

Memorandum:

Greater Brockman Subterranean Habitat Assessment and Modelling

Rio Tinto Iron Ore

September 2022

GREATER BROCKMAN SUBTERRANEAN HABITAT ASSESSMENT AND MODELLING

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GLOSSARY

2D	Two Dimensional
3D	Three Dimensional
AEM	Airbourne Electromagnetics
AWT	Above Water Table
BrIF	Brockman Iron Formation
BS1	Brockman Syncline 1
BS2	Brockman Syncline 2
BS3	Brockman Syncline 3
BS4	Brockman Syncline 4 (excludes Boolgeeda Creek reference area)
BWT	Below Water Table
EIA	Environmental Impact Assessment
extent	lateral spatial extent of suitable habitat
GSWA	Geological Survey of Western Australia
in-situ	in the original place – related to habitat remaining in the ground
Leapfrog	Leapfrog® Geo – computing software
LOM	Life of Mine
Long Term	Long-term scenarios at 2350
mbgl	Metres below ground level
meshes	Leapfrog terminology for surfaces
Min WL	minimum water levels
MMIF	Marra Mamba Iron Formation
mRL	Metres Relative Level (groundwater elevation relative to sea level)
Strand	Category of drill log coding indicating stratigraphic member
Suitable habitat	categorisation of habitat from 3D modelling of high and medium ranked zones
Tag	Category of drill log coding showing lithology, mineralisation or physical structure
thickness	vertical extent of suitable habitat
WCS	‘Worst case Scenario’
WT	Water table

1. INTRODUCTION

Rio Tinto Iron Ore (Rio Tinto), on behalf of its fully owned subsidiary, Hamersley Iron Pty Limited (the Proponent), owns and operates the Brockman 2/Greater Nammuldi Sustaining Project and the Brockman 4 Sustaining Tonnes Project, collectively termed the Greater Brockman Project. Rio Tinto is evaluating the potential to expand existing mining operations under the Brockman Syncline Proposal (the Proposal).

Biologic Environmental Survey (Biologic) was commissioned by Rio Tinto to provide 3D modelling of subterranean fauna habitats and assessment of habitat values over the entire Brockman Syncline. The results of the modelling will be used to inform an Environmental Impact Assessment of subterranean fauna for the Proposal (Figure 1.1; Biologic, 2022).

Biologic worked extensively with Rio Tinto to improve the understanding of the associations between subterranean fauna, geology, and hydrogeology. An assessment of prospective suitability, extent, thickness, and connectivity of subterranean fauna habitats has been undertaken and resulted in a detailed modelling of potential troglofauna habitat (above water table, AWT) and stygofauna habitat (below water table, BWT) throughout the Brockman Syncline before and after implementation of the Proposal.

This subterranean habitat assessment integrates three layers of evaluation:

1. Categorisation of the 2D surface geology for habitat suitability (Section 2);
2. 3D habitat modelling from drill hole information AWT and BWT (Section 3); and
3. Groundwater geochemical profiling of stygofauna habitats BWT (Section 4).

Modelling constraints and limitations are discussed in Section 5. The resulting habitat assessments are detailed in Sections 6 to 8, classified into troglofauna and stygofauna sections, and summarising the pre-impact and proposed impact scenarios.

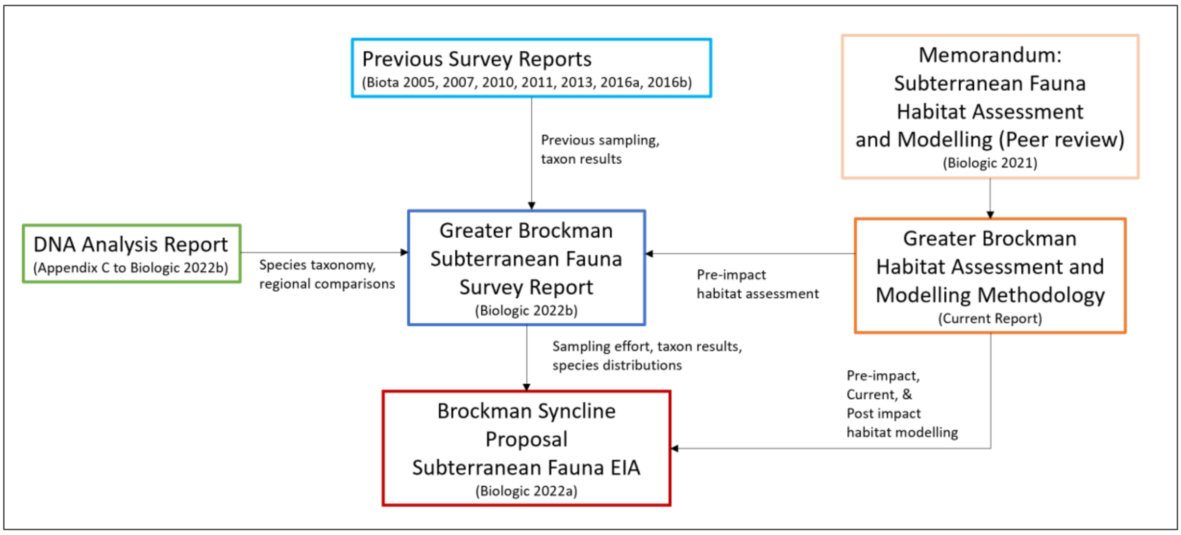


Figure 1-1: Document flow chart for Greater Brockman EIA

This document provides:

- Methods and results of 3D habitat modelling of suitable stygofauna habitats within each section of the Proposal;
- Methods and results of groundwater geochemical profiling, where completed, to help inform stygofauna habitat suitability; and
- Assessment of subterranean habitat in the Development Envelope and impacts to habitats under different scenarios.

A separate, peer-reviewed habitat modelling memorandum (Biologic, 2021) has defined the basic technical methodology for 3D habitat modelling undertaken in Leapfrog® Geo. Variations to the peer reviewed memorandum and important additional evaluations specific to the Proposal are discussed in Section 3.

Sections of the Development Envelope

For the purposes of assessment and habitat modelling, the Development Envelope has been conceptually split into four sections () as follows:

- **Brockman Syncline 1 (BS1)**: Proposed AWT and BWT pits at BS1 East and West.
- **Brockman Syncline 2 (BS2)**: Proposed AWT and BWT pits including Pits 1-3 and Pit 14. The proposed pit at Lens G is also included in this report.
- **Brockman Syncline 3 (BS3)**: Proposed AWT and BWT pits including Marra Mamba pit M. The proposed AWT and BWT pits at Diesel, Sandalford; Monkey; Lauriston; Creekside; Orbe; Brokenwood and Marra Mamba (MM)-J) are also included in this report.
- **Brockman Syncline 4 (BS4)**: Extension of the existing Marra Mamba pits R and Q to support BWT mining plus proposed AWT and BWT pits at Endeavour, and Marra Mamba pits N and O.

These four sections also reflect the domains throughout which 3D modelling of subterranean fauna habitats was undertaken (Figure 1-2).

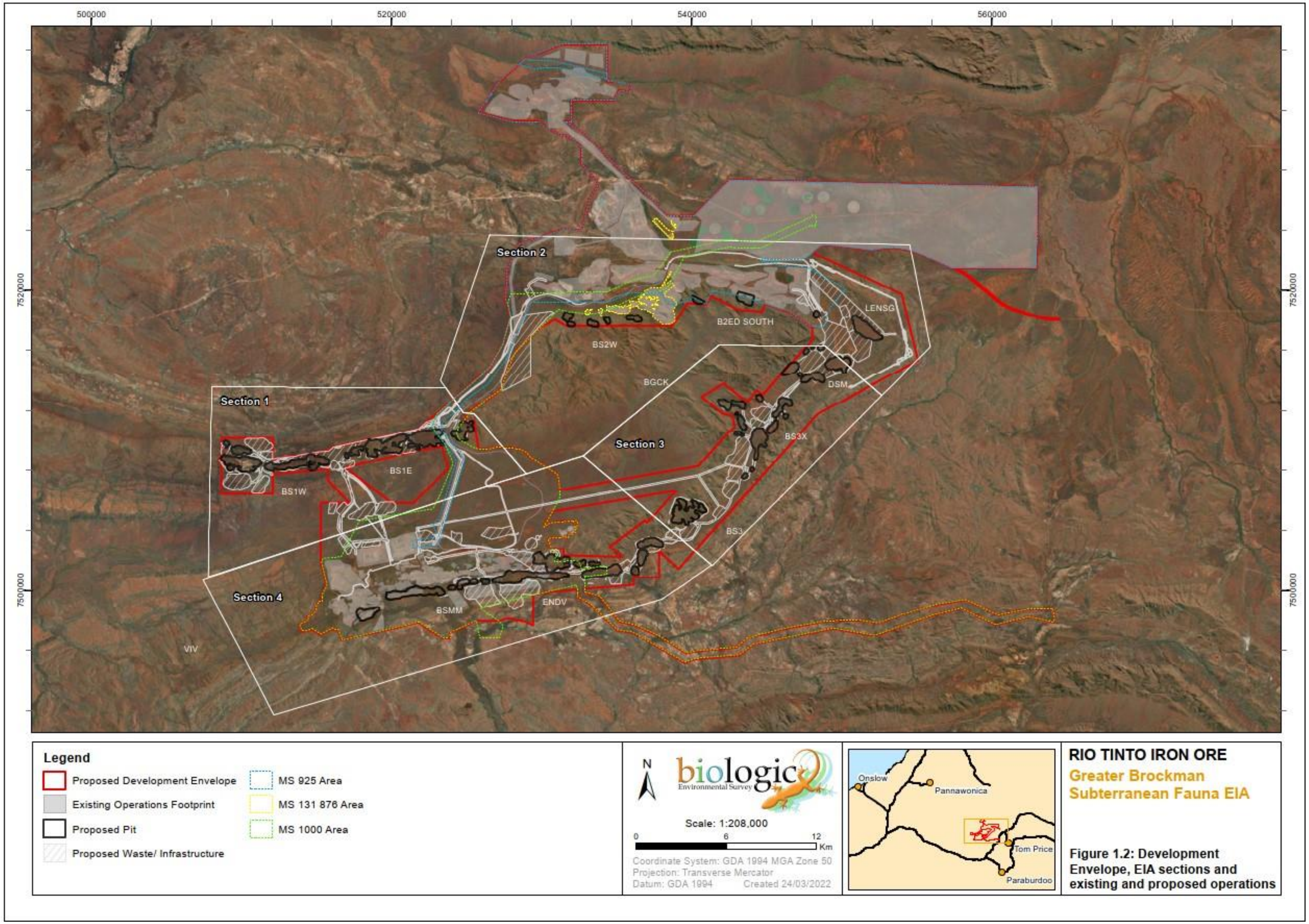


Figure 1-2: Development Envelope, EIA sections, and existing and proposed operations

2. 2D CATEGORISATION OF SURFACE GEOLOGY

Surface geological mapping information from the Geological Survey of Western Australia (GSWA 1:250,000 series mapping, refer Figure 2-1) was assessed and categorised for subterranean fauna habitat suitability. This analysis was undertaken to provide preliminary and supplementary local context for the extent and connectivity of potential subterranean habitats throughout the landscape and Proposal.

The GSWA geological mapping was categorised for AWT and BWT habitat suitability based on available sampling information (summarised Rio Tinto subterranean fauna data, and Biologic Environmental previous surveys), and previous experience in similar geological settings throughout the Pilbara region.

A five-point classification system shown in Table 2-1, was developed by Biologic to differentially rank suitability of lithologies based on the geological characteristics and the potential to host subterranean fauna. The classification was applied against both AWT habitat potential for troglofauna and BWT habitat potential for stygofauna.

Table 2-1 Geological habitat suitability ranks used in the 2D habitat assessment

2D Habitat suitability rank	Typical geological characteristics	Potential subterranean fauna occurrence (based on available sampling info)
Low	Impermeable, or very low permeability. Devoid of open fractures, secondary porosity or cavities	No evidence or very little evidence of subterranean fauna occurrence within this unit, in similar contexts.
Low-Medium	Rarely features well-developed cavities, open fractures, or porosity	Scarce evidence of subterranean fauna occurrence, in rare cases, or inconclusive.
Medium	May feature cavities, fractures, or porosity under some circumstances, or to a limited extent.	There is evidence of subterranean fauna occurring in this unit, but not in all circumstances. Assemblages not expected to be rich or abundant.
Medium-High	Often features cavities, fractures, or secondary porosity, reasonably well connected	Considerable evidence of occurrence based on reasonable sampling effort. Sometimes abundant and diverse assemblages, not in all circumstances.
High	Almost always features caves/ cavities, fractures and/or secondary porosity, forming a well-developed network of interconnected voids	Sampling throughout the region frequently detects rich and diverse subterranean fauna assemblages, almost always considered to be a key habitat for subterranean species.

A detailed account of the surface geology of the Brockman Syncline as shown on Figure 2-1, is categorised under the system in Table 2-2. The 'Map Code' column in Table 2-2 links to the GSWA surface geology codes/ descriptions provided in Figure 2-1). The hydrological characteristics column aggregates a summary of findings to each lithology, where available, from the Brockman Syncline: Hydrogeological Assessment (Rio Tinto, 2020b) internal report provided by Rio Tinto.

Using this understanding of the surface geological attributes and potential classifications, furthered the development of 3D coding and provides a solid reference for further interpretations.

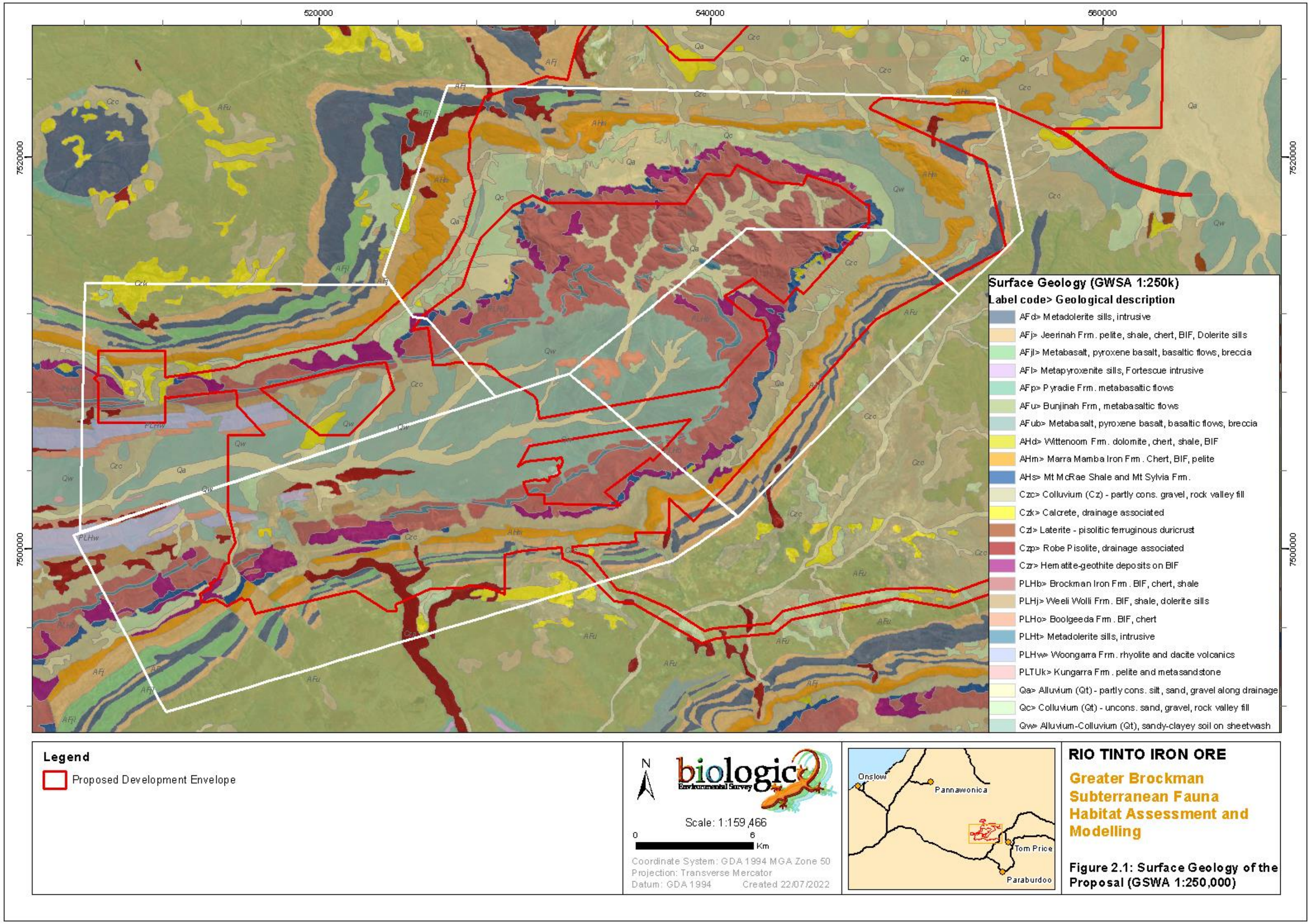


Figure 2-1: Surface Geology of the Proposal (GSWA 1:250,000)

Table 2-2: Potential habitat suitability of surface geological units within and surrounding the Development Envelope

Stratigraphic unit	Description	Subterranean fauna suitability assessment	Map Code	AWT Habitat	BWT Habitat	Hydrology Characteristics
Quaternary Detritals						
Alluvium	Alluvium - unconsolidated silt, sand, and gravel; in drainage channels and adjacent floodplains	Well known habitat for subterranean fauna, especially BWT. Flooding may reduce habitat for troglofauna. Sediment textures may influence variability in habitat extent, suitability.	Qa	Med	High	Variable aquifer properties
Colluvium	Colluvium - unconsolidated quartz and rock fragments in soil	Well known habitat for subterranean fauna, especially BWT. Sediment textures may influence variability in habitat extent, suitability.	Qc	Med-High	Med-High	Variable aquifer properties
Sheetwash soil/ clay	Alluvium and colluvium - red-brown sandy and clayey soil; on low slope and sheetwash areas	Sand-clay lower porosity than gravelly alluvium/ colluvium, thick clay may be impermeable	Qw	Low	Low	Aquitard
Tertiary Detritals						
Colluvium	Colluvium - partly consolidated quartz and rock fragments in silt and sand matrix; old valley-fill	Well known habitat layer for subterranean fauna, where sediment textures are coarse, less consolidated	Czc	Med-High	Med-High	Variable aquifer properties
Calcrete	Calcrete - sheet carbonate, found along major drainage lines	Well known habitat for subterranean fauna, almost always highly weathered, karstic. Can support high abundance/ diversity assemblages	Czk	High	High	Typically highly permeable when saturated
Robe Pisolite	Pisolitic limonite deposits developed along river channels	Well known regional habitat layer for subterranean fauna, almost always highly weathered, porous/ cavernous. Can support high abundance/ diversity assemblages	Czp	High	High	Typically highly permeable when saturated
Hematite-goethite deposits	Hematite-goethite deposits on banded iron-formation and adjacent scree deposits	Well known regional habitat layer for subterranean fauna, almost always highly weathered, porous, fractured. Can support high abundance/ diversity assemblages. Typically occurs on upper flanks/ caps of ranges	Czr	High	Med	Rarely BWT, can be highly permeable
Hamersley Group						
Weeli Wolli Iron Formation	Banded iron-formation (commonly jasperlitic), pelite, and numerous metadolerite sills	Poorly sampled. Mostly low permeability, assumed insufficient void spaces.	PLHj	Low	Low	Low permeability/ Low Storage
Brockman Iron Formation (BrIF)	Dales Gorge, Joffre Members: Banded iron-formation, chert, and pelite	Well known regional habitat layer for subterranean fauna, almost always high abundance/ diversity assemblages. mostly AWT. Dales Gorge and Joffre Members typically most prospective, shale bands and dolerite sills within stratigraphy can create barriers. Much of this formation occurs high in the landscape, moderating suitability for stygofauna.	PLHb	Med-High	Med-High	Fractured and mineralised rock aquifer, High conductivity Medium storage
Brockman Iron Formation (BrIF)	Whaleback Shales, Yandicoogina Shales: Pelite, Shales, BIF and Cherts	Whaleback and Yandicoogina Members tends to be less prospective, with shale bands and massive/ fresh BIF more prevalent, except where highly fractured or weathered.	PLHb	Med-Low	Med-Low	Lower conductivity and storage than DG, Joffre
Mt McRae Shale/ Mt Sylvia Formation	Pelite, shale, chert, and banded iron formation	Mt McRae Shales typically impermeable, potential habitat barrier. Mt Sylvia thin, poorly sampled.	AHs	Low	Low	Aquitard/ Aquiclude

Stratigraphic unit	Description	Subterranean fauna suitability assessment	Map Code	AWT Habitat	BWT Habitat	Hydrology Characteristics
Wittenoom Dolomite	Metamorphosed thin- to medium-bedded dolomite, dolomitic pelite, chert, and volcanic sandstone	Well known habitat for stygofauna where weathered/ karstic. Can support high abundance/ diversity assemblages where suitable groundwater occurs. Typically occurs BWT in valleys. Paraburdoo and Bee Gorge Members most prospective, West Angela Shales can be lower permeability. In some cases, fresh dolomite and shale can act as aquitard.	AHd	Rarely AWT	Med-High	Fractured rock aquifer, often karstic. Can be localised areas of lower permeability.
Marra Mamba Iron Formation (MMIF)	Mt Newman Member: Banded iron-formation, and pelite	Well known regional habitat layer for subterranean fauna, almost always high abundance/ diversity assemblages. Often occurs AWT & BWT. Upper member (Mt Newman) typically most prospective. Much of this formation occurs high in the landscape, moderating suitability for stygofauna. Increased secondary porosity hosted within mineralisation	AHm	High	Med	High hydraulic conductivity Medium storage
Marra Mamba Iron Formation (MMIF)	McLeod and Nammuldi Members: Succession of BIFs, Shales and Cherts	Lower members (McLeod and Nammuldi) often fresh/ impermeable. Succession of BIFs, Shales and Cherts, may act as no flow boundary except when heavily fractured.	AHm	Med-High	Med-Low	Can be localised fractured rock aquifer near surface. Potential aquitard/ aquiclude at depth
Boolgeeda Iron Formation	Fine-grained, finely laminated iron-formation; pelite and chert	Poorly sampled. Mostly low permeability, assumed insufficient void spaces.	PLHo	Low-Med	Low-Med	Medium storage, med to low conductivity
Woongarra Rhyolite	Metamorphosed rhyolite, rhyodacite, rhyolitic breccia, and banded iron-formation	Poorly sampled. Mostly low permeability, assumed insufficient void spaces.	PLHw	Low	Low	Aquitard
Kungarra Formation	Pelite (mudstone), metasandstone, local stromatolitic dolomite	Poorly sampled. May have some potential where fractured or weathered, particularly in localised dolomite	PLTUk	Low-Med	Low-Med	Poorly sampled, uncertain
Fortescue Group						
Hardey Formation	Feldspathic metasandstone, pebbly metasandstone, metaconglomerate	Poorly sampled. Assumed low to moderate permeability, higher where fractured/ faulted/ weathered.	AFh	Low	Low	Poorly sampled, uncertain
Jeerinah Formation	Thin basalt flows interbedded with pelite, shale, chert, BIF, meta sandstone, and thinly bedded dolomite. Hosts a high density of intruded dolerite sills (up to 50% of the formation).	Mostly low permeability/ insufficient void spaces, except where weathered/ fractured/ faulted. Localised superficial habitat patches where calcareous/ weathered fractured. It underlies and therefore wraps around the syncline	AFj	Low-Med	Med	Typically Low Hydraulic conductivity Low storage Can be localised fractured rock aquifer
Mafic sills	Layered sills, generally coarse-grained metapyroxenite	Typically impermeable, potential habitat barrier	PLHt	Low	Low	Aquiclude
Bunjinah Formation	Pillowed and massive metabasaltic flows, metabasaltic breccia, metamorphosed volcanic sandstone and chert	Poorly sampled. Assumed low to moderate permeability, higher where fractured/ faulted/ weathered.	AFu	Low	Low-Med	Aquitard
Dolerite sills	Medium- to coarse-grained metadolerite sills	Typically impermeable, potential habitat barrier Dyke swarm cross-cut syncline and act as hydraulic barriers.	AFd	Low	Low	Low permeability, aquiclude

3. 3D HABITAT MODELLING METHODOLOGY

Overview

Assessing and modelling subterranean habitats in three dimensions (3D) facilitates the visualisation and quantitative estimation of suitable subterranean habitats within specific modelled boundaries. Rather than representing planar, two dimensional (2D) potential areas of occupancy for subterranean species, 3D estimates include representation of the likely depth or thickness of suitable geological/ hydrogeological strata (i.e., the 3D extent of subterranean habitat) throughout the modelling area. Volumetric calculations can quantify the proportion of suitable habitat subjected to loss or reduction by the proposed impacts, relative to the wider extent of potential habitat remaining unaffected.

The methodology for three-dimensional modelling of subterranean habitat has been summarised in Figure 3-1, and commences with compiling all available drill hole information throughout the Proposal and surrounds into Leapfrog® Geo 2021.1.3 software (Leapfrog). The compiled data set was coded to reflect subterranean fauna habitat suitability categories related to the physical structure of the rock and its ability (where known) to provide suitable void spaces for subterranean fauna. Coded drilling information was then used to create 3D models of suitable subterranean habitats within a specific 'boundary of confidence'. The vertical extent of drilling in each drill location forms a limit to the maximum thickness (or depth from surface) of the suitable habitat that could confidently be modelled, however interpretation based on stratigraphy could further extrapolate potential habitat. With suitable habitat defined, volumetric calculations could be extracted and summarised for each category and scenario.

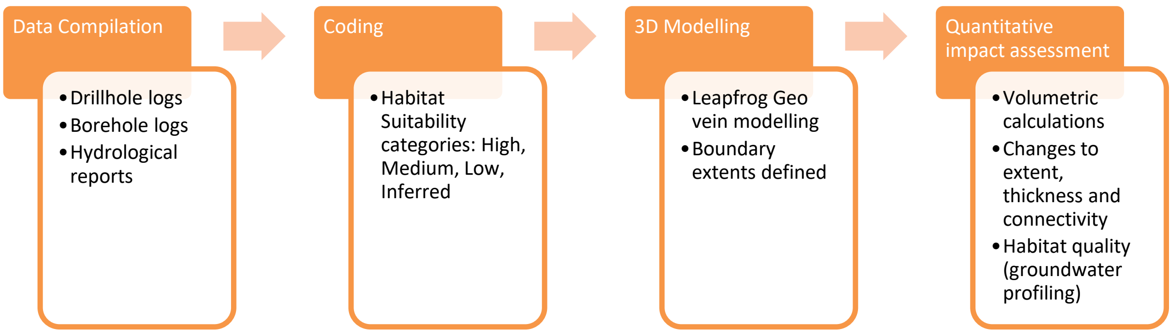


Figure 3-1: Flow diagram of the 3D habitat modelling and assessment process

Data compilation

Compilation of several datasets for Greater Brockman (GBO) included reviewing lithology information from drill-hole logging data and bore logs, analysing diamond drill cores, along with reviewing hydrogeological information, geophysical data, and structural information from technical reports provided by Rio Tinto (Aquaterra, 2005; Rio Tinto, 2013, 2020a, 2020b).

Drill hole data from geological and hydrogeological databases were exported from Rio Tinto databases and compiled in Excel for processing in Leapfrog. More than 31,545 holes and over

2,325,600 metres of drilling was recorded throughout the Development Envelope as shown in Table 3-1. Not all these drill points could be used due to validation issues, missing data, incomplete logging etc, nevertheless final model numbers are significantly robust and provided in the impact assessment section (Sections 7 to 8).

Table 3-1:Summary of compiled drilling data by drill type

	No. of Holes		
Hole Type	**Hydrogeology**	**Geology**	**Metres**
WB/MB	1203		133,968
Diamond		1446	125,277
RC		27,863	2,038,941
Other		1033	27,415
Subtotal	1203	30,342	
Total		**31,545**	**2,325,602**

Combined lithological data from all drilling programs throughout the Development Envelope was coded to represent the stratigraphic unit (strand) encountered, and mineralisation/ geomorphology characteristics (tag). Where no strand or tag information was available, further coding of lithological logs and comments was required to generate a standardised coding framework and saved within an external dataset. In particular, the hydrogeological drilling data provided very different lithological information to geological logs and required validation against bore logs and hydrogeological reports. Hydrogeological information regarding the porosity, transmissivity, and hydrogeological characteristics of coded units was integrated into the assessment for BWT habitat units.

Habitat Suitability Coding

After comprehensive review of all lithological data, five subterranean fauna habitat suitability code categories - high, medium, low, uncertain and inferred (Table 3-2) were applied to the compiled lithological (strand/tag) data. Table 3-2 provides a description of the habitat suitability categories used to classify the combined strand/ tag codes with examples of common logging descriptors.

All strand/ tag code combinations were collaboratively assessed by Biologic and Rio Tinto personnel with suitable expertise, to determine their most likely suitability for supporting subterranean fauna (AWT and BWT). This assessment was based upon evidence of subterranean fauna habitat features recorded in the data (*e.g.* fissures and cavities, hydrated weathering, unconsolidated gravel textures, and occasionally cavities and core losses).

Visual assessment of diamond drill cores (where available) from each Development Envelope section was undertaken to validate the suitability codes of strand/ tag code combinations. The visual assessment confirmed the occurrence of habitable features (*e.g.* well-developed fissures, cavities, secondary porosity, gravel zones, and occasional large cavities) at various depths in stratigraphic units ranked ‘high’ and ‘medium’ throughout the drilled profile.

The application of subterranean habitat suitability codes for each strand/ tag combination was based on previous experience with subterranean habitat assessment in similar geological settings, sampling information from similar geological settings (where available), and discussion with project geologists/ hydrogeologists where strand/tag combinations were unfamiliar.

Table 3-2 Habitat suitability code categories for subterranean fauna habitat modelling

Code category	Description	Examples
High	Code refers to a geological unit known to frequently support subterranean fauna (AWT/ BWT) including rich assemblages or, Code specifically records observation of subterranean habitat features such as fractures, pore spaces, cavities, or unconsolidated material.	Strand/ tag denotes unit that is always or almost always porous, weathered, vuggy, e.g. 'Hydrated', 'Cavity', 'Fractured', 'Broken ground', or 'High grade' within Dales Gorge, Mt Newman, Hematite, Goethite, CID/Pisolite, Calcrete, Silcrete, or Dolomite.
Medium	Geological units known to support subterranean fauna (AWT/BWT) in some circumstances (such as fractured or weathered rock habitats) or, A geological unit known to support subterranean fauna less frequently, less consistently, or less diverse assemblages based on previous experience in similar geological contexts. Fractures, pore spaces, cavities, and secondary weathering features are recorded as less well developed, less frequently occurring, or not specifically recorded but known to occur within this unit.	Variety of other Strand/Tags within Brockman, Marra Mamba, Wittenoom and Detrital units. Includes DG, JOF, NEW, Footwall zone, Hematite/Goethite, CID/Pisolite, Calcrete, Silcrete, and Dolomite. Examples 'mineralised', 'unmineralised', 'low grade', 'waste', 'quartz', and 'BIF'. Also 'Fault' which allows for fractures that are not always coded. Mineralised iron-bearing detrital formations and unconsolidated detritals (e.g. gravels, cobbles, scree), and 'cavity fill'
Low	A geological unit that very rarely supports subterranean fauna, or lacks the physical characteristics required for supporting subterranean fauna (i.e. insufficient void spaces or porosity). Also used for known barriers to hydrogeological/ geological habitat connectivity such as clays, shales, dolerite dykes and sills.	Strand/ tag combination denotes impermeable or fresh rock - e.g. MCS black shales, FOR group, dolerite (dyke/ sill), limonite, and fresh BIF, shale, or dolomite. Also detrital layers dominated by fine textured silt and clay.
Inferred	Zone occurs mostly BWT, above system basement, and some stratigraphic information is available, however the information density is unable to classify as above, and suitability unable to be confirmed by sampling.	Infrequent/ atypical strand/tags (or partially missing data) within otherwise suitable stratigraphic members. Units within the DG, NEW above basement where drilling data partially complete
Uncertain	Units that lacked sufficient information or context to classify as above – lacking geology/ hydrogeology logging and/or stratigraphic information.	Typically intervals missing sufficient data to classify.

3D Modelling in Leapfrog

Habitat modelling is principally derived from the stratigraphic models provided by Rio Tinto. A review of available Leapfrog models provided by Rio Tinto revealed a series of areas modelled in high detail but lacked a single overall regional stratigraphic model covering the Development Envelope. Most likely this was due to the size of the area, the amount of data to process, the varying complexity of each section and how each section is managed within the Development Envelope. To mitigate this, four habitat models were created. Firstly, a 'vein' model was completed for the AWT covering the entire Development Envelope. A vein model was also used to create the BWT habitats at BS2 and BS4. Whereas for BS1 and BS3, detailed stratigraphic models were available, habitat modelling could be completed using a 'refined' vein modelling approach in the BWT.

Vein modelling in Leapfrog allows spatial interpolation and linking of the same codes together throughout a modelling boundary, creating meshes or surfaces that can be exported or quantified as volumes. Similarly, a 'refined' vein model also interpolates the same code together but can be constrained within a stratigraphic unit which gives a much more useful description on exporting habitat volumes and regions where there is very little information.

Data processing settings within Leapfrog can vary for each model though where possible similar specifications were used, and these are set out in Table 3-3.

Table 3-3: Leapfrog Geo Model specifications

Specifications	Model Setting	AWT	BWT BS1	BWT BS2 and BS4	BWT BS3
Geology Model: General tab	Surface resolution	25-50	25-50	25-50	25
	Snap to data:	Drilling only	Drilling only	Drilling only	Drilling only
Vein Model: Surfacing tab	Boundary filter	Off	Off	Off	Off
	Maximum snap distance	25 (50 for detritals)	25 (50 for detritals)	25 (50 for detritals)	25-50
	Snap to data	All data	Inherit from GM (All data)	All data	Inherit from GM (All data)
	Pinch out	Yes	Yes	Yes	Yes

Modelling boundaries

Together with the model specifications, spatial boundaries are defined in Leapfrog to limit the degree of extrapolation of the model away from the data. Subterranean fauna habitats were modelled using the following lateral and vertical boundaries and presented in two distinct zones, Zone A and B.

Topography

Topographic information (LiDAR and elevation mapping, provided by Rio Tinto) formed the upper vertical boundary of the habitat modelling. The proposed and current/approved pit shells were extracted from the topography as additional vertical boundaries for impact scenarios.

Lateral boundaries

A 300 m radial boundary was enforced around the location of each drill hole to limit modelling extrapolation to a reasonable distance from each drilling data point. This boundary was chosen following consultation with geologists to determine a conservative estimate for extrapolation of geological information. In BWT habitat evaluations this boundary is known as Zone A.

In areas where drilling was very sparse or infrequent (*e.g.* at BS1 and BS3), the generation of this lateral boundary created gaps (artefacts) in the extent of habitat modelling, particularly BWT. To visualise better continuity of habitats, a second radial boundary of 1000 m around each drill hole was examined in the BWT scenarios and is referred to as Zone B.

System basement

Defining a conceptual basement of the synclinal aquifer system relevant for subterranean fauna habitat modelling was an important step to limit the ultimate depth of potentially suitable BWT habitat in the Brockman Syncline. The primary information used to inform the basement was the hydrogeological characteristics of the lower strata specifically porosity, modelled in 3D using baseline stratigraphic models. Bore logs and diamond cores were investigated, as well as groundwater yields, pump testing, and results of hydrogeological investigations. Finally, subterranean fauna sampling information was cross-checked where available, with the results of groundwater profiling surveys (targeting physicochemical parameters such as dissolved oxygen).

In most sections of the Brockman Syncline, the available information showed that some potential habitat could occur deeper than 100-120 m below surface, therefore a 150 m ultimate system basement was used for modelling. An exception to this is in the BS1 West compartment, where the available data suggested that 100 m below surface was more suitable for the conceptual system basement due to a decline in water quality with depth.

Water levels

Pre-impact

The Brockman Syncline has a series of hydrogeological compartments (separated by dykes and conceptual hydrogeological barriers) with different water table levels relative to the surface. Known water levels for each compartment were merged to form the overall synclinal water table layer and generate the 'pre-impact' water table (Figure 3-2 A). Meshes were created using the snapping to data function and with adaptive resolution selected. The resulting mesh was used as the primary vertical constraint between AWT and BWT in the habitat model.

Current

The current water level was amalgamated from the current measured head levels at BS2, BS3 and BS4 (provided by Rio Tinto). In the remaining parts of the syncline, namely BS1, the pre-impact water levels were used (Figure 3-2 B). Meshes were created using the snapping to data function and with adaptive resolution selected.

Proposed

Groundwater contours, provided by Rio Tinto, were used to determine predicted changes in water level under the various impact scenarios. Contours were provided as Min WL (minimum water levels) that were imported into Leapfrog and meshes created using the snapping to data function and with adaptive resolution selected. The resulting water table layers formed well constrained meshes and the vertical boundaries between AWT and BWT habitat under each of the impact scenarios.

Proposed Version H groundwater contours are shown in Figure 3-2C Life of Mine (LOM) contours without third party drawdown which was used for the proposed scenario at year 2050, and Figure 3-2D contours without third-party predicted drawdown was used for the Combined long-term scenario at year 2350.

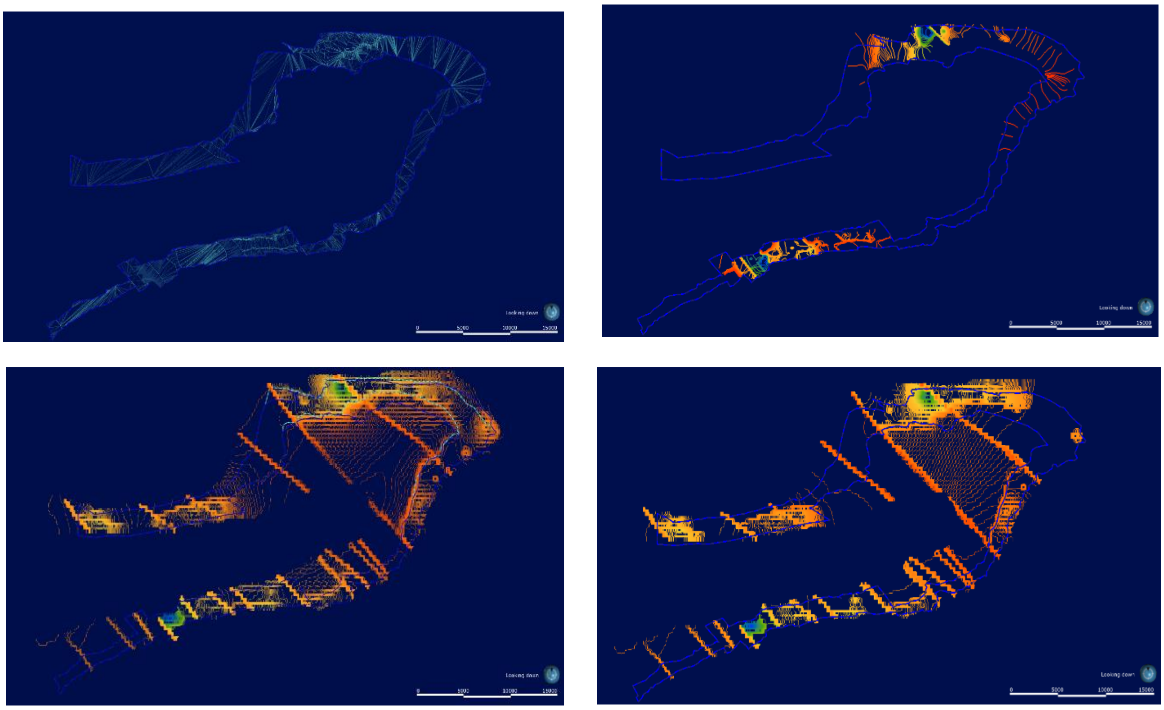


Figure 3-2 Water level contours A) Pre-impact, B) Current showing update of head end 2021 in BS2, B23 and BS4 C) Groundwater contours: Version H Min WL for LOM 2050, D) Groundwater contours: Version H Min WL Long-term 2350

Cumulative

Cumulative impact groundwater contours were assessed only at BS1 where third party influence (Fortescue Metals Eliwana Project maximum approved groundwater drawdown contours) was incorporated in the groundwater modelling. Differences in groundwater contours at BS1 are shown in Figure 3-3 between Combined Long-term 2350 with or without third party groundwater drawdown.

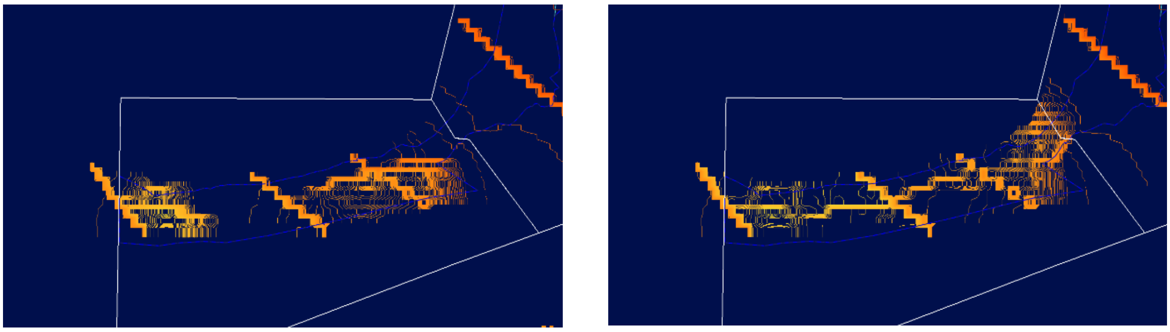


Figure 3-3: Version H Min WL groundwater contours for Combined Long-term 2350 impact, D) Version H Min WL groundwater contours for Cumulative 2350 scenario

Model categorisation

Following substantial evaluation of data and modelled 3D habitat, habitat suitability was characterised in two zones. Zone A is a detailed 3D modelling zone where the three classifications (High, Medium, Low from Table 3-2) were reasonably certain or laterally continuous within the 300 m boundary. Zone B was separated as another zone where the ‘inferred’ or “uncertain” habitat code categorisation (Table 3-2) dominates and the potential for habitat is subjected to the generalised stratigraphic categorisations outlined in Section 2 within a 1000 m boundary.

- Zone A: ‘Detailed 3D modelling zone’

Zone A represents areas that have been intensively drilled throughout the Brockman Syncline with a very high density of drill logging information from 31,137 drill holes and bores. Geological information recorded over 2,325,154 metres of drilling which was used to model the subterranean fauna habitats into suitability categories (Table 3-4). The depth of drill holes and bores was highly variable within and between the various sections of the Syncline with an overall mean depth of 102 m below surface and a standard deviation of 56 m. Almost all the habitat modelled in Zone A was well above the system basement (as defined in Section 3 above).

Table 3-4: Habitat suitability categories used in the 3D habitat model (Zone A)

Habitat suitability category	Description
High	Geological units known to typically support subterranean fauna including rich assemblages in most settings (e.g. Channel Iron Deposits, Calcrete, hydrated ironstone formations) and/or, Directly observed habitat features such as fractures, pore spaces, cavities, and coarse unconsolidated material.
Medium	Geological units known to support subterranean fauna in some circumstances/ settings where sufficiently fractured or weathered (e.g. Banded Iron Formations, Dolomite, alluvials/ colluvials) and/or, Habitat features (fractures, porosity, cavities) are as less well developed, less frequently occurring, or unable to be directly observed, but very likely to occur in this unit.
Low	Geological units that very rarely support subterranean fauna, or lack the physical characteristics required for supporting subterranean fauna (*i.e.* insufficient void spaces or porosity). Also used for known barriers to hydrogeological/ geological habitat connectivity such as clays, shales, dolerite dykes and sills.

- Zone B: 'Stratigraphic modelling zone'

Zone B surrounds Zone A laterally and at depth, where a lower density of information was available and habitat suitability is generally referred to as 'Inferred'. It is possible, and likely, that subterranean fauna could occur outside of the modelled High' and 'Medium' habitat volumes of Zone A and beyond the conservative confidence boundaries of Zone A, hence Zone B is depicted to a maximum boundary of 1000 m away from drill collars.

As the density of data is much lower in Zone B compared to Zone A, 'veins' were unable to be defined with confidence. Habitat modelling in this zone is reliant upon inferred and extrapolated stratigraphic trends. As the majority of Zone B is BWT, the hydrological characteristics of the stratigraphic units in Zone B (as shown in Table 2-2) were evaluated and applied to the model.

Conceptual aquifer system boundaries were used as lateral boundaries for modelling in Zone B, including the regional dolerite sill within the Joffre J6 unit of the BrIF, the Fortescue Group stratigraphy occurring at the lower boundary of the Nammuldi Member of the MMIF, and the conceptual 'system basement' as described above.

Conservative estimation

Multiple strategies were employed to ensure the volume of habitat used as input for the EIA process was based on conservative estimates:

- Limiting extrapolation of vein shapes to 300 m radius from drilling data points representing the area of maximum confidence in the drill logging information and interpretation of habitat suitability within Zone A.
- Categorisation of Zone B to further incorporate a maximum of suitable habitat within well constrained lateral boundaries that are geologically or hydrogeologically supported.
- Resolution of the modelling blocks were set to 25 m in bedrock stratigraphy and 50 m over detritals– blocks of 100 m or more would have been more efficient over large areas, however these smaller blocks provide greater precision.

- Where vein shapes were modelled with uncertainty or potential artefacts, Leapfrog overlaid the more highly suitable habitat categories with less suitable ones, resulting in uncertain vein shapes being minimised.

Impact scenarios

The assessment of impacts on subterranean habitat involves extracting impacts (such as pits and water level changes) from the pre-impact habitat. Each scenario is compared against the pre-impact habitat model and quantified for volumetric changes or loss of habitat. Six scenarios were evaluated, the results of which are presented in Section 6 to 8.

The following impact scenarios were considered in this assessment:

- Pre-impact;
- Current (2021);
- Proposed Life of Mine (2050, Proposal impacts only);
- Proposed Long-term (2350, Proposal impacts only);
- Combined Long-term (2350, Current and Proposal impacts); and
- Cumulative (2350, Current, Proposal, and third-party impacts).

3D Modelling of these impact scenarios are explained separately for AWT and BWT habitat modelling, as there is variation between the impact modelling for troglofauna and stygofauna habitats.

Pre-impact Scenario

The pre-impact scenario was used as a baseline reference for the impact assessment and models the AWT/BWT habitat prior to any mining or groundwater drawdown impacts within the Development Envelope.

Impact Scenarios for Troglofauna (AWT)

For troglofauna (AWT habitat), the bottom of the system is defined by the pre-impact water table, as no prospective habitat is assumed to be suitable for troglofauna below this level. Direct impacts focus on removing the pit volumes from the existing pre-impact habitat model.

Current Scenario

The current scenario modelled habitat remaining following removal of existing and approved Rio Tinto pit volumes within the Development Envelope from the modelled pre-impact habitat. Only BS2 and BS4 experienced current impacts (i.e. pits from BS2/ Nammuldi and BS4 approved under Ministerial Statements 925, 131, 867 and 1000).

In BS1 and BS3, there are no current impacts from pits and therefore the current scenario is the same as the pre-impact scenario.

Proposed LOM 2050 Scenario

The proposed scenario modelled new proposed pit volumes for all areas (BS1, BS2, BS3, and BS4) which were extracted from the pre-impact habitat model. The proposed scenario was modelled separately to any impacts under the current scenario.

Combined Long-term 2350 Scenario

Combined Long-term impacts on troglofauna habitat have modelled a combination of current/ approved Rio Tinto mining operations (refer current scenario), as well as proposed mining operations associated with the Proposal (refer proposed scenario), for the end of LOM (2050) Proposed and current/ approved pit volumes were merged in Leapfrog and then extracted from the pre-impact habitat model.

Impact Scenarios for Stygofauna (BWT)

For stygofauna (BWT Habitat), impacts are assessed by removal of the pit volumes as well as application of different predicted water level changes or drawdown for each scenario.

Current Scenario

The ‘current’ water table was derived from merging the pre-impact water table in BS1 with current (2021) head water levels in BS2, BS3 and BS4, as provided by Rio Tinto.

The current scenario represents habitat intact at present (2021) given existing Rio Tinto operations within the Development Envelope (i.e. current pits and drawdown from B2/ Nammuldi and B4 operations approved under Ministerial Statements 925, 131, 867 and 1000).

Proposed LOM Scenario 2050

The Proposed LOM scenario represents impacts from proposed pits and associated groundwater drawdown in 2050 for all sections of the Development Envelope (BS1, BS2, BS3, and BS4). Groundwater layers following proposed drawdown were modelled by Rio Tinto at the end of Life of Mine (2050) (LOM), and it was not possible to differentiate the effects of the current/ approved drawdown (at B2/NAM and B4) and the proposed drawdown within the water surface provided. Therefore, the Proposed LOM scenario BWT included some habitat loss from approved/existing operations and some habitat loss from the Proposal, at year 2050.

To quantify the direct impacts from the Proposal only, the current habitat loss was subtracted from Proposed LOM habitat loss in the volumetric calculations. This provided a fair and reasonable quantification of the direct impacts of the Proposal on BWT habitats at each section. However, all mapping and visualisations of the Proposed LOM scenario BWT showed habitat remaining intact following a combination of current/ approved and proposed impacts, at year 2050.

Proposed Long-term scenario 2350

A hypothetical ‘long-term’ proposed scenario was developed to assess the evaporative loss to BWT habitats from proposed pits only. Groundwater layers following proposed pits and drawdown were modelled by Rio Tinto at year 2350, without the effects of evaporative loss from current/ approved operations (at B2/NAM and B4). Losses associated directly with current/ approved pits and groundwater drawdown were then subtracted to calculate the evaporative loss from proposed pits only.

Combined long-term scenario (2350)

The combined long-term scenario modelled BWT habitat remaining under combined impacts of current/ approved and proposed mining operations at year 2350; representing a maximum/ worst-case scenario (WCS) for predicted BWT habitat loss. The Combined long-term scenario combined the impacts of:

- pits and predicted groundwater drawdown from current/ approved and proposed scenarios;
- potential evaporative losses from open BWT pits following closure to year 2350 (including backfilling of selected pits as per the Proposal);
- Rio-Tinto current/ approved operations only within the Brockman Syncline (i.e. no third-party operations such as the Eliwana Iron Ore Mine Project).

Cumulative (third-party) long-term (2350)

The cumulative long-term scenario modelled BWT habitat remaining at year 2350 under combined impacts of current/ approved, proposed, and reasonably foreseeable mining operations, including third-party groundwater drawdown impacts from the Eliwana Iron Ore Mine Project.

The cumulative impact scenario combined the impacts of:

- pits and predicted groundwater drawdown from current/ approved and proposed scenarios;
- potential evaporative losses from open BWT pits following closure to year 2350 (including backfilling of selected pits as per the Proposal);
- Third-party groundwater drawdown impacts at BS1 from the Eliwana Iron Ore Mine Project.

Third-party groundwater drawdown impacts comprised digitised drawdown contours from publicly available data and modelling associated with the approval the Eliwana Iron Ore Mine Project Environmental Review Document (FMG, 2018). This impact scenario is subject to the data, assumptions, and constraints/ limitations of the third-party drawdown modelling as published. The Cumulative long-term scenario represents an indicative WCS which assumes that the full amount of groundwater abstraction approved at Eliwana is realised. However, actual groundwater abstraction at Eliwana may be subject to updated monitoring data and water modelling, as well as third-party operational needs and future water licensing/ approvals that are not able to be foreseen.

The application and results of the impact scenarios are detailed in Sections 6 to 8.

4. GROUNDWATER PHYSICOCHEMICAL PROFILING

Groundwater quality is known to strongly affect habitat suitability for stygofauna, and therefore it was important to determine how physiochemical conditions change spatially across the Development Envelope and with depth. The potential suitability of stygofauna habitat at depths greater than 100 mbgl in the Pilbara region is the subject of ongoing investigations and required testing within the local hydrogeological context.

Groundwater sampling for laboratory chemical analysis has been undertaken since the 1990's across the Development Envelope, with a majority of the data collected for the BS4 and B2N mining operations (Rio Tinto, 2020b). Limited data has been collected away from these mining areas to depths that could test the limits of suitable habitat in different compartments of the syncline.

Rio Tinto monitoring reports characterise groundwater quality as typically fresh, with electrical conductivities varying between 400 and 1,500 µS/cm and pH values ranging from between 5.5 and 8.5 with a mean of 7.4. Groundwater quality is generally within ANZECC & ARMCANZ (2000) guidelines for aquatic ecosystems, with the exception of copper and zinc, which were recorded at elevated levels at some sites (Rio Tinto, 2020b).

While predicting future changes to groundwater quality following drawdown remains a challenge, observing and modelling the existing groundwater profiles provides an insight into the potential variability of current conditions. Targeted groundwater profiling surveys present a snapshot of the physicochemical characteristics (particularly dissolved oxygen, salinity, and pH) at the time of survey, and form a basis from which to assess the groundwater quality at different depths in different areas.

In February and October 2021, Biologic conducted profiling studies of 73 water bores and drill holes throughout BS1, BS3, and the eastern part of BS2 (Table 4-1), with the aim of characterising the vertical physiochemical profile of the groundwater, to inform 3D habitat modelling. The sampling targeted holes/ bores at variable depths up to 200 mbgl, with an aim of providing adequate representation throughout known aquifer compartments at the time of sampling, within the available bores and holes. Refer Section 10 for a schematic view of the groundwater profiling for dissolved oxygen.

Table 4-1: Summary of groundwater profiling holes/ bores by type and section

Hole Type	BS1	BS2	BS3	Total
Diamond			1	1
Geotech			2	2
Monitoring Bore	30	3	10	43
RC holes (uncased)	4		17	21
Production Bore	2	1	2	5
Other			1	1
Total	**36**	**4**	**33**	**73**

Profiling Methodology

An YSI-EXO1 probe was used to measure a suite of parameters including conductivity (including specific conductivity (SPCond), dissolved oxygen (DO), pH, oxidation-reduction potential (ORP), Turbidity, Temperature, Pressure and Depth (YSI, 2021). Physiochemical parameters were measured from the top of the water table to the end of hole (if possible) with measurements collected every second downhole.

Water Quality Parameters

Guidance on parameters and their range extent or suitable application are provided below and used to inform the results presented in Section 8.

Conductivity

Conductivity analysis in water is related to ionic concentration of materials that can conduct electricity and was measured in µS/cm. As temperature affects conductivity values, these values have been normalized to a specific temperature – namely 25˚ Celsius and are reported as Specific Conductance (SPCond) values. Typical conductivity values at 25˚ Celsius are shown in Table 4-2 for different water qualities.

Table 4-2: Typical conductivity values (SPCond) for different water types (YSI, 2021)

Conductivity	µS/cm	Description and use
De-ionized water	1	Drinking
Rainwater	50	Drinking and irrigation
Drinking	500	Drinking
Industrial Waste	5,000	Limited use, very saline
Seawater	50,000	Seawater, some industrial/mining use

Dissolved Oxygen (DO)

Most aquatic organisms require dissolved oxygen to survive however there has been very little study on exactly how much stygofauna need to survive. Hose (2015) provided a baseline quantification for water parameters which indicates that stygofauna are rarely found more than 100 mbgl nor where dissolved oxygen concentrations in the groundwater are less than 0.3 mg O_2/L. Modelled ranges were reviewed at 0.3, 0.5, 1 and 2 mg O_2/L concentrations. Outlier measurements (e.g. above 8 mg/L or 100% saturation) were excluded from analysis by examining the histogram of data values in Leapfrog, prior to building the water quality profile iso-surfaces. Refer Section 10 for a schematic presentation of the ODO results.

pH (potential Hydrogen/ acidity)

In general, water with a pH of 7 is considered neutral while pH < 6 is considered acidic and with a pH > 8 is considered basic or alkaline. The normal range for pH in groundwater systems is from 6 to 8.5.

Habitat Model Application

Dissolved oxygen, pH and Specific Conductance values were applied to the modelled subterranean habitat as evaluations. Evaluations are completed using the Numeric Modelling function in Leapfrog which allows creation of iso-surfaces or volumes at a specific value or range of values. The value ranges applied to each parameter followed the guidance ranges presented above. Where possible, the Iso-surfaces were tightly constrained to the data.

The groundwater profile (in relation to specific conductivity, dissolved oxygen and pH) was modelled against the suitable 3D habitat in each assessment area, enabling a comparison of the likely groundwater profile pre and post impacts are applied. The variability of the groundwater profiles is subject to change by season, over time and with further groundwater changes.

Validation of the measured data required comparison of the measured values against the drill hole casing slot depths. While uncased holes can be evaluated for stygofauna occurrence, cased holes are much better at constraining the depth of preferred habitat, especially if there are multiple or layered aquifers. Validation also ensured that two adjacent holes, with different slot depths, did not have overlapping or dipolar values, to simplify the numerical modelling evaluation. Values that overlapped were 'ignored' selectively in the Leapfrog® Geo dataset.

Visual results are presented under of the BWT pre-impact scenario and under the Combined Long-term or WCS scenario in Section 8.

5. CONSTRAINTS AND LIMITATIONS OF THE 3D MODELLING

Limitations and constraints associated with the 3D modelling study are detailed below.

There is no specific regulatory guidance for subterranean fauna habitat categorisation or modelling. The habitat modelling study is based on qualitative and quantitative assessment of the geomorphological, geostructural, hydrogeological, and physicochemical parameters of lithologies within the Brockman Syncline. The study was undertaken in order to determine suitable habitats for subterranean fauna above and below the water table, in and surrounding the Proposal.

The assessment of habitat suitability is based on the physical characteristics of the lithology in relation to the presence and abundance of subterranean voids that form habitat for subterranean fauna. The assessment was limited to the data and information available as detailed in Section 3. Extrapolation and data interpretation was constrained to the model boundaries as applied in Section 3, such that there was a high confidence in the modelling, and the zones or 'veins' of habitat were not extended throughout unknown lithologies, or to areas well beyond the limits of data.

It is not possible to precisely represent the occurrence, extent, and connectivity of fine scale voids that may provide habitat. However, the methodologies used herein to model veins of potential subterranean fauna habitat within and between lithologies provides the finest resolution of subterranean fauna habitat modelling currently known in the industry.

Geological structures such as faults, shears, and disconformities (where present) were fully integrated within the model, to the limits of data available. Other structures such as dykes and sills were derived from the drilling log data and interpretations of Rio Tinto geologists and hydrogeologists and integrated into the model as surfaces (refer Section 3). The creation of 3D habitat 'veins' occurred within this geostructural framework, therefore there was no limitation in regard to the inclusion of geological structures, and influence of these structures on the habitat 'veins' has been modelled as represented by the available data.

The aim of the 3D modelling is to provide a realistic representation of the suitability, extent, and connectivity of geological and hydrogeological habitats for subterranean fauna. Other factors that may influence the distribution or occurrence of subterranean fauna species (such as habitat humidity, water infiltration rates, ecological factors, behavioural factors, nutrient sources, and evolutionary history of the fauna species) are subject to their own limitations regarding available data/ knowledge and were unable to be integrated into the modelling study.

Data regarding weathering and oxidation states within the lithology was not consistently available across the modelling area at the time of assessment, and therefore could not be reliably integrated into the model. Nevertheless, the categorisation of Strand and Tag logging codes, along with multiple other information sources as detailed in Section 3 provided a consistent, reliable basis for identification of subterranean voids and porous zones that have resulted from weathering processes.

Airborne Electromagnetics data was reviewed in conjunction with drilling and bore logging data, hydrogeological interpretations, and groundwater physicochemistry profiling to identify potentially resistive layers (such as clays and fresh rock) that form the basement of the aquifer. The modelling of the system basement was undertaken to the limit of available data at the time of assessment, independently of the subterranean fauna habitat 'vein' modelling as detailed in Section 3.

In response to the variable depth of the system basement from topography, the vertical limit of 3D modelling was variable across the modelling areas (between 100 mbgl and 150 mbgl as described in Section 3). Stygofauna recorded from bores slotted deep in the profile provided further evidence of the potential for porous hydrogeological habitat at similar depths, in the same areas, to support stygofauna (refer Biologic 2022). Further testing of these deep stygofauna assemblages, utilising appropriately constructed bores, may be useful to confirm the findings.

There was no publicly available 3D information on AWT impacts (i.e. approved pit shells) from the adjacent Eliwana Iron Ore Mine to integrate into the AWT impact modelling scenarios. Nevertheless, these areas were expected to occur beyond the model boundaries to the north of the Development Envelope at BS1, and were therefore omitted.

Cumulative impact scenarios BWT (i.e. groundwater drawdown from Eliwana and BSP combined) were subject to the data, assumptions, and constraints/ limitations of the third-party drawdown modelling as published (FMG 2018). The Cumulative long-term scenario represents an indicative worst-case scenario assuming the maximum groundwater abstraction as approved under the current water license at the Eliwana operations. However, actual groundwater abstraction at Eliwana may differ from published modelling due to third-party influences.

6. SUBTERRANEAN HABITAT IMPACT ASSESSMENT FRAMEWORK

The 3D modelling facilitates assessment of potential impacts to subterranean fauna habitat by providing:

- Predicted changes to habitat thickness, connectivity, and extent under each scenario;
- Volumetric quantification of the impacts to habitat– changes to volume of habitat remaining in-situ, volume of habitat lost in m^3, and proportional comparisons to the pre-impact volume (i.e. % remaining); and
- Investigation of habitat quality within the predicted BWT habitat remaining, based on groundwater physicochemical profiles measured on site.

Assessment of habitat condition

Changes to habitat extent, thickness, and connectivity were assessed via 3D model comparisons before and after the proposed impact, particularly in areas where key subterranean fauna were recorded.

Assessment of habitat connectivity/ continuity for subterranean fauna is based around the understanding and visualisation of three major geological/ hydrogeological factors:

1. geological structures such as folds, faults, and shears, in situations where these structures significantly interrupt the connectivity of the habitable stratigraphy.
2. geological intrusives such as dykes and sills, where the intrusive geology is less porous/ less fractured, or otherwise less suitable as habitat than the remaining stratigraphy; and
3. the thickness of modelled habitat (AWT or BWT) and position of the water table relative to the habitable stratigraphic layers.

Quantification of habitat impacts

3D volumetric calculations of subterranean habitats have been used as the basis for quantitative impact assessment under multiple impact scenarios referred to in Section 3 and Table 6-1. The measured volume of habitat remaining presented in m^3 is used to calculate volumetric loss of habitat for each scenario presented in Sections 7 to 8 and summarised in Section 9.

Groundwater physiochemistry

Impacts to groundwater physiochemistry were assessed by numeric modelling of groundwater parameters summarised in Section 4. Current groundwater profiles were applied against the suitable 3D habitat in sections BS1, BS2 and BS3, enabling a comparison of the likely groundwater quality before and after the proposed groundwater drawdown.

In consideration of both the known suitable range of groundwater conditions for stygofauna, and the pre-impact conditions measured down-hole at each site, an assessment was made comparing the likely range of conditions in the post-drawdown habitat remaining in-situ. A particular focus was given on sites where unique or putatively restricted stygofauna were recorded.

Table 6-1: Framework for assessment of subterranean fauna habitat

Habitat Modelling Method	Impact Scenario	Suitability	Extent	Thickness	Connectivity
		Suitability (physical structure) of geological/ hydrogeological habitat.			3D connectivity/ fragmentation of suitable geological/ hydrogeological habitat.
Surface geology	Indirect	Potential habitat suitability categories: High, Med-High, Medium, Low-Med, Low. Surface geology categorised for AWT/ BWT habitat suitability as shown in Table 2-2. Potential suitability based on GSWA 1:250,000 series geological descriptions and previous experience in similar geological settings.	Potential AWT/ BWT habitat area shown throughout Development Envelope and surrounds.	No thickness (2D only). Geological suitability below surface is assumed/ unconfirmed.	Potential habitat connectivity assumed within same-coloured formations (2D).
3D habitat modelling	'Pre-impact'	Suitability categories: High, Medium, Low., Uncertain, Inferred. 3D modelling based on drill log data, diamond cores, geological validation, previous experience. Suitable AWT/ BWT habitat shown as modelled extent (comprising high/ medium suitability).	Extent of suitable habitat shown as thickness grids (in 2D maps). Maximum extent of suitable habitat modelling extends 300 m from each drill hole in Zone A, mapped as 'habitat modelling boundary'	Habitat thickness (m) shown as colour gradient in 2D. AWT: extends from surface to max depth of drilling, or to pre-impact water table. BWT: extends to max depth of drilling, below pre-impact water table to the system basement.	Connected suitable habitat shown as colour mapping within 'habitat modelling boundary'. Empty spaces within 'habitat modelling boundary' may indicate data gaps in modelling of suitable habitat. Major geological structures (*e.g.* dykes, major faults/ shears) that may impede connectivity assessed via habitat modelling vs regional stratigraphy modelling.
	'Current', 'Proposed', 'Combined', 'Cumulative'	Impact scenarios show remaining habitat (combined high/ medium suitability), with 3D extent of impact zones (current pits, or current and proposed pits) removed and in BWT groundwater drawdown applied. No change in suitability ranking – impact scenarios show extent/ thickness/ connectivity of habitat remaining after mining.	Proposed pits and Current pits all occur within 'habitat modelling boundary'. Any habitat shown outside Proposed pits or Current pits indicates extent/ thickness of habitat expected to remain beneath pits/ drawdown after impacts.	Habitat thickness (m) shown as colour gradient in 2D.	Visual assessment of impact to suitable habitat also shown in relevant 3D modelling outputs. Visual assessment of fragmentation/ connectivity of remaining high/ medium suitability habitat AWT/ BWT. Attention to connected habitats within and outside of Proposed pits where any 'at risk' taxa were recorded.

7. TROGLOFAUNA 3D HABITAT ASSESSMENT

The final 3D model of AWT troglofauna habitats is based on a large amount of drill-hole information, as shown in Table 7-1. In total, 31,138 drill holes were used to model the AWT habitats throughout the Development Envelope. More than 1.4 million metres of AWT downhole length were categorised into troglofauna habitat suitability categories as described in Section 3 (Table 7-1). Modelling the AWT habitats with such a large amount of data resulted in a high degree of confidence in the troglofauna habitat assessment and the assessment of impacts to habitats.

Table 7-1: Drill hole information used to model AWT habitats throughout the Development Envelope

	Number of holes	Total metres drilled (all holes)	Mean drill depth [m], (st. dev.)	Maximum drill depth [m] (single hole)
BS1	4,691	211,808	45 (24)	174
BS2	11,882	525,111	44 (24)	292
BS3	1,919	93,349	49 (24)	195
BS4	12,644	615,440	49 (23)	202
Overall	**31,138**	**1,445,818**	**46 (24)**	**292**

An overview of all pre-impact AWT habitats within the Development Envelope, as obtained from the 3D model, are shown in Figure 7-1.

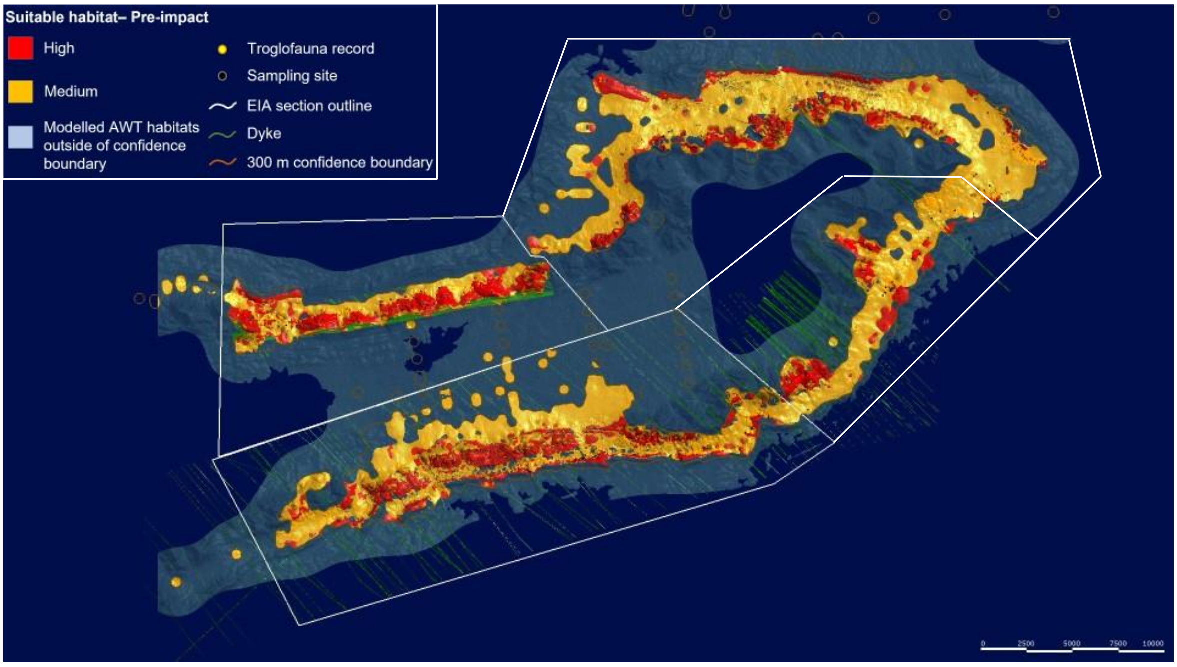


Figure 7-1: Overview of pre-impact AWT Troglofauna Habitat for the Development Envelope

Brockman Syncline 1

The 3D modelling of AWT habitats in the BS1 section is supported by 212 km of logging data from 4,691 drillholes (Table 7-1), evaluation of diamond cores, geophysical data, and a recently revised stratigraphic model. Owing to this high density of data, there is a very high level of confidence in the detailed shape and extent of high and medium suitability 'veins' AWT throughout the BS1 section with total metres per suitability category shown in Table 7-2.

Table 7-2: Overview of drill hole data per habitat suitability category at BS1

Habitat suitability category	Total metres (m)	Mean interval thickness (m)*	Min interval thickness (m)	Max interval thickness (m)
High	74,020	17.0	6.1	152.0
Medium	122,278	23.5	10.0	148.0
Low	9,659	10.8	5.1	82.0
Inferred	5,563	6.9	1.0	60.9

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Pre-impact Habitat Assessment

At BS1, the 3D modelling shows extensive, continuous, and variably thick (averaging 45 m) troglofauna habitat along the strike of the ridgeline and throughout the synclinal valley (Figure 7-2A, Figure 7-3A, Table 7-2). Large patches of suitable thick AWT habitat occur in well-connected patches associated with the hills and ridges of the Brockman Range. Geologically, these hills comprise the Dales Gorge, Whaleback Shale, and Joffre Members of Brockman Iron Formation (BrIF). Where exposed to weathering and intense fracturing from faults or deformation, such units are well-known to provide suitable habitats for troglofauna. The synclinal valley to the immediate north of the Brockman Range at BS1 hosts thin to moderately thick AWT habitats comprised of colluvial detritals and calcrete. The detrital habitats AWT are continuous along strike of the valley and are locally contiguous with the bedded ironstone habitats formed in BrIF within the hills and mountains.

Numerous dykes and faults occur within the bedrock formations at sub-perpendicular angles to the strike at BS1. Most dykes extend north-westerly from the syncline (approximately 300 degrees azimuth), while a major regional dyke occurs separating BS1 East and BS1 West in a more perpendicular direction (approximately 300 degrees azimuth), that offsets the water table by over 40 m. AWT habitat connectivity likely exists, regardless of the minor dykes, via the detritals occurring in the valley above these geological structures (Figure 7-2A, Figure 7-3A).

The hills on the northern side of the synclinal valley at BS1 are formed in MMIF, which is also known to provide highly suitable habitats that support troglofauna assemblages (Biologic, 2018); however, this area is part of the Eliwana Iron Ore Mine Project and is beyond the modelling boundary and scope of this Memo. Consequently, the habitat modelling was not extended throughout the full width of prospective habitats (Figure 7-2 and Figure 7-3) and more suitable habitats are expected to exist at BS1, particularly within the northern MMIF and detrital valley outside of the modelling boundary.

Current Habitat Assessment

As there are no current impacts AWT in BS1, the current habitat volumes are the same as the pre-impact section above.

Proposed LOM 2050 Habitat Assessment

The 3D modelling shows a moderate reduction in habitat thickness within the pit areas, but this does not change the extent or connectivity of the suitable AWT habitats at BS1. The synclinal valley to the immediate north of the Brockman Range at BS1 maintains thin to moderately thick AWT habitats. Patches of thick AWT habitats remain in-situ throughout BS1 (compare A and B of Figure 7-2 and Figure 7-3). It is expected that suitable habitats are expected to exist (unmodelled) north of BS1, particularly within the MMIF and detrital valley and in the south within the Brockman Ranges.

Approximately 844,990,000 m^3 of the suitable habitat modelled throughout BS1 is expected to remain under the proposed scenario this equates to approximately 79% of the pre-impact habitat.

A detailed breakdown of AWT habitat volumes lost and retained at BS1 under the Proposed LOM scenario is shown in Table 9-1.

Combined Long-term Habitat Assessment

The Combined Long-term (2350) suitable habitat at BS1 AWT is the same as the Proposed LOM 2050 impact assessment as there are no current impacts for BS1.

Third-party operations (Eliwana Iron Ore Mine Project) are very close to the proposed mining footprint and likely impact the same troglofauna habitat as the proposed BS1 pits. Due to lack of available impact information (3D pit-shell meshes) it was not possible to quantify the AWT impact of these third-party operations in the 3D habitat model.

The measured volumetric AWT habitat remaining is presented in m^3 for each scenario in Table 7-3. Calculated habitat loss is presented as a percentage of the pre-impact habitat.

Table 7-3: Volumetric troglofauna habitat at BS1 under each impact scenario

	Volume ('000 m3)				% of pre-impact habitat		
	Pre-impact	**Current 2021***	**Proposed LOM 2050^**	**Combined Long-term 2350°**	**Current 2021**	**Proposed LOM 2050**	**Combined Long-term 2350**
Remaining Habitat							
High	287,660	287,660	175,330	175,330	100.0	61.0	61.0
Medium	783,710	783,710	669,660	669,660	100.0	85.4	85.4
Zone A: Suitable Habitat (H and M)	**1,071,370**	**1,071,370**	**844,990**	**844,990**	**100.0**	**78.9**	**78.9**
Low	105,060	105,060	99,442	99,442	100.0	94.7	94.7
Inferred	965,240	965,240	935,140	934,570	100.0	96.9	96.8
Habitat Loss							
High	0	0	112,330	112,330	0.0	39.0	39.0
Medium	0	0	114,050	114,050	0.0	14.6	14.6
Habitat Loss (H and M)	**0**	**0**	**226,380**	**226,380**	**0.0**	**21.1**	**21.1**
Low	0	0	5,618	5,618	0.0	5.3	5.3
Inferred	0	0	30,100	30,670	0.0	3.1	3.1

* the volume of current/ approved pits within the Development Envelope was subtracted from the pre-impact modelled habitat
^ the volume of proposed pits was subtracted from the pre-impact modelled habitat
° the volumes of both current/ approved pits as well as proposed pits were subtracted from the pre-impact modelled habitat

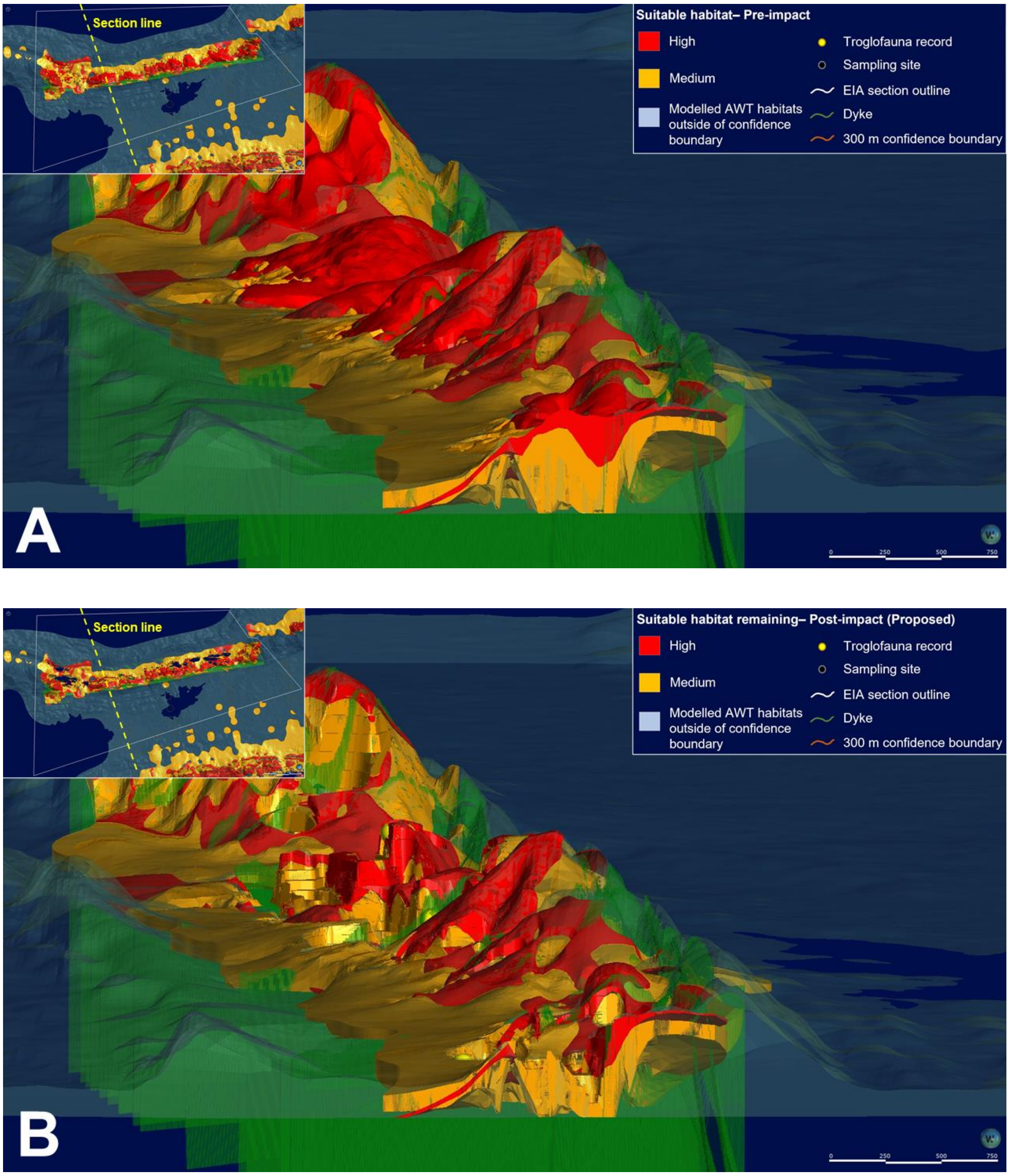
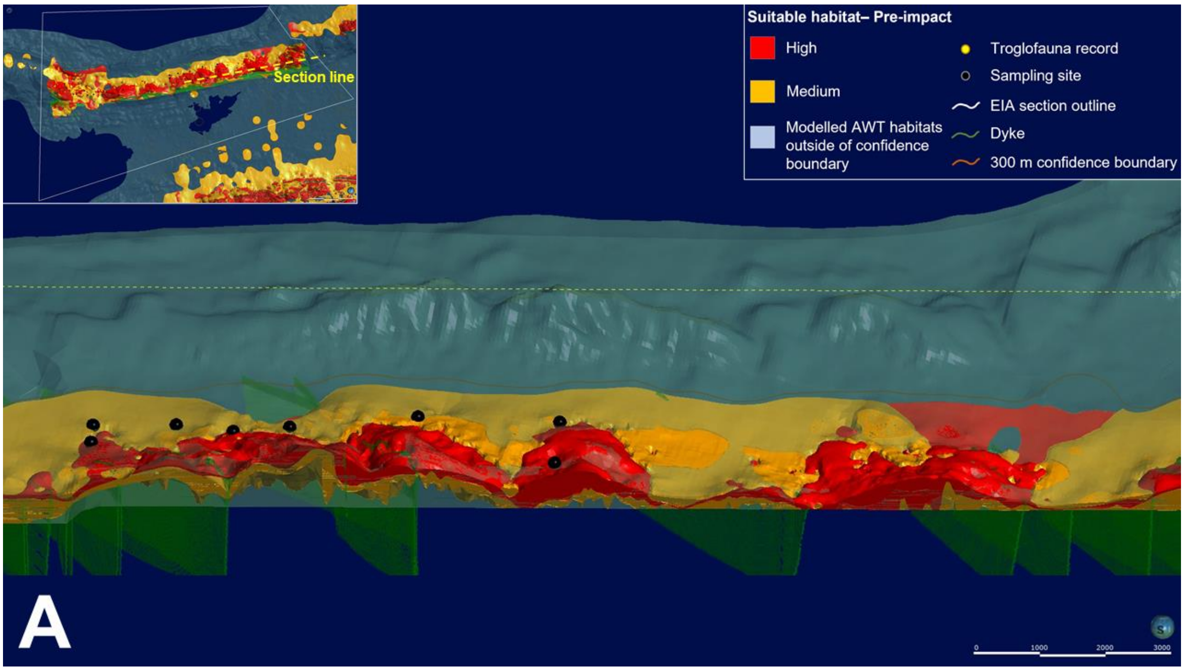


Figure 7-2: Cross-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact and (B) post-impact (proposed) at BS1.*Vertical scale exaggerated x5*



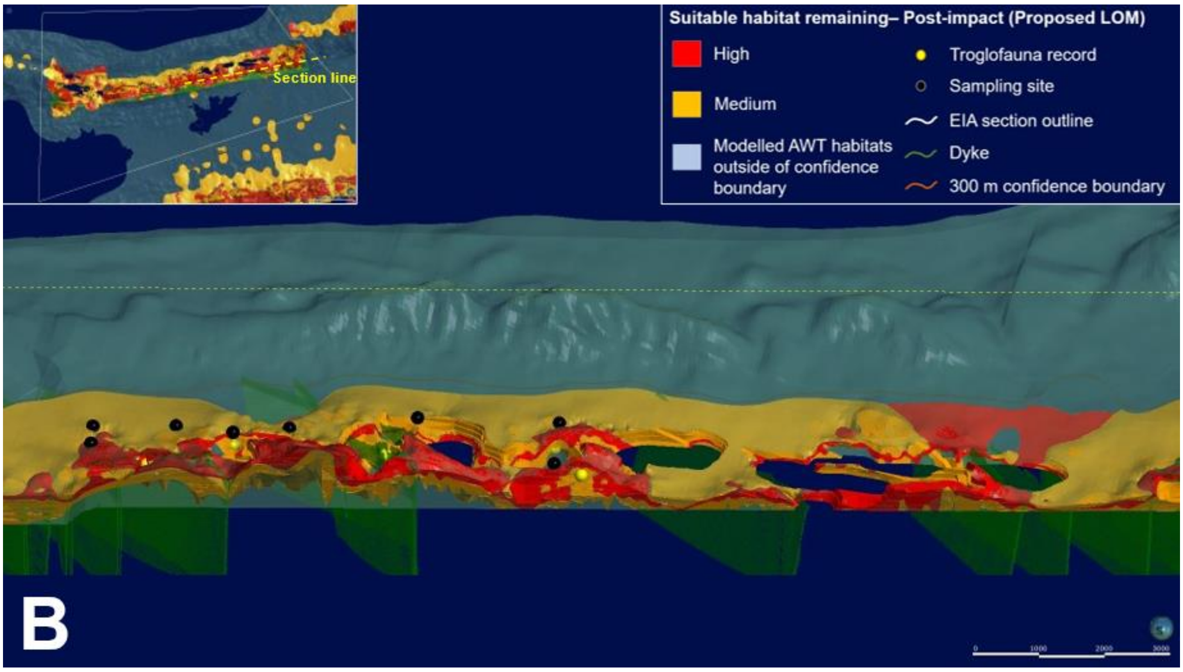


Figure 7-3: Long-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact and (B) post-impact (proposed) at BS1. Vertical scale exaggerated x5

Brockman Syncline 2

The AWT habitat modelling in the BS2 area is supported by 525 km of logging data from 11,822 drill holes (Table 7-1), evaluation of diamond cores, geophysical data, and regional stratigraphic model. Owing to this high density of data, there is a very high level of confidence in the shape and extent of high and medium suitability 'veins' AWT throughout most parts of the BS2 section with total metres per suitability category shown in Table 7-4.

Table 7-4: Overview of drill hole data per habitat suitability category at BS2

Habitat suitability category	Total metres (m)	Mean interval thickness (m)*	Min interval thickness (m)	Max interval thickness (m)
High	141,632	18.2	6.3	218.0
Medium	327,852	26.1	11.8	280.0
Low	39,212	12.9	6.0	92.0
Inferred	15,923	8.7	0.1	134.2

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Pre-impact Habitat Assessment

At BS2 suitable troglofauna habitats (AWT) are extensive, continuous, and moderately thick (averaging 44 m) throughout the broad synclinal valley, and increasingly thick suitable habitat occurs along the flanks and upland areas of the Brockman Range (along the southern margin of the Development Envelope at BS2). Medium to high suitability bedded ironstone geologies (respectively in BrIF and MMIF) outcrop at the southern and northern margins of the wide synclinal valley at BS2, which itself hosts suitable troglofauna habitat in AWT detrital formations between the two ridges (Figure 7-4A, Figure 7-5A, Table 7-4).

Localised patchiness of the AWT habitat occurs along the southern flank of the valley where Mt McRae Shales outcrop on the flanks of the Brockman Range, as well as in the main strike of the valley where clay lenses occur AWT.

Dykes and faults within bedrock geologies are common at BS2 and strike the syncline in a perpendicular fashion. The dykes are not likely to form complete barriers for troglofauna movement (or at least, not for all species) owing to the well-connected detrital habitats AWT in the valley, above the bedrock. Beyond the southern boundary of 3D modelling, towards the centre of the syncline, available regional geological information suggests a continuation of thick, contiguous habitat in BrIF throughout the mountainous area of the Brockman Range.

In the western part of the BS2 section, habitat appears patchier due to lower drilling density and fewer drill holes that were able to be sampled for troglofauna. The continuity of habitat through this area is expected to remain contiguous and substantial throughout the modelled detrital valley and mountainous Brockman Range.

Current Habitat Assessment

Approved mining operations have shown a moderate reduction in suitable troglofauna habitat along the northern flanks of the Marra Mamba and southern base of the Brockman Formation (compare A and B of Figure 7-4 and 7-5). Throughout the valley, habitat remains contiguous and connected. Further and vast prospective AWT habitats likely exist south of the proposed pits outside of the Zone A (300 m) modelling boundary and within the prospective Brockman Iron Formation Ranges.

Approximately 2,880,540,000 m^3 of suitable habitat is estimated to exist under the current approved scenario (Table 7-5) which equates to 89.2% of the pre-impact habitat. The calculated habitat loss of suitable habitat is 348,860,000 m^3 of the pre-impact scenario.

Proposed LOM 2050 Habitat Assessment

Visual comparisons of the Proposed scenario against the pre-impact and current scenarios showed minimal changes to habitat extent, thickness, and connectivity (compare A and C of Figure 7-4 and 7-5). Extensive areas of prospective AWT habitat remain throughout the central valley of the BS2 section (Figure 7-4 and 7-5).

The calculated habitat loss of suitable habitat is 73,800,000 m^3 of the pre-impact scenario or approximately 2.3% habitat loss. With consideration of the current modelled habitat volume, the total suitable habitat remaining after implementation of the Proposal would be 2,806,740,000 m^3 throughout BS2 that is expected to remain in-situ (Table 7-5). A detailed breakdown of AWT habitat volumes lost and retained at BS2 under the Proposed LOM scenario is shown in Table 9-1.

Combined Long-term 2350 Habitat Assessment

Under the Combined Long-term impact scenario, there is a moderate reduction of suitable habitat with only minor changes to habitat extent, thickness, and connectivity. Extensive areas of prospective AWT habitat remain unaffected throughout the BS2 area, particularly in the vast detrital valley located between current and proposed pits (compare A and D of Figure 7-4 and Figure 7-5). Further and vast prospective AWT habitats likely exist south of BS2 within the Brockman Iron Formation, outside of the 3D modelling boundary.

Approximately 2,806,740,000m^3 of the suitable habitat modelled throughout BS2 is expected to remain unaffected under the Combined long-term scenario (Table 7-5).

Table 7-5: Volumetric impacts to troglofauna habitat at BS2 for each impact scenario

	Volume (m^3) ('000)				% of pre-impact total		
	Pre-impact	Current 2021*	Proposed LOM 2050^	Combined Long-term 2350°	Current	Proposed	Combined Long Term
Remaining Habitat							
High	582,400	467,740	556,100	441,440	80.3	95.5	75.8
Medium	2,647,000	2,412,800	2,599,500	2,365,300	91.2	98.2	89.4
Zone A: Suitable habitat (H and M)	3,229,400	2,880,540	3,155,600	2,806,740	89.2	97.7	86.9
Low	476,080	466,960	475,090	465,970	98.1	99.8	97.9
Inferred	3,547,904	3,473,469	3,537,804	3,463,369	97.9	99.7	97.6
Habitat Loss							
High	0	114,660	26,300	140,960	19.7	4.5	24.2
Medium	0	234,200	47,500	281,700	8.8	1.8	10.6
Habitat Loss (H and M)	0	348,860	73,800	422,660	10.8	2.3	13.1
Low	0	9,120	990	10,110	1.9	0.2	2.1
Inferred	0	74,435	10,100	84,535	2.1	0.3	2.4

* the volume of current/ approved pits within the Development Envelope was subtracted from the pre-impact modelled habitat
^ the volume of proposed pits was subtracted from the pre-impact modelled habitat
° the volumes of both current/ approved pits as well as proposed pits were subtracted from the pre-impact modelled habitat

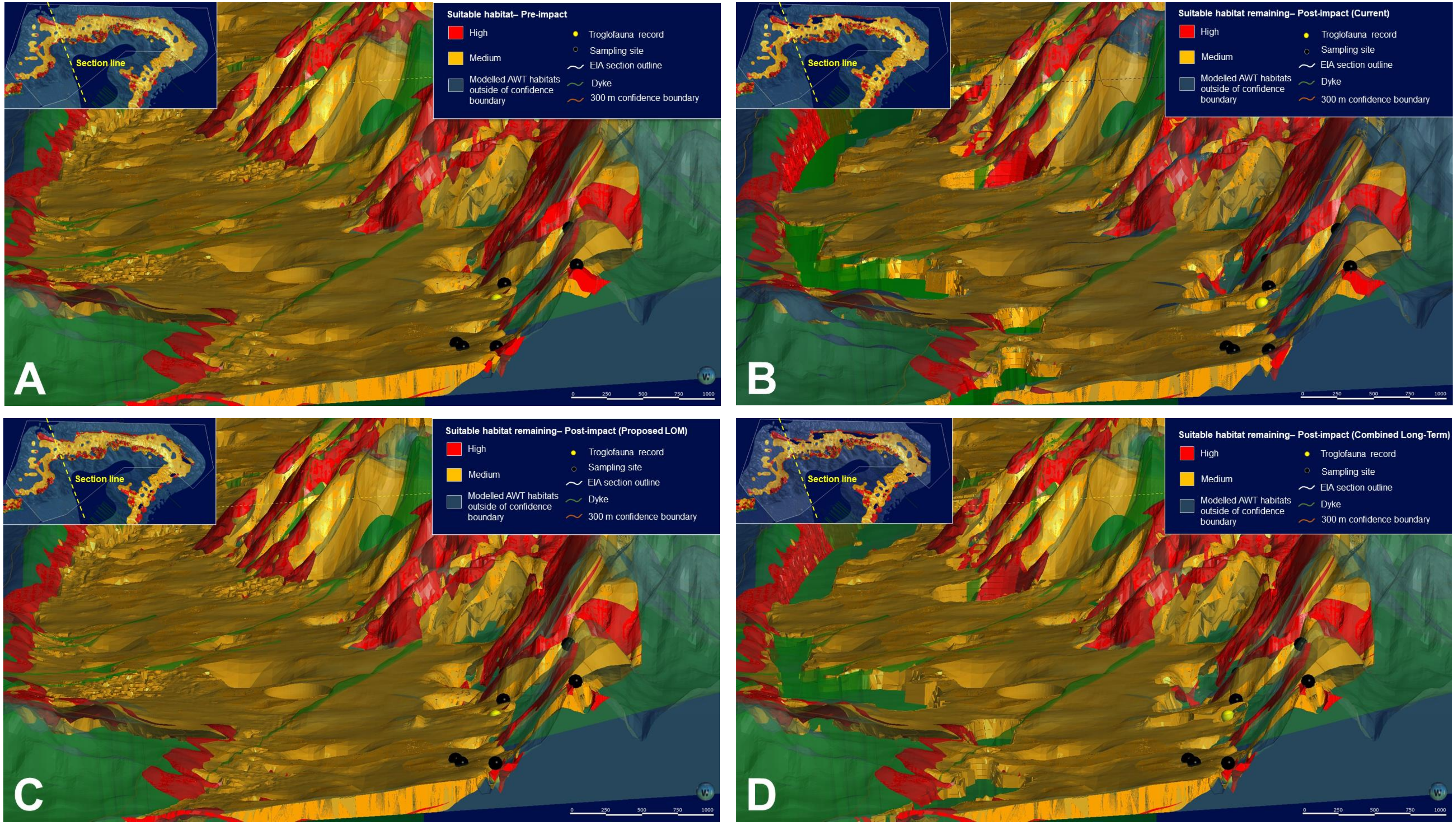


Figure 7-4: Cross-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact, (B) post-impact (current), (C) post-impact (proposed LOM) and (D) post-impact (combined long-term) at BS2. *Vertical scale exaggerated x5*

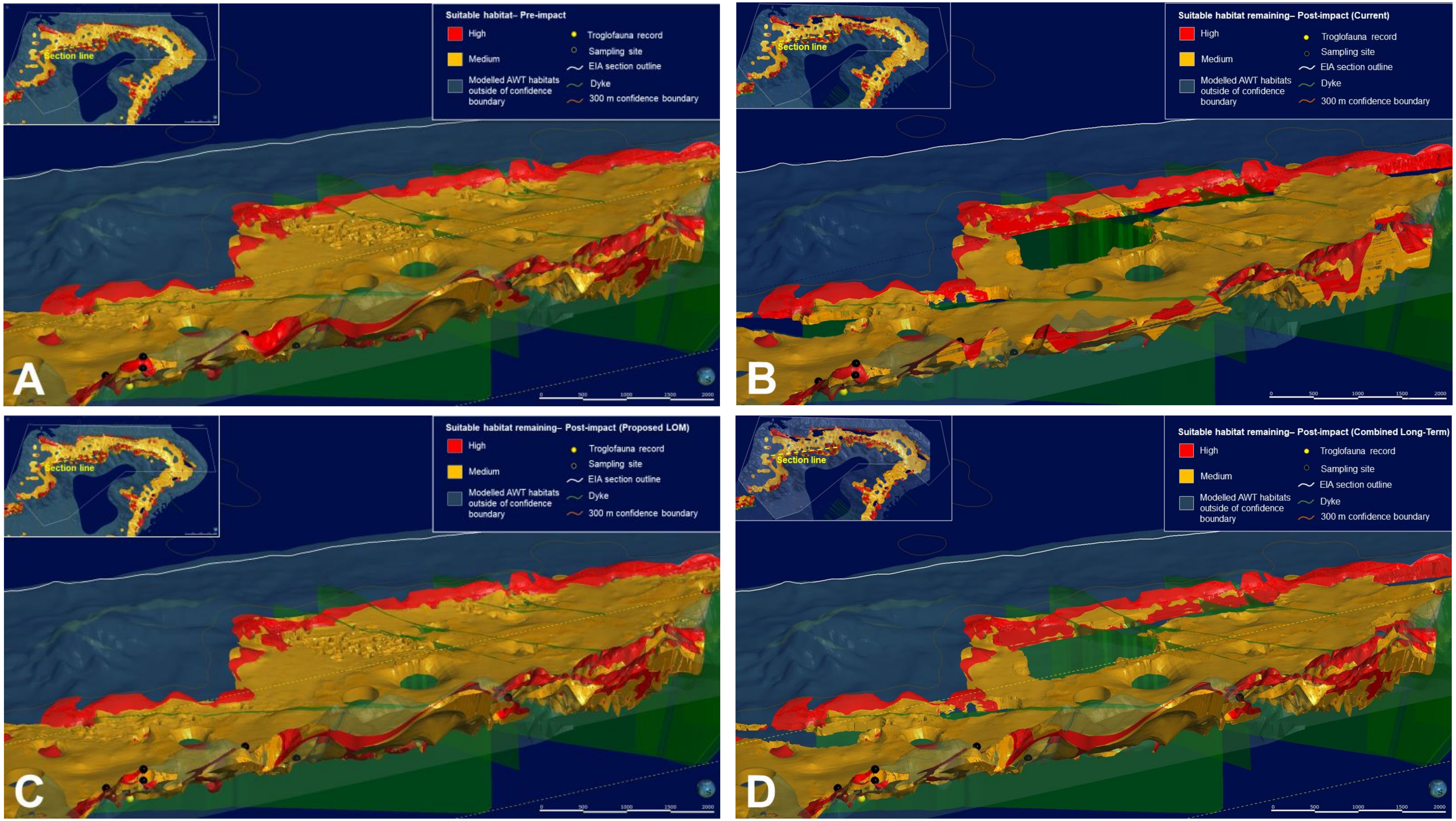


Figure 7-5: Long-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact, (B) post-impact (Current), (C) post-impact (Proposed LOM) and (D) post-impact (Combined Long-term) at BS2. *Vertical scale exaggerated x5*

Brockman Syncline 3

The AWT habitat modelling in the BS3 section is supported by 93 km of logging data from 1,919 drill holes (Table 7-1), diamond cores, geophysical data, and a revised stratigraphic model. There is a high level of confidence in the shape and extent of high and medium suitability 'veins' of AWT throughout most parts the BS3 section as demonstrated with the total metres outlined in Table 7-6.

Table 7-6: Overview of drill hole data per habitat suitability category at BS3

Habitat suitability category	Total metres (m)	Mean interval thickness (m)	Min interval thickness (m)	Max interval thickness (m)
High	27,397	24.6	9.4	170.0
Medium	49,480	26.1	10.0	195.1
Low	10,444	14.7	6.0	129.6
Inferred	5,949	7.5	1.3	58.0

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Pre-impact Habitat assessment

At BS3, 3D modelling shows extensive, continuous and variably thick (averaging 49 m) troglofauna habitats AWT along the strike of the synclinal valley (Figure 7-6 and Figure 7-7, Table 7-6). The 3D habitat modelling only extends up into the Brockman Range at a few locations in this section based on available drilling, and where it does so (in the centre of the section around BSMM pits, and in the south around BS3 pit), the modelling confirms that the Brockman Range provides very thick suitable habitats AWT (>250 m AWT) (Figure 7-6 and Figure 7-7). The 3D modelling does not extend laterally into the upland parts of the Brockman Range due to limitations in available drilling data. These areas are likely to provide additional thick suitable habitat AWT.

By comparison, the valley hosts thin to moderately thick AWT habitats (averaging 25 m). The south-eastern side of synclinal valley (MMIF) provides further highly suitable troglofauna habitats.

Numerous dykes and faults occur within the bedrock throughout the BS3 section at angles roughly perpendicular to the strike of the valley (Figure 7-6 and Figure 7-7). The number and extent of the dykes throughout the modelled habitat in this section is interpreted as a potential factor influencing the ability of troglofauna species to disperse. However, the AWT detrital habitats within the valley are known to be well-connected above the dykes in the bedrock, therefore some troglofauna species may be able to disperse around or beyond to compartmentalised bedrock habitats.

Current Habitat Assessment

As there are no current impacts in BS3, the current suitable habitat is the same as the pre-impact section above.

Proposed LOM 2050 Habitat Assessment

Visual comparisons of the pre-impact and post-impact (proposed) scenario showed the following changes to habitat extent, thickness, and connectivity:

- 3D modelling shows a slight reduction in habitat thickness in the location of the proposed pits, but the overall extent of suitable AWT habitats remains unaffected. Patches of thick AWT habitats remain in-situ throughout BS3 (compare A and B of Figure 7-6 and Figure 7-7).
- 3D modelling indicates that habitat connectivity will be maintained, despite a series of dykes and faults throughout the BS3 area. Whilst the dykes are expected to restrict the wider connectivity of habitats in the BrIF and MMIF parallel to the strike of the ranges (particularly in southern parts of the BS3 area), they do not occur beyond the basement rocks and AWT habitats remain connected along strike via the detrital valley. The proposed pits do not remove a high proportion of the wider available AWT habitat in any given compartment (Figure 7-6 and Figure 7-7).
- Further highly prospective AWT habitats likely exist in the MMIF along the south-eastern side of the synclinal valley, outside of the 3D modelling boundary.

At BS3, approximately 1,397,800,000m3 of the suitable habitat modelled is expected to remain in-situ under the proposed scenario. This is the equivalent of about 89.8% of pre-impact habitat. (Table 7-7).

A detailed breakdown of AWT habitat volumes lost and retained at BS3 under the Proposed LOM scenario is shown in Table 9-1.

Combined Long-term 2350 Habitat Assessment

The Combined Long-term (2350) suitable habitat at BS3 are reported the same as the Proposed LOM 2050 impact assessment as there are no current impacts for BS3.

Table 7-7: Volumetric impacts to troglofauna habitat at BS3 for each impact scenario

	Volume ('000 m^3)				% of pre-impact		
	Pre-impact	Current 2021*	Proposed LOM 2050^	Combined Long Term 2350°	Current	Proposed	Combined Long Term
Remaining Habitat							
High	288,140	288,140	208,100	208,100	100.0	72.2	72.2
Medium	1,268,300	1,268,300	1,189,700	1,189,700	100.0	93.8	93.8
Zone A: Suitable habitat (H and M)	1,556,440	1,556,440	1,397,800	1,397,800	100.0	89.8	89.8
Low	279,420	279,420	276,120	276,120	100.0	98.8	98.8
Inferred	1,343,470	1,343,470	1,314,767	1,314,767	100.0	97.9	97.9
Habitat Loss							
High	0	0	80,040	80,040	0.0	27.8	27.8
Medium	0	0	78,600	78,600	0.0	6.2	6.2
Habitat Loss (H and M)	0	0	158,640	158,640	0.0	10.2	10.2
Low	0	0	3,300	3,300	0.0	1.2	1.2
Inferred	0	0	28,703	28,703	0.0	2.1	2.1

* the volume of current/ approved pits within the Development Envelope was subtracted from the pre-impact modelled habitat
^ the volume of proposed pits was subtracted from the pre-impact modelled habitat
° the volumes of both current/ approved pits as well as proposed pits were subtracted from the pre-impact modelled habitat

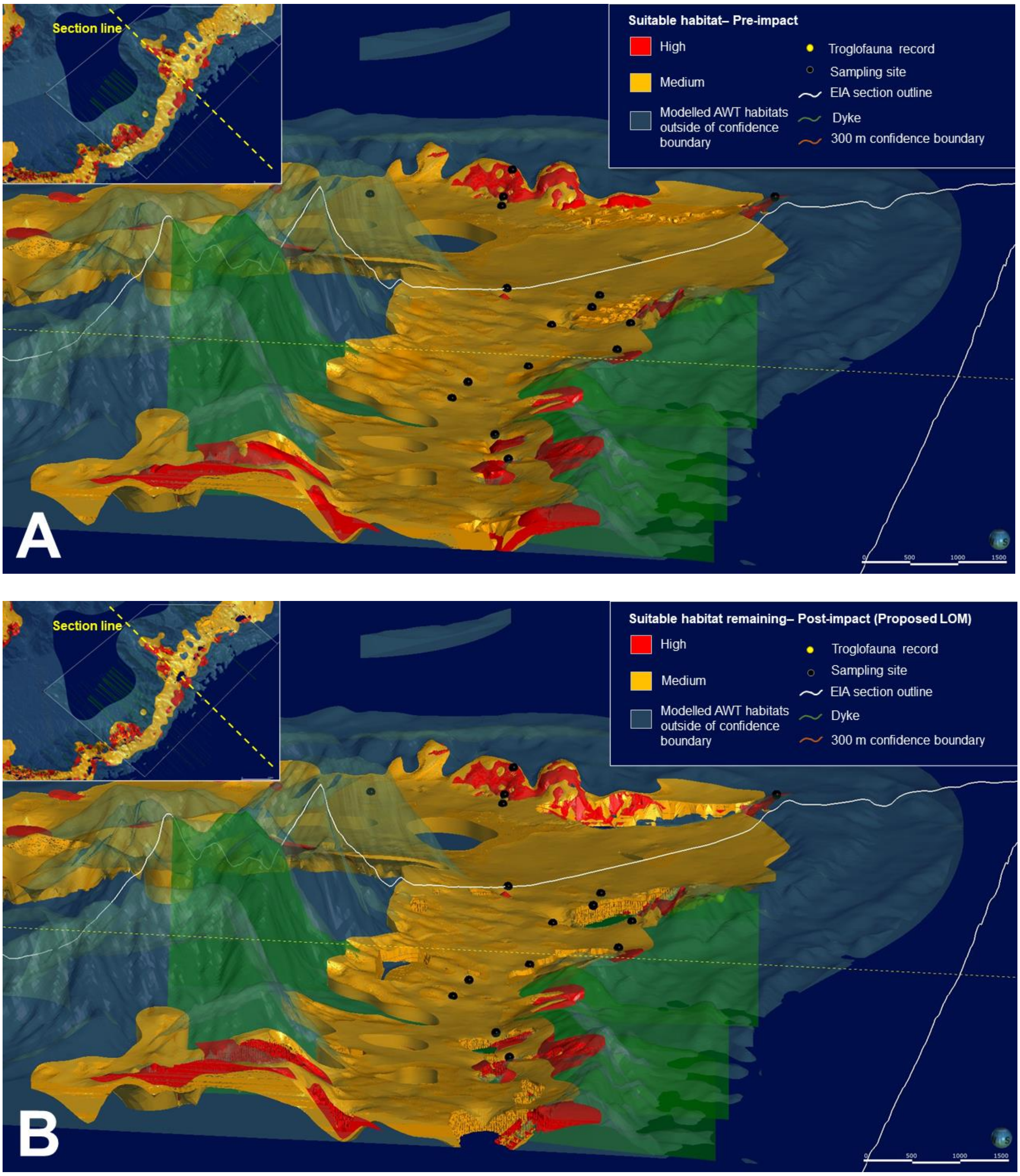


Figure 7-6 Cross-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact and (B) post-impact (proposed) at BS3. *Vertical scale exaggerated x5*

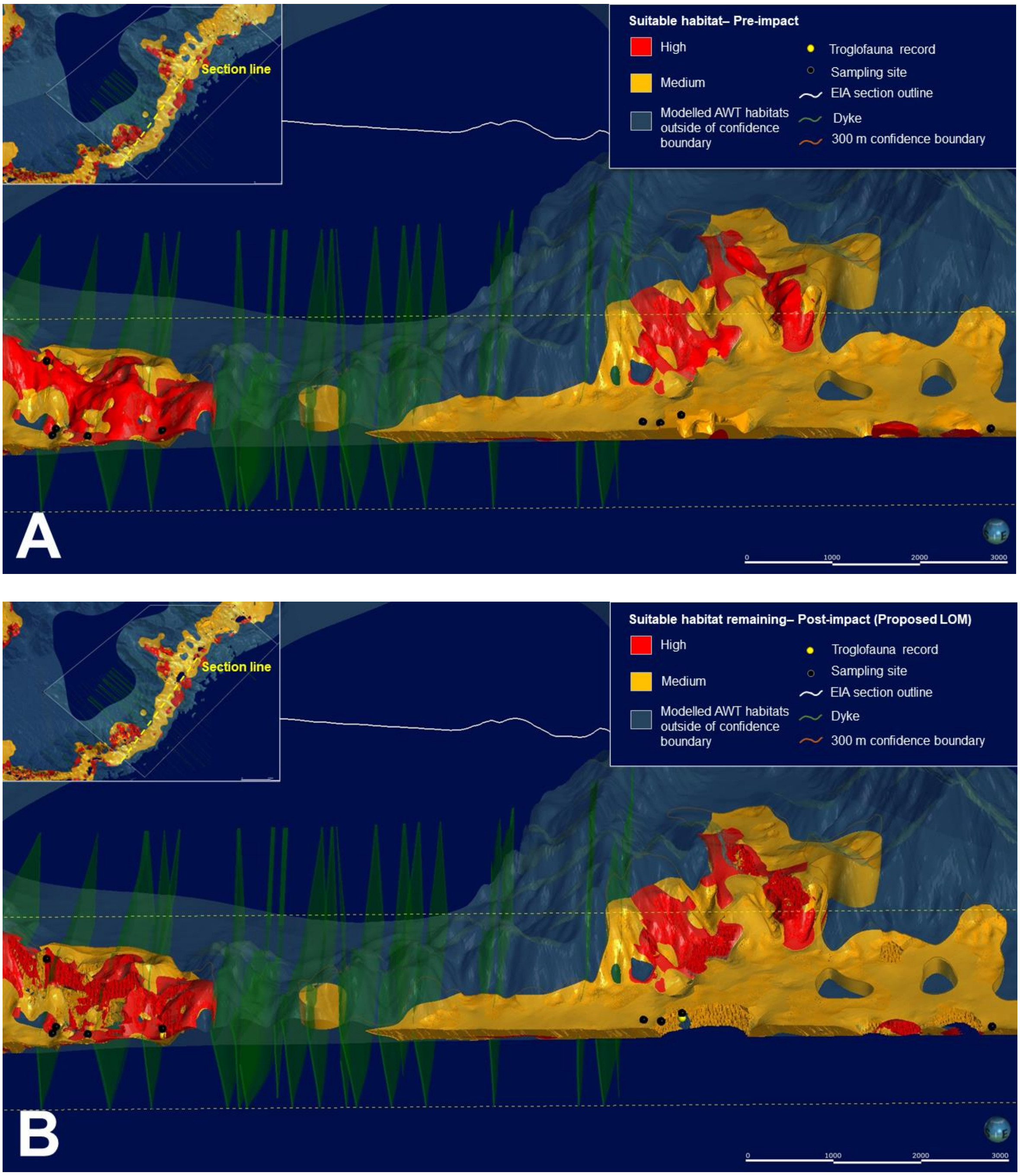


Figure 7-7: Long-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact and (B) post-impact (proposed) at BS3. *Vertical scale exaggerated x5*

Brockman Syncline 4

The AWT habitat modelling in the BS4 section is supported by 615 km of logging data from 12,644 drill holes (Table 7-1), diamond cores, geophysical data, and a finalised stratigraphic model. There is a high level of confidence in the shape and extent of high and medium suitability 'veins' of AWT throughout the BS4 section, as summarised by the total metres in Table 7-8. The modelling does not extend to the south of the MMIF ridge (i.e. to the south of the proposed pits) due to a lack of drilling data in this area, though this lithology may provide additional suitable AWT habitat.

Table 7-8: Overview of drill hole data per habitat suitability category at BS4

Habitat suitability category	Total metres (m)	Mean interval thickness (m)	Min interval thickness (m)	Max interval thickness (m)
High	270,394	28.0	10.5	155.2
Medium	253,298	20.1	8.0	170.4
Low	76,565	17.4	8.0	116.1
Inferred	14,672	8.2	0.9	84.0

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Pre-impact Habitat assessment

At BS4, extensive, moderately to highly thick (averaging 49 m) suitable troglofauna habitats are found along the strike of the syncline. The synclinal valley in this section is compressed and very thin, therefore the majority of habitat is within the BrIF and MMIF bedrock, which occur in adjacent, contiguous bands striking roughly east-west and dipping moderately to steeply to the south (Figure 7-8A, Figure 7-9A, Table 7-8). These two bands have been brought together by intense folding, faulting, and deformation in this section of the syncline, which has increased the fracturing of the rock and resulted in numerous transverse dykes (mainly at SE to NW angles as in BS1) intruding and cutting through the stratigraphy. Consequently, complex fractured and weathered rock habitats occur throughout in this section AWT, and there is a thinner detrital habitat occurring above the dykes.

Current Habitat Assessment

Current and approved mining operations have shown a moderate reduction in suitable troglofauna habitat along the northern flanks of the Brockman Range and only slight reduction on the southern MMIF hills. (compare A and B of Figure 7 8 and Figure 7 9). Habitat becomes patchy throughout the valley as there are thin detritals, in a highly complex geological system. Connectivity between the Brockman and MMIF would exist only within weathered rock systems and very little within the valley detritals. Further extensive prospective geological habitat likely exists outside of the 3D modelling boundary to the south within the MMIF, to the west in the continuation of the syncline, and to the east towards BS3.

Under the current scenario, over 1,818,320,000 m^3 of suitable AWT habitat in BS4 is expected to remain which equates to almost 79% of suitable AWT habitat.

Proposed LOM 2050 Habitat Assessment

Visual comparisons of the pre-impact and post-impact (proposed) scenario shows a slight reduction in habitat thickness in the location of the proposed pits, but the overall extent of suitable AWT habitats remains largely unaffected along the southern flanks of the MMIF(compare A and C of Figure 7 8 and Figure 7 9).

AWT habitats are naturally patchy at a localised scale throughout BS4, and connectivity along strike is likely to be affected by a series of transverse dykes and faults throughout the BS4 area. Nevertheless, the proposed pits do not appear to remove a high proportion of the wider available AWT habitat in any given compartment (i.e. between dykes).

Approximately 166,180,000 m^3 of the suitable habitat modelled is expected to be removed under the proposed scenario (Table 7-9) or 7.2% of the pre-impact habitat. With consideration of the current modelled habitat volume, the total suitable habitat remaining after implementation of the Proposal would be 1,652,140,000 m^3 throughout BS2 that is expected to remain in-situ.

A detailed breakdown of AWT habitat volumes lost and retained at BS4 under the Proposed LOM scenario is shown in Table 9-1.

Combined Long-term 2350 Habitat Assessment

The Combined long-term impacts on habitat connectivity, thickness and extent are mostly focused on the central and western part of BS4. The extent, thickness, and connectivity of the remaining AWT habitat is likely sufficient to support troglofauna species, particularly in the eastern part of BS4 (compare A and D of Figure 7 8 and Figure 7 9). Approximately 1,652,140,000m3 of the suitable habitat modelled is expected to remain in-situ under the Combined long-term scenario (Table 7-9). This equates to approximately 72% of the pre-impact suitable habitat.

Table 7-9: Volumetric impacts to troglofauna habitat at BS4 for each impact scenario

	Volume (m^3) ('000)				% of pre-impact total		
	Pre-impact	Current 2021	Proposed 2050	Combined Long Term 2350°	Current	Proposed	Combined Long Term
Remaining Habitat							
High	699,740	342,520	617,440	260,240	48.9	88.2	37.2
Medium	1,604,300	1,475,800	1,520,300	1,391,900	92.0	94.8	86.8
Suitable habitat (H and M)	2,304,040	1,818,320	2,137,740	1,652,140	78.9	92.8	71.7
Low	956,020	933,040	940,050	917,060	97.6	98.3	95.9
Inferred	2,401,585	2,319,077	2,362,284	2,279,776	96.6	98.4	94.9
Habitat Loss							
High	0	357,220	82,300	439,500	51.1	11.8	62.8
Medium	0	128,500	84,000	212,400	8.0	5.2	13.2
Habitat Loss (H and M)	0	485,720	166,180	651,900	21.1	7.2	28.3
Low	0	22,980	15,970	38,960	2.4	1.7	4.1
Inferred	0	82,508	39,301	121,810	3.4	1.6	5.1

* the volume of current/ approved pits within the Development Envelope was subtracted from the pre-impact modelled habitat
^ the volume of proposed pits was subtracted from the pre-impact modelled habitat
° the volumes of both current/ approved pits as well as proposed pits were subtracted from the pre-impact modelled habitat

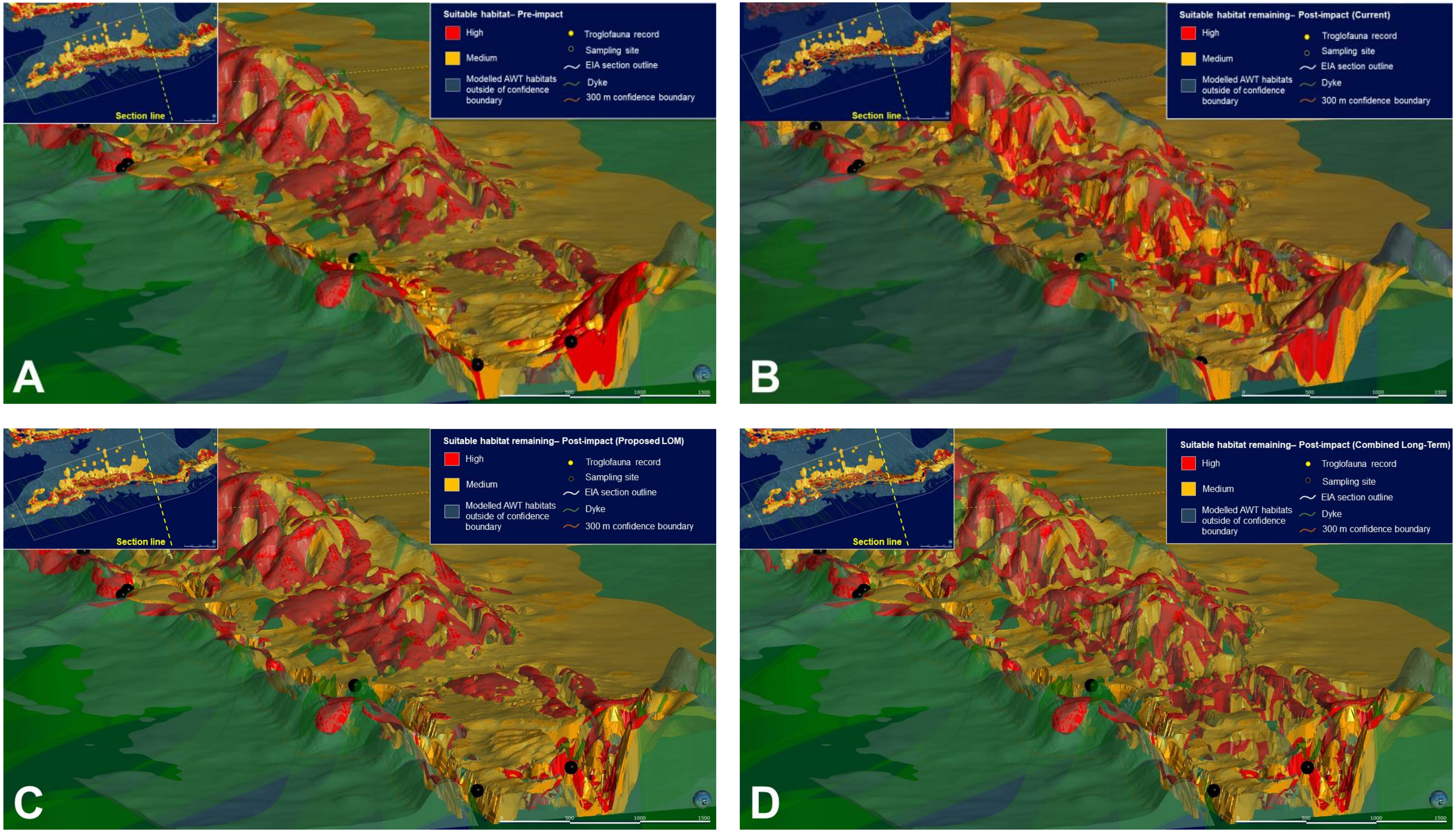


Figure 7-8 Cross-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact, (B) post-impact (current), (C) post-impact (proposed) and (D) post-impact (combined long term) at BS4. Vertical scale exaggerated x5

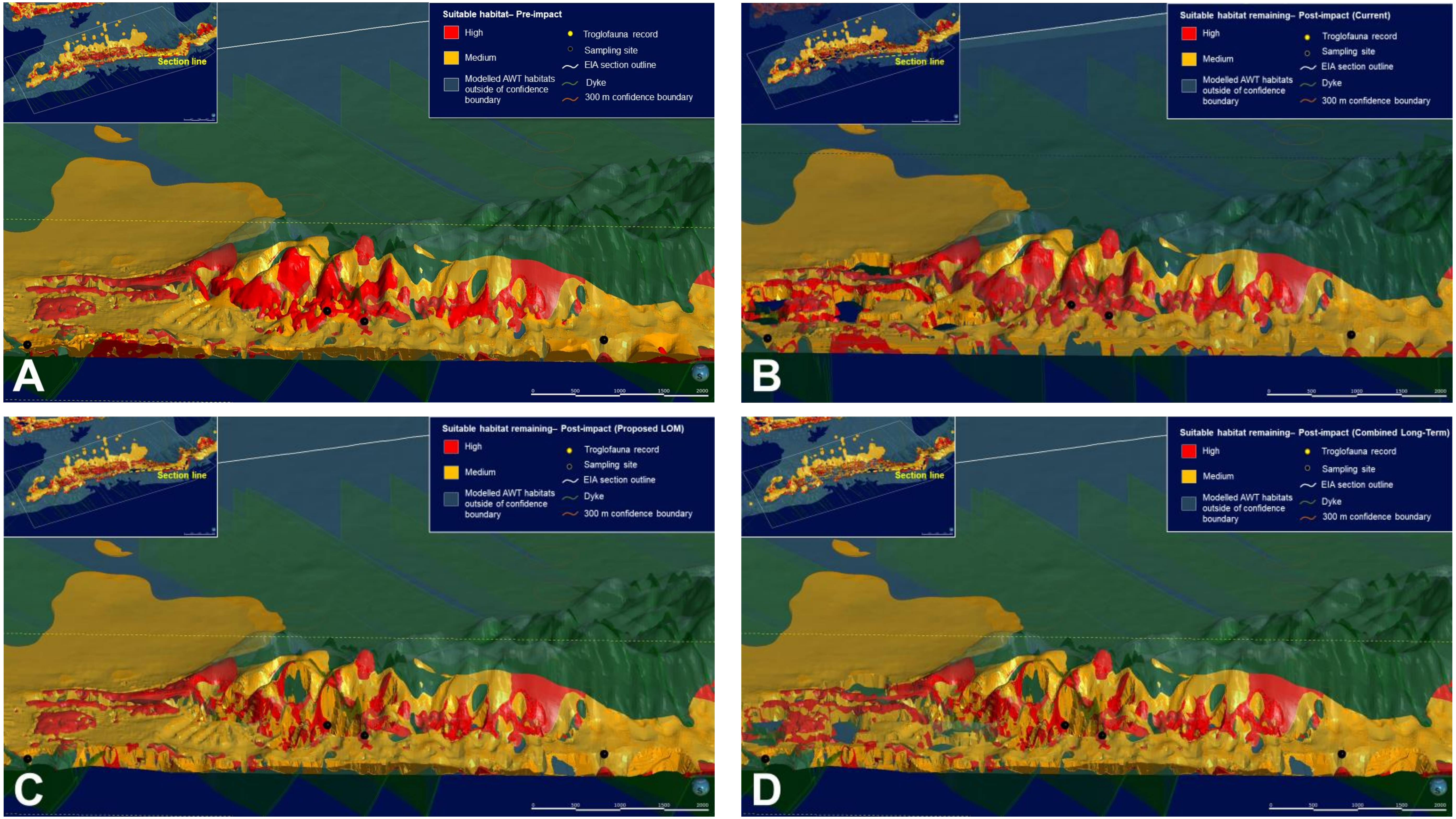


Figure 7-9: Long-section of the 3D subterranean habitat model showing AWT habitats (A) pre-impact, B) post-impact (current), (C) post-impact (proposed) and (D) post-impact (combined long term) at BS4. *Vertical scale exaggerated x5*

8. STYGOFAUNA 3D HABITAT ASSESSMENT

The final 3D model of BWT stygofauna habitat (Figure 8-1) is based on a large amount of drill-hole information, as shown in Table 8-1. In total, 17,515 drill holes were used to model the BWT habitats throughout the Development Envelope. More than 860 kilometres of BWT metres were categorised into stygofauna habitat suitability categories as described in Section 3 (Table 8-1). Modelling the BWT habitats with such a large amount of data resulted in a high degree of confidence in the stygofauna habitat assessment and the assessment of impacts to habitats overall. However, it should be noted that the depth extent of drilling did not always extend below the defined basement and hence Habitat Zone B (inferred habitat) is more pronounced in the model, particularly at depth, where data to model Habitat Zone A was not readily available.

Table 8-1: Drill hole information used to model BWT habitats throughout the Development Envelope

	Number of holes/ bores	Total metres BWT (m)	Mean downhole interval [m] (st. dev.)	Maximum drill depth [m] (single hole/ bore)
BS1	2,621	95,060	36 (30)	166
BS2	7,421	434,188	59 (52)	435
BS3	947	33,178	35 (30)	180
BS4	6,524	298,203	46 (43)	315
Total	**17,515**	**860,682**	**49 (46)**	**435**

An overview of all pre-impact BWT habitats within the Development Envelope, as obtained from the 3D model, are shown in Figure 8-1.

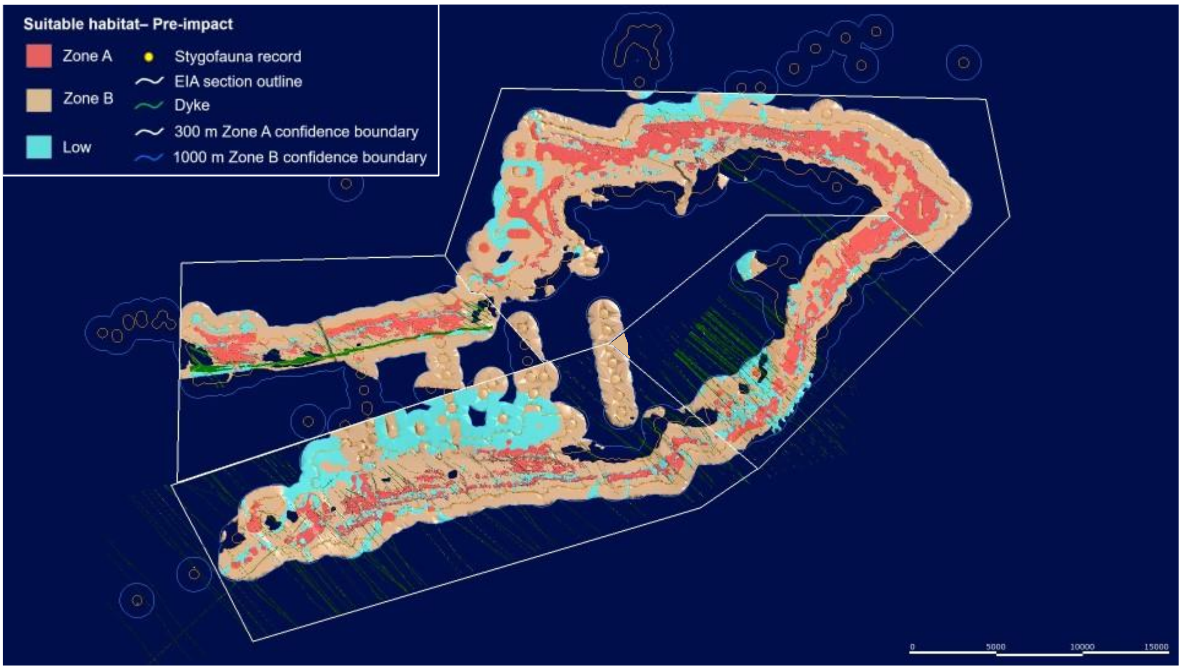


Figure 8-1: Overview of pre-impact BWT stygofauna habitat model for the Development Envelope.

Brockman Syncline 1

The BWT habitat modelling in the BS1 section is supported by 95 km of logging data from 2,621 drill holes (Table 8-1 and Table 8-2), diamond cores, geophysical data, and a local stratigraphic model. There is a high level of confidence in the shape and extent of the 'veins' of suitable BWT habitat in Zone A throughout the BS1 Section, with total metres per suitability category shown in Table 8-2. Habitat Zone B is defined stratigraphically and grouped under inferred habitat suitability. In the absence of any conflicting information, all suitably porous rock types, excluding those with low permeability, are interpreted as potential habitat in Zone B.

Table 8-2: Overview of drill hole data per habitat suitability category at BS1 (BWT)

Habitat suitability category	Total metres (m)	Mean interval thickness (m)	Min interval thickness (m)	Max interval thickness (m)
High	13,145	15.4	3.6	154.5
Medium	69,738	28.9	9.4	144.0
Low	6,527	11.8	4.0	134.9
Inferred	5,640	16.7	5.2	100.8

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Groundwater quality assessment

Groundwater quality is typically fresh across BS1, with conductivities varying between 400 and 2,700 µS/cm (Table 8-3, Figure 8-2A and Figure 8-3A). The slightly elevated (above 2500 µS/cm) conductivity values are restricted to the easternmost part of BS1 East (Figure 8-2A) and correspond to a small, compartmentalised zone between two dolerite dykes. These conditions are unlikely to make a significant difference for any stygofauna present, as it is still within the freshwater range.

Dissolved oxygen profiles were mainly variable between the two major hydrogeological compartments at BS1 East and BS1 West (Table 8-3; Figure 8-2B and Figure 8-3B, also refer Section 10). BS1 East (Figure 8-2B, Section 10) showed several bore profiles where dissolved oxygen levels greater than 1mg/L was not limited by depths approaching and in excess of 100 mbgl. Across BS1 West (Figure 8 3B) there appears to be lower dissolved oxygen levels in general than at BS1E, and also a shallower oxic profile, with dissolved oxygen conditions becoming more consistently low (<1mg/L) at depths approaching 100 mbgl.

Anoxic conditions in certain bores may be due to localised effects such as depth from surface to the water table (i.e. in areas of greater topographical relief), or local differences in porosity of the rock. The more consistently anoxic conditions at depths around 100 mbgl at BS1 West, in most cases coinciding with the lower porosity Mt McRae Shales, were inferred to indicate a potential depth limitation for suitable stygofauna habitat.

Most of BS1 contains neutral to slightly alkaline water quality (Table 8-3) with pH values ranging from between 6.4 and 8.5 with a mean of 7 (Table 8-3, Figure 8-2C and Figure 8-3C).

Table 8-3: Water quality assessment for BS1

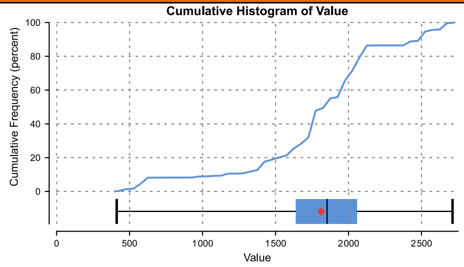
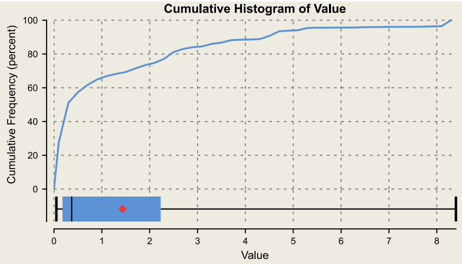
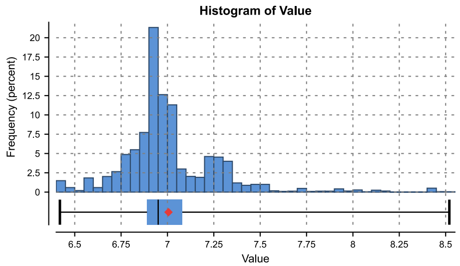
Parameter	Range (min-max)	Histogram of data ranges	Interpretation
Specific Conductivity (µS/cm)	<412-2713		Mostly fresh/ drinking quality – minor variability in conductivity corresponding to smaller hydrogeological compartments. Variability in SPCond is unlikely to be significant for stygofauna (within fresh/ drinking quality), with no clear spatial or vertical trends.
ODO (mg/L)	0.05-8.4		In BS1 East, minor variability in ODO corresponding to smaller hydrogeological compartments. Majority of modelled habitat in BS1E is suitably oxygenated (>1mg/L), throughout profile (Figure 8-10). In BS1 West, dissolved oxygen levels decrease more rapidly with depth from approx. 60mbgl (Figure 8-10). At depths below 100mbgl in BS1W, dissolved oxygen <0.3mg/L, potentially limiting for stygofauna.
pH	6.4-8.5		Neutral water profile - becomes more alkaline in the central BS1 East region. Variability in pH is unlikely to be significant for stygofauna (neutral to slightly alkaline).

Table 8-4 shows the slotted interval depth/s for boreholes with stygofauna recorded. The maximum slotting depth for a bore with stygofauna recorded at BS1E was 118m-142m, while in BS1 West the deepest slotted interval for a bore where stygofauna were recorded was 64m-87 m. For bores with two slotted intervals (e.g. MB20BS1W0009 and MB19BS1E0003) it was not possible to confirm which interval the stygofauna were recorded from.

Table 8-4: Slotting, habitat suitability and geology info of bores at BS1 where stygofauna have been recorded

Bore hole	Slotted from (mbgl)	Slotted to (mbgl)	Habitat suitability	Geology	Stygofauna recorded
			BS1 West		
MB20BS1W0009*	39	64	Medium	BIF, Chert, Ore	Yes*
MB20BS1W0009* (interval 2)	64	87	Low	BIF	Yes*
			BS1 East		
MB19BS1E0003*	33	60	High	BIF, Shale, Chert	Yes*
MB19BS1E0003* (interval 2)	60	93	Low	BIF	Yes*
MB19BS1E0005	118	142	Low	Wittenoom Dolomite	Yes
MB19BS1E0015	42	60	Medium	BIF	Yes

* Where bores are slotted in multiple intervals, it is not possible to determine which interval stygofauna were detected from.

Groundwater profiling and detailed habitat modelling at BS1 East showed a range of moderately to highly suitable habitat characteristics (in terms of porosity and dissolved oxygen), with depth increasing to 100 mbgl and beyond (Section 10). Meanwhile the water table at BS1 West occurred lower in the profile and both hydrogeological habitat suitability (porosity/ fracturing) and dissolved oxygen levels decreased more consistently at depths approaching 100 mbgl. For this reason, 100 mbgl was considered an appropriate system basement at BS1 West, whereas at BS1 East, 150 mbgl was considered more appropriate, as at other sections of the syncline.

BS1 BWT impact assessments

The assessment of BWT impacts on subterranean habitat involves extracting impacts (such as pits and water level changes) from the pre-impact habitat. Each scenario is quantified into remaining habitat and then compared against the pre-impact habitat model (Table 8-5). Volumetric changes or loss of habitat are calculated initially against the pre-impact scenario. The proposed habitat loss has also been compared to the current remaining habitat as this is the most realistic interpretation of impact from the Proposal.

At BS1 there are no current impacts from existing/ approved Rio Tinto mining operations, and therefore the proposed volumetric loss is the same for current and pre-impact scenarios (Table 8-5).

Table 8-5: Volumetric BWT stygofauna habitat at BS1 under each impact scenario.

	Volume ('000 m3)					
	Pre-impact	Current 2021	Proposed LOM 2050	Proposed Long-term 2350	Combined Long-term 2350	Cumulative Long-term 2350
Remaining Habitat						
High	66,010	66,010	4,645	3,939	3,939	97
Medium	268,478	268,478	34,104	32,664	32,664	12,773
Low	330,420	330,420	127,852	125,779	125,779	62,824
Inferred	3,479,682	3,479,682	2,129,910	2,020,438	2,020,438	1,315,390
Zone A: Suitable habitat (H+M)	334,488	334,488	38,748	36,603	36,603	12,871
Zone B: Inferred	3,479,682	3,479,682	2,129,910	2,020,438	2,020,438	1,315,390
Suitable habitat (Zone A + Zone B)	**3,814,170**	**3,814,170**	**2,168,658**	**2,057,041**	**2,057,041**	**1,328,261**
Habitat Loss*						
High	0	0	61,365	62,071	62,071	65,913
Medium	0	0	234,375	235,814	235,814	255,705
Low	0	0	202,568	204,641	204,641	267,596
Inferred	0	0	1,349,772	1,459,244	1,459,244	2,164,292
Zone A: Suitable habitat (H+M)	0	0	295,740	297,885	297,885	321,617
Zone B: Inferred	0	0	1,349,772	1,459,244	1,459,244	2,164,292
Habitat Loss (Zone A + Zone B)	**0**	**0**	**1,645,512**	**1,757,129**	**0.0**	**43.1**

* Volumetric habitat loss is calculated from the pre-impact habitat volumes. Details for each impact scenario components can be found in Section 3: Impact scenarios

Pre-impact Habitat Assessment

At BS1, 3D modelling shows large patches of suitable stygofauna habitat along the strike of the syncline and synclinal valley (Figure 8 4A, Figure 8 5A and Figure 8 6A). The synclinal valley hosts thin to moderately thick (averaging 36 m) BWT habitats, hosted by detrital aquifers and fractured/weathered rock aquifers below. These habitats in the valley are connected to the Brockman Iron Formation (BrIF) on the ranges which is partially below water table in this section and provides further prospective stygofauna habitats. The northern side of the synclinal valley is composed of MMIF which is mostly beyond the modelling boundary, but which also provides suitable stygofauna habitats where saturated.

Numerous minor transverse dykes and faults occur at BS1, as well as two major, central/ perpendicular dykes (Figure 8 4, Figure 8 5 and Figure 8 6) that correspond to water level differences of approximately 40 m from BS1 West to BS1 East (EMM, 2021). Minor transverse dykes do not appear to affect water levels and may not fully compartmentalise the groundwater habitat.

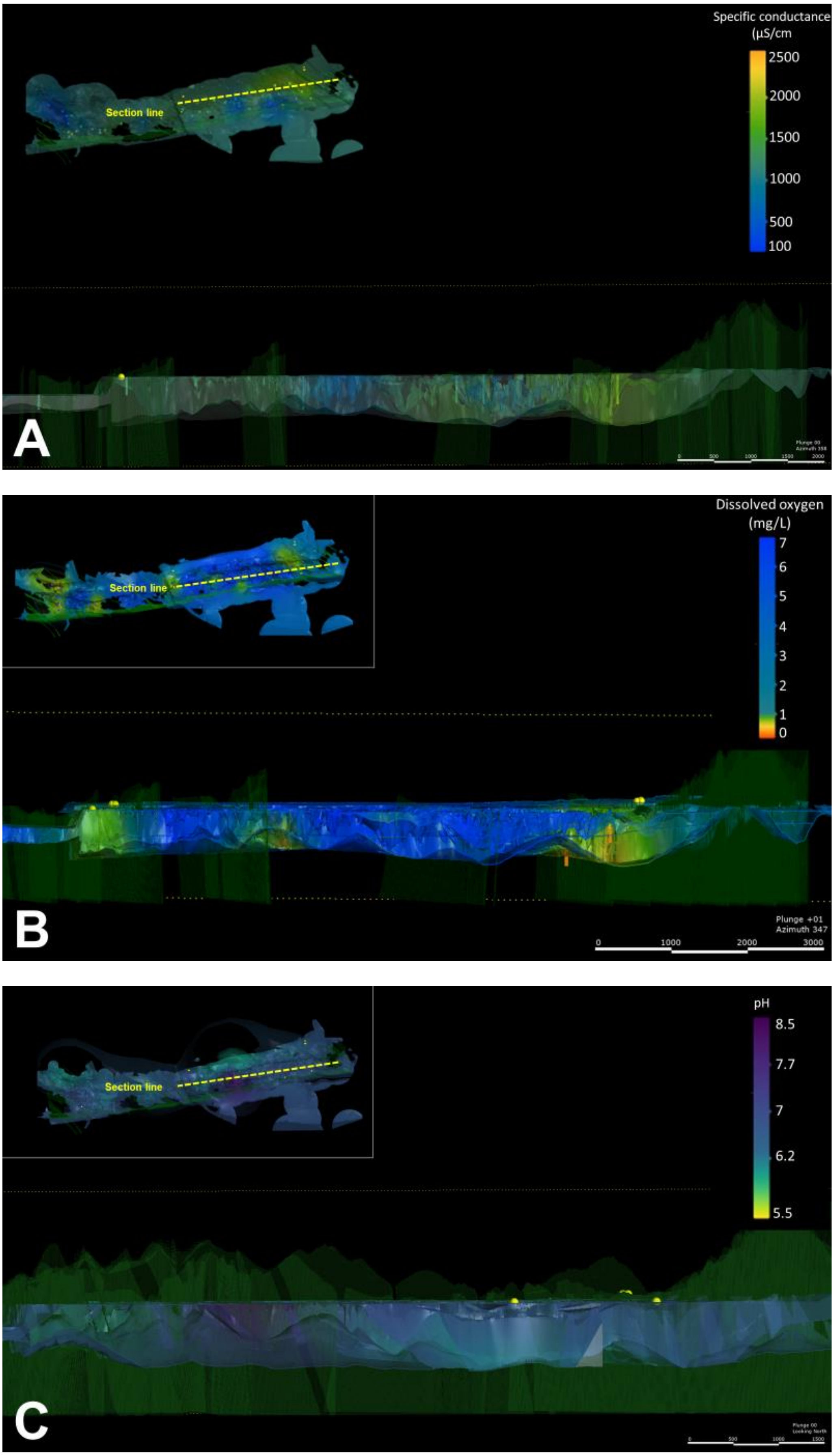


Figure 8-2: Long-section of BS1 East showing (A) specific conductance, (B) dissolved oxygen and (C) pH within pre-impact habitats. ***Vertical scale exaggerated x5***

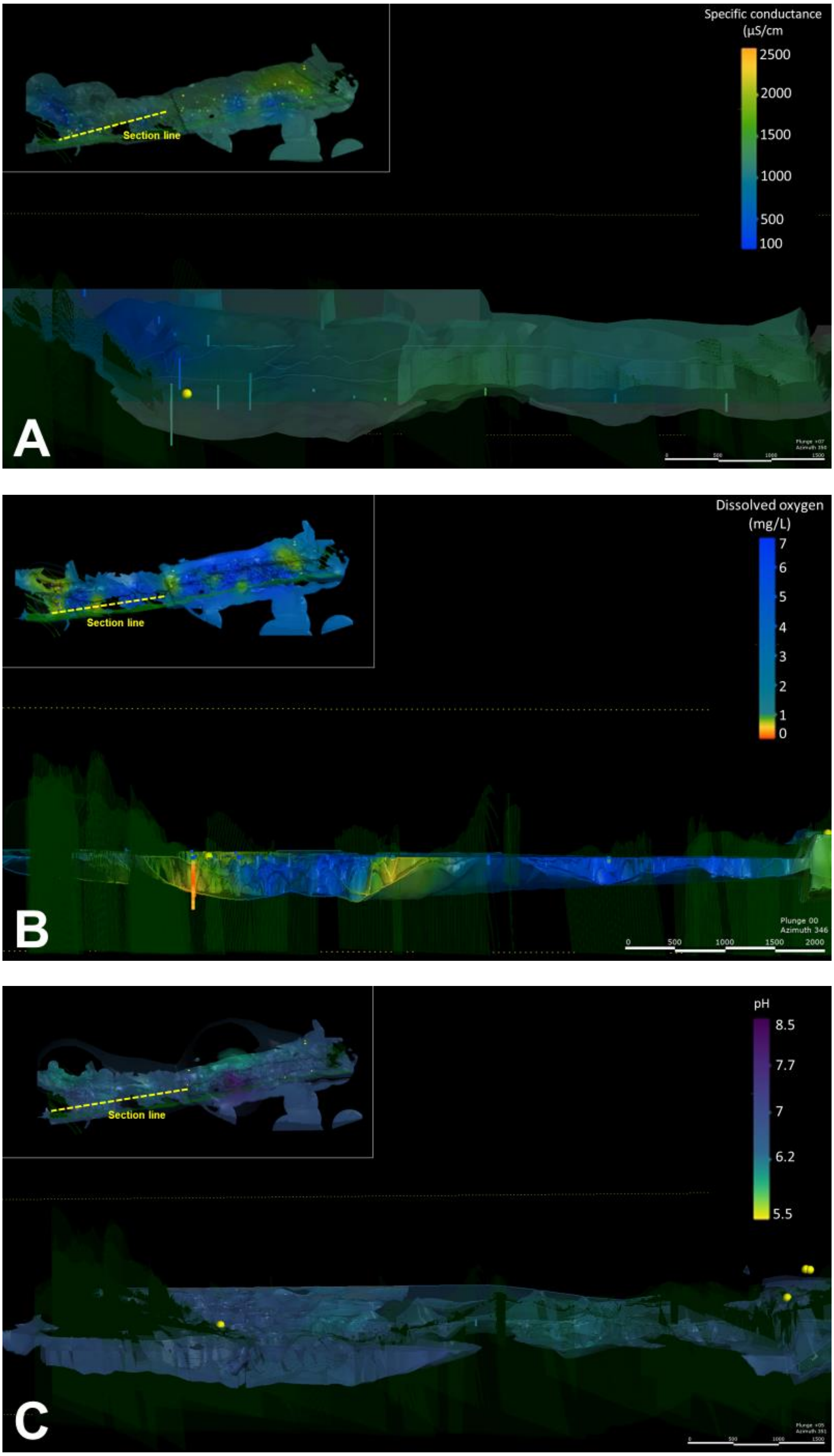


Figure 8-3: Long-section of BS1 West showing (A) specific conductance, (B) dissolved oxygen, and (C) pH, within pre-impact habitats. ***Vertical scale exaggerated x5***

Current Habitat Assessment

There are no current impacts at BS1, hence the current scenario is unchanged from the pre-impact scenario (compare A and B of Figure 8 4, Figure 8 5 and Figure 8 6).

Proposed LOM 2050 Habitat Assessment

Visual comparisons of the pre-impact and Proposed LOM 2050 scenario showed the following changes to habitat extent, thickness, and connectivity:

- The lateral extent of habitat remains continuous over the BS1 Section especially within the main valley.
- The thickness of Zone A suitable habitat across the BS1 section is expected to be significantly reduced, There is notable thinning of the habitat in the southern section, especially in BS1 West, below the mountainous ranges, this is attributed to the declining water level no longer being able to provide suitable conditions at this depth. Zone B Habitat will maintain considerable thickness to the system basement depths of 100 m in BS1 West and 150 m in BS1 East, and
- Connectivity may be increasingly influenced by the transverse dykes within the bedrock as the water table declines (compare A and C of
- Figure 8-4 , Figure 8-5 and Figure 8-6). It is unknown if these dykes will compartmentalise habitat, however the major barrier between BS1 West and East would be further accentuated.

The remaining habitat is expected to continue to support stygofauna assemblages, based on:

- The occurrence of suitably porous, fractured, and weathered hydrostratigraphic units (e.g. Dales Gorge Member, Wittenoom Formation, Mt Newman Member, and others) above the system basement within the remaining parts of Zone A and Zone B,
- Groundwater quality profiling showing that the dissolved oxygen and salinity conditions within the remaining parts of Zone A and Zone B (at depths between 70 mbgl and 135 mbgl) are within suitable ranges for stygofauna (Table 8-3).
- The recorded occurrence of several stygofauna species at considerable depths BWT (i.e. between 118 m and 142 m in Wittenoom Dolomite, Table 8-4) in the BS1 East section.

At BS1, approximately 2,168,658,000 m^3 of the suitable habitat modelled throughout BS1 is expected to remain in-situ under the proposed scenario (Table 8-5). A detailed breakdown of BWT habitat volumes lost and retained at BS1 under the Proposed LOM scenario is shown in Tables 9-2 (Proposed LOM vs Pre-impact) and 9-3 (Proposed LOM vs Current scenario).

Proposed Long-term 2350 Habitat Assessment

There is minimal change between the Proposed Long-term 2350 scenario and the Proposed LOM 2050 habitat assessment (compare C and D Figure 8 4). Any differences are attributed to the change in modelled groundwater drawdown which is calculated to be around 3% reduction from the Proposed LOM scenario.

At BS1, approximately 2,057,041,000 m^3 of the suitable habitat modelled throughout BS1 is expected to remain in-situ under the Proposed Long-term scenario (Table 8-5).

Combined Long-term 2350 Habitat Assessment

There is no difference in the Proposed Long-term and Combined Long-term 2350 scenario as there are no current impacts at BS1 (compare D and E in Figure 8 4).

Cumulative Long-term 2350 Habitat Assessment

Cumulative impacts at BS1 present a worst-case scenario and involve inclusion of third-party groundwater drawdown impacts from the Eliwana Iron Ore Mine Project. Direct mining impacts (pits) from third parties were not included in the assessment as they were outside of the modelled boundary of the 3D model. The cumulative assessment noted the following changes to habitat extent, thickness and connectivity:

- Saturated habitat above basement in BS1 West will be almost entirely lost. The connectivity of BWT habitat across the BS1 section is likely to be significantly impacted due to removal of saturated habitat in BS1 West (Figure 8 4F and Figure 8 5F); and
- There will most likely be increased influence of dykes as groundwater barriers in BS1 East as the water table declines (compare A and F of Figure 8 4 and Figure 8 5).

Approximately 1,328,261,000 m^3 of the suitable habitat modelled throughout BS1 is expected to remain in-situ under the cumulative scenario (Table 8-5), with the majority being maintained in BS1 East. BS1 West may become unsuitable to sustain stygofauna under the cumulative impact scenario.

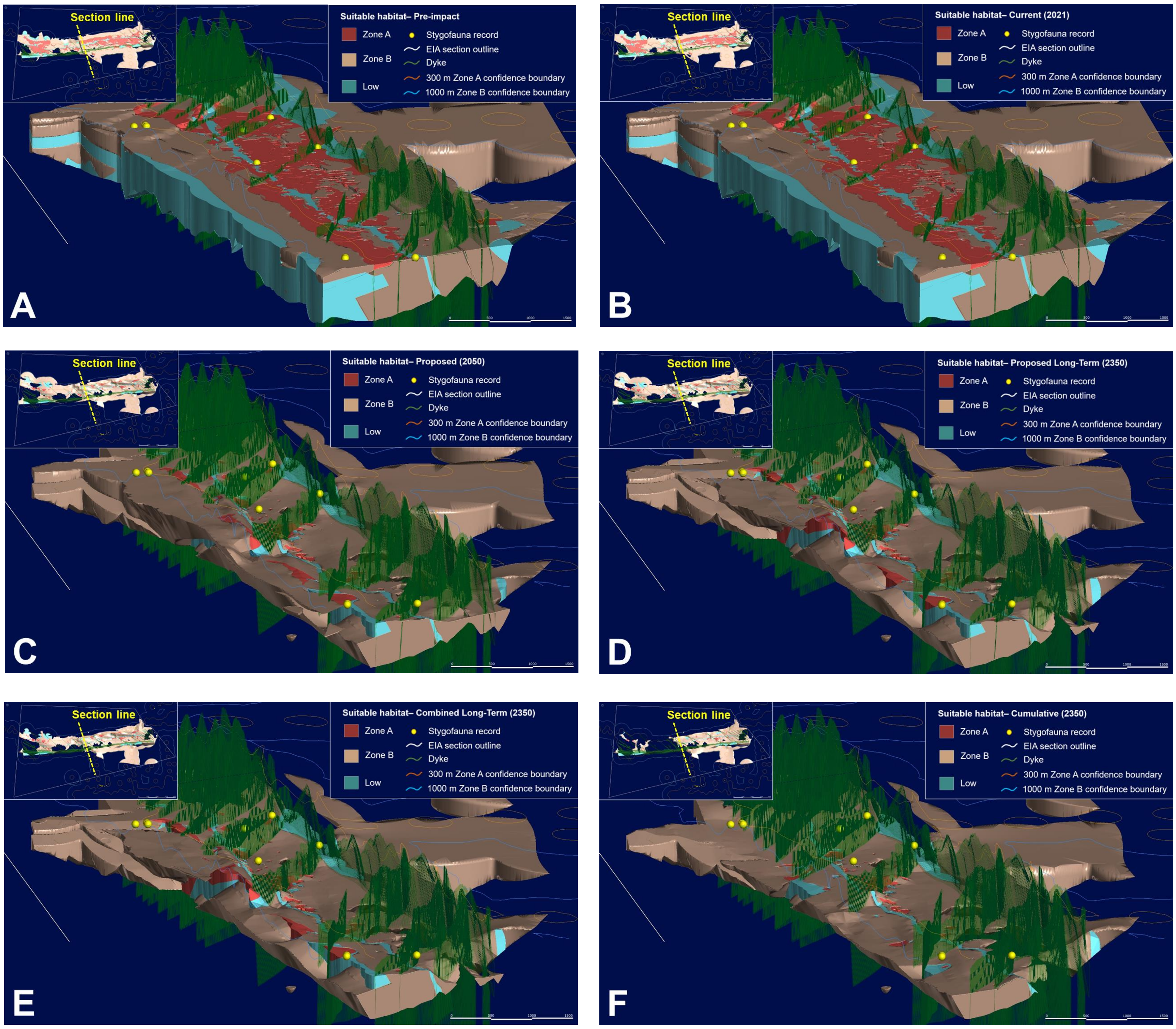


Figure 8-4: Cross -section of the 3D subterranean habitat model showing BWT habitats at BS1 for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), (E) Combined Long-term (2350), and (F) Cumulative (2350) scenario. *Vertical scale exaggerated x5*

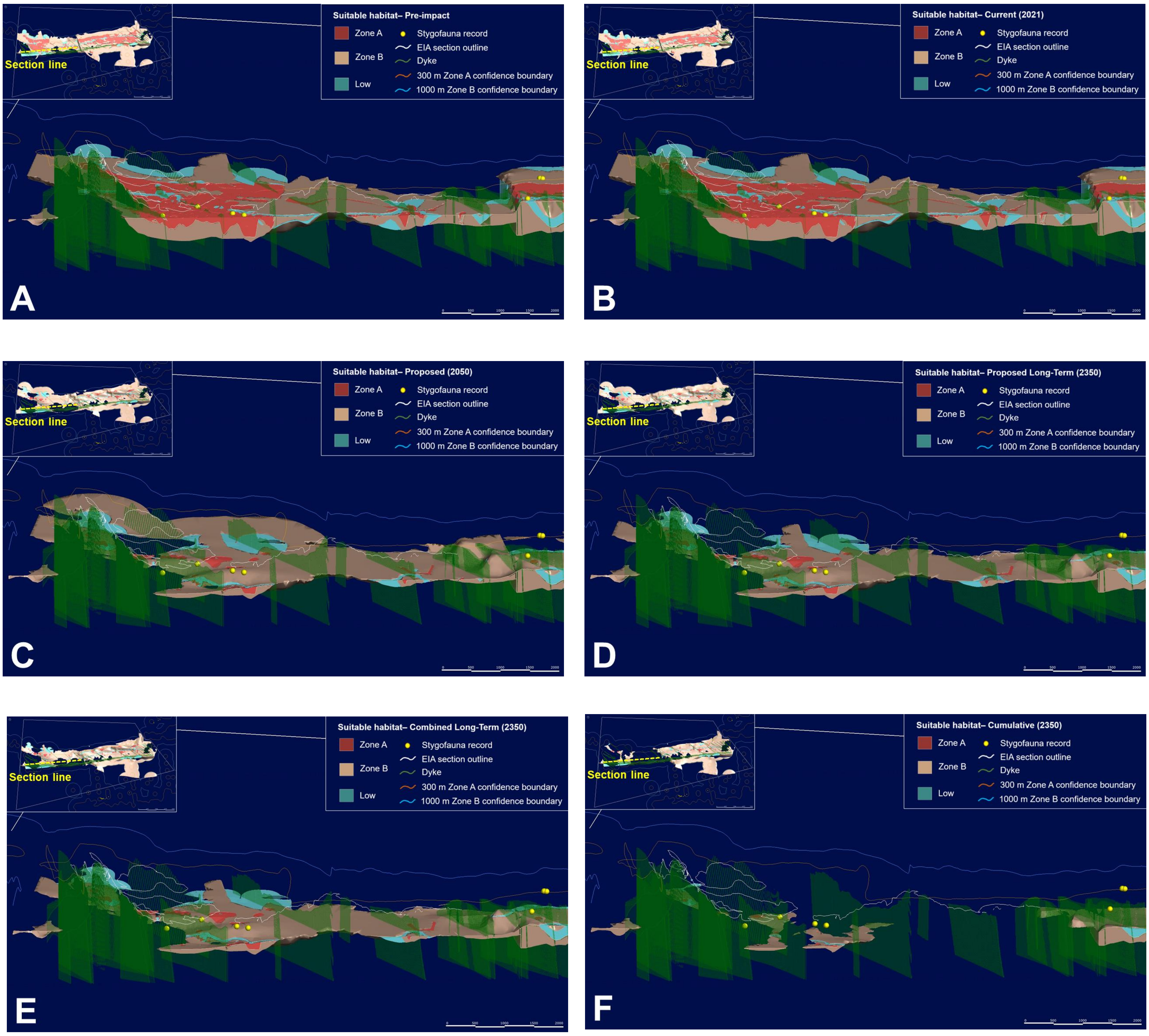


Figure 8-5: Long -section of the 3D subterranean habitat model showing BWT habitats at BS1 West for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), (E) Combined Long-term (2350), and (F) Cumulative (2350) scenario. *Vertical scale exaggerated x5*

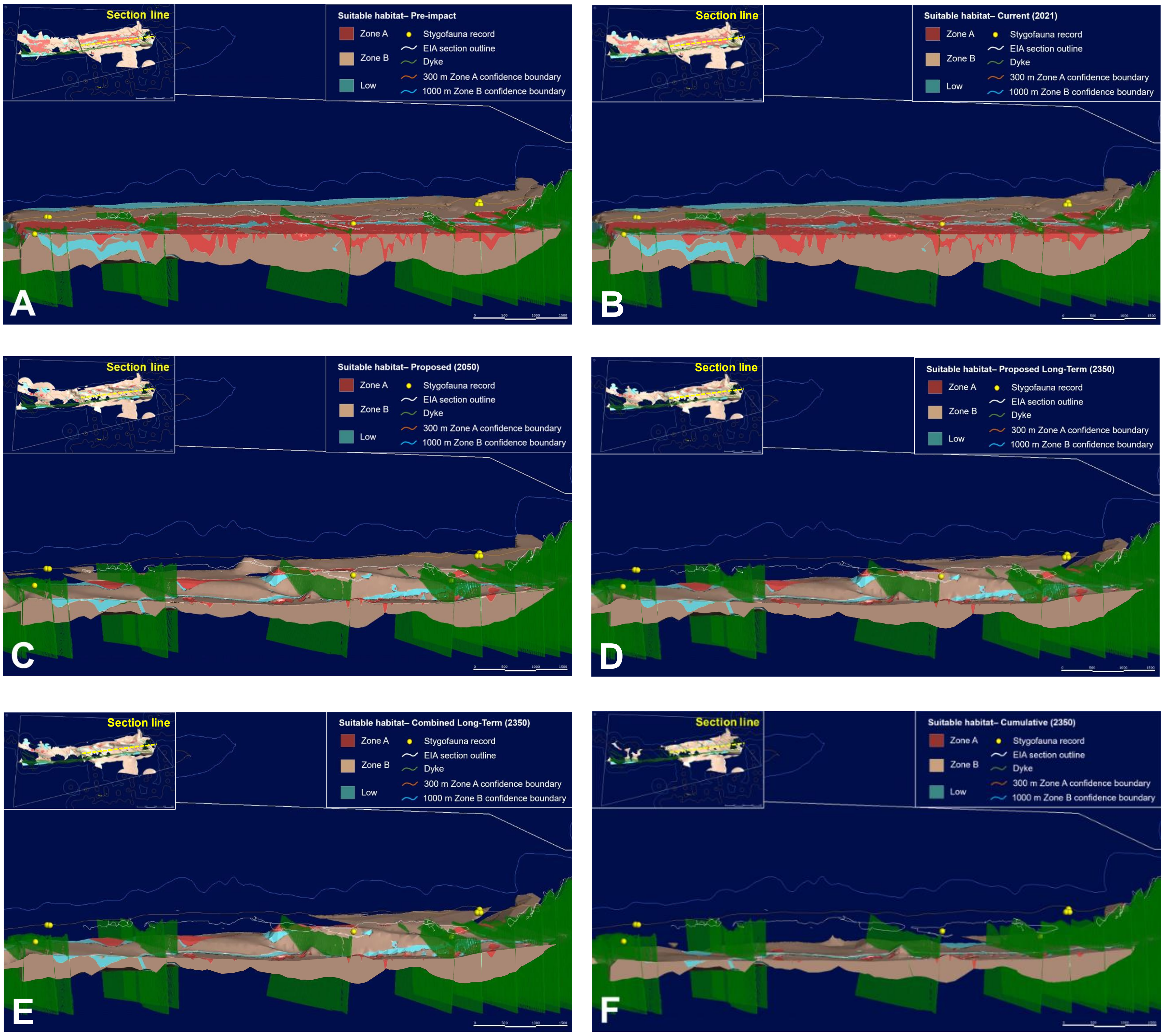


Figure 8-6: Long -section of the 3D subterranean habitat model showing BWT habitats at BS1 East for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), (E) Combined Long-term (2350), and (F) Cumulative (2350) scenario. *Vertical scale exaggerated x5*

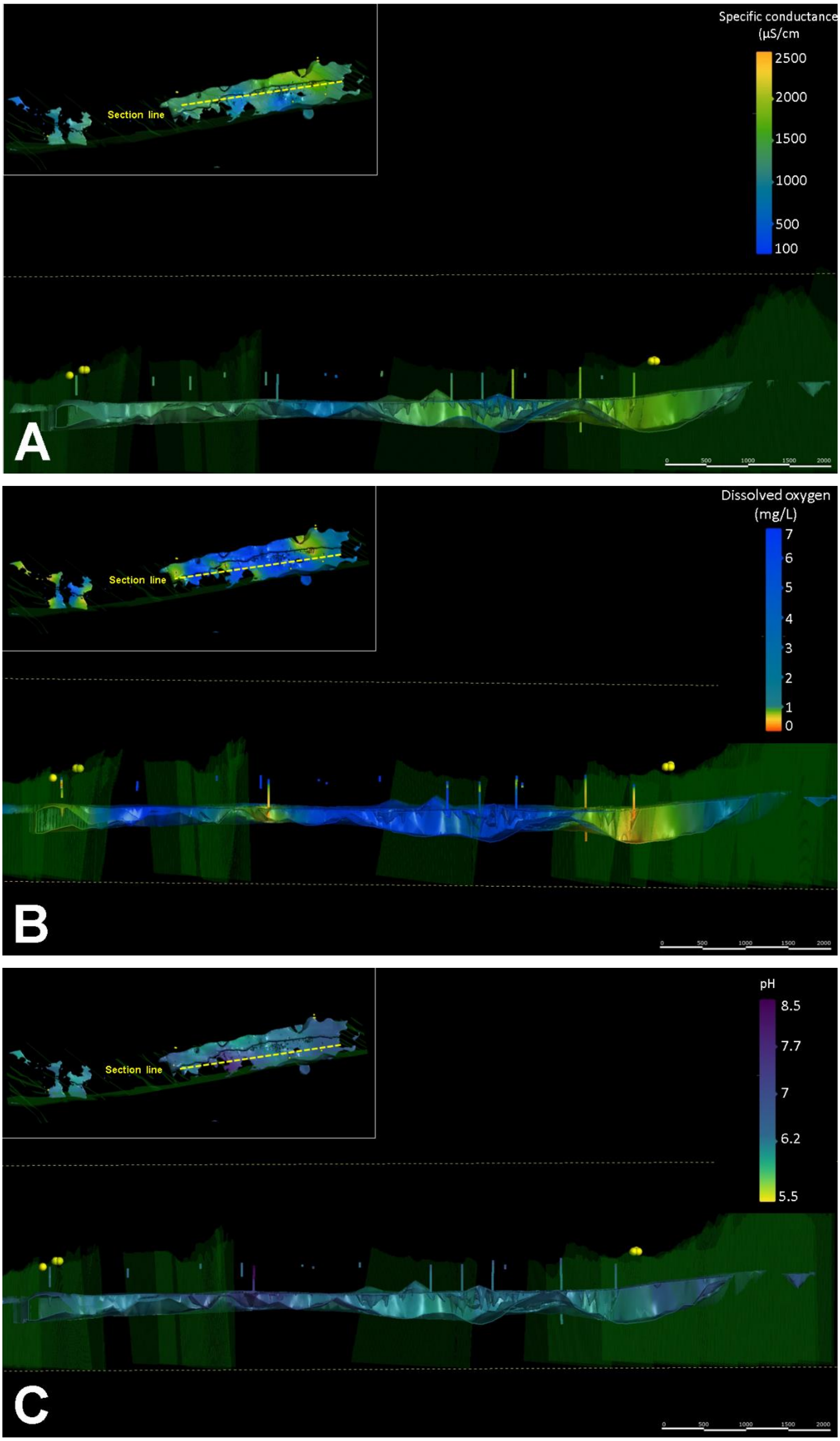


Figure 8-7: Long-section of BS1 East showing (A) specific conductance, (B) dissolved oxygen and (C) pH within post-impact habitats (cumulative scenario) *Vertical scale exaggerated x5*

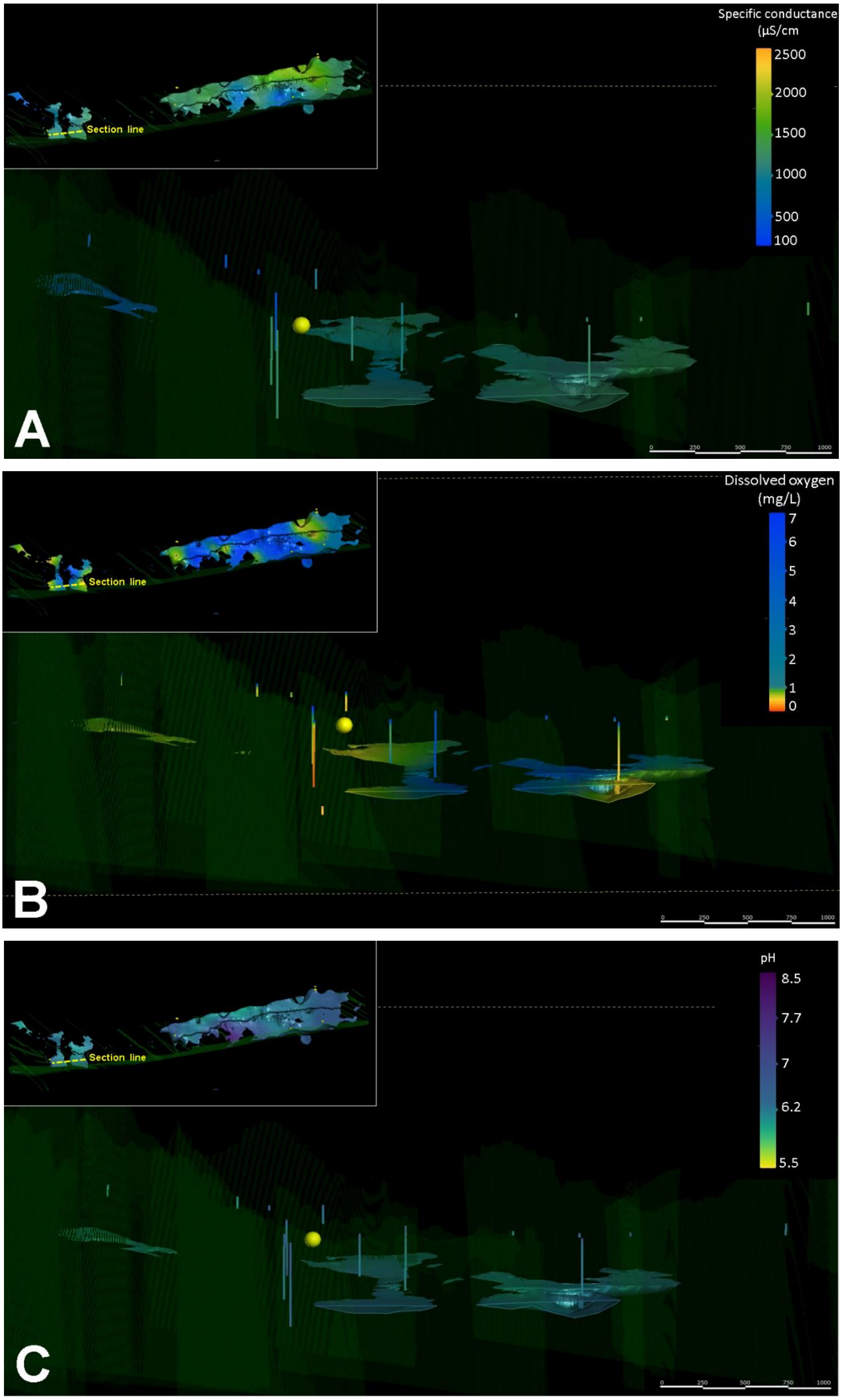


Figure 8-8: Long-section of BS1 West showing (A) specific conductance, (B) dissolved oxygen, and (C) pH, within post-impact habitats (cumulative scenario) ***Vertical scale exaggerated x5***

Brockman Syncline 2

The BWT habitat modelling in the BS2 section is supported by 434 km of logging data from 7,421 drill holes (Table 8-1 and Table 8-6), diamond cores, geophysical data, and a regional stratigraphic model. There is has a high level of confidence in the shape and extent of the 'veins' of suitable BWT habitat in Zone A throughout the BS2 Section with total metres per suitability category shown in Table 8-6. Habitat Zone B is defined stratigraphically and grouped under inferred habitat suitability In the absence of any conflicting information, all suitably porous rock types, excluding those with low permeability, are interpreted as potential habitat in Zone B.

Table 8-6: Overview of drill hole data per habitat suitability category at BS2 (BWT)

Habitat suitability category	Total metres (m)	Mean interval thickness (m)	Min interval thickness (m)	Max interval thickness (m)
High	140,148	26.3	8.0	197.8
Medium	198,323	26.2	6.0	259.5
Low	69,331	23.7	7.8	210.0
Inferred	26,367	16.2	2.9	426.8

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Groundwater quality assessment

Groundwater quality assessment in BS2 is based on a small number of available sites in the eastern section. Iso-surfaces were not able to be evaluated independent of BS3 data and only cover the area between Diesel and Lens G at BS2. The results summarised in Table 8-7 show available data. Further profiling data of areas in the central and southwestern areas of BS2 section may be required for a more comprehensive assessment of the BS2 section.

Groundwater quality is fresh to brackish, with electrical conductivities varying between 1392-4661µS/cm (Table 8-7). Dissolved oxygen levels range from a minimum of 0.17 mg/L to 4.61 mg/L (Table 8-7). Dissolved oxygen conditions were relatively consistent between the bores profiled, despite considerable depth of the water table from surface, and the groundwater profile modelling showed that there was no consistent anoxic zone in the lower parts of the profile (Section 10). Groundwater profiling often finished due to end of hole or limitations of the depth of cabling before anoxic conditions were detected, at depths up to and beyond 100 mbgl across the eastern BS2 area (Figure 8-11B).

BS2 contains neutral ground water with pH values ranging from between 6.8 and 7.5 (Table 8 7 and Figure 8-7C).

Table 8-7: Water quality assessment for BS2

Parameter	Range (min-max)	Interpretation
Specific Conductivity (µS/cm)	<1392-4661	Mostly fresh/ drinking quality at BS2 east, tending to slightly brackish in the north, closer to Lens G. Unlikely to be a significant variability for stygofauna
ODO (mg/L)	0.2-4.61	Majority of modelled habitat in BS2 east is suitably oxygenated (>1mg/L), throughout profile. Very deep habitat (approaching 150 mbgl) still >0.3mg/L.
pH	6.8-7.5	Neutral water profile at BS2 east.

BS2 BWT Impact Assessments

The assessment of BWT impacts on subterranean habitat involves extracting impacts (such as pits and water level changes) from the pre-impact habitat. Each scenario is quantified into remaining habitat and then compared against the pre-impact habitat model (Table 8-8). Volumetric changes or loss of habitat are calculated initially against the pre-impact scenario. The proposed habitat loss has also been compared to the current remaining habitat as this provides a realistic interpretation of impact from the Proposal against current water levels.

Table 8-8: Volumetric BWT stygofauna habitat at BS2 under each impact scenario

	Volume (m^3) ('000)				
	Pre-impact	**Current**	**Proposed LOM 2050**	**Proposed Long-term 2350**	**Combined Long-term 2350**
Remaining Habitat					
High	398,570	82,673	29,977	28,285	28,190
Medium	942,220	265,870	81,332	54,614	54,568
Low	802,890	378,400	74,849	45,598	45,596
Inferred	12,535,600	9,096,700	5,930,400	4,865,800	4,854,100
Zone A: Suitable habitat (H+M)	**1,340,790**	**348,543**	**111,309**	**82,899**	**82,758**
Zone B: Inferred	**12,535,600**	**9,096,700**	**5,930,400**	**4,865,800**	**4,854,100**
Suitable habitat (Zone A + Zone B)	**13,876,390**	**9,445,243**	**6,041,709**	**4,948,699**	**4,936,858**
Habitat Loss					
High	0	315,897	368,593	370,285	370,380
Medium	0	676,350	860,888	887,606	887,652
Low	0	424,490	728,041	757,292	757,294
Inferred	0	3,438,900	6,605,200	7,669,800	7,681,500
Zone A: Suitable habitat (H+M)	**0**	**992,247**	**1,229,481**	**1,257,891**	**1,258,032**
Zone B: Inferred	**0**	**3,438,900**	**6,605,200**	**7,669,800**	**7,681,500**
Habitat Loss (Zone A + Zone B)	**0**	**4,431,147**	**7,834,681**	**8,927,691**	**8,939,532**

* Volumetric habitat loss is calculated from the pre-impact habitat volumes. Details for each impact scenario components can be found in Section 3: Impact scenarios

Pre-impact Habitat Assessment

At BS2, extensive, continuous, and thick suitable stygofauna habitats are hosted by the deep detrital aquifer in the synclinal valley (Figure 8-9 and Figure 8-10). The Brockman Iron Formation (BrIF) and Marra Mamba Iron Formation (MMIF) bands are relatively far apart in this section, making the synclinal valley more extensive compared to other sections of the Development Envelope. The BrIF ranges to the south of the synclinal valley do not provide prospective BWT habitats for stygofauna, as the ranges are tall and mostly above water table in this section.

Some patchiness in Zone A habitat occurs in the south-western corner of BS2 (Figure 8-9 and Figure 8-10). This apparent patchiness is due to availability of drill hole information. Accordingly, the Zone B habitat modelling dominates this southern extent of prospective suitable habitat. It is expected that thick and continuous habitats exist throughout the synclinal valley at BS2, including the area in the south-western corner.

Fewer dykes have been modelled through the BS2 section than other sections of the Syncline, however two major dykes (Figure 8-9) and associated fault systems cross the full width of modelled habitat (striking from ESE to WNW) corresponding with changes in groundwater levels, and potential compartmentalisation of the aquifer system. Other than these major structures, minor dykes are not considered to restrict groundwater connectivity within the overlying tertiary detrital aquifer.

Groundwater quality analysis of the southeast region between Diesel and Lens G demonstrates favourable water conditions with fresh, non-saline oxygenated water (above 0.3 mg/l) to depths in excess of 100 mbgl (refer Section 10). Although the groundwater profiling shown in Section 10 was not able to detect a consistent anoxic zone at depths deeper than 100 mbgl at the BS2 section, the deep occurrence of highly oxygenated groundwater suggested that 150 mbgl would be more appropriate than 100 mbgl for a conceptual system basement. This assessment was limited to the eastern part of BS2, where groundwater profiling data was available.

Sampling of slotted bores in the BS2 compartment did not record stygofauna, but uncased drill holes that did record stygofauna were open below water table between 51m-85 mbgl.

Current Habitat Assessment

Current and approved mining operations have shown a considerable reduction in suitable stygofauna habitat throughout the BS2 Section (compare A and B of Figure 8-9 and Figure 8-10). Current approved groundwater drawdown affects the central part of BS2 with lesser impacts to the south-west and east-southeast areas. Visual comparisons of the pre-impact and current scenario showed that saturated habitat varied in thickness, particularly below and adjacent to the pits (compare A and B of Figure 8-9 and Figure 8-10). Extensive, thick prospective BWT habitats are shown to remain intact in the southwest section of BS2. Overall BWT habitat remains connected, albeit at reduced thickness, throughout the central part of BS2. Approximately 9,445,243 m^3 of suitable habitat modelled throughout BS2 is modelled in-situ under the current scenario (Table 8.8). This equates to approximately 68% of the pre-impact modelled habitat (Table 8.8).

Proposed LOM 2050 Habitat Assessment

Visual comparisons of the pre-impact and post-impact (proposed) scenario showed the following changes to habitat extent, thickness, and connectivity:

- A considerable reduction in habitat extent, thickness, and connectivity in the northern/central section of the synclinal valley at BS2. (compare A and C Figure 8-9 and Figure 8-10).
- Habitat extent, thickness, and connectivity remain largely unaffected in the area where stygofauna were recorded (south-western and south-eastern corner of BS2)

Approximately 6,041,709,000 m^3 of the suitable habitat modelled throughout BS2 is expected to remain in-situ under the proposed scenario (Table 8.8). This equates to approximately 64% of the current modelled habitat (Table 8.8).

In consideration of the current habitat scenario, an additional 3,403,534,000 m^3 of suitable habitat has been removed from current habitat values (Table 8-9). A detailed breakdown of BWT habitat volumes lost and retained at BS2 under the Proposed LOM scenario is shown in Tables 9-2 (Proposed LOM vs Pre-impact) and 9-3 (Proposed LOM vs Current scenario).

Table 8-9: Volumetric calculations of suitable habitat under the Proposed LOM and Long-term scenarios as related to the current habitat values

	Volume (m3) ('000)			% of current total	
	Current	Proposed LOM 2050	Proposed Long-term 2350	Proposed LOM 2050	Proposed Long-term 2350
BS2					
In-situ Suitable Habitat	9,445,243	6,041,709	4,948,699	64	52
Loss of Suitable Habitat	4,431,147	3,403,534	4,496,544	36	48

Proposed Long-term 2350 Habitat Assessment

There is a 12% additional loss of habitat under the Proposed Long-term 2350 scenario compared to the Proposed LOM 2050 habitat assessment (compare C and D of Figure 8-9 and Figure 8-10). The additional loss in habitat under the Proposed Long-term 2350 scenario are due to long-term evaporative losses from proposed pits at BS2.

Approximately 4,948,699 m^3 of the suitable habitat modelled throughout BS2 is expected to remain in-situ under the Proposed Long-term 2350 scenario (Table 8-8). This equates to approximately 52% of the current modelled habitat (Table 8-9).

Combined Long-term 2350 Habitat Assessment

Combined Long-term impacts result in a considerable volumetric reduction of approximately 8,927,691,000 m^3 of suitable habitat at BS2, or approximately 64.3% of the pre-impact suitable habitat as modelled. 3D modelling shows a considerable reduction in habitat extent, thickness, and connectivity in the northern/central section of the synclinal valley at BS2, but this area does not contain any known restricted stygofauna species. The thickness and connectivity of BWT habitat at BS2 east is expected to be reduced, due to the increased influence of numerous dykes within the bedrock as the water table declines.

Approximately 4,936,858 m^3 of the suitable habitat modelled throughout BS2 is expected to remain in-situ under the Combined Long-term 2350 scenario (Table 8-8). This equates to approximately 52% of the current modelled habitat (Table 8-8).

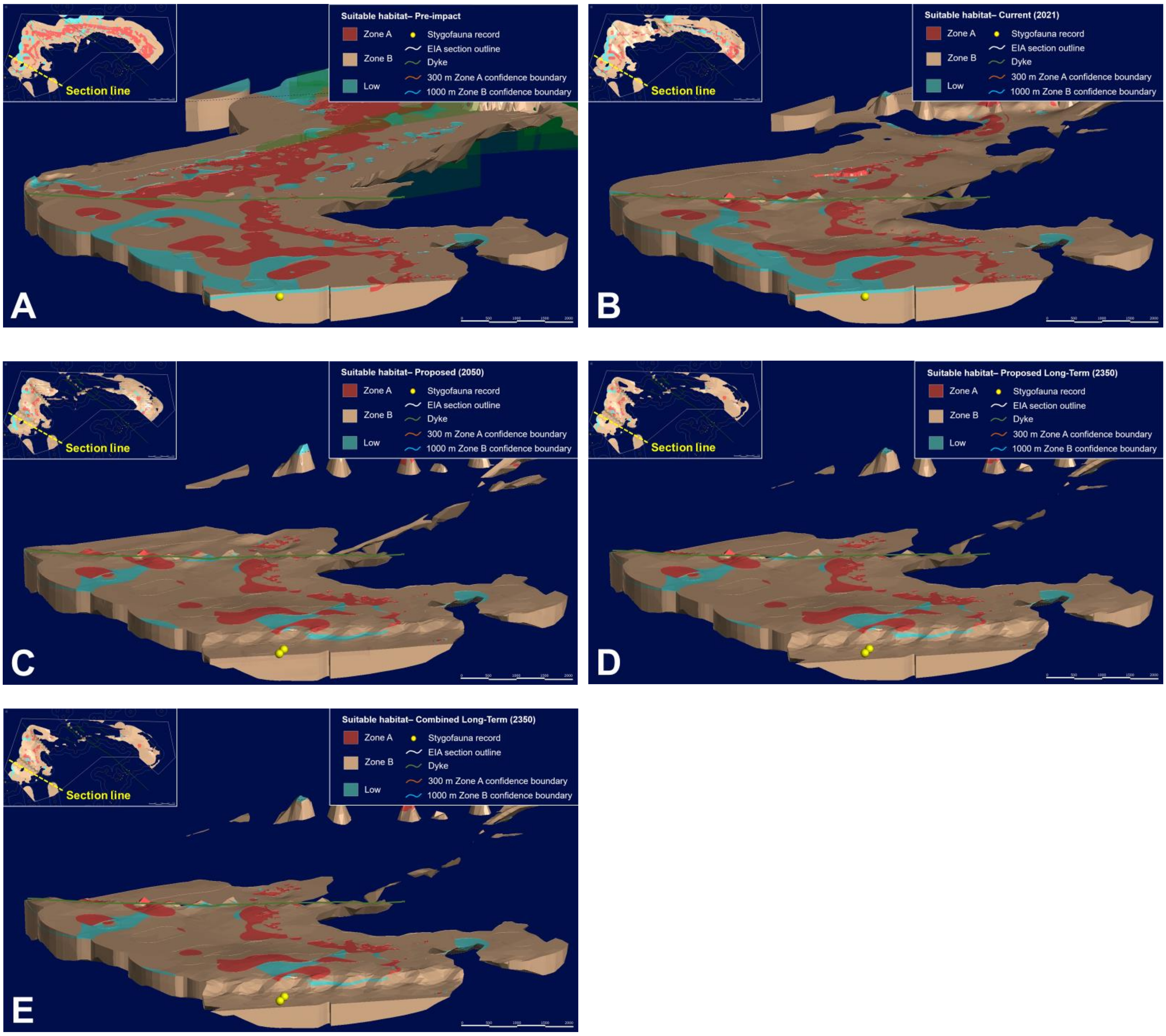


Figure 8-9: Cross-section of the 3D subterranean habitat model showing BWT habitats at BS2 for (A) pre-impact, (B) Current (2021), (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. *Vertical scale exaggerated x5*

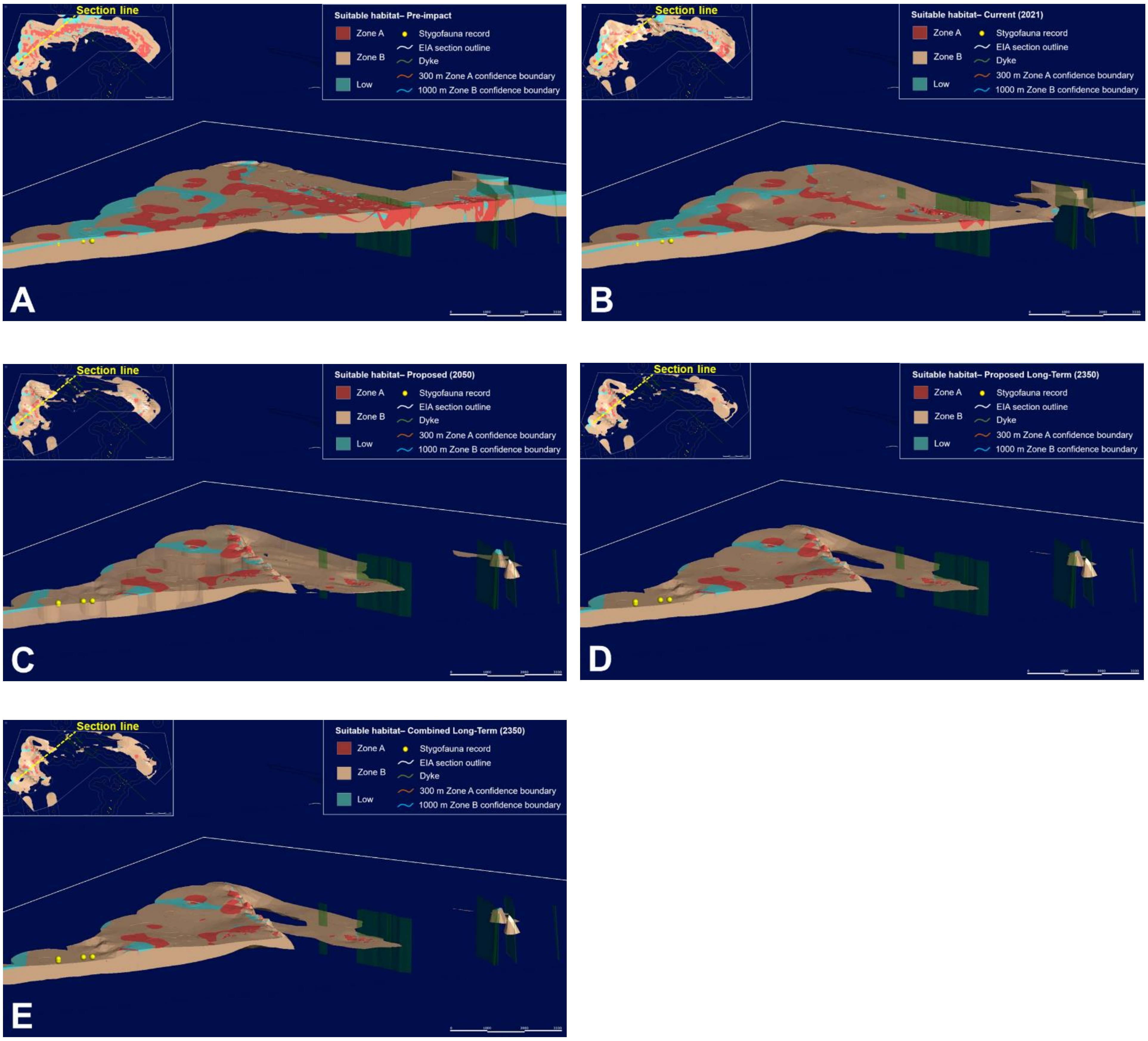


Figure 8-10: Long -section of the 3D subterranean habitat model showing BWT habitats at BS2 for (A) pre-impact, (B) Current (2021), (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. ***Vertical scale exaggerated x5***

Brockman Syncline 3

The BWT habitat modelling in the BS3 section is supported by 33 km of logging data from 947 drill holes (Table 8-1 and Table 8-10), diamond cores, geophysical data, and a local stratigraphic model. There is has a high level of confidence in the shape and extent of the 'veins' of suitable BWT habitat in Zone A throughout the BS3 Section with total metres per suitability category shown in Table 8-10. Habitat Zone B is defined stratigraphically and grouped under inferred habitat suitability. In the absence of any conflicting information, all suitably porous rock types, excluding those with low permeability, are interpreted as potential habitat in Zone B.

Table 8-10: Overview of drill hole data per habitat suitability category at BS3 (BWT)

Habitat suitability category	Total metres (m)	Mean interval thickness (m)	Min interval thickness (m)	Max interval thickness (m)
High	7,781	18	6.1	76.0
Medium	17,968	21	6.8	110.9
Low	3,839	15	3.9	90.4
Inferred	3,590	15	3.1	74.9

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

Groundwater quality assessment

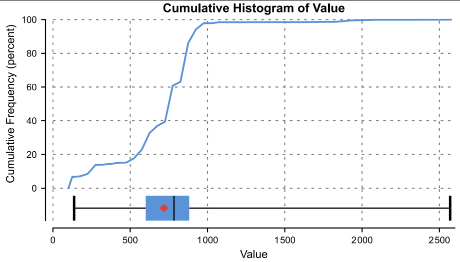
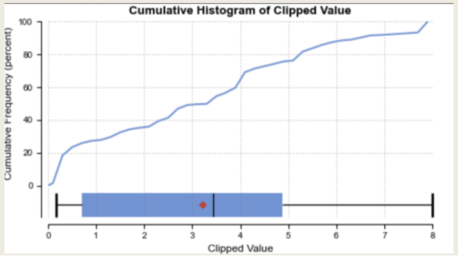
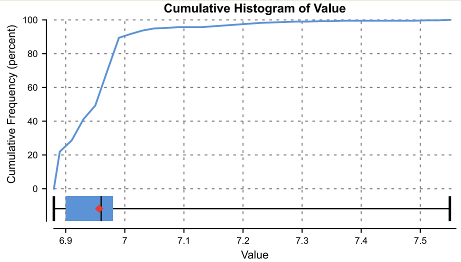
Groundwater measurements were taken mostly from the northern section of BS3, from the dyke crosscutting Diesel Pit to the south side of the Southern Pits. The southern part of BS3 could not be evaluated due to limited available groundwater profiling data.

Groundwater quality is typically fresh, with electrical conductivities varying between 137 µS/cm and 2,569 µS/cm (Table 8-11 and Figure 8-11A). One water profile collected central to BS3 shows elevated conductivity (above 2500 µS/cm) at shallow depths. Further data is required to validate whether this measurement was localised to the bore/ hole at the time of survey.

Dissolved oxygen levels range from a minimum of 0.17 mg/L to 8.19 mg/L Table 8-11: Water quality assessment for BS3, Table 8-11). Dissolved oxygen conditions are variable between bores profiled, and between different hydrogeological compartments (refer Section 10), however the groundwater profile modelling showed that there was no consistent anoxic zone in the lower parts of the profile, and suitably oxic conditions were frequently detected at depths up to and beyond 100 mbgl across the BS3X compartments (Figure 8-11B).

Most of BS3 contains neutral to slightly acidic ground water with pH values ranging from between 5.86 and 8, with a mean of 6.95 (Table 8-11 and Figure 8-11C).

Table 8-11: Water quality assessment for BS3

Parameter	Range (min-max)	Histogram of data ranges	Interpretation
Specific Conductivity (µS/cm)	<137 - 2569		Mostly fresh/ drinking quality – minor variability, unlikely to be significant for stygofauna, with no clear spatial or vertical trends.
ODO (mg/L)	0.17-8.19		Majority of modelled habitat at BS3 is suitably oxygenated (>1mg/L), throughout profile. Minor variability between separate compartments in respect to the depth below surface of the oxygenated profile. No overall spatial trends (Figure 8-17). Outlying or potentially erroneous values were clipped at 8 mg/L via histogram analysis.
pH	5.86.8		Neutral water profile – very little spatial or vertical variability in pH.

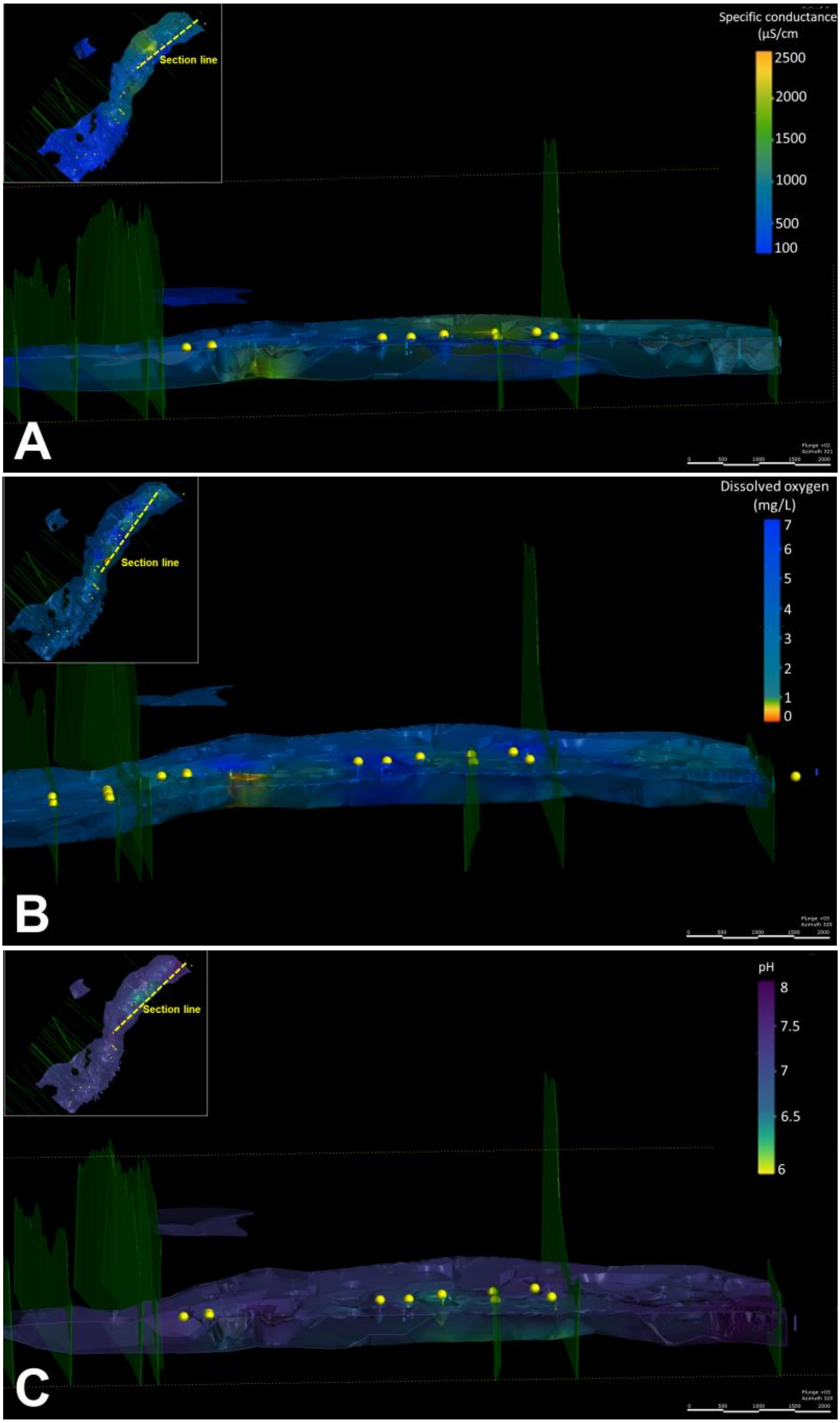


Figure 8-11: Long-section of BS3 (northern section) showing (A) specific conductivity, (B) dissolved oxygen, and (C) pH, within pre-impact habitat. *Vertical scale exaggerated x5*

Table 8-12 presents the slotting details of boreholes with stygofauna present at BS3 section (divided into its three major compartments). At the central and southern section, the slotting depths ranged from approximately 42m to 88 mbgl. At the northern compartment, the slotting depths ranged from 36m to 54 mbgl.

Table 8-12: Slotting, habitat suitability and geology at bores at BS3 where stygofauna were recorded

Area and bore hole	Slotted from (mbgl)	Slotted to (mbgl)	Habitat suitability	Lithology	Stygofauna recorded
BS3 North					
MB19BS3X0007	36	54	Med/ Low	Mt Newman/ Mc Leod (MMIF)	Yes
MB19BS3X0009	36	54	Med/ Low	Mt Newman/ Mc Leod (MMIF)	Yes
BS3 Central					
MB19BS3X0001	42	60	Low	Mc Leod (MMIF)	Yes
MB19BS3X0002	44	60	Medium	Mt Newman (MMIF)	Yes
MB19BS3X0003	68	86	Medium	Wittenoom Formation	Yes
BS3 South					
MB17BS30004	87	88	Low	Mt McRae Shale	Yes
MB19BS30002	36	54	Medium	Mt Newman (MMIF)	Yes
MB19BS30008	42	60	Low	Wittenoom Formation	Yes

Table 8-13: Volumetric BWT stygofauna habitat at BS3 under each impact scenario

	Volume (m^3) ('000)				
	Pre-impact	**Current**	**Proposed LOM 2050**	**Proposed Long-term 2350**	**Combined Long-term 2350**
Remaining Habitat (total)					
High	69,294	42,216	8,407	7,415	7,415
Medium	272,960	231,750	78,241	49,837	49,837
Low	174,520	162,090	90,733	76,441	76,441
Inferred	2,797,056	2,747,634	1,837,250	1,578,966	1,578,966
Zone A: Suitable habitat (H+M)	342,254	273,966	86,648	57,252	57,252
Zone B: Inferred	2,797,056	2,747,634	1,837,250	1,578,966	1,578,966
Suitable habitat (Zone A + B)	**3,139,310**	**3,021,600**	**1,923,898**	**1,636,218**	**1,636,218**
Habitat Loss					
High	0	27,078	60,887	61,879	61,879
Medium	0	41,210	194,719	223,123	223,123
Low	0	12,430	83,787	98,079	98,079
Inferred	0	49,422	959,806	1,218,090	1,218,090
Zone A: Suitable habitat (H+M)	0	68,288	255,606	285,002	285,002
Zone B: Inferred	0	49,422	959,806	1,218,090	1,218,090
Habitat Loss (Zone A + B)	**0**	**117,710**	**1,215,412**	**1,503,092**	**1,503,092**

* Volumetric habitat loss is calculated from the pre-impact habitat volumes. Details for each impact scenario components can be found in Section 3: Impact scenarios

BS3 BWT Impact Assessments

The assessment of BWT impacts on subterranean habitat involves extracting impacts (such as pits and water level changes) from the pre-impact habitat. Each scenario is quantified into remaining habitat and then compared against the pre-impact habitat model (Table 8-13). Volumetric changes or loss of habitat are calculated initially against the pre-impact scenario. The proposed habitat loss has also been compared to the current remaining habitat as this is the most realistic interpretation of impact from the Proposal.

Pre-impact Habitat Assessment

At BS3, 3D modelling shows extensive, continuous, and relatively thick stygofauna habitats primarily within the synclinal valley (Figure 8-12, Figure 8-13 and Figure 8-14). Large patches of thick BWT habitat occur throughout the synclinal valley (Zone A), associated with deep detrital aquifers and fractured rock aquifers lying below. These patches are supported by deeper prospective stygofauna habitats within Habitat Zone B, which occurs mostly below Zone A and also extends more widely and with more continuity along the synclinal valley.

Dykes, faults, and folds are common at BS3 and strike the syncline in a near perpendicular fashion. These geological structures compartmentalise the bedrock aquifers and reduce overall habitat connectivity along strike. Nevertheless, some habitat connectivity is expected to be maintained through the overlying detrital aquifer in the synclinal valley.

There is a groundwater divide in the northern section of BS3. South of the groundwater divide (affecting most of BS3), groundwater flows along strike in a south westerly direction, occasionally over-topping dykes and flowing from one compartment to the next. Groundwater quality is considered suitable for stygofauna with dissolved oxygen mostly above 1 mg/L across all compartments. There is some localised variability in bore profiles, but the majority of bores profiled showed highly oxic conditions at the maximum depth of profiling – approaching and in some cases beyond 100 mbgl (Section 10).

Current Habitat Assessment

The eastern part of the BS3 section is marginally affected by groundwater drawdown from current operations at B2/NAM despite the occurrence of ESE-NW trending dykes that intrude the bedrock (i.e. current drawdown is likely to only affect detritals at BS3). The continuity of habitat through the affected area and the remaining areas at BS3 is as modelled.

Proposed LOM 2050 Habitat Assessment

Visual comparisons of the pre-impact and post-impact (proposed) scenario showed the following changes to habitat extent, thickness, and connectivity:

- The thickness and connectivity of BWT habitat across the BS3 section is expected to be reduced throughout the BS3 section, due to the increased influence of numerous dykes within the bedrock as the water table declines (compare A and B of Figure 8-12, Figure 8-13 and Figure 8-14).

- However, these impacts will be most pronounced within the northern and central hydrogeological compartments of BS3 section, with the southern compartment showing only minor changes in the thickness and extent of suitable habitat in Zone A and Zone B (Figure 8-12, Figure 8-13 and Figure 8-14).

Habitat remaining in Zone B is expected to continue to support stygofauna assemblages, based on:

- The occurrence of suitably porous, fractured, and weathered hydrostratigraphic units (mainly within several members of the Wittenoom Dolomite, and Mt Newman Member) above the system basement within Zone B;
- Groundwater quality profiling showing that the dissolved oxygen and salinity conditions at considerable depths (e.g. between 90 mbgl and 150 mbgl) are still within suitable ranges for stygofauna (Table 8-11, Section 10); and
- The recorded occurrence of several stygofauna species at considerable depths BWT (i.e. between 68 m and 88 m in Mt Newman Member) in the BS3 section (Table 8-12).

Table 8-14: Volumetric calculations of suitable habitat under the Proposed LOM and long-term scenarios as related to the current habitat values

	Volume (m3) ('000)			% of current total	
	Current	Proposed LOM 2050	Proposed Long-term 2350	Proposed LOM 2050	Proposed Long-term 2350
BS3					
In-situ Suitable Habitat	3,021,600	1,923,898	1,636,218	65	54
Loss of Suitable Habitat	117,710	1,097,702	1,385,382	35	46

Approximately 65% of the ‘current’ suitable habitat modelled throughout BS3 is expected to remain in-situ under the proposed scenario (Table 8-14Table 8-13). A detailed breakdown of BWT habitat volumes lost and retained at BS3 under the Proposed LOM scenario is shown in Tables 9-2 (Proposed LOM vs Pre-impact) and 9-3 (Proposed LOM vs Current scenario).

Proposed Long-term 2350 Habitat Assessment

The BWT proposed long-term impacts scenario modelled at BS3 includes evaporative losses from proposed pits at 2350 and minor propagation of groundwater drawdown impacts from existing operations at BS2 in the northern compartments of BS3. Approximately 1,636,218 or 52% of the suitable habitat modelled throughout BS3 is expected to remain in-situ under the Proposed Long-term scenario (Table 8-13).

The groundwater drawdown impacts are limited to the northern hydrogeological compartments, with minimal change from in the central and southern compartments, due to numerous dykes providing barriers for groundwater drawdown propagation.

A reasonable thickness and extent of BWT habitat is expected to remain intact within Zone B throughout all compartments of the BS3 section and is expected to remain broadly suitable for stygofauna species.

Combined Long-term 2350 Habitat Assessment

There is little difference in the Proposed and Combined Long-term 2350 Scenario as there are no current impacts at BS3 Figure 8-12, Figure 8-13 and Figure 8-14 D and E).

Approximately 1,636,218 or 52% of the suitable habitat modelled throughout BS3 is expected to remain in-situ under the Combined Long-term scenario (Table 8-13).

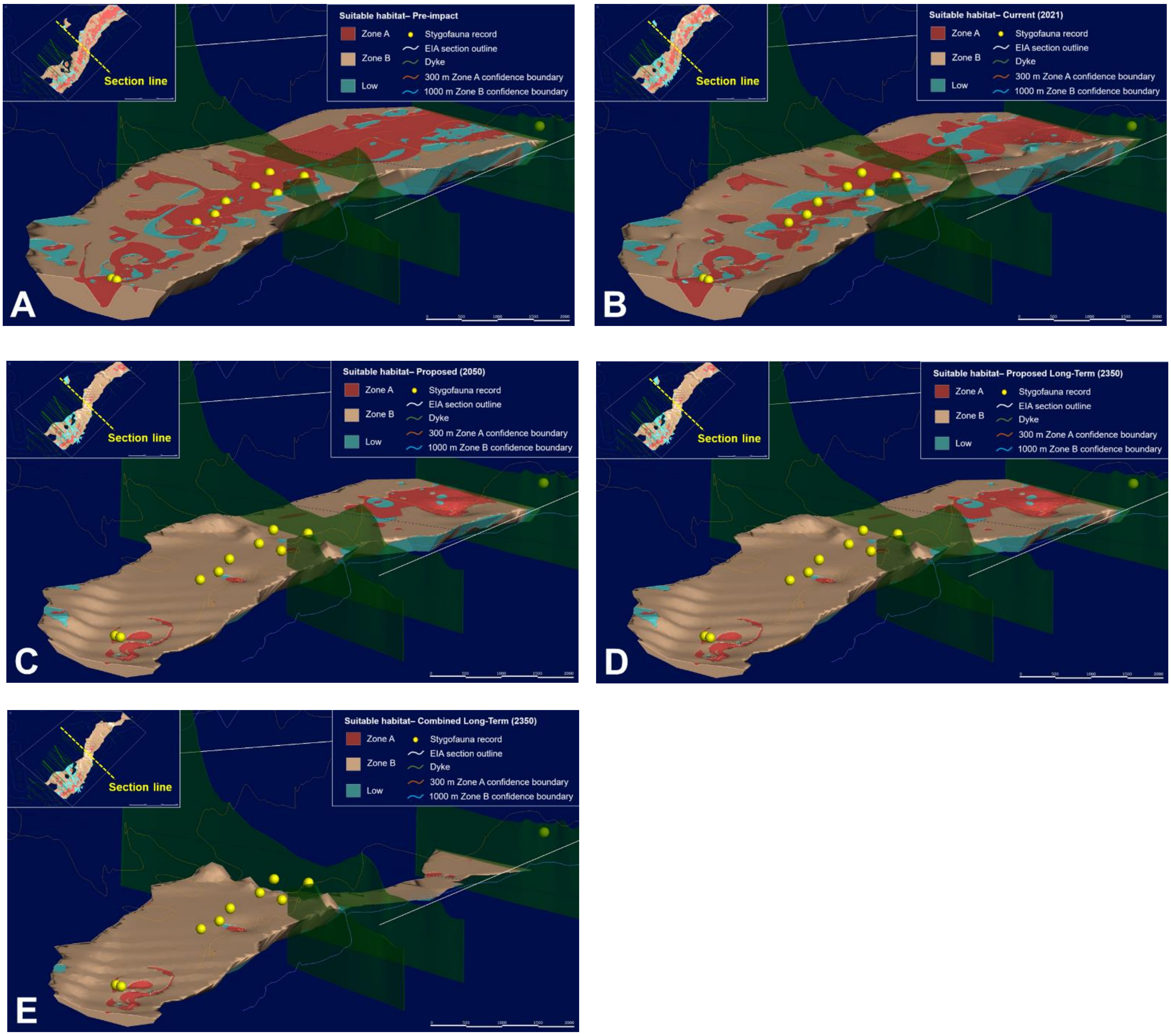


Figure 8-12: Cross -section of the 3D subterranean habitat model showing BWT habitats at BS3 for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. *Vertical scale exaggerated x5*

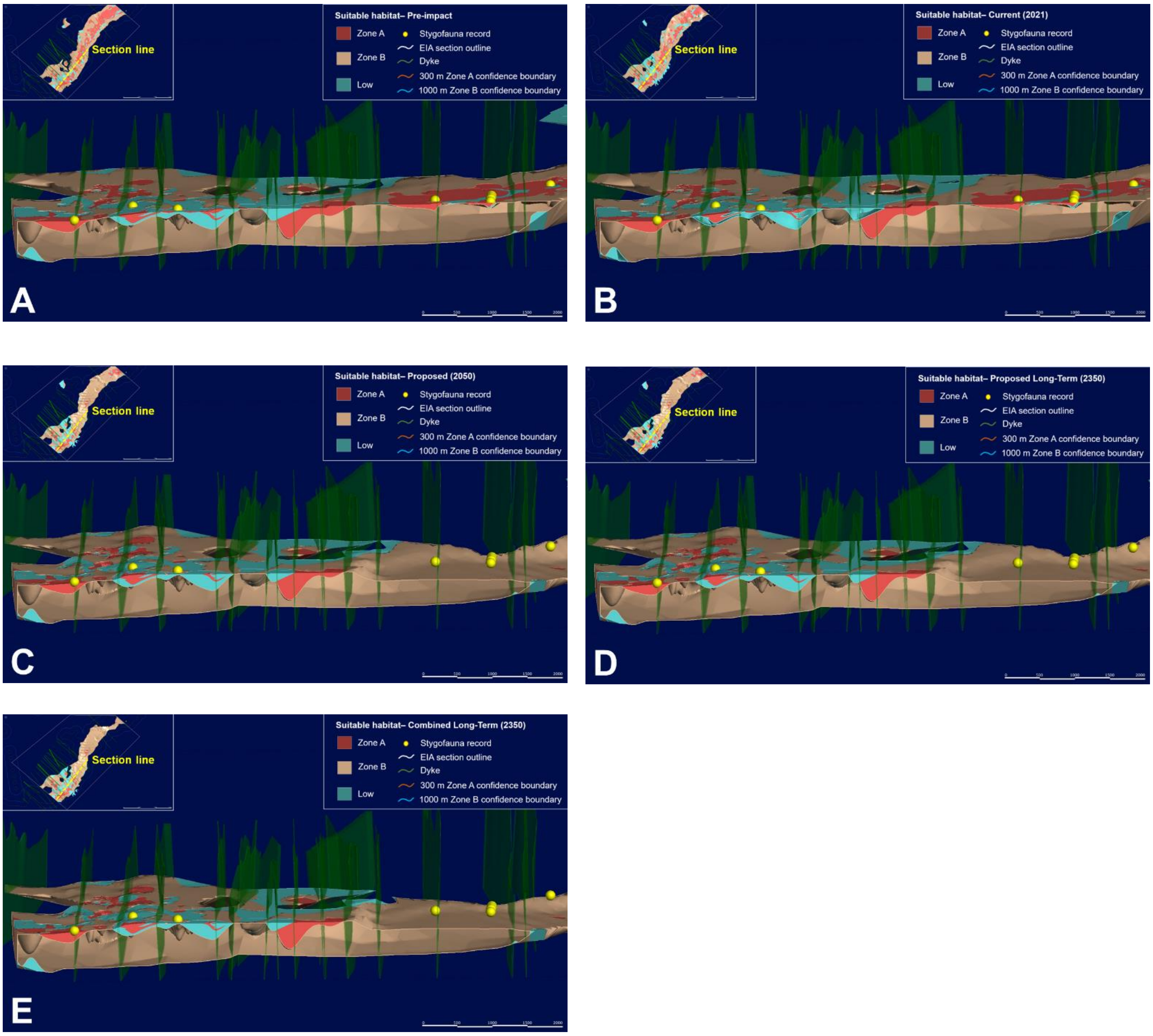


Figure 8-13: Long-section of the 3D subterranean habitat model showing BWT habitats at BS3 South for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. *Vertical scale exaggerated x5*

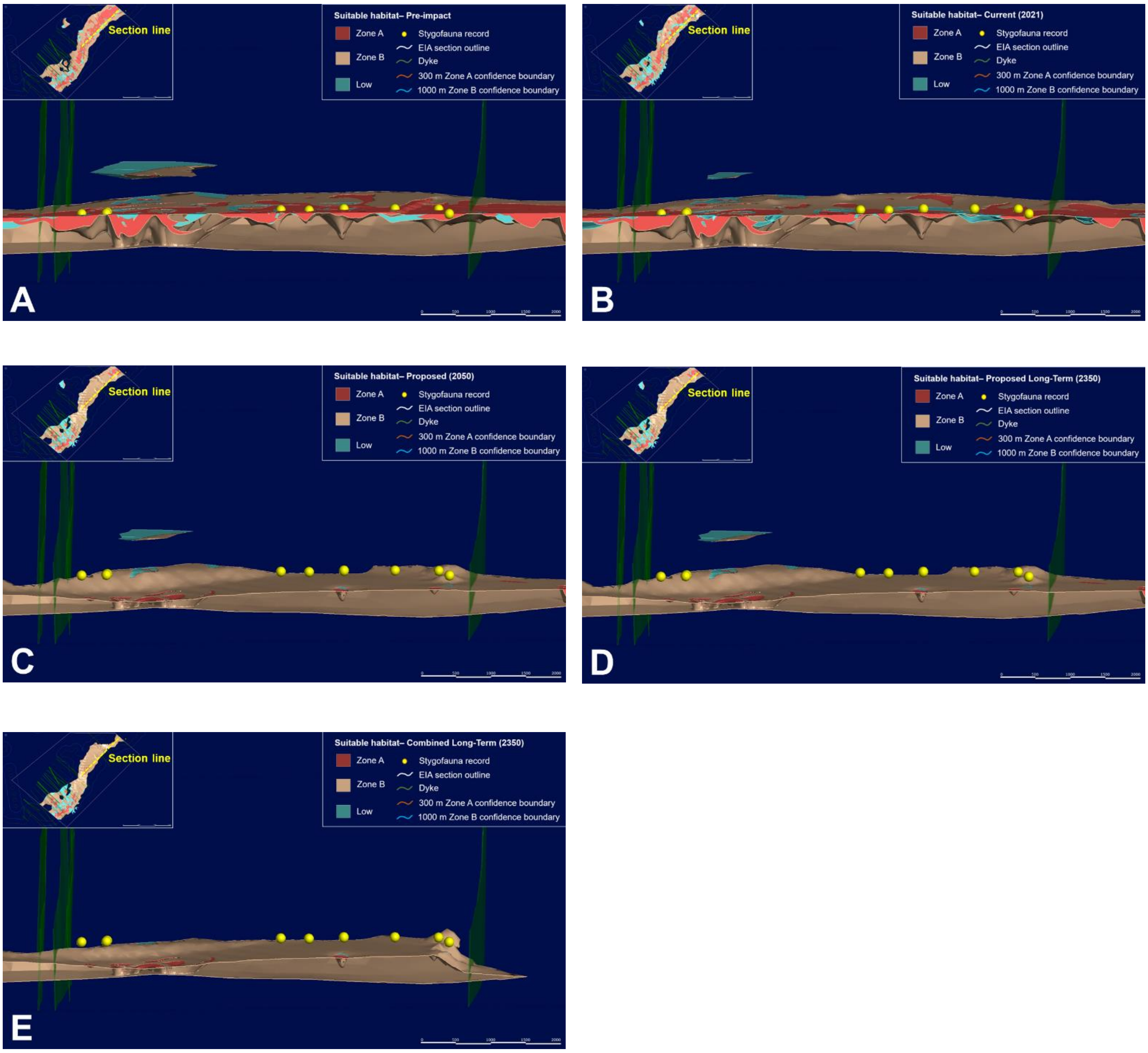


Figure 8-14: Long -section of the 3D subterranean habitat model showing BWT habitats at BS3 North for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. *Vertical scale exaggerated x5*

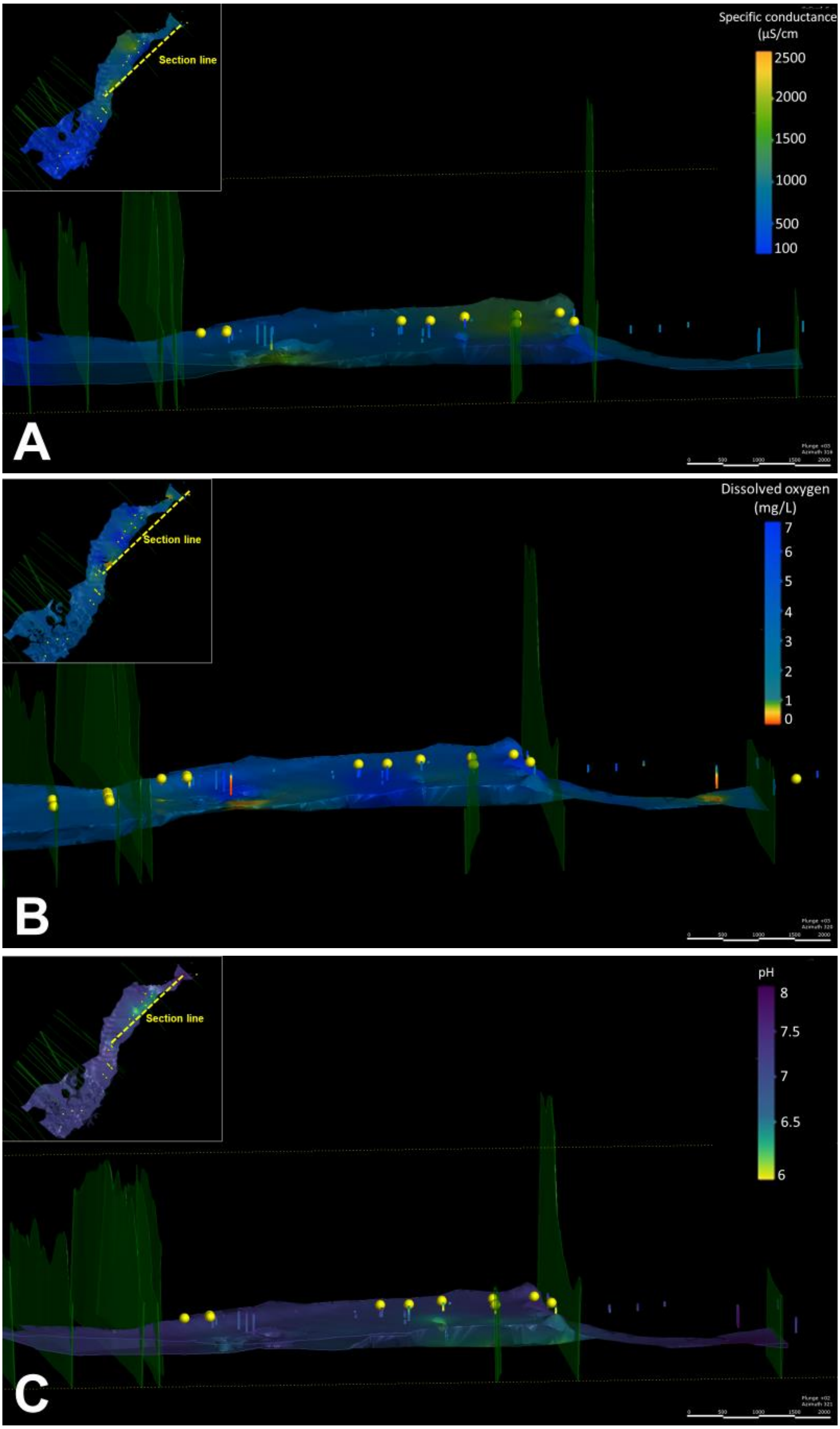


Figure 8-15: Long-section of BS3 (northern section) showing (A) specific conductivity, (B) dissolved oxygen, and (C) pH, within post-impact habitat (long-term scenario) *Vertical scale exaggerated x5*

Brockman Syncline 4

Given the lack of stygofauna species records from sampling in the Brockman Syncline BWT habitats at BS4 (refer Biologic 2022), the High/ Medium/ Low/ Inferred habitat suitability categories described in this section relate only to porosity properties of the lithologies present, and not the value of the BWT habitat for stygofauna species and assemblages, or the likelihood of stygofauna to occur.

The BWT habitat modelling in the BS4 section is supported by 298 km of logging data from 6524 drill holes (Table 8-1), diamond cores, geophysical data, and a regional stratigraphic model. Biologic has a high level of confidence in the shape and extent of the 'veins' of suitable BWT habitat in Zone A throughout the BS4 Section with total metres per suitability category shown in Table 8-15. Habitat Zone B is defined stratigraphically and grouped under inferred habitat suitability. In the absence of any conflicting information, all suitably porous rock types, excluding those with low permeability, are interpreted as potential habitat in Zone B.

Table 8-15: Overview of drill hole data per habitat suitability category at BS4 (BWT)

Habitat suitability category	Total metres (m)	Mean interval thickness (m)	Min interval thickness (m)	Max interval thickness (m)
High	79,026	26.9	8.3	223.7
Medium	149,820	26.5	8.0	257.9
Low	47,451	22.7	7.4	245.3
Inferred	21,906	20.1	7.1	315.5

*Note: mean interval thickness is not a measure of the average thickness of the habitat layer as modelled.

^Given the lack of stygofauna records from BS4 section as described in Biologic (2022), the BWT habitat suitability categories relate to the variable porosity of the lithologies only.

Groundwater quality assessment

Groundwater profiling data was not available at BS4.

BS4 BWT Impact Assessments

The assessment of BWT impacts on subterranean habitat involves extracting impacts (such as pits and water level changes) from the pre-impact habitat. Each scenario is quantified into remaining habitat and then compared against the pre-impact habitat model (Table 8-16). Volumetric changes or loss of habitat are calculated initially against the pre-impact scenario. The proposed habitat loss has also been compared to the current remaining habitat as this is the most realistic interpretation of impact from the Proposal. If applicable, comparison is under the Proposed scenario.

Table 8-16: Volumetric impacts to stygofauna habitat at BS4 for each impact scenario

	Volume (m^3) ('000)				
	Pre-impact	**Current**	**Proposed LOM 2050**	**Proposed Long-term 2350**	**Combined Long-term 2350**
Remaining Habitat					
High	180,880	90,919	41,958	39,807	39,447
Medium	526,800	342,620	205,420	198,740	198,620
Low	1,238,800	658,300	303,060	298,110	298,110
Inferred	15,075,400	13,442,200	9,742,200	8,888,600	8,888,400
Zone A: Suitable habitat (H+M)	**707,680**	**433,539**	**247,378**	**238,547**	**238,067**
Zone B: Inferred	**15,075,400**	**13,442,200**	**9,742,200**	**8,888,600**	**8,888,400**
Suitable habitat (Zone A + Zone B)	**15,783,080**	**13,875,739**	**9,989,578**	**9,127,147**	**9,126,467**
Habitat Loss					
High	0	89,961	138,922	141,073	141,433
Medium	0	184,180	321,380	328,060	328,180
Low	0	580,500	935,740	940,690	940,690
Inferred	0	1,633,200	5,333,200	6,186,800	6,187,000
Zone A: Suitable habitat (H+M)	**0**	**274,141**	**460,302**	**469,133**	**469,613**
Zone B: Inferred	**0**	**1,633,200**	**5,333,200**	**6,186,800**	**6,187,000**
Habitat Loss (Zone A + Zone B)	**0**	**1,907,341**	**5,793,502**	**6,655,933**	**6,656,613**

* Volumetric habitat loss is calculated from the pre-impact habitat volumes. Details for each impact scenario components can be found in Section 3: Impact scenarios.

^Given the lack of stygofauna records from BS4 section as described in Biologic (2022), the BWT habitat suitability categories relate to the variable porosity of the lithologies only.

Pre-impact Habitat Assessment

At BS4, relatively extensive and thick suitable stygofauna habitats are found along the strike of the syncline within fractured/weathered rock aquifers below the MMIF and BrIF bands, as well as within tertiary detrital aquifers and deeper fractured rock aquifers in the synclinal valley in between the two bands (Figure 8-16 and Figure 8-17). The two bands are relatively close together in this section, brought together by intense folding, faulting, and deformation which affected this area of the syncline and created numerous complex geological structures. Consequently, BWT habitats are a little bit less continuous and more complex compared to other sections of the Development Envelope, but the modelling did not reveal any major breaks in the overall continuity of habitat at the landscape scale.

Geological structures such as dykes, faults, and folds are common at BS4 and strike in a north-west to south-east striking direction (Figure 8-16 and Figure 8-17). These structures are expected to reduce overall habitat connectivity along strike by compartmentalising bedrock aquifers below the MMIF and BrIF bands and within the synclinal valley. Nevertheless, many dykes in this area are not considered impermeable due to faults and fracturing, and periodic overtopping through detritals is expected to provide some habitat connectivity along strike.

Current Habitat Assessment

Approved mining operations have shown a slight reduction in suitable BWT stygofauna habitat throughout the BS4 Section (compare A and B of Figure 8-16 and Figure 8-17). Current approved groundwater drawdown affects the central part of BS4 around the approved pits with lesser affect to the east and west.

Visual comparisons of the pre-impact and post-impact (current) scenario showed the following changes to habitat extent, thickness, and connectivity:

- Saturated Zone A habitat is patchy throughout the valley varying from thick to thin bands especially below and adjacent to the pits. (compare A and B Figure 8-16 and Figure 8-17). Zone B habitat is thick and continuous throughout the BS4 Section and accounts for the majority of modelled habitat.
- Vast prospective and unaffected BWT habitats is expected to remain in the east and west areas of BS4.

Under the current scenario, over 13,875,739,000 m^3 (Table 8-16) of suitable BWT habitat in BS4 is modelled to remain, which is approximately 88% of the pre-impact habitat (Table 9-2).

Proposed LOM 2050 Habitat Assessment

The pre-impact extent and thickness of the BWT habitat at BS4 appears naturally very banded and patchy and fragmented (Figure 8-16 and Figure 8-17), and sampling in bores and drill holes throughout the section detected no stygofauna species (Biota, 2005, 2007). Therefore, the direct reduction of the BWT habitat under the proposed LOM scenario cannot have a high impact to stygofauna values, as no stygofauna values are known to occur.

Approximately 9,989,578,000 m3 of the suitable habitat modelled throughout BS4 is expected to remain in-situ under the proposed scenario (Table 8-16) which is approximately 72% of the current habitat (Table 8-17). A detailed breakdown of BWT habitat volumes lost and retained at BS4 under the Proposed LOM scenario is shown in Tables 9-2 (Proposed LOM vs Pre-impact) and 9-3 (Proposed LOM vs Current scenario).

Table 8-17: Volumetric calculations of suitable habitat at BS4 under the Proposed LOM and Proposed Long-term scenarios as a percentage of current habitat

	Volume (m^3) ('000)			% of current total	
	Current	Proposed LOM 2050	Proposed Long-term 2350	Proposed LOM 2050	Proposed Long-term 2350
BS4					
In-situ Suitable Habitat	13,875,739	9,989,578	9,127,147	72	66
Loss of Suitable Habitat	1,907,341	3,886,161	4,748,592	28	34

*Given the lack of stygofauna records from BS4 section as described in Biologic (2022), the BWT habitat suitability categories relate to the variable porosity of the lithologies only.

Proposed Long-term 2350 Habitat Assessment

There is minimal change between the Proposed Long-term 2350 scenario and the Proposed LOM 2050 habitat assessment (compare C and D Figure 8-16 and Figure 8-17) at BS4. Any differences are attributed to the change in modelled groundwater drawdown which is calculated to be around 6% reduction from the Proposed LOM scenario.

Approximately 9,127,147,000 m^3 of suitable habitat modelled throughout BS4 is expected to remain in-situ under the Proposed Long-term scenario (Table 8-17).

Combined Long-term 2350 Habitat Assessment

Visual comparisons of the pre-impact and post-impact (Combined Long Term) scenario showed the following changes to habitat extent, thickness, and connectivity:

- The combined long-term impacts result in a reduction of approximately 42% of the pre-impact volume of habitat (Zone A and Zone B combined), while approximately 58% of the pre-impact volume is expected to be retained (
- Saturated Zone A habitat is patchy throughout the valley varying from thick to thin bands especially below and adjacent to the pits. Zone B habitat is thick and continuous throughout the BS4 Section and accounts for the majority of remaining modelled habitat.
- Vast prospective and unaffected BWT habitats is expected to remain in the east and west areas of BS4.

Approximately 9,126,467,000 m^3 of suitable habitat modelled throughout BS4 is expected to remain in-situ under the Combined Long-term scenario (Table 8-16).

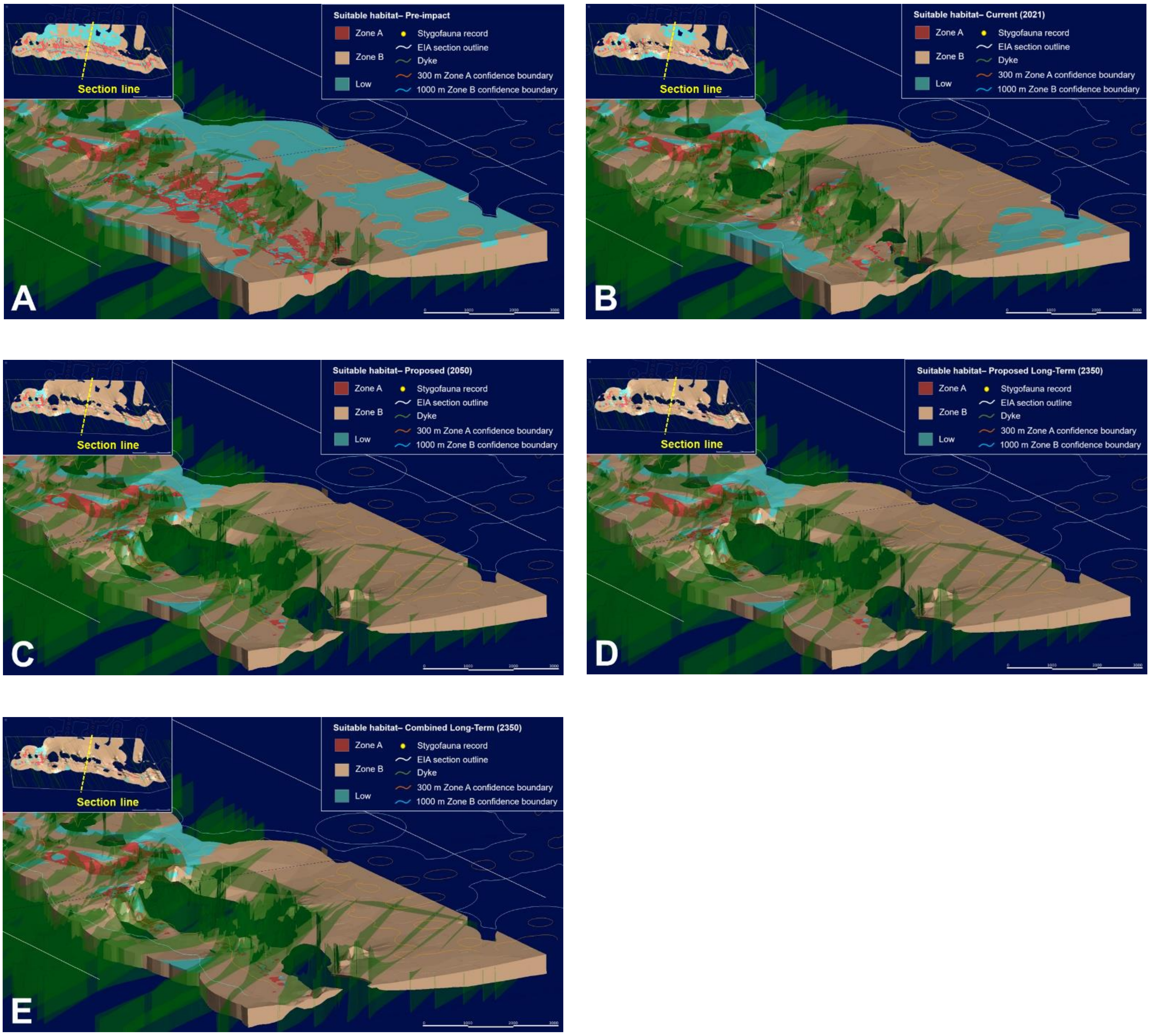


Figure 8-16: Cross-section of the 3D subterranean habitat model showing BWT habitats at BS4 for (A) pre-impact, (B) Current (2021), (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. *Vertical scale exaggerated x5*

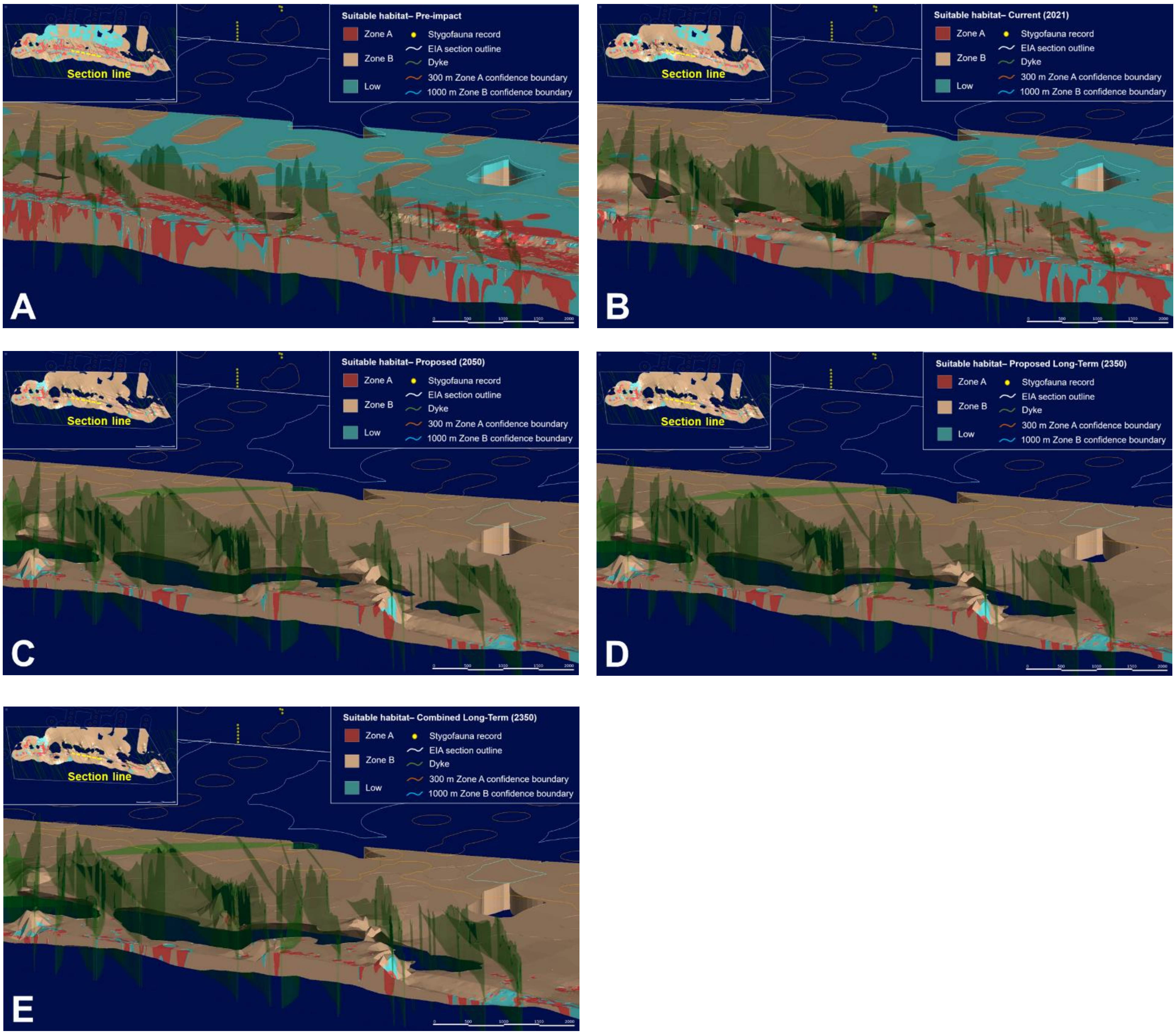


Figure 8-17: Long-section of the 3D subterranean habitat model showing BWT habitats at BS4 for (A) pre-impact, (B) Current (2021, (C) Proposed LOM (2050), (D) Proposed Long-term (2350), and (E) Combined Long-term (2350) scenario. ***Vertical scale exaggerated x5***

9. SUMMARY OF VOLUMETRIC CALCULATIONS

Troglofauna AWT suitable habitat volume summary

Table 9-1: Volumes of Troglofauna AWT Suitable Habitat as a percentage of pre-impact values

	Volume (m^3) ('000)				% of pre-impact habitat		
	Pre-impact	Current	Proposed	Combined Long Term	Current	Proposed	Combined Long Term
BS1							
Suitable Habitat Retained	1,071,370	1,071,370	844,990	844,990	100	79	79
Loss of Suitable Habitat	0	0	226,380	226,380	0	21	21
BS2							
In-situ Suitable Habitat	3,229,400	2,880,540	3,155,600	2,806,740	89	98	87
Loss of Suitable Habitat	0	348,860	73,800	422,660	11	2	13
BS3							
In-situ Suitable Habitat	1,556,440	1,556,440	1,397,800	1,397,800	100	90	90
Loss of Suitable Habitat	0	0	158,640	158,640	0	10	10
BS4							
In-situ Suitable Habitat	2,304,040	1,818,320	2,137,740	1,652,140	79	93	72
Loss of Suitable Habitat	0	485,720	166,300	651,900	21	7	28
Total Development Envelope							
Suitable Habitat Retained	**8,161,250**	**7,326,670**	**7,536,130**	**6,701,670**	**90**	**92**	**82**
Loss of Suitable Habitat	**0**	**834,580**	**625,120**	**1,459,580**	**10**	**8**	**18**

Stygofauna BWT suitable habitat volume summary

Table 9-2: Volumetric Summary of Stygofauna BWT Habitat by impact scenario, as a percentage of pre-impact habitat values

	Volume (m^3) ('000)						% of pre-impact habitat				
	Pre-impact	Current	Proposed LOM 2050	Proposed long-term 2350	Combined long-term 2350	Cumulative third Party	Current	Proposed LOM 2050	Proposed Long-term 2350	Combined long-term 2350	Cumulative third-party 2350
BS1											
Suitable Habitat Retained	3,814,170	3,814,170	2,168,658	2,057,041	2,057,041	1,328,261	100	57	54	54	35
Loss of Suitable Habitat	0	0	1,645,512	1,757,129	1,757,129	2,485,909	0	43	46	46	65
BS2											
In-situ Suitable Habitat	13,876,390	9,445,243	6,041,709	4,948,699	4,936,858	/	68	44	36	36	/
Loss of Suitable Habitat	0	4,431,147	7,834,681	8,927,691	8,939,532	/	32	56	64	64	/
BS3											
In-situ Suitable Habitat	3,139,310	3,021,600	1,923,898	1,636,218	1,636,218	/	96	61	52	52	/
Loss of Suitable Habitat	0	117,710	1,215,412	1,503,092	1,503,092	/	4	39	48	48	/
BS4											
In-situ Suitable Habitat	15,783,080	13,875,739	9,989,578	9,127,147	9,126,467	/	88	63	58	58	/
Loss of Suitable Habitat	0	1,907,341	5,793,502	6,655,933	6,656,613	/	12	37	42	42	/

*Note: 'Suitable habitat' comprises Zone A (High, Medium) and Zone B (Inferred)
^Given the lack of stygofauna records from BS4 section as described in Biologic (2022), the BWT habitat suitability categories relate to the variable porosity of the lithologies only.

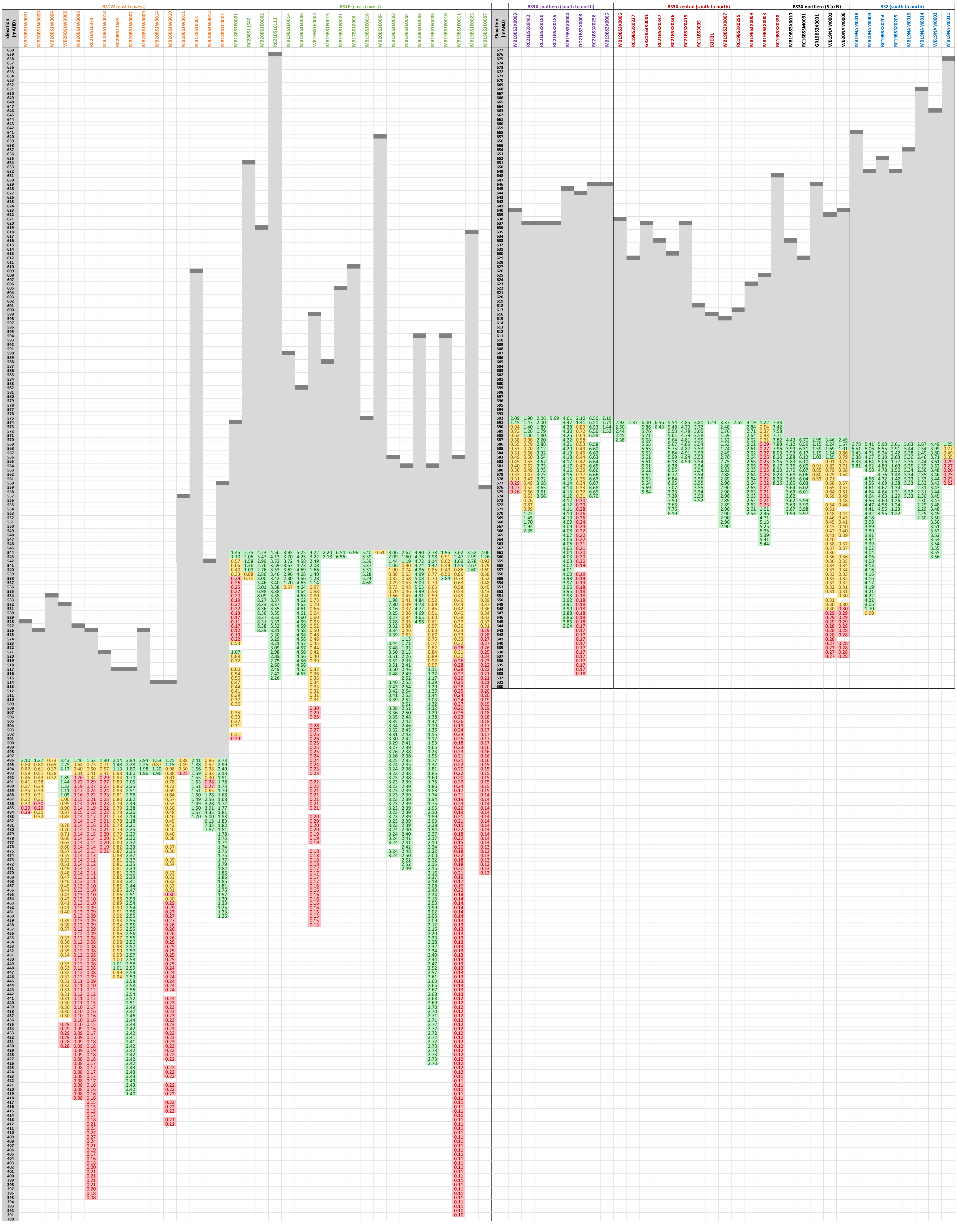
Table 9-3: Volumetric Summary of Stygofauna BWT Habitat by impact scenario as a percentage of the current scenario

	Volume (m^3) ('000)			% of current habitat	
	Current	**Proposed LOM 2050**	**Proposed Long-term 2350**	**Proposed LOM 2050**	**Proposed Long-term 2350**
BS1					
Suitable Habitat Retained	3,814,170	2,168,658	2,057,041	57	54
Loss of Suitable Habitat	0	1,645,512	1,757,129	43	46
BS2					
In-situ Suitable Habitat	9,445,243	6,041,709	4,948,699	64	52
Loss of Suitable Habitat	4,431,147	3,403,534	4,496,544	36	48
BS3					
In-situ Suitable Habitat	3,021,600	1,923,898	1,636,218	65	54
Loss of Suitable Habitat	117,710	1,097,702	1,385,382	35	46
BS4^					
In-situ Suitable Habitat	13,875,739	9,989,578	9,127,147	72	66
Loss of Suitable Habitat	1,907,341	3,886,161	4,748,592	28	34

*Note: 'Suitable habitat' comprises Zone A (High, Medium) and Zone B (Inferred)
^Given the lack of stygofauna records from BS4 section as described in Biologic (2022), the BWT habitat suitability categories relate to the variable porosity of the lithologies only.

10. Summary of Groundwater Dissolved Oxygen Data

Schematic showing average Dissolved Oxygen (ODO) (mg/L) per 1 m interval down hole (m AHD). Top of measurements indicates average water table (+/- 1 m AHD). End of measurements indicates end of hole and/ or end of profiling data. Dark grey bars indicate collar location (m AHD). Green cells indicate ODO >1mg/L. Yellow cells indicate ODO 0.3mg/L - 1mg/L. Red cells indicate low ODO <0.3mg/L. Sites grouped by hydrogeological compartment, and ordered from left to right respectively, east to west for BS1, and south to north for BS3X and BS2.



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