# Appendix 4

# Overburden Emplacement Concept Design – Pells Sullivan Meynink (December 2013)

(Total No. of pages including blank pages = 32)

Note: A colour version of this Appendix can be viewed on the Project CD

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Our Ref: PSM167-007R
Date: 2 December 2013

Hy-Tec Industries Pty Limited
391 Jenolan Caves Road
HARTLEY QLD 2790

ATTENTION: DARRYL THIEDEKE

Dear Darryl,

**RE: AUSTEN QUARRY STAGE 2 - OVERBURDEN EMPLACEMENT CONCEPT DESIGN**

Please find enclosed our report on the concept design of the Austen Quarry Stage 2 Overburden Emplacement. We trust this report is in keeping with your requirements and would be pleased to discuss any aspect.

For and on behalf of
PELLS SULLIVAN MEYNINK

TIM SULLIVAN

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**Hy-Tec Industries Pty Limited**

# AUSTEN QUARRY STAGE 2
# OVERBURDEN EMPLACEMENT CONCEPT DESIGN

**Report PSM167-007R** **December 2013**

## CONTENTS



**FIGURES**



**APPENDICES**

## 1. INTRODUCTION

This report presents the results of a planning assessment, geotechnical strategy and concept design for the Stage 2 Overburden Emplacement for Austen Quarry, Hartley. This assessment forms part of the overall planning for Stage 2 extension of the quarry, with extraction extending out to 35 years.

Figure 1 shows the existing Stage 1 overburden emplacement, the existing extraction area, the final Stage 2 pit perimeter and the site topography.

The existing quarry development is termed Stage 1 and the new planned extraction out to year 35 is termed Stage 2. The existing and the new planned overburden emplacements have been given similar names, Stage 1 and 2 respectively. However, within that, the pit development itself will proceed through a number of stages and these stages relate to various volumes of overburden. The sequence of pit development in Stage 2 are termed Pit Stage A to G.

The overburden emplacement strategy was developed separately and entails a number of separate placements in different areas, termed emplacement phases. Figure 2 shows the overburden and waste rock generation through the quarry life. The relationship between the overburden and waste rock generation, pit stages and the various emplacement phases is also shown in Figure 2. It is noted that the emplacement phases do not match the pit production stages exactly, but merely illustrate concept phasing of the construction of the emplacement.

## 2. BACKGROUND

### 2.1. History

The author of this document has been associated with the overburden emplacement since it was first planned in around 1996. The history of geotechnical studies and assessments of the overburden emplacement at Austen Quarry comprises:

1. The overburden emplacement for Stage 1 of the Austen Quarry was designed by the author of this document in 1996 during the initial quarry planning.
2. The geotechnical design included consideration of:
    a) siting
    b) foundation conditions
    c) local drainage
    d) locations of any groundwater seepages or springs in the area
    e) assessment of topography
    f) assessment of local ephemeral watercourses affected by the emplacement and any likely water impacts
    g) assessment of the overburden material and likely performance in the emplacement.

3. The design considerations for the Stage 1 emplacement also included liaison with Mr S. Brooks of the NSW Soil Conservation Service regarding design and minimisation of any downstream impacts.
4. The emplacement was inspected and reviewed in January 2007, soon after the quarry commenced operation and after the first lift had been placed.
5. The emplacement was inspected and reviewed again in August 2009 and earlier this year in May.

## 2.2. Existing Emplacement Design and Construction Considerations

The Stage 1 emplacement was designed as a permanent structure and had a number of the design and construction considerations comprising:

- A maximum overall slope on the downstream face of 26°.
- Individual lifts constructed at the angle of repose, assumed 35° to 40°.
- The surface of individual lifts graded at 3° to 5° away from downstream face, in order to control erosion.
- The materials in the lifts are placed such that the coarser more competent rock is located towards the outside of the emplacement.
- The emplacement was constructed from the bottom lift up.
- Water management around the emplacement is a key element.
- A sedimentation dam was required.

This emplacement has performed well and is stable with minimal erosion on rehabilitated faces.

## 2.3. Overburden and Waste Rock Emplacement Requirements

Stage 2 overburden and waste rock generation volumes are presented in Table 2.1 and Figure 2. The Stage 2 emplacement storage requirements are:

- An additional insitu 2.2 $Mm^3$ of overburden and waste rock will be generated.
- Assuming a conservative swelling factor of 1.3, this translates to an additional loose volume of 2.9 $Mm^3$.
- Assuming an insitu density of 2.0 $t/m^3$, this translates to an additional 4.4 Mt.

**TABLE 2.1**
**PIT DEVELOPMENT STAGE VOLUMES AND TONNAGES**
**(Provided by RW Corkery & Co Pty Limited)**

| TIMELINE | INSITU VOLUME | INSITU VOLUME | AGG QUALITY VOLUME | AGG QUALITY | WASTE ROCK VOLUME | WASTE ROCK TONNES |
|---|---|---|---|---|---|---|
| | (bcm) | (bcm) | (bcm) | tonnes | (bcm) | tonnes |
| | Cumulative | Per Stage | | | | |
| Stage A (EP1) | 2,457,100 | 464,900 | 371,920 | 966,992 | 92,980 | 185,960 |
| Stage B (EP2) | 2,800,900 | 343,800 | 275,040 | 715,104 | 68,760 | 137,520 |
| Stage C (EP3) | 4,034,900 | 1,234,000 | 987,200 | 2,566,720 | 246,800 | 493,600 |
| Stage D (EP4) | 5,845,700 | 1,810,800 | 1,448,640 | 3,766,464 | 362,160 | 724,320 |
| Stage E (EP5) | 9,874,400 | 4,028,700 | 3,625,830 | 9,427,158 | 402,870 | 805,740 |
| Stage F (EP6) | 13,720,300 | 3,845,900 | 3,461,310 | 8,999,406 | 384,590 | 769,180 |
| Stage G (EP7) | 16,379,900 | 2,659,600 | 2,393,640 | 6,223,464 | 265,960 | 531,920 |
| **Total** | **16,379,900** | **16,379,900** | **14,157,340** | **36,809,084** | **2,222,560** | **4,445,120** |

Note: table taken from RW Corkery & Co Pty Limited email of 19 November 2013.
bcm = bank cubic metres
EP1 - EP7 = Overburden Emplacement Phases

## 2.4. Design Constraints

There are some environmental constraints on the emplacement design including:

- The quarry development area is environmentally and ecologically sensitive, due to its proximity to Cox's River, and the surrounding native vegetation.
- Consideration must also be given to the sight lines from the surrounding vantage points, resulting in the need for progressive vegetated external slopes when the emplacement is above 790mAHD, in order to minimise visual impacts.
- Sediment runoff must be controlled to minimise impact to existing waterways.

In addition, for emplacement planning and design there are a number of logistical and geotechnical constraints including:

- The overburden and weathered materials are mainly produced in the upper elevations and with larger quantities earlier in the extraction schedule.

- The valley floors are located well below the initial development of the extraction area.
- Because of the topography, access to the floor of valleys is difficult.
- The valley sides are quite steep.
- All the valley locations close to extraction area have topographic constraints.

## 3. CONCEPT DESIGN AND DEVELOPMENT

### 3.1. Introduction

The Stage 2 emplacement design and strategy builds on the good performance of Stage 1 to date, but of necessity includes some changes and differences. The Stage 1 emplacement was designed and constructed from the bottom up as a final landform in a particular topographic setting. The Stage 2 emplacement:

1. Entails larger volumes of overburden and weathered rock generated over the 35 years of extraction.
2. Completely fills a valley, which contained a number of separate branches.
3. Takes place in difficult topography with steep valley side slopes up to around 30°.

This means it is important for stability and economic considerations that the Stage 2 strategy and design needs to be modified compared to Stage 1.

The strategy for the Stage 2 emplacement will involve the following:

1. The emplacement is located in the valley immediately adjacent to the extraction area on the south western side, which allows short hauls, Figure 3.
2. This emplacement completely fills the valley, Figure 3.
3. The emplacement entails two elements, the main emplacement, and where necessary, rehabilitation above 790mAHD constructed in a form to marry into the existing topography.
4. The emplacement is constructed by end tipping across the valley.
5. A more substantial sediment pond is constructed well downstream of the emplacement.
6. The "downstream" face of each lift of the final Stage 2 emplacement needs to be designed in the field, based on the materials available at that time and including the emplacement performance to date and the local hydrology.

These aspects are discussed in the following sections.

### 3.2. Siting

Due to the sensitivity of the surrounding area, geometry and economic factors, it is proposed that the Stage 2 emplacement be located as close to the extraction area as possible. Therefore, the emplacement is located in the valley to the immediate west and south of the extraction area, Figure 3. This location benefits from being naturally screened from many surrounding areas.

The Stage 2 emplacement, together with the rehabilitation of both Stage 1 and 2 emplacements, have a combined volume of 3 $Mm^3$ and follows the valley line down to 700mAHD, Figure 3.

### 3.3. Planned Quarry Development

The quarry development entails the existing extraction area and a separate area on a ridge further south, which join to form a single pit after Pit Development Stage D.

The development in the existing extraction area to the north will comprise:

- Develop the Stage 1 extraction area out to its full plan, extent except for the retention of the northern barrier.
- Continue the development of the floor from 750mAHD (current) to 730mAHD (Stage B), to 715mAHD (Stage E).
- A haul road (to 795mAHD) on the southwest pit face.
- In Stage D, once the "hill" of the southern extraction area has been excavated, the two parts will be merged into a single pit.
- This single pit will progress to 685mAHD in Stage G.

In the South, the development will comprise the following components:

- Flatten the existing ridges, from 804mAHD to 745mAHD in Stages A to E.
- Develop the floor, from 745mAHD to 685mAHD in Stages E to G.
- Develop an ex-pit haul road in Stage A downhill across the natural topography from 772mAHD to 730mAHD, which is around the toe of the overburden emplacement.

Appendix A presents the quarry development plans.

Until the ex-pit haul road is developed in Stage A, filling of the overburden emplacement will be from the north along the existing haul road, which is used for access to the valley west of the Stage 1 emplacement.

### 3.4. Emplacement Concept and Development

The concept for the Stage 2 emplacement of the overburden and waste rock has been developed around the planned quarry and other constraints set out above, including:

1. Filling the valley adjacent to the extraction area, Figure 3. This valley is visually screened from the surrounding areas to an elevation of 790mAHD and therefore there is minimal visual impact.
2. Keeping the in-situ "rock ridge" between the pit and the overburden emplacement which allows valley storage to be maximised.
3. The emplacement is constructed from two directions:
   a) By filling from the haul road along the existing emplacement to the north. This is the initial phase of filling, and will incorporate all overburden materials until the construction of the sediment dam and the ex-pit haul road is complete by the end of Pit Development Stage A, Figure 5.
   b) By filling across the valley from the end of the ex-pit haul road. This effectively fills the valley floor and provides a stable base for advancing further lifts from the ex-pit haul road, Figure 6.
   c) Filling above 770mAHD will be from both sides.
   d) This will be constructed up to 790mAHD.
4. This allows flat access or downhill haulage, and is the shortest haul option.
5. The emplacement would be constructed in lifts up to 20m high, at angle of repose.
6. This temporary downhill face would be rehabilitated progressively from the bottom up at an overall angle of 26° in 10m batter heights; Figures 5 to 11 shows the final downhill batters when completed.
7. Any filling above 790mAHD up to 810mAHD is potentially not visually screened from the east and northeast. Therefore, for placement of overburden above 790mAHD, construction of the emplacement lifts would commence from the outer perimeter which would be immediately profiled and revegetated to provide a visual screen of overburden placement behind.
8. In this case, the geometry of the rehabilitation areas above 790mAHD is designed to fit with surrounding landforms by incorporating gentle sloping curves that resemble the surrounding natural landform.
9. When rehabilitated, the emplacement will be visually similar to the surrounding natural state.
10. This strategy allows a single permanent sediment dam to be constructed further down the valley at 700mAHD to act as "catch storage" for both dirty water and any erosion generated from filling higher up the valley.

Figure 2 presents the volume of the Stage 2 emplacement with time. Figure 3 presents the concept design for the Stage 2 emplacement in plan. Figure 4 presents a sectional view of the emplacement and the existing valley floor topography.

Figures 5 to 11 present the Stage 2 emplacement development phasing plans.

Following the clearing of vegetation and stripping of soil, the emplacement should be advanced as follows:

- Filling at the point of unloading.
- Overall advance downslope to the south.
- Individual lifts advancing normal to the direction of overall advance, across the valley towards the west.
- Conventional lifts as follows:
  - surface of individual lifts graded at 3 to 5% away from the free face
  - placement of coarser blocky rock towards the outside of the slope
  - berms between lifts sized to fit within the overall angle constraint.

### 3.5. Surface Water Management

Surface water management is very important and needs to be in place prior to the development of the Stage 2 emplacement.

This will entail construction of the main permanent sediment pond or a sediment control dam structure at the downstream location, see Figure 3. This structure needs to be designed and constructed with consideration for its importance to both sediment control and downstream erosion control.

The sediment dam at the toe of the valley is located a distance downstream from the emplacement along a flat valley floor. This ensures:

- The sediment dam capacity is maximised.
- Any sediment from the emplacement is contained.
- An added safety as a catch berm for any debris.

As a result, any potential adverse outcomes are effectively controlled and managed at the downstream end.

### 3.6. Rehabilitation

Rehabilitation of the existing and proposed emplacement is as follows:

**Stage 1 Emplacement (Emplacement Phase 1)**

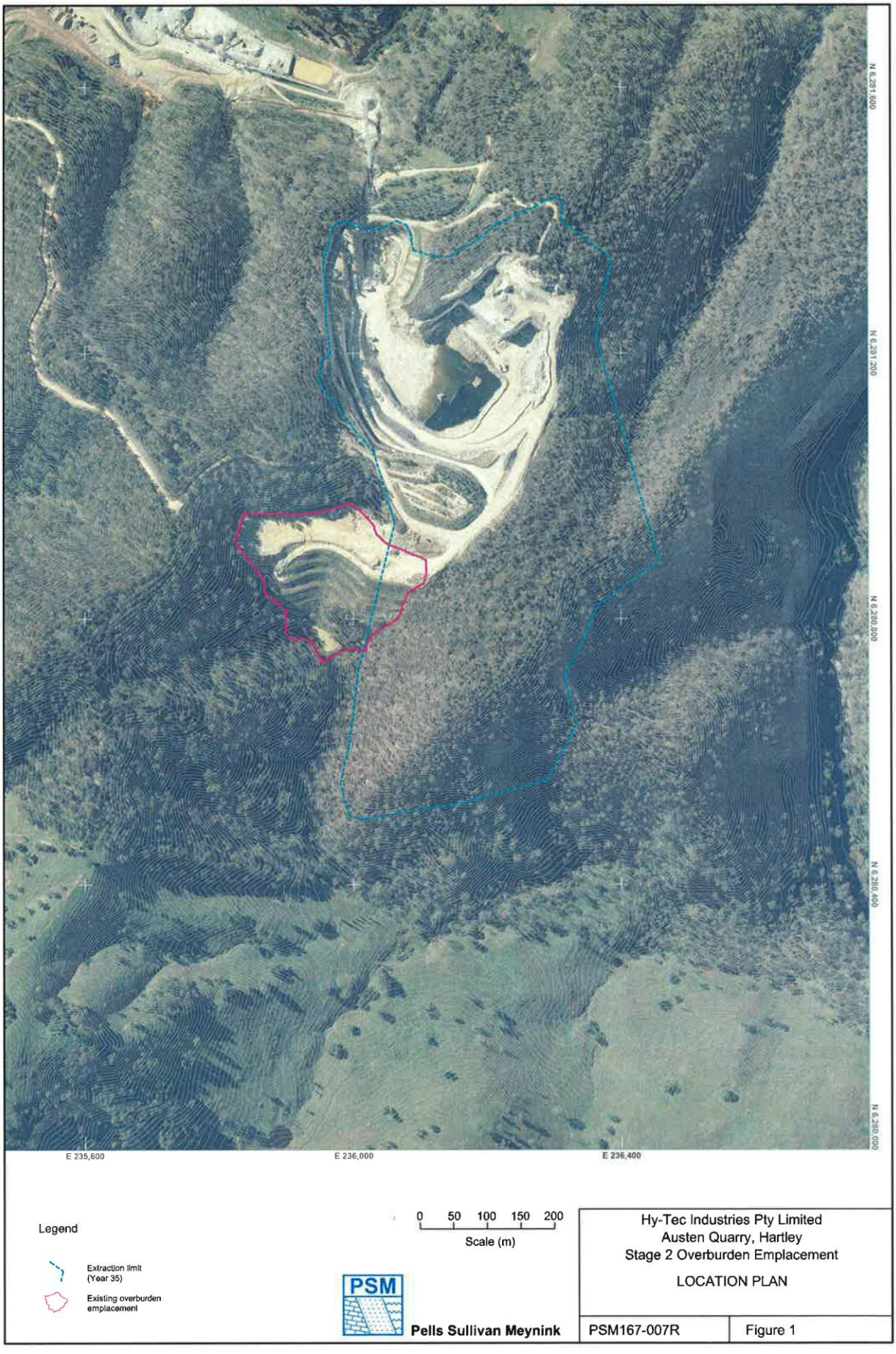
- Overburden is likely to be initially placed above the 790mAHD on the existing emplacement prior to extension to the south and west. The outer face of each 10m lift, up to 810mAHD will be immediately rehabilitated on completion and profiling.
- The geometry of the emplacement lifts above 790mAHD are designed to fit with surrounding landforms by incorporating gentle sloping curves that resemble the surrounding natural landform.
- This rehabilitation of the existing emplacement provides visual screening of the proposed emplacement extension to the west.

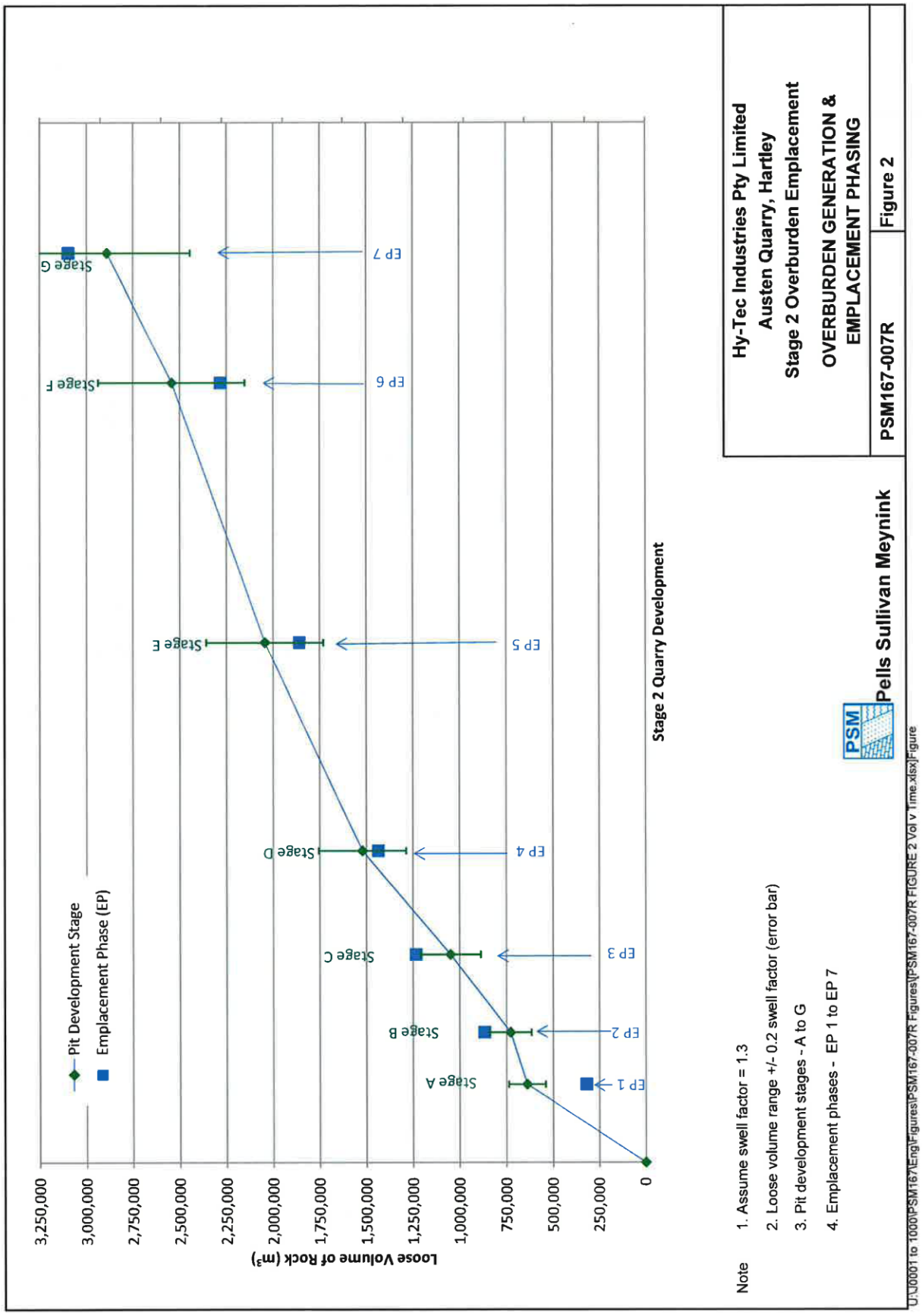
**Stage 2 Emplacement (Emplacement Phases 2 to 7)**

- The rehabilitation for the proposed emplacement will be up to 810mAHD, should the volumes be required.
- The geometry of the rehabilitation areas above 790mAHD is designed to fit with surrounding landforms by incorporating gentle sloping curves that resemble the surrounding natural landform.
- The rehabilitation will be undertaken in sections, with full strips constructed to the final level, rehabilitated and vegetated.
- It is anticipated that the outer-most strip will be constructed first, to provide screening for construction of subsequent strips.
- It is understood a more detailed description of the rehabilitation sequence and method will be provided in the EIS for the Austin Quarry Stage 2 Extension.

For and on behalf of
PELLS SULLIVAN MEYNINK

TIM SULLIVAN


N 6,281,600
N 6,281,200
N 6,280,800
N 6,280,400
N 6,280,000
E 235,600
E 236,000
E 236,400
Legend
Extraction limit (Year 35)
Existing overburden emplacement
0 50 100 150 200
Scale (m)
PSM
Pells Sullivan Meynink
Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
LOCATION PLAN
PSM167-007R
Figure 1


Loose Volume of Rock (m³)
3,250,000
3,000,000
2,750,000
2,500,000
2,250,000
2,000,000
1,750,000
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
Pit Development Stage
Emplacement Phase (EP)
Stage A
Stage B
Stage C
Stage D
Stage E
Stage F
Stage G
EP 1
EP 2
EP 3
EP 4
EP 5
EP 6
EP 7
Stage 2 Quarry Development
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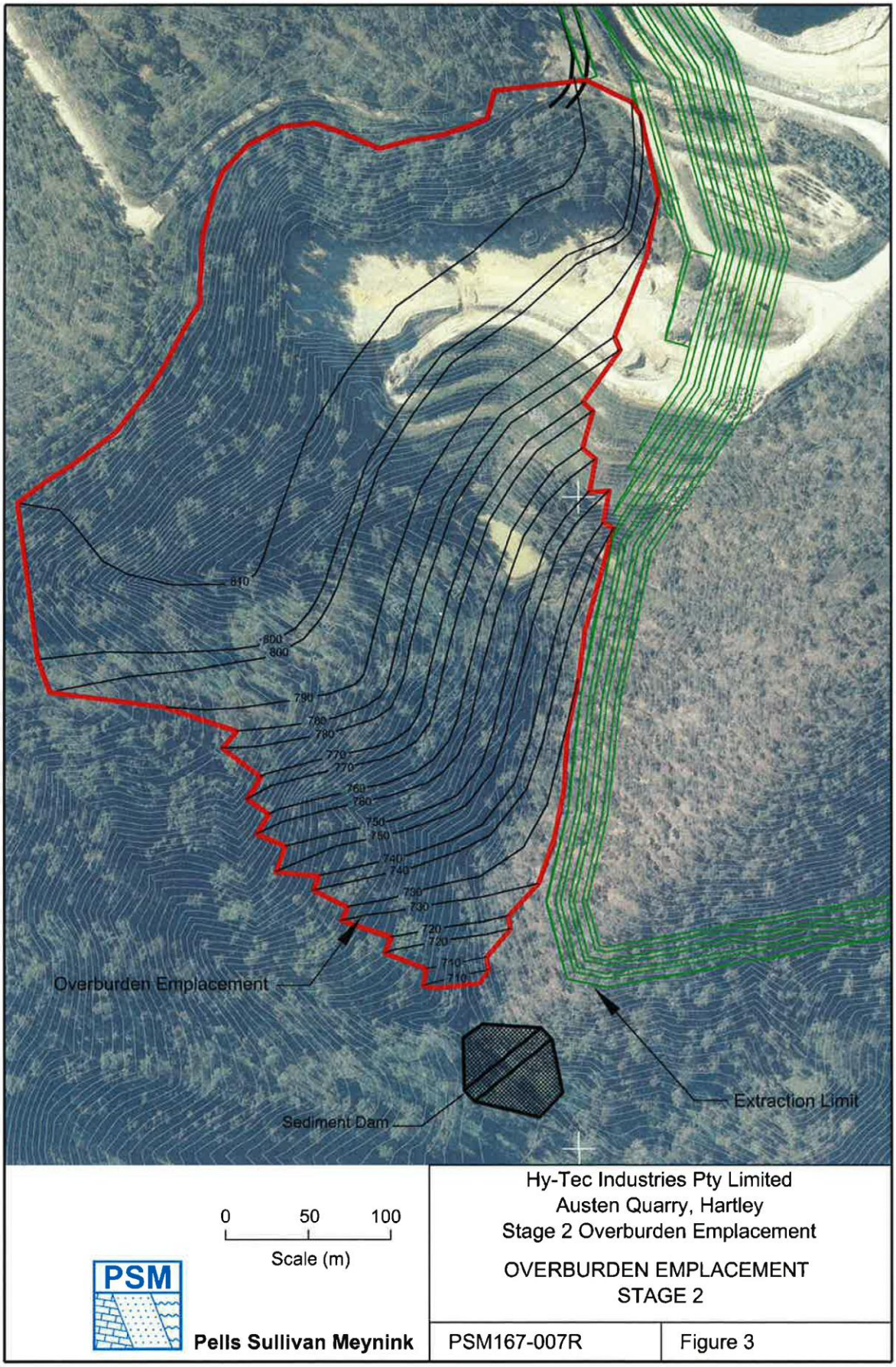
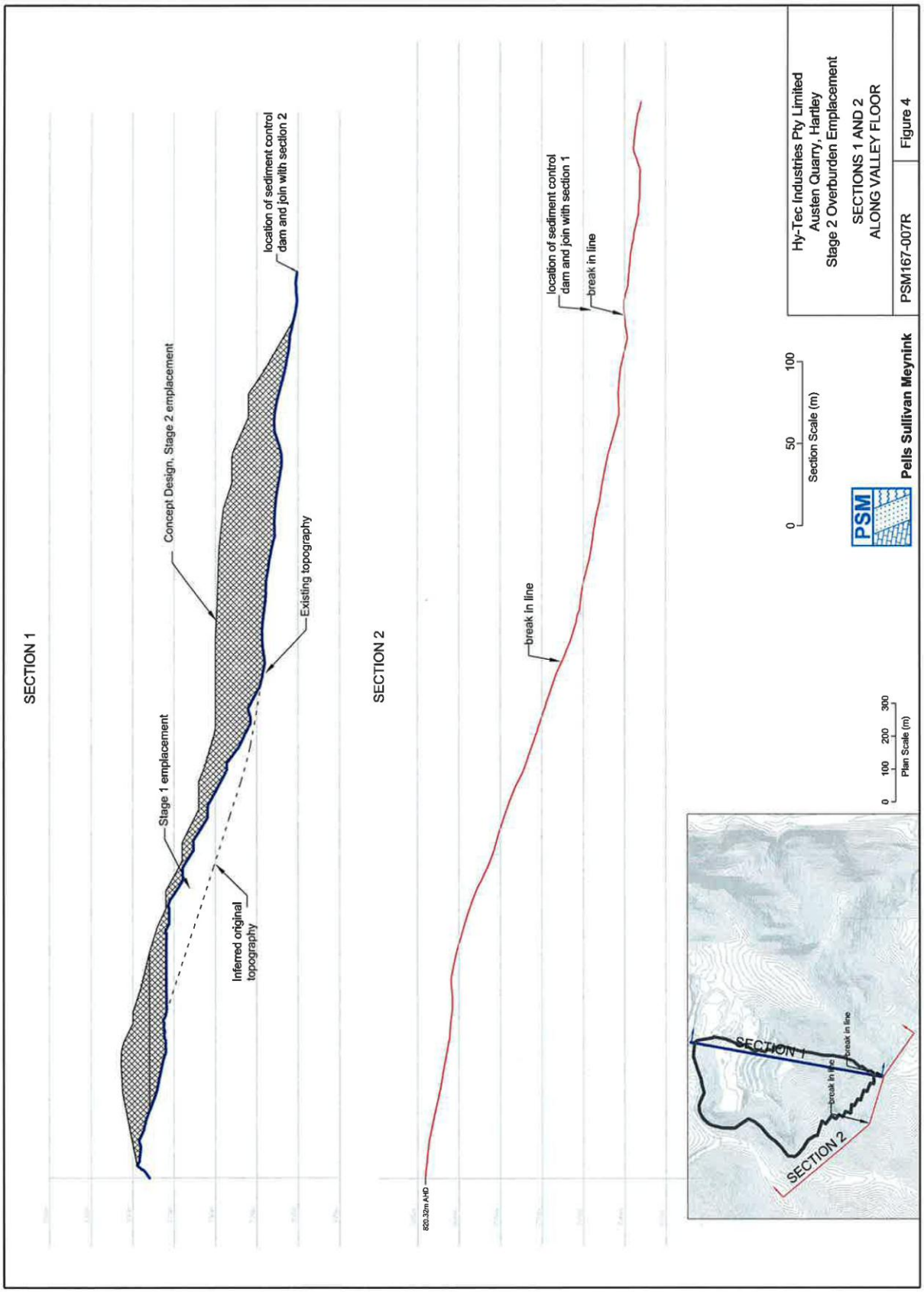
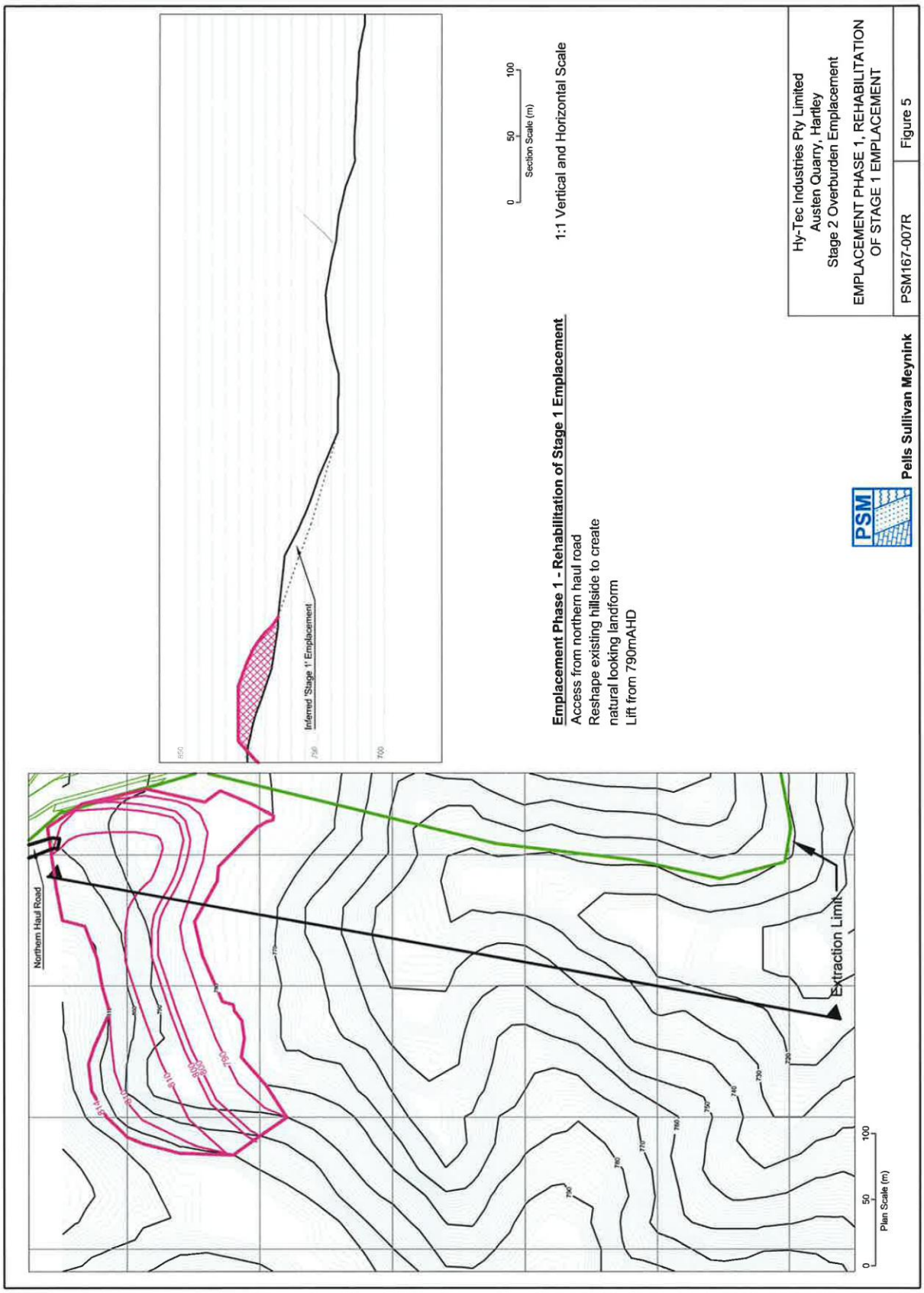
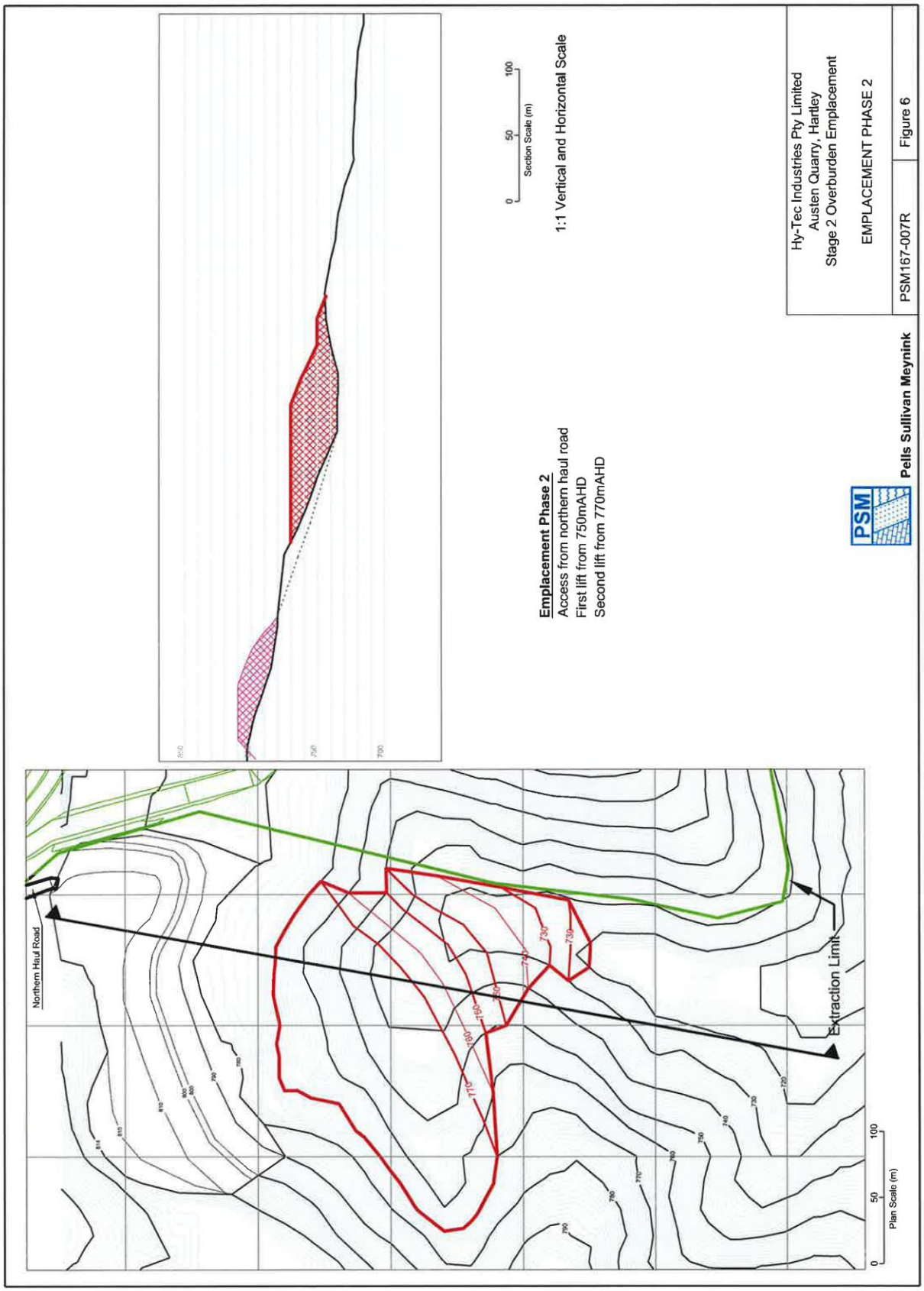
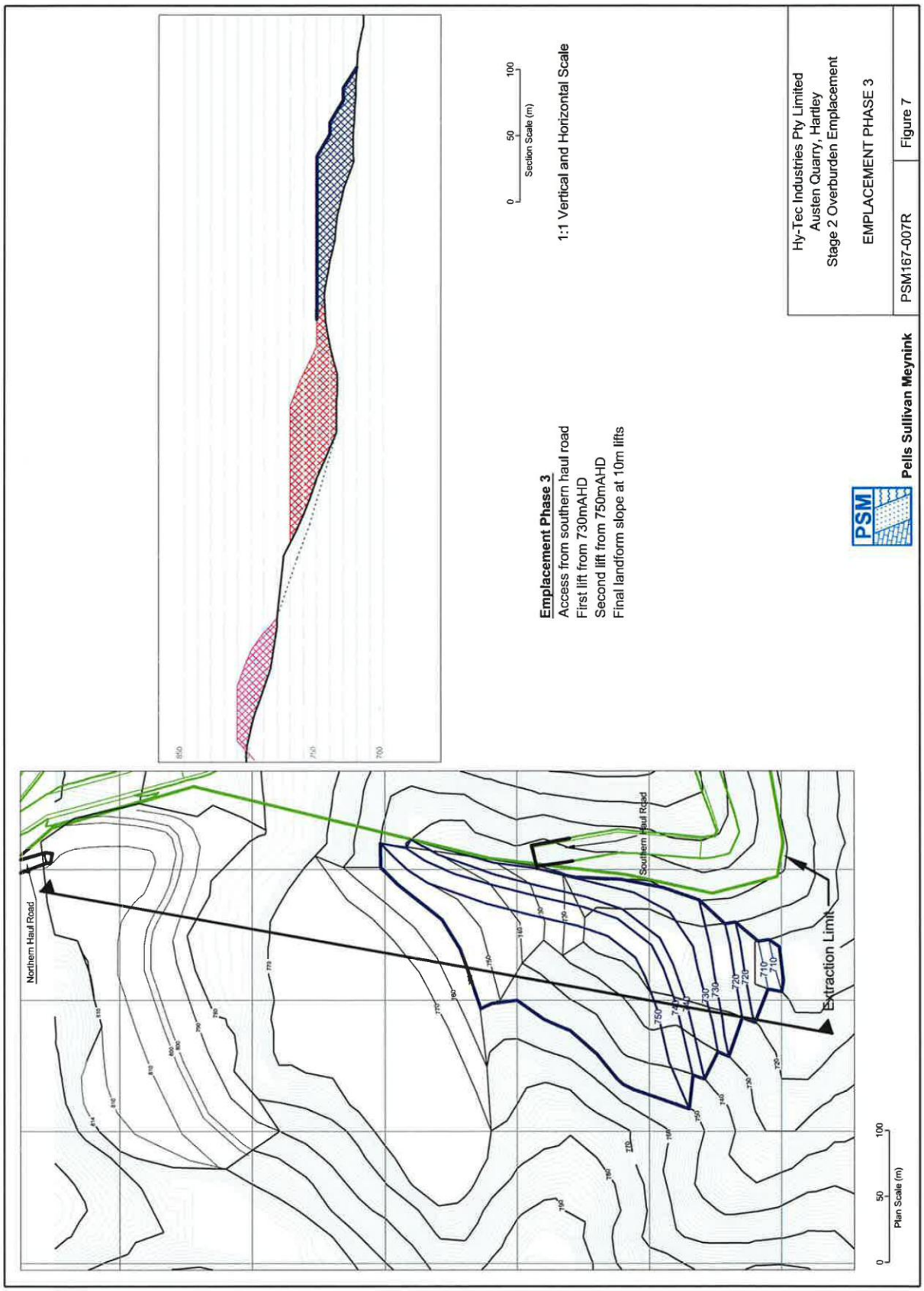
Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
OVERBURDEN GENERATION & EMPLACEMENT PHASING
PSM167-007R
Figure 2
Note
1. Assume swell factor = 1.3
2. Loose volume range +/- 0.2 swell factor (error bar)
3. Pit development stages - A to G
4. Emplacement phases - EP 1 to EP 7
U:\J0001 to 1000\PSM167\Engl\Figures\PSM167-007R Figures\[PSM167-007R FIGURE 2 Vol v Time.xlsx]Figure


810
800
800
790
780
780
770
770
760
760
750
750
740
740
730
730
720
720
710
710
Overburden Emplacement
Extraction Limit
Sediment Dam
0
50
100
Scale (m)
PSM
Pells Sullivan Meynink
Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
OVERBURDEN EMPLACEMENT
STAGE 2
PSM167-007R
Figure 3


SECTION 1
Concept Design, Stage 2 emplacement
location of sediment control dam and join with section 2
Existing topography
Stage 1 emplacement
Inferred original topography
SECTION 2
location of sediment control dam and join with section 1
break in line
break in line
820.32m AHD
0
50
100
Section Scale (m)
PSM
Pells Sullivan Meynink
Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
SECTIONS 1 AND 2
ALONG VALLEY FLOOR
PSM167-007R
Figure 4
0
100
200
300
Plan Scale (m)
SECTION 1
SECTION 2
break in line
break in line


Northern Haul Road
Extraction Limit
Inferred 'Stage 1' Emplacement
Section Scale (m)
0
50
100
Plan Scale (m)
1:1 Vertical and Horizontal Scale
Emplacement Phase 1 - Rehabilitation of Stage 1 Emplacement
Access from northern haul road
Reshape existing hillside to create
natural looking landform
Lift from 790mAHD
PSM
Pells Sullivan Meynink
Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 1, REHABILITATION
OF STAGE 1 EMPLACEMENT
PSM167-007R
Figure 5


Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 2
PSM167-007R
Figure 6
Pells Sullivan Meynink
PSM
Emplacement Phase 2
Access from northern haul road
First lift from 750mAHD
Second lift from 770mAHD
1:1 Vertical and Horizontal Scale
Section Scale (m)
0
50
100
Northern Haul Road
Extraction Limit
Plan Scale (m)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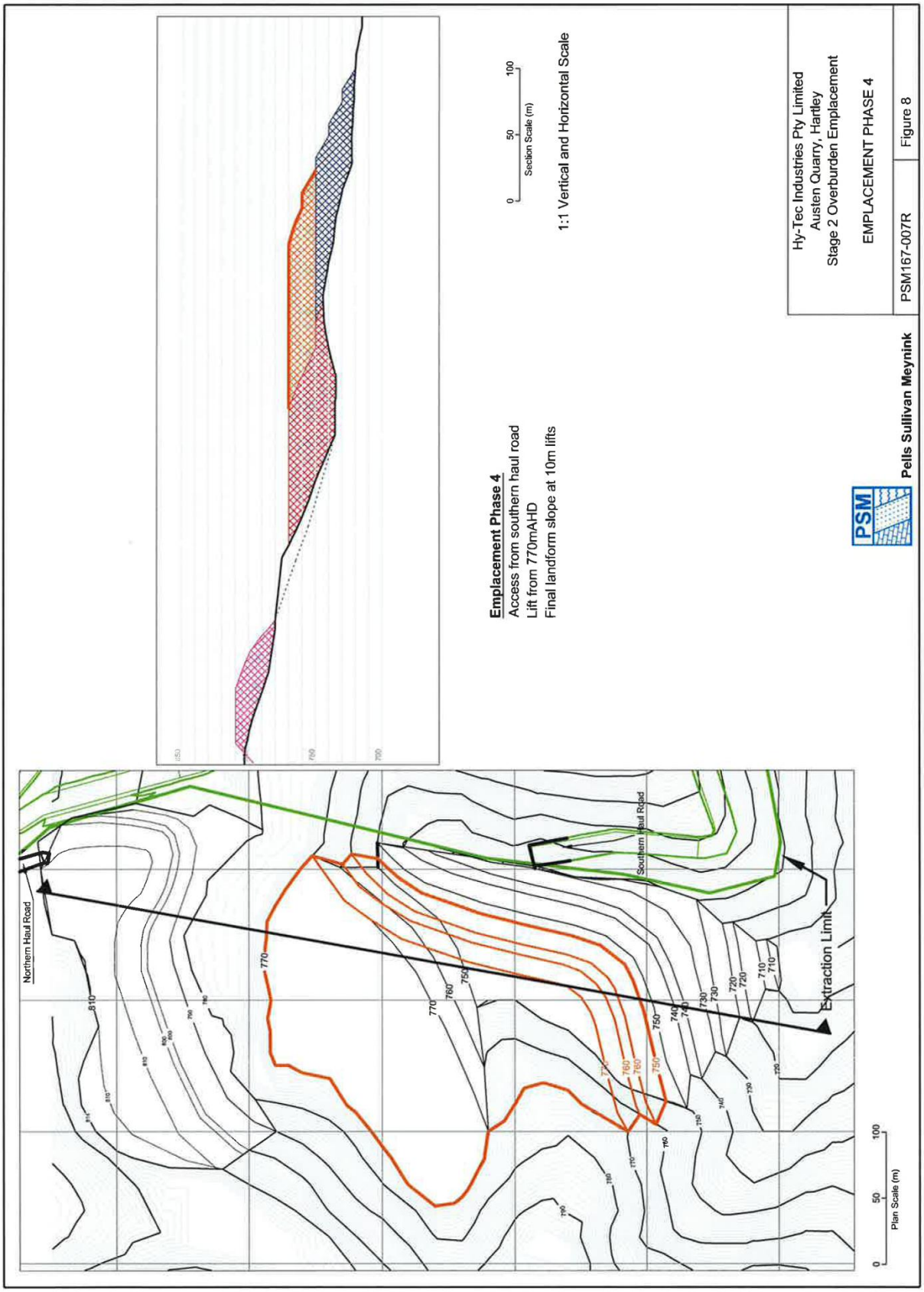
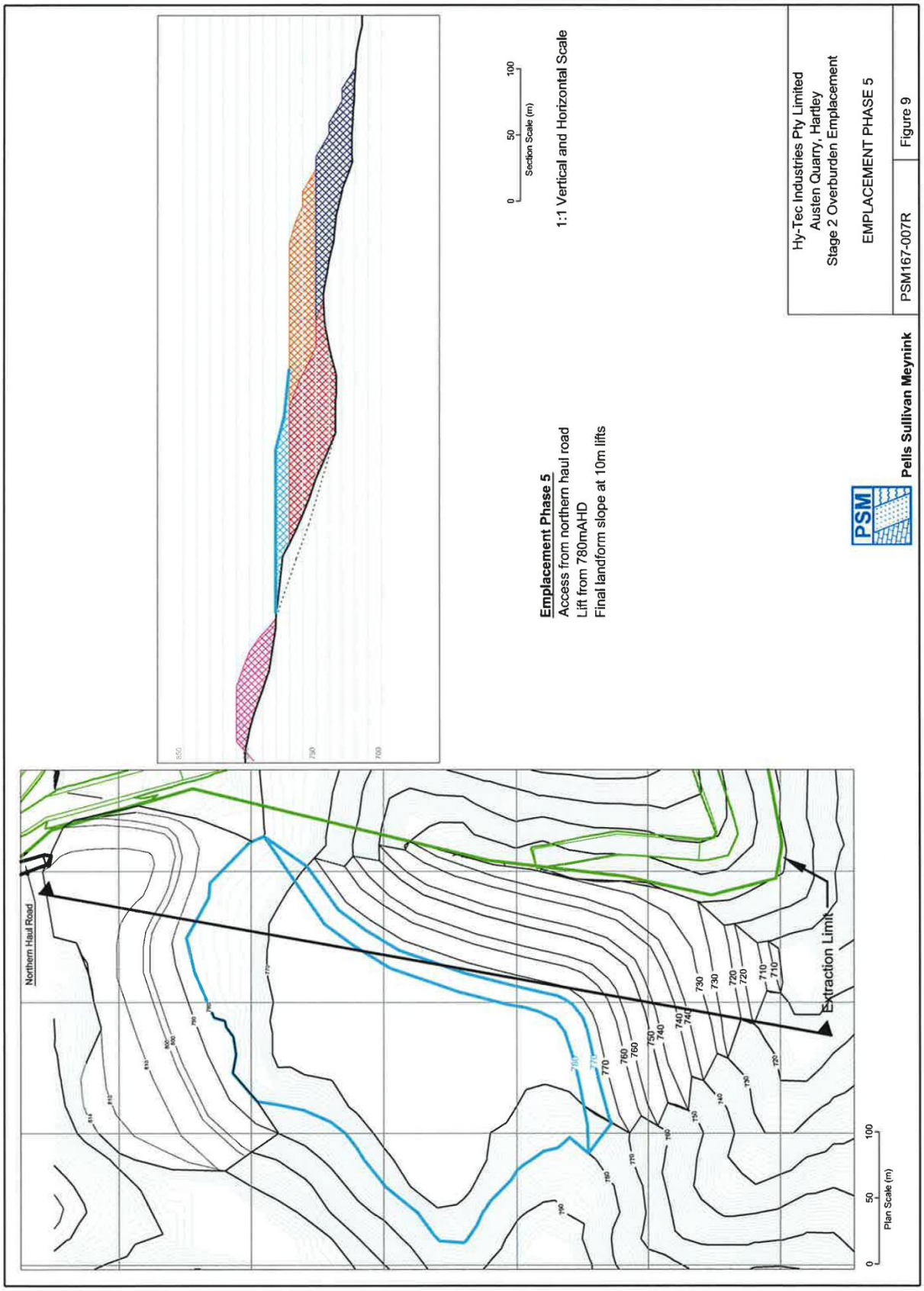
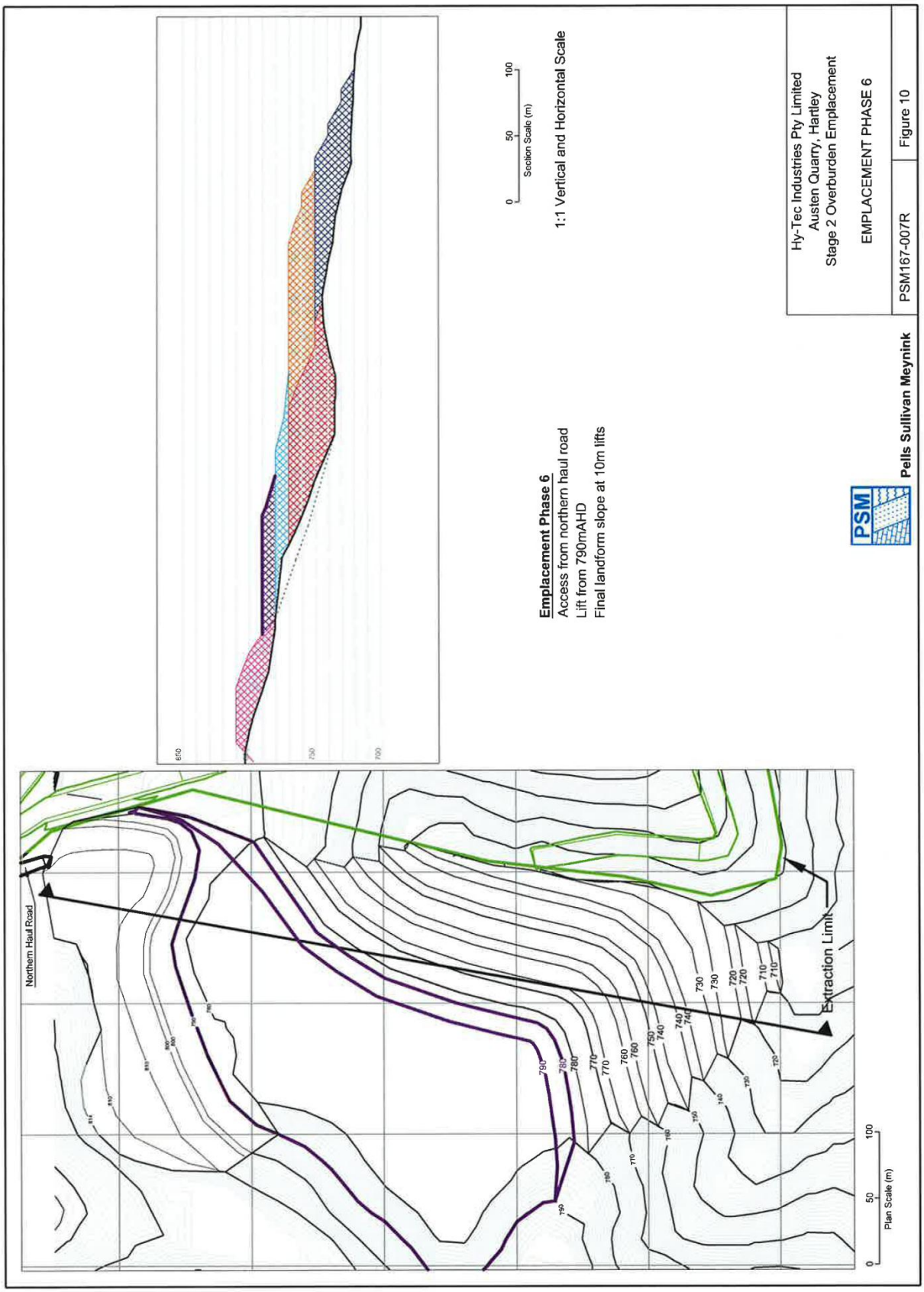
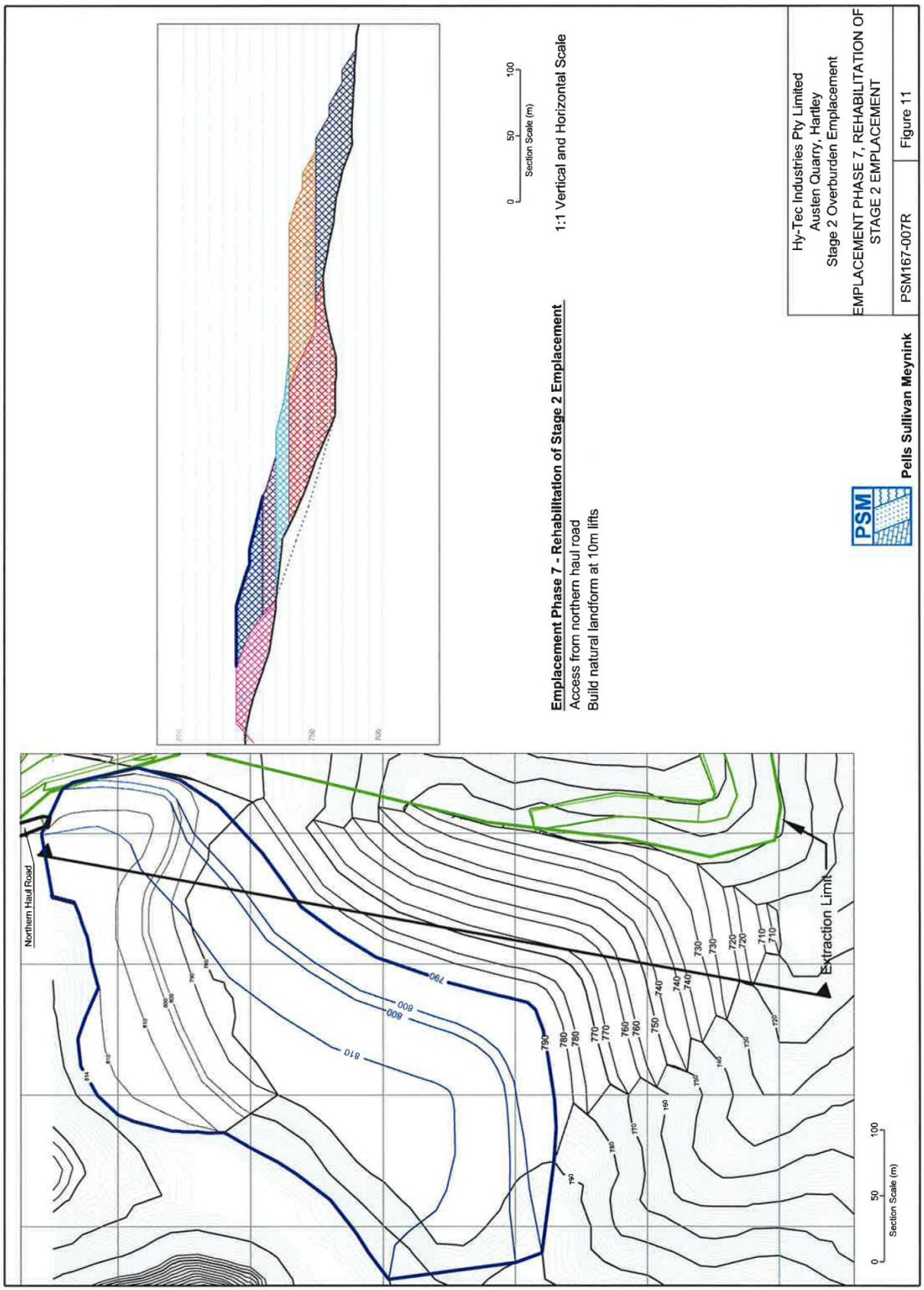
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 3
PSM167-007R
Figure 7
Pells Sullivan Meynink
PSM
Emplacement Phase 3
Access from southern haul road
First lift from 730mAHD
Second lift from 750mAHD
Final landform slope at 10m lifts
1:1 Vertical and Horizontal Scale
Section Scale (m)
0
50
100
Northern Haul Road
Southern Haul Road
Extraction Limit
Plan Scale (m)


Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 4
PSM167-007R
Figure 8
Pells Sullivan Meynink
PSM
Emplacement Phase 4
Access from southern haul road
Lift from 770mAHD
Final landform slope at 10m lifts
1:1 Vertical and Horizontal Scale
Section Scale (m)
0
50
100
Northern Haul Road
Southern Haul Road
Extraction Limit
Plan Scale (m)

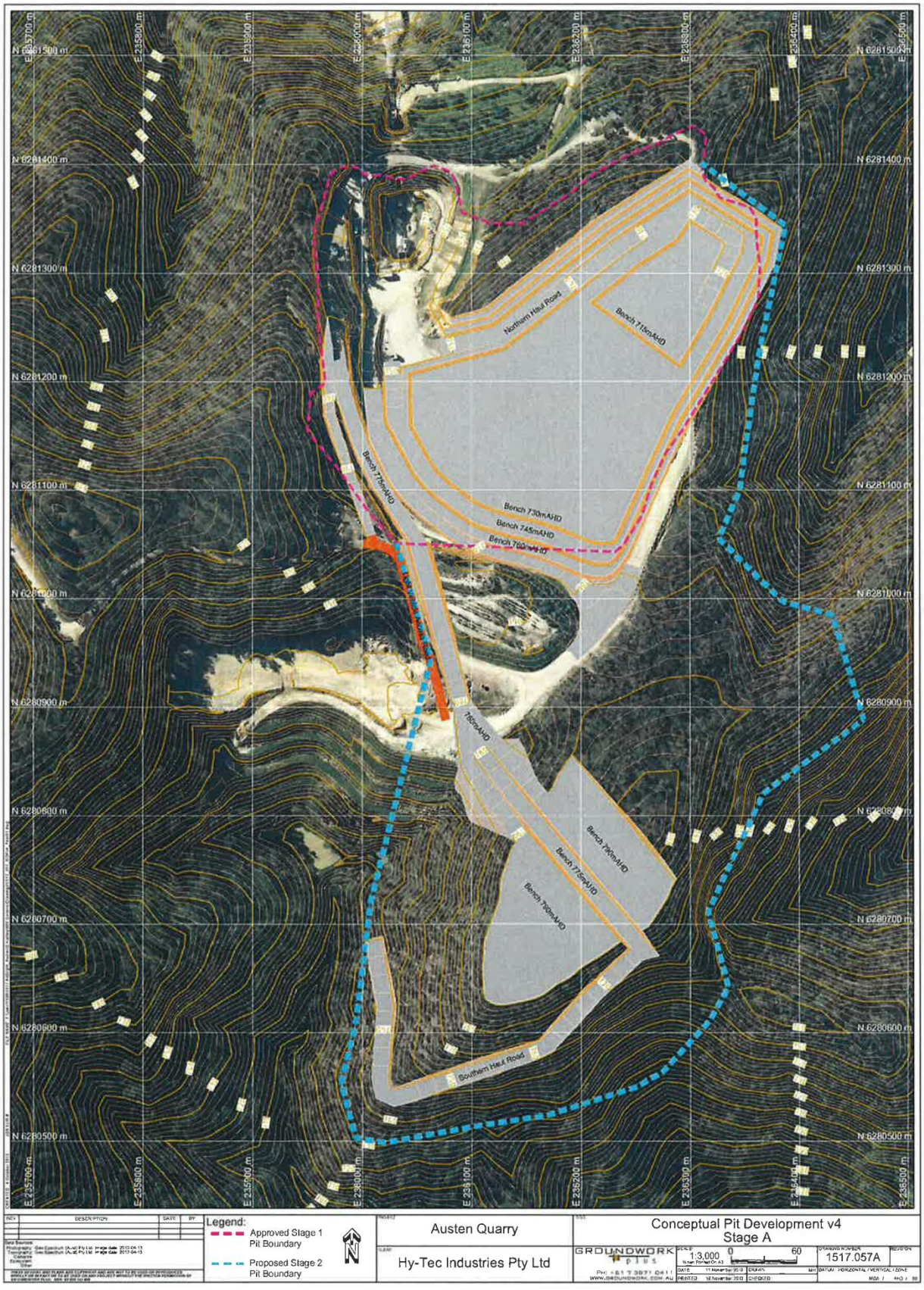

Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 5
PSM167-007R
Figure 9
Pells Sullivan Meynink
PSM
Emplacement Phase 5
Access from northern haul road
Lift from 780mAHD
Final landform slope at 10m lifts
1:1 Vertical and Horizontal Scale
Section Scale (m)
0
50
100
Northern Haul Road
Extraction Limit
Plan Scale (m)

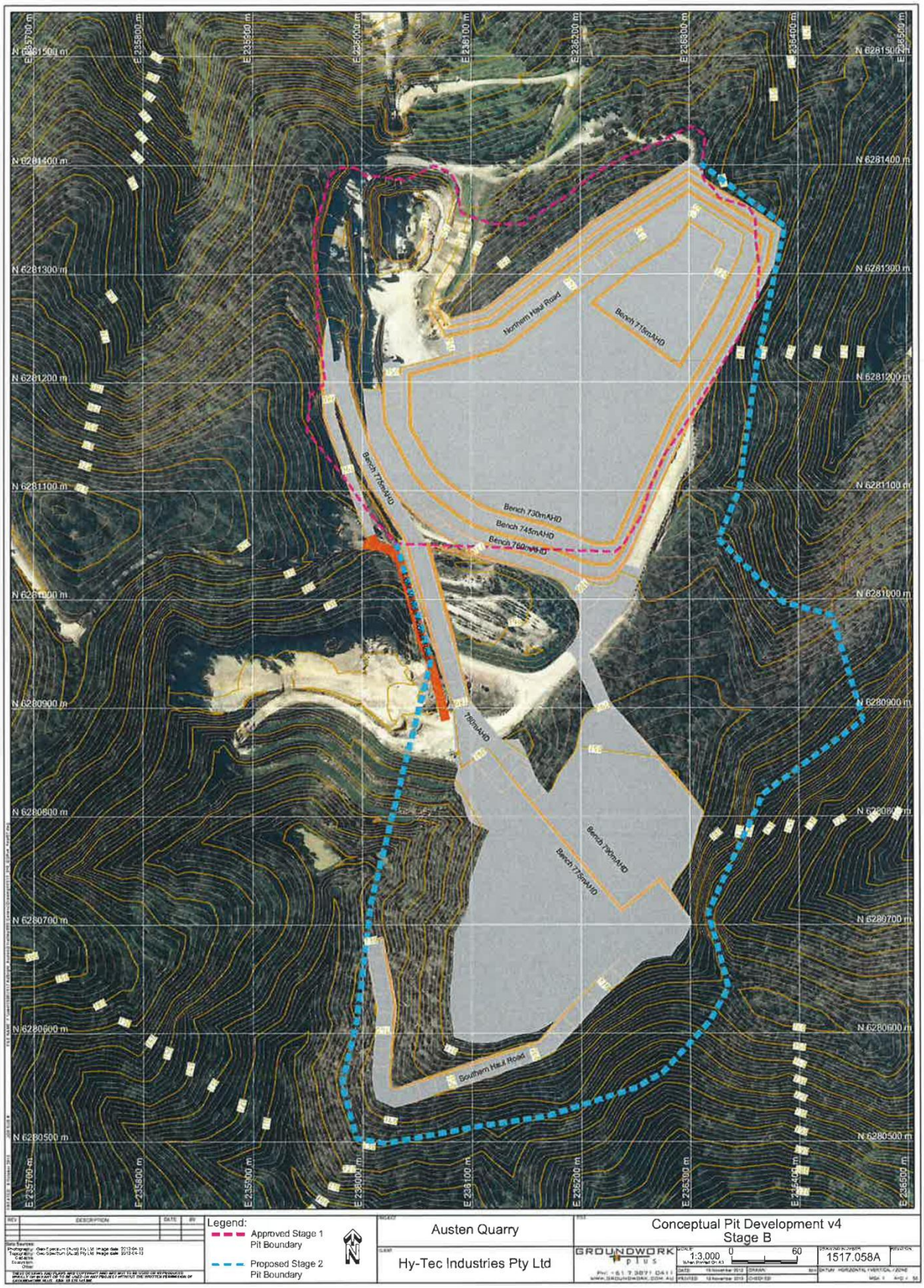

Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 6
PSM167-007R
Figure 10
Pells Sullivan Meynink
PSM
Emplacement Phase 6
Access from northern haul road
Lift from 790mAHD
Final landform slope at 10m lifts
1:1 Vertical and Horizontal Scale
Section Scale (m)
0
50
100
Northern Haul Road
Extraction Limit
Plan Scale (m)

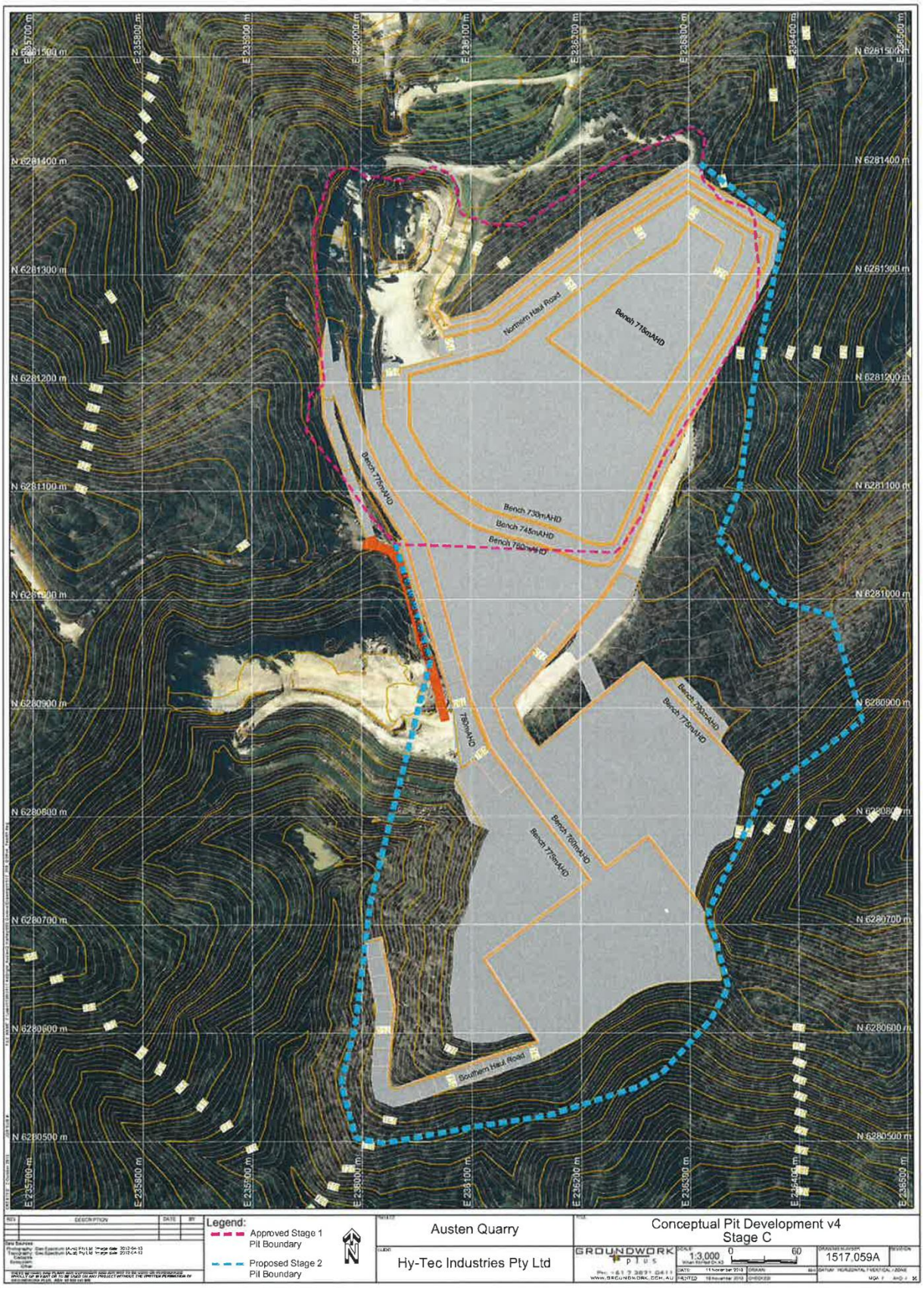

Northern Haul Road
Extraction Limit
790
800
810
Section Scale (m)
0
50
100
Section Scale (m)
0
50
100
1:1 Vertical and Horizontal Scale
Emplacement Phase 7 - Rehabilitation of Stage 2 Emplacement
Access from northern haul road
Build natural landform at 10m lifts
PSM
Pells Sullivan Meynink
Hy-Tec Industries Pty Limited
Austen Quarry, Hartley
Stage 2 Overburden Emplacement
EMPLACEMENT PHASE 7, REHABILITATION OF STAGE 2 EMPLACEMENT
PSM167-007R
Figure 11

# APPENDIX A

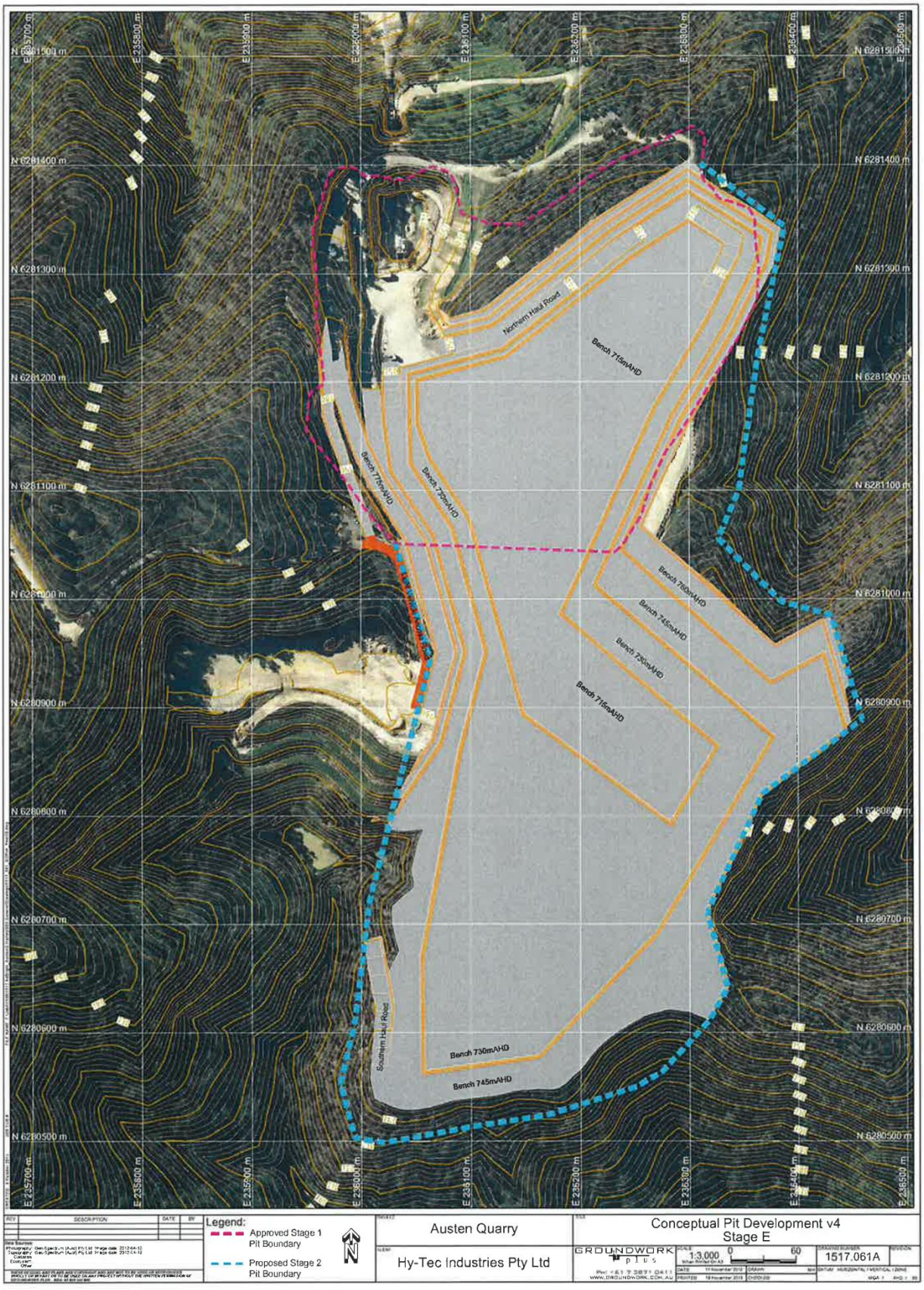
# QUARRY PIT DEVELOPMENT PLANS

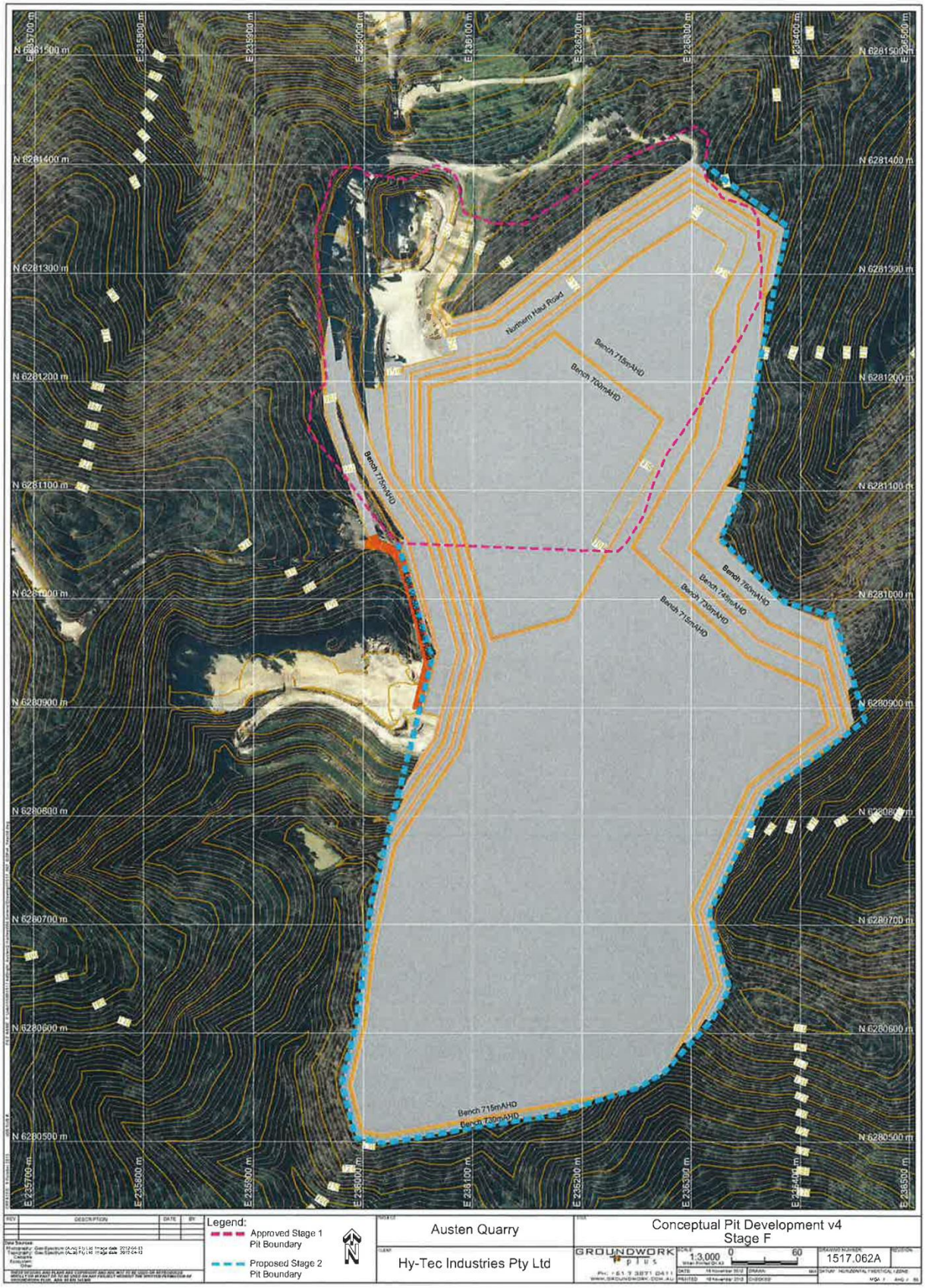

Northern Haul Road
Bench 715mAHD
Bench 775mAHD
Bench 730mAHD
Bench 745mAHD
Bench 760mAHD
780mAHD
Bench 790mAHD
Bench 775mAHD
Bench 760mAHD
Southern Haul Road
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage A
GROUNDWORK plus
1:3,000
1517.057A


Northern Haul Road
Bench 715mAHD
Bench 775mAHD
Bench 730mAHD
Bench 745mAHD
Bench 760mAHD
780mAHD
Bench 790mAHD
Bench 775mAHD
Southern Haul Road
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage B
GROUNDWORK plus
1:3,000
1517.058A


Northern Haul Road
Bench 715mAHD
Bench 775mAHD
Bench 730mAHD
Bench 745mAHD
Bench 760mAHD
Bench 700mAHD
Bench 715mAHD
Bench 685mAHD
Bench 700mAHD
Bench 715mAHD
Southern Haul Road
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage C
1:3,000
1517.059A


Northern Haul Road
Bench 715mAHD
Bench 775mAHD
Bench 730mAHD
Bench 745mAHD
Bench 760mAHD
Bench 745mAHD
Bench 775mAHD
Bench 760mAHD
Southern Haul Road
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage D
GROUNDWORK plus
1:3,000
1517.060A


Northern Haul Road
Bench 715mAHD
Bench 775mAHD
Bench 760mAHD
Bench 745mAHD
Bench 730mAHD
Bench 715mAHD
Southern Haul Road
Bench 730mAHD
Bench 745mAHD
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage E
GROUNDWORK plus
1:3,000
1517.061A


Northern Haul Road
Bench 715mAHD
Bench 700mAHD
Bench 715mAHD
Bench 730mAHD
Bench 745mAHD
Bench 760mAHD
Bench 715mAHD
Bench 730mAHD
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage F
GROUNDWORK plus
1:3,000
1517.062A


Northern Haul Road
Bench 715mAHD
Bench 700mAHD
Bench 685mAHD
Bench 775mAHD
Bench 780mAHD
Bench 745mAHD
Bench 730mAHD
Bench 715mAHD
Bench 700mAHD
Bench 685mAHD
Bench 655mAHD
Bench 700mAHD
Bench 715mAHD
Bench 730mAHD
Legend:
Approved Stage 1 Pit Boundary
Proposed Stage 2 Pit Boundary
Austen Quarry
Hy-Tec Industries Pty Ltd
Conceptual Pit Development v4 Stage G
GROUNDWORK plus
1:3,000
1517.066A