



Appendix A. Construction: Airborne Noise



A.1 Introduction

Extensive construction would be undertaken to build the Melbourne Metro Rail Project (Melbourne Metro).

The infrastructure proposed to be constructed as part of Melbourne Metro includes:

- Two nine kilometre rail tunnels from South Kensington to South Yarra
- New underground stations at:
 - Arden
 - Parkville
 - CBD North
 - CBD South
 - Domain
- Turnback at West Footscray station.

The project is presented as precincts as follows:

- Precinct 1: Tunnels (outside other precincts) including the Fawkner Park construction work site
- Precinct 2: Western Portal, with the following two design options:
 - Design
 - Alternative Design Options
- Precinct 3: Arden Station
- Precinct 4: Parkville Station
- Precinct 5: CBD North Station
- Precinct 6: CBD South Station
- Precinct 7: Domain Station
- Precinct 8: Eastern Portal
- Precinct 9: Western Turnback (West Footscray station).

The objective of construction noise and vibration management is to avoid subjecting sensitive receivers to unreasonable noise or vibration for the duration of the project. This is to be achieved by following the approach in Section A.2.1.

Construction noise is to be managed in compliance with EPA *Noise Control Guidelines* Publication 1254 (EPA 1254). See Section A.2.2.

Information about construction activity has been provided by MMRA's constructability advisor Advisian. It is anticipated that the construction methodology would evolve and be refined once the Proponent is appointed and detailed construction plans are developed.

The proposed approach to construction is to maximise construction work during Normal Working Hours (as defined in EPA 1254). Works undertaken outside of Normal Working Hours are to comply with the Guideline Noise Levels (as defined in EPA 1254). The exception to this would be *Unavoidable Works* (works which cannot practicably meet the scheduled requirements because the work involves continuous work or would pose an unacceptable risk to life or property, or risk a major traffic hazard).

Unavoidable Works include:

- Railway occupations that must be undertaken 24-hours a day to limit the disruption to the rail network. The railway occupations are proposed to consist of:

- Two occupations of 1 week at the Western Portal and 4 to 5 weekends of 24-hour work (applicable to both design options)
- Two occupations of approximately 1.5 weeks at the Eastern Portal and 5 weekends of 24-hour work
- TBM launch preparation and TBM launch – this work is proposed to be undertaken during Normal Working Hours, however, if it is not completed then it would extend into other periods. This is anticipated to take 4 to 5 weeks at each of the relevant locations
- Concrete pour - this work is proposed to be undertaken during Normal Working Hours, however, if it is not completed then it would extend into other periods. This is anticipated to occur on a regular basis
- Cut and cover construction across Flinders Street is expected to last for 2 to 3 months with a smaller scale operation outside of Normal Working Hours
- TBM removal at Eastern Portal - this work is proposed to be undertaken during Normal Working Hours, however, if it is not completed then it would extend into other periods. This is anticipated to take 4 to 6 weeks in total
- Road occupations:
 - Flinders Street (2 to 3 months)
 - Kensington Road (up to 3 weekends).

A.2 Methodology

A.2.1 Approach

The following approach has been used to assess construction noise:

- Typical construction scenarios and the times at which they are proposed to occur (e.g. during Normal Working Hours or outside of Normal Working Hours) and the locations where construction activities are expected to occur have been provided by Advisian.
- Specific Guideline Noise Levels (as per EPA 1254) based on baseline noise measurements have been determined at sensitive receivers in the vicinity of the construction.
- An acoustic model has been built using the environmental noise modelling software package SoundPLAN. The model in SoundPLAN includes:
 - topography
 - building structures
 - noise sources
 - noise sensitive receivers
 - ground absorption
 - air absorption
- ISO 9613-2:1996 Acoustics – *Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) has been used to predict construction noise levels for typical scenarios of construction activity
- Neutral meteorological conditions have been used. As the sensitive receivers are close to the noise sources, meteorology is not expected to have a significant impact
- Where Guideline Noise Levels are predicted to be exceeded options for alternative construction methodologies and/or mitigation have been considered.



A.2.2 Criteria

It is proposed that the approach in EPA *Noise Control Guidelines* Publication 1254 (EPA 1254) apply to the Melbourne Metro.

The purpose of EPA 1254 is to protect nearby residences from unreasonable noise and it applies to construction activities. EPA 1254 states that *commercial and other premises affected by noise should be considered and reasonable measures implemented to reduce impact on these premises*. EPA 1254 provides recommended hours of operation of a construction work site and Guideline Noise Levels for works undertaken outside of *Normal Working Hours*. Time periods and Guideline Noise Levels are presented in Table A.1.

Table A.1 : Time periods and guideline noise levels

| Time Period | Applicable Hours | Guideline Noise Levels | |
|------------------------|---|--|---|
| | | Up to 18 months after project commencement | 18 months or more after project commencement |
| Normal Working Hours | 7am to 6pm Monday to Friday 7am to 1pm Saturday | No specified Guideline Noise Level - noise reduction measures apply | |
| Weekend / Evening work | 6pm to 10pm Monday to Friday 1pm to 10pm Saturday 7am to 10pm Sunday and Public Holiday | Noise level at any residential premises not to exceed background noise by 10 dB(A) or more | Noise level at any residential premises not to exceed background noise by 5 dB(A) or more |
| Night | 10pm to 7am Monday to Sunday | Noise is to be inaudible within a habitable room of any residential premises | |

Exceptions include Unavoidable Works which are works that cannot practicably meet the schedule requirements because the work involves continuous work (such as a concrete pour) or would otherwise pose an unacceptable risk to life or property, or risk a major traffic hazard. Affected premises should be notified of the intended work, its duration and times of occurrence. The relevant authority must be contacted and any necessary approvals sought.

Specific requirements apply to the construction activities and these are provided in Section A.4 Mitigation.

A.2.3 Guideline Noise Levels

The construction Guideline Noise Levels at specific residential locations are provided in Table A.2 for avoidable work occurring outside of Normal Working Hours.

The Guideline Noise Levels for evening and weekend work are external noise levels and are based on background noise levels, L_{A90} , measured during the evening period.

The requirement at night is for construction noise to be inaudible within a habitable room of residential premises. The specific construction of buildings and the location of habitable rooms are beyond the scope of this assessment. For this assessment an external night time Guideline Noise Level has been determined as follows in order to assess whether a construction scenario is predicted to achieve the requirement of inaudibility. The Proponent may, however, wish to undertake further assessment to include building specific information.

The night Guideline Noise Level is presented as an external Guideline Noise Level based upon the following:

- i. Assume that the ambient noise level in a typical habitable room, such as a bedroom, is approximately 30 dBL_{Aeq} .
- ii. If, inside the building, the construction noise levels are 10 dB below the ambient noise level i.e. 20 dBL_{Aeq} then it is likely that construction noise would be inaudible.

- iii. Typically the loss from outside to inside across a partly open window is 15 dB (Reference: *Guidelines for Community Noise, World Health Organisation, 1999*: assumes that the noise reduction from outside to inside with the window partly open is 15 dB) leading to an external Guideline Noise Level of 35 $dB(A)$.
- iv. If external construction noise at a residence is at least 10 dB below the external ambient noise level then it is likely to be inaudible.

The proposed external Guideline Noise Level would be the greater of '10 dB below the external ambient noise level' or 35 $dB(A)$.

Table A.2 : Construction Guideline Noise Levels for Evening and Night Construction Work

| Locations (Residential) | Evening Guideline Noise Levels $dBL_{Aeq,15 \text{ minutes}}$ | | Night Guideline Noise Level $dBL_{Aeq,30 \text{ minutes}}$ | Comments |
|---|---|--|---|--|
| | Up to 18 months after project commencement | 18 months or more after project commencement | | |
| Precinct 1 – Tunnels | | | | |
| Fawkner Park | 61 | 56 | 55 | Based on noise measurements at 68 Toorak Road |
| Linlithgow Avenue Emergency Access Shaft | 64 | 59 | 58 | Based on noise measurements at the Melburnian Apartments, 250 St. Kilda Road |
| Fawkner Park Emergency Access Shaft | 61 | 56 | 55 | Based on noise measurements at 68 Toorak Road |
| Precinct 2 – Western Portal | | | | |
| | 60 | 55 | 51 | Based on noise measurements at 138 Kensington Road |
| | 53 | 48 | 43 | Based on noise measurements at 1 Altona Street |
| Precinct 3 – Arden Station | | | | |
| | 60 | 55 | 46 | Based on noise measurements at 141 Laurens Road |
| Precinct 4 – Parkville Station | | | | |
| | 69 | 64 | 51 | Based on noise measurements at the Royal Melbourne Hospital |
| Precinct 5 – CBD North Station | | | | |
| | 70 | 65 | 48 | Based on noise measurements at QV Apartments, 300 Swanston Street |
| Precinct 6 – CBD South Station | | | | |
| | 70 | 65 | 55 | Based on noise measurements at Uni Lodge, 238 Flinders Street, Melbourne |
| Precinct 7 – Domain Station | | | | |
| | 63 | 58 | 49 | Based on noise measurements at 2-14 Albert Road |
| Precinct 8 – Eastern Portal | | | | |
| | 56 | 51 | 44 | Based on noise measurements at 139 Osborne Street |
| | 51 | 46 | 52 | Based on noise measurements at 6 William Street |
| | 48 | 43 | 35 | Based on noise measurements at 19 William Street |
| Precinct 9 – Western Portal Turnback | | | | |
| | Only Unavoidable Work would be undertaken outside of Normal Working Hours | | | |



A.2.4 Model

An acoustic model has been built using the environmental noise modelling software package SoundPLAN version 7.2. The model in SoundPLAN includes:

- Topography
- Building structures
- Noise sources
- Noise sensitive receivers
- Ground absorption
- Air absorption
- Meteorology.

The ISO 9613-2:1996 *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* (ISO 9613-2) methodology would be used to predict construction noise levels for typical scenarios of construction activity.

A.2.5 Assumptions

The following assumptions have been made:

- All plant for each scenario is operating concurrently. This is a conservative approach as in practice this is unlikely to occur
- Noise sensitive receivers are based upon the land use survey prepared for Melbourne Metro
- Construction vehicles on public roads are not included for this assessment.

A.2.6 Source Noise Levels

The source noise levels used in the acoustic modelling are provided in Table A.3.

Table A.3 : Sound Power Levels of Construction Equipment

| Equipment | Sound Power Level (SWL) (dB) | | | | | | | | SWL dB(A) | Source of data |
|--|------------------------------|-----|-----|-----|-----|-----|-----|-----|--------------|---------------------------------------|
| | Octave Band Frequency (Hz) | | | | | | | | | |
| | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | | |
| Material Delivery Trucks, Forklifts | 100 | 97 | 94 | 92 | 88 | 87 | 86 | 84 | 95 | Jacobs Database |
| Water Treatment Plant, Bentonite | 98 | 103 | 88 | 86 | 93 | 94 | 87 | 90 | 99 | DEFRA Noise Database 2008 |
| Grouting Plant | 104 | 100 | 98 | 95 | 91 | 91 | 89 | 88 | 99 | Jacobs Database |
| Concrete Pump | 112 | 104 | 98 | 99 | 101 | 101 | 94 | 86 | 106 | DEFRA Noise Database 2008 |
| Concrete Trucks | 111 | 102 | 94 | 97 | 98 | 106 | 88 | 83 | 108 | DEFRA Noise Database 2008 |
| Spoil Trucks | 101 | 92 | 83 | 83 | 88 | 84 | 78 | 71 | 91 | DEFRA Noise Database 2008 |
| 500/600t Crane | 108 | 107 | 101 | 102 | 101 | 101 | 92 | 83 | 106 | DEFRA Noise Database 2008 |
| Crane (Gantry/Crawler) | 101 | 99 | 96 | 98 | 94 | 91 | 82 | 77 | 99 | DEFRA Noise Database 2008 |
| Jackhammer | 110 | 103 | 101 | 96 | 91 | 95 | 108 | 97 | 110 | DEFRA Noise Database 2008 |
| Excavator With Rock Breaker | 109 | 108 | 108 | 111 | 110 | 107 | 104 | 101 | 114 | DEFRA Noise Database 2008 |
| Excavator | 113 | 106 | 105 | 105 | 101 | 99 | 96 | 91 | 107 | DEFRA Noise Database 2008 |
| Roadheader | 125 | 125 | 119 | 120 | 112 | 110 | 102 | 92 | 120 | Jacobs Database |
| Back-Up Power Generators | 85 | 99 | 93 | 89 | 88 | 84 | 80 | 72 | 93 | DEFRA Noise Database 2008 |
| Cooling Towers | 88 | 91 | 90 | 88 | 84 | 81 | 75 | 67 | 90 | Jacobs Database |
| Ventilation Fans | 45 | 60 | 68 | 78 | 81 | 83 | 76 | 63 | 87 | Jacobs Database |
| TBM | 109 | 111 | 109 | 109 | 106 | 104 | 102 | 95 | 112 | Jacobs Database |
| Desanding Plant | 108 | 109 | 109 | 111 | 104 | 103 | 95 | 90 | 111 | Jacobs Database |
| D-wall Rig | 102 | 99 | 91 | 88 | 84 | 82 | 78 | 72 | 91 | DEFRA Noise Database |
| Piling Rig (Bored) | 112 | 120 | 109 | 108 | 106 | 104 | 96 | 89 | 111 | DEFRA Noise Database |
| Drilling Rig | 113 | 121 | 106 | 107 | 108 | 107 | 104 | 102 | 114 | DEFRA Noise Database |
| Loaders/Back hoe | 102 | 94 | 92 | 92 | 91 | 88 | 87 | 78 | 96 | DEFRA Noise Database |
| Concrete Agitator Idling | 95 | 86 | 87 | 92 | 88 | 87 | 84 | 72 | 94 | Jacobs Database |
| Concrete Agitator driving inside plant | 99 | 88 | 84 | 85 | 88 | 87 | 80 | 71 | 92 | Jacobs Database |
| Strand Feeder | 80 | 78 | 80 | 82 | 93 | 92 | 91 | 89 | 98 | Jacobs Database |
| Grinder/Hand Held Power Tools | 76 | 74 | 80 | 85 | 97 | 95 | 100 | 96 | 104 | Jacobs Database |
| 1500 Super T Beam Concrete Mould, Normal Operation | 122 | 134 | 115 | 111 | 107 | 106 | 107 | 99 | 120 | Jacobs Database |
| Rail Cutter (Husqvarna K 1260 Rail) | 114 | 106 | 98 | 97 | 111 | 112 | 110 | 103 | 117 | Jacobs Database / Husqvarna Catalogue |

A.2.7 Construction scenarios

The construction scenarios are detailed in Table A.4.



| Precinct | Scenario | Working Hours | Construction Scenario | Description / Key Activities | Key Noise Generating Equipment | | | | | | | | | | | | | | | | |
|-----------------------------|----------|----------------------------|---|---|--------------------------------|--------------|-----------------|-----|------------------|----------------|--------------------------|------------|-----------|------------------------|-------------|------------------------|-----------------------------------|-----------------|---------------|----------------|-------------------------|
| | | | | | Piling Rig (bored) | D-wall Plant | Desanding Plant | TBM | Ventilation Fans | Cooling Towers | Back-up power generators | Roadheader | Excavator | Excavator/Rock Breaker | Jack Hammer | Crane (Gantry/Crawler) | Spoil trucks (loading and idling) | Concrete trucks | Concrete pump | Grouting plant | Concrete batching plant |
| 3. Arden Station | | | | | | | | | | | | | | | | | | | | | |
| Design | A | Normal Working Hours | Station box (piling or diaphragm wall), excavation, construction - no roof deck | Piling, excavation, spoil; removal and concrete pour | o | o | o | | | | | | | | o | o | | | | | o |
| | B | 24 hours Unavoidable Works | TBM preparation for launch | TBM preparation for launch | | | | o | | | | | | | | | | | | o | o |
| | C | 24 hours Unavoidable Works | TBM launch | TBM workshops, concrete segment production, general construction, site laydown and office areas | | | o | | o | o | o | | | | o | | | | o | o | o |
| | D | 24 hours | Site works | TBM workshops, concrete segment production, general construction, site laydown and office areas | | | | | | | | | | | o | | | | | o | |
| 4. Parkville Station | | | | | | | | | | | | | | | | | | | | | |
| Design | A | Normal Working Hours | Station box piling (or diaphragm wall), excavation and construction with no roof deck | Piling, excavation, spoil removal | o | o | o | | | | | | | | o | | | | | | o |
| | B | 24 hours | Station box piling (or diaphragm wall), excavation and construction with roof deck | Piling, excavation, rock breaking, spoil removal | | | | | | | | | | | o | o | | | | | o |
| | C | Normal Working Hours | Piped roof construction of access across Royal Parade to VCCC | Underground roof piping from both ends of Royal Parade, bored piling | o | | | | | | | | | | | | | | | | o |
| | D | 24 hours Unavoidable Works | Concrete pour | | | | | | | | | | | | | | o | o | | | |
| 5. CBD North | | | | | | | | | | | | | | | | | | | | | |
| | A | Normal Working Hours | Demolition | Demolition of buildings corner of Swanston and Latrobe streets | | | | | | | | | | | o | o | | | | | o |
| | B | Normal Working Hours | Shaft construction | Piling/ Diaphragm wall, excavation, spoil removal and concrete pour | o | o | o | | o | | | | | | o | o | | | o | o | o |
| | C(i) | 24 hours | Cavern construction | Excavation, cavern construction, spoil removal, concrete delivery | | | | | o | | | | | o | o | o | | | o | o | o |



| Precinct | Scenario | Working Hours | Construction Scenario | Description / Key Activities | Key Noise Generating Equipment | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------|----------|----------------------------|---|---|--------------------------------|--------------|-----------------|-----|------------------|----------------|--------------------------|------------|-----------|------------------------|-------------|------------------------|-----------------------------------|-----------------|---------------|----------------|-------------------------|----------------------------------|--|----------------------------|--|---|---|---|
| | | | | | Piling Rig (bored) | D-wall Plant | Desanding Plant | TBM | Ventilation Fans | Cooling Towers | Back-up power generators | Roadheader | Excavator | Excavator/Rock Breaker | Jack Hammer | Crane (Gantry/Crawler) | Spoil trucks (loading and idling) | Concrete trucks | Concrete pump | Grouting plant | Concrete batching plant | Water treatment plant, bentonite | Material Delivery trucks, unloading (steel components) Forklifts | Other specialist equipment | | | | |
| | C(ii) | 24 hours | Cavern construction | Excavation, cavern construction, spoil removal, concrete delivery, no rock breaking, roadheader submerged. | | | | | | o | | | | | | o | | | o | o | | | o | | | o | o | |
| | D | 24 hours Unavoidable Works | Concrete pour | | | | | | | | | | | | | | | | | o | o | | | | | | | |
| 6. CBD South | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design | A | Normal Working Hours | Demolition | Demolition of buildings | | | | | | | | | | | | o | o | | o | o | | | | | | | | o |
| | B | Normal Working Hours | Shaft construction | Piling/ Diaphragm wall, excavation, spoil removal and concrete pour | o | o | o | | o | | | | | | | o | o | | o | o | | | | | | | o | o |
| | C(i) | 24 hours | Cavern construction | Excavation, cavern construction, spoil removal, concrete delivery | | | | | o | | | | o | | | o | | | o | o | | | | | | | o | o |
| | C(ii) | 24 hours | Cavern construction | Excavation, cavern construction, spoil removal, concrete delivery, no rock breaking, road-header submerged. | | | | | o | | | | | | | o | | | o | o | | | o | | | | o | o |
| | D | 24 hours Unavoidable Works | Cut and cover construction of access across Flinders Street to Flinders Street Station | Piling/ Diaphragm wall, excavation, spoil removal and concrete pour | o | o | o | | | | | | | | | o | | | o | o | | | o | | | | | o |
| | E | 24 hours Unavoidable Works | Flinders Street Station access works | Breaking through entrance into Flinders Street Station | | | | | | | | | | | | | | o | | o | | | | | | | | o |
| | F | 24 hours Unavoidable Works | Concrete pour | | | | | | | | | | | | | | | | | | o | o | | | | | | |
| 7. Domain | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design | A(i) | Normal Working Hours | Shaft construction and station box piling (or diaphragm wall), excavation and construction with no roof deck. | Piling, excavation, spoil removal and concrete pour | o | o | o | | | | | | | | | o | | | o | o | o | o | o | | | | o | |
| | A(ii) | Normal Working Hours | Shaft construction and station box piling (or diaphragm wall), excavation and construction with no roof deck. | Piling, excavation, spoil removal and concrete pour | o | o | o | | | | | | | | | o | | | o | o | o | o | o | | | | o | |



A.3 Results

A.3.1 Precinct 1: Tunnels

Above ground construction in the Tunnels precinct would occur at:

- Fawkner Park construction work site
- Linlithgow Avenue emergency access shaft
- Fawkner Park emergency access shaft.

The construction scenarios for Precinct 1 are provided in Table A4.

Fawkner Park Construction Site

Scenario A is for Shaft construction. These works are proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply to Normal Working Hours.

Scenario B is for the TBM launch preparation and Scenario C is for the TBM launch. These works are proposed to be undertaken during the Normal Working Hours and Guideline Noise Levels do not apply. If these works are not completed during Normal Working Hours then they would need to be continued until complete. This may require work outside of Normal Working Hours. Such work would be classed as Unavoidable Work and Guideline Noise Levels do not apply. It is anticipated that this work would only occur twice for a period of four to five weeks during the construction period.

Construction noise levels without additional mitigation have been predicted for Scenarios A, B and C and the results are provided in the following figures.

Although works are not anticipated outside of Normal Working Hours, other than Unavoidable Works, if they are undertaken then the specific Guideline Noise Levels provided in Table A.2 would apply.

Linlithgow Avenue Emergency Access Shaft

Scenario A is for Shaft construction. This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Construction noise levels without additional mitigation have been predicted for Scenario A in the following figures.

Although works are not anticipated outside of Normal Working Hours, other than Unavoidable Works, if they are undertaken then the specific Guideline Noise Levels provided in Table A.2 would apply.

Fawkner Park Emergency Access Shaft

Scenario A is for Shaft construction. This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Construction noise levels without additional mitigation have been predicted for Scenario A and the results are provided in the following figures.

Although works are not anticipated outside of Normal Working Hours, other than Unavoidable Works, if they are undertaken then the specific Guideline Noise Levels provided in Table A.2 would apply.



Figure A.1: Fawcner Park Construction Scenario A - Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours



Figure A.2: Fawcner Park Construction Scenario B - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

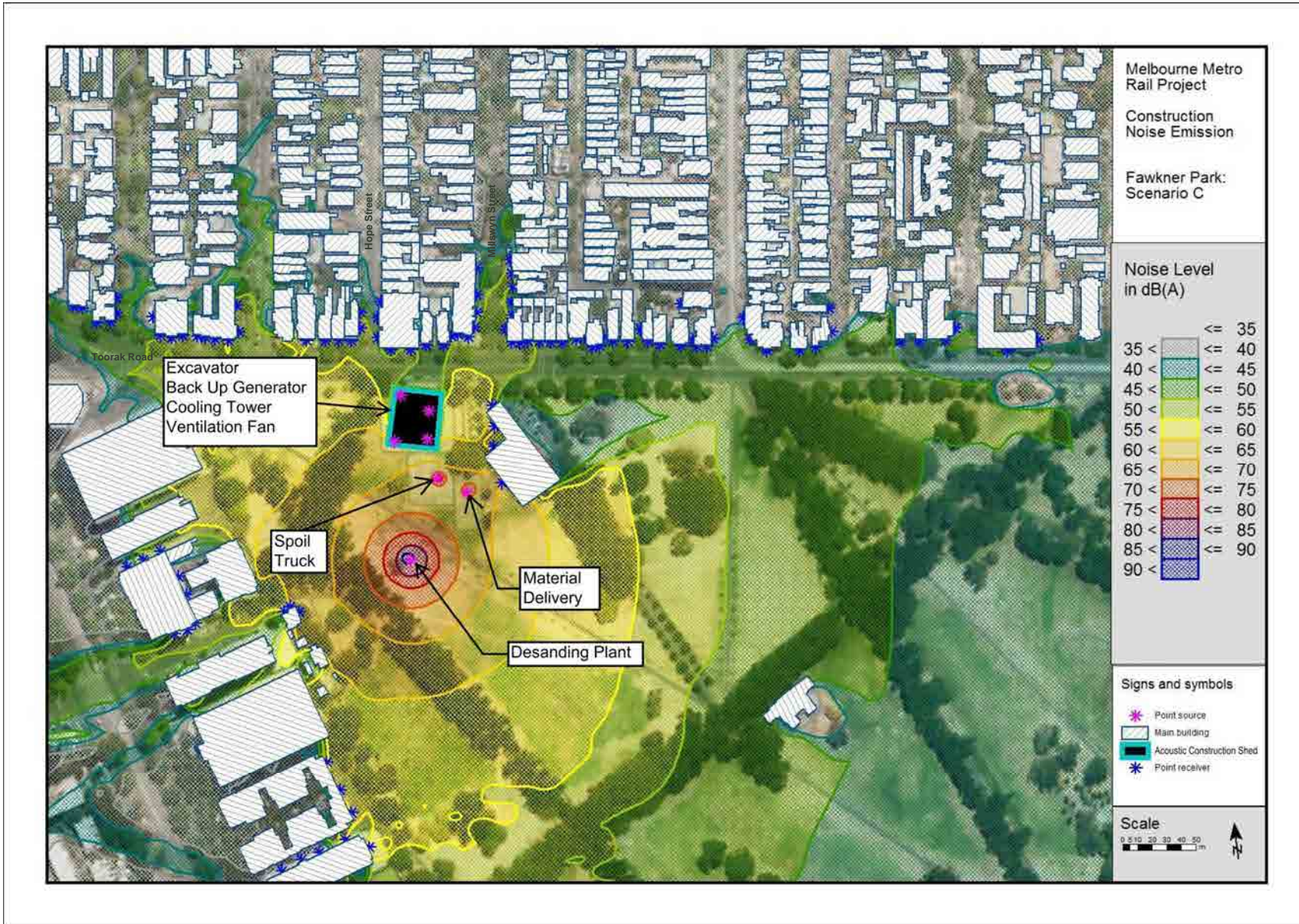


Figure A.3: Fawkner Park Construction Scenario C - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

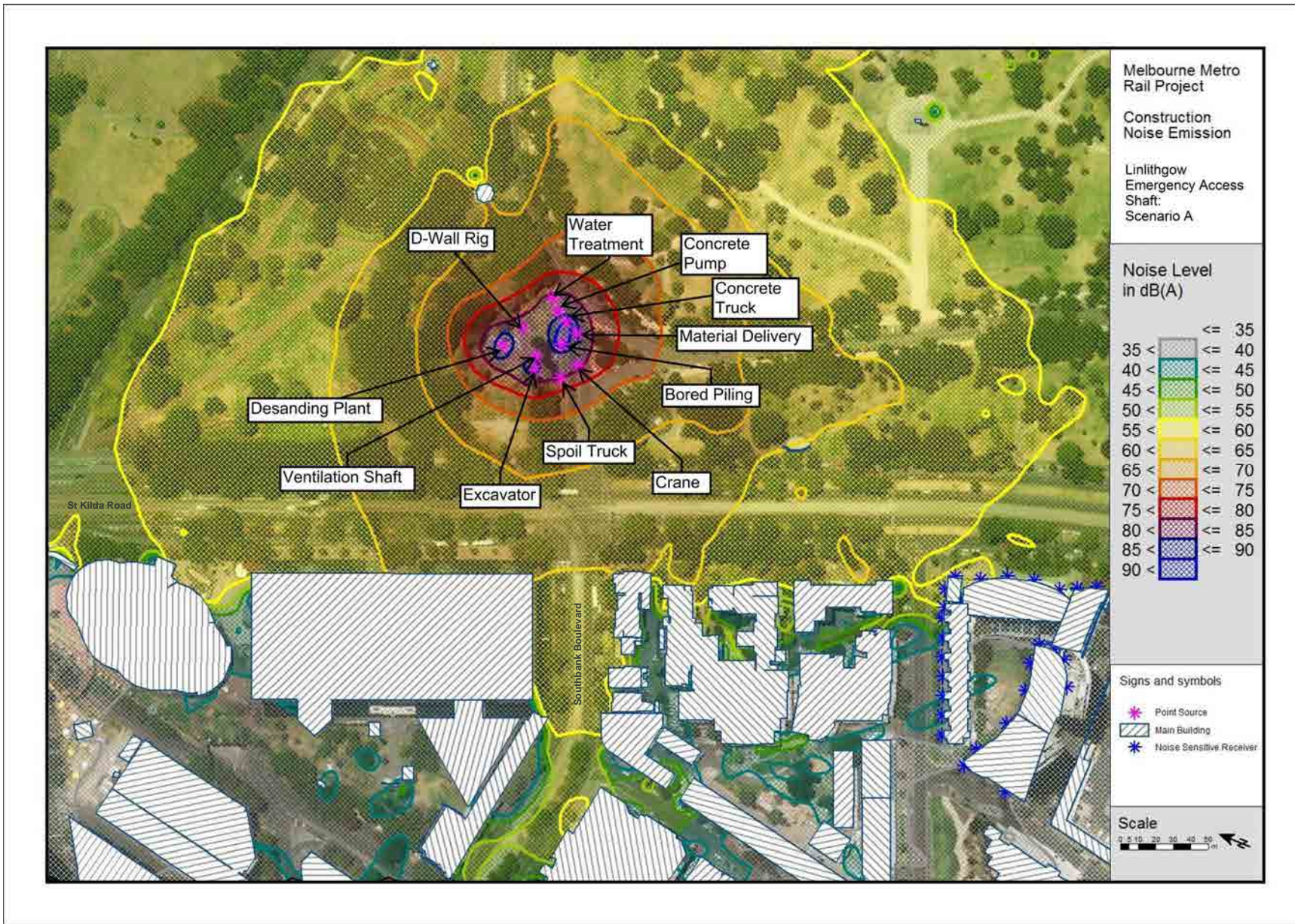


Figure A.4: Linlithgow Emergency Access Shaft Construction Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours



Figure A.5: Fawkner Park Emergency Access Shaft Construction Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours



A.3.2 Precinct 2: Western Portal

Noise sensitive receivers in the vicinity of the construction activities include:

- The pavilion at the JJ Holland reserve
- Residential locations in the vicinity of the portal and construction work sites including residences on:
 - Ormond Street
 - Altona Street
 - Tennyson Street
 - Kensington Road
 - Hobsons Road.

A freight terminal, owned by VicTrack, is located to the south of the construction.

A.3.2.1 Design

For the Design a number of properties on Childers Street would be acquired and demolished for the Melbourne Metro.

The construction scenarios for Precinct 2: Design, are provided in Table 2.4.

Scenario A is a rail occupation (24 hours). This work is classed as Unavoidable Work due to the impact on the rail network and consequently Guideline Noise Levels do not apply. This scenario is anticipated to occur twice for one week periods and for four to five weekends over the construction period. Two scenarios have been modelled for Scenario A:

- Scenario A(i) outside of Normal Working Hours: excludes cutting of the rail tracks
- Scenario A(ii) during Normal Working Hours: includes cutting of the rail tracks

Scenario B is for the Decline Structure and TBM removal. This work is proposed to be undertaken during Normal Working Hours and would only occur outside of Normal Working Hours if the TBM removal was not completed during Normal Working Hours. This work would be classed as Unavoidable Work and Guideline Noise Levels do not apply. This construction activity is anticipated to occur twice for a total of five to six weeks over the construction period.

Scenario C is for Track work preparation and cut and cover. This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Although works are not anticipated outside of Normal Working Hours, other than Unavoidable Works, if they are undertaken then the Guideline Noise Levels in Table A.2 would apply.

Construction noise levels without additional mitigation have been predicted for Scenarios A(i) and A(ii), B and C and the results are provided the following figures.

A.3.2.2 Alternative Design Options

The construction scenarios for Precinct 2: Alternative Design Options are provided in Table 2.4. For the variation the residence at 135 Ormond Street near the Western Portal would be acquired and demolished.

Scenario A is a road occupation (24 hours). This work is classed as Unavoidable Work due to the impact on local roads (with the closure of Kensington Road) and consequently Guideline Noise Levels do not apply. This scenario is anticipated to occur up to three weekends over the construction period.

Scenario B is a rail occupation. This is Unavoidable Work due to the impact on the rail network and Guideline Noise Levels do not apply. This scenario is anticipated to occur twice for one week periods and for four to five weekends over the construction period. Two scenarios have been modelled for Scenario A:

- Scenario B(i) outside of Normal Working Hours: excludes cutting of the rail tracks
- Scenario B(ii) Normal Working Hours: includes cutting of the rail tracks.

Scenario C is for the Decline Structure and Shaft Construction. This work is proposed to be undertaken during is a rail occupation (24 hours). This work is classed as Unavoidable Work due to the impact on the rail network and consequently Guideline Noise Levels do not apply. This construction activity is anticipated to occur twice for a total of five to six weeks over the construction period.

Scenario D is for the TBM removal. This work is proposed to be undertaken during Normal Working Hours. If this work is not completed during Normal Working Hours then it would need to continue outside of Normal Working Hours until it is complete. This work would be classed as Unavoidable Work. It is anticipated that this would four to six weeks over the construction period.

Although works are not anticipated outside of Normal Working Hours, other than Unavoidable Works, if they are undertaken then the Guideline Noise Levels in Table A.2 would apply.

Construction noise levels without additional mitigation have been predicted for Scenarios A, B, C and D and the results are provided in the following figures.



Figure A.6: Western Portal Construction – Design, Scenario A(i) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

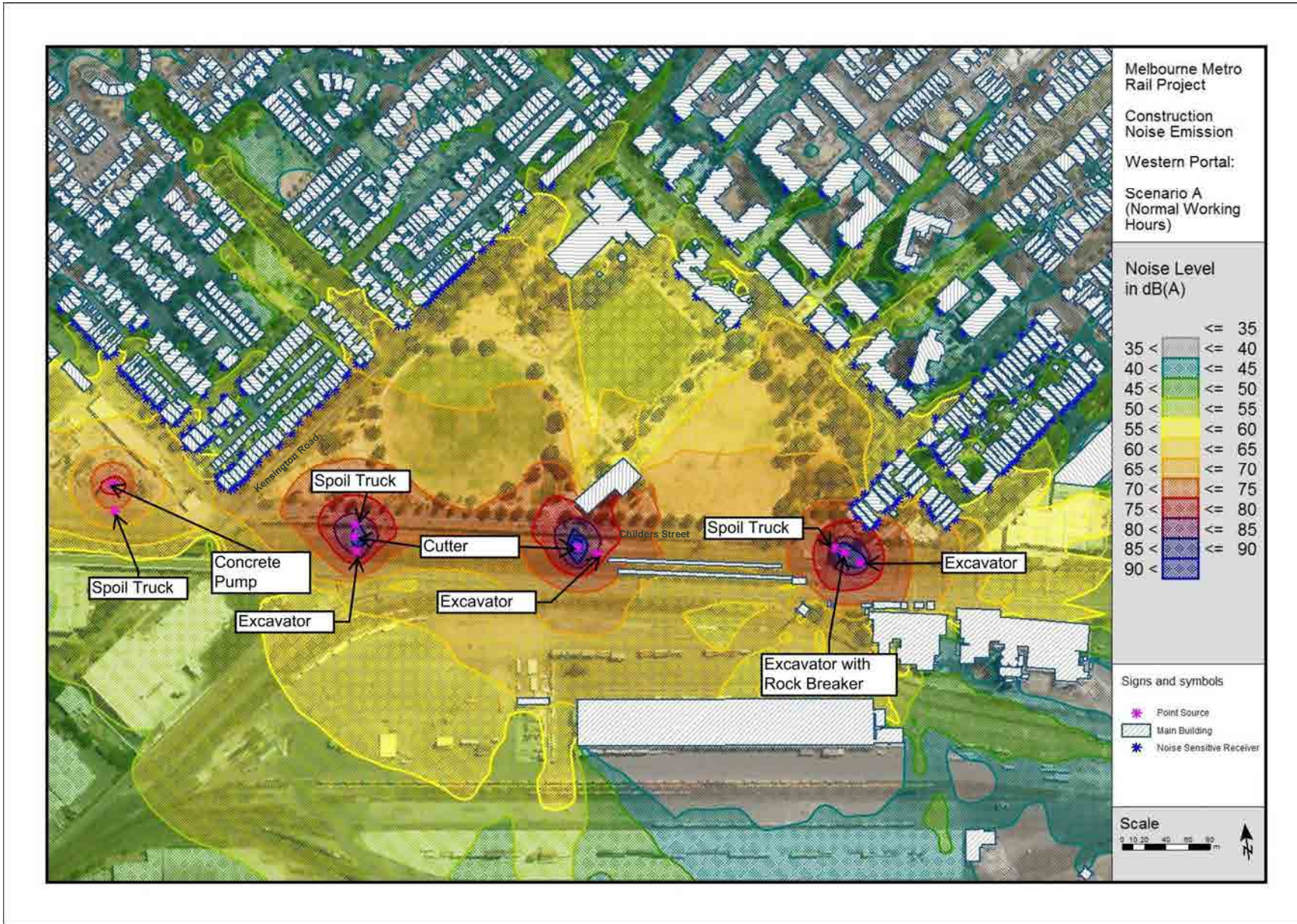


Figure A.7: Western Portal Construction - Design, Scenario A(ii) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours to allow for rail cutting activities

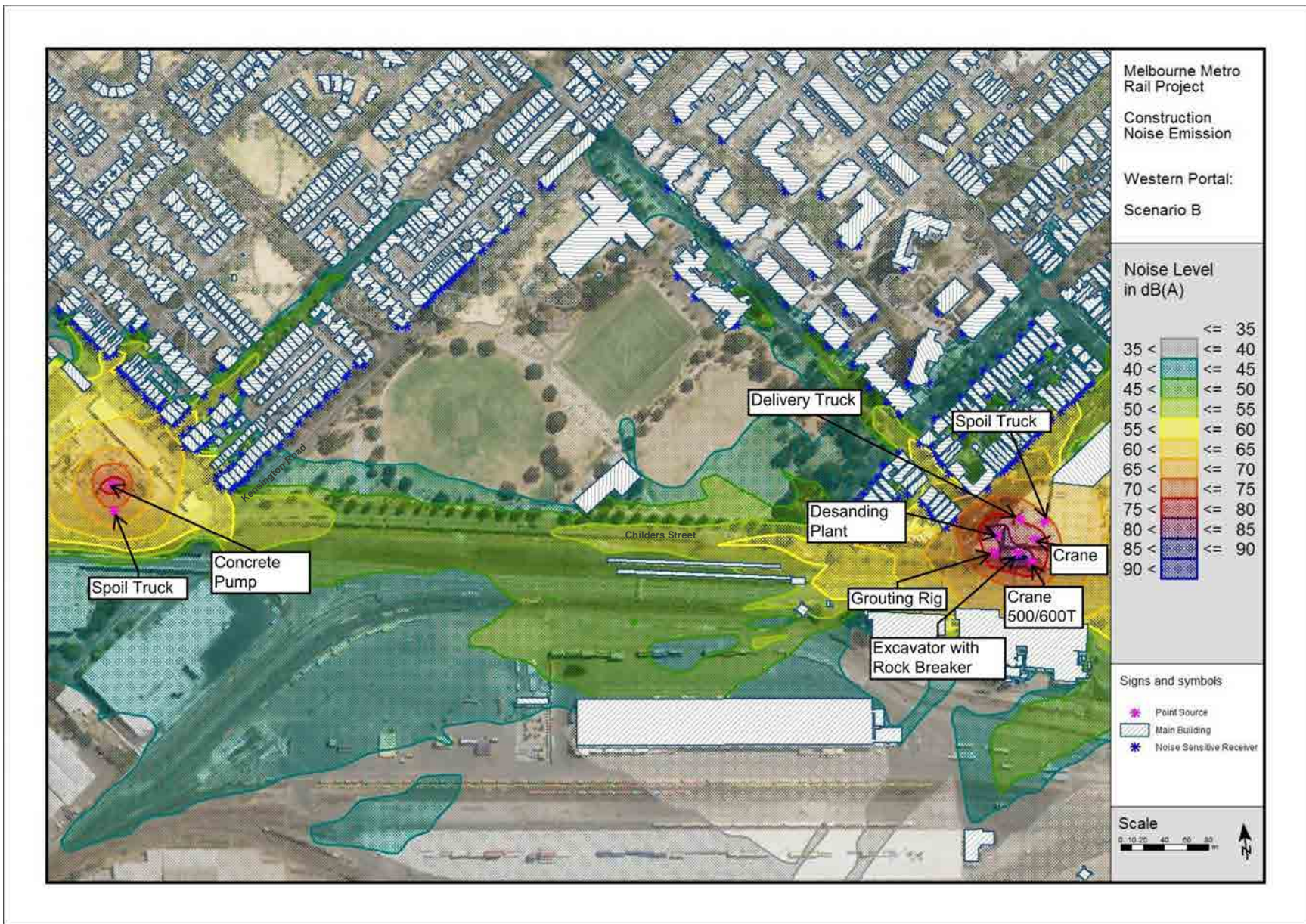


Figure A.8: Western Portal Construction – Design, Scenario B - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works



Figure A.9: Western Portal Construction - Design, Scenario C - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours



Figure A.10: Western Portal Construction - Alternative Design Options, Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

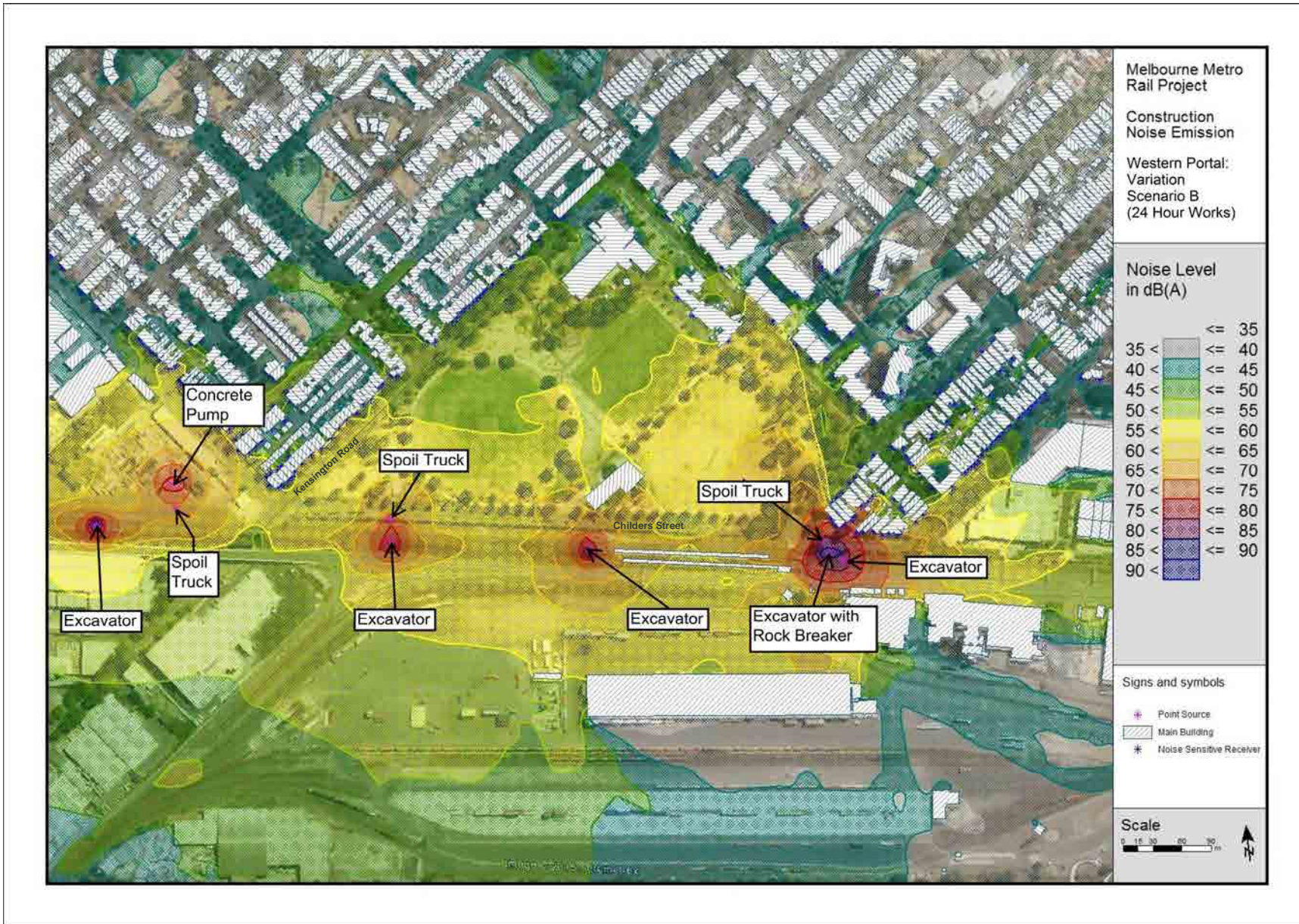


Figure A.11: Western Portal Construction - Alternative Design Options, Scenario B(i) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works



Figure A.12: Western Portal Construction - Alternative Design Options, Scenario B(ii) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours to allow for rail cutting activities

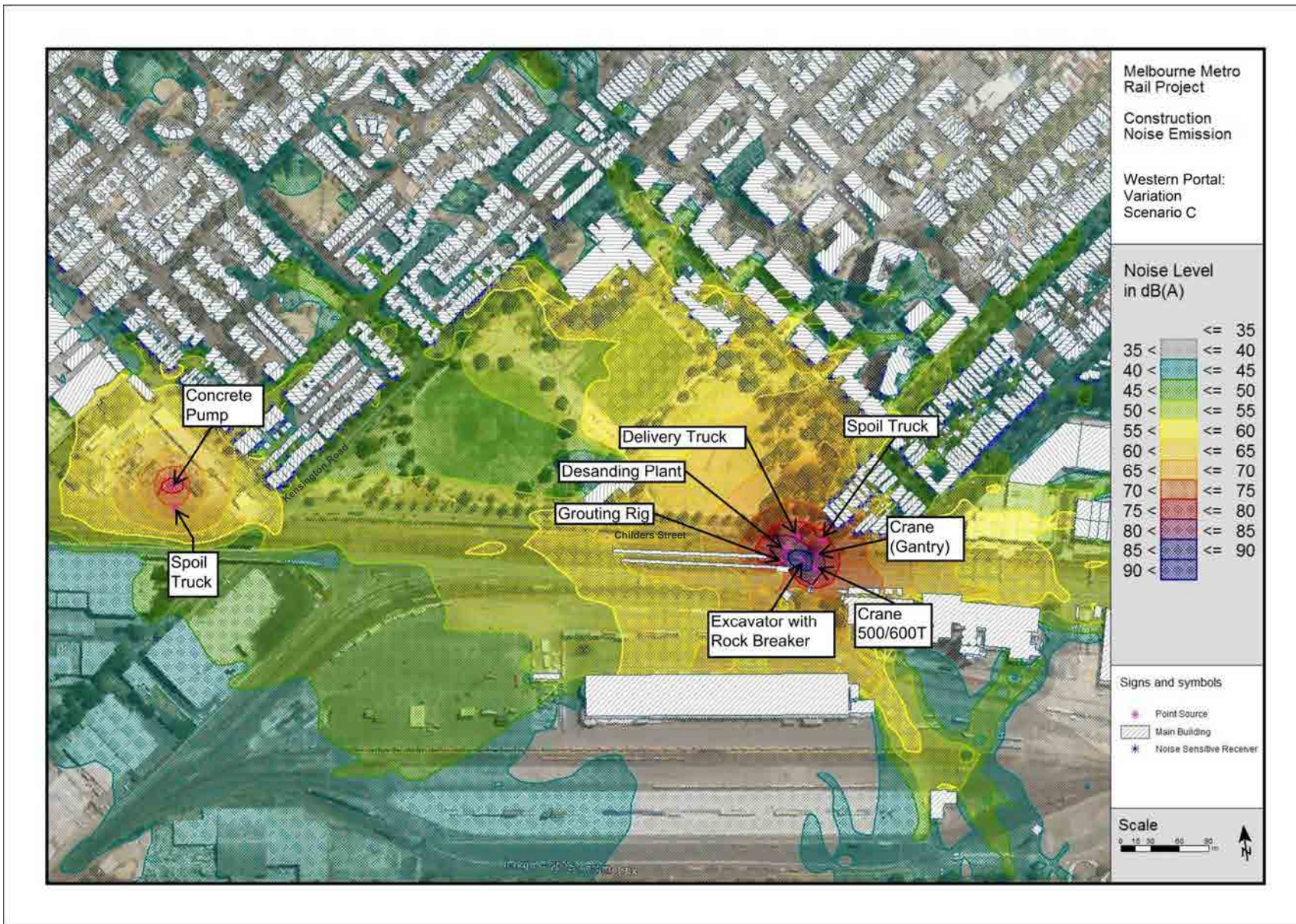


Figure A.13: Western Portal Construction – Alternative Design Options, Scenario C - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours

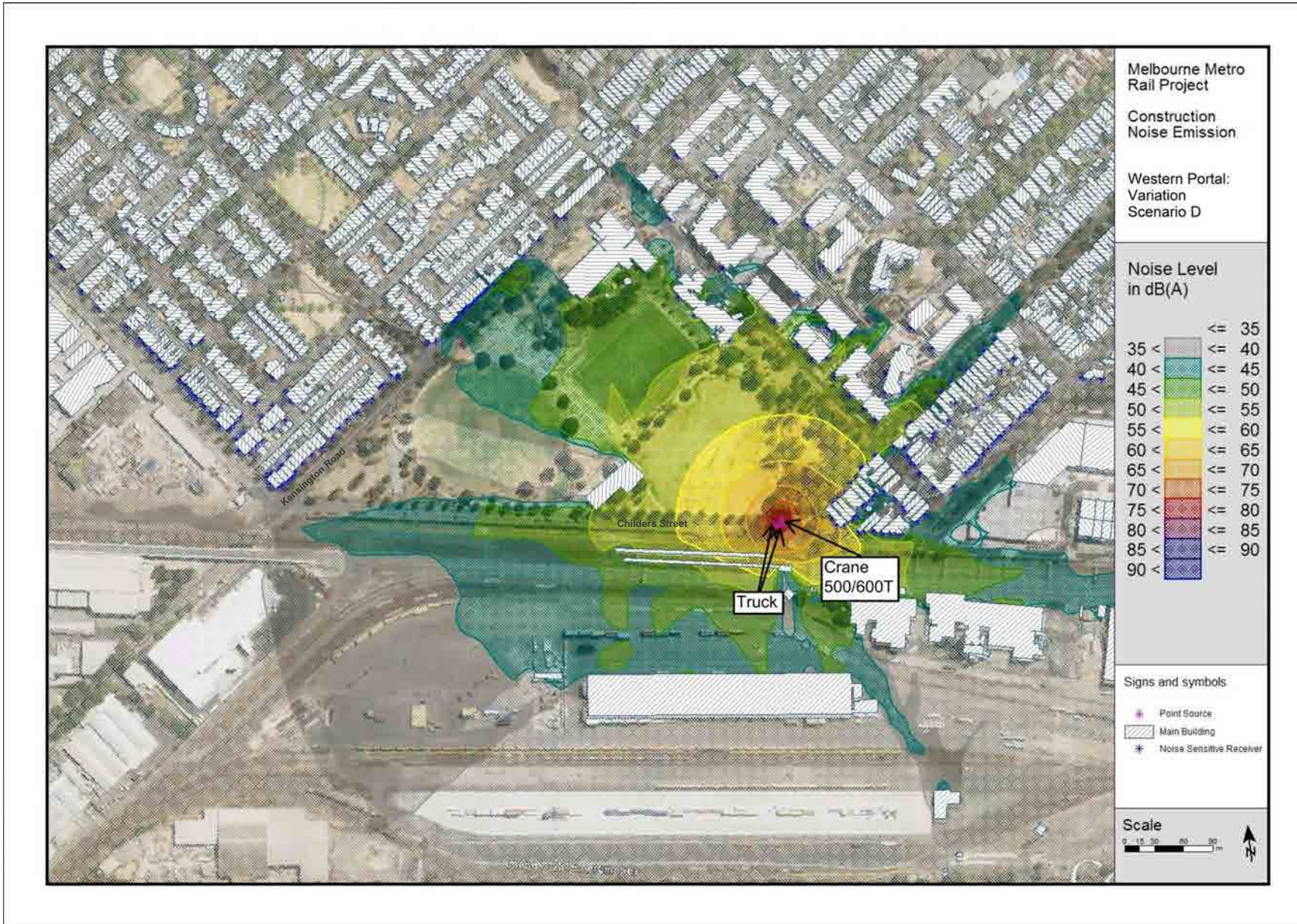


Figure A.14: Western Portal Construction – Alternative Design Options, Scenario D - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works



A.3.3 Precinct 3: Arden Station

Noise sensitive receivers in the vicinity of the construction activities include:

- Residential locations on:
 - Laurens Street
 - Munster Terrace
 - Stawell Street
 - Queensbury Street West
- Pavilions at the North Melbourne Recreational Centre.

The construction scenarios for Precinct 3 are provided in Table A.4.

Scenario A is for Station box construction. This work is proposed to be undertaken during the Normal Working Hours and Guideline Noise Levels do not apply.

Scenario B is for the TBM launch preparation and Scenario C is for the TBM launch. These works are proposed to be undertaken during the Normal Working Hours and Guideline Noise Levels do not apply. If these works are not completed during Normal Working Hours then they would need to be continued until complete. This may require work outside of Normal Working Hours. Such work would be classed as Unavoidable Work and Guideline Noise Levels do not apply. It is anticipated that this work would only occur twice for a period of four to five weeks during the construction period.

Scenario D is for site operations. These works are proposed to occur over 24 hours and Guideline Noise Levels would apply for construction work undertaken outside of Normal Working Hours. The specific Guideline Noise Levels are provided in Table A.2. For work outside of Normal Working Hours, construction vehicles would be required to use the Barwise Street access.

Construction noise levels without additional mitigation have been predicted for Scenarios A, B, C and D and the results are provided in the following figures.



Figure A.15: Arden Station Precinct Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over Normal Working Hours

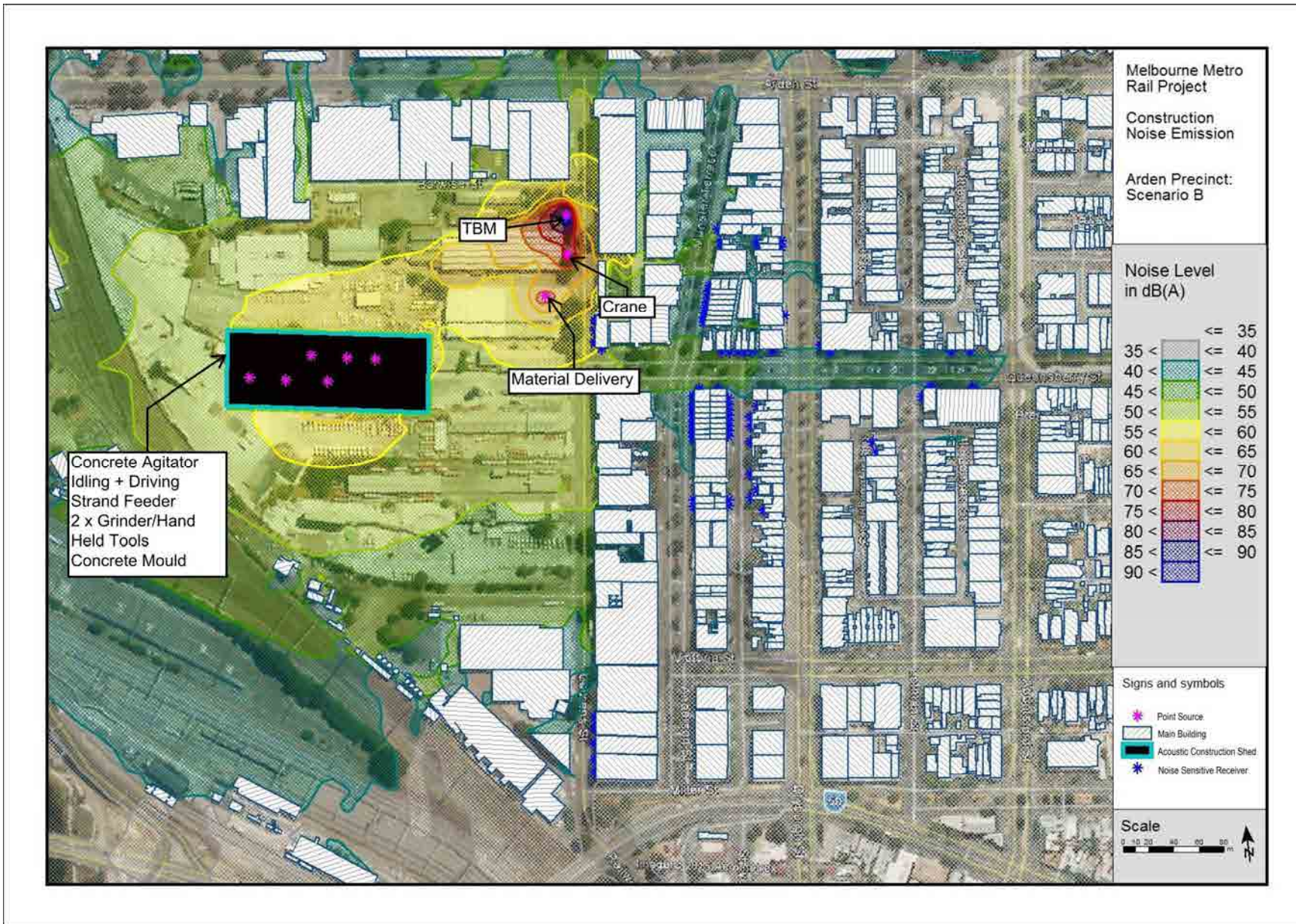


Figure A.16: Arden Station Precinct - Scenario B Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours, Unavoidable Works

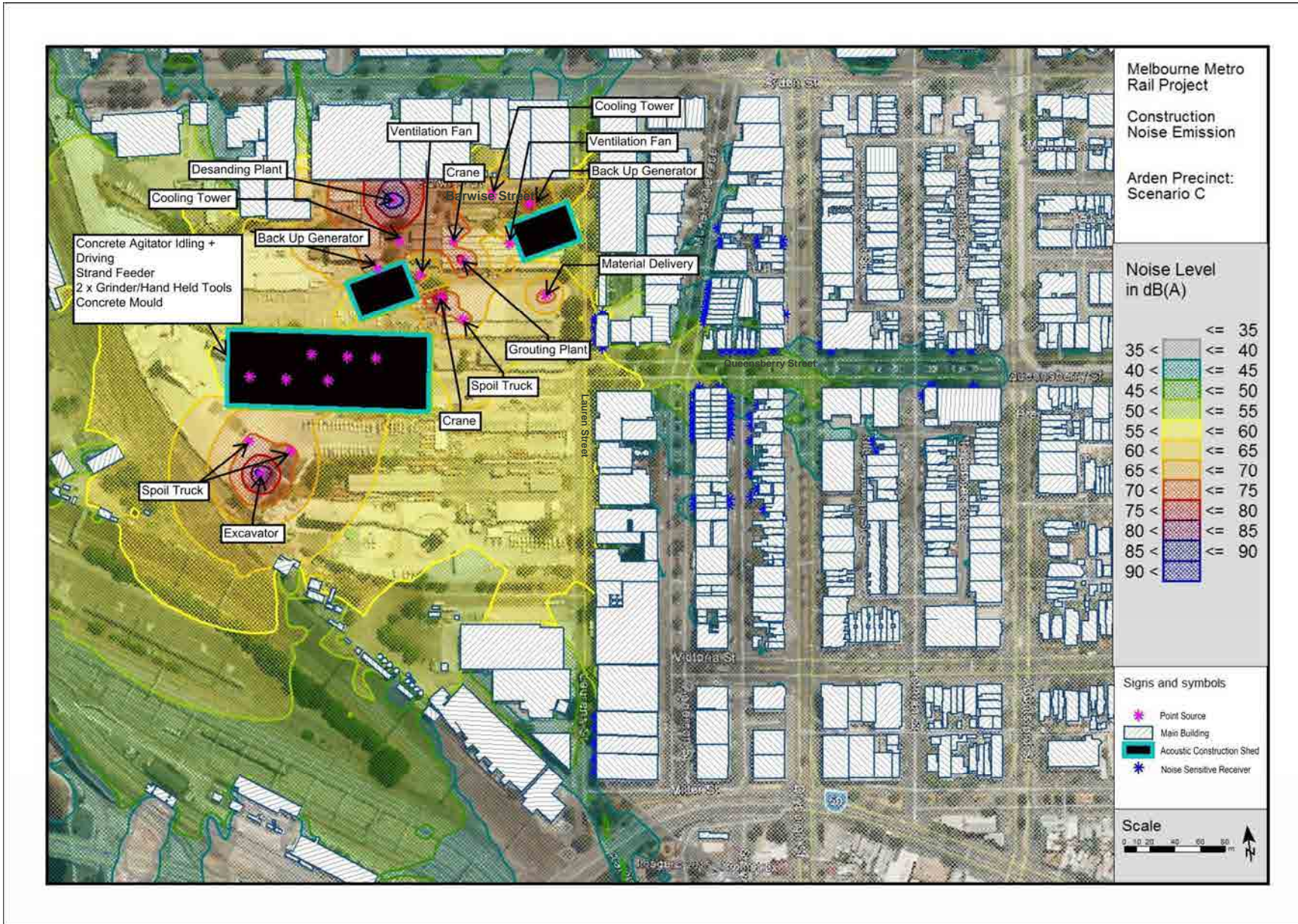


Figure A.17: Arden Station Precinct - Scenario C Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours, Unavoidable Works



Figure A.18 : Arden Station Precinct - Scenario D Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours



A.3.4 Precinct 4: Parkville Station

Parkville station is a busy precinct with tram lines along Royal Parade, Flemington Road and Swanston Street and bus routes along Grattan Street and Royal Parade. There has been a lot of recent construction in the area and it is generally a noisy area with constant traffic operating throughout the day. Hospital emergency vehicles and helicopters operate 24 hours a day.

Grattan Street would be closed to traffic during construction. Sensitive receivers in the vicinity of the construction activities include:

- Royal Women's Hospital (RWH)
- Royal Melbourne Hospital (RMH)
- Victorian Comprehensive Cancer Centre (VCCC)
- University of Melbourne Faculty of Medicine (UoM FoM)
- Peter Doherty Institute (PDI)
- Other education buildings associated with the University of Melbourne (including the Alan Gilbert building)
- Residential buildings in the backstreets.

Sensitive receivers further back from the tunnel and/or station include:

- Melbourne Private Hospital (MPH)
- Howard Florey Laboratories
- Walter and Eliza Hall Institute
- Bio21 Institute
- The Kenneth Myer Building.

The construction scenarios for Precinct 4 are provided in Table A.4.

Scenario A is for Station box construction (no roof deck). This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Scenario B is for the Station box construction (with roof deck), acoustic construction sheds and noise barrier would be in place. This work is proposed to be undertaken over 24 hours. Guideline Noise Levels apply for construction work undertaken outside of Normal Working Hours and these are provided in Table A.2.

Scenario C is for the construction for access across Royal Parade to VCCC. This work would be conducted during Normal Working Hours. If compliance can be shown with the evening the night time Guideline Noise Levels then the contractor would be able to undertake this work over 24 hours.

Scenario D is for Concrete pouring. This work is proposed to be undertaken during Normal Working Hours but could extend into outside of Normal Working Hours if not completed. This would be Unavoidable Work and Guideline Noise Levels do not apply. The activity is anticipated to occur daily in varying locations.

Construction noise levels without additional mitigation have been predicted for Scenarios A, B, C and D and the results are provided in the following figures.



Figure A.19 : Parkville Station Precinct - Scenario A - Predicted Noise Levels at 1.5 m above ground - Construction activities to be undertaken during Normal Working Hours



Figure A.20 : Parkville Station Precinct - Scenario B - Predicted Noise Levels at 1.5 m above ground - Construction activities to be undertaken over 24 hours



Figure A.21: Parkville Station Precinct - Scenario C - Predicted Noise Levels at 1.5 m above ground - Construction activities to be undertaken during Normal Working Hours

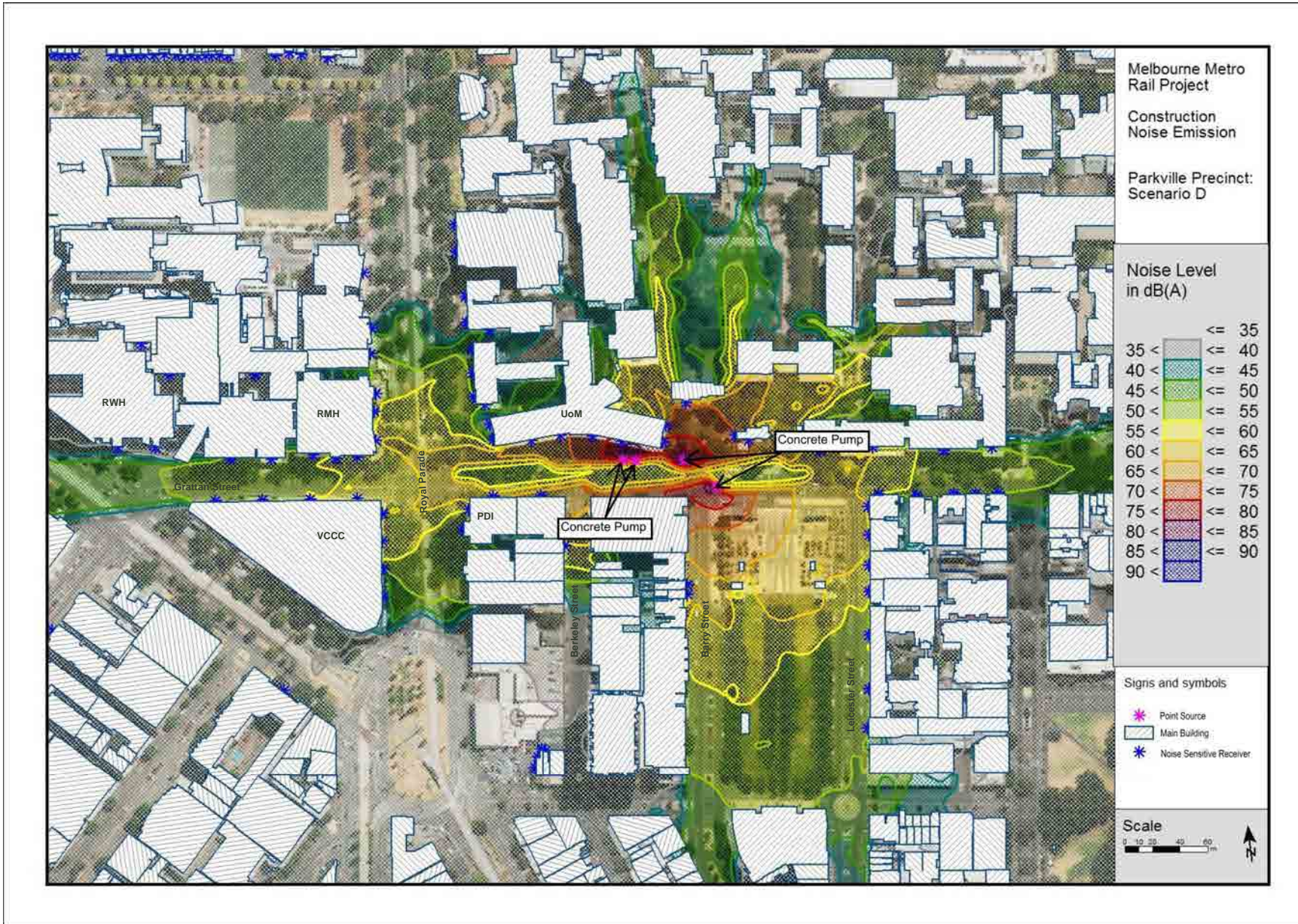


Figure A.22: Parkville Station Precinct - Scenario D - Predicted Noise Levels at 1.5 m above ground - Construction activities to be undertaken over 24 hours Unavoidable Works



A.3.5 Precinct 5: CBD North Station

CBD North station is a busy commercial precinct which includes a range of land uses. It is highly developed with a mix of modern and heritage buildings. Trams run along Latrobe Street and Swanston Street. There would be permanent closure of Franklin Street east of Swanton Street to all traffic.

Sensitive receivers in the vicinity of the construction activities include:

- RMIT University
- Residential apartment towers
- Melbourne Central Shopping Centre
- Melbourne Central Station
- State Library
- Melbourne City Baths.

The construction scenarios are provided in Table A.4.

Scenario A is for Demolition. This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Scenario B is for Shaft construction. This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Scenario C is for the Cavern construction. This work would be conducted over 24 hours. Guideline Noise Levels would apply for construction work undertaken outside of Normal Working Hours and these are provided in Table A.2. Two scenarios of Scenario C are presented:

- Scenario C(i) Roadheader not yet submerged
- Scenario C(ii) Roadheader fully submerged.

Scenario D is for Concrete pour. This work is proposed to be undertaken during Normal Working Hours, however, could extend beyond Normal Working Hours if not completed. This would be classed as Unavoidable Work and Guideline Noise Levels do not apply. It is anticipated to occur daily in varying locations.

Construction noise levels without additional mitigation have been predicted for Scenarios A, B, C and D and the results are provided in the following figures.

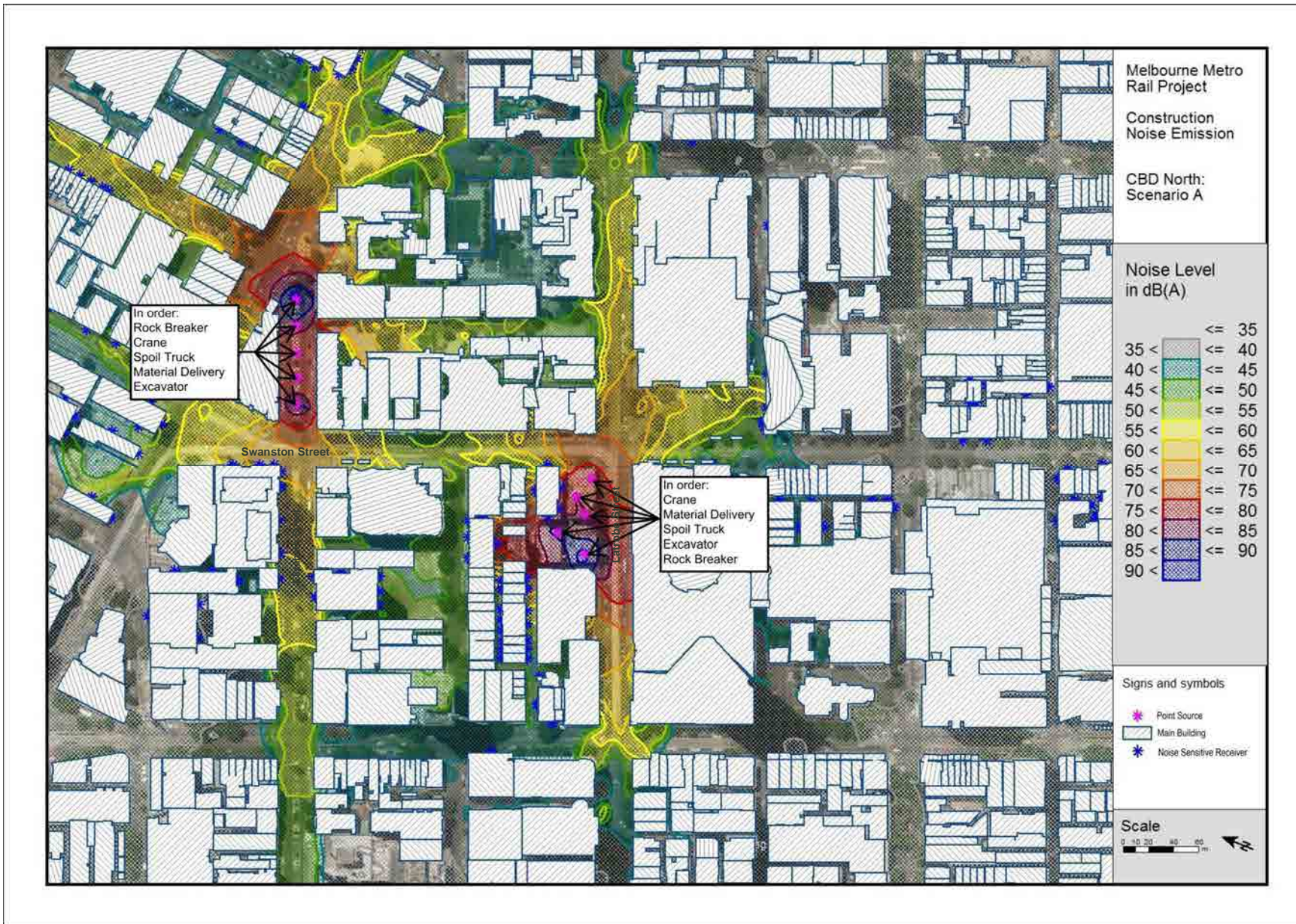


Figure A.23: CBD North Station Precinct - Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours

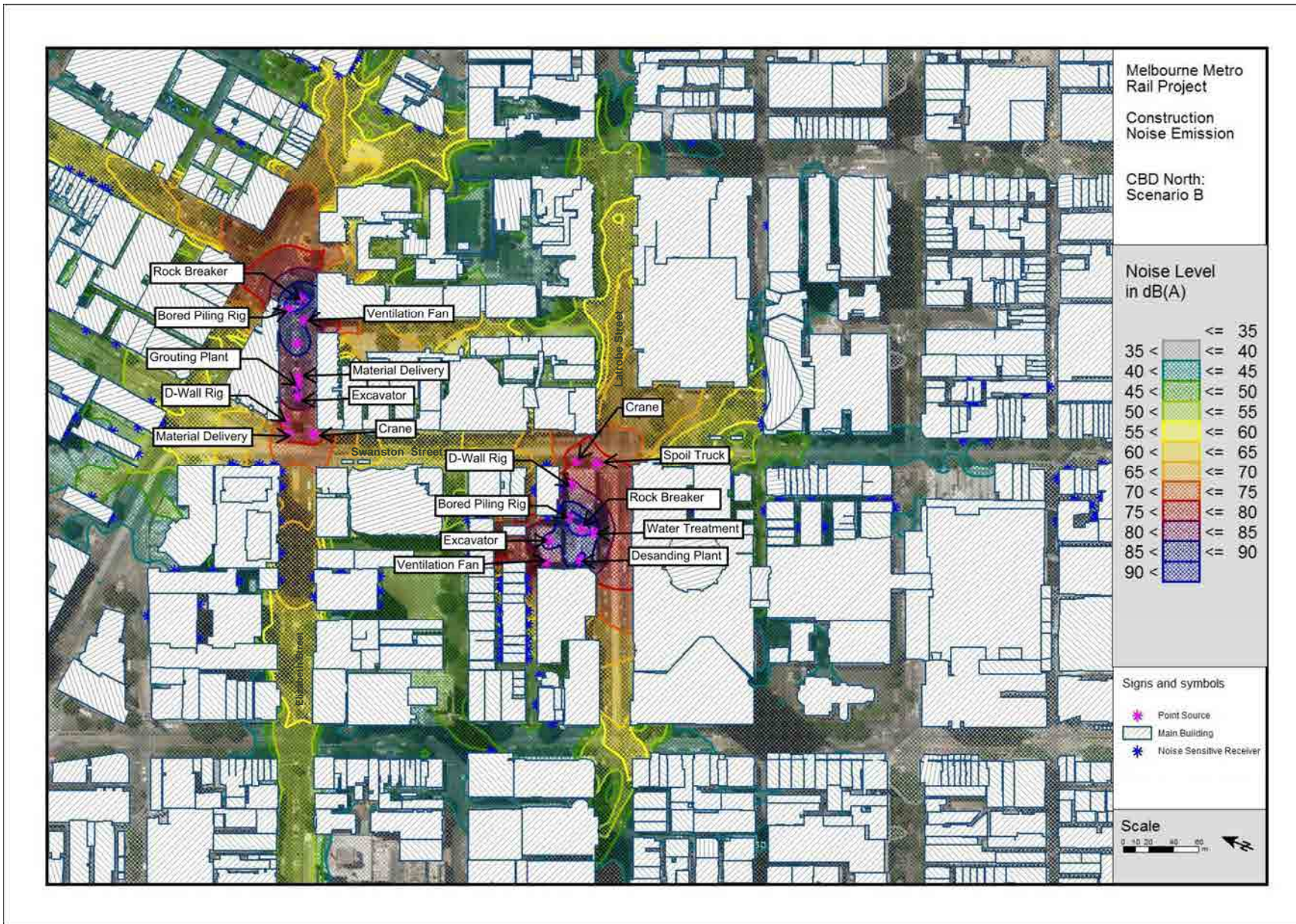


Figure A.24: CBD North Station Precinct - Scenario B - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours

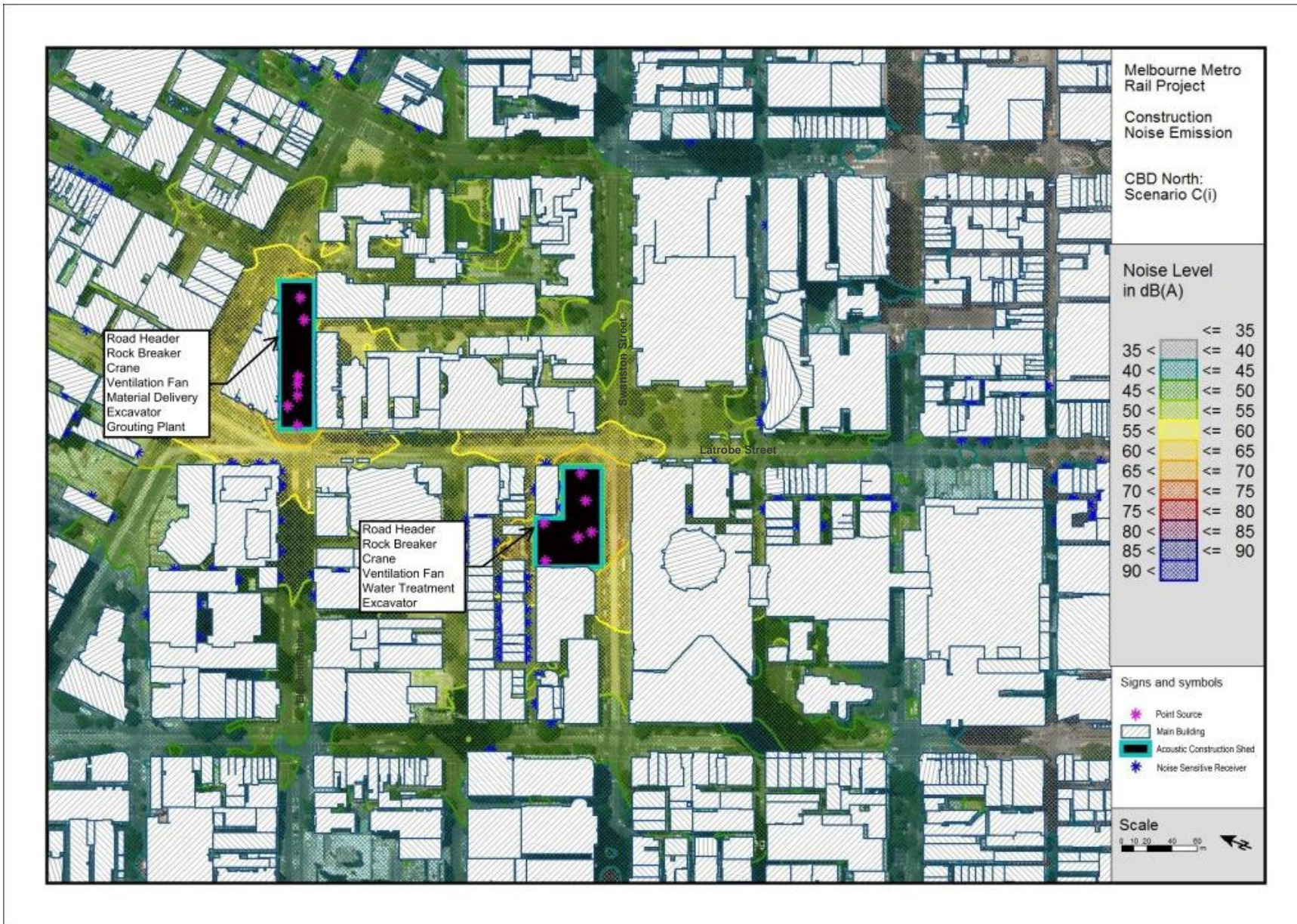


Figure A.25: CBD North Station Precinct - Scenario C(i) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours

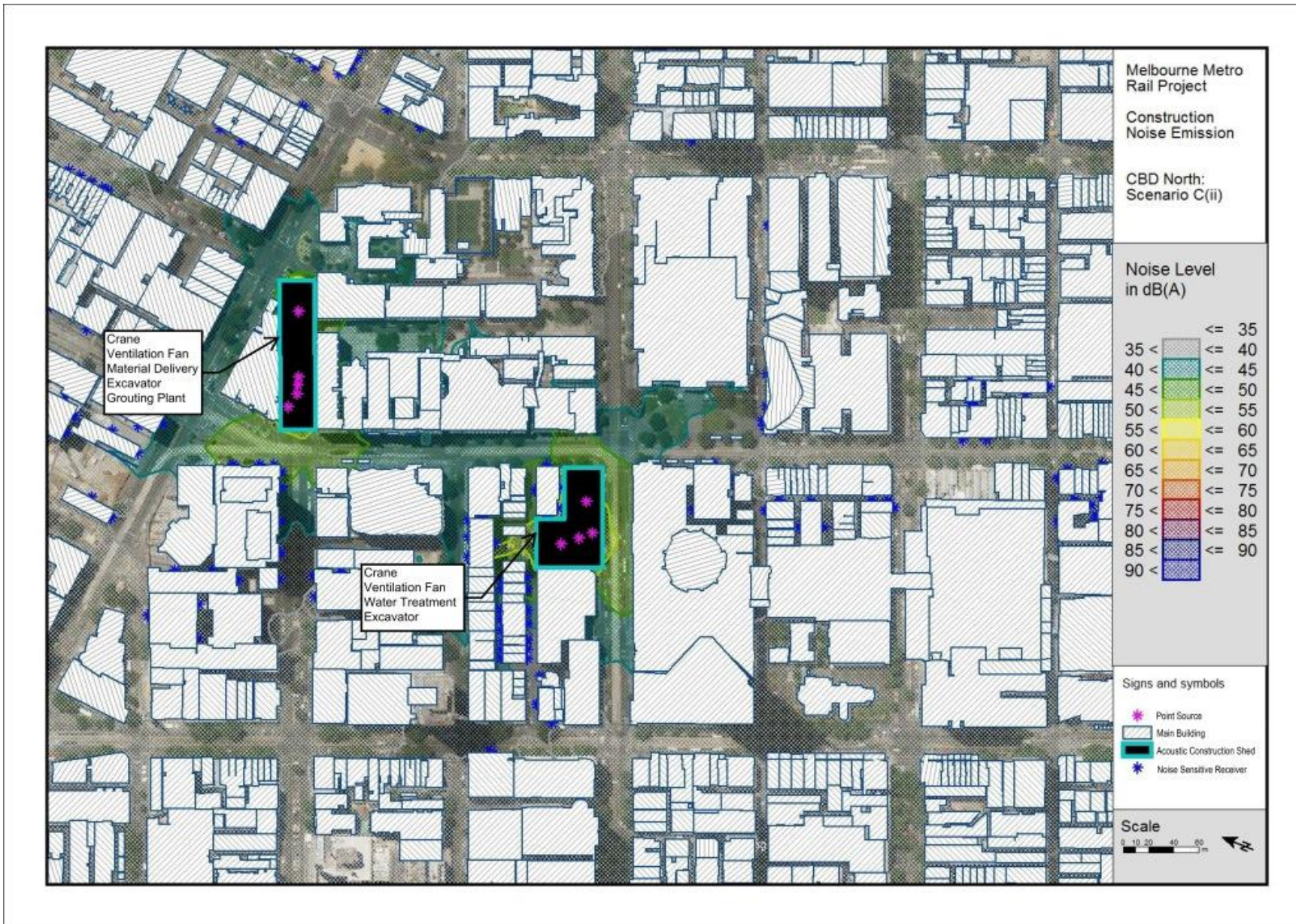


Figure A.26: CBD North Station Precinct - Scenario C(ii) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours

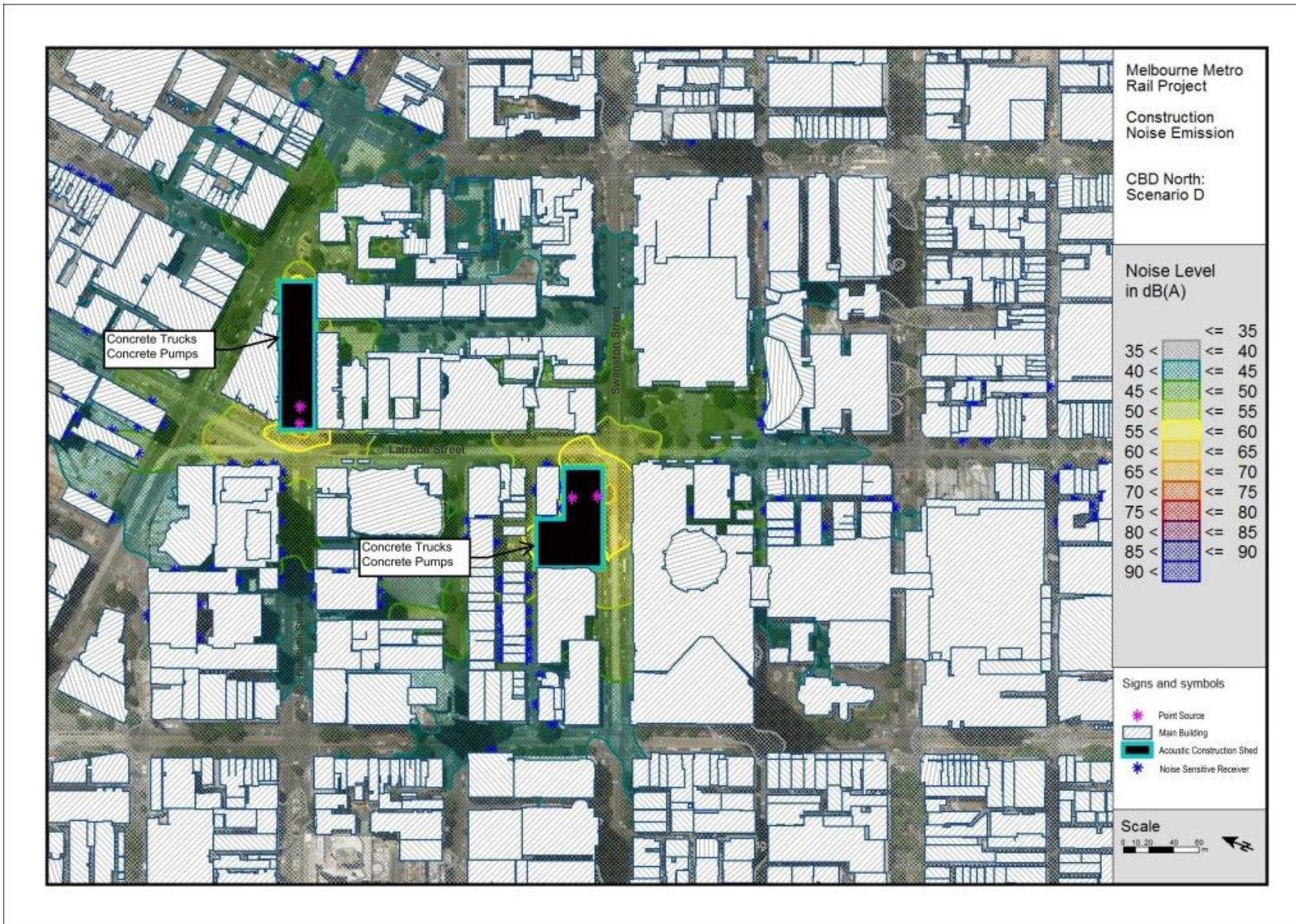


Figure A.27 : CBD North Station Precinct - Scenario D - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works



A.3.6 Precinct 6: CBD South Station

CBD South station is a highly urbanised and dense inner urban area with retail outlets, cafés, bars etc. It is highly developed with a mix of modern and heritage buildings. Trams run along Swanston Street, Collins Street and Flinders Street.

Sensitive receivers in the vicinity of the construction activities include:

- Federation Square
- St Paul's Cathedral
- Melbourne Town Hall (concerts)
- Flinders Street Station
- Westin Hotel
- Nicholas Building
- Young and Jackson Hotel
- Manchester Unity Building
- Wales Building
- ACMI
- Residential (down lanes).

The construction scenarios are provided in Table A.4.

Scenario A is for Demolition. This work is proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply.

Scenario B is for Shaft construction. This work is proposed to be undertaken during the Normal Working Hours and Guideline Noise Levels do not apply.

Scenario C is for the Cavern construction. This work would be conducted over 24 hours. Guideline Noise Levels would apply for construction work undertaken outside of Normal Working Hours and these are provided in Table A.2. Two scenarios of Scenario C are presented:

- Scenario C(i) Roadheader not yet submerged
- Scenario C(ii) Roadheader fully submerged.

Scenario D is for Cut and Cover construction. This work would be conducted over 24 hours. Guideline Noise Levels would apply to construction work undertaken outside of Normal Working Hours. These are provided in Table A.2.

Scenario E is for Cut and Cover construction across Flinders Street. This work is proposed to be undertaken over 24 hours as Flinders Street would need to be closed. This work would be classed as Unavoidable Work and Guideline Noise Levels do not apply. It is anticipated that this work would last for 2 to 3 months over the construction period. These works are to be undertaken within an acoustic construction shed.

Scenario F is for Concrete pour. This work is proposed to be undertaken during Normal Working Hours, however, could extend beyond Normal Working Hours if not completed. This would be classed as Unavoidable Work and Guideline Noise Levels do not apply. It is anticipated that this would occur daily during the construction period in differing locations.

Construction noise levels without additional mitigation have been predicted for Scenarios A, B, C, D, E and F and the results are provided in the following figures.

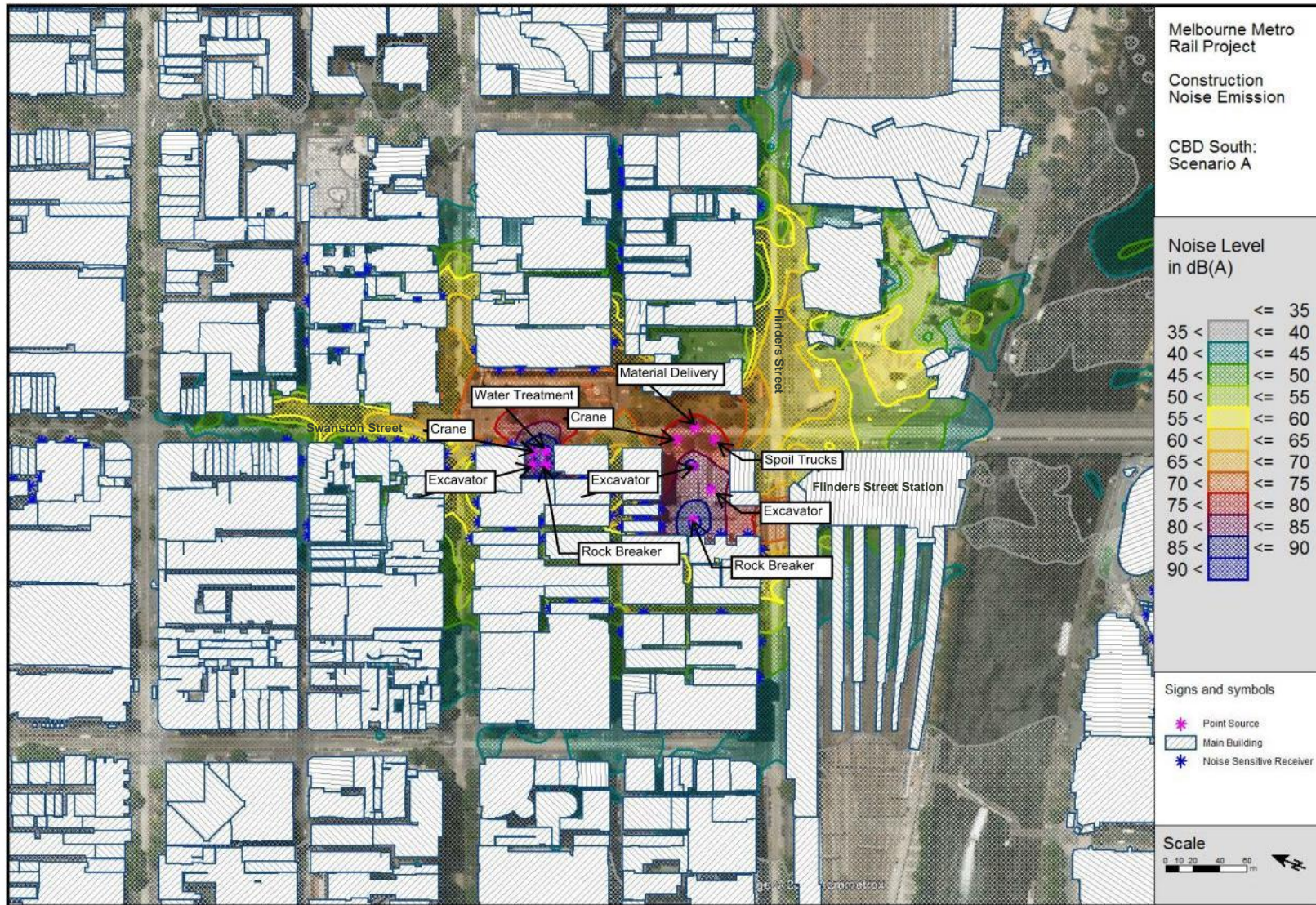


Figure A.28: CBD South Station Precinct - Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours



Figure A.29: CBD South Station Precinct - Scenario B - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours



Figure A.30: CBD South Station Precinct - Scenario C(i) Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours

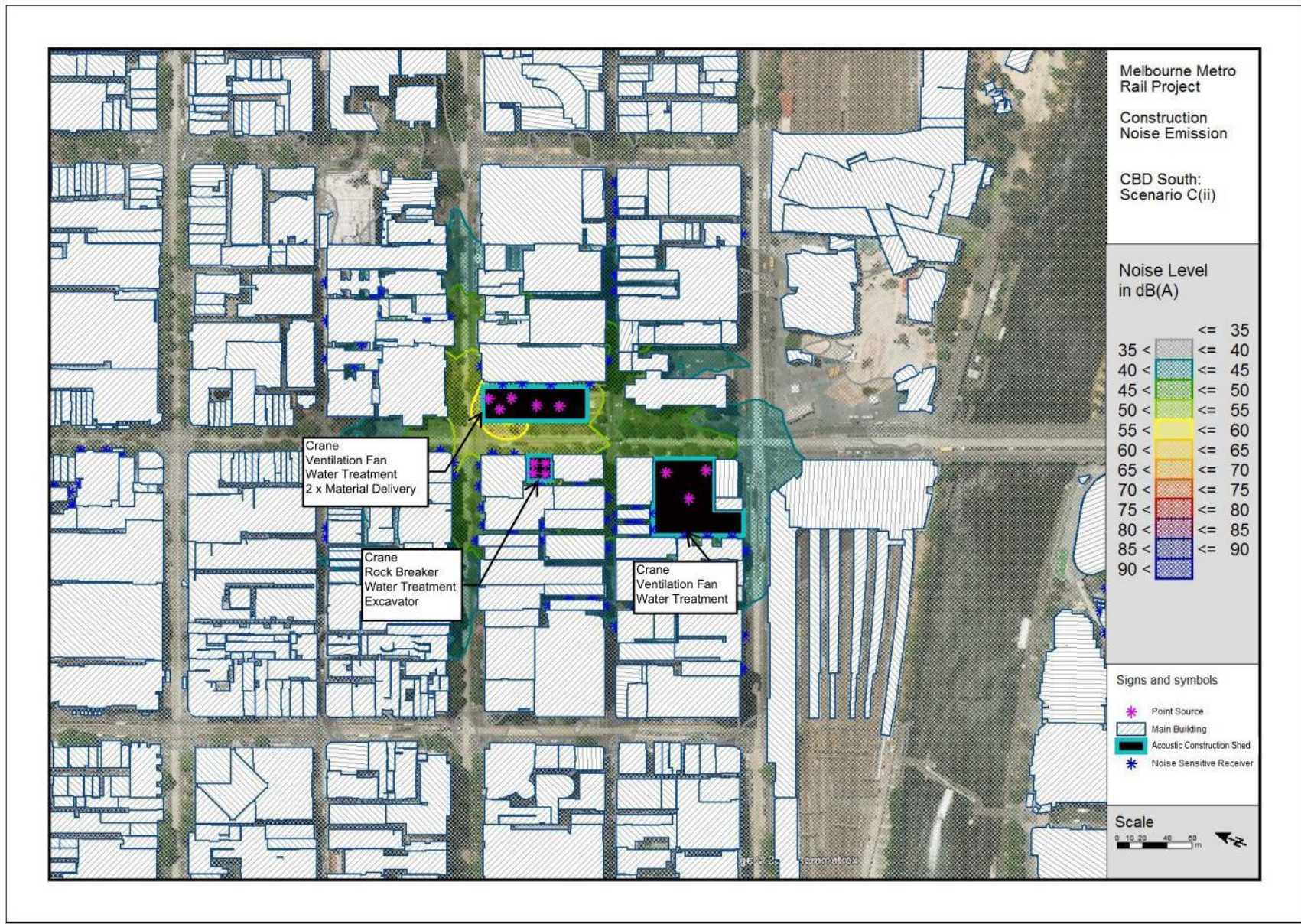


Figure A.31: CBD South Station Precinct - Scenario C(ii) Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours

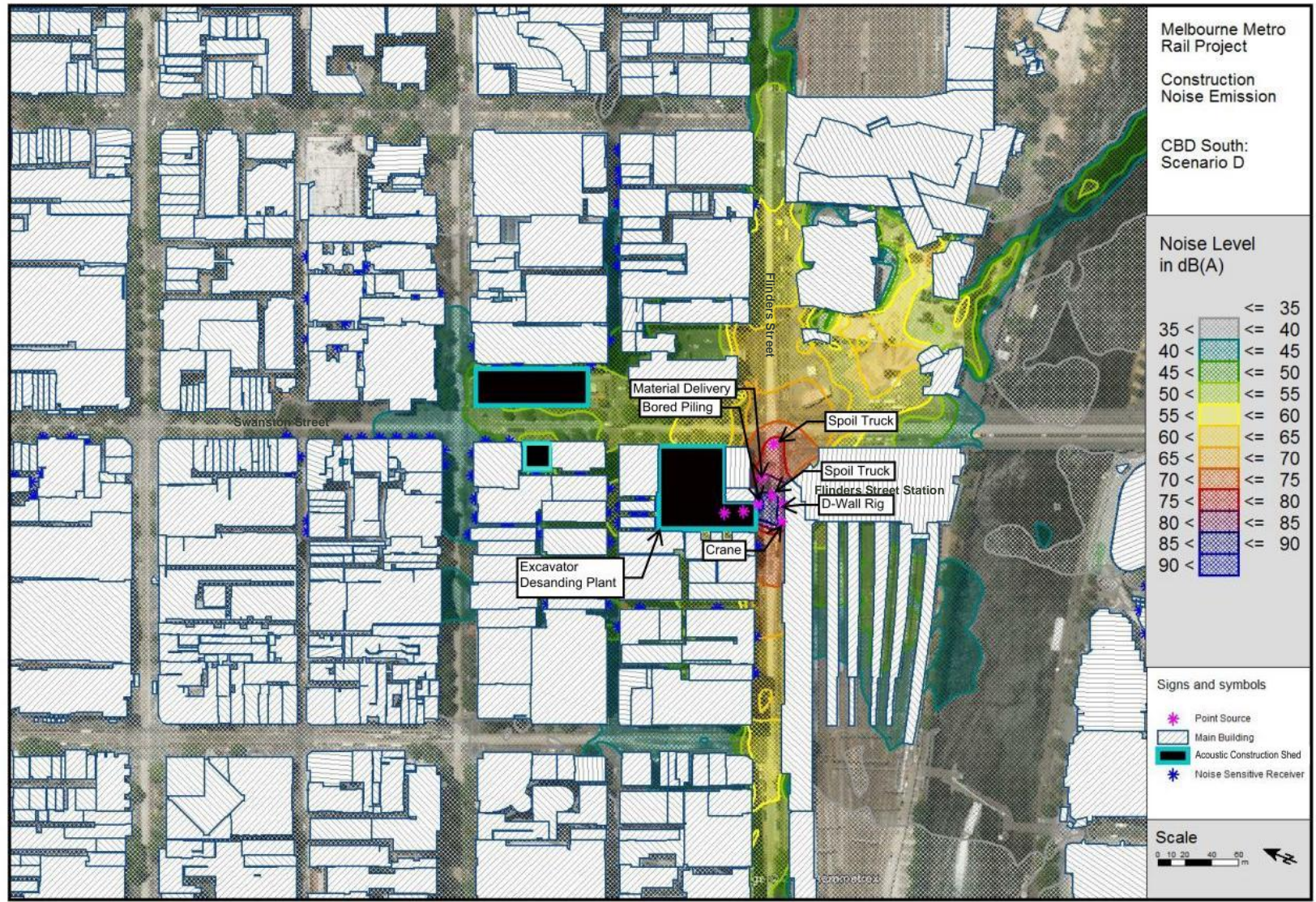


Figure A.32: CBD South Station Precinct - Scenario D Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

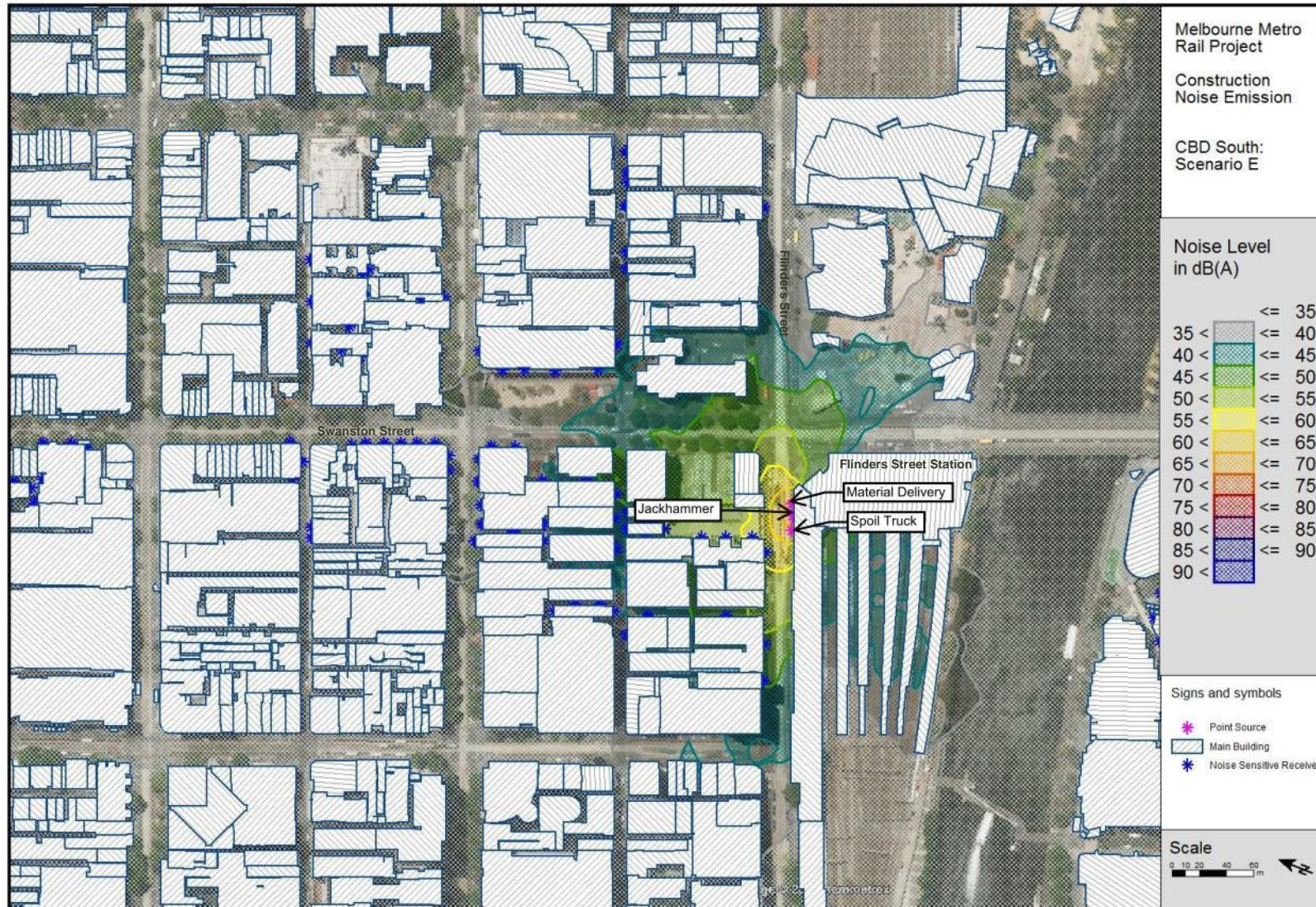


Figure A.33: CBD South Station Precinct - Scenario E - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

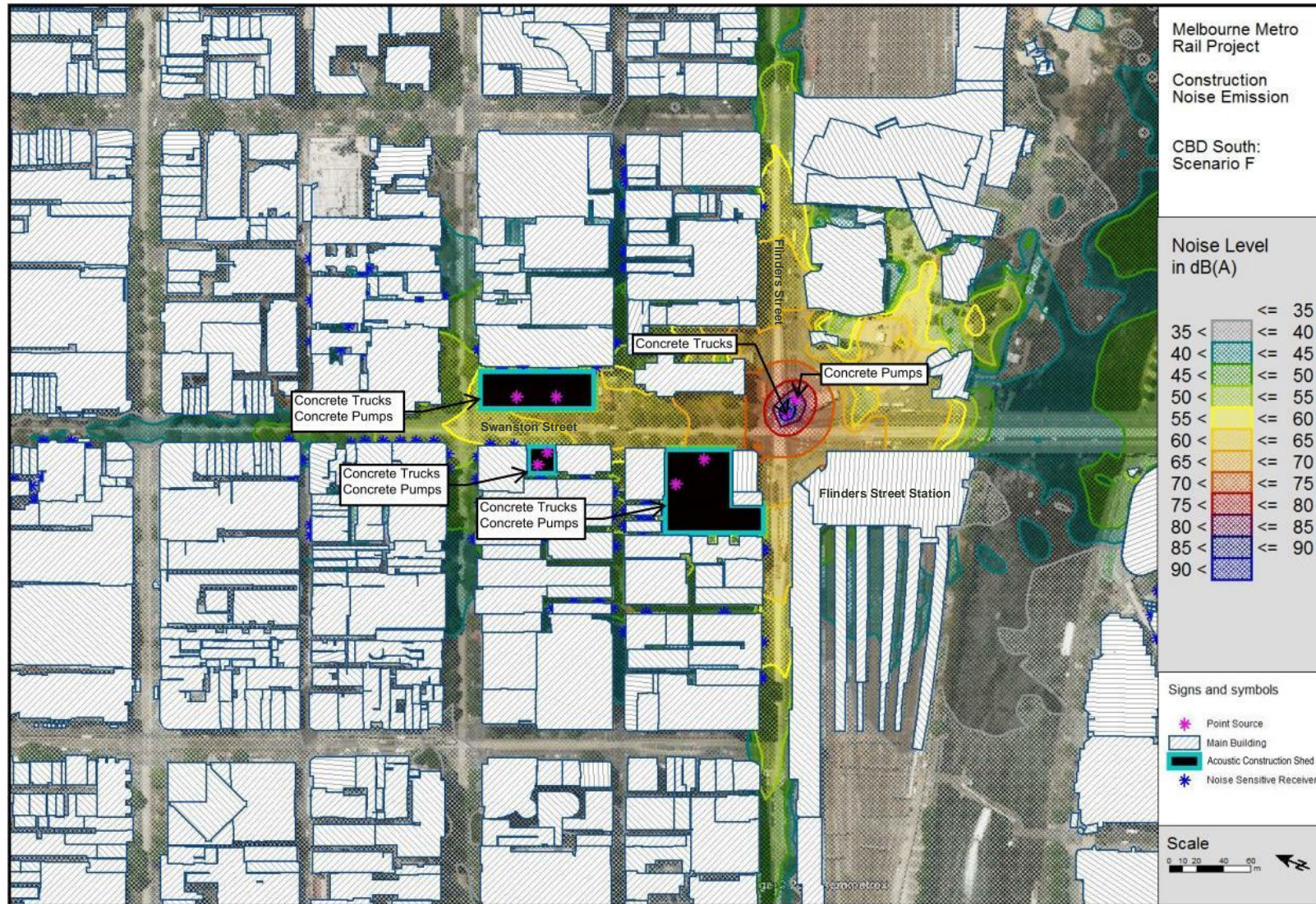


Figure A.34: CBD South Station Precinct - Scenario F- Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works



A.3.7 Precinct 7: Domain Station

Sensitive receivers in the vicinity of the construction activities include:

- High rise residential apartment buildings and hotels.

Construction work would be undertaken during Normal Working Hours until the station roof deck is in place.

- Station box construction would be undertaken during Normal Working Hours until the roof deck is in place and then it would be undertaken over 24 hours.
- Tunnelling operations, truck access – 24 hours
- There would be an enclosure over the construction works on the Edmund Herring Oval.

The construction scenarios are provided in Table 2.4.

Scenario A(i) and A(ii) is for Shaft construction and station box piling, excavation and construction with no roof deck. This scenario is split across St. Kilda Road to allow for traffic flow including tram operations. This work is proposed to be undertaken during Normal Working Hours. Guideline Noise Levels do not apply during Normal Working Hours.

Scenario B and Scenario C are for the TBM launch preparation and TBM launch respectively. These works are proposed to be undertaken during the Normal Working Hours and Guideline Noise Levels do not apply during Normal Working Hours. If these works are not completed during Normal Working Hours then they would need to be continued until complete. This may require work outside of Normal Working Hours. Such work would be classed as Unavoidable Work and Guideline Noise Levels do not apply. It is anticipated that this would occur for a period of four to five weeks twice over the construction period.

Construction noise levels without additional mitigation have been predicted for Scenarios A(i), A(ii) B and C and the results are provided in the following figures.

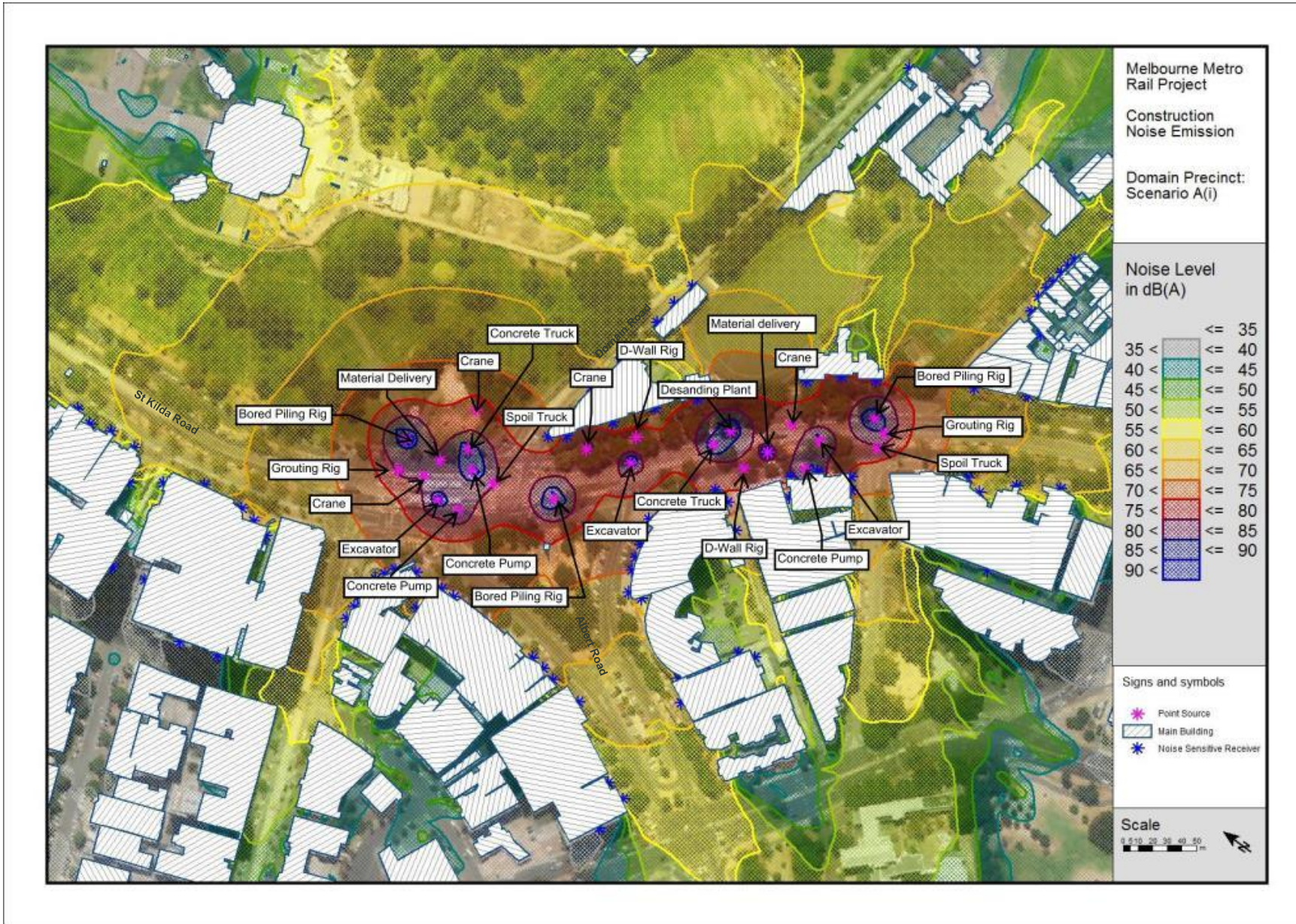


Figure A.35: Domain Station Precinct - Scenario A(i) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours

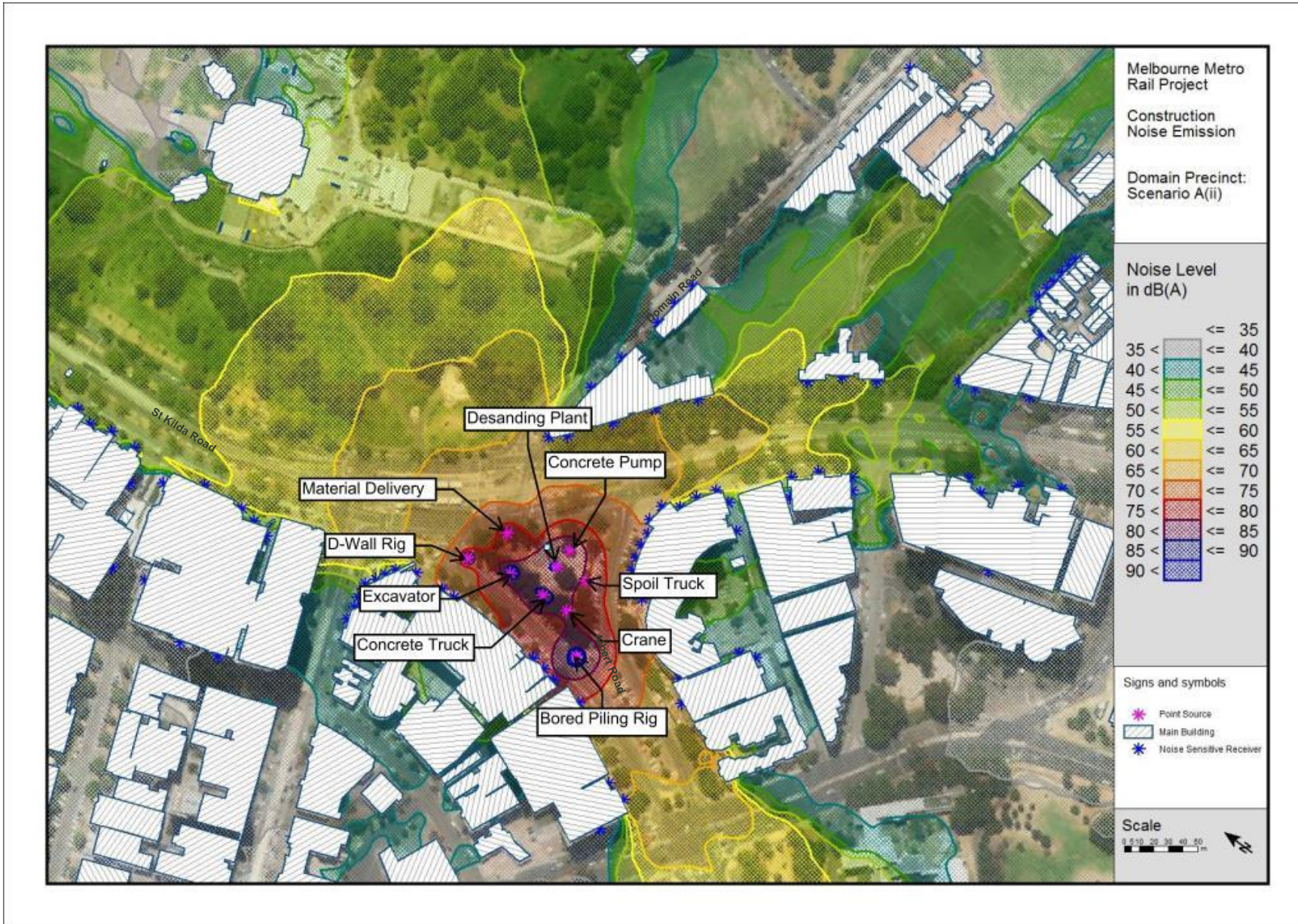


Figure A.36: Domain Station Precinct - Scenario A(ii) - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken during Normal Working Hours

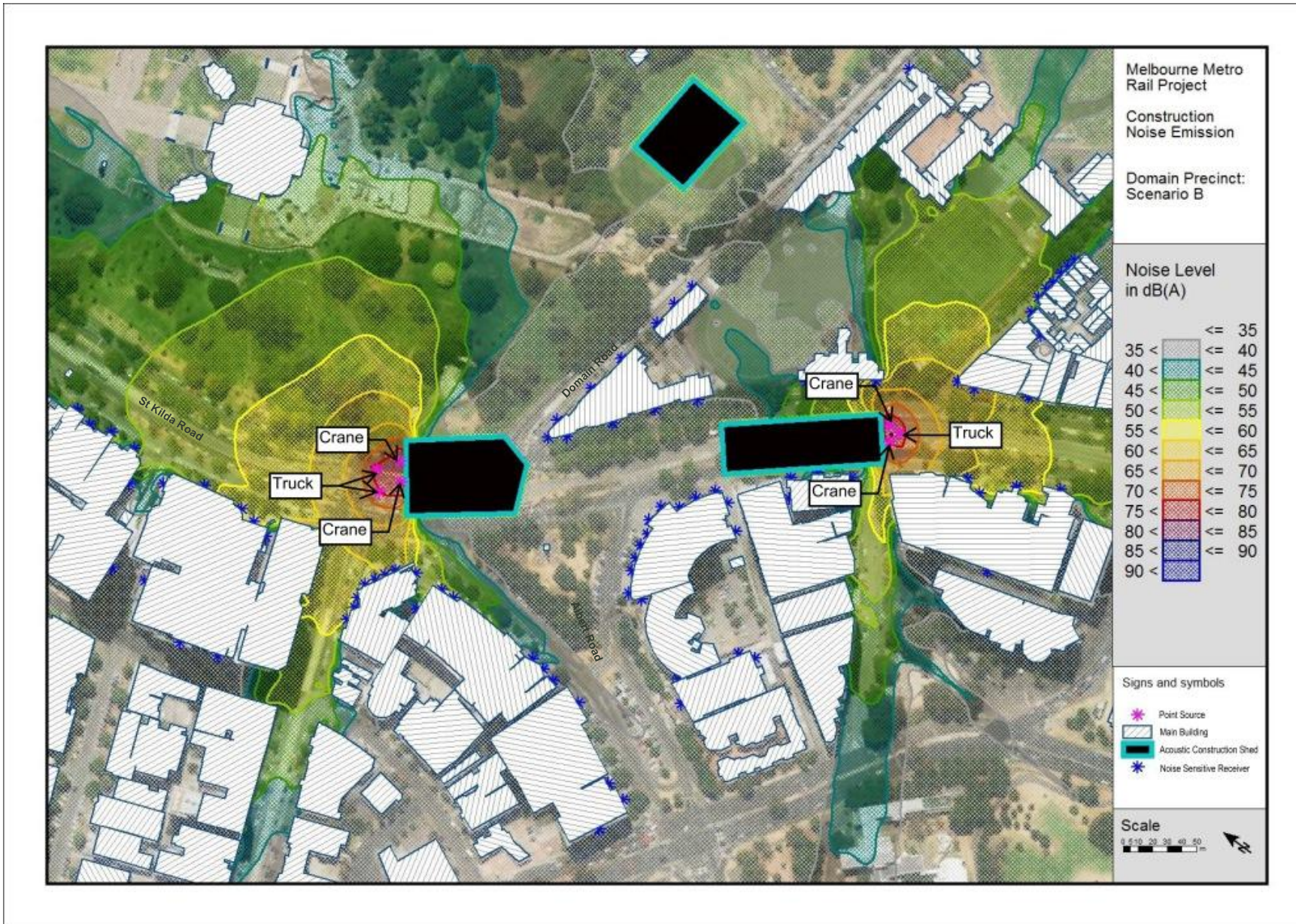


Figure A.37: Domain Station Precinct - Scenario B - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works. Note: locations of sheds are indicative only.

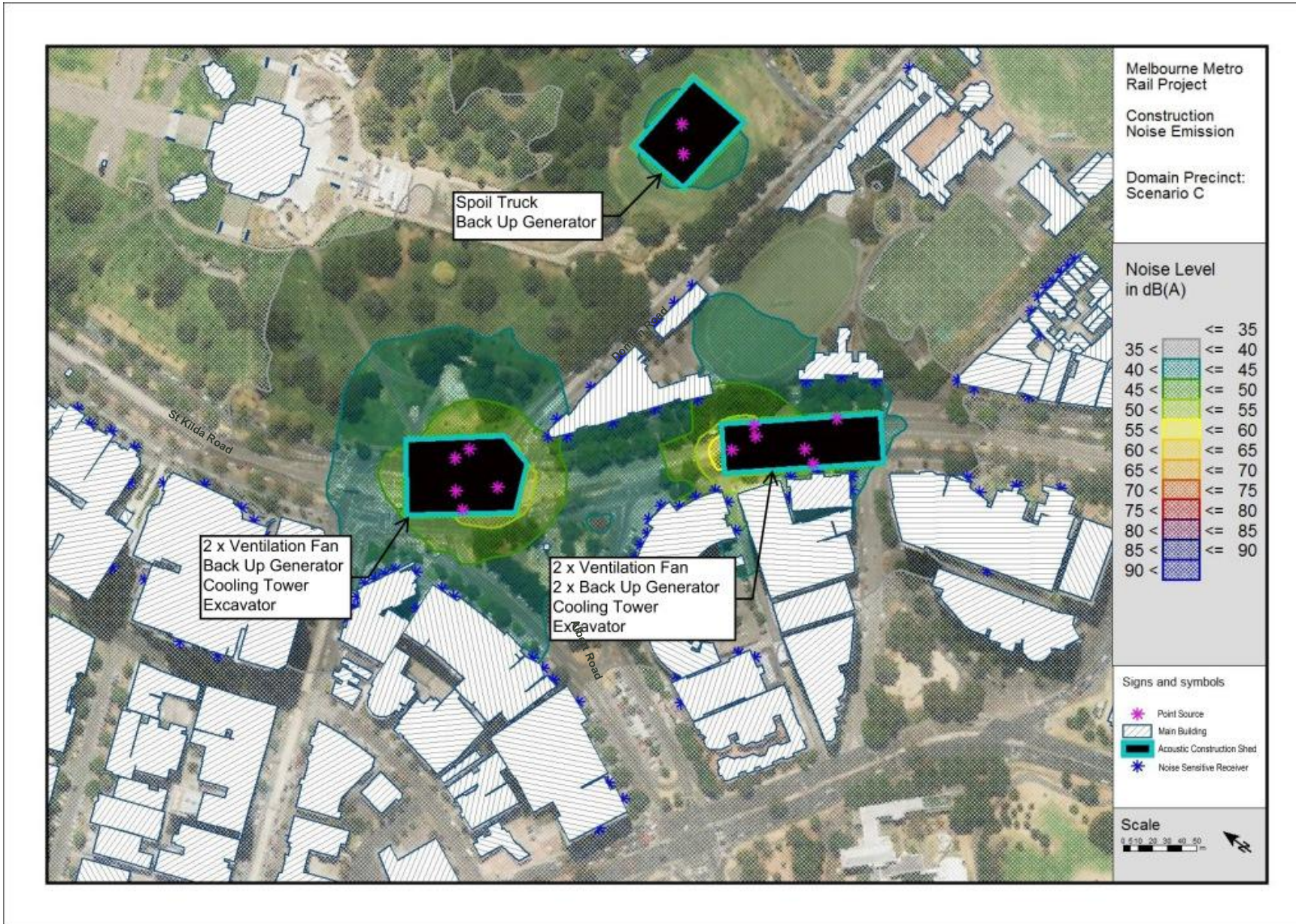


Figure A.38: Domain Station Precinct -Scenario C - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works. Note: locations of sheds are indicative only.



A.3.8 Precinct 8: Eastern Portal

The construction scenarios are provided in Table A.4.

Scenario A is for a Rail occupation (24 hours). This work is classed as Unavoidable Works due to impact on the rail network and Guideline Noise Levels do not apply. These works are anticipated to occur twice for a period of approximately 1.5 weeks and 5 weekends of 24 hour work.

Scenario B is for the TBM removal. This work is proposed to be undertaken during Normal Working Hours. If this work is not completed during Normal Working Hours then it would need to continue outside of Normal Working Hours until it is complete. This work would be classed as Unavoidable Work. It is anticipated that this would four to six weeks in total over the construction period.

Construction noise levels without additional mitigation have been predicted for Scenarios A and B and the results are provided in the following figures.

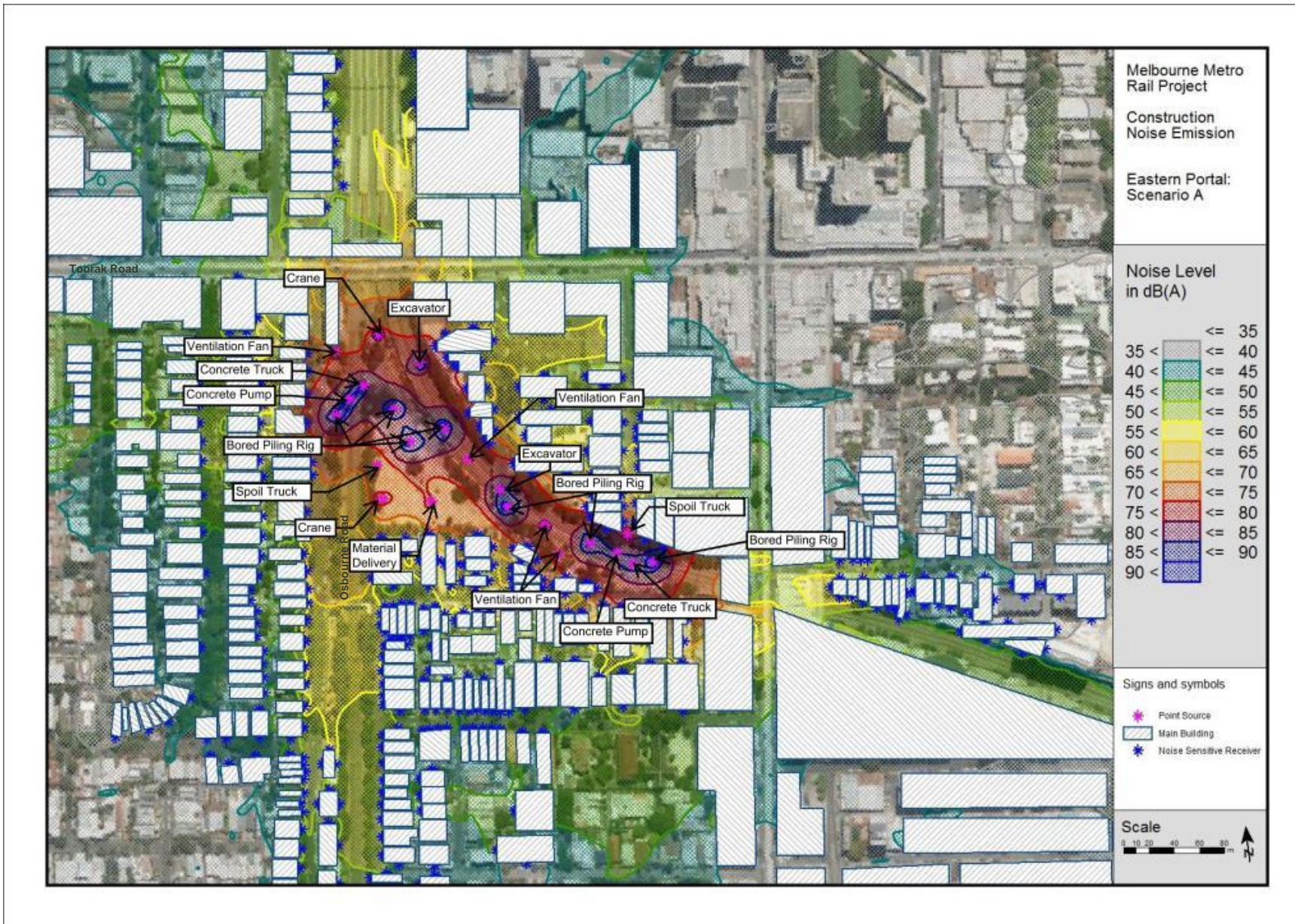


Figure A.39: Eastern Portal Precinct - Scenario A - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works

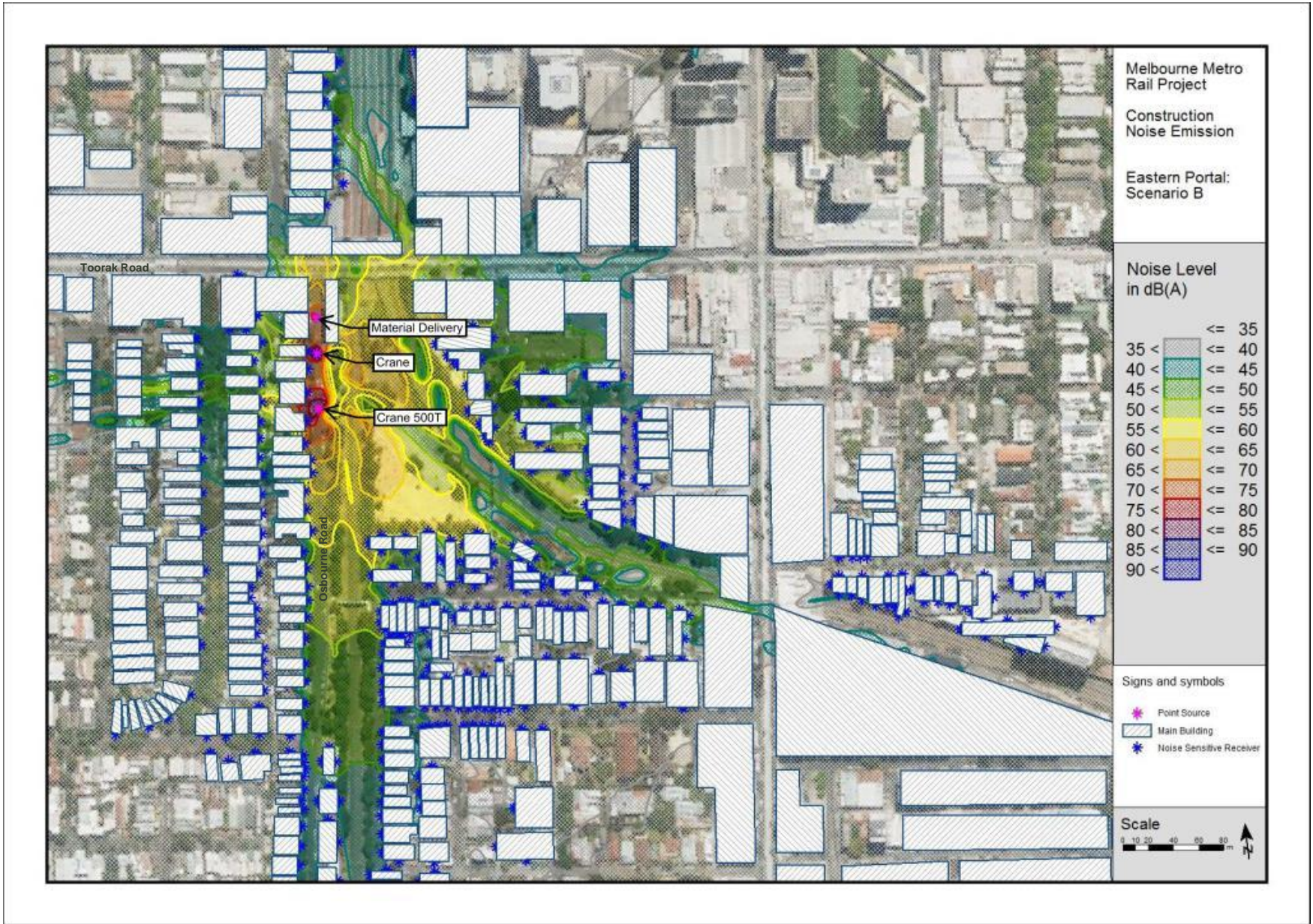


Figure A.40: Eastern Portal Precinct - Scenario B - Predicted Noise Levels at 1.5 m above ground - construction activities to be undertaken over 24 hours Unavoidable Works



A.3.9 Precinct 9: Western Turnback

Precinct 9: West Footscray (Assessment Project)

Sensitive receivers in the vicinity of the Western Turnback at West Footscray are residential.

Construction noise levels without additional mitigation have been predicted for Scenario A and the results are provided in the following figure.

These works would be a Rail Occupation and would therefore be classed as Unavoidable Works and Guideline Noise Levels do not apply.



A.4 Additional Mitigation

A.4.1 Mitigation Requirements

EPA 1254 requires that the following work measures apply:

- Use the lowest noise work practices and equipment to meet the requirements of the job.
- Site buildings, access roads and plant should be positioned such that the minimum disturbance occurs to the locality. Barriers such as hoardings or temporary enclosures should be used. The site should be planned to minimise the need for reversing vehicles.
- All mechanical plant is to be silenced by the best practical means using current technology. Mechanical plant, including noise suppression devices should be maintained to the manufacturer's specifications. Internal combustion engines are to be fitted with a suitable muffler in good repair.
- Fit all pneumatic tools operated near a residential area with an effective silencer on their air exhaust port.
- Install less noisy movement / reversing working systems for equipment and vehicles that would operate for extended periods, during sensitive times or in close proximity to sensitive sites. Occupational health and safety requirements of use of working systems must be followed.
- Turn off plant when not in use.
- All vehicular movements to and from the site to only occur during the scheduled *Normal Working Hours*, unless approval has been granted by the relevant authority.
- Where possible, no truck associated with work should be left standing with its engine operational in a street adjacent to a residential area.
- Special assessment of vibration risks may be needed such as for pile driving or works structurally connected to sensitive premises.

The following work measures would also apply to Melbourne Metro:

- Scheduling noisy activities for less sensitive times and providing periods of respite.
- Stockpiling excavated material in tunnels overnight for daytime removal.
- Providing acoustic doors at tunnel entrances.
- Planning daytime deliveries.
- Turning off equipment/ vehicles when not in use.
- Use of barriers (noise barriers / stockpiles / shipping containers / site buildings) to block line of sight between construction activities and sensitive receivers.
- Use of temporary enclosures.
- Maintaining equipment - use of the quietest equipment available that is suitable to fulfil a task.
- Use of broad band reversing alarms and / or variable level alarms (adjust in level according to the background noise level).
- Avoid dropping materials from heights.
- Use of resilient materials to avoid metal to metal contact and or damping to reduce radiated noise.
- Improving sound insulation at the receiver (e.g. upgrading glazing) (optional).
- Community consultation – this would be dealt with in detail by the Stakeholder Engagement and Communications teams.
- Appropriate work behaviour (i.e. no shouting, slamming doors, etc.)

The noise mitigation provided is indicative only. Ultimately it would need to be designed by the Contractor responsible for the construction works. Specific indicative noise mitigation is provided with respect to noise barriers and acoustic construction sheds.

Noise barriers are assumed to be of the order of 10 to 15 kg/m² with no gaps or holes. They would only be effective when they are blocking line of sight between the sensitive receiver and the construction work. An example of suitable barrier is shown in the figure below. Equally shipping containers or other types of noise barriers would be appropriate.



Figure A.42 : Example of noise barriers

Acoustic construction sheds are assumed to have a weighted sound reduction index of the order of R_w 50 and would need to include attenuated openings and overlapping sliding doors (that incorporate sealing elements). An example of an enclosure is shown in the figure below.



Figure A.43 : Example of acoustic construction shed



In built up areas such as Parkville, CBD North and CBD South and Domain noise barriers would be of limited benefit as they would only protect low rise sensitive receivers and in many cases apartment blocks and high rise buildings would have a view of the works over the barrier. In such cases enclosures would be required to achieve effective mitigation.

Noise mitigation in addition to the mitigation already included in the design is shown in the following figures. This mitigation includes options for additional noise barriers and acoustic construction enclosures. In particular the following has been included:

- Precinct 1: Tunnels
 - Fawkner Park: noise barriers up to a height of 6 m; acoustic construction shed
 - Linlithgow Avenue Emergency Access Shaft: noise barriers are not recommended as the works are to be conducted during Normal Working hours only
 - Fawkner Park Emergency Access Shaft: noise barrier up to a height of 6 m
- Precinct 2: Western Portal: noise barriers up to a height of 6 m
- Precinct 3: Arden Station: noise barriers up to a height of 6 m; off-reservation treatment (building mitigation); acoustic construction shed
- Precinct 4: Parkville Station: Acoustic construction sheds over the openings in the station box. Noise barriers up to a height of 6 m on the outside of the construction vehicles working adjacent to the station box. Noise barriers up to a height of 6 m at University Square.
- Precinct 5: CBD North Station: Acoustic construction sheds with a noise lock for truck access (i.e. one door is always closed between the construction work and the exterior)
- Precinct 6: CBD South Station: Acoustic construction sheds with a noise lock for truck access (i.e. one door is always closed between the construction work and the exterior)
- Precinct 7: Domain Station: Acoustic construction sheds with a noise lock for truck (i.e. one door is always closed between the construction work and the exterior) and noise barriers up to a height of 6 m
- Precinct 8: Eastern Portal - noise barriers up to a height of 6 m
- Precinct 9: Western Turnback (West Footscray) – noise barriers up to a height of 2.5 m.

A.4.2 Construction Environmental Management Plan

Preparation of a construction environmental management plan that covers noise and vibration - this plan should include:

- Details of the project and proposed construction works methodology and timeframe
- Contact details of the key staff
- Project noise and vibration limits
- Hours of operation
- Details of the affected receivers
- Details of the expected sources, impacts and mitigation measures
- Noise and vibration monitoring requirements
- Stakeholder engagement / community consultation
- Complaints handling
- Construction staff induction with respect to noise and vibration
- Details of requirements for documentation for quality assurance and for approvals.

A.4.3 Community Consultation

Effective community consultation would be essential to the management of the community's expectations. This would be managed by the Stakeholder and Engagement team. The following should be employed:

- Neighbours predicted to be impacted by the project should be informed of the nature and duration of the specific works. Information should be provided a suitable amount of time prior to the impact occurring.
- Potentially noise affected neighbours should be informed about the nature of construction stages and noise reduction measures. Activities should be described along with information about duration.
- A contact should be set up for the community to access
- 24 hour contact details should be provided through letters and site signage
- A register of complaints is to be kept (which includes a description of the complaint, details of the complainant and the actions that were taken), and a complaint response procedure to be followed which provides a quick response to handling complaints.

A.4.4 Scheduling of Activities

Construction activities should be scheduled to minimise impact on the community. The following approach should be adopted:

- Schedule noisy activities for the noisiest time of the day
- Undertake noisy activities during Normal Working Hours
- Provide periods of respite.



Figure A.44: Tunnels Precinct Fawkner Park Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.45: Tunnels Precinct Fawkner Park Scenario B Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24-hours Hours Unavoidable Works – with additional mitigation

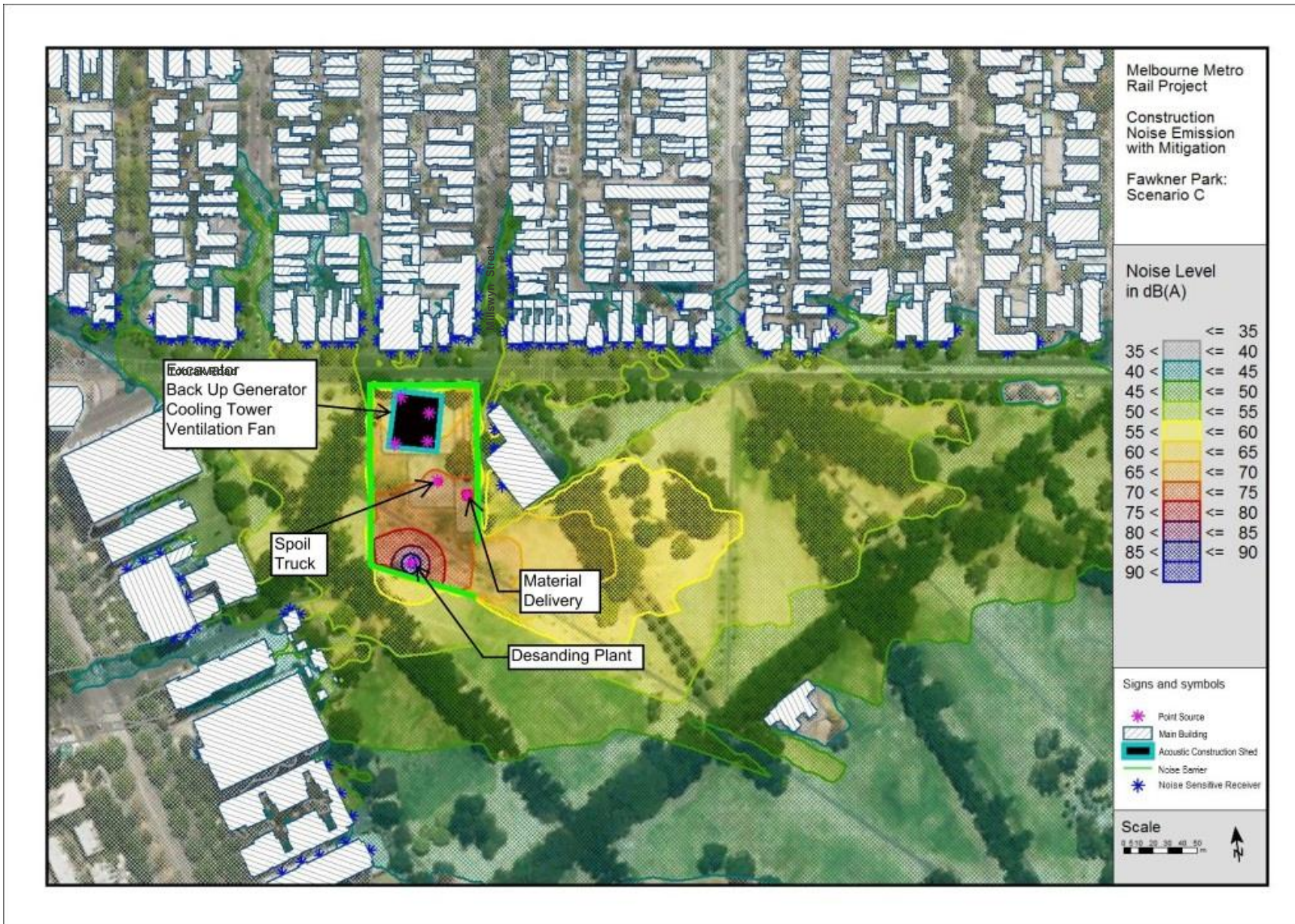


Figure A.46: Tunnels Precinct Fawkner Park Scenario C Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24-hours Hours Unavoidable Works – with additional mitigation



Figure A.47: Fawkner Park Emergency Access Shaft Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.48: Western Portal Construction Design, Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation

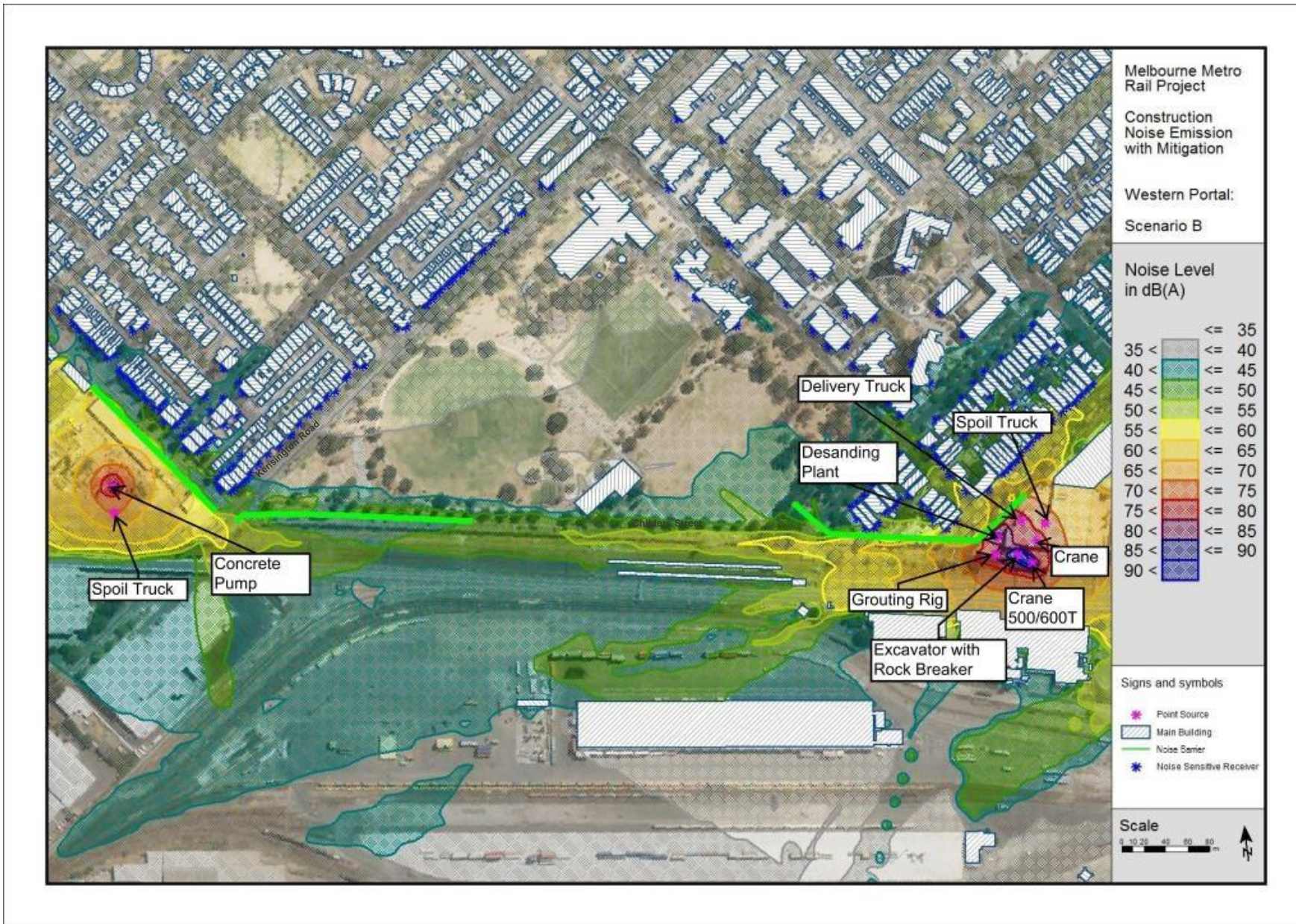


Figure A.49: Western Portal Construction Design, Scenario B Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.50: Western Portal Construction Design, Scenario C Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.51: Western Portal Construction Alternative Design Options, Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



Figure A.52: Western Portal Construction Alternative Design Options, Scenario B Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



Figure A.53: Western Portal Construction Alternative Design Options, Scenario C Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.54: Western Portal Construction Alternative Design Options, Scenario D Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



Figure A.55: Arden Precinct Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to during Normal Working Hours – with additional mitigation

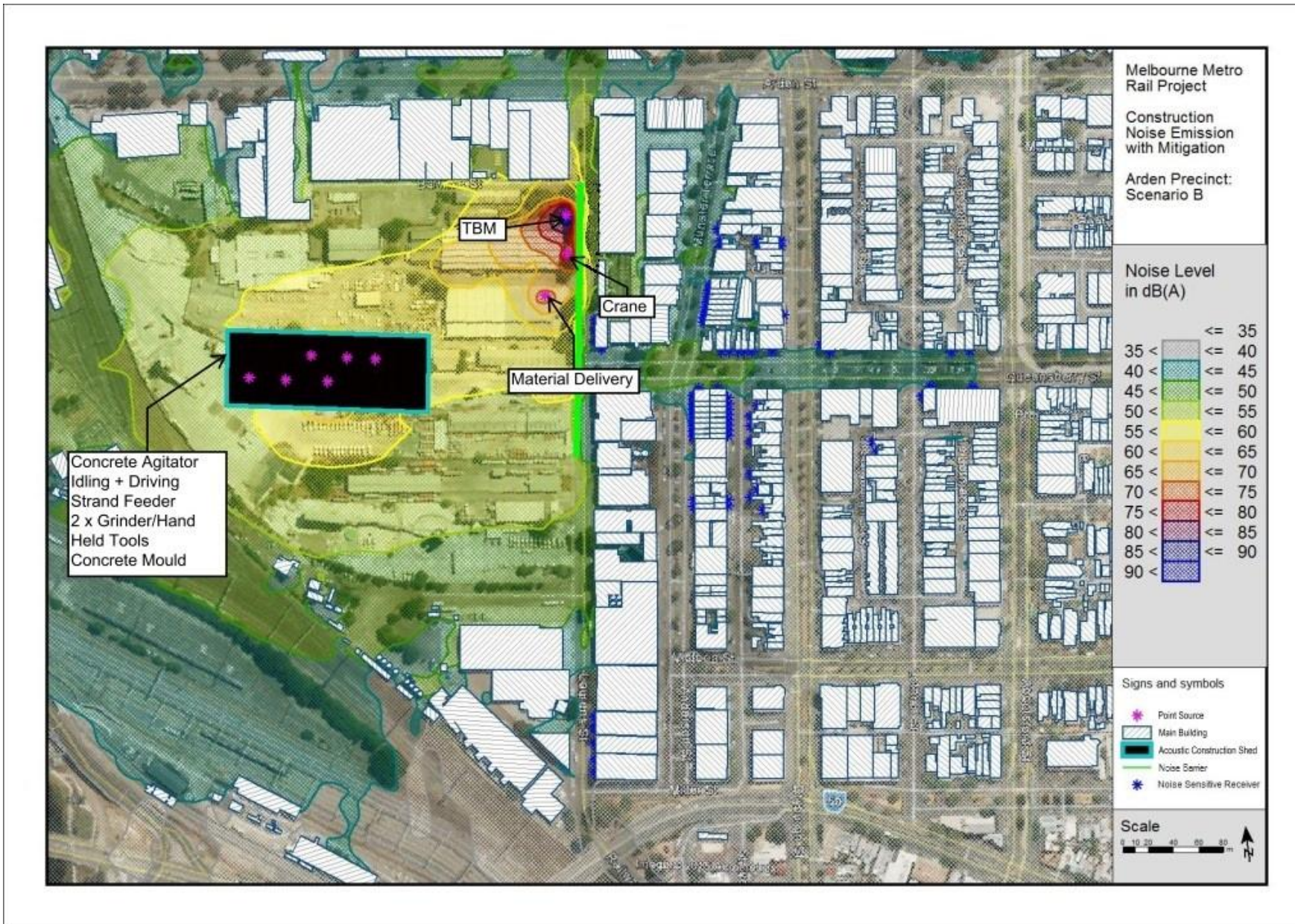


Figure A.56: Arden Precinct Scenario B Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



Figure A.57: Arden Precinct Scenario C Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Works – with additional mitigation



Figure A.58: Arden Precinct Scenario D Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours – with additional mitigation

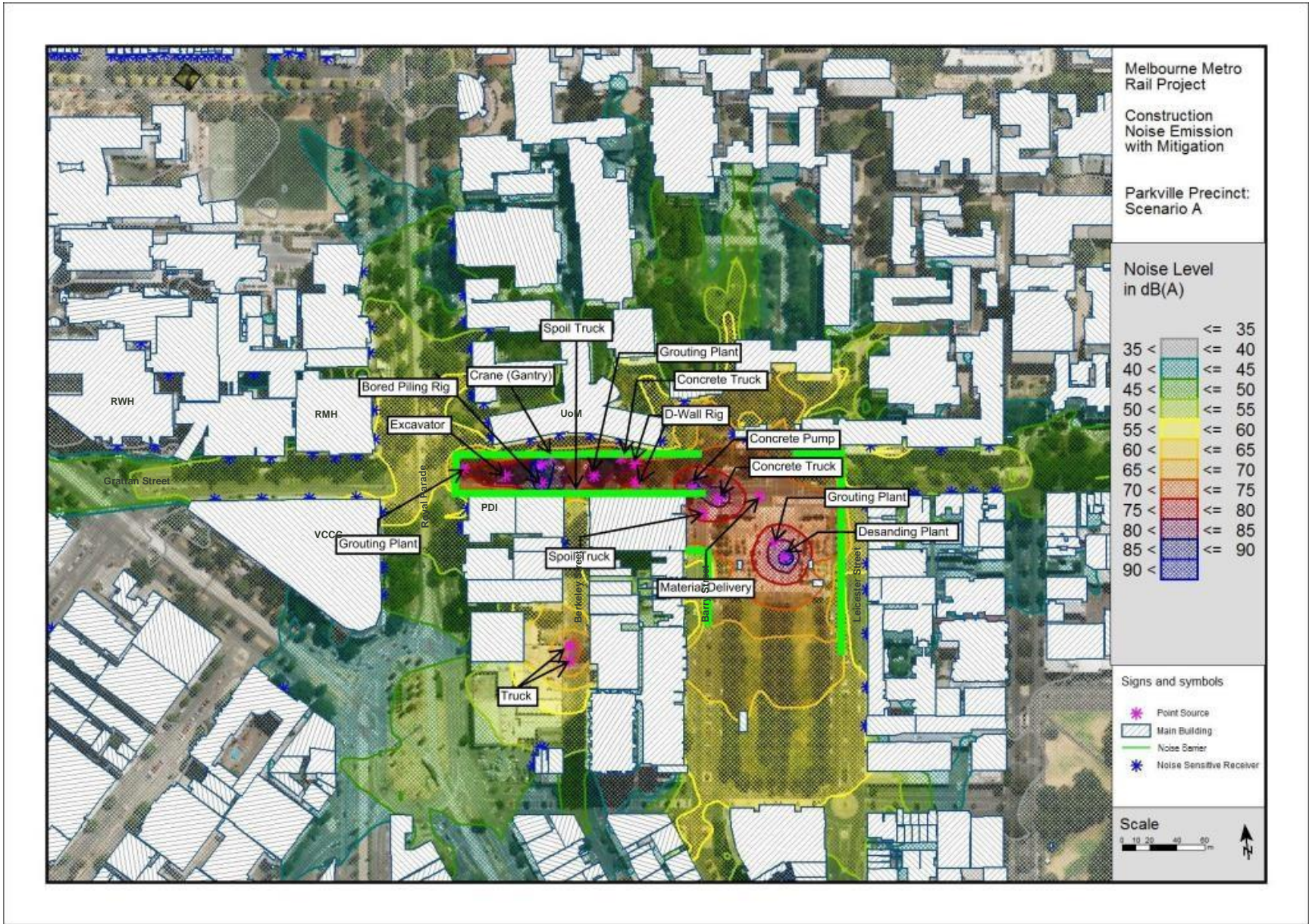


Figure A.59: Parkville Precinct Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.60: Parkville Precinct Scenario B Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours – with additional mitigation

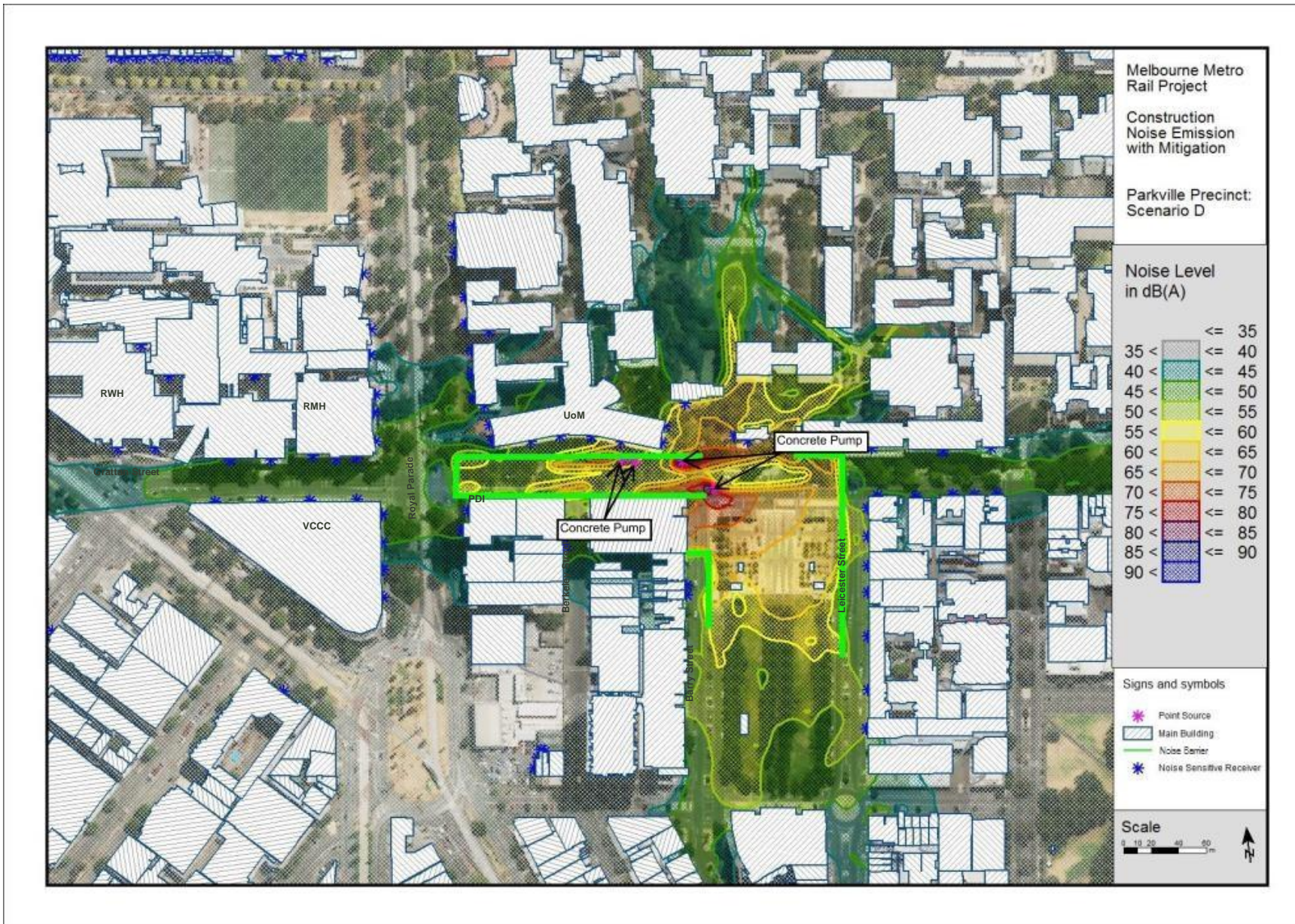


Figure A.61: Parkville Precinct Scenario D Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



Figure A.62: CBD South Precinct Scenario F Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



Figure A.64: Domain Precinct Scenario A(ii) Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken during Normal Working Hours – with additional mitigation



Figure A.65: Eastern Portal Precinct Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation

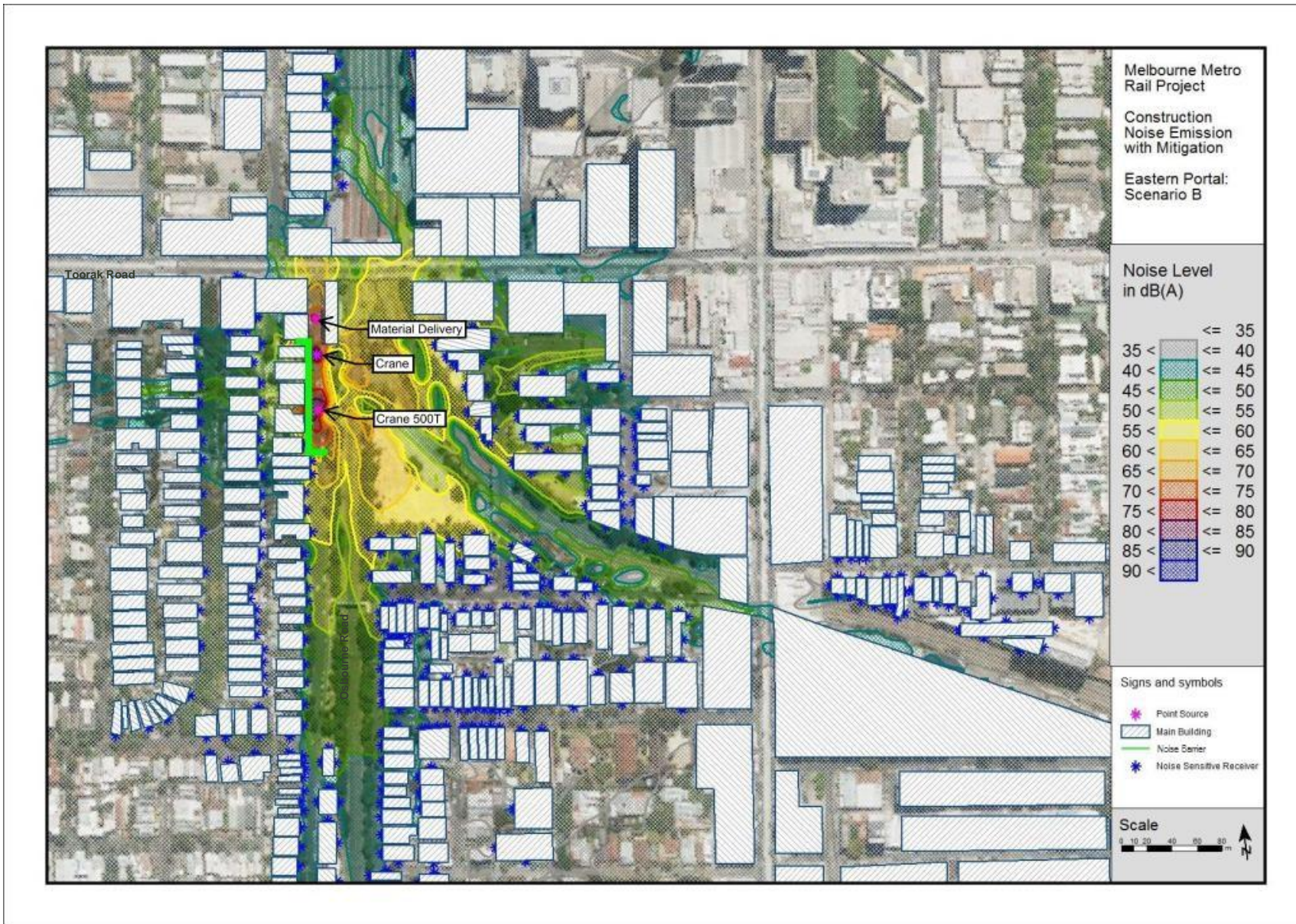


Figure A.66: Eastern Precinct Scenario B Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation

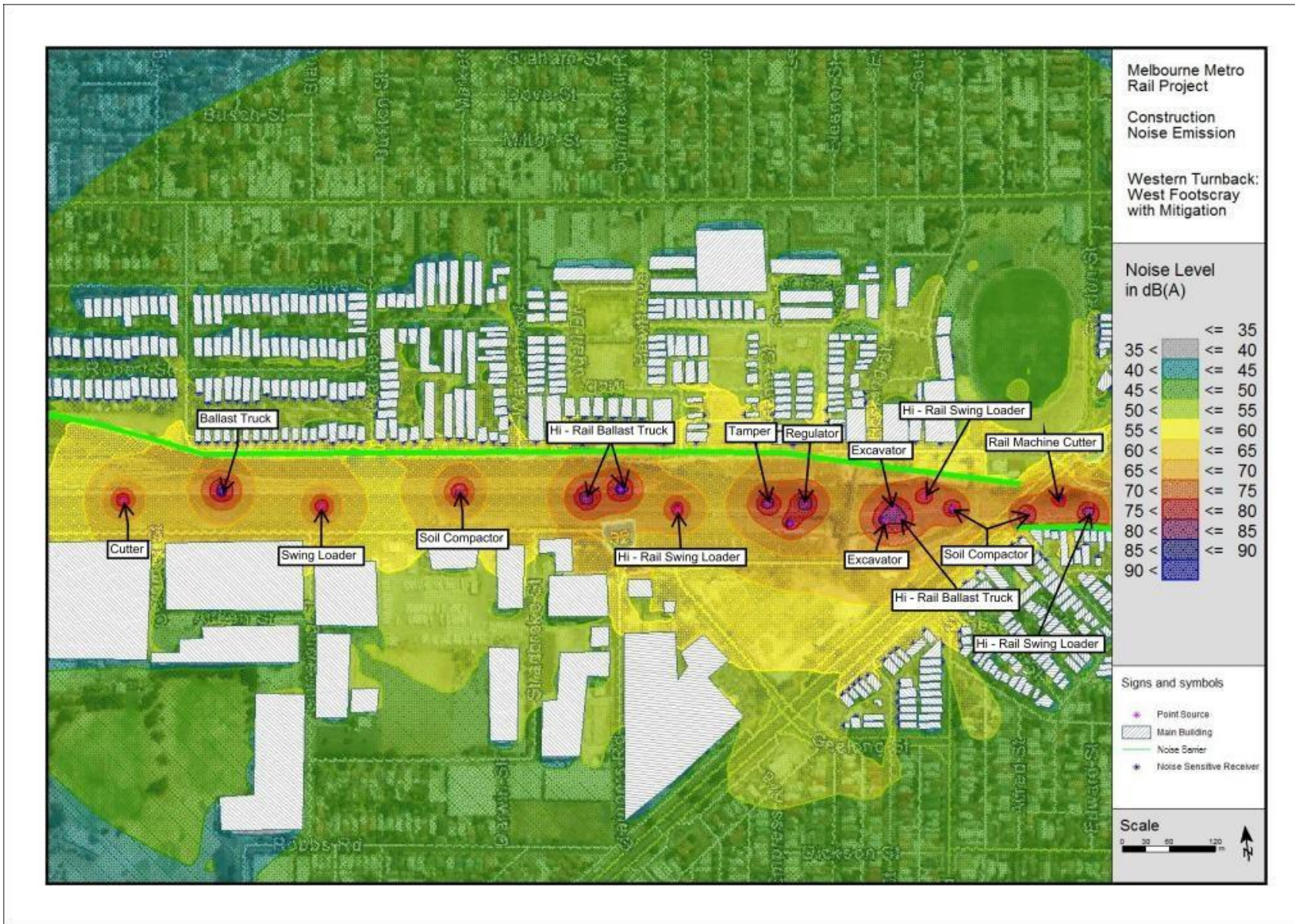


Figure A.67: West Footscray Turnback Scenario A Predicted Noise Levels at 1.5 m above ground – construction activities to be undertaken over 24 hours Unavoidable Work – with additional mitigation



A.5 Discussion

The assessment is based on all equipment operating concurrently which is conservative (worst case) as this is unlikely to occur in practice. Consequently, noise levels are expected to be lower than shown in the predictions.

A.5.1 Precinct 1: Tunnels

Fawkner Park:

Compliance with the requirements of EPA 1254 is predicted to be achieved.

The construction activities at Fawkner Park are proposed to occur during Normal Working Hours or be Unavoidable Work and Guideline Noise Levels do not apply. At this location a noise barrier is proposed (around the works) up to a height of 6 m to reduce construction noise at sensitive receivers. With this mitigation the construction noise levels are predicted to be in the order of 55 dB(A) at the nearby residential locations. This is lower than the baseline average measured noise levels at the sensitive receivers on Toorak Road of 69 dBL_{Aeq,day}, 68dB L_{Aeq,evening} and 65 dBL_{Aeq,night}.

The highest noise level predicted at the community building in Fawkner Park is in the order of 61 dBL_{Aeq}. This is on the façade of the building closest to the construction and in most areas of the building the predicted noise levels are lower. The highest predicted noise level is in the order of the average measured daytime external noise level at this facility of 61 dBL_{Aeq}.

Linlithgow Avenue Emergency Access Shaft:

Compliance with the requirements of EPA 1254 is predicted to be achieved.

At The Melburnian, 250 St. Kilda Road, Melbourne, in the vicinity of the Linlithgow Avenue Emergency Access Shaft the average daytime noise level measured was 63 dBL_{Aeq,day}.

The construction of the Emergency Access Shaft at Linlithgow Avenue is proposed to be undertaken during Normal Working Hours. The construction noise level predicted at the Arts Centre is in the order of the measured average noise level and the construction noise level predicted at the Melburnian is lower than the measured average level (without any mitigation). Noise barriers are not considered to be of significant acoustic value and therefore are not recommended.

Fawkner Park Emergency Access Shaft:

Compliance with the requirements of EPA 1254 is predicted to be achieved.

The construction activities are proposed to occur during Normal Working Hours. With a noise barrier up to a height of 6 m, construction noise levels, at most residential locations in the vicinity of the Fawkner Park Emergency Access Shaft, are predicted to be less than the baseline average noise level measured at 68 Toorak Road, of 69 dBL_{Aeq,day}. Some residences are at times predicted to experience noise levels marginally higher.

At the Christchurch Grammar School, noise levels of up to 50 dB(A) are predicted. This is lower than the average noise level measured at the community building in Fawkner Park.

A.5.2 Precinct 2: Western Portal

A.5.2.1 Design and Alternative Design Options

Compliance with the requirements of EPA 1254 is predicted to be achieved.

In the vicinity of the Western Portal, the average baseline noise levels during the day period were measured to be 67 dBL_{Aeq} at 138 Kensington Road and at 3 Childers Street and 59 dBL_{Aeq} at 1 Altona Street, Kensington. During the night period the measured average noise levels were 61 dBL_{Aeq} at 138 Kensington Road, 60 dBL_{Aeq} at 3 Childers Street and 53 dBL_{Aeq} at Altona Street.

In this precinct construction work is proposed to be generally undertaken during Normal Working Hours. The only construction works proposed to be undertaken outside of Normal Working Hours are Unavoidable Works and Guideline Noise Levels do not apply.

To manage noise impact, all rail cutting work would be conducted during Normal Working Hours as it is a noise intensive activity.

With mitigation (barriers up to 6 m high), the construction noise levels in the vicinity of the sensitive receivers on Kensington Road are predicted to be lower than the measured baseline average noise level during Normal Working Hours. During the night period, the construction noise levels are predicted to be in the order of the measured baseline average noise level for all scenarios except for Design Scenario A where some residences are predicted to experience noise levels marginally higher.

With mitigation the construction noise levels in the vicinity of the sensitive receivers on Childers Street are predicted to be lower than the measured baseline noise level during Normal Working Hours for all construction scenarios except for Design Scenario C where the noise levels are predicted to be higher than the baseline noise levels by the order of 3 dB at a small number of properties. During the night period, the construction noise levels are predicted to be in the order of the measured baseline noise levels for all scenarios.

With mitigation the construction noise levels in the vicinity of the sensitive receivers on Altona Street are predicted to be in the order of the measured baseline average noise levels during the day period. During the night period the construction noise levels in this area are predicted to be higher than the baseline average noise levels for the Design scenarios by up to 6 dB at a small number of properties. The residences between Altona Street and the construction have been removed, exposing these properties to construction noise (and also to noise from the railway and vehicles on Childers Street) for all scenarios. For the Alternative Design Options, the construction noise levels are predicted to be of the order of the measured baseline average noise levels except for Scenario B, where the predicted noise levels, at some residences, are marginally higher than existing.

Extensive community consultation would be required along with a construction noise (and vibration) management plan that may include respite / relocation where appropriate.

A.5.3 Precinct 3: Arden Station

Compliance with the requirements of EPA 1254 is predicted to be achieved with the mitigation proposed.

In the vicinity of the Arden Station construction work site, at 41 Laurens Street, the baseline average noise levels were measured to be 62 dBL_{Aeq} during the day and 56 dBL_{Aeq} during the night.

With noise mitigation (acoustic construction sheds and a noise barrier up to 6 m in height) noise levels are predicted to be equal to or less than the baseline levels, with the exception of Level 3 of 142-144 Laurens Street for Scenario A (during Normal Working Hours) and Scenario C during the night time period. Noise levels for Level 3 of 142-144 Laurens Street are predicted to be up to 4 dB higher than the average daytime and night time baseline noise levels.



The Guideline Noise Levels which apply for construction work outside of Normal Working Hours (for Scenario D) are predicted to be complied with at ground and first levels of the nearby apartment buildings. At levels 2 and 3 of 142-144 Laurens Street and Level 3 of 731-735 Queensberry Street it is predicted that the internal requirement for inaudibility may not be achieved (by up to 3 dB). If in practice this is the case and the residents are disturbed by construction noise then off-reservation treatment (building mitigation) in the form of improved glazing may be appropriate.

A.5.4 Precinct 4: Parkville Station

Compliance with the requirements of EPA 1254 is predicted to be achieved.

Parkville Station is a very busy area with trams, traffic, helicopters and recent construction work. In the vicinity of the construction work site, the baseline average noise levels during the day were measured to be up to 74 dBL_{Aeq}. Many of the buildings in this area are sealed air-conditioned buildings and therefore the building façade provides a higher level of mitigation with respect to noise ingress than typical residential buildings that may rely upon natural ventilation.

For Scenario A, prior to the installation of acoustic mitigation, the noise levels at the nearby hospitals are predicted to be in the order of the baseline noise levels. At the University of Melbourne Faculty of Medicine building and the Peter Doherty Institute the construction noise levels are predicted to be higher than the baseline average noise levels and potentially up to 77 dB(A) externally. This noise level would be regularly experienced in this precinct.

Once the roof deck is located over the station box (Scenario B) and noise barriers up to 6 m are in place construction noise levels are predicted to be similar to baseline average noise levels at the nearest residential / hospital sensitive receivers. Noise levels at all residential and hospital locations are predicted to comply with the Guideline Noise Levels outside of Normal Working Hours. The noise levels at the University of Melbourne Faculty of Medicine Building and the Peter Doherty Institute are predicted to be up to 74dB(A) (similar to existing).

With the mitigation proposed, external noise levels due to construction at the Victorian Cancer Care Centre, Royal Melbourne Hospital Melbourne Private Hospital are predicted to be in the order of the day time baseline average noise levels for all construction scenarios at all levels of the buildings.

While compliance with the Guideline Noise Levels is predicted at the properties on Pelham and Berkeley Streets, it is recommended that vehicle use associated with the construction laydown site nearby to the properties is kept to a minimum outside of Normal Working Hours.

Scenario C is *to be* undertaken during Normal Working Hours and is for access across Royal Parade. This work is to be conducted underground with an acoustic shed over the opening. Bored piling would occur during this time. Noise levels are predicted to be in the order of baseline average daytime noise level at the Victorian Cancer Care Centre and the Royal Melbourne Hospital (and lower elsewhere). It is noted that both the Royal Melbourne Hospital and the Victorian Cancer Care Centre have sealed facades that would mitigate noise ingress.

For Scenario D, which includes Unavoidable Works, noise levels are predicted to be lower than the night time baseline average noise levels at the nearby hospitals and residential locations.

The University of Melbourne Faculty of Medicine and the Peter Doherty Institute do not have residents / patients, however, both of these buildings house bio-resources which are sensitive to noise. In the case of the Peter Doherty Institute, the bio-resources are located both in a purpose-built space away from the façade (level 9) accessed via a noise lock and on the level 8 and 9 Grattan Street facade. The bio-resources are not expected to be adversely impacted by airborne construction noise as the predicted construction noise levels (external), while higher than the average baseline external noise levels, are not greater than the maximum external baseline noise levels. In the case of the Melbourne University Faculty of Medicine Building, the bio-resources are located

on the upper level adjacent to the façade - a space with no windows. If it is identified that bio-resources are at risk of disturbance from airborne noise from construction activities then treatment to the façade of the bio-resources room would be required. Bio-resources at other facilities are not expected to be disturbed by airborne construction noise as the noise levels are similar to existing levels.

A.5.5 Precinct 5: CBD North Station

Compliance with the requirements of EPA 1254 is predicted to be achieved.

In the vicinity of CBD North Station, the average noise levels during the day period were measured to be 61 dBL_{Aeq} at the sensitive receivers on Swanston Street and 69 dBL_{Aeq} at the sensitive receivers on Latrobe and Franklin Streets. The average noise levels during the night period were measured to be 57 dBL_{Aeq} at the sensitive receivers on Swanston Street and 63 dBL_{Aeq} at the sensitive receivers on Latrobe and Franklin Streets.

The demolition and shaft construction (Scenarios A and B) are proposed to be undertaken during Normal Working Hours and Guideline Noise Levels do not apply. Noise associated with these activities is predicted to be higher than the baseline average noise levels at some locations in the vicinity of these works. The noise levels associated with this work would, however, be similar to other construction work that occurs within the city during Normal Working Hours.

Scenario C would be 24-hour work and would be undertaken in acoustic construction sheds with noise locks (two sets of doors) so that when trucks enter the sheds there would only be one door open at a time. With these sheds in place there remains a risk that the night time noise requirement of inaudibility in a habitable room may not be achieved at the closest sensitive receivers when the roadheader is within the shed and not yet submerged within the tunnel. Once the roadheader becomes submerged within the tunnel compliance with the Guideline Noise Levels is predicted.

The Proponent would need to prepare a construction methodology which shows compliance with the Guideline Noise Levels for work to be undertaken outside of Normal Working Hours. Noise monitoring to confirm compliance would be required.

Scenario D is for a concrete pour and is proposed to be undertaken, where possible, during Normal Working Hours. It is, however, anticipated that it would often extend to outside of Normal Working Hours. This would be Unavoidable Works. The noise levels due to this activity are predicted to be less than the baseline night time average noise levels at most sensitive receivers. At some locations, the noise levels are predicted to be marginally higher than the baseline noise levels.

A.5.6 Precinct 6: CBD South Station

Compliance with the requirements of EPA 1254 is predicted to be achieved.

In the vicinity of CBD South Station the baseline average noise levels were measured to be 71 dBL_{Aeq} and 65 dBL_{Aeq} during the day and night periods respectively at Uni Lodge in Flinders Street and 65 dBL_{Aeq} and 60 dBL_{Aeq} during the day and night periods respectively at the Westin Hotel next to the City Square.

CBD South is a very busy area typical of a city with trams, vehicles and general city noise. There are a number of sensitive receivers in the vicinity of CBD South station including the Westin Hotel, the Town Hall (which hosts concerts and events) and residential dwellings.

Initially, construction activities (Demolition and Shaft Construction - Scenarios A and B) in CBD South would be undertaken during Normal Working Hours. The noise levels associated with these activities are predicted to at times be higher than the baseline average noise levels and would be typical of construction / demolition activities which are regularly undertaken in the city.

Once the station box has a roof deck, then work is proposed to be undertaken over 24-hours. These works would need to comply with the relevant Guideline Noise Levels which apply outside of Normal Working Hours.



Due to the height of the buildings in the vicinity of the construction works noise barriers would be of limited benefit and therefore acoustic construction sheds are proposed.

Scenario C would be 24-hour work and would be undertaken in acoustic construction sheds with noise locks (two sets of doors) so that when trucks enter the sheds there would only be one door open at a time. With these sheds in place there remains a risk that the night time noise requirement of inaudibility in a habitable room may not be achieved at some sensitive receivers when the roadheader is within the shed and not yet submerged within the tunnel. Once the roadheader becomes submerged within the tunnel compliance with the Guideline Noise Levels is predicted.

The Proponent would need to prepare a construction methodology which shows compliance with the Guideline Noise Levels if work is to be undertaken outside of Normal Working Hours.

Scenarios D and E are for Unavoidable Works (24-hours) and involve work on Flinders Street. These works are localised to the Flinders Street Area. It is anticipated that this work would take two to three months. Scenario E would include a small acoustic construction enclosure for jack hammering.

Scenario F is for a concrete pour. This is proposed to be undertaken where possible during Normal Working Hours. It is however anticipated that it would often extend to outside of Normal Working Hours. This would be Unavoidable Works. The noise levels due to this activity are predicted to be less than the baseline average night time average noise levels at most sensitive receivers. Some locations are predicted to experience noise levels marginally higher at times.

A.5.7 Precinct 7: Domain Station

Compliance with the requirements of EPA 1254 is predicted to be achieved.

In the vicinity of Domain Station the average noise levels during the day period were measured to be 64 dBL_{Aeq} and 59 dBL_{Aeq} during the day and night periods respectively at 1-29 Albert Road.

Initially construction would be undertaken during Normal Working Hours and Guideline Noise Levels do not apply. It is predicted that, with barriers up to a height of 6 m, construction noise levels would generally be similar to baseline average noise levels at sensitive receivers. There would, however, be residential locations on higher floors which would overlook the construction work sites and therefore would not benefit from the mitigation provided by the barriers. At time the construction noise levels are predicted to be marginally higher than the existing noise levels at these locations.

The TBM preparation for launch and the launch itself (Scenarios B and C) are Unavoidable Works and Guideline Noise Levels do not apply. The intention is for this work to be undertaken during Normal Working Hours, however, if it is not completed then it may be necessary to extend into the evening / night period. This is anticipated to occur twice for five to six weeks over the duration of the project. When this work is undertaken acoustic construction sheds would be in place. It is predicted that the noise levels due to these construction works would be of the order of the baseline noise levels at sensitive receivers. There would, however, be residential locations such as The Royce Hotel, 398 St. Kilda Road and The Domain where the predicted noise levels are marginally higher than existing.

A.5.8 Precinct 8: Eastern Portal

Compliance with the requirements of EPA 1254 is predicted to be achieved.

The construction work undertaken at the Eastern Portal would be either Unavoidable Work or during Normal Working Hours and therefore Guideline Noise Levels do not apply. However, it is recommended that noise barriers up to a height of 6 m are located around the construction activities to reduce the impact on the sensitive receivers.

At some locations, at some times, construction noise levels are predicted to be greater than the baseline average noise levels even with the noise barriers in place.

The noise barriers for construction noise would also mitigate noise from trains. Extensive community consultation would be required along with a construction noise (and vibration) management plan.

Baseline noise levels have been measured in a number of locations in this precinct. These are identified in Table A.5 along with comments regarding the impact of predicted construction noise levels in these areas.

Table A.5: Baseline Noise Levels at Eastern Portal

| Address | L _{Aeq} , dB | | Comment |
|---------------------------------|-----------------------|-------|--|
| | Day | Night | |
| 139 Osborne Street, South Yarra | 57 | 54 | Construction noise levels at the ground floor of residences are predicted to be of the order of baseline average noise levels. At upper levels the construction noise levels are predicted to be higher than the baseline average noise levels at times for both Scenario A and B. |
| 4 William Street, South Yarra | 53 | 45 | Residences in this area and towards the south may experience noise levels up to 6 dB higher than the night time baseline average noise levels for Scenario A. |
| 6 William Street, South Yarra | 69 | 62 | Upper floors of residences in this area may experience noise levels up to 6 dB higher than the night time baseline average noise levels for both Scenarios A and B. |
| 10 William Street, South Yarra | 50 | 46 | Residences closest to the rail corridor may experience noise levels up to 10 dB higher than the baseline average noise levels during the most intense periods of construction work for both Scenarios A and B. |
| 19 William Street, South Yarra | 51 | 44 | Residences closest to the rail corridor may experience noise levels up to 10 dB higher than the baseline average noise levels during the most intense periods of work for both Scenarios A and B. |
| 3 Chambers Street, South Yarra | 53 | 50 | Residences closest to the rail corridor may experience noise levels up to 10 dB higher than the baseline average noise levels during the most intense periods of work. Residences further to the east (near Chapel Street) may experience noise levels up to 6 dB higher than the baseline average noise levels for Scenario A. |

Where noise levels are predicted to be well above the existing noise levels and residents are adversely impacted then respite and or temporary relocation may be appropriate.

A.5.9 Precinct 9: Western Turnback

Compliance with the requirements of EPA 1254 is predicted to be achieved.

The construction work undertaken at the Western Turnback options would be either Unavoidable Work or during Normal Working Hours. Therefore, Guideline Noise Levels do not apply. However, it is recommended that noise barriers up to a height of 2.5 m are located around the construction activities to reduce the impact on the sensitive receivers.



With these noise barriers the highest noise levels are predicted to be 60 to 65 dB(A). This is less than noise levels typically adjacent to a busy road.



121 Exhibition Street

Melbourne VIC 3000

PO Box 23061 Docklands VIC 8012 Australia