Department of Energy, Mines, Industry Regulation & Safety (DEMIRS)

ABANDONED MINE FEATURES ASSESSMENT

WHEAL ELLEN, WA
REHABILITATION REPORT

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WML
Consulting Engineers

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1 INTRODUCTION

The Department of Energy, Mines, Industry Regulation & Safety (DEMIRS) engaged WML Consultants (WML) to undertake an intrusive geotechnical assessment of abandoned mine features at Wheal Ellen, in Northampton, Western Australia and to update the GHD 2020 rehabilitation options report. These include shafts, open cuts, stopes, costeans, and shallow workings. Based on the geotechnical investigation undertaken in November of 2024, a total of 37 abandoned mine features occurring below ground were assessed. Above ground features were not assessed as these included dumps, stockpiles, tailing storage facilities, buildings, and infrastructure, which do not present a below ground void safety risk. This report presents a review of the previous rehabilitation recommendations and provides alternative rehabilitation solutions based on the findings discussed in the accompanying geotechnical report, 11953-G-R-001. The report includes detailed descriptions, sketches, and discussions for each rehabilitation solution.

The rehabilitation study was authorised by DEMIRS via Purchase Order 502890 Rev 3, dated 27th of August 2024.

This report and the information presented herein must be read in conjunction with the attached "*Report Limitations*".

1.1 Client supplied information

The following information was made available from the Client for the purpose of this report:

- Drone aerial imagery, circa 2020, prepared by DPLH.
- Abandoned Mines Inventory feature photographs at Wheal Ellen, circa 2000 and 2020, prepared by DEMIRS.
- Historical maps, surveys, and longitudinal sections of Wheal Ellen Lead Mine, provided by DEMIRS.
- Abandoned mine feature data set in excel format, prepared by DEMIRS.
- Remediation Methodology Report. Wheal Ellen Mine Shafts and Open Pits Remediation, October 2020, prepared by GHD. Report Number: 1253209-81785-32.
- Geotechnical Report. Wheal Ellen Mine Shafts and Open Pits Geotechnical Assessment and Remediation Methodology, September 2020, prepared by GHD. Report Number: 1253209-50132-10.

1.2 Objectives of this report

The objectives of this rehabilitation report are to:

- Review the suitability of previous rehabilitation recommendations prepared by GHD in light of information obtained during the intrusive investigation works.
- Recommend the 2020 rehabilitation solutions be implemented or provide alternative rehabilitation solutions for the below ground abandoned mine features.

WML have provided the following information for each proposed solution:

- Description and rationale.
- Schematics/drawings showing the process/arrangement/design.
- Plant and equipment required to do the works.
- Material specification where relevant (e.g. material type, sizing, density, moisture content) and volumes.
- Potential or likely sources of material.
- Timing and/or sequencing requirements.
- Potential risks to effective implementation including any impact from groundwater or unfavourable geochemistry where applicable.
- Post rehabilitation monitoring requirements.
- Personnel and specific technical expertise required.
- Suitability of each option against each known feature.

In addition, the rehabilitation recommendations have been assessed against the following criteria:

1. Provide a permanent solution to mitigate safety and geotechnical risks associated with the features, including any lateral workings and subsidence risk zones.
2. Minimise risk to personnel during construction.
3. Require minimal ongoing monitoring or maintenance.
4. Be technically feasible and cost-effective.
5. Minimise disturbance to the existing environment and heritage values.

2 PREVIOUS REHABILITATION RECOMMENDATIONS

GHD prepared a rehabilitation options report (Report Number: 1253209-81785-32) for the below ground abandoned mine features at Wheal Ellen in 2020, however, due to the limitations of the COVID 19 pandemic and the travel / work restrictions at the time, an intrusive investigation was not able to be undertaken, and the rehabilitation solutions presented in their report were designed based upon visual observations only. The recommended rehabilitation options (Treatments A to D) provided in the options report prepared by GHD (Report Number: 1253209-81785-32) comprise variations of directly backfilling the features with various grades of crushed rock and GHD's rehabilitation options have allowed for the "occasional occurrence of sinkholes along the lode sub-crop". WML do not consider this statement to meet the criteria for rehabilitation of abandoned mine features because future sinkholes may cause significant risk to human life.

WML have undertaken the intrusive geotechnical investigation at Wheal Ellen in November 2024 (Report Number: 11953-G-R-001) and have re-evaluated and re-assessed the suitability of the rehabilitation solutions for the abandoned mine features put forth by GHD in October 2020 (Report Number: 1253209-81785-32). Based on the revised criteria of not accepting future sinkhole occurrences, WML have provided alternative rehabilitation options in this report which are intended to be long-term and lasting solutions.

The accompanying geotechnical report, 11953-G-R-001, has categorised the features based on the type of feature. These are shown in Table 1 below. This table also summarises the WML's recommended rehabilitation solution for each of these categories. These are discussed in Section 3.

Table 1: Feature category and recommended rehabilitation

Feature Category	Feature Type	WML Recommended Rehabilitation
Category 1a	Rehabilitated features	Do not rehabilitate
Category 1b	Shallow workings & minor / imperceptible depressions	Do not rehabilitate
Category 2	Small depressions / shallow workings / costeans / trenches	Blade the area to soften the feature
Category 3	Shallow shafts and excavations with soft / unknown base conditions	Reinforced earth backfill
Category 4	Backfilled / waterlogged deep shafts	Concrete backfill
Category 5	Open pits / deep shafts that have been excavated to form open pits	Concrete and soil backfill
Category 6	Deep shafts	Concrete slab

During the intrusive geotechnical investigation, the base conditions of the features requiring rehabilitation (beyond blading the area to soften the feature), were unable to be validated (for Feature Categories 3 to 6). High groundwater levels were observed within the base of majority of the features; therefore, the base of the waterlogged features were unable to be investigated and validated along with features greater than 3.5 m deep.

For the Category 3 to 6 features, the available historical information also suggests that these are significantly deep shafts (ranging between 15 m – 80 m deep), and the historical maps suggest interconnectivity at depth and underground lateral workings between majority of these features.

Evidence of erosion gulleys and channels directed into and through some of these features, particularly the features situated within the main and old workings, were observed on site during the geotechnical investigation undertaken in November 2024. Majority of these features are situated downslope, and water would tend to drain towards and into

these features. It is likely that some or all these features are backfilled with silty materials which have been washed into the base during rainfall events.

During the investigation undertaken by GHD in 2020, a sinkhole was observed at Feature S0113147. It should be noted that this feature has been historically mapped to comprise lateral workings and is situated within an erosion gulley that transports with loose silty materials into the shaft. After periods of prolonged rainfall or after the wet season, these silty materials become saturated and can become suspended in water and have very little to no shear strength. In this condition, the soils are susceptible to sudden and catastrophic deformation (i.e. sinkholes) which occur because the soil cannot hold itself under its own weight and "liquifies". The soil in the base of the feature behaves like a liquid and flows downwards into the network of underground lateral mine workings (i.e. flow liquefaction).

Therefore, this evidence shows that backfilling these features is not considered a suitable rehabilitation option due to the following:

- The features have been historically recorded to be of significant depths (> 15 m).
- The features are filled with water; therefore, their current depths are unknown.
- The base conditions are unable to be investigated and potentially comprise false floors.
- The base of these features are likely partially filled with silty and dispersive materials and are known to comprise significant lateral workings based on the historic maps.
- The depth and the condition of any existing backfill material within these features is unknown (the features may be backfilled with rocky materials or fine-grained and dispersive materials).
- The risk of false floors opening up causing subsidence and sinkholes in the future is high.
- The features may also be temporarily plugged with rocky and/or soil backfill material sitting on top of metal sheeting, wooden planks, or tree branches. which may give the appearance of a well-backfilled shaft (i.e. false floor); however, this is likely to corrode and degrade one day in the future and would cause subsidence within the base as this material falls downwards and into the network of lateral workings.

Therefore, any backfill material cast into the base of these features has the potential to deform significantly at a future date when the support of the backfill material from the existing conditions fail. Sudden failure presents high risk to people walking around the site as these features may appear to be safely rehabilitated, however, could instantaneously subside at any time in the future.

GHD have identified that drainage improvement and regrading works are required to redirect drainage pathways that currently flow directly into these features. This would encourage water to flow away from the strike of the lode and prevent ponding within the features. WML agree with this recommendation and have also provided advice in Section 3.8 that aim to improve drainage and redirect surface water flow away from the mine features.

GHD have also commented on the risk of subsidence and the possibility of up to 1 m deep sinkholes occurring along the access road and have provided risk mitigation measures to be followed during the construction works. WML has assessed the 3D LiDAR scans and photographs of the rock mass visible above the water surface within the walls of the features. With an assumption there will be a modest increase in rock mass quality with increase in depth, various methods of underground stope stability assessments have been undertaken that indicate the expected underground stopes based upon historic mining records should be stable for a rock mass rating (RMR_{76}) of 40 – 50. WML have revised this risk to a lower level and this is discussed in Section 3.9.

3 WML REHABILITATION RECOMMENDATIONS

The rehabilitation solutions posed for each of the features have been designed to best minimise the risk of significant surface subsidence occurring and generating depressions which may cause more significant injuries. WML have considered the longevity of these rehabilitation recommendations and have provided solutions which are aimed to last hundreds of years into the future as well as be easily identifiable for future generations.

WML have also considered the cost feasibility and ease of constructability of these solutions to be carried out by local contractors, as well as constructing these solutions in a way that causes minimal impacts to the environment by way of minimal ground clearance and through the use of locally available and sustainably sourced fill materials.

The rehabilitation of these abandoned mine features have not been designed to allow for future land use / redevelopment, therefore, WML recommend leaving the locations of the rehabilitations easily identifiable by way of leaving the surface proud with backfill material and / or using metal plaques, engravings, or identifiers on the bridging solutions to make the locations obvious for people walking or driving around the area. The intent of this is to further minimise risk by limiting the public's interaction with these rehabilitated features.

Six (6) alternative rehabilitation recommendations have been assessed to potentially rehabilitate the 37 underground mining related features identified at Wheal Ellen. The following solutions will be detailed subsequently and include:

1. Leave as is – no rehabilitation required.
2. Blading the area to reduce steepness of slopes and soften the feature.
3. Reinforced earth backfill
4. Concrete plug
5. Reinforced earth cap – open cuts
6. Concrete slab cap

The six (6) feature categories identified in the accompanying geotechnical report, 11953-G-R-001, have been classified in accordance with observations made on site during the geotechnical investigation and in terms of the risk posed to humans, vehicles, livestock, and pets. The recommendations below pertain to the features assigned to these categories.

The following recommendations are based on the results of the intrusive site investigation undertaken in November of 2024. While the ground conditions appeared consistent across the site, the contractor should be aware the ground conditions may vary across the site and the excavatability of the natural strata may also vary due to variable depths of the extremely weathered rock layer. It should also be noted that whilst WML have attempted to identify voids and drives within each feature, the potential for unknown voids, drives and underground lateral workings may exist.

The following advice regarding construction equipment and timing is preliminary only, and the earthwork contractor should assess the site conditions to determine the exact requirements for machinery and construction equipment.

The rehabilitation solutions may require some modifications during construction pending observations of ground conditions and other variables. WML have made these recommendations on the assumption that the design engineer shall be on site during construction for some of the features, specifically the features filled with water, to advise and modify the methodology and rehabilitation specifics as required.

3.1 Leave as is – no rehabilitation required

Rehabilitation for up to 19 features is not considered necessary as they exist as Category 1a and 1b features, typically in the form of rehabilitated features or shallow workings / minor depressions on the ground surface, generally indiscernible from the natural topography of the site. The risk of void collapse and presence of / proximity to lateral workings is very low. These features also pose very low risk of trips and falls to humans, livestock, or pets, and a 4x4 vehicle should be able to traverse these features.

The base conditions have been validated during the geotechnical investigation and are considered to be stable.

If DEMIRS believes some rehabilitation is necessary to reduce risk, we recommend Solution 2 below be considered.

3.2 Blading the area to reduce steepness of slopes and soften the feature

This method may be suited to Category 2 features, should rehabilitation be required. These features typically exist as shallow workings, minor depressions, costeans, and trenches on the ground surface, mostly indiscernible from the natural topography of the site, however, are generally deeper than Category 1 features. The risk of void collapse and presence of / proximity to lateral workings is very low. These features also pose low risk of trips and falls to humans, livestock, or pets, and a 4x4 vehicle should be able to traverse these features.

The base conditions have been validated during the geotechnical investigation and are considered to be stable.

Five (5) features have been identified within the site where this solution may be suited:

Table 2: Blading rehabilitation recommended for selected features

Feature Category	Feature Number
Category 2	S0113104
	S0113118
	S0113125
	S0113133
	S0113163

Table 3: Blading rehabilitation recommendations

Requirements	Description
Plant and equipment	Posi track, small dozer, or 5t+ excavator.
Material specification for imported fill	No imported material is required. It is recommended the feature be backfilled and softened using the spoil surrounding the berm of these features.
Quantity / volume of material	See Section 4.
Potential source of material	Spoil piles around the berm of these features.
Timing	It is anticipated a single feature could be rehabilitated in a space of 30 min to 1 hour pending the amount of vegetation and debris that needs to be removed from the base and pruning/clearing to gain access to the feature, size of the feature, and machinery chosen for the work.
Potential environmental risk, including groundwater, flora and fauna	This may cause some disturbance to the existing ground surface and surrounding environment. Small trees may need to be removed in areas of dense vegetation to allow for a clear path for the equipment to access the feature locations. It is considered in most cases, small trees within and around the feature can be left in place as part of the rehabilitation process.
Potential risk to contractors and operators	At these features it has been determined that there is very low risk of underground features / lateral workings / subsidence. Therefore, these features pose very low additional risk to a competent earthwork contractor.
Personnel and technical expertise	Any competent and experienced earthwork contractor should be able to undertake this work.

Requirements	Description
Post rehabilitation maintenance and monitoring	None required.

3.3 Reinforced earth backfill

This rehabilitation method has been selected for Category 3 features, which have soft or unknown ground conditions at the base of these features. These features potentially contain a false floor and are at risk of voids opening up and collapsing. These features pose medium risk of trips and fallings into shafts to humans, livestock, and pets, and a 4x4 vehicle should not attempt to traverse these features.

Soil backfill is not considered suitable for these features as the base conditions of these features are unknown and have not been investigated. This method is suited for features where there exists concern that the floor may potentially give way and collapse, and where these features may extend deeper than they may appear.

Two (2) features have been identified within the site where this solution leads itself:

Table 4: Reinforced earth backfill recommended for selected features

Feature Category	Feature Number
Category 3	S0113122
	S0113143

Table 5: Reinforced earth backfill rehabilitation recommendations

Requirements	Description
Plant and equipment	7-22t+ excavator. The contractor should assess the reach of the excavator to ensure it can reach the base of these features. A small (up to 6t) dump truck to bring fill from the stockpiles across the site to the feature location. A loader or excavator to load the dump truck. If imported fill material is required: a tipper haul truck to import granular fill material to site.
Material specification for imported fill	Any imported fill material should comprise a clean inert granular material with a fines content < 15% and no particles > 100 mm. The top 300 mm of backfill must include at least 50% material passing the 2.36 mm sieve size and no particles > 25 mm. See Section 3.7.
Quantity / volume of material	See Section 4.
Potential source of material	Fill material exists on-site in the form of surrounding spoil piles and stockpiles which are considered geotechnically suitable for re-use as backfill. If DEMIRS deem this material unsuitable for re-use, imported fill material will be required. Site won fill material may also be used as described in Section 3.7. The contractor is to provide details of sustainable locally sourced, cost-effective fill material to the designer for approval. The fill needs to be a granular, clean, inert, natural material, however, there are no specific structural requirements of this material as it is simply backfilling an existing void. This can consist of spoil generated from nearby

Requirements	Description
	construction projects or be sourced commercially; however, the material must meet the specifications.
Timing	The timing is dependent on the contractor's ability, personnel and equipment used. We assume a typical time allowance for each feature, depending on its size, should take approximately 1-2 days.
Potential environmental risk, including groundwater, flora and fauna	This may cause some disturbance to the existing ground surface and surrounding environment.
Potential risk to contractors and operators	The contractor needs to ensure the haulage routes from stockpiled fill material (site won or imported) are safe and suitable. During the initial phases of the rehabilitation, we recommend machinery maintains a minimum setback distance of 3 m from the edge of these features. The contractor should be aware of slips, trips, and falls into these features, and the potential risk of ground collapse due to lateral workings / subsidence / underground features. Personnel should maintain a minimum setback distance of 1 m from the edge of these features.
Personnel and technical expertise	Any competent and experienced earthwork contractor should be able to undertake this work.
Post rehabilitation maintenance and monitoring	These features have been identified to have medium risk of lateral / deep workings below a false base, therefore one site visit, to conduct a visual assessment, 6 months after the rehabilitation has been completed, and flown surveys 2 years post rehabilitation and again 10 years post rehabilitation is recommended to assess the performance of the rehabilitation solution. If no deformation is observed 12 years post rehabilitation to the features, no further monitoring is required.

3.4 Concrete plug

Concrete may be used to backfill the base of the Category 4 features listed in Table 6. Some of these features will then be backfilled to the surface using suitable fill material.

A concrete plug for the Category 5 features listed below is also WML's preferred solution to rehabilitate these features, however, will be dependent on the nature of the base conditions observed during the rehabilitation work. Temporary dewatering shall be required to validate and observe the base conditions. If this cannot be achieved, and the location of the shafts within the base of these features cannot be identified, the reinforced backfill solution detailed in Section 3.5 will be required.

The exact dimensions of the concrete plug and required excavation works must be assessed and finalised at the detailed design stage. An assessment of the groundwater quality must be undertaken to inform the structural design.

This rehabilitation solution is suitable for nine (9) features:

Table 6: Concrete plug rehabilitation may be considered for selected features

Feature Category	Feature Number
Category 4	Old Workings Shaft
	Old Workings Pass

	S0113103
	S0113130
Category 5	S0113097
	S0113141
	S0113147
	S0113149
	S0113151

Table 7: Concrete plug rehabilitation recommendations

Requirements	Description
Plant and equipment	7-22t+ excavator. The contractor should assess the reach of the excavator to ensure it can reach the base of these features. A long reach excavator shall be required for Category 5 features. A small (up to 6t) dump truck to bring fill from the stockpiles across the site to the feature location. A loader or excavator to load the dump truck. Concrete truck and pump or cement mixer.
Material specification for imported fill	Any imported fill material should comprise a clean inert granular material with a fines content < 15% and no particles > 100 mm. The top 300 mm of backfill must include at least 50% material passing the 2.36 mm sieve size and no particles > 25 mm. See Section 3.7.
Quantity / volume of material	See Section 4.
Potential source of material	Fill material exists on-site in the form of surrounding spoil piles and stockpiles which are considered geotechnically suitable for re-use as backfill. This may be used to backfill Category 4 features. If DEMIRS deem this material unsuitable for re-use, imported fill material will be required. Imported fill material will be required to backfill Category 5 features as insufficient fill material exists on site. Site won fill material may also be used as described in Section 3.7.2. The contractor is to provide details of sustainable locally sourced, cost-effective fill material to the designer for approval. The fill needs to be a granular, clean, inert, natural material, however, there are no specific structural requirements of this material as it is simply backfilling an existing void. This can consist of spoil generated from nearby construction projects or be sourced commercially; however, the material must meet the specifications. Concrete reinforcement specifications TBD.
Timing	The timing is dependent on the contractor's ability, personnel and equipment used. We assume a typical time allowance for each feature, depending on its size, should take approximately 1-2 days for Category 4 features and between 1-2 weeks for Category 5 features.
Potential environmental risk, including groundwater, flora and fauna	This may cause some disturbance to the existing ground surface and surrounding environment.

Requirements	Description
Potential risk to contractors and operators	The contractor needs to ensure the haulage routes for imported material are safe and suitable. During the initial phases of the rehabilitation, we recommend machinery maintains a minimum setback distance of 3 m from the edge of these features. The contractor should be aware of slips, trips, and falls into these features, and the potential risk of ground collapse due to lateral workings / subsidence / underground features. Personnel should maintain a minimum setback distance of 1 m from the edge of these features.
Personnel and technical expertise	Any competent and experienced earthwork contractor should be able to undertake this work.
Post rehabilitation maintenance and monitoring	These features have been identified to have medium risk of lateral / deep workings below a false base, therefore one site visit, to conduct a visual assessment, 6 months after the rehabilitation has been completed, and flown surveys 2 years post rehabilitation and again 10 years post rehabilitation is recommended to assess the performance of the rehabilitation solution. If no deformation is observed 12 years post rehabilitation to the features, no further monitoring is required.

3.5 Reinforced earth cap

A reinforced earth cap solution is an alternative option for Category 5 features in the instance that temporary dewatering is unsuccessful and the location and size of the shafts within the base of these open cuts cannot be identified. This will serve to prevent material loss through the mine shafts should the base of these features collapse and subside.

This rehabilitation solution is a suitable alternative for five (5) features:

Table 8: Reinforced earth cap rehabilitation may be considered for selected features

Feature Category	Feature Number
Category 5	S0113097
	S0113141
	S0113147
	S0113149
	S0113151

Table 9: Reinforced earth cap rehabilitation recommendations

Requirements	Description
Plant and equipment	22t+ excavator. The contractor should assess the reach of the excavator to ensure it can reach the base of these features. A long reach excavator shall be required. 10t vibratory padfoot roller. A small (up to 6t) dump truck to bring fill from the stockpiles across the site to the feature location. A loader or excavator to load the dump truck.
Material specification for imported fill	Any imported fill material should comprise a clean inert granular material with a fines content < 15% and no particles > 100 mm. The top 300 mm of backfill must include at least 50% material passing the 2.36 mm sieve size and no particles > 25 mm. See Section 3.7.

Requirements	Description
Quantity / volume of material	See Section 4.
Potential source of material	Imported fill material will be required to backfill Category 5 features as insufficient fill material exists on site. Site won fill material may also be used as described in Section 3.7.2. The contractor is to provide details of sustainable locally sourced, cost-effective fill material to the designer for approval. The fill needs to be a granular, clean, inert, natural material, however, there are no specific structural requirements of this material as it is simply backfilling an existing void. This can consist of spoil generated from nearby construction projects or be sourced commercially; however, the material must meet the specifications.
Timing	The timing is dependent on the contractor's ability, personnel and equipment used. We assume a typical time allowance for each feature, depending on its size, should take approximately 2-3 weeks. This time assumes a site won or readily imported stockpiled material is available.
Potential environmental risk, including groundwater, flora and fauna	This may cause some disturbance to the existing ground surface and surrounding environment.
Potential risk to contractors and operators	The contractor needs to ensure the haulage routes for imported material are safe and suitable. During the initial phases of the rehabilitation, we recommend machinery maintains a minimum setback distance of 3 m from the edge of these features. The contractor should be aware of slips, trips, and falls into these features, and the potential risk of ground collapse due to lateral workings / subsidence / underground features. Personnel should maintain a minimum setback distance of 1 m from the edge of these features.
Personnel and technical expertise	Any competent and experienced earthwork contractor should be able to undertake this work.
Post rehabilitation maintenance and monitoring	These features have been identified to have high risk of lateral / deep workings below a false base, therefore one site visit, to conduct a visual assessment, 6 months after the rehabilitation has been completed, and flown surveys 2 years post rehabilitation and again 10 years post rehabilitation is recommended to assess the performance of the rehabilitation solution. If no deformation is observed 12 years post rehabilitation to the features, no further monitoring is required.

3.6 Concrete slab cap

Category 6 features exist as deep shafts and the available historical information suggests these shafts once extended to significant depths. These features pose high risk of trips and falling into shafts to humans, livestock, and pets and may result in fatal consequences.

This solution tends itself to rectangular shaped features and have typically been identified as main shafts or within direct vicinity of these. Weathered rock of poor to fair rock mass quality was identified within the walls of these features. WML have undertaken geotechnical assessment of the ground conditions around these features and assessed the stability of the shaft walls. Based on this, concrete slabs are considered a suitable rehabilitation option.

Three (3) features have been identified where this method is considered suitable:

Table 10: Concrete slab cap rehabilitation considered for selected features

Feature Category	Feature Number
Category 6	Pass No. 1 North
	S0113145
	S0113158

Table 11: Concrete slab cap rehabilitation recommendations

Requirements	Description
Plant and equipment	22t+ excavator (with rock pick / breaker). Concrete truck and pump or cement mixer. Crane or reach loader for placing form across the voids.
Material specification for imported fill	Any imported fill material should comprise a clean inert granular material with a fines content < 15% and no particles > 100 mm. The top 300 mm of backfill must include at least 50% material passing the 2.36 mm sieve size and no particles > 25 mm. See Section 3.7.
Quantity / volume of material	n/a
Potential source of material	Concrete and steel reinforcement dimensions and specifications TBD.
Timing	The timing is dependent on the contractor's ability, personnel and equipment used. We assume a typical time allowance for each feature, should take approximately 7 days.
Potential environmental risk, including groundwater, flora and fauna	No negative environmental impacts are anticipated as a consequence of this rehabilitation solution.
Potential risk to contractors and operators	The contractor needs to ensure the haulage routes for any imported materials are safe and suitable. During the initial phases of the rehabilitation, we recommend machinery maintains a minimum setback distance of 4 m from the edge of these features. The contractor should be aware of slips, trips, and falls into these features, specifically working from heights requirements. Personnel should maintain a minimum setback distance of 1 m from the edge of these features. It is recommended that working at heights gear be utilised by personnel working around these features during the rehabilitation work, even after the void has been backfilled.
Personnel and technical expertise	Any competent and experienced earthwork contractor should be able to undertake this work.
Post rehabilitation maintenance and monitoring	One site visit, to conduct a visual assessment, 1 year after the rehabilitation has been completed, and once every 5 years post rehabilitation is recommended to visually assess the performance of the rehabilitation solution.

3.7 Fill suitability

3.7.1 In-situ material quality

The existing spoil piles and material stockpiles surrounding the features typically comprises of fine to coarse-grained gravelly SAND / sandy GRAVEL, which are also considered geotechnically suitable for re-use as fill material for

rehabilitation works (subject to DEMIRS/DPLH approval). This material may be re-used to permanently backfill any features with reinforcement. It is recommended that this material not be used within the final 300 mm of backfill unless any particles greater than 25 mm are removed, to promote regrowth of vegetation.

It is important to note that the dispersity of this material has not been tested, however, visual observations in the field suggested that this material is likely to be dispersive. Therefore, it is not considered suitable for re-use as permanent, long-term backfill in any deep waterlogged shafts where underground lateral workings are potentially present.

Reutilising the existing materials available on site in the form of spoil piles and material stockpiles around the main workings, is a sustainable and cost-effective source of fill material for the rehabilitation solutions detailed in this report. Utilising the available local fill will eliminate the negative environmental factors and costs associated with hauling imported fill to Northampton. It will also reduce the quantity of stockpiled material across the site, which may result in a more aesthetically pleasing environment. It is anticipated that sufficient fill material exists within the spoil and stockpiles to rehabilitate Category 3 and Category 4 features, however, additional fill may need to be sourced for the rehabilitation of Category 5 features.

Where WML have stated these materials are subject to DEMIRS/DPLH approval, this is only if this material yields a contaminated sites issue or is deemed to have heritage value.

Water obtained during dewatering works may be re-used during construction to moisture condition backfill material within the features.

3.7.2 Site won fill

Fill may potentially be won from the areas indicated on Figure 1. It is anticipated that up to 0.6 m to 1 m of material may be available. However, this option would require further investigation by way of excavation of test pits to determine the depth of fill material and 3D ground modelling to determine the volume available for use.

Figure 1: Potential areas of fill source

3.7.3 Imported fill

All imported fill material to be used should meet the following requirements:

- Clean inert, well-graded, granular fill material.
- With fines content < 15%.
- 75% passing the 25 mm sieve size.
- No particles > 250 mm.
- Less than 2% organics.
- No deleterious material.

The top 300 mm of backfill must include at least 50% material passing the 2.36 mm sieve size and no particles > 25 mm.

Imported fill material is to be approved by the WML site engineer prior to use.

3.8 Drainage

S0113151, S0113097, S0113149, S0113147, & S0113141:

These features are situated within lower lying areas and are susceptible to surface run-on / run-off erosion. Evidence of erosion within the walls of the open cuts was observed on site and Feature S0113147 is situated within an erosion gulley and is backfilled with silty materials that have washed into the void. Improving the drainage in the areas around these features is recommended to prevent erosion and minimise ponding on top of the rehabilitated features.

Drainage may be improved via the following methods:

1. Overfill the features with non-dispersive, erosion resistant materials post rehabilitation to raise the entire area and prevent surface water flow along the strike of the mined lode. This would require either imported fill material to be sourced or fill to be won on site.
2. Regrade and reshape the affected areas to promote surface water to flow an alternative pathway away from the features and strike of the lode. This may involve cutting and lowering the level of the existing access track to elevate the mine features. This can be completed as part of the site winning investigation works and would require civil 3D modelling of the site to determine final landform. The data from the test pitting program will determine the excavatability of the site and limitations of the final landform to be achieved with conventional machinery.

3.9 Stope stability assessment

WML have undertaken an assessment of the stability of the underground stopes as detailed in the historical longitudinal section plan of workings (1926), see Figure 2. The available historical information also indicates that the lode shear dips 60-80 degrees west and the width of galena ore veins ranges from 12 in (Wheal Ellen North – smaller workings) to 6 ft (Wheal Ellen – main workings). An estimation of the rock mass quality was assessed on site during the geotechnical investigation via 3D LiDAR scanning and through visual observations. WML has also assessed the 3D LiDAR scans and photographs of the rock mass visible above the water surface within the walls of the features.

Assessments have been undertaken based on an estimated rock mass quality, conservative dimensions (width, length and dip) of the mined stope and the thickness of the crown pillar, and assuming that the underground stopes have remained un-backfilled.

With an assumption there will be a modest increase in rock mass quality with increase in depth, various methods of underground stope stability assessments have been undertaken that indicate the expected underground stopes based upon historic mining records should be stable for a rock mass rating (RMR_{76}) of 40 – 50.

Based on the analysis above, the underground stopes are unlikely to collapse to cause significant surface subsidence. This is also evidenced based on the fact that the site has remained stable for approximately 150 years. Should these stopes collapse and cave, it is anticipated that any surface subsidence would be within the order of magnitude of a few

hundred millimetres. Vehicle loadings from 4x4 vehicles and light plant are not expected to cause failure of the underground stopes.

Based on the above, large machinery, when not actively working on the rehabilitation of the mine features, should maintain an offset distance of 5 m from the edge of known mine voids or the open cut slopes. The risk of voids or subsidence occurring outside of this exclusion zone is very low.

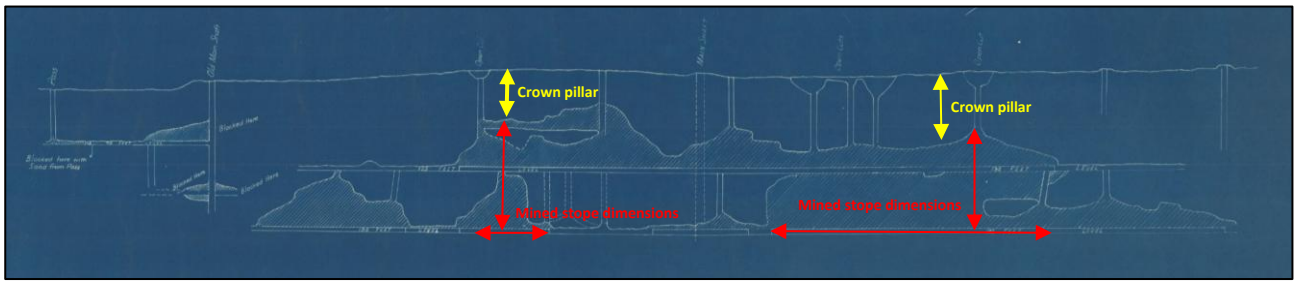

Figure 2: Longitudinal plan of workings (1926)

4 FEASIBILITY

The six (6) feature categories identified in the accompanying geotechnical report, 11953-G-R-001, have been classified in accordance with observations made on site during the intrusive ground investigation and in terms of the risk posed to humans, vehicles, livestock, and pets.

The feasibility of each solution has been assessed in terms of long-term suitability, ongoing maintenance and monitoring, cost, risk to construction personnel, constructability, and environmental risk. The approximate volumes of each feature have been provided within the subsequent table to assist with determination of amount of required fill material.

WML's recommended rehabilitation solutions for each of the features are summarised in Table 12 below.

Table 12: WML Preferred Rehabilitation Solutions

Features	Estimated Fill Volume (m^3)	Risk Rating	Recommended Rehabilitation Solution
Category 1a: Rehabilitated features			
S0113107*	n/a	Low	**WML Recommended Solution – Leave as is.** Rehabilitation of these features is not considered necessary as these features have been rehabilitated and are performing well. *Note: *These features could not be located on site and are assumed to have been rehabilitated.*
S0113111	n/a		
S0113114	n/a		
S0113123*	n/a		
S0113127	n/a		
S0113128	n/a		
S0113129	n/a		
S0113134	n/a		
S0113136*	n/a		
S0113137	n/a		
Category 1b: Shallow workings & minor / imperceptible depressions			
S0113105	n/a	Low	**WML Recommended Solution – Leave as is.** Rehabilitation of these features is not considered necessary as these features are typically indiscernible from the surrounding environment and pose low risk to humans/pets/vehicles. Leave as is. Do not rehabilitate.
S0113106	n/a		
S0113115	n/a		
S0113126	n/a		
S0113131	n/a		
S0113132	n/a		
S0113139	n/a		
S0113160	n/a		
S0113167	n/a		
Category 2: Small depressions / shallow workings / costeans / trenches			
S0113104	n/a	Low to Medium	**WML Recommended Solution – Blade the area.**
S0113118	n/a		

Features	Estimated Fill Volume (m^3)	Risk Rating	Recommended Rehabilitation Solution
S0113125	n/a		These features are slightly deeper than Category 1 features and if DEMIRS believes some rehabilitation is necessary, the surrounding spoil piles can be bladed back into the depression and the area can be bladed with a dozer to reduce steepness of slopes and soften the feature.
Category 3: Shallow shafts and excavations – soft / unknown base conditions			
S0113122	50-70	Medium to High	**WML Recommended Solution – Reinforced earth backfill** These features pose medium risk of void collapse as base conditions are typically unknown and medium risk of trips and falls to humans. Soil backfill alone is not considered suitable as the base conditions have not been investigated and these features are potentially significantly deeper and more extensive than they appear. The existing spoil and stockpiled material located around the site may be utilised. Alternatively, imported fill will be required if DEMIRS deem site won material unsuitable for re-use.
S0113143	120-150		
Category 4: Backfilled / waterlogged deep shafts			
Old Workings Shaft	n/a	Medium to High	**WML Preferred Solution – Concrete plug** These features pose high risk of void collapse as base conditions are typically unknown and high risk of trips and falls to humans. A concrete plug is most suitable for these features. Soil backfill alone is not considered suitable as the base conditions have not been investigated and these features are potentially significantly deeper and more extensive than they appear. The existing spoil and stockpiled material located around the site may be utilised. Alternatively, imported fill will be required if DEMIRS deem site won material unsuitable for re-use.
Old Workings Pass	n/a		
S0113103	75-85		
S0113130	45-50		
Category 5: Open cuts with shafts in the base			
S0113097	700	High	**WML Recommended Solution – Concrete plug** These features pose high risk of void collapse as base conditions are documented to comprise shafts within the base of the open cuts and pose high risk of trips and falls to humans. A concrete backfill is most suitable for these features. Temporary dewatering will also be required. Soil backfill alone is not considered suitable as the base conditions have not been investigated and these features are potentially significantly deeper and more extensive than they appear. The existing spoil and stockpiled material located around the site may be utilised. Alternatively, imported fill will be required if DEMIRS deem site won material unsuitable for re-use. **Alternative Solution Pending Dewatering Works – Reinforced earth cap** If temporary dewatering is not achievable, and the locations of the shafts within the base of these features cannot be identified to plug, a reinforced earth cap solution will be considered. This will be dependent upon observations during the rehabilitation works.
S0113147	800-1000		
S0113149	250-300		
S0113151	1300		

Features	Estimated Fill Volume (m^3)	Risk Rating	Recommended Rehabilitation Solution
Pass No 1 North	n/a	Medium to Critical	**WML Recommended Solution – Concrete slab** This feature poses low risk of surface subsidence due to the underground lateral workings, however high to critical risk of major injury due to falling into the feature. These features are waterlogged and the depth of the shafts are unknown as are the base conditions. A concrete slab should be installed over these features.
S0113145	n/a		
S0113158	n/a		

5 CLOSURE

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We draw your attention to the attached "*Report Limitations*" included with this report. This information sheet is intended to provide additional information about this report and information included within it. This information is provided not to reduce the level of responsibility accepted by WML but to ensure that all parties that rely on this report, and the information contained herein, are aware of the responsibilities that each assumes in so doing.

6 REFERENCES

1. 1926. Plan of Workings. Longitudinal Section. *Wheal Ellen Lead Mine. Northampton WA.* Ref 1685.
2. GHD. October 2020. Remediation Methodology Report. *Wheal Ellen Mine Shafts and Open Pits Remediation.*
3. GHD. October 2020. Geotechnical Report. *Wheal Ellen Mine Shafts and Open Pits Geotechnical Assessment and Remediation Methodology.*

LIMITATIONS

REPORT LIMITATIONS

This geotechnical report is provided for the sole use by the Client. This report must not be applied for any other purpose or project except the one originally contemplated without written authorisation from WML. WML accepts no responsibility for the use of this report / document, in whole or in part, in other contexts or for any other purpose.

WML have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, documents and information supplied, and previous experience. If changes occur in the nature or design of the project, however minor, it is recommended WML review this report to assess their impacts and provide additional recommendations, if any. WML does not assume any responsibility or liability for problems that arise due to developments on site of which we were not informed.

This report utilises data and information provided by third parties, including, but not limited to sub-consultants, published data, and the Client. This information has been assumed to be correct unless otherwise stated. WML assumes no responsibility for assessments made partly or entirely based on information provided by third parties or for the adequacy, incompleteness, inaccuracies, or reliability of any data provided by third parties.

It is the responsibility of the Client to transmit the information, recommendations, and limitations of this report to the appropriate organisations or people involved in design of the project, including, but not limited to developers, builders, owners, buyers, architects, engineers, and designers.

WML's opinions are based on upon information that existed at the time of the production of this report and ground conditions encountered at the time the site study was performed. This geotechnical report should not be relied upon if its adequacy has been affected by: the passage of time, by man-made events, such as construction on or adjacent to the site, or by natural events, such as floods, earthquakes, or groundwater fluctuations. In the event of the above changes, WML should be contacted to determine if this report is still reliable or whether additional testing is required.

The subsurface conditions identified within this report are based only upon investigation locations where subsurface tests have been conducted and / or samples obtained, which are explicitly representative of the specific sample or test location. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and unknowns or variations in ground conditions between test locations that cannot be inferred or predicted. Actual subsurface conditions may differ significantly from those indicated in this report. Specific warning is also given that many factors, either natural or artificial, may render ground conditions different from those which pertained at the time of the investigation. WML does not accept any responsibility for any variance in the ground conditions that may exist across the site. If unexpected subsurface conditions are encountered, WML shall be notified immediately to review those conditions and provide additional and/or modified recommendations, as necessary.

This geotechnical assessment is based upon judgment of the investigation data, visual observations of the site and materials encountered, along with the proposed land use and project specifications. The findings and recommendations presented within this report represent professional opinions and estimates and should not be taken as fact unless explicitally stated. In general, statements of fact are are limited to what was done and / or what was observed on site.

The recommendations provided in this report are preliminary only; final recommendations can only be given after observing the actual subsurface conditions revealed during construction. WML does not assume responsibility or liability for the recommendations in this report if construction observation has not been performed by a WML geotechnical engineer.

Our services did not include any contamination or environmental assessment of the site or adjacent sites. The equipment and techniques used to perform a geoenvironmental study differ from those used to perform a geotechnical investigation. If you require any geoenvironmental information for your project, WML can advise on further steps to be undertaken.

WML have performed our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty, expressed or implied, is made as to the professional advice included in this report.

APPENDIX A

GEOTECHNICAL REPORT

Department of Energy Mines, Industry Regulation & Safety (DEMIRS)

ABANDONED MINE FEATURES ASSESSMENT

WHEAL ELLEN GEOTECHNICAL REPORT

April 2025

11953-G-R-001 Public Document

WML

Consulting Engineers

Document History and Status				
Revision	**Prepared By**	**Reviewed By**	**Purpose of Issue**	**Date**
-	IG	SM	Public Issue	15/04/2025

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Reviewer

For and on behalf of WML Consultants Pty Ltd

CONTENTS

TABLES

APPENDICES

1 INTRODUCTION

The Department of Energy, Mines, Industry Regulation & Safety (DEMIRS) engaged WML Consultants (WML) to undertake an intrusive geotechnical assessment of abandoned mine features at Wheal Ellen, in Northampton, Western Australia and to update the proposed 2020 rehabilitation options report. These features include shafts, open cuts, stopes, costeans, and shallow workings. 25 abandoned mine features occurring below ground level, detailed in the 2020 non-intrusive geotechnical report prepared by GHD were further investigated, alongside 12 features which were also detailed on the provided DEMIRS database. Above ground features were not assessed as these included dumps, stockpiles, tailing storage facilities, buildings, and infrastructure, which do not present a below ground void safety risk. This report presents the results of the intrusive geotechnical investigation and details the findings of the different types of features identified on site.

The geotechnical study was authorised by DEMIRS via Purchase Order 502890 Rev 3, dated 27th of August 2024.

This report and the information presented herein must be read in conjunction with the attached "*Report Limitations*".

1.1 Site description

The site is located approximately 2 km south-west from the Northampton townsite, in Western Australia, and is accessible via Drage Road. The abandoned mine features are situated within a gated area and is restricted from the public. The ground surface across majority of the site is covered with low to medium lying grass, weeds, medium trees and small shrubs are scattered across the site. The southern portion of the site (near the old workings) is more densely vegetated than the central portion (near the main shaft and material stockpiles). An unsealed access track passes through the site and runs alongside the mapped abandoned mining features.

Based on the available topographical information and information presented in the existing geotechnical report prepared by GHD (Wheal Ellen Mine Shafts and Open Pits Geotechnical Assessment and Remediation Methodology Report), the RLs of the site ranges from approximately 110 m AHD to 130 m AHD, and slopes gently downwards from north-east to south-west.

A watercourse passes directly adjacent and to the west of the northern strike of features (to the east of the access track). A watercourse also runs alongside the features mapped as the old working in the southern area of the site. Drainage gulleys and erosion channels were observed in the central portion of the site (to the west of the access track and around the main mine workings). Old head workings and material stockpiles are present in this area.

The previous investigation and inventory photographs from 2000 and 2020 indicated groundwater levels to be slightly lower than those encountered on site by WML in November 2024 and the base of some open cut features were photographed as dry in the inventory photographs from 2000, while the same feature bases were observed to comprise groundwater at the time of WML's investigation.

There is 1 distinct strike positioned in a north easterly direction. The location of the mine features is shown on the site maps, 11953-G-D-001 – 003.

It should be noted that WML have not assessed any tailings storage facilities, dumps, material stockpiles, buildings, or infrastructure as these do not present a below ground void safety risk.

1.2 Client supplied information.

The following information was made available from the Client for the purpose of this report:

- Drone aerial imagery, circa 2020, prepared by DPLH.
- Abandoned Mines Inventory feature photographs at Wheal Ellen, circa 2000 and 2020, prepared by DEMIRS.
- Historical maps, surveys, and longitudinal sections of Wheal Ellen Lead Mine, provided by DEMIRS.
- Abandoned mine feature data set in excel format, prepared by DEMIRS.
- Remediation Methodology Report. Wheal Ellen Mine Shafts and Open Pits Remediation, October 2020, prepared by GHD.

- Geotechnical Report. Wheal Ellen Mine Shafts and Open Pits Geotechnical Assessment and Remediation Methodology, October 2020, prepared by GHD.

1.3 Objectives of this report

The objectives of the geotechnical investigation was to assess the following characteristics:

- Geometric characteristics of the features, including any lateral workings (e.g. dimensions, volume, shape).
- Base conditions and presence of material or obstructions of the features.
- Structural stability and subsidence potential or risk zones.
- Underground connectivity between features.
- Presence of groundwater or hydrogeological features which may have an impact on rehabilitation.
- Surface hydrology flow which may impact upon features.
- The presence of flora and fauna within the features.

2 FIELD PROGRAMME

2.1 Intrusive fieldwork

Fieldwork for the intrusive investigation was carried out between the 17th and 19th of November 2024, by qualified WML geotechnical engineers and comprised:

- Field mapping to observe each of the existing mine features (e.g. measuring the geometry) and to take record photographs and videos.
- Flora and fauna was visually assessed by geotechnical engineers and any information about these is generic only.
- 3D LiDAR scanning of the features.
- Ground probing.
- Detection of groundwater at each feature location using a dip meter.
- Shallow test pits, excavated with a 10t excavator with a 900 mm bucket.

The fieldwork was undertaken in accordance with WML's Safety Management Plan.

Each location for intrusive ground investigation was checked for underground services against Dial-Before-You-Dig plans, prior to any excavations works.

2.1.1 Field mapping, down hole scanning

Features were field mapped by geotechnical engineers from WML to target evidence of voids and geotechnical deformation. The data gathered from 3D scanning has been combined with existing data sets and the results of the geophysical investigations, to support the void risk assessments and rehabilitation recommendations.

2.1.2 Dimensions & groundwater readings

Each feature, where safe to do so, was investigated using hand tools to measure the voids and determine the ground conditions at both the base of the feature and of the surrounding area. The dimensions of the features were measured using a laser pointer measuring device and / or tape measures. A dip meter was also lowered down the features where water was observed via 3D scanning and / or visually to determine the presence and depth of water from the top of the surrounding ground level. Where the base conditions of features were observed to be dry, a dip meter was not lowered.

2.1.3 Ground probing

Ground probing was undertaken within Category 5 features to determine the general size and shape of the shafts obscured by silty materials or groundwater levels. These features have been documented in the historical maps to comprise typically of shafts / passes that have been turned into open cuts. Determining the location of the shafts and their sizes is significant to determine the risk ratings of these features, designing rehabilitation solutions and its constructability.

2.1.4 Machine excavated test pits / ramming

Test pitting works were undertaken utilising a 10t excavator with a 900 mm bucket. Test pitting in the base of Category 1a features uncovered presence of backfilled shafts. These shafts have been well backfilled, and the soils are reasonably compact. Scratching and excavations in the remainder of the features investigated, typically refused on shallow rock up to depths of 2 m bgl.

3 FINDINGS

3.1 Summary of known features

A total of 37 mining features occurring below ground level were recorded and mapped during field investigation in November of 2024.

Based on the poor to moderate quality rock mass identified on majority of the site, the 3D LiDAR scans, and the available historical information which suggests there are relatively narrow lodes, and therefore, narrow voids (this was also evidence through 3D LiDAR scanning) we have determined that the collapse of any below ground lateral voids below 10 m depth to be of very low risk to humans as minimal surface deformation / subsidence would be expressed. Therefore, the risk of ground movement from collapse of any underground lateral workings is deemed to be very low. Furthermore, these mine workings are more than 150 years old and are still stable.

Based on the 37 features assessed on site, we have grouped the features into 6 distinct categories as summarised in Table 1 below.

It should be noted that Features S0113107, S0113123, and S0113136 could not be located on site; it is likely that these features have been rehabilitated in the last 24 years.

Table 1: Summary classification of abandoned mine features

Category	Description	Features	
1a	Rehabilitated features. The investigation methods confirmed the stability of base conditions of the features. **S0113107, S0113223 & S0113136: these features could not be located on site – they are presumed to be rehabilitated.*	S0113107* S0113111 S0113114 S0113123* S0113127	S0113128 S0113129 S0113134 S0113136* S0113137
1b	Shallow workings and trenches/costeans that appears to be minor depressions within the ground surface, or imperceptible impressions. The investigation methods confirmed the stability of base conditions of the features.	S0113105 S0113106 S0113115 S0113126 S0113131	S0113132 S0113139 S0113160 S0113167
2	Small depressions / shallow workings / costeans / trenches. The investigation methods confirmed the stability of base conditions of the features.	S0113104 S0113118 S0113125	S0113133 S0113163
3	Shallow shafts and excavations with soft / unknown base conditions. The base of these features may also be filled with loose soils, vegetation, rocky backfill material, etc. The investigation methods suggest the base conditions of these features are potentially unstable.	S0113122 S0113143	
4	Backfilled or waterlogged deep shafts. The available historical information suggests these are shafts / passes which extend to significant depths beneath the ground surface (> 15 m) and are potentially interconnected at depth. These features are likely to extend to significant depths below what is visible (i.e. scannable) and are likely to comprise false floors. The base conditions of the shafts are unknown and are potentially unstable.	Old Workings Shaft Old Workings Pass S0113103 S0113130	
5	Open pits and deep shafts that have been excavated to form open pits. These features are waterlogged and at the time of the investigation, the exact dimensions and location of the shafts were unknown. The available historical information suggests these are shafts / passes which extend to significant depths beneath the ground surface (> 15 m) and are potentially interconnected at depth. These features are likely to extend to significant depths below what is visible (i.e. scannable) and are likely to comprise false floors. The base conditions of the shafts are unknown and potentially unstable. **S0113147: this feature is a backfilled shaft that is situated within a drainage gulley. The rehabilitation for this feature is likely to be similar to the other features in this category.*	S0113147* S0113151 S0113149 S0113097	
6	Deep shafts. The available historical information suggests these are shafts / passes which extend to significant depths beneath the	Pass No 1 North	

	ground surface (> 15 m) and are potentially interconnected at depth. These features are likely to extend to significant depths below what is visible (i.e. scannable) and are likely to comprise false floors. The base conditions of the shafts are unknown and potentially unstable.	S0113145 S0113158	

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5 REFERENCES

1. Fremantle Trading Co. Ltd. March 1969. 100ft to an inch scale map. *Wheal Ellen. Northampton WA.* Ref 10837.
2. n.d. 50ft to an inch scale map. *Wheal Ellen Lead Mine. Northampton.* Ref 5744.
3. n.d. Geological Map. *Wheal Ellen. Northampton.* Ref 1689.
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5. Standards Australia. 2017. *Geotechnical Site Investigations*. AS 1726:2017. SAI Global.
6. Fremantle Trading Co. Ltd. October 1925. Longitudinal Section. 100ft to 1 inch scale map. *Wheal Ellen Northampton WA.* Ref 10836.
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8. GHD. October 2020. Geotechnical Report. *Wheal Ellen Mine Shafts and Open Pits Geotechnical Assessment and Remediation Methodology.*

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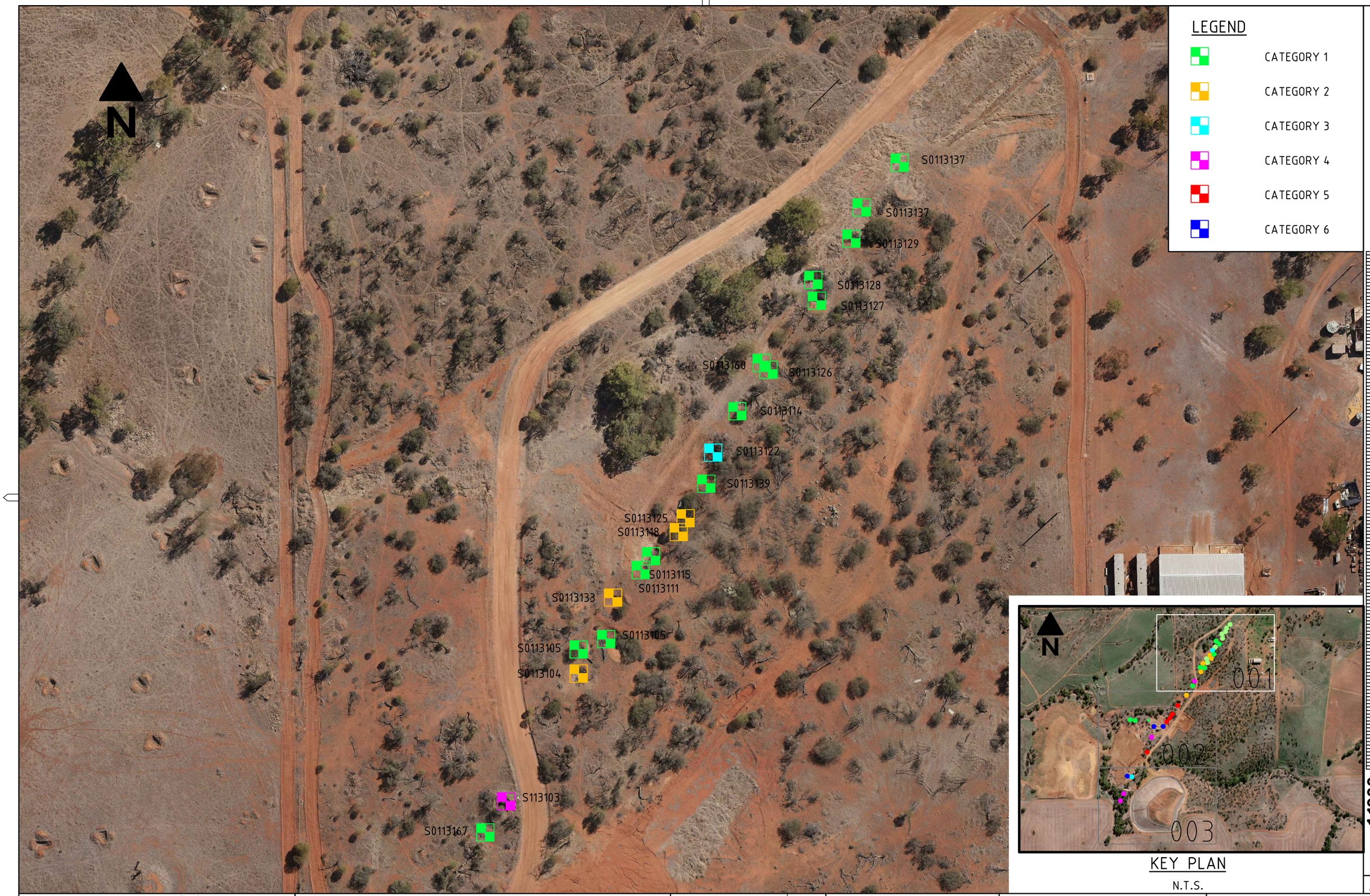
DRAWINGS



KEY PLAN

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CLIENT
DEMIRS

PROJECT
WHEAL ELLEN MINE VOID REHABILITATION

DRAWING TITLE
WHEAL ELLEN MINE REHABILITATION FEATURE CATEGORY MAP AREA - SHEET 1

CONSULTANT DRAWING NUMBER
11953-G-D-001

11953-G-D-001 B

N

S0113163

S0113151

S0113197

S0113149

S0113132

S0113131

S0113123

S0113147

S0113158

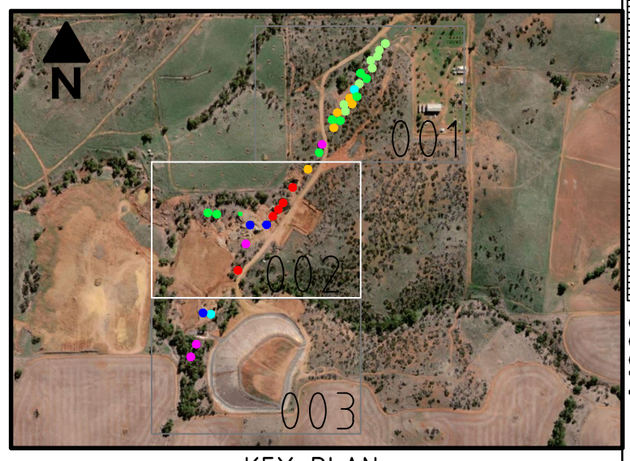
PASS NO. 1 NORTH

S113130

S0113141

LEGEND

- CATEGORY 1
- CATEGORY 2
- CATEGORY 3
- CATEGORY 4
- CATEGORY 5
- CATEGORY 6



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REVISIONS

N°	DESCRIPTION	APPROVED	DATE	DRAWN
B	FINAL ISSUED		I.G. 28.03.2025	C.H.
A	ISSUED FOR CLIENT REVIEW		I.G. 29.11.2024	C.H.

NAMES PRINTED IN FULL		DATE
DESIGNED	I. GOLIJANIN	NOV '24
DRAWN	C. HICK	NOV '24
VERIFIED		
APPROVED		

CLIENT
DEMIRS

PROJECT
WHEAL ELLEN MINE VOID REHABILITATION

DRAWING TITLE
WHEAL ELLEN MINE REHABILITATION FEATURE CATEGORY MAP AREA - SHEET 2

CONSULTANT DRAWING NUMBER
11953-G-D-002

11953-G-D-002 B

N

S0113145

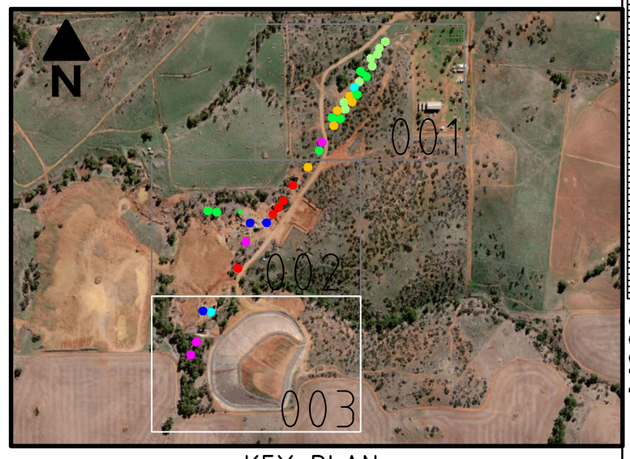
S0113143

OLD WORKINGS PASS

OLD WORKINGS SHAFT

LEGEND

- CATEGORY 1
- CATEGORY 2
- CATEGORY 3
- CATEGORY 4
- CATEGORY 5
- CATEGORY 6



KEY PLAN

N.T.S.

SCALE 1:1000

A3

WML Consulting Engineers
Civil | Geotechnical | Structural

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CLIENT
DEMIRS

PROJECT
WHEAL ELLEN MINE VOID REHABILITATION

DRAWING TITLE
WHEAL ELLEN MINE REHABILITATION FEATURE CATEGORY MAP AREA - SHEET 3

CONSULTANT DRAWING NUMBER
11953-G-D-003

11953-G-D-003 B

APPENDIX A

FIELD NOTES

CATEGORY 1A

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113111	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113114	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113127	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113128	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	19/11/24

PHOTOGRAPHS

Figure 3

WML Consulting Engineers	Feature S0113128	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	19/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113129	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113134	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113137	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

CATEGORY 1B

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113106	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113106	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113115	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113126	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113131	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113132	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113139	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113160	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113167	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

CATEGORY 2

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113104	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113118	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113125	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113133	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113163		
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

CATEGORY 3

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113122	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113143	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

CATEGORY 4

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature Old Working Pass	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN

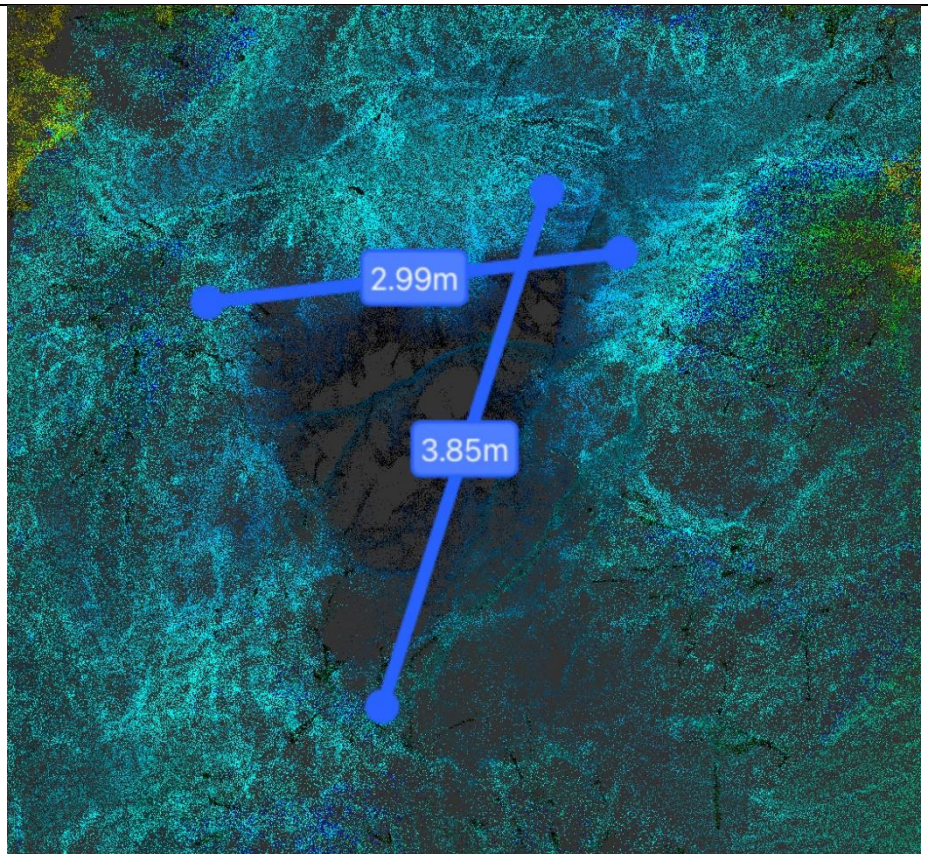


Figure 1

WML Consulting Engineers	Feature Old Working Pass	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature Old Working Shaft	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN

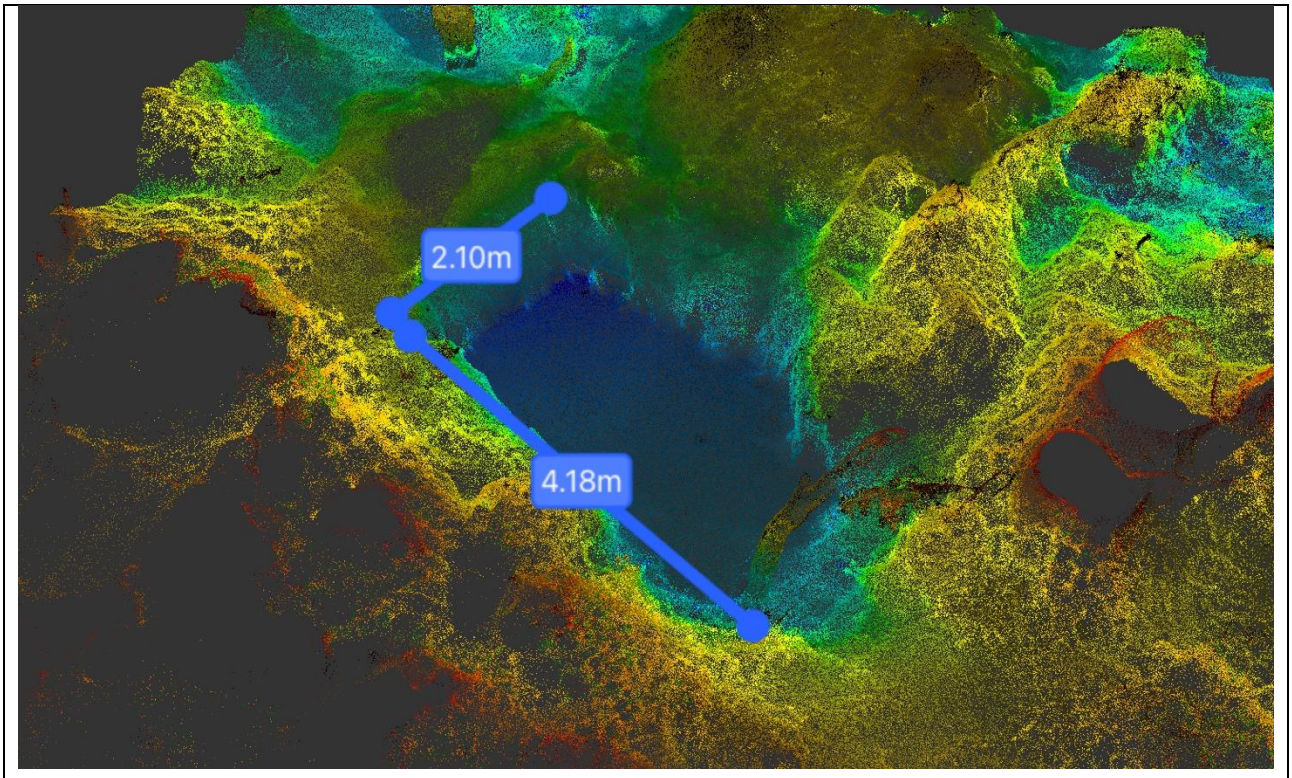


Figure 1

WML Consulting Engineers	Feature Old Working Shaft	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113103	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	19/11/24

3D LIDAR SCAN

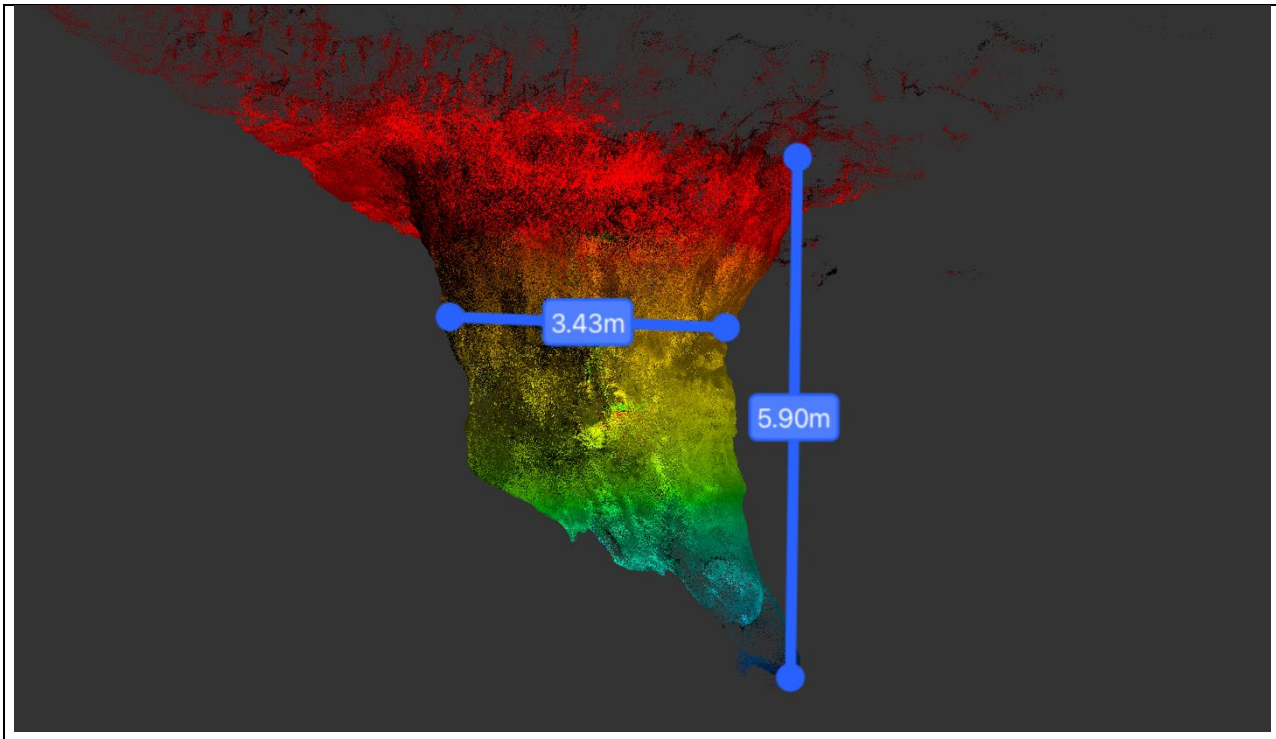


Figure 1

WML Consulting Engineers	Feature S0113103	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	19/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113130	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN

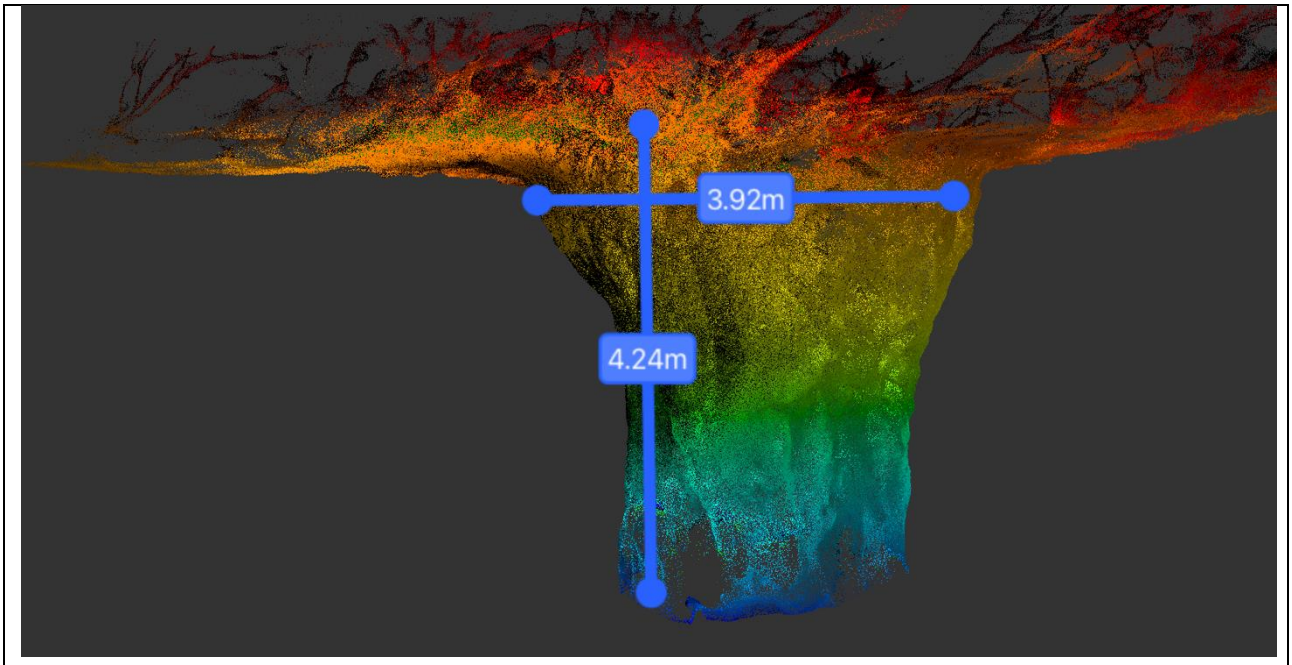


Figure 1

WML Consulting Engineers	Feature S0113130	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

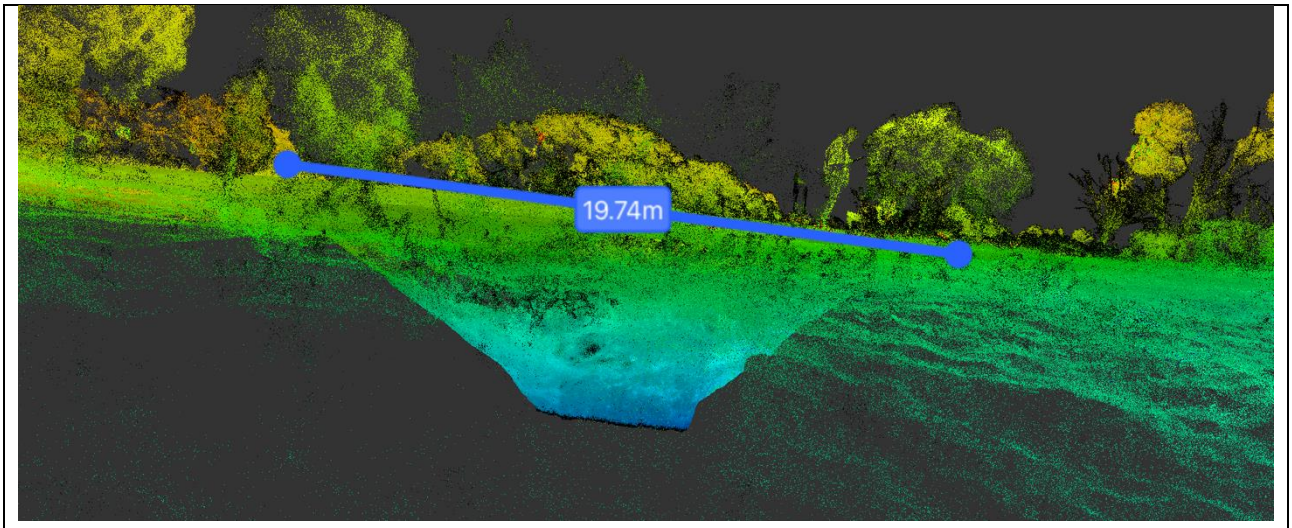
PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113141	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN



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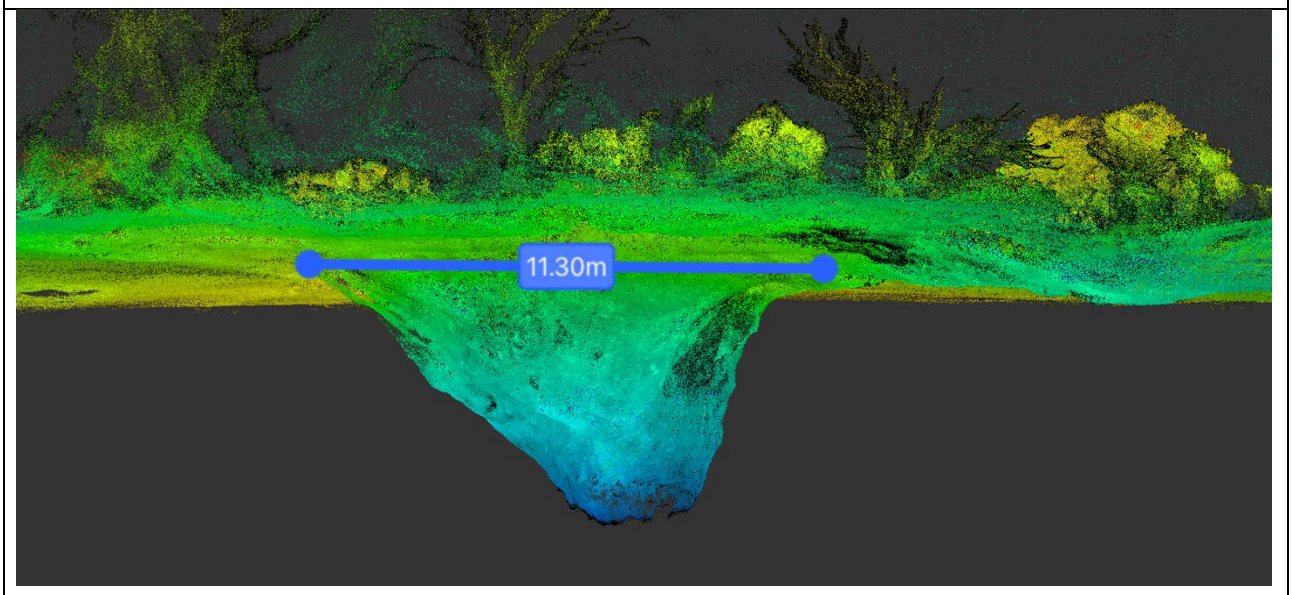

Figure 2

WML Consulting Engineers	Feature S0113141	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

CATEGORY 5

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113097	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN

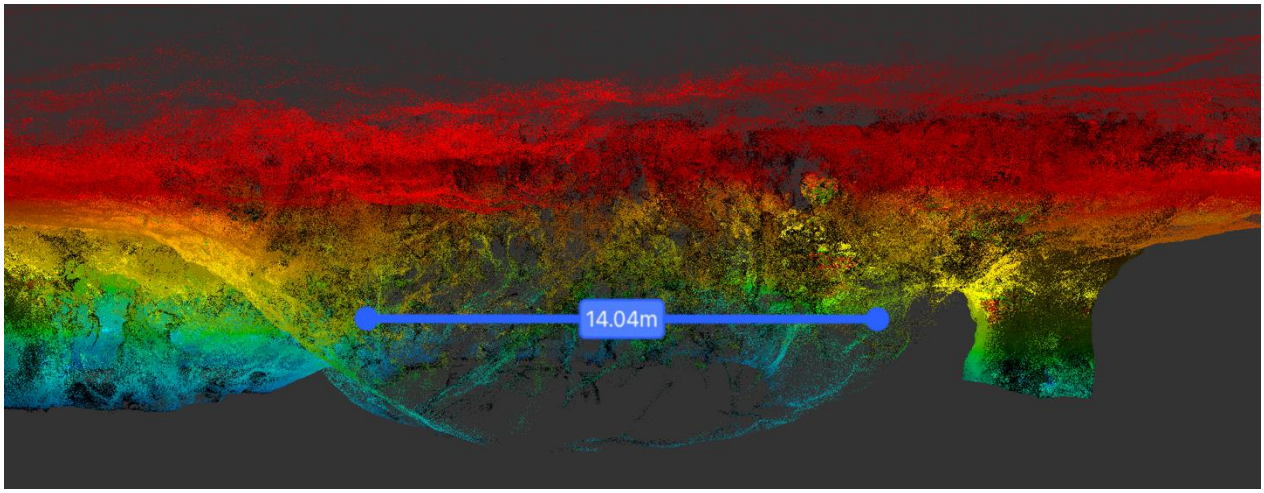

Figure 1

WML Consulting Engineers	Feature S0113097	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

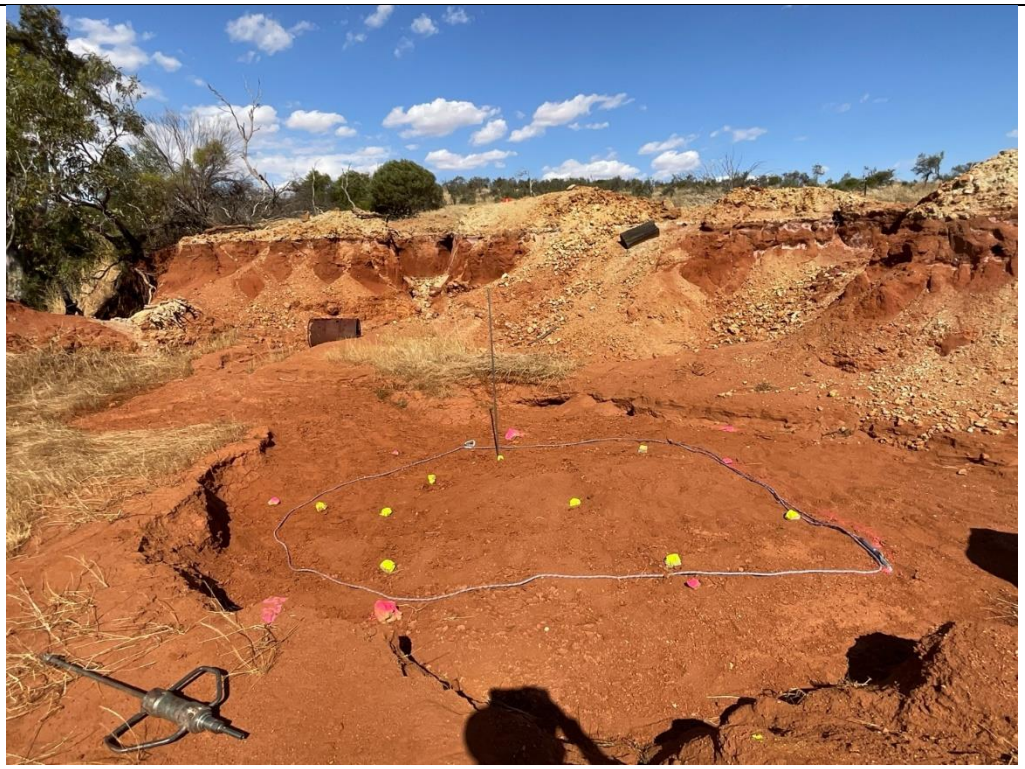

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Figure 2

WML Consulting Engineers	Feature S0113147	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN

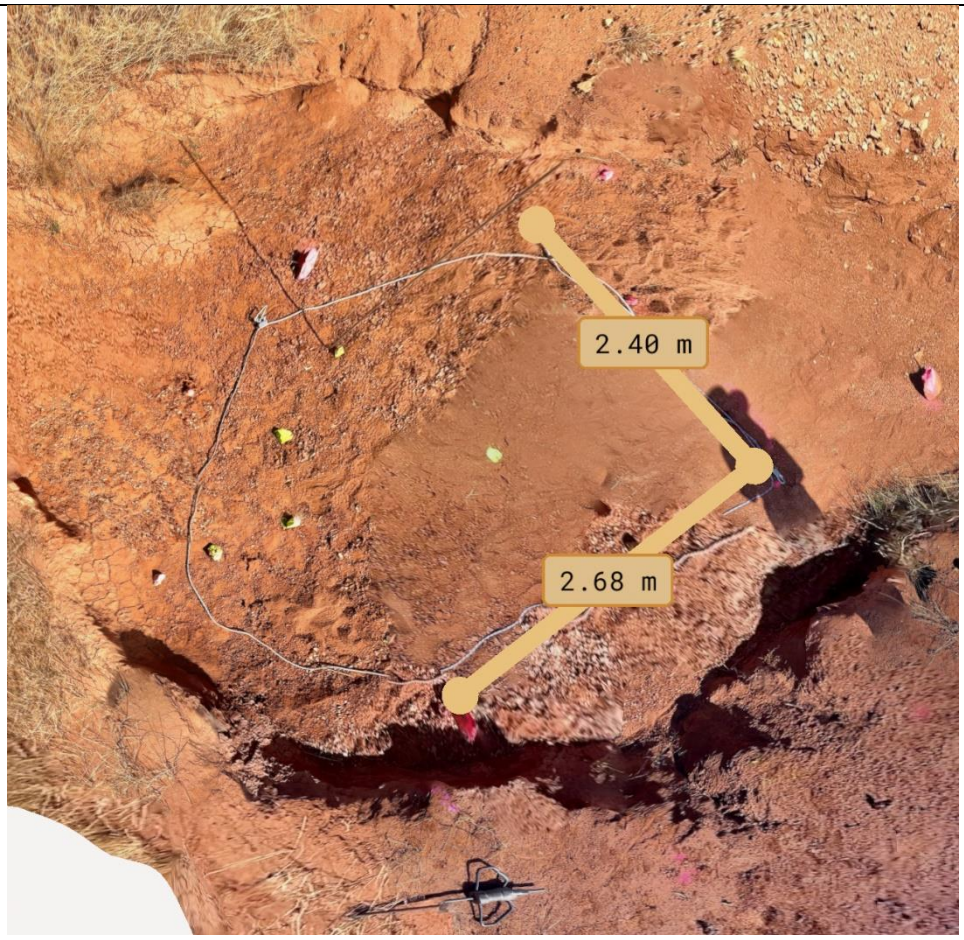


Figure 1

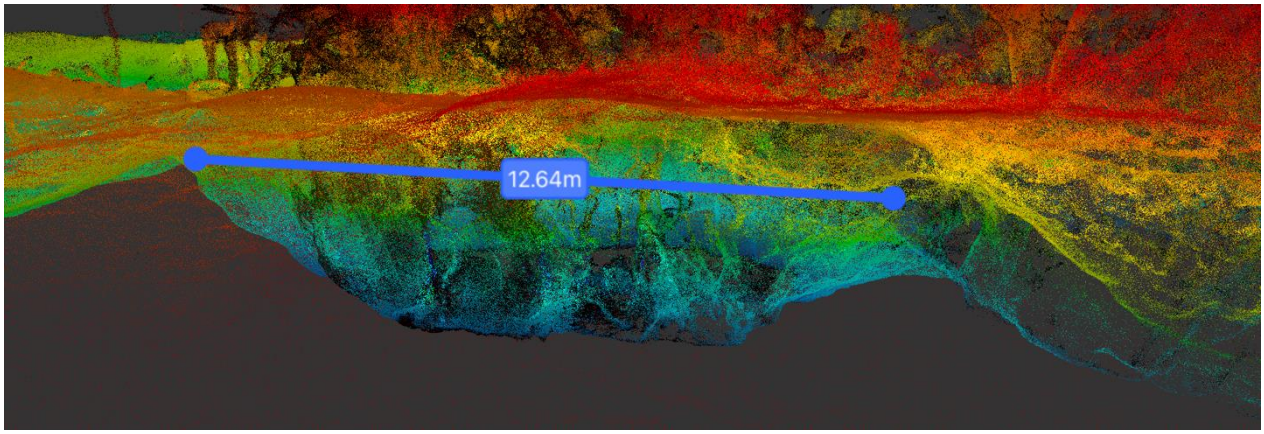
WML Consulting Engineers	Feature S0113147	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

WML Consulting Engineers	Feature S0113149	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN



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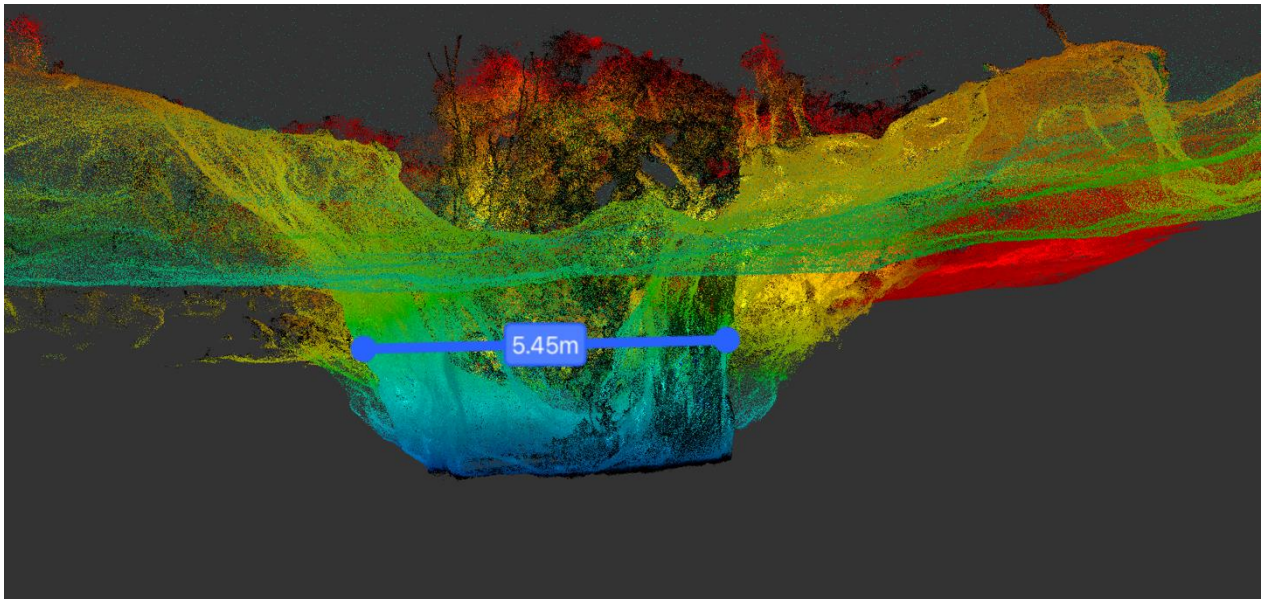


Figure 2

WML Consulting Engineers	Feature S0113149	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

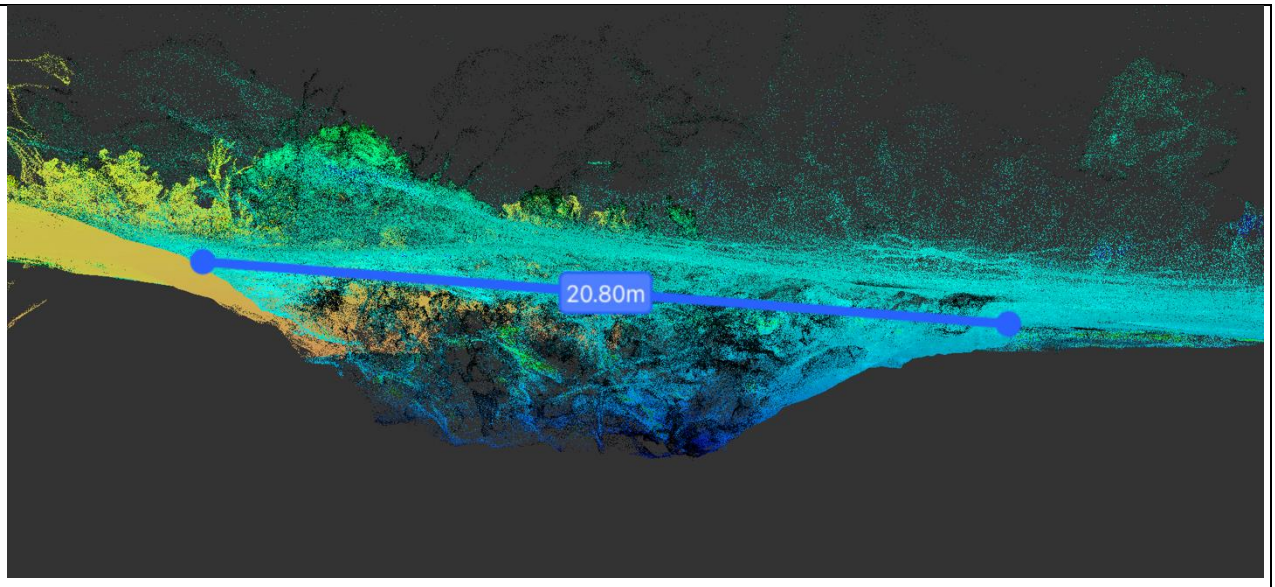
WML Consulting Engineers	Feature S0113151	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 3

WML Consulting Engineers	Feature S0113151	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN



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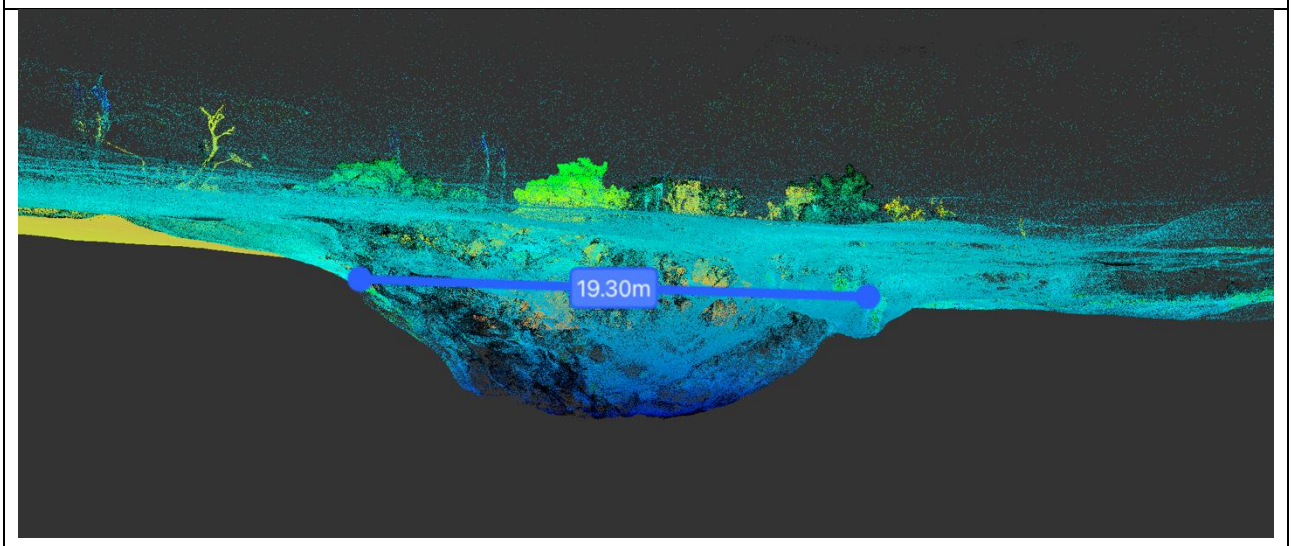

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WML Consulting Engineers	Feature S0113151	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

CATEGORY 6

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature Pass No. 1 North	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113145	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 3

WML Consulting Engineers	Feature S0113145	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

PHOTOGRAPHS

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113158	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24

3D LIDAR SCAN

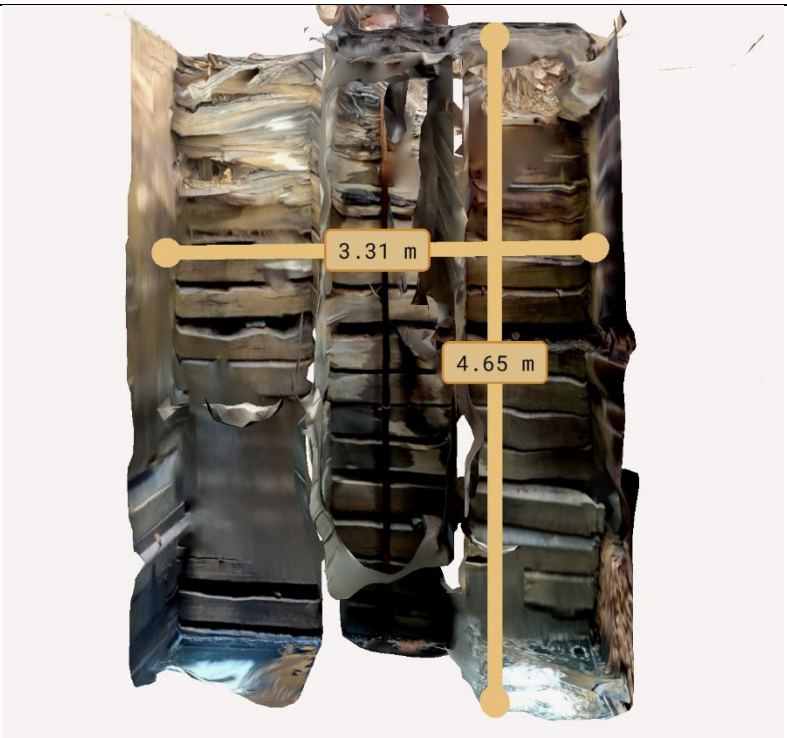

Figure 1

Figure 2

WML Consulting Engineers	Feature S0113158	Project No:	11953
	Client: Department of Energy, Mines, Industry Regulation and Safety (DEMIRS)	Date:	18/11/24