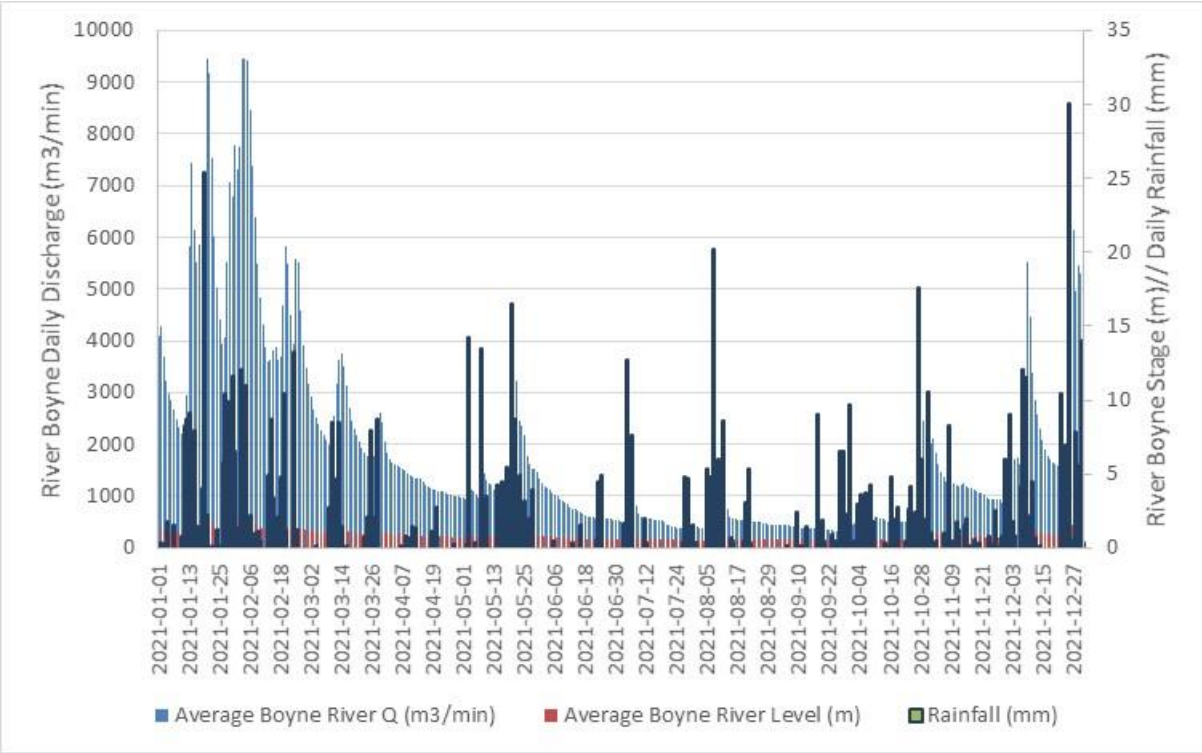


Figure 6.10: River Boyne Discharge and Stage Alongside Daily Rainfall, Jan-Dec 2021

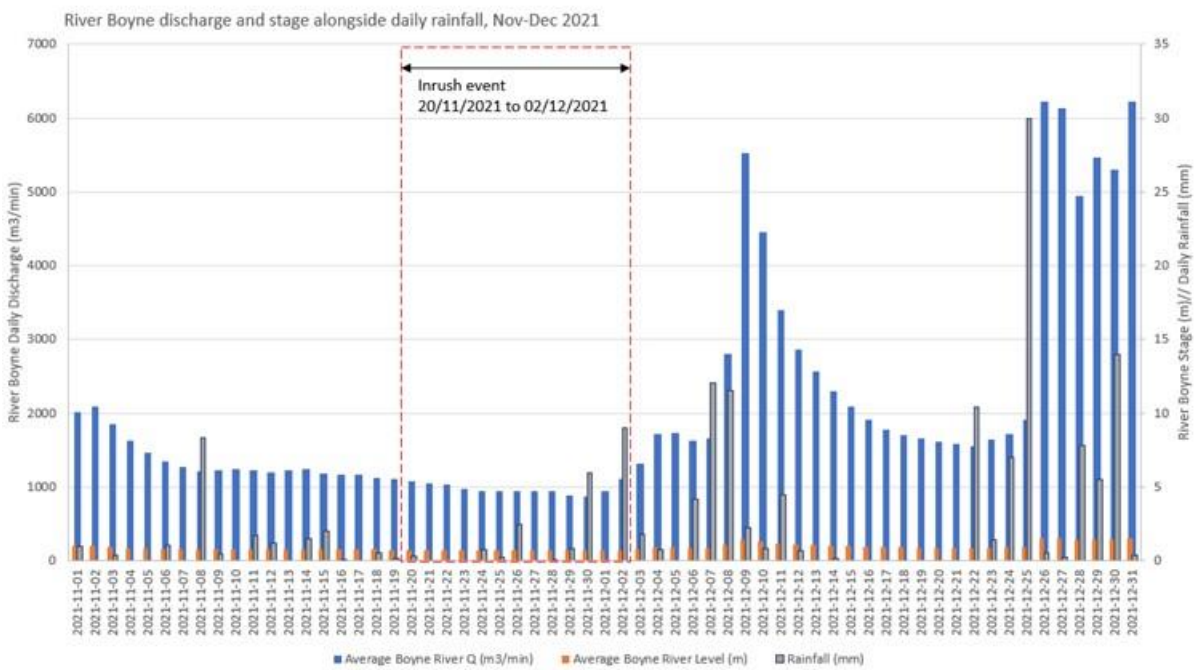


Figure 6.11: River Boyne Discharge and Stage with the Context of Precipitation During November and December 2021.

7 Updated Interpretation

7.1 Hydrogeological Model

The earlier hydrogeological model which was used to support the planning application for the RAR7 development did not anticipate the magnitude of the inrush event that occurred in November 2021. Earlier work had identified a need for pre-grouting intervention of the RAR (refer to Section 6.1.1) and it is understood this was undertaken in the 248.5 – 249mbgl zone but not in the 453.7 m zone or elsewhere. Spinner tests indicate positive inflows and outflows between 360m and 460m accounting for over 70% of the total flow. No fluid movement was recorded below 610m.

The S and Gainstown faults, in close proximity to the TRDEX and RAR7 infrastructure created a paleo-historic structure that has resulted in a significantly thickened UDL sequence. A series of faults have together created a series of terraces and at one time there was a significant extensional stress regime in the area north and east of the TRDEX. Evidence suggests this would have underwent later compression and tightening. A more recent extensional event is not thought by Boliden's geological team to have influenced the mine area. The sequence of UDL contains jointing, fractures, discontinuities (cavities and fissures) and, at depth, a set of fault splays emanating from the foot wall of the S fault. The upper 400m of the UDL has a 'poor' rock quality (RQD <70%, often less than 50%). The next 400m depth of UDL still contains an appreciable number of poor RQD results, many of which are attributable to weak materials such as friable shales.

The development of cavities, as indicated by the losses of drill fluid circulation and the substantial grouting interventions indicate a system of apertures connected over considerable distances (hundreds of metres) as also evidenced by inter-well responses. The degree to which the system has actively circulating groundwater is unknown but the inrush event was able to sustain substantial flows (nearly 52,800m^3/day, or nearly 53 megalitres a day) seemingly without sign of abatement.

The cavity features encountered during pilot drilling of Borehole N02481, at 248.5 m could not be completely plugged despite nearly 50 tonnes of cement used implying an open zone with enhanced transmissivity. The RAR pilot hole had further grouting injection and interventions and it is highly uncertain how effective this was. Once the drill-string passed through this zone and rods and drilling muds were set against the cavity, it would normally be assumed that inflows and losses would have subsided for the remaining duration of drilling. However this does not seem to be the case from the RAR drilling record.

Given a hard-rock, limestone fractured aquifer with shale inter-bedding it is extremely unlikely that there would have been pervasive interconnection and transmissivity all the way to full RAR depth (~1000m). However, the record from RQDs, recorded inflows, spinner tests, inter-well responses, the severe ground conditions at N02413 and VWP data indicate that within the UDL, which mainly transmits flow by discrete lateral fractures there must also be vertical and horizontal connectivity over hundreds of metres. This groundwater bearing zone (or aquifer given the high inrush flow rates observed) appears to have 'transmissive' properties to a depth in the order of >600m in some areas.

Below which the UDL would appear to become less transmissive, although still capable of permitting substantial groundwater flow at depths of 800-900m, as evidenced by sustained inflows into the TRDEX. The inflows into the TRDEX were at maximum about an order of magnitude smaller (up to 5000m^3/day) than the inrush inflows (c. 52,000m^3/day). Both the TRDEX and RAR inflows occurred post-groundwater control interventions and could potentially have been higher, if not mitigated.

The TRDEX inflows were sustained at an average of 2300m^3/day and showed no sign of depletion during the TRDEX development. The timing of maximum inflows into the TRDEX corresponded to a dry summer period, when no recharge would have been available to shallow, superficial aquifers. In June 2021 when the highest TRDEX flows occurred it was at the same time as some residents explicitly noted their wells drying. The specific cause of this cannot be determined with certainty because the data records/ monitoring is not exact enough to confirm. However, over a sustained period of time, without recharge, groundwater removal from the TRDEX would have lowered groundwater levels. Typically boulder clay / alluvial shallow aquifer would be decoupled from the deeper UDL hydrogeology. In this setting however, as evidenced from the inrush several kilometres distant at the RAR site which had a demonstrable effect on monitoring and community wells at Shambo and Robinstown it must be concluded that some form of connection is present between deep and shallow groundwater systems.

The drawdown pattern in response to the inrush event is difficult to interpret fully with the current monitoring network and array of observations, some piezometric deflection is observed in the area north and east of the TRDEX tunnel, other monitoring wells located further south, near Robinstown also show response to the inflow event. The E-W trending major faults such as the Navan fault do not appear to be compartmenting the upper superficial units, instead it is likely that connection is occurring across the majority of the aquifer blocks in the UDL. The VWP information also suggests there is a widely connected fracture network at both deep and shallow elevations that responds almost immediately to a dewatering condition such as the inrush event, moreover the water pressures in the VWPS also rebounded almost simultaneously when the RAR7 was plugged. Elsewhere other monitoring wells show a delayed response which is unlikely to be simply aquifer depressurisation and lithostatic relaxation but instead indicates drainable porosity effects.

The sensors within the VWPs (N02176, N02473, N02495) show similar depressurisation in both deep and intermediate zones due to the inrush. At other times, some VWPs show separate hydraulic zonation whilst other VWPs show paired response. Both the inrush drawdown and recovery response is very clearly represented in the three VWP boreholes at multiple levels. This indicates that the inflow immediately dewatered transmissive zones, that depressurisation occurred across virtually the whole UDL thickness and drainable porosity effects followed thereafter as the system equilibrated to a new boundary condition (the draining RAR). The sustainment of flow for nearly two weeks strongly implies that the fracture system is connected across multiple vertical levels.

Hydrochemical results are inconclusive. Hydrological data and in particular signal data for stream flows in the River Boyne is inconclusive.

The resultant hydrogeological model from these observations is presented graphically in Figure 7.1 and has the following key features.

- A system of well-connected, transmissive fractures extends through the UDL to more than 400m depth at the Tara Deep location, which tapers down in transmissivity below this depth but is still hydrogeologically active and capable of sustaining flows (TRDEX inflows). The anomalously transmissive hydraulic properties (compared to Tara Navan mine) may be related to structural controls resulting in a more 'open' stress system. Earlier interpretations from geophysics suggested a substantial number of fault splays and discontinuities but Boliden claim later drilling and re-interprepation of geophysics has not proved this;
- The system is recharged from surface infiltration permeating the shallow till, alluvial units and the weathered rockhead. Recharging groundwater travels through fractures and fissures to at least 400m depth. The aquifer is not homogenous or isotropic, large variations may be present at relatively short distance and there are undoubtedly zonally isolated horizontal units locally confined by intervening shales. However interconnection has been proven at a larger scale than hitherto anticipated and providing continuity of flow. The degree of vertical connection in the UDL at depths below 400-600m is likely to become increasingly sparse.
- Cross completion of former exploration boreholes may potentially be exacerbating hydraulic connection through the UDL. The number of open, cross-completed or leaking exploration boreholes is outside of the scope of this study.

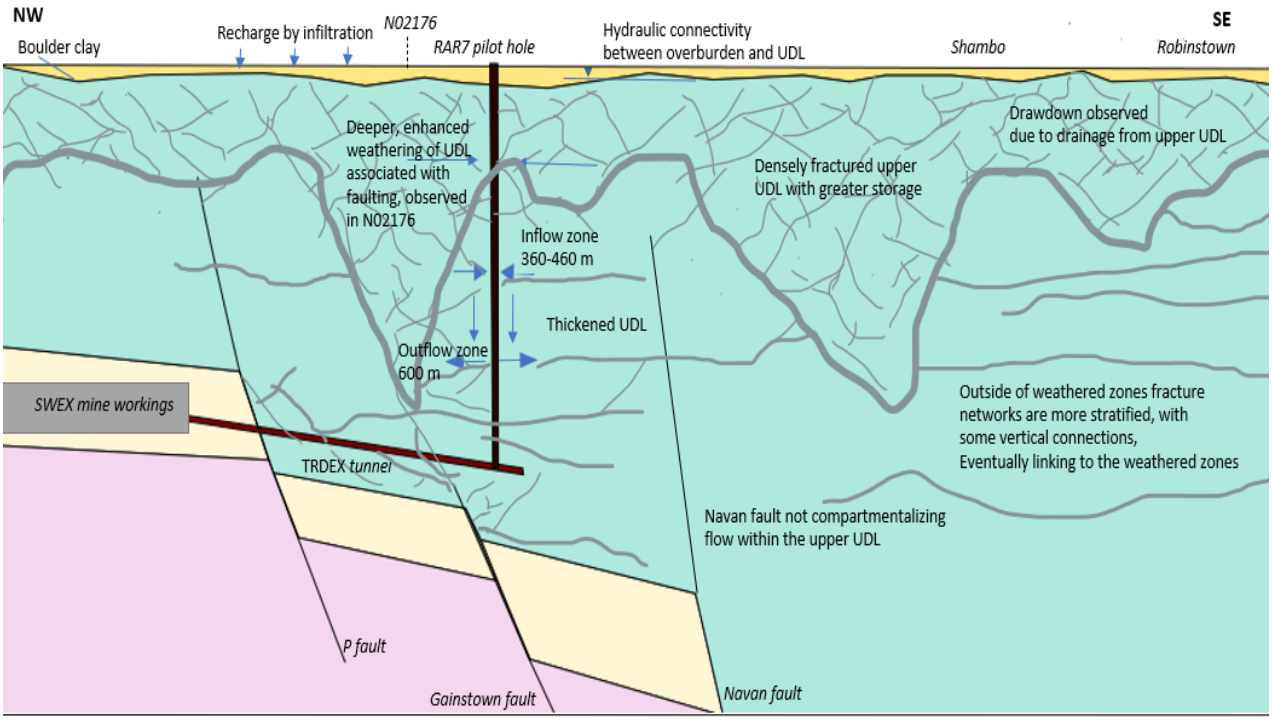


Figure 7.1: Schematic Diagram of Updated Conceptual Site Model

7.2 Cause of the Inrush

The RAR7 pilot hole was drilled through a near 1000m thick UDL zone with enhanced transmissivity likely extending to at least 600m depth. Open and transmissive cavities which had been encountered in pilot drilling at 248.5m depth were partially addressed by pre-grouting (radial grout curtain injections) from 215m to 281m depth. The RAR7 drill string also encountered deeper cavities and fracture zones in the weathered UDL such as at 453.7 mbgl which were not mitigated. At least a 300m lateral hydraulic connection between fractures was present as indicated by connection between boreholes N02481 and N02176.

Non-grouted drill holes can be a source of localised inrush and cross-connection and Boliden has commented that there are old non-grouted exploration drill holes influencing the hydrogeology of SWEX and Tara deep. No data however was provided on this so this information is noted but cannot be brought into the conceptualisation. The effectiveness of the grout curtain applied between 215m to 281m is uncertain in sealing the 248.5m open zone and another water loss encountered at a depth of 266m. Boliden reported no water loss at greater depths, for example the 453.7m zone but the RAR driller's log shows a large range of poor ground conditions and loss of fluids at both shallower and deeper depths.

Water was reported cascading into the borehole from fissures above the rest water level during the spinner test on the 2nd of December 2021 which at this time, when the RAR7 had been plugged was 60m bgl. There is a likelihood that the inflow of 2200m^3/hour at the height of the inrush event was an accumulation of inflows from multiple horizons that became larger as the inrush went on because the connected fracture network became progressively 'developed', in other words increasingly flushed and more efficient.

The pilot hole breaking through into the tunnel at 991m enabled an initial release of 300m^3/hour from most likely the 375-454m zone (based on a combination of downhole log results, driller's remarks and un-grouted sections). Boliden contend that the main flow was from the 278.5m cavity that had purportedly been grouted but may not have been properly sealed. This cannot be verified with the data provided. A significant component of inflow is likely to have come from the upper zone of the hole as only the upper 10m was cased off. When drill rods were removed, this started to create a wash-out of infilled fractures, and over a 60bar pressure differential, the flow increased and the system started to behave as a large groundwater sink. Groundwater was drained from the fracture network in the UDL and, after the drainage zone expanded, from intergranular storage in the upper superficial unit.

7.3 Analysis of Radius of Influence

The hydraulic response to the inrush event has been analysed according to conventional pumping test behaviour. This has been done for drawdown data collected from the mid-level VWP (N02176) and recovery data when the RAR 7 raise bore was plugged (see Figure 7.3 and Figure 7.4).

The inflows occurring during the inrush event appear as two steps - refer to Figure 7.2 that relate to i) the initial breakthrough on the 20th November, and ii) the removal of the well-bore drill string on the 23rd of November which released much more water. Having two steps or stages in outflow is not ideal for pumping test analysis as there is not a continuous outflow rate. Slightly better data analysis is achievable with the recovery stage when the raise bore was plugged on December 1st.

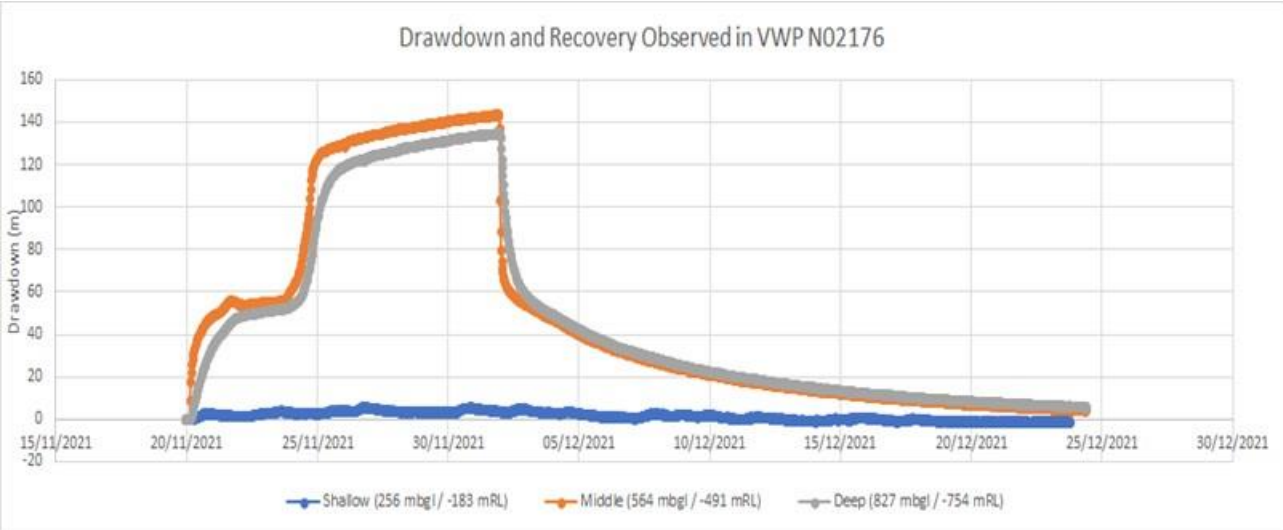
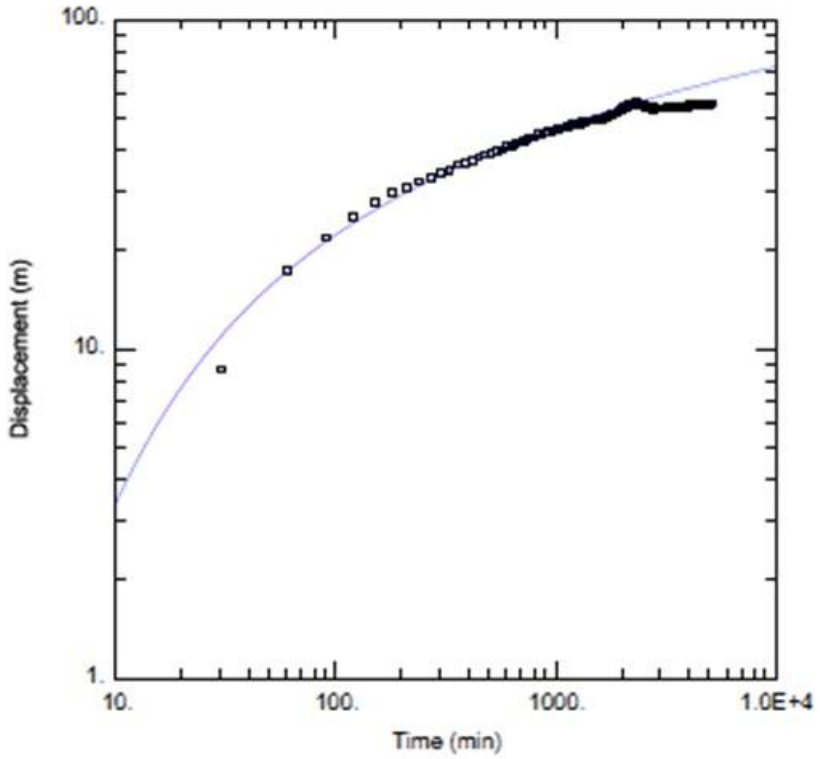


Figure 7.2: Drawdown and Recovery in VWP N02176

Selected pumping test analysis plots for a) the drawdown stage and b) the recovery stage are presented below.



WELL TEST ANALYSIS

Data Set: N:\...\N02176 Mid VWP DD Stage 1.aqt
Date: 03/22/22 Time: 11:41:30

PROJECT INFORMATION

Company: Wardell Armstrong
Client: DECC
Project: ZS611401
Location: Tara Boliden
Test Well: Inrush analysis
Test Date: 20.11.2021

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	0	0

Observation Wells

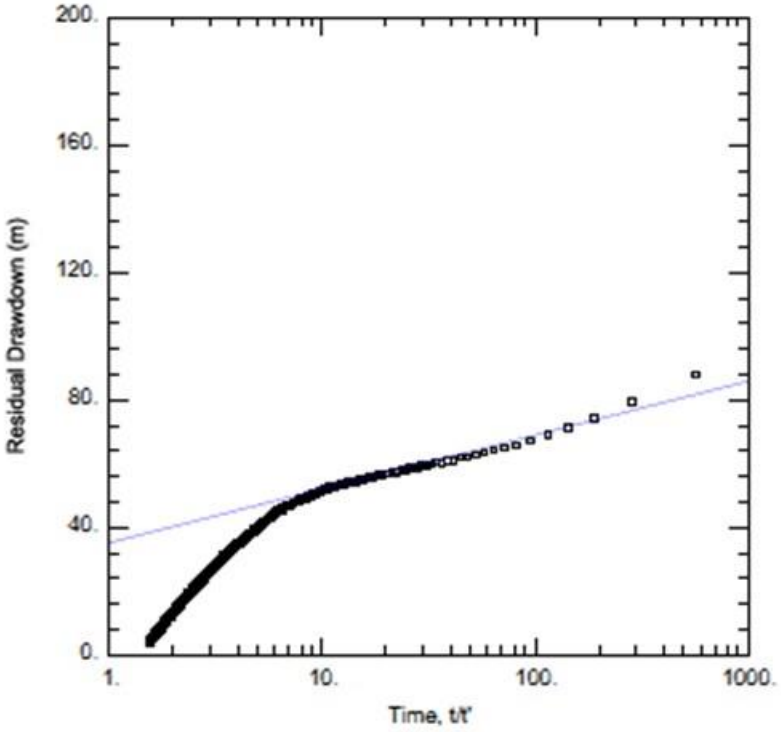
Well Name	X (m)	Y (m)
▫ N02176 Mid	212	212

SOLUTION

Aquifer Model: Confined
T = 383.5 m^2/day
Kz/Kr = 1.

Solution Method: Theis
S = 9.439E-5
b = 1000. m

Figure 7.3: Pumping Test Analysis Plots for the Drawdown Stage from N02176 Intermediate VWP



WELL TEST ANALYSIS

Data Set: N:\...\N02176 Mid VWP Residual Stage4.aqt
Date: 03/22/22 Time: 12:36:49

PROJECT INFORMATION

Company: Wardell Armstrong
Client: DECC
Project: ZS611401
Location: Tara Boliden
Test Well: Inrush analysis
Test Date: 20.11.2021

AQUIFER DATA

Saturated Thickness: 1000. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
New Well	0	0

Observation Wells

Well Name	X (m)	Y (m)
▫ N02176 Mid	212	212

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)
T = 573.5 m^2/day S/S' = 0.008178

Figure 7.4: Pumping Test Analysis Plots for the Recovery Stage from N02176 Intermediate VWP

Because the recovery stage is unaffected by the two step outflow rates, this analysis is considered slightly more reliable, and the resultant T value of 573m^2/d is taken as the best estimate for aquifer transmissivity. The storativity value (S) of 9.44 E^{-05} derived from the drawdown stage seems reasonable for the UDL aquifer.

Applying these values into a forward predictive model using Jacob-Cooper analysis enables a simple analytical calculation of the possible (idealised) extent and drawdown from the inrush event at far-field locations. Similar analysis can be undertaken for the TRDEX inflows experienced during 2020 to 2021. This analysis is highly simplified and assumes an isotropic aquifer material (has equal properties in all directions), which is not fully represenattive for the situation at Tara but nonetheless provides a basis for analysis. Despite the analytical shortcomings, the analysis is useful and valid to give general conclusions. The predictive analysis assumes the aquifer material is porous and has the same properties in all direction which is clearly different from the fracture model. However, when viewing groundwater behaviour at a scale of several kilometres and using bulk terms such as overall transmissivity, the predictive analysis describes what an idealised, homogenous system would behave like and this is what is used at this stage of interpretation.

The following parameters have been used to model drawdown at Robinstown.

Table 7.1: Hydrogeological Parameters

Q Inflow rates		T Transmissivity	R Radial Distance	S Storage Coefficient
m^3/d		m^2/d	m	-
Inrush (measured from RAR7)	52,800	573	3700	0.0000944
TRDEX tunnelling (measured from Tunnel midpoint)	2300	573	4810	0.0000944

Drawdowns at Robinstown using these parameters have been predicted using Jacob-Cooper analysis and then compared against actual drawdown values recorded.

Inrush event November to December 2021

Predicted drawdown (m) at Robinstown	Actual Drawdown (m) at Robinstown	Notes
19.8	20.74	The 20.74m drawdown was recorded in TD-MW8. An average drawdown from the 17 DW and MW wells was 4.7m. Predictions and actual results are based on 15 days of drawdown.

TRDEX inflows June 2021		
Predicted drawdown (m) at Robinstown	Actual Drawdown (m) at Robinstown	Notes
1.72	2.2 – 2.5	The 2.2-2.5m drawdown was noted to occur in June 2021 at several locations in the community well survey. The general finding is also corroborated by a sub-set of the approximately 27 community well owners who reported drying in their shallow wells.

The analysis suggests that at the average inflow rates and the average distance from the mid-point of the TRDEX tunnel, a drawdown of approximately 1.7m could have been experienced at Robinstown during the TRDEX tunnelling period. A seperate analysis indicates that for the 15-day period of the inrush event at RAR7 when a much greater inflow was occurring, a drawdown of nearly 20m could have occurred at Robinstown. These values are indicative only as transmissivity and many of the other aquifer parameters and connections are variable.

The actual drawdowns recorded at Robinstown and other monitoring points are in a similar order of magnitude to the predictions. The actual water levels in the summer of 2021 and at the time of the inrush event in the affected community wells have not been recorded. Therefore, the contribution to drawdown occurring from natural factors such as the dry, non-recharging seasonal conditions versus the effect from the Tara mine cannot be distinguished with the data available. However, on the basis of the timing of observed drawdowns, the groundwater theoretical response and other lines of evidence it does seem plausible that a component, probably not more than 50% of the drawdown effect in 2021 was being caused by water losses in the TRDEX. The observed water level differential (the water level difference relative to available pre-inrush levels) are presented in Figure 7.5 and Figure 7.6.

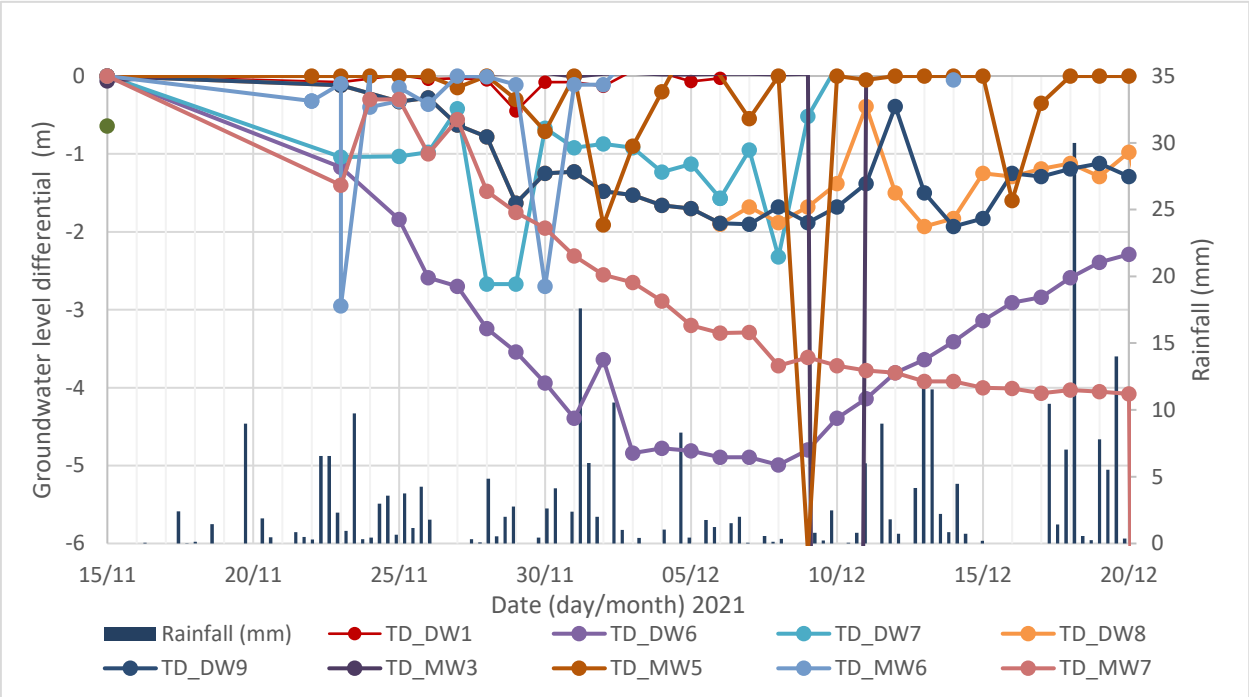


Figure 7.5: Tara Deep Groundwater Level Differentials for MW2, MW3, MW5, MW6, MW7, DW1, DW6, DW7, DW8, DW9 During Inrush Event (20/11/21- 02/12/21).

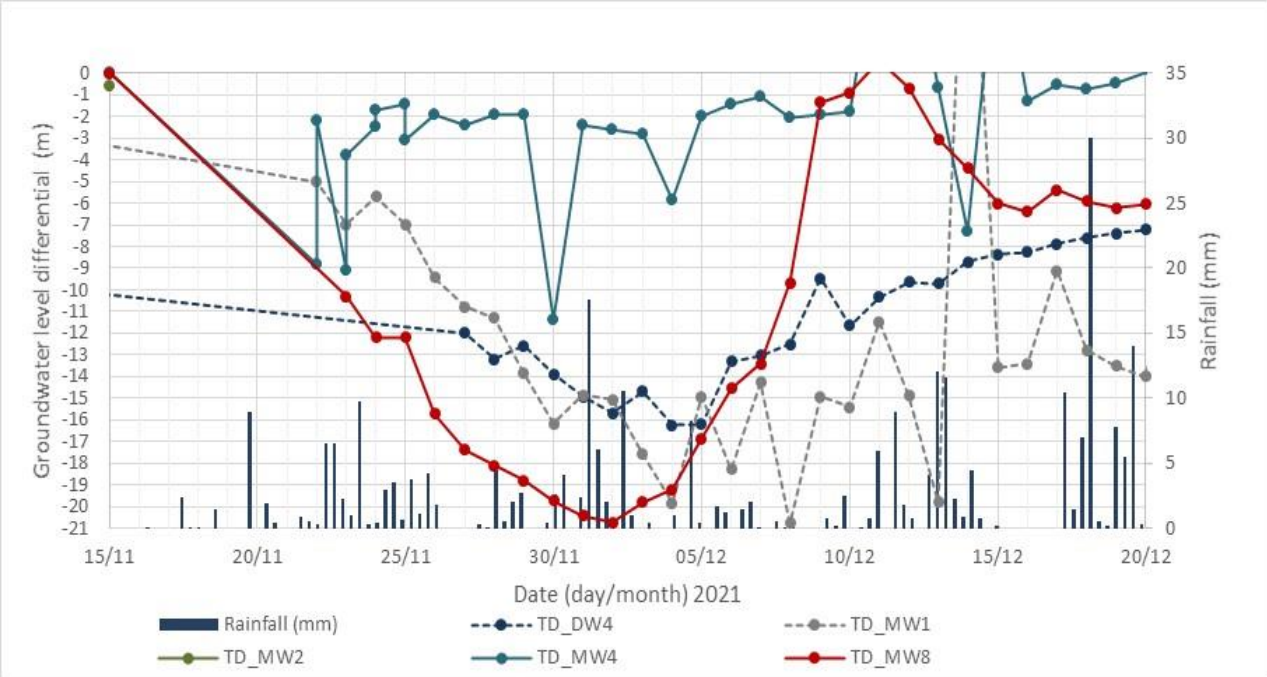


Figure 7.6: Tara Deep Groundwater Level Differentials for MW1, MW2, MW4, MW8, DW4 During Inrush Event (20/11/21- 02/12/21).

7.4 Interaction with Robinstown / Shambo Wells

Several aspects of the current hydrogeological model tend to give more plausibility than previously thought to Tara Deep interacting with groundwater resources in the Robinstown / Shambo area - several kilometres distant. This includes the identification that the east-west faults are not effectively compartmenting the UDL aquifer as previously thought. The VWP responses also show how the UDL pressure responses can be broadly similar at different elevations in some wells. The November 2021 inrush event had a discernible effect on monitoring wells in Shambo / Robinstown.

The first complaint the Council received about wells going dry was on the 1st of July 2021 but the fact that there were 16 well grant applications received from the Robinstown/Shambo area between June 2020 & Sept 2021 suggests the problem was ongoing for a while before then. Well grant applications are made by households that are seeking support to improve their water source. The EPA received a first complaint on 25/06/2021. Reports were made from well owners (Meath Council Consultants Report, 2022) that the 'drying out' of wells had been gradual and continuous for some time (at least 21 months). Some well owners identified that drying had happened in the past during dry summers also. However there appears to be a more concentrated effect in the 2020 -2021 period than before. Wells in the area of interest are thought to have began to go dry in March 2020, significantly earlier than the first reports that emerged from the area, and continued to happen up to and into December 2021.

A correlation with TRDEX tunnelling is noted in that inflowing drainage into the TRDEX was reported from October 2019 albeit at initially low rates. However, into 2020 there was a series of progressively increasing step change in inflow rates as described in Section 4.3.3. This culminated in the highest inflows in June 2021 when many residents began reporting reduction in their well water levels.

Predictive work as described above based on simplified analytical models using aquifer parameters derived from the VWP responses to the inrush event show that the inflow rates recorded at the TRDEX development as well as the RAR7 inrush, would have theoretically caused noticeable effects to be experienced at Robinstown / Shambo:

1. A predicted drawdown of 1.7m in the UDL during June 2021 due to TRDEX tunnelling inflows.
2. A predicted drawdown of 19.8m in the UDL during November 2021 due to the inrush event with monitoring verifying that drawdowns actually experienced were of a similar order of magnitude.

The 1.7m drawdown occurring over the 2020-2021 period would have not necessarily been noticeable during wet and recharging periods but could have become a noticeable feature during drier periods with no recharge. Furthermore, the community record of affected wells (Section 6.2.3.) indicates that of the residents who attributed drying of their wells to Tara's activities, approximately 70% had shallow wells in the order of between 3-7m deep which would clearly be more vulnerable to drying than deep wells and could have been affected by a drawdown in the 1.7m range in the underlying UDL creating an underdrainage effect on the upper Tills and alluvium.

The severity of impact to local community wells has become a significantly contentious issue with local residents forming their own action group with committee representatives (*Shambo and District Water Action Group*). Viewpoints from the resident's action group were requested to be included in this report and a meeting was held via a video link on the 05th May 2022 between the report authors, GSRO and representatives from the group. Some of the most significant observations voiced by the action group and the chronology between well drawdown and Tara activities had already, independently been identified by the data analysis in this report. The action group requested the following ten points be noted (included *verbatim*):

1. Rock break that registered with seismology office on Mother's Day last year (14th March 2021), this led to a number of miners requiring medical attention.
2. Well's starting to go dry within 1 week of this,
3. Major flood of mine in November due to drilling through underground lake.
4. Wells continuing to go dry in December, unheard of events.
5. Detail in the report on the volume of water that flooded into the mine and was extracted from the water table...I estimate 1 million litres an hour, 24 million litres a day and somewhere between 0.5 - 1 billion litres over the event.....this needs to be in the report.
6. My new well dropping 40-50 feet during the flood and going dry and slowly recovering once the hole was plugged, took 12 weeks, showing direct correlation to Tara deep activity and impact on aquafers feeding Shambo / Robinstown.
7. Shallow wells now not recharging.
8. All water gone from dykes and ditches and streams in Shambo.
9. No similar issues being seen in neighbouring townslands and parishes.
10. New wells having to be drilled down to 400 ft, when water was always available in the past at 30 feet or once rock was hit at 75 feet.

In addition, the following data was also provided by the action group:

11. A new well was drilled (DW6) by a resident, at their own expense in June 2021, because their existing well had gone dry. The new well was drilled into the rock at 36m, with a pump at 25m. The water initially was 9 metres from the top of the well and was delivering at 200 gallons an hour.
12. Following the inrush event in November 2021, the new well water level dropped and proceeded to drop to 26 metres and temporarily went dry as the water level dropped below the submersible pump.

13. Once Tara mines plugged the hole the well started to recover and has recovered at a rate of 40cms a week, and is now at 14.6 metres from the top, still 5m lower than before the inrush event. The owner considers the well is unlikely to recover to where it was before the 'aquifer damage'.
14. On the call, it was made clear that drying of wells across a large cross-section of residents became noticeably apparent from May 2021 onwards, although some residents experienced effects earlier.
15. The pronounced effect observed on resident's wells in 2020-2021 was hitherto not seen in previous years and therefore regarded as a new condition. Also, it was commented that the effect was localised to the Shambo, Robinstown area with virtually no effect elsewhere suggesting some geological control or structure creating a north-south linkage.
16. The timing of an onset of complaints corresponds with the period in which greater inflows were recorded from the TRDEX tunnelling at 4944m^3/day (206m^3/hour). The timing of the second observed effect corresponds with the inrush with wells completely drying (and slowly recovering after the RAR was plugged).

A hydrogeological association with the rock-burst of the 14th of March 2021 cannot be made. The documentation associated with the rock-burst at the '1830' stope within the SWEX mine (including geotechnical report, an independent verification and photo and monitoring records) do not indicate any groundwater interaction and a dry-condition – no water was released, and it is therefore considered a geo-mechanical stress event: spalling i.e. sudden disintegration of rock under strain.

In conclusion, because some of the correlations and chronologies match, which were independently identified before data from the Shambo Action Group was made available, there are reasons to believe that a direct effect and impact has been experienced.

7.5 Monitoring

The hydrogeological monitoring being undertaken is assessed below:

7.5.1 Groundwater inflow rate measurements and timing

It is recommended that weekly spot measurements of inflows at locations (currently numbering 53) within the existing mine workings and the TRDEX tunnel continue to be reported on a weekly basis. Additionally inflows from surface/probe holes and 'minor inflows' should also be accounted for on a weekly basis. Figure 7.7 presents the locations of these inflow measurements to the underground mine workings. The key observations of the groundwater inflows are discussed in Section 4.3.3. The observations have proved useful in determining net changes in inflow in different zones and the magnitude of inflows which could have been significant enough to cause effect on water levels at the order of magnitude observed in Robinstown and Shambo areas.

Weekly groundwater inflow measurements will continue to provide useful contextual information to review alongside the VWP and water levels in the vicinity of Tara Deep.

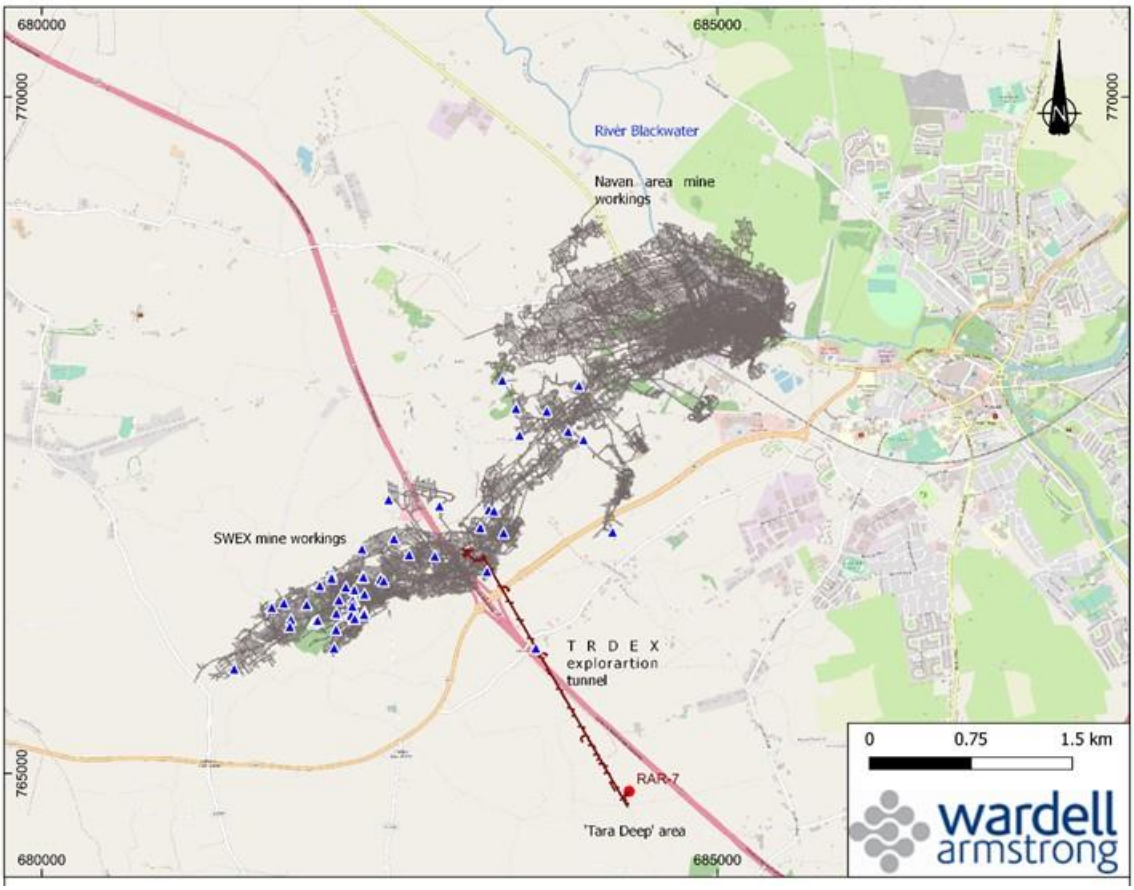


Figure 7.7: Location of Underground Mine Water Inflows.

7.5.2 Vibrating Wire Piezometers (VWPs)

The VWPs installed in four boreholes (as discussed in Section 6.2.4) have been key to determining the hydraulic continuum in the UDL unit. For example, the VWP in N02592, installed at 64 mbgl, c. 700m to the west of RAR7 showed a clear response to the inrush event.

VWP data is complex, some of the data shows that in some areas there is zonal isolation and the UDL aquifer is complex. The VWP data shows that the inflows to the TRDEX tunnel and other pressure changing effects (loss of drilling fluids) often affected both equally shallow, intermediate and deep instruments. N02176 is the only borehole of the four with VWP installations that shows a diverging pressure response at different elevations.

It is recommended the monitoring of the VWP data is continued on the current set and that further VWPS are installed in areas to monitor future underground mine workings. Monitoring needs to address the North-south bias of the current array by installing more wells in east and west locations. Monitoring wells need to be placed so as to directly overlie the footprint of the mine workings as well as offset wells that are spaced in concentric radii recommended at 500, 1000 and 1500m to evaluate the effect of dewatering.

7.5.3 Community monitoring wells

The community monitoring network (Section 6.2.2) has been operated until recently as daily measurements from eight dedicated monitoring points (TD_MW01 to TD_MW08) and nine selected domestic wells (TD_DW01 to TD_DW09) within the Tara Deep area. Monitoring has occurred since the in-rush event on a daily basis, dropping back to weekly monitoring in April 2022. The monitoring has confirmed there is hydraulic connectivity across the Navan fault.

A further 52 monitoring boreholes are monitored on a monthly basis in the vicinity of the SWEX and Navan mine working areas. These are presented in Appendix E. Two surveys on community wells in the vicinity of Tara Deep have been undertaken by; 1) Meath County Council's Consultants reported on 70 community wells and 2) a wider census by Boliden Tara Mines with 565 entries. Figure 7.8 presents the community wells surveyed by Boliden Tara Mines, indicating the depth of the wells. The water supplies that are more vulnerable to a reduction in groundwater level are the shallowest boreholes (red dots).

Boliden has upgraded their community monitoring programme with the installation of eleven automated data loggers to obtain high temporal resolution water level data on a long-term basis. This will be useful to review alongside rainfall and groundwater inflow data to better understand potential impacts of the Tara Deep underground infrastructure on community wells and develop a recharge model when enough data has been collected (at least one full years worth).

Additionally, the drilling of six nested piezometers, comprising one shallower (c. 5-20 m) and one deeper (c. 60-100m) piezometer, are planned within the area to the east of the RAR7 site, as outlined within the boxes in Figure 7.9. This will be useful to confirm the vertical hydraulic connectivity, and therefore degree of vulnerability of community boreholes within this area. It is understood planning permission is still to be obtained to complete these installations. These boreholes will be installed with pressure transducers to monitor water levels on a daily basis[25] .

[25] Tara Deep: Hydrogeology Monitoring Plan, Piteau Associates, December 2021

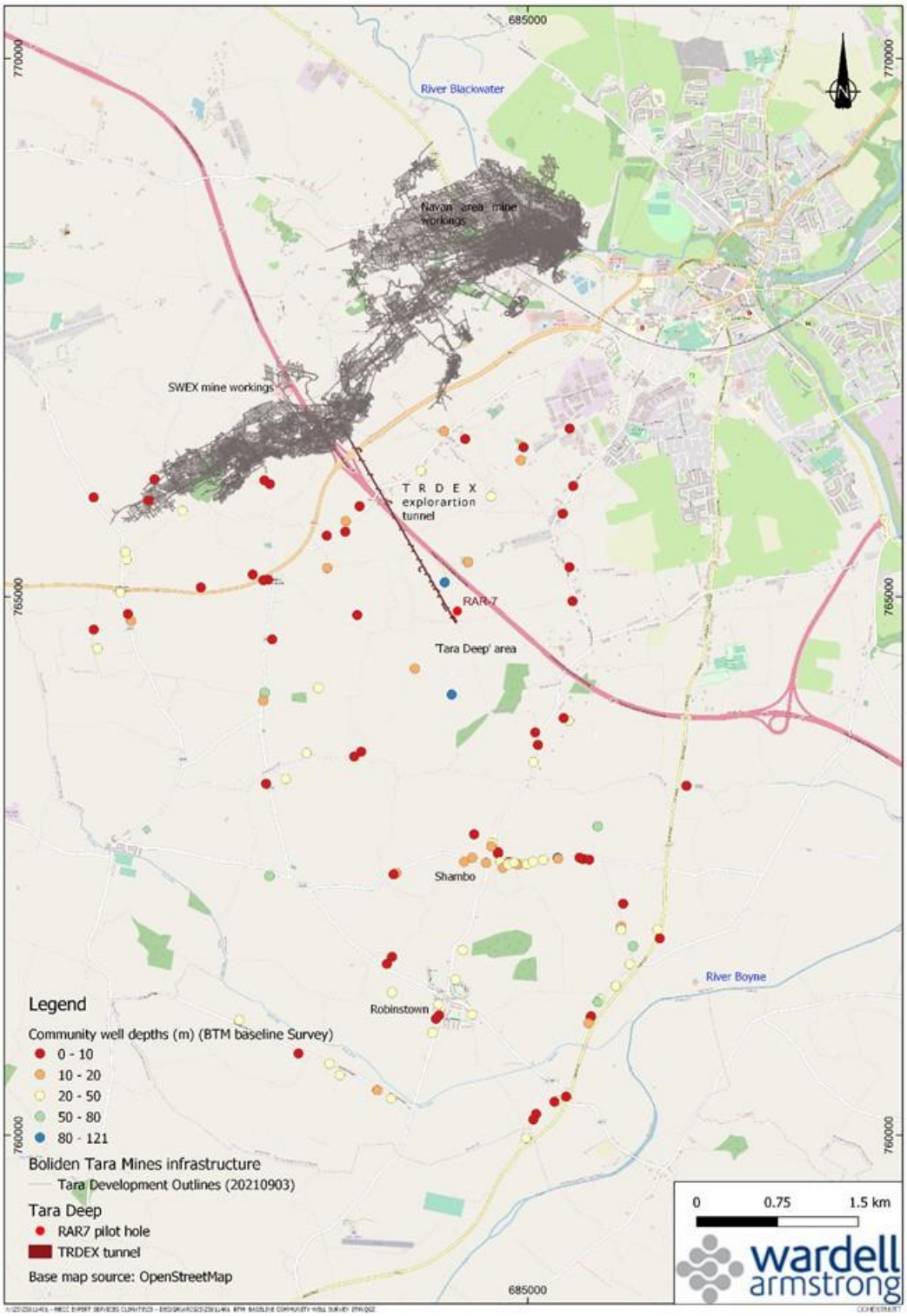


Figure 7.8: Locations and Depths of Community Wells Surveyed by Boliden Tara Mines.

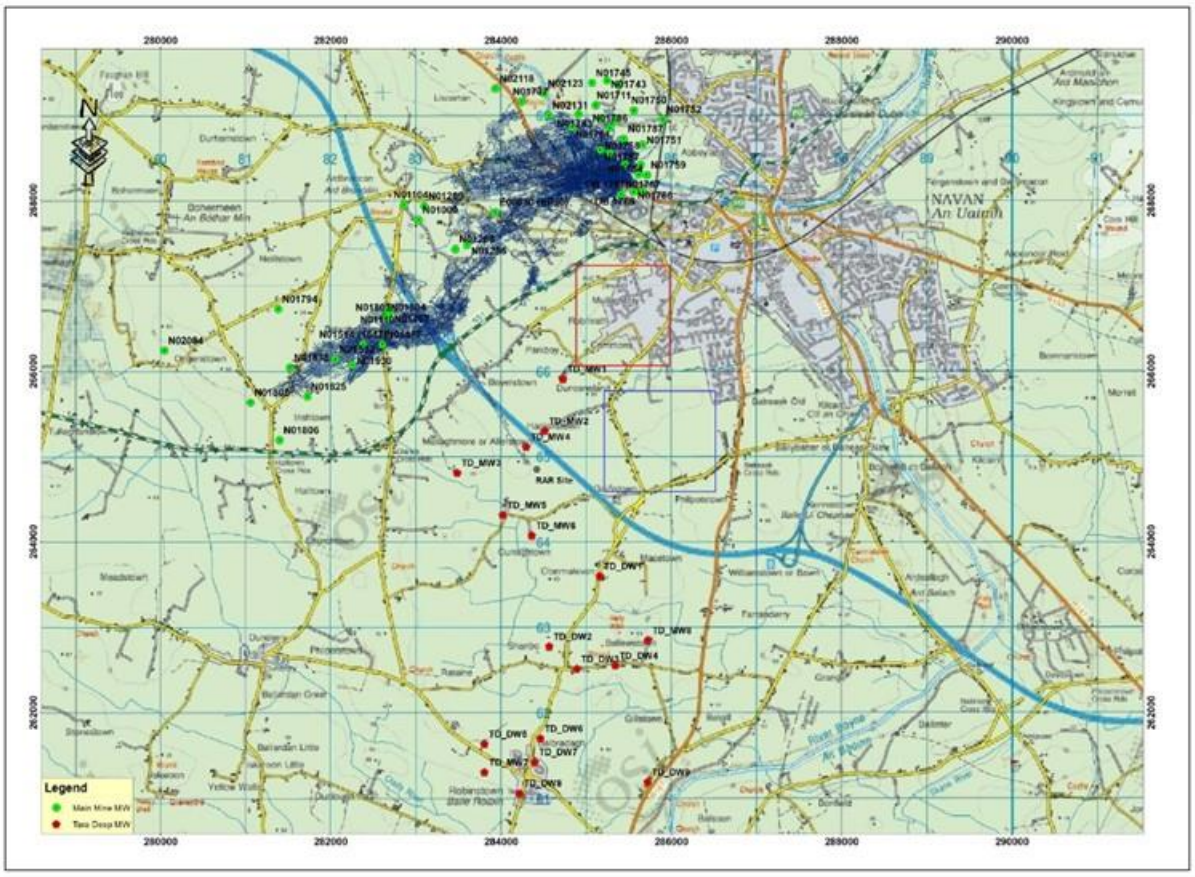


Figure 7.9: Location of Planned Nested Piezometers to the East (blue box) and North- East (red box) Source: Tara Deep: Hydrogeology Monitoring Plan, Piteau, December 2021).

7.5.4 Rainfall and River Boyne measurements

There are no key surface water features in the immediate vicinity of Tara Deep. The River Boyne discharge and level data was reviewed (Section 6.2.6) and concluded that there was no obvious impact to/from surface water observed during the in-rush event. However, in discussions with the Shambo action group there was a viewpoint expressed that overall drainage lines and surface water at sites in the area have been subject to more 'drying' than usual. This cannot be confirmed but does warrant further monitoring and analysis, particularly given the shallow well systems and connection between the Tara Deep UDL dewatering with Superficial units is now being considered plausible / likely.

Daily rainfall for 1970 to 2021 was reviewed (Figure 7.10). This indicated 2020 was a slightly wetter year (+15 mm) and 2021 was a drier year (-126 mm) relative to the long-term average of 860 mm/ year. Reduced rainfall, and in turn reduced recharge increases the vulnerability of water suppliers from shallow boreholes. This could be a contributing factor to the reductions in groundwater levels in community wells in Robinstown and Shambo areas. The preceding rainfall conditions have been carefully considered in this review and carefully qualified statements made accordingly.

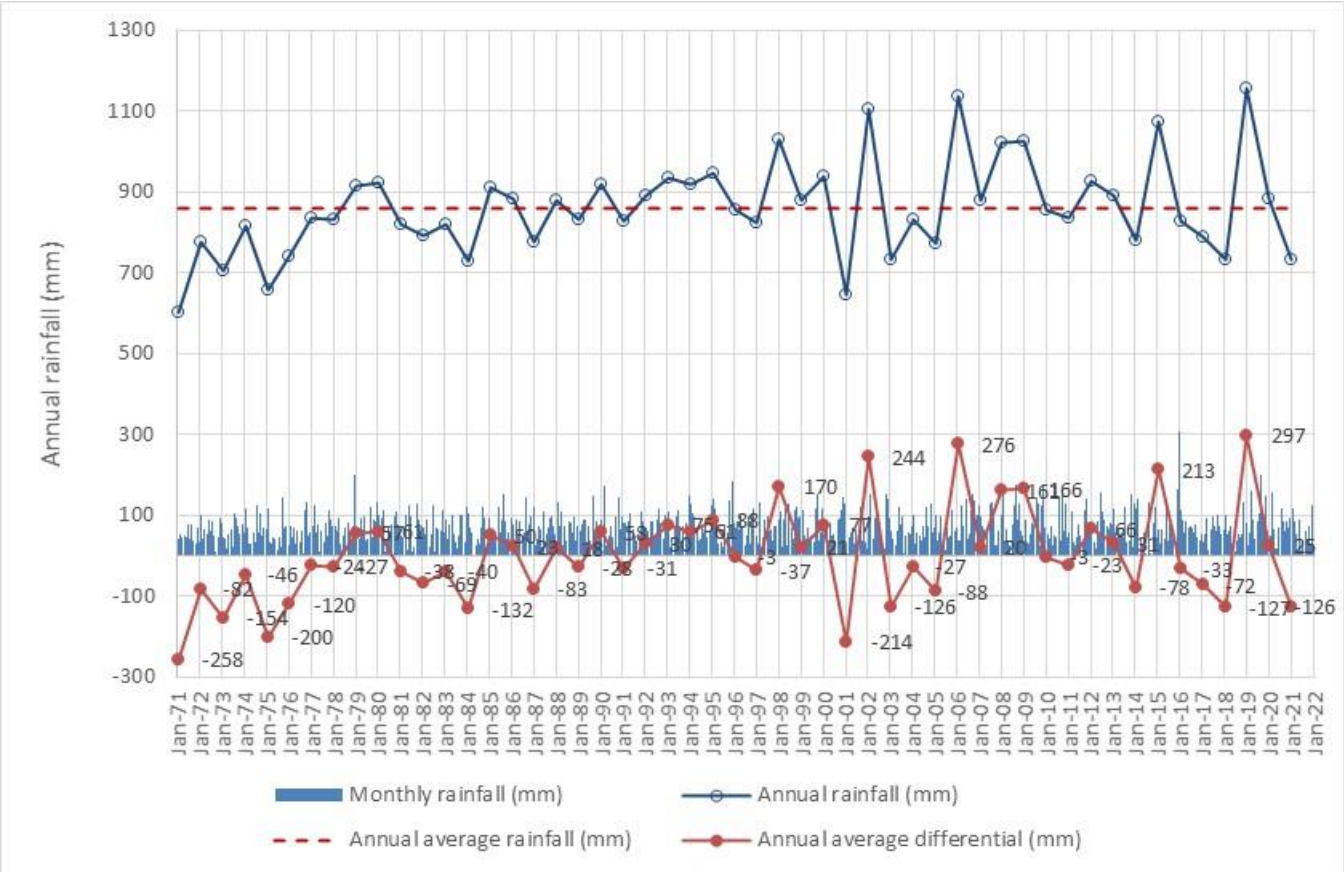


Figure 7.10: Annual Average Rainfall from the Randalstown Meteorological Station (1971-2021)

It is recommended an updated monitoring plan to improve characterisation of hydrogeological (groundwater) and hydrological (surface water) conditions above the Tara Deep orebody is undertaken. This would also support the assessment of potential future changes to the hydrogeology that may occur due to tunnel development or planned subsequent mine operations

8 Summary And Conclusions

8.1 Summary

The inrush event of the 20th November 2021 from the RAR7 raise bore was caused by the 0.381m diameter drilling penetrating the UDL formation and releasing groundwater from an extensive set of cavities in part of the aquifer that had previously been considered limited (the weathered UDL) and flow constrained to isolated cavity zones. It appears from the test work undertaken and aquifer responses that a much more enlarged zone of increased transmissivity reaching to at least 415m (especially important is the 375-415m depth zone as indicated by the spinner tests). Inflows from the 248.5m cavity zone could have been important (although this was meant to have been grout sealed) and a 453m depth zone as indicated by the cavity sections of the N02481 geotechnical borehole. Pre-grouting was undertaken on the 215 to 281mbgl zone.

The inflow continued with no sign of abating until the hole was successfully packered and grouted on the 2nd of December. By which time, the inrush event had caused a marked change in porewater pressure in the surrounding aquifer and a decline in water levels as observed in monitoring wells as far south as Shambo and Robinstown. Following packering and cessation of inflow, groundwater levels were observed to recover in the community wells.

Analysing the results of the change in water level and porewater pressure changes has enabled some aquifer parameters (Transmissivity and Storativity) to be derived, which in turn have been used to assess whether the flow rates from the inrush event and the earlier TRDEX tunnelling could feasibly have caused the water level reductions observed at resident's wells and boreholes. In particular were the long-standing complaints of well drying in Shambo and Robinstown linked to the TRDEX dewatering that occurred during 2020 and 2021?

The analysis undertaken indicates it is plausible that the TRDEX inflows caused groundwater level reductions in the order of 2m. Not all wells and boreholes were affected, the pattern of effect appears to be strongly aligned in a north-south orientation, the individual effect on a particular borehole cannot be confirmed with precision because of the random nature of fracture pathways and connections. It appears plausible that the shallowest and most vulnerable wells in the order 7m depth could have been more adversely affected than others and were induced to dry out when above average TRDEX tunnel inflows occurred during the 2021 summertime when water levels were already depressed. It is important to emphasise this impact would have more likely been experienced by the most vulnerable of the community wells i.e those that were drilled to shallow depths, but that deeper wells, depending on the individual hydraulic connection may also have been adversely impacted. This appears to be the case according to the reported community grievances. Draw-down at depths greater than the predicted 'average' amount of 2m would have also been possible where a direct connection was present.

8.2 Recommendations

GSRO may wish to consider some of the following recommendations based on this report:

Future Monitoring

- Groundwater monitoring frequency in the Tara Deep area should be dependent on the activity level occurring. Under periods of no sub-surface development, the frequency should be weekly, extending to monthly for prolonged no-activity periods. When planned sub-surface works are to be carried out, monitoring frequency should be increased to daily intervals for at least a week before commencement, throughout the period of planned activity and for at least 3 weeks afterwards.
- All datums and reference points for monitoring should be recorded in an inventory with GPS, well collar details and photo-log.
- It is recommended Boliden-Tara continue using the automated data-loggers installed in the Tara Deep wells which from the weekly update reports are understood to have been deployed following the inrush. The automated measurements should be collected along with weekly manual measurements to maintain calibration.
- Data logger recordings should be maintained in the pilot hole (referred to in Update Report Week 3 2022 attached) and the VWP recordings should also be maintained.
- Regarding other monitoring data, measurements of inflows associated with the tunnel and Tara Deep infrastructure should be continued on the weekly basis and reported in weekly report.
- Tunnel and/or RAR seepages should be reported along with other dewatering volumes (if not already). Boliden has reported that post inrush there is no measurement of groundwater inflow to the Tara Deep exploration tunnel. As dewatering of the flood water advances water meters will be installed (week 24) which will provide accurate flow measurements.
- The existing array of monitoring points is considered sufficient for the time being. Future monitoring locations will need to be reviewed depending on the footprint of the proposed workings. This assumes the planned six nested piezometers will be completed.
- It is recommended that a suitable surface watercourse is selected and monitored to evaluate the hydrography of the area. The watercourse should be un-lined and unaffected by agricultural or other discharges.

Future Development Works

- Any further drilling or similar development in the Tara Deep area should undergo new hydrogeological risk assessment in advance using an updated conceptualisation. The precautionary principles that are referenced in this document with respect to hydrogeological uncertainty should be used.
- Unless proven unnecessary, it is expected that all sub-surface works will require targeted pre-grouting and casing methods to seal the formation from cross-completion and discharge.

- The development technique of the full-scale RAR ventilation shaft (4.5m diameter) should be re-assessed in terms of the adequacy of planning conditions, revision and update of such planning conditions to include mitigation measures and monitoring. Given the inrush that occurred with the pilot hole it is assumed that much greater precautionary casing, grouting and groundwater control would need to be employed for full scale shaft development. Given the difficulty and uncertainty with respect to identifying active fissures, alternative methods such as shuttering and ring-casing advance of the RAR need to be fully evaluated and given preference.
- The development of stopes, drives and further capital works such as the deepening of the TRDEX for the Tara Deep deposit should proceed when informed by suitable hydrogeological risk assessment, on the basis that interaction with near surface groundwater stores and pathways is possible. Development works need to be designed and executed so that dewatering, if at all, is temporary and minimal. As such capital development must be designed to prevent permanent dewatering and mining work such as stopes designed to minimise dewatering.

Future Risk Assessment

- Given the hydrogeological sensitivity of the site, it is recommended that numerical groundwater modelling, with an agreed calibration accuracy, should be undertaken and evaluated, to understand the potential for change to the groundwater system / hydrogeology of the area. The layout of stopes, drives and underground capital should be simulated (transiently) as drainage zones within the Tara Deep deposit, and the resultant effect on the water table modelled. Modelling should take into account dry, wet and drought conditions to understand likely effect and impact. Assessment of the dewatering on water resources should then be appraised. To support the modelling, additional pumping tests, tracer work and analysis should be considered.
- The current monitoring network is sufficient to maintain surveillance of the current Tara Deep activities and therefore automated, instrument monitoring should be maintained. The monitoring network will need expansion depending on the proposed footprint of the proposed Tara Deep development.
- It is important to emphasise that the network of fractures and interconnections in the UDL aquifer is not a uniform or predictable spatial feature. Fractures and discontinuities act as discrete (isolated) features that at a large enough scale have an overall pervasive effect. However, the degree to which one location is affected compared to another is not uniform and risk assessment, modelling and predictions of impact will need to assess effect within probability ranges.

Appendix A: Data Register

APPENDIX A: ZS611401 - Boliden Tara Mines Inrush Assessment - Incoming data register

Category/ Folder	File Name	Date received	Sender
Community Engagement	GSRO_Robinstown_211011	18/01/2022	DECC
Geology	N02481_LOG_(original geotechnical hole)RAR7	18/01/2022	DECC
Monitoring	TaraMines_Water_Recording_Database_Readings	18/01/2022	DECC
Monitoring	TaraMines_Water_Recording_Database_SamplingLocations	18/01/2022	DECC
Hydrogeology	TD_UpdatedDiscussionOfConceptualModel_1121 (002)	18/01/2022	DECC
Hydrogeology	TD_Draft Hydrgeological Monitoring Plan_1221	18/01/2022	DECC
Hydrogeology	GWNewsletterNo51_Page28_33-John Paul Moore	18/01/2022	DECC
Hydrogeology	Hydrogeological Report	18/01/2022	DECC
Hydrogeology	Tara 3	18/01/2022	DECC
Hydrogeology	Further Information Response RI014791	18/01/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 3 2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 TD_WeeklyMonitoringReport_18January2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_18.01.2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_18.01.2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Groundwater level monitoring_SWEX and NevLisRath	18/01/2022	DECC
Inflow Incident Weekly Reporting	Groundwater level monitoring_Tara Deep_WK 50	18/01/2022	DECC
Inflow Incident Weekly Reporting	Groundwater level monitoring_SWEX and NevLisRath	18/01/2022	DECC
Inflow Incident Weekly Reporting	Groundwater level monitoring_Tara Deep	18/01/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 52	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 TD_WeeklyMonitoringReport_28December	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_28.12.2021	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_28.12.2021	18/01/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 1 2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_04January2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_04.01.2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_04.01.2022	18/01/2022	DECC
Inflow Incident Weekly Reporting	All Mine GW Locations	18/01/2022	DECC
Inflow Incident Weekly Reporting	Event log water make Tara Deep	18/01/2022	DECC
Inflow Incident Weekly Reporting	Flooded Areas 02 Dec 21 Plan	18/01/2022	DECC

Category/Folder	File Name	Date received	Sender
Inflow Incident Weekly Reporting	Meath Chronirle Dec 4 Front Page	18/01/2022	DECC
Inflow Incident Weekly Reporting	Meath Chronirle Dec 4 page 6 and 7	18/01/2022	DECC
Inflow Incident Weekly Reporting	Meath Chronirle Dec 4	18/01/2022	DECC
Inflow Incident Weekly Reporting	SECA-A' Flooded Areas 02 Dec 21 Plan	18/01/2022	DECC
Inflow Incident Weekly Reporting	Water_System_Summary	18/01/2022	DECC
Inflow Incident Weekly Reporting	Response to request for Information_21.12.2021	18/01/2022	DECC
3D_MineModel	GSRO Full MIne.lfview	21/01/2022	DECC
3D_MineModel	GSRO_scenes	21/01/2022	DECC
3D_MineModel	LeapfrogSetup-2021.2.2	21/01/2022	DECC
3D_MineModel	Tara Deep Jan 2022 GSRO.lfview	21/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 TD_WeeklyMonitoringReport_25January2022	26/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_25.01.2022	26/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_25.01.2022	26/01/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 4 2022	26/01/2022	DECC
Geology	PL4502 2016-2018 Exploration Report	31/01/2022	DECC
Geology	PL4502 2018-2020 Exploration Report	31/01/2022	DECC
Geology	Tara_Deep_Expl_Plans_20210708	31/01/2022	DECC
Geology	Tara Deep Exploration Drift 7th 6 Month Report March 2021	31/01/2022	DECC
Geology	Tara Deep Summary Report 20201028	31/01/2022	DECC
Geology	Athboy_BlockReport_Sept2019	31/01/2022	DECC
Geology	PL3622_Renewal_Report_2019	31/01/2022	DECC
Geophysics	The_Seismic_Interpretation_Report_2013_v1	31/01/2022	DECC
Geophysics	The_Seismic_Acquisition_Report_2013_v1	31/01/2022	DECC
Geophysics	The_Seismic_Processing_Report_2013_v1	31/01/2022	DECC
Geophysics	Pr_11Bol01_PL3622E.sgy	31/01/2022	DECC
Geophysics	Pr_11Bol01_PL3622W.sgy	31/01/2022	DECC
Geophysics	Pr_12-Bol-04_1380R.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol04_PL3622.sgy	31/01/2022	DECC
Geophysics	Pr_12-Bol-05_1380R.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol05_PL1496.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol05_PL3622.sgy	31/01/2022	DECC

Category/Folder	File Name	Date received	Sender
Geophysics	Pr_12-Bol-06_1380R.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol06_PL3851.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol06_PL3852.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol07_PL3851.sgy	31/01/2022	DECC
Geophysics	Pr_12Bol07_PL3852.sgy	31/01/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 TD_WeeklyMonitoringReport_1February2022	03/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_01.02.2022	03/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_01.02.2022	03/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 4 Boliden_ Monitoring Wells Pump Testing	03/02/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 5 2022	03/02/2022	DECC
Data from Boliden	GSRO_Map_25k	09/02/2022	DECC
Data from Boliden	GSRO_Map_10k	09/02/2022	DECC
Data from Boliden	GSRO_Map_5k	09/02/2022	DECC
Data from Boliden	GSRO Data Request	09/02/2022	DECC
Data from Boliden	Copy of Borrapport Tara Deep Nr 1	09/02/2022	DECC
Data from Boliden	Copy of Borrapport Tara Deep Nr 2	09/02/2022	DECC
Data from Boliden	Copy of Borrapport Tara Deep Nr 3	09/02/2022	DECC
Data from Boliden	Copy of Borrapport Tara Deep Nr 4	09/02/2022	DECC
Data from Boliden	5 (ix)Monitoring Wells Pump Testing Report	09/02/2022	DECC
Data from Boliden	10. Rainfall Data	09/02/2022	DECC
Data from Boliden	Micron Reports	09/02/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 6 2022	09/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_8February2022	09/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_08.02.2022	09/02/2022	DECC
Data from Boliden	N02413_Log	10/02/2022	DECC
Data from Boliden	N02207_Log	10/02/2022	DECC
Data from Boliden	Log_N02176	10/02/2022	DECC
Data from Boliden	Presentation to the GSRO	10/02/2022	DECC
Data from Boliden	MARR2124 Tara Rpt_COMBINED	10/02/2022	DECC
Data from Boliden	11. River Flow and Level 2021	14/02/2022	DECC
Data from Boliden	MAIN MINE WEEKLY GROUNDWATER FLOWS '20-'21	16/02/2022	DECC

Category/Folder	File Name	Date received	Sender
Data from Boliden	NEVLISRATH WEEKLY GROUNDWATER FLOWS '20-'21	16/02/2022	DECC
Data from Boliden	SWEX-TARA DEEP WEEKLY GROUNDWATER FLOWS '20-'21	16/02/2022	DECC
Data from Boliden	TARA DEEP GROUNDWATER FLOWS 2020-2021	16/02/2022	DECC
Data from Boliden	Tara Deep Hydrochemistry	16/02/2022	DECC
Data from Boliden	Tara Deep Inflow Locations.dxf	16/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_15February2022	16/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_15.02.2022	16/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_15.02.2022	16/02/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 7 2022	16/02/2022	DECC
Data from Boliden	TD_UpdatedVWPGraphs_0222	18/02/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 8 2022	24/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_22February2022	24/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_22.02.2022	24/02/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_22.02.2022	24/02/2022	DECC
Geology	Drill hole logs	24/02/2022	DECC
Geology	Log_N01937	24/02/2022	DECC
Geology	Log_N02176	24/02/2022	DECC
Geology	Log_N02217	24/02/2022	DECC
Geology	Log_N02251	24/02/2022	DECC
Geology	Log_N02357	24/02/2022	DECC
Geology	Log_N02360	24/02/2022	DECC
Geology	Log_N02362	24/02/2022	DECC
Geology	96-1380-N1351_fe01	24/02/2022	DECC
Geology	96-1380-N1353_83d6	24/02/2022	DECC
Geology	96-1380-N1355_e8d2	24/02/2022	DECC
GIS	G_Flt_shp	24/02/2022	DECC
GIS	Navan_Deposit_Struct_3D	24/02/2022	DECC
GIS	Navan_Deposit_Struct_line	24/02/2022	DECC
GIS	Navan_Deposit_Struct_polygon	24/02/2022	DECC
GIS	Navan_Deposit_Struct_text	24/02/2022	DECC
GIS	Navan_Flt_shp	24/02/2022	DECC

Category/Folder	File Name	Date received	Sender
GIS	RAR#7_Collar_ITM_shp	24/02/2022	DECC
GIS	S_Flt_shp	24/02/2022	DECC
GIS	Tara_Development_Outlines_20210903_ITM_shp	24/02/2022	DECC
GIS	TD_Monitoring Wells	24/02/2022	DECC
GIS	trdex_mapping_3D_shp	24/02/2022	DECC
GIS	trdex_mapping_pgon_shp	24/02/2022	DECC
GIS	trdex_mapping_pline_shp	24/02/2022	DECC
GIS	trdex_mapping_text_shp	24/02/2022	DECC
GIS	Vent_raise_rar7	24/02/2022	DECC
GIS	Vent_Shambo_Wells	24/02/2022	DECC
GIS	VWP_Collars_ITM_shp	24/02/2022	DECC
GIS	Water Pumping Rates	24/02/2022	DECC
GIS	Robinstown_2021.mxd	24/02/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 8 2022	02/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_1March2022	02/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_01.03.2022	02/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_01.03.2022	02/03/2022	DECC
EPA downloads	Annual Environmental Monitoring Report- TailingsSF-Tara Mines2020	02/03/2022	DECC
EPA downloads	EPA- Annual Environmental Report - 2020	02/03/2022	DECC
EPA downloads	Tara TMF - Water Framework Directive Assessment	02/03/2022	DECC
EPA downloads	TSF- existing environment and impact of the activity (2016)	02/03/2022	DECC
EPA downloads	TSF- Flood risk assessment scoping	02/03/2022	DECC
Data from Boliden	Coyle Environmental MW7 & MW8 Field Notes	04/03/2022	DECC
Data from Boliden	Log_N02592	04/03/2022	DECC
Data from Boliden	N02473_DRILL_LOG	04/03/2022	DECC
Data from Boliden	N02570_LOG	04/03/2022	DECC
Data from Boliden	N02572_Log	04/03/2022	DECC
Data from Boliden	N02595_Log	04/03/2022	DECC
Data from Boliden	N02610 log	04/03/2022	DECC
Data from Boliden	N02616 Log	04/03/2022	DECC
Data from Boliden	N02621_log	04/03/2022	DECC

Category/Folder	File Name	Date received	Sender
Data from Boliden	TD_MW7_ Log	04/03/2022	DECC
Data from Boliden	TD_MW8_Log	04/03/2022	DECC
Data from Boliden	N02176	04/03/2022	DECC
Data from Boliden	N02473	04/03/2022	DECC
Data from Boliden	N02495	04/03/2022	DECC
Data from Boliden	N02592	04/03/2022	DECC
Community Engagement	Shambo-Robinstown_Hydrogeology_Report_FINAL_RM09032022	09/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_8March2022	09/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_08.03.2022	09/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_08.03.2022	09/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 4 - Water sample results from Pilot Hole	09/03/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 9 2022	09/03/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 10 2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 TD_WeeklyMonitoringReport_15March2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_15.03.2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_15.03.2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 11 2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 - TD_WeeklyMonitoringReport_22March2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 Groundwater level monitoring_Tara Deep_22.03.2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3 Groundwater level monitoring_SWEX and NevLisRath_22.03.2022	23/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 4 - BOL2201A_Tara_Mines_Report	23/03/2022	DECC
Data from Boliden	Drift_0860_TRDEX1_ITM_dxf	21/03/2022	DECC
Data from Boliden	Drift_0860-TRDEX1_ITM	23/03/2022	DECC
Data from Boliden	0860-TRDEX1	23/03/2022	DECC
Data from Boliden	BOL2201A_Tara_Mines_Report	23/03/2022	DECC
Data from Boliden	Complete Baseline Survey for TD	25/03/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 12 2022	30/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1_TD_WeeklyMonitoringReport_29March2022	30/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2_Groundwater level monitoring_Tara Deep_29.03.2022	30/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 3_Groundwater level monitoring_SWEX and NevLisRath_28.03.2022	30/03/2022	DECC
Inflow Incident Weekly Reporting	Appendix 4_Baseline Well Survey Findings	30/03/2022	DECC

Category/Folder	File Name	Date received	Sender
Inflow Incident Weekly Reporting	Weekly Update Report_Week 13 2022	08/04/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 TD_WeeklyMonitoringReport_6April2022	08/04/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1 TaraDeep_WeeklyData_28Mar-03Apr_2022	08/04/2022	DECC
Data from Boliden	Level Logger data_TD series wells	12/04/2022	DECC
Inflow Incident Weekly Reporting	Appendix 1_Weekly Water Level Data_04.04.2022-10.04.2022	13/04/2022	DECC
Inflow Incident Weekly Reporting	Appendix 2 - TD_WeeklyMonitoringReport_12April2022	13/04/2022	DECC
Inflow Incident Weekly Reporting	Weekly Update Report_Week 14 2022	13/04/2022	DECC

Appendix B: Exploration Tunnel Development Chronology

APPENDIX B: ZS611401 - Boliden Tara Mines Inrush Assessment - Chronology of Tara Deep TRDEX tunnel

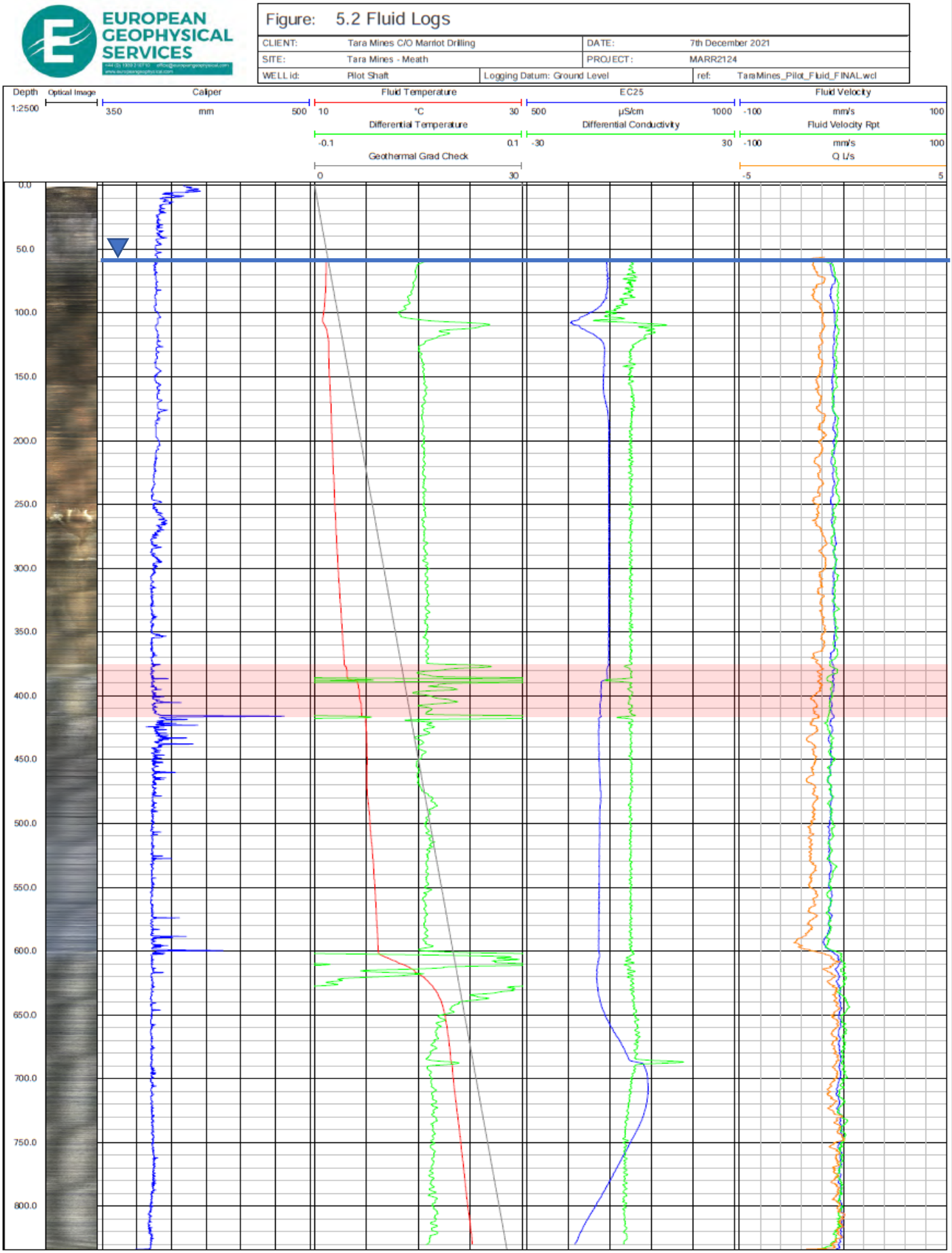
Date	Activity (Extract from reports)	Source
1996 to 2006	Number of deep exploration holes, drilled close to the Mine Lease intersected Pale Beds-hosted ore grade mineralisation representing a down-dip extension of the Navan Orebody and this was subsequently termed the South West Extension (the SWEX).	Exploration Plans, PL4502, Navan, Co Meath, BTM, July 2021
2011- 2012	Seismic Surveying intersecting Tara Deep mineralisation area	Exploration Plans, PL4502, Navan, Co Meath, BTM, July 2021
2012-present	Diamond drilling, acquisition of additional 2D seismic data, largeloop and down-hole EM and AMT surveys in Tara Deep area.	Exploration Plans, PL4502, Navan, Co Meath, BTM, July 2021
22nd June 2017	A report documenting TRDEX exploration tunnel plans submitted to the Exploration and Mining Division (EMD).	Tara Deep Exploration Drift, Update March 2021, Boliden.
22nd August 2017	The EMD accepted exploration tunnel to be a part of Boliden's exploration program for PL4502.	Tara Deep Exploration Drift, Update March 2021, Boliden.
8th November 2017	Meath County Council approved the TRDEX exploration tunnel as exempted development	Tara Deep Exploration Drift, Update March 2021, Boliden.
Late 2018 (exact date?)	TRDEX exploration tunnel development started	
End March 2018	836.5 m total development in vicinity of TRDEX exploration tunnel. Note- this is not just linear development but also "considerable 'enabling' development close to mining operations in SWEX comprising accesses to main ramp, truck loading bays, ventilation drifts and raises."	Tara Deep Exploration Drift, Update March 2021, Boliden.
End April 2018	350 m of linear development along TRDEX exploration tunnel completed	Tara Deep Exploration Drift, Update March 2021, Boliden.
End September 2018	263m of TRDEX tunnel development. This is equivalent to 180m lateral advance since end March. TRDEX tunnel head at the northern boundary of PL4502.	Tara Deep Exploration Drift, Update March 2021, Boliden.
September 30th 2018	TRDEX exploration tunnel development started within PL4502 area.	Tara Deep Exploration Drift, Update March 2021, Boliden.
Sep-18	The drift was successfully advanced through the D Fault using short rounds, 'spiling' (advanced drilling and steel insertion with cement grout to stabilise the back and sidewalls). Although advance rates were significantly slower through the fault no significant problems were encountered.	Tara Deep Exploration Drift, Update March 2021, Boliden.
Sep-18	Drifting speed has increased to about 20m per week in September, 2	Tara Deep Exploration Drift, Update March 2021, Boliden.
End March 2019	Tunnel advanced by 281m bringing the drift south of the northern boundary of PL4502. A further 102m has been developed as support infrastructure in the form of truck loading bays, re-muck bays and sumps.	Tara Deep Exploration Drift, Update March 2021, Boliden.
Sept 2018 to end March 2019	Drifting speed during the 6 months to March month-end has been steady at about 15m per week. This speed was adversely affected by the need to install a 20m grout curtain following the intersection of pressurised water in U28880 (see above), and water seepage in the drift.	Tara Deep Exploration Drift, Update March 2021, Boliden.

Date	Activity (Extract from reports)	Source
End March 2019	One geotechnical probe hole (U28880), being deepened, was at a depth of 814m at March month-end. The hole was dry until 714m when a fracture network was intersected that initially resulted in 40l/min being measured at the hole-collar. The water flow steadily increased to 250l/min at a pressure of around 60bar by 765m. Subsequent drilling to March month-end revealed a constant flow of 250l/min, but pressure then dropped to 50bar.	Tara Deep Exploration Drift, Update March 2021, Boliden.
End March 2019	Following the installation of the grout curtain, a percussion hole (W1360), drilled from the face of the 0860 TRDEX1 revealed a water-make at 18m depth with a flow rate of 120l/min.	Tara Deep Exploration Drift, Update March 2021, Boliden.
End Sept 2019	The TRDEX tunnel advanced by 80m bringing the drift further south of the northern boundary of PL4502. A further 95.7m has been developed as support infrastructure in the form of truck loading bays, re-muck bays and sumps, including the dedicated, ATEX-compliant, drilling chamber 0860 TRDDC1.	Tara Deep Exploration Drift, Update March 2021, Boliden.
End Sept 2019	Probe hole U28880 was completed at a depth of 861m with water flow at 250l/min and 52bar pressure	Tara Deep Exploration Drift, Update March 2021, Boliden.
End Sept 2019	An underground probe hole (U30829), was at a depth of 176m . The hole was dry until 47m when a fracture network was intersected that initially resulted in 1,000l/min being measured at the holecollar and a pressure of 81bar. The hole was fully pressure-grouted and re-drilling revealed a drop in water flow to 350l/min at 76bar. Subsequent drilling to September month-end showed no change in flow rates and pressures.	Tara Deep Exploration Drift, Update March 2021, Boliden.
Oct-19	Advance of the 0860 TRDEX1 has been adversely affected by a significant water-bearing structure intersected at the face during October 2019	Tara Deep Exploration Drift, Update March 2021, Boliden.
Jan-Feb 2020	Remediation works to deal with a significant water bearing structure during Q1: A number of short probe holes and separate water relief holes were drilled from the TRDEX tunnel	Tara Deep Exploration Drift, Update March 2021, Boliden.
Sept 2019 to end March 2020	The TRDEX exploration tunnel advanced by 60.4m. A further 99m has been developed as support infrastructure in the form of truck loading bays (TRDTL8 for 25m) a second drill cubby 0860 TRDDC2 (74m) to facilitate downward drilling of the Navan Terrace from the TRDEX tunnel.	Tara Deep Exploration Drift, Update March 2021, Boliden.
March to end Sept 2020	The TRDEX tunnel advanced by 489.8m. A further 185m has been developed as support infrastructure.	Tara Deep Exploration Drift, Update March 2021, Boliden.
Sept 2020- end March 2021	768.6m of TRDEX tunnel advance, which includes all development. The TRDEX tunnel approaching 1.8km in length, bringing the tunnel within 200m of the planned location of RARR and associated fan station.	Tara Deep Exploration Drift, Update March 2021, Boliden.
May-Sept 2021	237m advance in TRDEX tunnel, with 593.6 m total tunnel development completed.	
Sep-21	Tunnel 1000m below ground level with total length 2.1 km. RAR position reached.	

Appendix C: Data Static Spinner Test Observation Summary

APPENDIX C: ZS611401 - Boliden Tara Mines Inrush Assessment –

Static Spinner Test Observation Summary



Key observations from static spinner test:

Depth (m bgl)	Observation
21	Inflow. Fissure zone- cascading water
26	Inflow. Fissure zone- cascading water
59	Downflow observed from 59m.
60.1	Water level
108	Inflow. Key structural feature (Fissure) coincident with step on temp. conductivity log.
375	Inflow. Key structural feature (Fissure) coincident with step on temp. conductivity log. Slight increase in contributions to downflow between 375-415m, continued downflow to ~600m.
377	Temp. conductivity log - notable step
386	Temp. conductivity log - notable step
389	Temp. conductivity log - notable step
402	Temp. conductivity log - notable step
406	Temp. conductivity log - notable step
415	Inflow. Key structural feature (Fissure) coincident with step on temp. conductivity log
420	Temp. conductivity log - notable step
475	Temp. conductivity log - notable step
599	Main outflow 599-601 m. Key structural feature (Fissure) coincident with step on temp. conductivity log from 599-601 m. Fluid velocity logs- largest deflection between 599-601m.
601	Main outflow 599-601 m. Key structural feature (Fissure) coincident with step on temp. conductivity log from 599-601 m
601	Little to no flow observed below 599-601m.
833.8	Base of plugged hole- soft sediment accumulation observed
919	Logging tool trapped
921	Logging tool trapped

Appendix D: Tara Deep Monitoring Borehole Information

APPENDIX D: ZS611401 - Boliden Tara Mines Inrush Assessment - Boliden Tara monitoring borehole locations relative to RAR7 pilot hole.

BH_ID	Easting _ING	Northing_ ING	Elevation (mAOD)	Well Depth (m)	Distance from RAR7PH (m)	Orientation from RAR7PH	Location description	Nearby borehole	Type	Well Description
TD_DW1			53.22	6.46	1450	SSE	South of ENE-SSW trending Navan fault, Shambo area		Domestic	Bored
TD_DW2			57.39	8	2070	S	South of ENE-SSW trending Navan fault, Shambo area	N01356	Domestic	Dug
TD_DW3			57.86	3	2380	SSE	South of ENE-SSW trending Navan fault, Shambo area		Domestic	
TD_DW4			51.75	120	2470	SSE	South of ENE-SSW trending Navan fault, Shambo area		Domestic	
TD_DW5			53.93	1.1	3270	SSW	South of ENE-SSW trending Navan fault, Robinstown area		Domestic	
TD_DW6			55.19	45	3150	S	South of ENE-SSW trending Navan fault, Robinstown area		Domestic	Bored
TD_DW7			57.84	43	3420	S	South of ENE-SSW trending Navan fault, Robinstown area		Domestic	Bored
TD_DW8			53.4	3	3800	S	South of ENE-SSW trending Navan fault, Robinstown area	N01407 (900m)	Domestic	Dug
TD_DW9			51.77	46	3880	SSE	South of ENE-SSW trending Navan fault, Robinstown area		Domestic	Bored
TD_MW1			56.39	38.9	1100	NNE	Gainstown Terrace, Footwall of S-fault	N01869	Monitoring	Bored
TD_MW2			57.8	16.2	470	NNE	Gainstown Terrace, Footwall of S-fault	N01351, N02616, N0223	Monitoring	Bored
TD_MW3			60.23	1.9	930	W	Gainstown Terrace, Hanging wall of S-fault	N01937 (c. 220m)	Monitoring	Dug
TD_MW4			58.78	100	290	NNW	Along NNW-SSE trending S-fault? (From S-fault .shp provided by Boliden) In shallow unit overlying mineralisation zone	N02462, N02349	Monitoring	Bored

BH_ID	Easting _ING	Northing_ ING	Elevation (mAOD)	Well Depth (m)	Distance from RAR7PH (m)	Orientation from RAR7PH	Location description	Nearby boreholes	Type	Well Description
TD_MW5			55.75	11.7	660	SW	Gainstown Terrace, Hanging wall of S-fault	N01355 (c. 300m)	Monitoring	Bored
TD_MW6			53.92	100	780	SSW	South of ENE-SSW trending Navan fault	N02474, N02552, N02475	Monitoring	Bored
TD_MW7			57.37	40	3600	SSW	South of ENE-SSW trending Navan fault, Robinstown area		Monitoring	Bored
TD_MW8			49.6	65	2390	SSE	South of ENE-SSW trending Navan fault, Shambo area		Monitoring	Bored
RAR7PH			57.4		NA	NA	Gainstwn Terrace, in immediate Hanging wall of the S-fault		RAR7 Pilot Hole	

Appendix E: Groundwater Level Monitoring Data- SWEX area/ Main mine

APPENDIX E: ZS611401 - Boliden Tara Mines Inrush Assessment - SWEX/NevLisRath Groundwater level monitoring data

	Nat. Grid Coords		Malin	TARA	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2020	2021	2021	2021	2021	2021	2021	2021	2021	2021
					mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl
Hole Number	Easting	Northing	Elev.	Elevation	01-Jan	01-Feb	01-Mar	01-Apr	01-May	01-Jun	01-Jul	01-Aug	01-Sep	01-Oct	01-Nov	01-Dec	01-Jan	01-Feb	01-Mar	01-Apr	01-May	01-Jun	01-Jul	01-Aug	01-Sep
N01742			44.40	1571.1	56.0	41.0		75.7	78.7	74.5	80.4	81.0	81.1	79.3	71.6	76.6	56.7	64.2	70.1	74.2	75.5	77.2	80.1	81.1	82.6
N01648			47.80	1574.5	47.0	50.0		66.7	67.3	66.0	65.2	64.9	64.9	65.1	65.7	64.5	53.6	63.7	63.6	63.6	64.0	64.3	64.8	65.0	65.3
N01650			37.20	1563.9	24.1	24.8		29.1	29.1	29.1	29.3	29.3	27.3	25.8	25.7	24.7	20.9	22.1	23.9	28.9	29.0	29.4	29.4	29.4	29.2
N01661			40.40	1567.1	97.0	97.0		97.0	97.0	97.0	97.0	97.0	97.0	95.2	94.8	89.3	78.9	80.8	83.1	85.9	86.3	88.2	92.8	93.1	93.7
N01711			48.10	1574.8	77.2	53.4		52.8	55.6	56.4	57.2	57.7	61.1	60.6	60.4	59.6	55.8	54.4	54.9	55.7	56.8	59.0	59.6	60.2	62.2
N01737			46.56	1573.3	48.3	47.3		51.3	55.9	52.4	50.1	69.1	54.2	63.1	65.5	47.2	43.4	43.0	44.3	46.6	48.0	50.6	51.9	54.1	57.9
N01742			45.80	1572.5	22.4	23.2		22.3	26.7	28.5	31.3	32.1	33.6	33.7	33.0	32.1	25.3	23.0	23.6	25.2	16.1	30.4	31.6	32.8	36.0
N01743			46.15	1572.9	26.7	27.7		26.5	31.1	32.3	34.9	35.7	37.1	37.2	37.5	36.4	30.2	27.8	28.8	30.3	32.3	34.9	36.0	37.2	39.9
N01745			47.70	1574.4	33.6	33.8		33.0	37.1	37.9	40.5	40.5	42.0	41.9	43.6	42.4	36.5	34.4	35.1	36.0	37.8	40.3	41.2	42.4	45.7
N01750			47.42	1574.1	14.3	15.8	13.7	14.5	17.3	18.4	17.8	18.0	19.3	22.6	19.2	17.9	13.1	12.0	14.1	14.6	15.0	16.4	17.3	19.1	21.8
N01751			46.41	1573.1	9.5	9.8		9.5	10.0	10.1	10.3	10.4	10.2	10.2	9.4	9.7	8.8	8.9	9.1	9.2	9.3	9.5	9.9	10.0	10.3
N01752			46.72	1573.4	0.8	0.8		1.1	1.4	1.9	1.9	1.6	1.3	1.4	0.9	0.7	0.1	0.6	0.8	1.0	1.2	1.4	1.8	1.8	2.4
N01753			49.07	1575.8	80.2	77.2		73.2	84.6	83.5	81.0	78.7	80.3	84.6	89.3	89.4	96.5	100.0	100.9	99.3	99.5	99.0	97.8	95.5	91.8
N01754			40.22	1566.9	7.2	7.4		7.3	7.7	8.5	9.0	9.2	8.5	7.5	6.4	6.6	6.0	6.3	6.7	7.0	7.3	7.9	9.0	9.4	9.8
N01755			36.54	1563.2	10.8	0.7		12.7	14.3	15.5	16.2	11.6	11.9	12.3	10.3	0.0	0.0	9.7	10.1	11.0	11.6	12.8	14.0	14.5	15.3
N01756			36.55	1563.3	0.5	0.5		0.9	0.9	0.9	0.8	0.9	0.8	0.7	0.5	0.0	0.0	0.2	0.6	0.9	0.8	0.9	1.0	0.9	0.9
N01757			36.69	1563.4	0.4	0.7		1.0	1.3	1.4	1.3	1.1	0.8	0.6	0.3	0.2	0.0	0.0	0.5	0.9	1.0	1.2	1.3	1.4	1.4
N01758			36.66	1563.4	0.2	0.2		0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2
N01759			40.33	1567.0	1.6	1.8		2.0	2.5	2.5	2.5	2.5	2.5	1.8	1.2	1.3	0.6	0.8	1.6	1.9	2.4	2.5	2.5	2.5	2.4
N01761			37.24	1563.9	0.7	1.0		1.3	3.1	3.9	3.1	2.8	1.8	1.4	0.6	0.7	0.0	0.4	0.8	1.3	2.2	3.5	3.7	3.8	4.0
N01765			44.53	1571.2	1.3	1.1		1.6	1.8	2.2	2.4	2.2	1.9	1.5	1.6	1.3	1.2	1.4	1.6	1.6	1.7	1.9	2.1	2.0	2.3
N01766			44.96	1571.7	15.1	15.1		15.2	15.3	15.4	15.3	15.2	15.0	15.2	15.2	15.2	15.1	15.6	15.1	15.2	15.2	15.2	15.2	15.2	19.0
N01767			48.84	1575.5	3.0	2.6		4.7	7.6	7.9	8.7	8.9	7.3	3.2	3.0	2.8	2.3	14.2	3.1	3.2	3.7	4.2	8.6	3.3	12.7
OB 1765			44.53	1571.2	1.3	1.1		1.5	1.7	2.1	2.1	2.0	2.1	1.4	1.4	1.5	1.1	1.2	1.5	1.7	1.9	2.0	2.2	2.1	2.3
OB 1766			44.96	1571.7	0.9	1.1		1.0	1.2	1.3	1.2	1.1	1.0	0.8	0.8	0.8	0.6	0.7	0.9	0.9	1.0	1.1	1.2	1.1	1.5
OB 1767			48.84	1575.5	2.7	2.2		3.2	3.0	3.5	3.3	3.2	3.2	2.8	2.7	2.5	1.9	2.2	2.7	3.0	3.5	3.3	3.4	3.2	3.5
N01783			48.26	1575.0	70.6	71.7	70.3	71.3	79.1	75.1	77.2	77.7	77.8	78.0	79.3	76.8	72.0	73.3	70.7	73.3	73.9	75.2	76.1	77.5	77.9
N01786			46.46	1573.2	85.3	84.6		81.7	81.4	81.5	81.5	81.5	81.5	81.5	83.1	81.5	81.5	81.5	81.5	81.6	81.3	81.6	81.6	81.5	81.6
N01787			44.40	1571.1	59.7	70.3		74.1	78.6	79.8	84.7	86.1	80.0	81.0	73.2	75.4	56.4	62.1	68.3	72.1	73.3	74.9	80.7	82.8	85.8
N02118			48.70	1575.4	40.8	41.2		42.0	48.4	48.4	50.9	52.5	52.2	62.9	64.5	46.9	42.3	41.0	42.4	44.6	45.3	50.1	51.6	53.4	56.1
N02123			41.23	1567.9	55.1	50.4	45.3	39.0	63.1	62.0	62.8	64.0	64.2	66.3	67.6	63.4	54.7	53.3	55.3	48.6	50.5	66.2	63.7	64.9	67.0
N02131			38.54	1565.2	142.5	164.5		159.2	159.3	150.3	152.8	151.7	150.2	149.3	146.9	148.3		170.4	144.0	145.1	147.4	152.3	148.3	148.6	113.3
E00030 (EP30)			68.4	1595.1	2.4	3.1	2.2	4.6	6.0	7.2	8.9	9.2	6.1	2.9	2.4	2.0	0.0	1.9	2.3	3.3	3.9	5.1	6.0	6.7	8.9
N01000			69.4	1596.1	10.5	10.2	9.9	8.8	8.9	8.9	9.0	8.9	8.9	9.0	12.9	12.0	27.8	26.5	26.6	26.6	27.8	30.7	30.0	30.3	31.5
N01104			65.3	1592.0	0.9	1.2	0.8	1.6	1.9	2.0	2.1	1.8	1.6	0.9		1.0	0.8	1.0	1.1	1.4	1.6	1.9	2.0	1.9	2.3
N01110			70.8	1597.5	91.2	84.6	81.4	86.4	90.2	93.4	97.3	99.0	101.3	99.2	96.5	95.7	86.7	84.3	87.1	86.3	87.1	90.1	92.5	94.3	96.4
N01255			67.2	1593.9	3.4	4.3	2.3	3.8	5.0	5.1	5.4	5.1	4.9	4.2	4.4	4.1	3.1	2.9	4.4	4.5	4.4	5.0	5.3	5.6	5.9
N01258			65.2	1591.9	2.2	2.5	2.1	2.7	3.2	3.3	3.5	3.1	2.8	2.5	2.6	2.2	1.3	2.2	2.4	2.8	2.5	3.0	3.2	3.2	3.4
N01269			66.3	1593.0	6.0	6.4	5.7	7.4	8.2	8.5	8.8	8.9	8.1	6.5	6.4	5.9	5.6	5.8	6.5	7.2	7.6	8.2	8.4	8.7	8.9
N01467			68.3	1595.0	56.5	56.0	51.0	51.6	56.6	59.8	66.0	68.2	74.9	67.3	63.8	62.6	59.5	50.1	49.4	50.9	52.4	57.3	60.6	63.5	66.7
N01477			70.7	1597.4	8.8	8.9	8.4			8.6	8.6	8.6	8.8	8.7	8.5	8.8	4.8	7	4.3	6.1	6.4		8.7	9.0	8.8
N01530			70.5	1597.2	16.6	15.8	16.4			19.1	22	24.1	27.3	28	30.2	31.8			16.7	17	17.3	20.3	24.4	30.9	32.1
N01532			72.9	1599.6	117.8	118	118.1			119.1	118.7	118	118.8	119.2	111	109	114.4	107.8	111.1	108.4	108.1	112.7	114	113.4	
N01625			73.3	1600.0	115.2	114.8	114.2			115.3	116.1	117.8	118.8	118.9	119.6	119.7	117.9	119.8	119.7	118.1	118.4	118.4	118.4	120.2	
N01638			73.1	1599.8	0.9	1.2	1.1			0.8	0.9	1.1	1.4	1.5	1.7	2	2.7	2.2	2.5	2.5	2.7	3.1	2	3.6	
N01794			72.5	1599.2	0.1	0.1	0.2			0.2	0.1	0.1	0.2	0	0	0	1.1	1	1.3	0.7	0.3	0.4	0.6	1.7	
N01803			70.8	1597.5	32.3	31.9	28.1	28.6	31.9	33.8	37.4	38.7	39.1	36.3	35.5	33.3	25.0	23.5	24.4	26.8	28.7	31.4	33.6	35.3	37.2
N01804			70.8	1597.5	30.2	29.8	26.4	27.9	32.2	34.9	40.7	42.4	44.5	40.2	38.6	35.9	26.1	23.7	24.5	28.0	31.1	35.0	38.2	40.9	43.7
N01805			77.8	1604.5	16.1	15.5	15.6			16.2	16.0	15.7	16.1	16.2	15.8	16.6	14.1	15.8	16.0	16.4	16.4	16.8	17.1	17.9	
N01806			78.3	1605.0	102.1	101.1	101.4			102							98.8	101.1	97.8	108.1	109.1	109	105	106.2	
N01514 (1547)			72.9	1599.6	0.3	0.4	0.3			0.4	0.4	0.3	0.3	0.3	0.1	0.2	0.3	0.2	0.3	0.2	0.3	0.3	0.1	0.1	0.1
N02084			78.0	1604.7	15.8	22.8			45.6	47.1	37.9	38.1	46.0	39.7	35.8	43.0	38.1	40.5	41.6	41.2	41.3	42.1	42.5	42.6	44.0

	Nat. Grid Coords		Malin	TARA	2021	2021	2021	2021	2021	2021	2021	2022	2022
					mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl	mbgl
Hole Number	Easting	Northing	Elev.	Elevation	01-Oct	01-Nov	02-Dec	09-Dec	16-Dec	23-Dec	29-Dec	06-Jan	14-Jan
N01742			44.40	1571.1	82.7	83.1	82.6	82.3	76.7	76.4	72.9	11.3	70.0
N01648			47.80	1574.5	65.7	65.3	64.9	63.9	65.1	65.0	65.2	65.1	65.2
N01650			37.20	1563.9	29.2	26.2	28.6	27.4	23.6	24.3	22.7		21.7
N01661			40.40	1567.1	93.9	94.2	94.3	94.3	94.2	94.4	93.9	93.5	93.5
N01711			48.10	1574.8	62.6	63.3	63.7	63.7	64.0	63.8	63.0	62.2	61.8
N01737			46.56	1573.3	58.0	57.9	61.0	61.1	59.0	57.6	56.4		52.7
N01742			45.80	1572.5	36.8	38.0	38.7	38.8	38.9	38.9	38.6	37.4	36.9
N01743			46.15	1572.9	40.7	41.7	42.4	42.4	42.7	42.7	42.6	40.9	41.4
N01745			47.70	1574.4	46.5	46.7	47.2	47.4	47.4	47.5	47.1	46.4	46.0
N01750			47.42	1574.1	22.1	22.6	22.8	22.8	23.0	22.9	22.9	21.9	20.8
N01751			46.41	1573.1	10.3	10.3	10.3	10.3	10.0	9.9	9.6	9.3	9.3
N01752			46.72	1573.4	2.4	2.0	1.8	1.6	1.4	1.4	1.0	0.9	1.0
N01753			49.07	1575.8	94.6	91.8	95.4	95.1	96.5	96.8	97.2	96.7	97.0
N01754			40.22	1566.9	9.8	9.2	9.1	8.7	7.5	7.4	6.8	6.5	6.5
N01755			36.54	1563.2	15.6	15.3	14.5	14.0	9.1	9.7	Flooded	8.6	9.3
N01756			36.55	1563.3	0.9	0.9	0.8	0.6	0.4	0.5	Flooded	0.3	0.5
N01757			36.69	1563.4	1.4	1.4	0.9	0.7	0.2	0.4	Flooded	0.0	0.3
N01758			36.66	1563.4	0.2	0.2	0.1	0.1	0.1	0.1	Flooded	0.0	0.1
N01759			40.33	1567.0	2.6	2.1	3.3	1.8	1.3	1.3	0.8	0.6	1.0
N01761			37.24	1563.9	3.2	1.4	2.6	1.4	0.8	1.0	0.3	0.0	0.7
N01765			44.53	1571.2	2.2	1.9	1.9	3.0	2.0	2.4	1.5		2.0
N01766			44.96	1571.7	18.9	19.0	19.0	19.1	19.0	18.9	18.9		19.4
N01767			48.84	1575.5	9.9	3.6	3.3	3.2	3.3	3.1	2.5		3.3
OB 1765			44.53	1571.2	2.2	2.0	2.9	1.9	1.8	1.9	1.5		2.0
OB 1766			44.96	1571.7	1.3	1.0	0.9	0.8	0.8	0.8	0.7		1.3
OB 1767			48.84	1575.5	3.3	3.0	3.0	2.9	3.1	3.0	2.3		3.3
N01783			48.26	1575.0	78.3	79.4	79.8	79.7	79.4	79.0	77.9	75.5	74.3
N01786			46.46	1573.2	81.6	91.6	81.6	81.5	86.1	81.6	85.8	85.8	85.9
N01787			44.40	1571.1	85.3	87.4	86.5	86.1	78.1	76.4	72.6	68.9	70.0
N02118			48.70	1575.4	56.2	56.2	59.8	58.7	58.1	57.2	55.8		53.5
N02123			41.23	1567.9	67.0	67.0	69.8	69.0	68.1	68.3	67.5		37.2
N02131			38.54	1565.2	139.0	139.0	151.7	148.0	146.1	145.4	143.6		141.7
E00030 (EP30)			68.4	1595.1	9.2	8.9	8.7	8.2	5.7	5.0	3.3	2.3	2.3
N01000			69.4	1596.1	32.7	32.9	32.6	32.0	31.1	31.1	30.0	25.1	31.5
N01104			65.3	1592.0	2.1	2.0	2.0	1.6	1.4	1.3	1.0	1.0	1.0
N01110			70.8	1597.5	100.1	104.8	106.5	106.4	106.8	104.9	104.6	101.7	101.2
N01255			67.2	1593.9	5.9	5.9	5.6	5.3	5.3	5.0	0.1		3.8
N01258			65.2	1591.9	3.5	3.1	3.0	2.5	2.5	2.4	2.1		2.3
N01269			66.3	1593.0	9.1	9.1	8.9	7.9	7.3	7.2	6.4	6.1	6.1
N01467			68.3	1595.0	73.9	74.7	76.8	76.9	77.1	76.4	75.8	72.7	71.5
N01477			70.7	1597.4	8.5	9.0	9.6	8.6	7.6	5.9	5.7	5.5	5.6
N01530			70.5	1597.2	27	24.2	24.4	23.7	22.2	22.3	18.1	16.2	16.4
N01532			72.9	1599.6		130.2	103.0	144.0	138.0	140.0	144.2	129.0	93.2
N01625			73.3	1600.0	120.2	120.2	120.2	122.0	120.2	122.5	120.3	122.3	120.3
N01638			73.1	1599.8	3.9	3.6	3.1	2.5	2.3	2.3	0.4	0.8	1.2
N01794			72.5	1599.2		1.7	0.3	0.0	0.2	0.0	0.0+	0.0+	0.1
N01803			70.8	1597.5		41.1	42.2	41.5	42.2	42.4	30.1		34.9
N01804			70.8	1597.5		49.5	51.1	50.8	48.0	48.2	45.0	41.5	41.3
N01805			77.8	1604.5		17.9	15.5	13.3	12.0	12.3	0.1	8.3	8.8
N01806			78.3	1605.0	114.7	114.7	104.0	92.0	101.8	107.1	87.0	89.0	90.0
N01514 (1547)			72.9	1599.6	0.1	0.1	0.2	0.3	0.3	0.2	0.3	0.2	0.2
N02084			78.0	1604.7	43.7	42.6	43.0	39.6	40.0	41.3	38.2	21.4	21.4

Appendix F: Groundwater Level Monitoring Data – Tara Deep Exploration Area

APPENDIX F: ZS611401 - Boliden Tara Mines Inrush Assessment - Tara Deep Groundwater level monitoring data (TD_DW1 to TD_DW9, TD_MW1 to TD_MW8)

TD_DW1		TD_DW2		TD_DW3		TD_DW4		TD_DW5		TD_DW6		TD_DW7		TD_DW8		TD_DW9	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
16/09/2021	56.91	08/09/2021	56.48	07/09/2021	56.36	07/09/2021	46.80	07/09/2021	59.022	07/09/2021	46.33	14/07/2021	57.73	15/09/2021	55.97	17/09/2021	52.43
24/09/2021	56.90	29/09/2021	56.22	05/10/2021	56.43	27/11/2021	34.80	29/09/2021	58.9	29/09/2021	45.50	29/09/2021	54.57	29/09/2021	55.56	24/09/2021	50.73
29/09/2021	56.90	05/10/2021	56.32	01/11/2021	56.53	28/11/2021	33.62	05/10/2021	58.75	05/10/2021	45.35	05/10/2021	54.53	05/10/2021	55.35	29/09/2021	53.15
05/10/2021	56.58	01/11/2021	56.32	15/11/2021	56.43	29/11/2021	34.21	01/11/2021	58.87	01/11/2021	42.75	01/11/2021	54.59	01/11/2021	55.88	05/10/2021	49.73
01/11/2021	57.14	15/11/2021	56.32	23/11/2021	56.43	30/11/2021	32.90	15/11/2021	58.92	15/11/2021	42.44	15/11/2021	53.85	15/11/2021	55.46	01/11/2021	49.46
15/11/2021	56.81	23/11/2021	56.32	25/11/2021	56.43	01/12/2021	31.89	23/11/2021	58.71	23/11/2021	41.27	23/11/2021	52.81	23/11/2021	55.28	15/11/2021	48.61
23/11/2021	56.73	25/11/2021	56.32	26/11/2021	56.43	02/12/2021	31.10	25/11/2021	58.71	25/11/2021	40.60	25/11/2021	52.82	25/11/2021	55.25	23/11/2021	48.49
25/11/2021	56.82	26/11/2021	56.32	27/11/2021	56.43	03/12/2021	32.11	26/11/2021	58.71	26/11/2021	39.85	26/11/2021	52.87	26/11/2021	55.33	25/11/2021	48.28
26/11/2021	56.77	27/11/2021	56.32	28/11/2021	56.43	04/12/2021	30.55	27/11/2021	58.85	27/11/2021	39.74	27/11/2021	53.43	27/11/2021	55.28	26/11/2021	48.33
27/11/2021	56.78	28/11/2021	56.32	29/11/2021	56.43	05/12/2021	30.60	28/11/2021	58.85	28/11/2021	39.20	28/11/2021	51.18	28/11/2021	55.28	27/11/2021	47.98
28/11/2021	56.76	29/11/2021	56.32	30/11/2021	56.43	06/12/2021	33.49	29/11/2021	58.85	29/11/2021	38.90	29/11/2021	51.18	29/11/2021	55.19	28/11/2021	47.83
29/11/2021	56.36	30/11/2021	56.32	01/12/2021	56.43	07/12/2021	33.77	30/11/2021	58.85	30/11/2021	38.50	30/11/2021	53.18	30/11/2021	55.18	29/11/2021	46.98
30/11/2021	56.73	01/12/2021	56.32	02/12/2021	56.43	08/12/2021	34.28	01/12/2021	58.85	01/12/2021	38.05	01/12/2021	52.93	01/12/2021	55.23	30/11/2021	47.36
01/12/2021	56.73	02/12/2021	56.32	03/12/2021	56.43	09/12/2021	37.34	02/12/2021	58.85	02/12/2021	38.80	02/12/2021	52.98	02/12/2021	55.18	01/12/2021	47.38
02/12/2021	56.68	03/12/2021	56.32	04/12/2021	56.43	10/12/2021	35.18	03/12/2021	58.85	03/12/2021	37.60	03/12/2021	52.93	03/12/2021	55.30	02/12/2021	47.13
03/12/2021	56.88	04/12/2021	56.32	05/12/2021	56.43	11/12/2021	36.49	04/12/2021	58.85	04/12/2021	37.66	04/12/2021	52.62	04/12/2021	55.29	03/12/2021	47.08
04/12/2021	56.85	05/12/2021	56.32	06/12/2021	56.43	12/12/2021	37.15	05/12/2021	59.01	05/12/2021	37.63	05/12/2021	52.72	05/12/2021	55.27	04/12/2021	46.95
05/12/2021	56.74	06/12/2021	56.32	07/12/2021	56.43	13/12/2021	37.10	06/12/2021	59.01	06/12/2021	37.55	06/12/2021	52.28	06/12/2021	55.28	05/12/2021	46.91
06/12/2021	56.78	07/12/2021	56.32	08/12/2021	56.50	14/12/2021	38.09	07/12/2021	59.01	07/12/2021	37.55	07/12/2021	52.9	07/12/2021	55.28	06/12/2021	46.72
07/12/2021	57.58	08/12/2021	59.62	09/12/2021	56.76	15/12/2021	38.44	08/12/2021	59.06	08/12/2021	37.45	08/12/2021	51.53	08/12/2021	55.38	07/12/2021	46.71
08/12/2021	57.67	09/12/2021	58.23	10/12/2021	56.78	16/12/2021	38.54	09/12/2021	59.63	09/12/2021	37.64	09/12/2021	53.33	09/12/2021	56.43	08/12/2021	46.93
09/12/2021	57.63	10/12/2021	56.32	11/12/2021	56.85	17/12/2021	38.92	10/12/2021	59.73	10/12/2021	38.05	10/12/2021	53.98	10/12/2021	56.87	09/12/2021	46.73
10/12/2021	57.63	11/12/2021	56.32	12/12/2021	56.51	18/12/2021	39.20	11/12/2021	59.06	11/12/2021	38.30	11/12/2021	54.16	11/12/2021	56.68	10/12/2021	46.93
11/12/2021	57.76	12/12/2021	56.32	13/12/2021	56.47	19/12/2021	39.41	12/12/2021	59.70	12/12/2021	38.63	12/12/2021	54.1	12/12/2021	56.53	11/12/2021	47.23
12/12/2021	57.70	13/12/2021	56.32	14/12/2021	56.40	20/12/2021	39.59	13/12/2021	59.71	13/12/2021	38.80	13/12/2021	54.98	13/12/2021	56.49	12/12/2021	48.22
13/12/2021	57.73	14/12/2021	56.32	15/12/2021	56.36	21/12/2021	39.45	14/12/2021	59.71	14/12/2021	39.03	14/12/2021	54.96	14/12/2021	55.27	13/12/2021	47.11
14/12/2021	57.66	15/12/2021	56.32	16/12/2021	56.36	22/12/2021	39.50	15/12/2021	59.70	15/12/2021	39.30	15/12/2021	55.21	15/12/2021	55.53	14/12/2021	46.68
15/12/2021	57.61	16/12/2021	56.32	17/12/2021	56.36	23/12/2021	39.99	16/12/2021	59.71	16/12/2021	39.53	16/12/2021	54.18	16/12/2021	55.80	15/12/2021	46.78
16/12/2021	57.67	17/12/2021	56.32	18/12/2021	56.36	24/12/2021	39.00	17/12/2021	59.71	17/12/2021	39.60	17/12/2021	55.13	17/12/2021	55.93	16/12/2021	47.36
17/12/2021	57.53	18/12/2021	56.32	19/12/2021	56.36	25/12/2021		18/12/2021	59.70	18/12/2021	39.85	18/12/2021	55.3	18/12/2021	56.00	17/12/2021	47.32
18/12/2021	57.40	19/12/2021	56.32	20/12/2021	56.36	26/12/2021	39.30	19/12/2021	59.61	19/12/2021	40.05	19/12/2021	54.53	19/12/2021	56.10	18/12/2021	47.42
19/12/2021	57.28	20/12/2021	56.32	21/12/2021	56.36	27/12/2021	39.90	20/12/2021	59.66	20/12/2021	40.15	20/12/2021	54.94	20/12/2021	56.14	19/12/2021	47.49
20/12/2021	57.28	21/12/2021	56.32	22/12/2021	56.36	28/12/2021	40.30	21/12/2021	59.70	21/12/2021	40.32	21/12/2021	55.04	21/12/2021	56.19	20/12/2021	47.32
21/12/2021	57.58	22/12/2021	56.32	23/12/2021	56.36	29/12/2021	40.75	22/12/2021	59.61	22/12/2021	40.14	22/12/2021	54.93	22/12/2021	56.13	21/12/2021	47.63
22/12/2021	57.58	23/12/2021	56.32	24/12/2021	56.36	30/12/2021	41.70	23/12/2021	59.70	23/12/2021	40.60	23/12/2021	54.93	23/12/2021	56.48	22/12/2021	46.08
23/12/2021	57.58	24/12/2021	56.32	25/12/2021		31/12/2021	41.45	24/12/2021	59.66	24/12/2021	40.69	24/12/2021	54.98	24/12/2021	56.38	23/12/2021	46.04
24/12/2021	57.50	25/12/2021		26/12/2021	56.93	01/01/2022	42.65	25/12/2021		25/12/2021		25/12/2021		25/12/2021		24/12/2021	47.53
25/12/2021		26/12/2021	62.01	27/12/2021	56.86	02/01/2022	43.57	26/12/2021	59.73	26/12/2021	40.97	26/12/2021	55.3	26/12/2021	58.6	25/12/2021	
26/12/2021	58.60	27/12/2021	57.27	28/12/2021	56.73	03/01/2022	43.14	27/12/2021	59.72	27/12/2021	41.43	27/12/2021	56.42	27/12/2021	58.89	26/12/2021	47.95
27/12/2021	57.98	28/12/2021	56.92	29/12/2021	56.68	04/01/2022	45.00	28/12/2021	59.72	28/12/2021	41.96	28/12/2021	57.13	28/12/2021	59.03	27/12/2021	48.73
28/12/2021	58.23	29/12/2021	56.81	30/12/2021	56.57	05/01/2022	45.31	29/12/2021	59.73	29/12/2021	42.49	29/12/2021	57.53	29/12/2021	59.12	28/12/2021	49.07
29/12/2021	58.46	30/12/2021	56.32	31/12/2021	56.74	06/01/2022	45.60	30/12/2021	59.72	30/12/2021	42.93	30/12/2021	57.82	30/12/2021	59.09	29/12/2021	49.66
30/12/2021	58.33	31/12/2021	60.42	01/01/2022	56.76	07/01/2022	44.85	31/12/2021	59.73	31/12/2021	43.36	31/12/2021	58.32	31/12/2021	59.47	30/12/2021	49.99
31/12/2021	58.77	01/01/2022	56.97	02/01/2022	56.66	08/01/2022	43.89	01/01/2022	59.73	01/01/2022	43.93	01/01/2022	59.11	01/01/2022	59.55	31/12/2021	50.21
01/01/2022	58.54	02/01/2022	56.32	03/01/2022	56.66	09/01/2022	44.55	02/01/2022	59.73	02/01/2022	44.43	02/01/2022	59.18	02/01/2022	59.36	01/01/2022	50.86
02/01/2022	58.37	03/01/2022	56.81	04/01/2022	56.57	10/01/2022	46.26	03/01/2022	59.73	03/01/2022	44.80	03/01/2022	59.48	03/01/2022	59.38	02/01/2022	50.71
03/01/2022	58.71	04/01/2022	56.32	05/01/2022	56.57	11/01/2022	46.04	04/01/2022	59.73	04/01/2022	45.10	04/01/2022	59.48	04/01/2022	59.32	03/01/2022	51.36
04/01/2022	58.36	05/01/2022	56.32	06/01/2022	56.36	12/01/2022	45.99	05/01/2022	59.73	05/01/2022	45.33	05/01/2022	59.47	05/01/2022	59.23	04/01/2022	51.38
05/01/2022	58.08	06/01/2022	56.32	07/01/2022	56.36	13/01/2022	46.19	06/01/2022	59.73	06/01/2022	45.66	06/01/2022	59.48	06/01/2022	59.19	05/01/2022	51.36
06/01/2022	58.53	07/01/2022	56.32	08/01/2022	56.36	14/01/2022	46.26	07/01/2022	59.73	07/01/2022	45.80	07/01/2022	59.45	07/01/2022	59.21	06/01/2022	51.49
07/01/2022	58.19	08/01/2022	56.32	09/01/2022	56.36	15/01/2022	46.86	08/01/2022	59.73	08/01/2022	46.00	08/01/2022	59.43	08/01/2022	59.27	07/01/2022	51.54
08/01/2022	58.55	09/01/2022	56.32	10/01/2022	56.50	16/01/2022	45.05	09/01/2022	59.73	09/01/2022	46.10	09/01/2022	59.38	09/01/2022	59.24	08/01/2022	51.56
09/01/2022	58.43	10/01/2022	56.32	11/01/2022	56.36	17/01/2022	46.76	10/01/2022	59.73	10/01/2022	46.50	10/01/2022	59.28	10/01/2022	59.14	09/01/2022	51.68
10/01/2022	58.36	11/01/2022	56.32	12/01/2022	56.46	18/01/2022	45.81	11/01/2022	59.73	11/01/2022	46.24	11/01/2022	59.18	11/01/2022	59.09	10/01/2022	51.63

TD_DW1		TD_DW2		TD_DW3		TD_DW4		TD_DW5		TD_DW6		TD_DW7		TD_DW8		TD_DW9	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
11/01/2022	58.53	12/01/2022	56.32	13/01/2022	56.44	19/01/2022	45.48	12/01/2022	59.71	12/01/2022	46.25	12/01/2022	59.18	12/01/2022	58.90	11/01/2022	51.72
12/01/2022	58.08	13/01/2022	56.32	14/01/2022	56.46	20/01/2022	45.80	13/01/2022	59.73	13/01/2022	46.55	13/01/2022	59.18	13/01/2022	58.94	12/01/2022	51.83
13/01/2022	57.85	14/01/2022	56.32	15/01/2022	56.36	21/01/2022	46.88	14/01/2022	59.73	14/01/2022	46.60	14/01/2022	59.11	14/01/2022	58.76	13/01/2022	52.13
14/01/2022	58.17	15/01/2022	56.32	16/01/2022	56.36	22/01/2022	44.97	15/01/2022	59.73	15/01/2022	45.71	15/01/2022	59.19	15/01/2022	58.84	14/01/2022	51.63
15/01/2022	58.13	16/01/2022	56.32	17/01/2022	56.36	23/01/2022	42.63	16/01/2022	59.73	16/01/2022	46.70	16/01/2022	59.08	16/01/2022	58.79	15/01/2022	51.73
16/01/2022	57.96	17/01/2022	56.32	18/01/2022	56.46	24/01/2022	44.95	17/01/2022	59.73	17/01/2022	46.78	17/01/2022	58.78	17/01/2022	58.60	16/01/2022	51.96
17/01/2022	57.93	18/01/2022	56.32	19/01/2022	56.46	25/01/2022	45.65	18/01/2022	59.72	18/01/2022	46.80	18/01/2022	58.81	18/01/2022	58.55	17/01/2022	51.81
18/01/2022	57.77	19/01/2022	56.32	20/01/2022	56.41	26/01/2022	45.17	19/01/2022	59.72	19/01/2022	46.82	19/01/2022	58.66	19/01/2022	58.53	18/01/2022	50.98
19/01/2022	57.73	20/01/2022	56.32	21/01/2022	56.41	27/01/2022	46.00	20/01/2022	59.72	20/01/2022	46.83	20/01/2022	58.48	20/01/2022	58.43	19/01/2022	51.81
20/01/2022	57.76	21/01/2022	56.32	22/01/2022	56.36	28/01/2022	45.60	21/01/2022	59.72	21/01/2022	46.83	21/01/2022	58.48	21/01/2022	58.33	20/01/2022	51.63
21/01/2022	57.72	22/01/2022	56.32	23/01/2022	56.36	29/01/2022	45.89	22/01/2022	59.71	22/01/2022	46.80	22/01/2022	58.13	22/01/2022	58.26	21/01/2022	50.83
22/01/2022	57.71	23/01/2022	56.32	24/01/2022	56.36	30/01/2022	45.60	23/01/2022	59.72	23/01/2022	46.84	23/01/2022	58.28	23/01/2022	58.18	22/01/2022	51.64
23/01/2022	58.03	24/01/2022	56.32	25/01/2022	56.36	31/01/2022	45.80	24/01/2022	59.72	24/01/2022	46.93	24/01/2022	58.08	24/01/2022	58.06	23/01/2022	51.92
24/01/2022	57.76	25/01/2022	56.32	26/01/2022	56.36	01/02/2022	46.28	25/01/2022	59.61	25/01/2022	46.90	25/01/2022	58.18	25/01/2022	58.33	24/01/2022	51.35
25/01/2022	57.76	26/01/2022	56.32	27/01/2022	56.36	02/02/2022	45.95	26/01/2022	59.69	26/01/2022	46.93	26/01/2022	57.62	26/01/2022	57.93	25/01/2022	51.63
26/01/2022	57.71	27/01/2022	56.32	28/01/2022	56.36	03/02/2022	46.91	27/01/2022	59.69	27/01/2022	46.80	27/01/2022	57.93	27/01/2022	57.83	26/01/2022	51.63
27/01/2022	57.72	28/01/2022	56.32	29/01/2022	56.36	04/02/2022	46.91	28/01/2022	59.69	28/01/2022	46.78	28/01/2022	58.11	28/01/2022	57.78	27/01/2022	51.72
28/01/2022	57.43	29/01/2022	56.32	30/01/2022	56.36	05/02/2022	42.65	29/01/2022	59.73	29/01/2022	46.75	29/01/2022	57.93	29/01/2022	57.76	28/01/2022	51.61
29/01/2022	57.38	30/01/2022	56.32	31/01/2022	56.36	06/02/2022	42.45	30/01/2022	59.69	30/01/2022	46.78	30/01/2022	58.11	30/01/2022	57.78	29/01/2022	51.48
30/01/2022	57.43	31/01/2022	56.32	01/02/2022	56.36	07/02/2022	45.51	31/01/2022	59.69	31/01/2022	46.55	31/01/2022	58.38	31/01/2022	57.56	30/01/2022	51.61
31/01/2022	57.78	01/02/2022	56.32	02/02/2022	56.36	08/02/2022	46.85	01/02/2022	59.66	01/02/2022	46.81	01/02/2022	57.63	01/02/2022	57.58	31/01/2022	51.78
01/02/2022	57.88	02/02/2022	56.32	03/02/2022	56.36	09/02/2022	46.53	02/02/2022	59.66	02/02/2022	46.90	02/02/2022	57.68	02/02/2022	57.43	01/02/2022	51.74
02/02/2022	57.73	03/02/2022	56.32	04/02/2022	56.36	10/02/2022	46.30	03/02/2022	59.69	03/02/2022	46.80	03/02/2022	57.81	03/02/2022	57.43	02/02/2022	51.63
03/02/2022	57.70	04/02/2022	56.32	05/02/2022	56.36	11/02/2022	45.66	04/02/2022	59.69	04/02/2022	46.80	04/02/2022	57.81	04/02/2022	57.43	03/02/2022	51.65
04/02/2022	57.70	05/02/2022	56.32	06/02/2022	56.36	12/02/2022	44.86	05/02/2022	59.67	05/02/2022	46.67	05/02/2022	57.68	05/02/2022	57.54	04/02/2022	51.65
05/02/2022	57.46	06/02/2022	56.32	07/02/2022	56.36	13/02/2022	46.43	06/02/2022	59.71	06/02/2022	46.69	06/02/2022	57.73	06/02/2022	57.96	05/02/2022	51.44
06/02/2022	58.44	07/02/2022	56.32	08/02/2022	56.46	14/02/2022	46.57	07/02/2022	59.69	07/02/2022	46.67	07/02/2022	57.76	07/02/2022	57.70	06/02/2022	51.53
07/02/2022	58.44	08/02/2022	56.32	09/02/2022	56.46	15/02/2022	46.77	08/02/2022	59.69	08/02/2022	46.66	08/02/2022	58.03	08/02/2022	57.69	07/02/2022	51.79
08/02/2022	58.53	09/02/2022	56.32	10/02/2022	56.46	16/02/2022	47.14	09/02/2022	59.69	09/02/2022	46.64	09/02/2022	58.19	09/02/2022	57.93	08/02/2022	51.89
09/02/2022	58.62	10/02/2022	56.32	11/02/2022	56.46	17/02/2022	47.06	10/02/2022	59.69	10/02/2022	46.60	10/02/2022	58.21	10/02/2022	57.96	09/02/2022	51.77
10/02/2022	58.68	11/02/2022	56.32	12/02/2022	56.46	18/02/2022	47.25	11/02/2022	59.71	11/02/2022	46.58	11/02/2022	58.28	11/02/2022	57.97	10/02/2022	51.89
11/02/2022	58.66	12/02/2022	56.32	13/02/2022	56.46	19/02/2022	48.45	12/02/2022	59.70	12/02/2022	46.80	12/02/2022	57.92	12/02/2022	57.72	11/02/2022	51.85
12/02/2022	58.33	13/02/2022	56.32	14/02/2022	56.36	20/02/2022	48.45	13/02/2022	59.71	13/02/2022	47.40	13/02/2022	58.04	13/02/2022	58.63	12/02/2022	51.98
13/02/2022	58.23	14/02/2022	56.32	15/02/2022	56.46	21/02/2022	48.14	14/02/2022	59.71	14/02/2022	46.28	14/02/2022	58.49	14/02/2022	58.64	13/02/2022	51.83
14/02/2022	58.72	15/02/2022	56.32	16/02/2022	56.61	22/02/2022	49.81	15/02/2022	59.71	15/02/2022	49.40	15/02/2022	59.65	15/02/2022	58.74	14/02/2022	52.33
15/02/2022	58.18	16/02/2022	56.32	17/02/2022	56.61	23/02/2022	50.10	16/02/2022	59.71	16/02/2022	49.62	16/02/2022	59.87	16/02/2022	59.04	15/02/2022	52.51
16/02/2022	58.29	17/02/2022	56.32	18/02/2022	56.70	24/02/2022	50.49	17/02/2022	59.71	17/02/2022	49.58	17/02/2022	59.98	17/02/2022	59.10	16/02/2022	52.66
17/02/2022	58.02	18/02/2022	58.32	19/02/2022	56.92	25/02/2022	50.38	18/02/2022	59.71	18/02/2022	50.07	18/02/2022	60.32	18/02/2022	59.30	17/02/2022	52.98
18/02/2022	58.41	19/02/2022	62.02	20/02/2022	56.92	26/02/2022	49.55	19/02/2022	59.75	19/02/2022	48.53	19/02/2022	59.54	19/02/2022	59.86	18/02/2022	53.16
19/02/2022	59.13	20/02/2022	62.02	21/02/2022	57.04	27/02/2022	48.02	20/02/2022	59.75	20/02/2022	48.53	20/02/2022	59.54	20/02/2022	59.86	19/02/2022	53.63
20/02/2022	59.13	21/02/2022	62.27	22/02/2022	56.96	28/02/2022	50.02	21/02/2022	59.75	21/02/2022	50.81	21/02/2022	61.30	21/02/2022	59.75	20/02/2022	53.63
21/02/2022	58.89	22/02/2022	59.63	23/02/2022	56.81	01/03/2022	49.99	22/02/2022	59.72	22/02/2022	51.45	22/02/2022	61.60	22/02/2022	59.71	21/02/2022	54.15
22/02/2022	58.75	23/02/2022	58.42	24/02/2022	56.76	02/03/2022	49.92	23/02/2022	59.75	23/02/2022	51.90	23/02/2022	61.68	23/02/2022	59.66	22/02/2022	54.49
23/02/2022	58.94	24/02/2022	57.80	25/02/2022	56.71	03/03/2022	48.43	24/02/2022	59.74	24/02/2022	52.17	24/02/2022	61.68	24/02/2022	59.62	23/02/2022	54.74
24/02/2022	58.64	25/02/2022	56.52	26/02/2022	56.66	04/03/2022	50.03	25/02/2022	59.75	25/02/2022	52.30	25/02/2022	61.60	25/02/2022	59.54	24/02/2022	54.59
25/02/2022	58.64	26/02/2022	56.32	27/02/2022	56.38	05/03/2022	50.00	26/02/2022	59.75	26/02/2022	52.46	26/02/2022	61.61	26/02/2022	59.20	25/02/2022	54.73
26/02/2022	58.15	27/02/2022	56.32	28/02/2022	56.34	06/03/2022	48.39	27/02/2022	59.73	27/02/2022	52.58	27/02/2022	61.61	27/02/2022	59.18	26/02/2022	54.13
27/02/2022	58.23	28/02/2022	56.32	01/03/2022	56.36	07/03/2022	48.88	28/02/2022	59.74	28/02/2022	52.63	28/02/2022	61.47	28/02/2022	59.45	27/02/2022	53.93
28/02/2022	58.59	01/03/2022	56.32	02/03/2022	56.46	08/03/2022	48.64	01/03/2022	59.73	01/03/2022	52.53	01/03/2022	61.40	01/03/2022	59.38	28/02/2022	54.82
01/03/2022	58.60	02/03/2022	56.32	03/03/2022	56.46	09/03/2022	48.63	02/03/2022	59.73	02/03/2022	53.28	02/03/2022	61.33	02/03/2022	59.35	01/03/2022	54.72
02/03/2022	58.64	03/03/2022	56.32	04/03/2022	56.41	10/03/2022	48.09	03/03/2022	59.72	03/03/2022	53.32	03/03/2022	61.26	03/03/2022	59.32	02/03/2022	54.75
03/03/2022	58.54	04/03/2022	56.32	05/03/2022	56.36	11/03/2022	48.09	04/03/2022	59.73	04/03/2022	53.33	04/03/2022	61.17	04/03/2022	59.17	03/03/2022	54.68
04/03/2022	58.50	05/03/2022	56.32	06/03/2022	56.36	12/03/2022	48.70	05/03/2022	59.70	05/03/2022	50.74	05/03/2022	61.07	05/03/2022	59.08	04/03/2022	54.50
05/03/2022	58.19	06/03/2022	56.32	07/03/2022	56.36	13/03/2022	49.74	06/03/2022	59.71	06/03/2022	50.53	06/03/2022	60.97	06/03/2022	59.03	05/03/2022	54.18
06/03/2022	58.09	07/03/2022	56.32	08/03/2022	56.36	14/03/2022	48.96	07/03/2022	59.73	07/03/2022	53.30	07/03/2022	60.97	07/03/2022	59.07	06/03/2022	54.20
07/03/2022	58.48	08/03/2022	56.32	09/03/2022	56.41	15/03/2022	49.08	08/03/2022	59.65	08/03/2022	50.93	08/03/2022	59.59	08/03/2022	59.06	07/03/2022	54.24

TD_DW1		TD_DW2		TD_DW3		TD_DW4		TD_DW5		TD_DW6		TD_DW7		TD_DW8		TD_DW9	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
08/03/2022	58.47	09/03/2022	56.36	10/03/2022	56.38	16/03/2022	49.36	09/03/2022	59.67	09/03/2022	50.90	09/03/2022	59.55	09/03/2022	59.14	08/03/2022	54.48
09/03/2022	58.39	10/03/2022	56.32	11/03/2022	56.38	17/03/2022	49.85	10/03/2022	59.67	10/03/2022	50.75	10/03/2022	59.41	10/03/2022	59.33	09/03/2022	54.43
10/03/2022	58.72	11/03/2022	56.32	12/03/2022	56.56	18/03/2022	49.8	11/03/2022	59.73	11/03/2022	50.75	11/03/2022	59.41	11/03/2022	59.33	10/03/2022	54.46
11/03/2022	58.72	12/03/2022	57.12	13/03/2022	56.61	19/03/2022	49.88	12/03/2022	59.73	12/03/2022	50.43	12/03/2022	59.49	12/03/2022	59.29	11/03/2022	54.46
12/03/2022	58.03	13/03/2022	57.22	14/03/2022	56.56	20/03/2022	51	13/03/2022	59.73	13/03/2022	50.93	13/03/2022	59.55	13/03/2022	59.55	12/03/2022	54.44
13/03/2022	58.83	14/03/2022	56.97	15/03/2022	56.46	21/03/2022	50.85	14/03/2022	59.69	14/03/2022	51.00	14/03/2022	59.38	14/03/2022	59.41	13/03/2022	54.68
14/03/2022	58.82	15/03/2022	56.32	16/03/2022	56.46	22/03/2022	49.75	15/03/2022	59.69	15/03/2022	51.04	15/03/2022	59.41	15/03/2022	59.40	14/03/2022	54.83
15/03/2022	58.79	16/03/2022	56.32	17/03/2022	56.56	23/03/2022	49.92	16/03/2022	59.69	16/03/2022	50.95	16/03/2022	59.43	16/03/2022	59.36	15/03/2022	54.82
16/03/2022	58.72	17/03/2022	56.32	18/03/2022	56.36	24/03/2022	50.56	17/03/2022	59.56	17/03/2022	51.15	17/03/2022	59.43	17/03/2022	59.18	16/03/2022	54.95
17/03/2022	58.23	18/03/2022	56.32	19/03/2022	56.36	25/03/2022	50.26	18/03/2022	59.61	18/03/2022	51.21	18/03/2022	59.38	18/03/2022	59.23	17/03/2022	54.31
18/03/2022	58.09	19/03/2022	56.32	20/03/2022	56.36	26/03/2022	50.4	19/03/2022	59.67	19/03/2022	51.17	19/03/2022	59.48	19/03/2022	59.06	18/03/2022	54.28
19/03/2022	58.2	20/03/2022	56.32	21/03/2022	56.36	27/03/2022	51.02	20/03/2022	59.65	20/03/2022	51.3	20/03/2022	59.58	20/03/2022	59.12	19/03/2022	54.33
20/03/2022	58.18	21/03/2022	56.32	22/03/2022	56.36	28/03/2022	50	21/03/2022	59.69	21/03/2022	51.4	21/03/2022	59.47	21/03/2022	59.08	20/03/2022	53.88
21/03/2022	58.12	22/03/2022	56.32	23/03/2022	56.36	28/03/2022	49.99	22/03/2022	59.56	22/03/2022	51.1	22/03/2022	59.45	22/03/2022	59.02	21/03/2022	54.08
22/03/2022	58.13	23/03/2022	56.32	24/03/2022	56.36	28/03/2022	51.02	23/03/2022	59.55	23/03/2022	51.1	23/03/2022	58.42	23/03/2022	58.96	22/03/2022	54.12
23/03/2022	58.1	24/03/2022	56.32	25/03/2022	56.36	28/03/2022	49.51	24/03/2022	59.58	24/03/2022	51.07	24/03/2022	59.39	24/03/2022	58.9	23/03/2022	54.04
24/03/2022	58.07	25/03/2022	56.32	26/03/2022	56.36	29/03/2022	51.06	25/03/2022	59.56	25/03/2022	51	25/03/2022	59.32	25/03/2022	58.83	24/03/2022	53.85
25/03/2022	57.85	26/03/2022	56.32	27/03/2022	56.36	29/03/2022	47.87	26/03/2022	59.46	26/03/2022	51	26/03/2022	59.28	26/03/2022	58.63	25/03/2022	53.74
26/03/2022	57.93	27/03/2022	56.32	28/03/2022	56.36	29/03/2022	49.19	27/03/2022	59.61	27/03/2022	50.95	27/03/2022	59.33	27/03/2022	58.59	26/03/2022	53.97
27/03/2022	57.8	28/03/2022	56.32	28/03/2022	56.36	29/03/2022	50.18	28/03/2022	59.54	28/03/2022	51.05	28/03/2022	59.28	28/03/2022	58.69	27/03/2022	53.68
28/03/2022	58.02	28/03/2022	56.32	29/03/2022	56.36	30/03/2022	48.59	28/03/2022	59.54	28/03/2022	51.05	28/03/2022	59.28	28/03/2022	58.69	28/03/2022	53.73
28/03/2022	58.00	29/03/2022	56.32	30/03/2022	56.36	30/03/2022	50.94	29/03/2022	59.51	29/03/2022	51.00	28/03/2022	59.28	28/03/2022	58.68	28/03/2022	53.7
28/03/2022	58.03	30/03/2022	56.32	31/03/2022	56.36	30/03/2022	50.65	30/03/2022	59.48	30/03/2022	50.95	28/03/2022	59.28	28/03/2022	58.69	28/03/2022	53.74
28/03/2022	58.02	31/03/2022	56.32	01/04/2022	56.36	30/03/2022	50.15	31/03/2022	59.47	31/03/2022	50.95	28/03/2022	59.14	28/03/2022	58.68	28/03/2022	53.73
28/03/2022	58.01	01/04/2022	56.32	04/04/2022	56.36	31/03/2022	50.95	01/04/2022	59.47	01/04/2022	50.95	29/03/2022	59.27	29/03/2022	58.67	28/03/2022	53.68
29/03/2022	58.01	04/04/2022	56.32	11/04/2022	56.36	31/03/2022	50.06	04/04/2022	59.66	02/04/2022	51.00	29/03/2022	59.27	29/03/2022	58.67	29/03/2022	53.59
29/03/2022	58.06	11/04/2022	56.32			31/03/2022	50.39	11/04/2022	59.61	03/04/2022	51.05	29/03/2022	59.15	29/03/2022	58.66	29/03/2022	53.8
29/03/2022	57.83					31/03/2022	50.48			04/04/2022	50.90	29/03/2022	59.25	29/03/2022	58.64	29/03/2022	53.69
29/03/2022	57.79					01/04/2022	51.01			04/04/2022	50.90	30/03/2022	59.26	30/03/2022	58.63	29/03/2022	53.16
30/03/2022	58.02					01/04/2022	50.93			05/04/2022	50.90	30/03/2022	59.25	30/03/2022	58.62	44650.04167	53.63
30/03/2022	58.03					01/04/2022	50.94			06/04/2022	50.99	30/03/2022	58.46	30/03/2022	58.60	44650.29167	53.77
30/03/2022	57.99					01/04/2022	49.13			06/04/2022	51.06	30/03/2022	59.23	30/03/2022	58.58	44650.54167	53.59
30/03/2022	57.97					02/04/2022	49.80			06/04/2022	51.08	31/03/2022	59.22	31/03/2022	58.56	44650.79167	53.56
31/03/2022	57.97					02/04/2022	50.18			06/04/2022	51.03	31/03/2022	59.22	31/03/2022	58.54	44651.04167	53.58
31/03/2022	57.97					02/04/2022	49.73			07/04/2022	51.12	31/03/2022	59.21	31/03/2022	58.52	44651.29167	53.5
31/03/2022	57.85					02/04/2022	47.95			07/04/2022	51.10	31/03/2022	58.78	31/03/2022	58.49	44651.54167	53.41
31/03/2022	57.58					03/04/2022	47.39			07/04/2022	51.05	01/04/2022	59.19	01/04/2022	58.48	44651.79167	53.41
01/04/2022	57.90					03/04/2022	48.62			07/04/2022	50.99	01/04/2022	59.18	01/04/2022	58.45	44652.04167	53.49
01/04/2022	57.93					03/04/2022	49.07			08/04/2022	51.00	01/04/2022	59.16	01/04/2022	58.44	44652.29167	53.58
01/04/2022	57.85					03/04/2022	49.12			08/04/2022	51.00	01/04/2022	59.17	01/04/2022	58.44	44652.54167	53.37
01/04/2022	57.92					04/04/2022	50.89			08/04/2022	50.99	02/04/2022	59.17	02/04/2022	58.44	44652.79167	53.47
02/04/2022	57.92					04/04/2022	50.90			08/04/2022	50.92	02/04/2022	58.86	02/04/2022	58.44	44653.04167	53.41
02/04/2022	57.92					04/04/2022	47.83			09/04/2022	50.93	02/04/2022	59.15	02/04/2022	58.45	44653.29167	53.53
02/04/2022	57.89					04/04/2022	47.19			09/04/2022	50.92	02/04/2022	58.72	02/04/2022	58.42	44653.54167	53.39
02/04/2022	57.88					05/04/2022	42.76			09/04/2022	51.00	03/04/2022	59.13	03/04/2022	58.41	44653.79167	53.25
03/04/2022	57.88					05/04/2022	47.67			09/04/2022	56.35	03/04/2022	59.13	03/04/2022	58.38	44654.04167	53.33
03/04/2022	57.86					05/04/2022	47.78			10/04/2022	56.35	03/04/2022	59.12	03/04/2022	58.36	44654.29167	53.29
03/04/2022	57.80					05/04/2022	46.93			10/04/2022	56.36	03/04/2022	58.33	03/04/2022	58.34	44654.54167	53.07
03/04/2022	57.89					06/04/2022	48.45			10/04/2022	56.35	04/04/2022	59.12	04/04/2022	58.33	44654.79167	53.34
04/04/2022	57.55					06/04/2022	47.34			10/04/2022	56.32	04/04/2022	59.13	04/04/2022	58.33	44655.04167	53.35
04/04/2022	57.91					06/04/2022	48.34			11/04/2022	56.34	04/04/2022	58.88	04/04/2022	58.18	44655.29167	53.47
04/04/2022	57.73					06/04/2022	47.27			11/04/2022	56.38	04/04/2022	59.13	04/04/2022	58.34	44655.36389	53.75
04/04/2022	57.72					07/04/2022	48.43					04/04/2022	59.12	04/04/2022	58.33	44655.54167	53.47
05/04/2022	57.72					07/04/2022	48.28					05/04/2022	59.12	05/04/2022	58.31	44655.79167	53.56
05/04/2022	57.74					07/04/2022	48.32					05/04/2022	58.74	05/04/2022	58.30	05/04/2022	53.35
05/04/2022	57.55					07/04/2022	46.66					05/04/2022	59.06	05/04/2022	58.29	05/04/2022	53.38

TD_DW1		TD_DW2		TD_DW3		TD_DW4		TD_DW5		TD_DW6		TD_DW7		TD_DW8		TD_DW9	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
05/04/2022	57.71					08/04/2022	48.34					05/04/2022	59.12	05/04/2022	58.27	05/04/2022	53.4
06/04/2022	57.73					08/04/2022	47.50					06/04/2022	59.11	06/04/2022	58.27	05/04/2022	53.36
06/04/2022	57.76					08/04/2022	47.82					06/04/2022	59.11	06/04/2022	58.26	06/04/2022	53.35
06/04/2022	57.75					08/04/2022	47.04					06/04/2022	59.11	06/04/2022	58.25	06/04/2022	53.49
06/04/2022	57.74					09/04/2022	42.81					06/04/2022	59.10	06/04/2022	58.24	06/04/2022	53.51
07/04/2022	57.76					09/04/2022	45.13					07/04/2022	59.10	07/04/2022	58.24	06/04/2022	52.87
07/04/2022	57.73					09/04/2022	46.74					07/04/2022	59.07	07/04/2022	58.23	07/04/2022	53.51
07/04/2022	57.67					09/04/2022	45.60					07/04/2022	58.86	07/04/2022	58.21	07/04/2022	53.39
07/04/2022	57.52					10/04/2022	47.54					07/04/2022	58.58	07/04/2022	58.19	07/04/2022	53.36
08/04/2022	57.62					10/04/2022	47.52					08/04/2022	58.99	08/04/2022	58.16	07/04/2022	53.2
08/04/2022	57.19					10/04/2022	47.43					08/04/2022	59.00	08/04/2022	58.14	08/04/2022	53.17
08/04/2022	57.60					10/04/2022	46.78					08/04/2022	58.59	08/04/2022	58.12	08/04/2022	53.37
08/04/2022	57.31					11/04/2022	48.09					08/04/2022	58.81	08/04/2022	58.11	08/04/2022	53.09
09/04/2022	57.57											09/04/2022	58.92	09/04/2022	58.08	08/04/2022	53.22
09/04/2022	57.59											09/04/2022	58.93	09/04/2022	58.04	09/04/2022	53.15
09/04/2022	57.55											09/04/2022	58.86	09/04/2022	58.03	09/04/2022	53.16
09/04/2022	57.56											09/04/2022	58.79	09/04/2022	58.01	09/04/2022	53.12
10/04/2022	57.55											10/04/2022	58.86	10/04/2022	57.99	09/04/2022	52.98
10/04/2022	57.59											10/04/2022	58.87	10/04/2022	57.98	10/04/2022	53.03
10/04/2022	57.57											10/04/2022	58.82	10/04/2022	57.97	10/04/2022	52.92
10/04/2022	57.57											10/04/2022	58.78	10/04/2022	57.97	10/04/2022	53.15
11/04/2022	57.59											11/04/2022	58.85	11/04/2022	57.95	10/04/2022	52.65
												11/04/2022	58.75	11/04/2022	57.94	11/04/2022	53.03
																11/04/2022	53.08

TD_MW1		TD_MW2		TD_MW3		TD_MW4		TD_MW5		TD_MW6		TD_MW7		TD_MW8	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
14/07/2021	54.63	14/07/2021	59.94	14/07/2021	66.75	09/09/2021	63.85	14/07/2021	65.53	07/09/2021	58.0	18/10/2021	55.00	18/10/2021	39.43
09/09/2021	54.03	28/07/2021	59.99	16/08/2021	66.75	20/09/2021	63.70	16/08/2021	64.53	09/09/2021	58.1	01/11/2021	54.72	01/11/2021	40.47
20/09/2021	53.83	16/08/2021	60.09	09/09/2021	66.75	05/10/2021	53.04	09/09/2021	65.03	20/09/2021	55.1	15/11/2021	54.42	15/11/2021	40.11
18/10/2021	51.76	09/09/2021	59.24	20/09/2021	66.70	12/10/2021	53.90	20/09/2021	64.33	05/10/2021	58.1	23/11/2021	53.02	23/11/2021	29.80
01/11/2021	50.80	20/09/2021	58.84	05/10/2021	66.70	18/10/2021	53.04	05/10/2021	65.43	12/10/2021	58.12	24/11/2021	54.12	24/11/2021	27.90
22/11/2021	45.79	05/10/2021	59.44	18/10/2021	66.63	01/11/2021	54.69	18/10/2021	63.03	18/10/2021	58.1	25/11/2021	54.12	25/11/2021	27.90
23/11/2021	43.83	18/10/2021	58.84	01/11/2021	66.70	15/11/2021	63.65	01/11/2021	65.38	01/11/2021	58.2	26/11/2021	53.42	26/11/2021	24.38
24/11/2021	45.08	01/11/2021	59.08	15/11/2021	66.66	22/11/2021	64.20	15/11/2021	65.83	15/11/2021	58.7	27/11/2021	53.86	27/11/2021	22.75
25/11/2021	43.83	15/11/2021	59.18	22/11/2021	66.58	22/11/2021	64.30	22/11/2021	65.83	22/11/2021	58.4	28/11/2021	52.94	28/11/2021	22.02
26/11/2021	41.38	22/11/2021	58.84	23/11/2021	66.60	23/11/2021	53.90	23/11/2021	65.83	23/11/2021	55.8	29/11/2021	52.67	29/11/2021	21.33
27/11/2021	40.03	23/11/2021	58.64	24/11/2021	66.60	24/11/2021	53.90	24/11/2021	65.83	24/11/2021	58.8	30/11/2021	52.47	30/11/2021	20.40
28/11/2021	39.50	24/11/2021	58.64	25/11/2021	66.60	25/11/2021	60.09	25/11/2021	65.83	25/11/2021	58.6	01/12/2021	52.11	01/12/2021	19.71
29/11/2021	33.27	25/11/2021	58.58	26/11/2021	66.60	26/11/2021	61.24	26/11/2021	65.83	26/11/2021	58.4	02/12/2021	51.87	02/12/2021	19.37
30/11/2021	34.63	26/11/2021	58.54	27/11/2021	66.60	27/11/2021	60.80	27/11/2021	65.68	27/11/2021	58.7	03/12/2021	51.77	03/12/2021	20.31
01/12/2021	35.94	27/11/2021	58.34	28/11/2021	67.50	28/11/2021	61.24	28/11/2021	65.83	28/11/2021	58.7	04/12/2021	51.53	04/12/2021	20.90
02/12/2021	35.73	28/11/2021	58.43	29/11/2021	66.67	29/11/2021	61.30	29/11/2021	65.53	29/11/2021	58.6	05/12/2021	51.22	05/12/2021	23.24
03/12/2021	33.23	29/11/2021	58.42	30/11/2021	66.64	30/11/2021	51.81	30/11/2021	65.12	30/11/2021	56.0	06/12/2021	51.12	06/12/2021	25.56
04/12/2021	30.99	30/11/2021	58.34	01/12/2021	66.60	01/12/2021	60.81	01/12/2021	65.83	01/12/2021	58.6	07/12/2021	51.13	07/12/2021	26.69
05/12/2021	35.86	01/12/2021	58.33	02/12/2021	66.60	02/12/2021	60.60	02/12/2021	63.92	02/12/2021	58.6	08/12/2021	50.70	08/12/2021	30.44
06/12/2021	32.53	02/12/2021	58.09	03/12/2021	66.63	03/12/2021	60.38	03/12/2021	64.93	03/12/2021	59.0	09/12/2021	50.81	09/12/2021	38.77
07/12/2021	36.55	03/12/2021	58.24	04/12/2021	67.50	04/12/2021	57.32	04/12/2021	65.63	04/12/2021	59.1	10/12/2021	50.70	10/12/2021	39.19
08/12/2021	30.03	04/12/2021	58.24	05/12/2021	66.70	05/12/2021	61.20	05/12/2021	66.33	05/12/2021	59.1	11/12/2021	50.64	11/12/2021	40.68
09/12/2021	35.88	05/12/2021	58.24	06/12/2021	66.60	06/12/2021	61.72	06/12/2021	65.83	06/12/2021	58.9	12/12/2021	50.61	12/12/2021	39.41
10/12/2021	35.38	06/12/2021	58.64	07/12/2021	66.75	07/12/2021	62.10	07/12/2021	65.33	07/12/2021	59.2	13/12/2021	50.50	13/12/2021	37.05
11/12/2021	39.34	07/12/2021	58.5	08/12/2021	66.75	08/12/2021	61.10	08/12/2021	65.83	08/12/2021	59.4	14/12/2021	50.50	14/12/2021	35.71
12/12/2021	35.91	08/12/2021	58.62	09/12/2021	66.70	09/12/2021	61.29	09/12/2021	59.72	09/12/2021	59.3	15/12/2021	50.42	15/12/2021	34.08
13/12/2021	31.01	09/12/2021	58.34	10/12/2021	66.75	10/12/2021	61.40	10/12/2021	65.83	10/12/2021	59.4	16/12/2021	50.41	16/12/2021	33.71
14/12/2021	63.33	10/12/2021	58.34	11/12/2021	66.75	11/12/2021	69.60	11/12/2021	65.78	11/12/2021	59.4	17/12/2021	50.35	17/12/2021	34.72
15/12/2021	37.22	11/12/2021	58.49	12/12/2021	66.72	12/12/2021	69.60	12/12/2021	65.83	12/12/2021	59.5	18/12/2021	50.39	18/12/2021	34.20
16/12/2021	37.38	12/12/2021	58.46	13/12/2021	66.69	13/12/2021	62.50	13/12/2021	65.83	13/12/2021	59.4	19/12/2021	50.37	19/12/2021	33.90
17/12/2021	41.68	13/12/2021	58.62	14/12/2021	66.70	14/12/2021	55.89	14/12/2021	65.83	14/12/2021	58.7	20/12/2021	50.34	20/12/2021	34.05
18/12/2021	38.03	14/12/2021	58.50	15/12/2021	66.70	15/12/2021	69.60	15/12/2021	65.83	15/12/2021	59.3	21/12/2021		21/12/2021	34.47
19/12/2021	37.28	15/12/2021	58.54	16/12/2021	66.65	16/12/2021	61.91	16/12/2021	64.23	16/12/2021	59.4	22/12/2021	49.11	22/12/2021	47.50
20/12/2021	36.80	16/12/2021	58.54	17/12/2021	66.69	17/12/2021	62.62	17/12/2021	65.48	17/12/2021	59.1	23/12/2021	50.23	23/12/2021	44.47
21/12/2021	41.99	17/12/2021	58.52	18/12/2021	66.70	18/12/2021	62.47	18/12/2021	65.83	18/12/2021	59.3	24/12/2021	50.27	24/12/2021	44.73
22/12/2021	43.62	18/12/2021	58.67	19/12/2021	66.68	19/12/2021	62.70	19/12/2021	65.83	19/12/2021	59.3	25/12/2021		25/12/2021	
23/12/2021	44.02	19/12/2021	58.72	20/12/2021	66.68	20/12/2021	62.80	20/12/2021	65.83	20/12/2021	59.4	26/12/2021	50.32	26/12/2021	55.74
24/12/2021	43.43	20/12/2021	58.33	21/12/2021	66.69	21/12/2021	62.83	21/12/2021	65.83	21/12/2021	59.0	27/12/2021	50.28	27/12/2021	56.08
25/12/2021		21/12/2021	58.54	22/12/2021	66.69	22/12/2021	62.83	22/12/2021	65.83	22/12/2021	59.0	28/12/2021	50.3	28/12/2021	56.12
26/12/2021	42.25	22/12/2021	58.56	23/12/2021	66.68	23/12/2021	62.79	23/12/2021	65.62	23/12/2021	59.0	29/12/2021	50.3	29/12/2021	56.28
27/12/2021	44.23	23/12/2021	58.53	24/12/2021	66.69	24/12/2021	63.0	24/12/2021	65.83	24/12/2021	59.4	30/12/2021	50.3	30/12/2021	56.35
28/12/2021	43.71	24/12/2021	58.84	25/12/2021		25/12/2021		25/12/2021		25/12/2021		31/12/2021	50.4	31/12/2021	56.49
29/12/2021	44.88	25/12/2021		26/12/2021	66.70	26/12/2021	63.3	26/12/2021	65.83	26/12/2021	59.61	01/01/2022	50.5	01/01/2022	56.53
30/12/2021	46.02	26/12/2021	58.90	27/12/2021	66.70	27/12/2021	63.4	27/12/2021	65.83	27/12/2021	59.60	02/01/2022	50.5	02/01/2022	56.34
31/12/2021	46.32	27/12/2021	59.04	28/12/2021	66.70	28/12/2021	63.4	28/12/2021	65.83	28/12/2021	59.58	03/01/2022	50.6	03/01/2022	56.04
01/01/2022	45.68	28/12/2021	59.08	29/12/2021	66.70	29/12/2021	63.50	29/12/2021	65.83	29/12/2021	59.6	04/01/2022	50.66	04/01/2022	56.21
02/01/2022	46.84	29/12/2021	59.15	30/12/2021	66.70	30/12/2021	63.49	30/12/2021	65.83	30/12/2021	59.59	05/01/2022	50.73	05/01/2022	56.12
03/01/2022	44.81	30/12/2021	59.19	31/12/2021	66.70	31/12/2021	63.64	31/12/2021	65.83	31/12/2021	59.64	06/01/2022	50.88	06/01/2022	55.01
04/01/2022	46.04	31/12/2021	59.26	01/01/2022	66.70	01/01/2022	63.69	01/01/2022	65.83	01/01/2022	59.65	07/01/2022	50.94	07/01/2022	54.76
05/01/2022	47.27	01/01/2022	59.30	02/01/2022	66.70	02/01/2022	63.69	02/01/2022	65.83	02/01/2022	59.61	08/01/2022	51.07	08/01/2022	54.25
06/01/2022	46.13	02/01/2022	59.42	03/01/2022	66.70	03/01/2022	54.90	03/01/2022	65.83	03/01/2022	59.66	09/01/2022	51.11	09/01/2022	54.11
07/01/2022	47.64	03/01/2022	59.38	04/01/2022	66.70	04/01/2022	63.02	04/01/2022	65.8	04/01/2022	59.63	10/01/2022	51.17	10/01/2022	53.75
08/01/2022	47.55	04/01/2022	59.34	05/01/2022	66.70	05/01/2022	63.59	05/01/2022	65.8	05/01/2022	59.57	11/01/2022	51.20	11/01/2022	52.98
09/01/2022	47.68	05/01/2022	59.38	06/01/2022	57.70	06/01/2022	68.8	44567	65.83	06/01/2022	56.57	12/01/2022	51.25	12/01/2022	51.60

TD_MW1		TD_MW2		TD_MW3		TD_MW4		TD_MW5		TD_MW6		TD_MW7		TD_MW8	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
10/01/2022	47.98	06/01/2022	59.45	07/01/2022	66.70	07/01/2022	64.29	44568	65.83	07/01/2022	59.47	13/01/2022	51.37	13/01/2022	50.07
11/01/2022	48.32	07/01/2022	59.47	08/01/2022	66.70	08/01/2022	63.89	08/01/2022	65.8	08/01/2022	59.59	14/01/2022	51.30	14/01/2022	47.68
12/01/2022	48.38	08/01/2022	59.45	09/01/2022	66.70	09/01/2022	63.8	09/01/2022	65.8	09/01/2022	59.58	15/01/2022	51.60	15/01/2022	45.96
13/01/2022	48.68	09/01/2022	59.50	10/01/2022	66.70	10/01/2022	63.8	10/01/2022	65.8	10/01/2022	59.2	16/01/2022	51.62	16/01/2022	46.02
14/01/2022	49.32	10/01/2022	59.59	11/01/2022	66.70	11/01/2022	55.4	11/01/2022	65.8	11/01/2022	59.5	17/01/2022	51.64	17/01/2022	45.29
15/01/2022	49.03	11/01/2022	59.46	12/01/2022	66.70	12/01/2022	69.6	12/01/2022	65.8	12/01/2022	59.5	18/01/2022	51.42	18/01/2022	44.90
16/01/2022	48.84	12/01/2022	59.31	13/01/2022	66.70	13/01/2022	61.7	13/01/2022	65.83	13/01/2022	59.3	19/01/2022	51.80	19/01/2022	44.85
17/01/2022	49.65	13/01/2022	59.38	14/01/2022	66.70	14/01/2022	54.3	14/01/2022	65.83	14/01/2022	56.6	20/01/2022	51.80	20/01/2022	44.81
18/01/2022	48.93	14/01/2022	59.39	15/01/2022	66.70	15/01/2022	69.6	15/01/2022	65.83	15/01/2022	59.4	21/01/2022	51.90	21/01/2022	44.81
19/01/2022	49.14	15/01/2022	59.32	16/01/2022	66.70	16/01/2022	62.87	16/01/2022	65.83	16/01/2022	59.4	22/01/2022	51.92	22/01/2022	44.80
20/01/2022	49.99	16/01/2022	59.29	17/01/2022	66.69	17/01/2022	69.60	17/01/2022	65.83	17/01/2022	59.36	23/01/2022	52.00	23/01/2022	44.71
21/01/2022	44.02	17/01/2022	59.33	18/01/2022	66.70	18/01/2022	59.95	18/01/2022	65.83	18/01/2022	59.24	24/01/2022	52.03	24/01/2022	44.72
22/01/2022	49.17	18/01/2022	59.12	19/01/2022	66.70	19/01/2022	53.70	19/01/2022	65.81	19/01/2022	59.47	25/01/2022	52.08	25/01/2022	44.71
23/01/2022	47.83	19/01/2022	59.19	20/01/2022	66.70	20/01/2022	59.38	20/01/2022	65.81	20/01/2022	59.30	26/01/2022	52.03	26/01/2022	44.70
24/01/2022	47.18	20/01/2022	58.94	21/01/2022	66.70	21/01/2022	51.80	21/01/2022	65.81	21/01/2022	59.22	27/01/2022	52.17	27/01/2022	44.60
25/01/2022	49.85	21/01/2022	58.97	22/01/2022	66.70	22/01/2022	59.76	22/01/2022	65.83	22/01/2022	59.24	28/01/2022	52.11	28/01/2022	44.60
26/01/2022	50.03	22/01/2022	58.79	23/01/2022	66.70	23/01/2022	62.45	23/01/2022	65.83	23/01/2022	59.24	29/01/2022	52.22	29/01/2022	44.58
27/01/2022	49.93	23/01/2022	59.04	24/01/2022	66.70	24/01/2022	61.40	24/01/2022	65.83	24/01/2022	59.24	30/01/2022	52.25	30/01/2022	44.45
28/01/2022	49.69	24/01/2022	59.12	25/01/2022	66.70	25/01/2022	57.50	25/01/2022	65.83	25/01/2022	59.02	31/01/2022	52.07	31/01/2022	44.20
29/01/2022	48.42	25/01/2022	58.99	26/01/2022	66.70	26/01/2022	53.47	26/01/2022	65.78	26/01/2022	59.12	01/02/2022	52.12	01/02/2022	44.20
30/01/2022	48.23	26/01/2022	58.81	27/01/2022	66.70	27/01/2022	57.04	27/01/2022	65.78	27/01/2022	59.25	02/02/2022	52.14	02/02/2022	44.18
31/01/2022	50.53	27/01/2022	58.96	28/01/2022	66.70	28/01/2022	54.15	28/01/2022	65.83	28/01/2022	59.12	03/02/2022	52.21	03/02/2022	44.16
01/02/2022	48.31	28/01/2022	58.84	29/01/2022	66.70	29/01/2022	58.25	29/01/2022	65.83	29/01/2022	59.12	04/02/2022	52.07	04/02/2022	44.20
02/02/2022	48.21	29/01/2022	58.74	30/01/2022	66.52	30/01/2022	54.50	30/01/2022	65.83	30/01/2022	58.93	05/02/2022	52.40	05/02/2022	44.25
03/02/2022	48.94	30/01/2022	58.69	31/01/2022	66.68	31/01/2022	53.05	31/01/2022	65.78	31/01/2022	59.18	06/02/2022	52.46	06/02/2022	44.65
04/02/2022	48.94	31/01/2022	58.89	01/02/2022	66.68	01/02/2022	52.85	01/02/2022	65.78	01/02/2022	59.17	07/02/2022	52.22	07/02/2022	46.59
05/02/2022	48.91	01/02/2022	58.69	02/02/2022	66.69	02/02/2022	61.50	02/02/2022	65.78	02/02/2022	59.00	08/02/2022	52.22	08/02/2022	47.80
06/02/2022	49.48	02/02/2022	58.84	03/02/2022	66.68	03/02/2022	59.50	03/02/2022	65.83	03/02/2022	59.12	09/02/2022	52.28	09/02/2022	49.43
07/02/2022	48.68	03/02/2022	58.74	04/02/2022	66.68	04/02/2022	59.50	04/02/2022	65.83	04/02/2022	59.12	10/02/2022	52.34	10/02/2022	51.28
08/02/2022	48.66	04/02/2022	58.74	05/02/2022	66.68	05/02/2022	69.60	05/02/2022	65.83	05/02/2022	59.17	11/02/2022	52.28	11/02/2022	51.45
09/02/2022	48.78	05/02/2022	58.76	06/02/2022	66.70	06/02/2022	62.25	06/02/2022	65.83	06/02/2022	59.30	12/02/2022	52.49	12/02/2022	50.96
10/02/2022	48.88	06/02/2022	58.90	07/02/2022	66.69	07/02/2022	62.70	07/02/2022	65.83	07/02/2022	59.32	13/02/2022	52.77	13/02/2022	51.95
11/02/2022	49.66	07/02/2022	58.97	08/02/2022	66.70	08/02/2022	58.84	08/02/2022	65.83	08/02/2022	59.27	14/02/2022	52.55	14/02/2022	52.38
12/02/2022	50.41	08/02/2022	58.98	09/02/2022	66.70	09/02/2022	61.50	09/02/2022	65.81	09/02/2022	59.20	15/02/2022	52.64	15/02/2022	52.99
13/02/2022	50.53	09/02/2022	58.96	10/02/2022	66.71	10/02/2022	63.10	10/02/2022	65.73	10/02/2022	58.87	16/02/2022	52.72	16/02/2022	53.07
14/02/2022	49.08	10/02/2022	59.19	11/02/2022	66.71	11/02/2022	62.99	11/02/2022	65.83	11/02/2022	59.24	17/02/2022	52.68	17/02/2022	53.26
15/02/2022	49.58	11/02/2022	59.27	12/02/2022	66.70	12/02/2022	63.70	12/02/2022	65.83	12/02/2022	59.17	18/02/2022	52.81	18/02/2022	53.53
16/02/2022	50.54	12/02/2022	59.59	13/02/2022	66.70	13/02/2022	63.85	13/02/2022	65.83	13/02/2022	59.43	19/02/2022	52.97	19/02/2022	55.29
17/02/2022	50.48	13/02/2022	59.59	14/02/2022	66.70	14/02/2022	63.70	14/02/2022	65.83	14/02/2022	59.40	20/02/2022	53.07	20/02/2022	56.05
18/02/2022	50.77	14/02/2022	58.97	15/02/2022	66.70	15/02/2022	53.04	15/02/2022	65.83	15/02/2022	59.41	21/02/2022	52.93	21/02/2022	55.22
19/02/2022	51.23	15/02/2022	60.79	16/02/2022	66.70	16/02/2022	53.90	16/02/2022	65.83	16/02/2022	59.43	22/02/2022	53.07	22/02/2022	55.30
20/02/2022	52.23	16/02/2022	60.76	17/02/2022	66.70	17/02/2022	53.04	17/02/2022	65.83	17/02/2022	59.37	23/02/2022	53.19	23/02/2022	55.32
21/02/2022	51.83	17/02/2022	60.75	18/02/2022	66.70	18/02/2022	54.69	18/02/2022	65.83	18/02/2022	59.37	24/02/2022	53.25	24/02/2022	55.31
22/02/2022	51.88	18/02/2022	60.91	19/02/2022	66.70	19/02/2022	63.65	19/02/2022	65.83	19/02/2022	59.51	25/02/2022	53.25	25/02/2022	55.29
23/02/2022	51.78	19/02/2022	59.64	20/02/2022	66.70	20/02/2022	64.20	20/02/2022	65.83	20/02/2022	59.63	26/02/2022	53.52	26/02/2022	55.72
24/02/2022	51.86	20/02/2022	59.84	21/02/2022	66.70	21/02/2022	64.30	21/02/2022	65.83	21/02/2022	59.64	27/02/2022	53.37	27/02/2022	55.41
25/02/2022	51.83	21/02/2022	61.30	22/02/2022	66.68	22/02/2022	53.90	22/02/2022	65.83	22/02/2022	59.64	28/02/2022	53.50	28/02/2022	55.38
26/02/2022	51.93	22/02/2022	61.33	23/02/2022	66.69	23/02/2022	61.35	23/02/2022	65.83	23/02/2022	59.64	01/03/2022	53.52	01/03/2022	55.33
27/02/2022	52.35	23/02/2022	61.30	24/02/2022	66.69	24/02/2022	63.90	24/02/2022	65.83	24/02/2022	59.44	02/03/2022	53.65	02/03/2022	54.97
28/02/2022	52.23	24/02/2022	61.44	25/02/2022	66.70	25/02/2022	63.90	25/02/2022	65.83	25/02/2022	59.59	03/03/2022	53.67	03/03/2022	54.86
01/03/2022	51.78	25/02/2022	61.26	26/02/2022	66.70	26/02/2022	62.90	26/02/2022	65.83	26/02/2022	59.54	04/03/2022	53.71	04/03/2022	54.33
02/03/2022	51.95	26/02/2022	59.84	27/02/2022	66.70	27/02/2022	63.80	27/02/2022	65.83	27/02/2022	59.32	05/03/2022	53.73	05/03/2022	55.68
03/03/2022	51.86	27/02/2022	59.76	28/02/2022	66.68	28/02/2022	63.65	28/02/2022	65.83	28/02/2022	59.35	06/03/2022	53.78	06/03/2022	55.12
04/03/2022	51.70	28/02/2022	61.44	01/03/2022	66.70	01/03/2022	63.48	01/03/2022	65.78	01/03/2022	59.28	07/03/2022	53.68	07/03/2022	55.17
05/03/2022	51.93	01/03/2022	59.50	02/03/2022	66.69	02/03/2022	64.05	02/03/2022	65.83	02/03/2022	59.23	08/03/2022	53.57	08/03/2022	56.04
06/03/2022	49.86	02/03/2022	59.50	03/03/2022	66.69	03/03/2022	64.05	03/03/2022	65.83	03/03/2022	59.27	09/03/2022	53.82	09/03/2022	54.68

TD_MW1		TD_MW2		TD_MW3		TD_MW4		TD_MW5		TD_MW6		TD_MW7		TD_MW8	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
07/03/2022	52.31	03/03/2022	59.64	04/03/2022	66.69	04/03/2022	64.05	04/03/2022	65.83	04/03/2022	59.18	10/03/2022	53.56	10/03/2022	54.64
08/03/2022	52.54	04/03/2022	59.79	05/03/2022	66.69	05/03/2022	64.05	05/03/2022	65.83	05/03/2022	59.28	11/03/2022	53.61	11/03/2022	55.29
09/03/2022	51.58	05/03/2022	59.74	06/03/2022	66.69	06/03/2022	64.08	06/03/2022	65.83	06/03/2022	59.30	12/03/2022	54.07	12/03/2022	55.03
10/03/2022	52.08	06/03/2022	59.70	07/03/2022	66.69	07/03/2022	63.73	07/03/2022	65.82	07/03/2022	59.31	13/03/2022	54.17	13/03/2022	55.48
11/03/2022	52.46	07/03/2022	59.64	08/03/2022	66.68	08/03/2022	62.88	08/03/2022	65.81	08/03/2022	59.31	14/03/2022	53.77	14/03/2022	56.65
12/03/2022	53.13	08/03/2022	59.64	09/03/2022	66.69	09/03/2022	64.05	09/03/2022	65.83	09/03/2022	59.17	15/03/2022	53.9	15/03/2022	56.67
13/03/2022	53.68	09/03/2022	59.66	10/03/2022	66.69	10/03/2022	54.40	10/03/2022	65.82	10/03/2022	59.27	16/03/2022	53.9	16/03/2022	56.6
14/03/2022	52.51	10/03/2022	59.59	11/03/2022	66.69	11/03/2022	58.40	11/03/2022	65.83	11/03/2022	58.67	17/03/2022	54.02	17/03/2022	55.55
15/03/2022	52.4	11/03/2022	59.59	12/03/2022	66.70	12/03/2022	55.90	12/03/2022	65.48	12/03/2022	59.31	18/03/2022	54.04	18/03/2022	55.35
16/03/2022	52.29	12/03/2022	59.69	13/03/2022	66.70	13/03/2022	63.75	13/03/2022	65.68	13/03/2022	59.49	19/03/2022	54.07	19/03/2022	55.1
17/03/2022	53.58	13/03/2022	59.84	14/03/2022	66.69	14/03/2022	63.55	14/03/2022	65.83	14/03/2022	59.48	20/03/2022	54.33	20/03/2022	54.69
18/03/2022	52.78	14/03/2022	59.59	15/03/2022	66.69	15/03/2022	63.55	15/03/2022	65.78	15/03/2022	59.44	21/03/2022	54.22	21/03/2022	55.35
19/03/2022	52.53	15/03/2022	59.65	16/03/2022	66.69	16/03/2022	63.60	16/03/2022	65.77	16/03/2022	59.40	22/03/2022	54.24	22/03/2022	55.01
20/03/2022	53.68	16/03/2022	54.48	17/03/2022	66.70	17/03/2022	63.88	17/03/2022	65.83	17/03/2022	59.27	23/03/2022	54.26	23/03/2022	54.76
21/03/2022	53.83	17/03/2022	59.69	18/03/2022	66.70	18/03/2022	63.84	18/03/2022	65.83	18/03/2022	59.32	24/03/2022	54.28	24/03/2022	54.27
22/03/2022	53.85	18/03/2022	59.79	19/03/2022	66.70	19/03/2022	63.95	19/03/2022	65.83	19/03/2022	59.24	25/03/2022	54.29	25/03/2022	53.85
23/03/2022	53.89	19/03/2022	59.73	20/03/2022	66.70	20/03/2022	64.05	20/03/2022	65.83	20/03/2022	59.31	26/03/2022	54.24	26/03/2022	53.57
24/03/2022	53.93	20/03/2022	59.77	21/03/2022	66.70	21/03/2022	55.40	21/03/2022	65.83	21/03/2022	59.30	27/03/2022	54.33	27/03/2022	53.29
25/03/2022	53.71	21/03/2022	59.83	22/03/2022	66.67	22/03/2022	63.95	22/03/2022	65.82	22/03/2022	59.40	28/03/2022	54.4	28/03/2022	53.03
26/03/2022	53.05	22/03/2022	59.76	23/03/2022	66.69	23/03/2022	63.25	23/03/2022	65.82	23/03/2022	59.37	28/03/2022	54.38	28/03/2022	53.07
27/03/2022	53.05	23/03/2022	59.65	24/03/2022	66.68	24/03/2022	53.78	24/03/2022	65.81	24/03/2022	59.34	28/03/2022	54.4	28/03/2022	52.97
28/03/2022	54.31	24/03/2022	59.72	25/03/2022	66.65	25/03/2022	63.25	25/03/2022	65.83	25/03/2022	59.24	28/03/2022	54.4	28/03/2022	53.21
28/03/2022	54.22	25/03/2022	59.70	26/03/2022	66.49	26/03/2022	64.18	26/03/2022	65.83	26/03/2022	58.94	28/03/2022	54.42	28/03/2022	53.11
28/03/2022	54.38	26/03/2022	59.52	27/03/2022	66.46	27/03/2022	63	27/03/2022	65.83	27/03/2022	58.97	29/03/2022	54.42	29/03/2022	53
28/03/2022	54.31	27/03/2022	59.49	28/03/2022	66.64	28/03/2022	63.1	28/03/2022	65.78	28/03/2022	59.26	29/03/2022	54.44	29/03/2022	52.89
28/03/2022	54.14	28/03/2022	59.78	28/03/2022	66.64	28/03/2022	63.1	28/03/2022	65.78	28/03/2022	59.26	29/03/2022	54.44	29/03/2022	52.78
29/03/2022	54.46	28/03/2022	59.73	29/03/2022	66.64	29/03/2022	63.7	29/03/2022	65.82	28/03/2022	59.26	29/03/2022	54.45	29/03/2022	52.65
29/03/2022	54.78	28/03/2022	59.81	30/03/2022	66.64	30/03/2022	61.8	30/03/2022	65.83	28/03/2022	59.26	30/03/2022	54.45	30/03/2022	52.54
29/03/2022	54.45	28/03/2022	59.78	31/03/2022	66.64	31/03/2022	63.8	31/03/2022	65.83	28/03/2022	59.23	30/03/2022	54.46	30/03/2022	52.4
29/03/2022	53.66	28/03/2022	59.69	01/04/2022	66.64	01/04/2022	62.8	01/04/2022	65.83	29/03/2022	59.32	30/03/2022	54.46	30/03/2022	52.28
30/03/2022	54.61	29/03/2022	59.83	04/04/2022	66.64	04/04/2022	53.8	04/04/2022	65.83	29/03/2022	59.35	30/03/2022	54.44	30/03/2022	52.2
30/03/2022	54.61	29/03/2022	59.90	11/04/2022	66.64	11/04/2022	63.8	11/04/2022	65.83	29/03/2022	59.35	31/03/2022	54.42	31/03/2022	52.07
30/03/2022	54.47	29/03/2022	59.82							29/03/2022	59.34	31/03/2022	54.42	31/03/2022	51.93
30/03/2022	53.65	29/03/2022	59.71							30/03/2022	59.34	31/03/2022	54.41	31/03/2022	51.81
31/03/2022	54.58	30/03/2022	59.75							30/03/2022	59.35	31/03/2022	54.42	31/03/2022	51.68
31/03/2022	54.81	30/03/2022	59.70							30/03/2022	59.33	01/04/2022	54.4	01/04/2022	51.55
31/03/2022	54.49	30/03/2022	59.66							30/03/2022	59.3	01/04/2022	54.4	01/04/2022	51.42
31/03/2022	53.39	30/03/2022	59.63							31/03/2022	59.29	01/04/2022	54.41	01/04/2022	51.31
01/04/2022	54.44	31/03/2022	59.70							31/03/2022	59.31	01/04/2022	54.42	01/04/2022	51.21
01/04/2022	54.54	31/03/2022	59.77							31/03/2022	59.25	02/04/2022	54.43	02/04/2022	51.09
01/04/2022	54.12	31/03/2022	59.60							31/03/2022	56.4	02/04/2022	54.43	02/04/2022	50.99
01/04/2022	53.99	31/03/2022	59.53							01/04/2022	59.2	02/04/2022	54.43	02/04/2022	50.89
02/04/2022	54.50	01/04/2022	59.59							01/04/2022	59.23	02/04/2022	54.43	02/04/2022	50.79
02/04/2022	54.74	01/04/2022	59.63							01/04/2022	59.14	03/04/2022	54.42	03/04/2022	50.69
02/04/2022	54.29	01/04/2022	59.57							01/04/2022	58.88	03/04/2022	54.43	03/04/2022	50.59
02/04/2022	53.58	01/04/2022	59.56							02/04/2022	59.19	03/04/2022	54.43	03/04/2022	50.51
03/04/2022	54.44	02/04/2022	59.66							02/04/2022	59.23	03/04/2022	54.49	03/04/2022	50.43
03/04/2022	54.53	02/04/2022	59.73							02/04/2022	59.15	04/04/2022	54.49	04/04/2022	50.35
03/04/2022	53.53	02/04/2022	59.59							02/04/2022	59.21	04/04/2022	54.52	04/04/2022	50.29
03/04/2022	53.29	02/04/2022	59.57							03/04/2022	59.24	04/04/2022	55.43	04/04/2022	47.85
04/04/2022	54.67	03/04/2022	59.67							03/04/2022	59.25	04/04/2022	55.17	04/04/2022	50.32
04/04/2022	54.86	03/04/2022	59.73							03/04/2022	59.25	04/04/2022	55.18	04/04/2022	50.26
04/04/2022	54.57	03/04/2022	59.63							03/04/2022	59.27	05/04/2022	55.18	05/04/2022	50.21
04/04/2022	54.37	03/04/2022	59.58							04/04/2022	59.27	05/04/2022	55.19	05/04/2022	50.15
05/04/2022	55.79	04/04/2022	59.71							04/04/2022	59.28	05/04/2022	55.19	05/04/2022	50.11
05/04/2022	55.95	04/04/2022	59.76							04/04/2022	58.77	05/04/2022	55.24	05/04/2022	50.05

TD_MW1		TD_MW2		TD_MW3		TD_MW4		TD_MW5		TD_MW6		TD_MW7		TD_MW8	
Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod	Date	WL_maod
05/04/2022	55.89	04/04/2022	59.49							04/04/2022	58.77	06/04/2022	55.25	06/04/2022	50.02
05/04/2022	55.48	04/04/2022	59.74							04/04/2022	60.18	06/04/2022	55.27	06/04/2022	49.98
06/04/2022	56.03	04/04/2022	59.55							04/04/2022	60.23	06/04/2022	55.28	06/04/2022	49.95
06/04/2022	56.30	05/04/2022	59.61							05/04/2022	60.23	06/04/2022	55.31	06/04/2022	49.92
06/04/2022	56.21	05/04/2022	59.70							05/04/2022	60.23	07/04/2022	55.32	07/04/2022	49.93
06/04/2022	55.54	05/04/2022	59.68							05/04/2022	60.05	07/04/2022	55.25	07/04/2022	49.91
07/04/2022	56.16	05/04/2022	59.66							05/04/2022	60.18	07/04/2022	55.18	07/04/2022	49.89
07/04/2022	56.13	06/04/2022	59.76							06/04/2022	60.22	07/04/2022	55.17	07/04/2022	49.85
07/04/2022	56.06	06/04/2022	59.77							06/04/2022	60.23	08/04/2022	55.16	08/04/2022	49.83
07/04/2022	55.89	06/04/2022	59.62							06/04/2022	57.14	08/04/2022	55.17	08/04/2022	49.79
08/04/2022	56.11	06/04/2022	59.53							06/04/2022	60.15	08/04/2022	55.16	08/04/2022	49.77
08/04/2022	56.22	07/04/2022	59.60							07/04/2022	60.2	08/04/2022	55.13	08/04/2022	49.75
08/04/2022	56.14	07/04/2022	59.63							07/04/2022	60.21	09/04/2022	55.12	09/04/2022	49.72
08/04/2022	55.63	07/04/2022	59.61							07/04/2022	60	09/04/2022	55.12	09/04/2022	49.69
09/04/2022	55.90	07/04/2022	59.61							07/04/2022	60.14	09/04/2022	55.11	09/04/2022	49.66
09/04/2022	55.90	08/04/2022	59.70							08/04/2022	60.17	09/04/2022	55.12	09/04/2022	49.63
09/04/2022	55.86	08/04/2022	59.74							08/04/2022	60.18	10/04/2022	55.14	10/04/2022	49.61
09/04/2022	55.63	08/04/2022	59.68							08/04/2022	60.18	10/04/2022	55.16	10/04/2022	49.59
10/04/2022	55.99	08/04/2022	59.63							08/04/2022	60.16	10/04/2022	55.16	10/04/2022	49.61
10/04/2022	56.11	09/04/2022	59.69							09/04/2022	60.17	10/04/2022	55.19	10/04/2022	49.6
10/04/2022	55.67	09/04/2022	59.72							09/04/2022	60.18	11/04/2022	55.19	11/04/2022	49.57
10/04/2022	55.59	09/04/2022	59.64							09/04/2022	60.15	11/04/2022	55.21	11/04/2022	49.56
11/04/2022	56.02	09/04/2022	59.54							09/04/2022	60.16				
11/04/2022	56.02	10/04/2022	59.67							10/04/2022	60.16				
		10/04/2022	59.68							10/04/2022	60.17				
		10/04/2022	59.69							10/04/2022	60.16				
		10/04/2022	59.65							10/04/2022	60.16				
		11/04/2022	59.73							11/04/2022	60.17				
		11/04/2022	59.79												

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