ENIVRONMENTAL NOISE IMPACT ASSESSMENT

OF

PMAXP MARINE INFRASTRUCTURE

7 February 2025

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EXECUTIVE SUMMARY

MWPA is proposing through the Port Maximisation Project (PMaxP) to construct and upgrade marine based infrastructure in the Geraldton Port. Acoustic Engineering Solutions (AES) has been commissioned by Mid West Ports Authority (MWPA) to undertake environmental noise impact assessments of the proposed constructions and operations of PMaxP marine based infrastructure. The aims of assessments are to determine whether or not the proposed constructions and operations would comply with the Environmental Protection (Noise) Regulations 1997 (the Regulations).

An acoustic model has been developed and twelve worst-case construction and operational scenarios are modelled:

Scenario 1 to 7:	represent the worst-case daytime construction activities for different stages.
Scenario 8:	represents the worst-case day and night-time dredging operations.
Scenarios 9 & 10:	represent the individual operations of new berth 1 and 8.
Scenarios 11 & 12:	represent the worst-case Geraldton Port operations including one of the newly constructed berths 1 and 8/9.

Scenarios 9 to 12 are operational scenarios and can happen at any time of a day (during the day, the evening and the night). Scenarios 1 to 8 are construction scenarios and not covered by the Regulations, however MWPA has assessed the potential construction noise impacts on the surrounding community.

Eleven closest noise-sensitive and commercial receivers are selected for the detailed assessments of noise impact. Noise levels are predicted for calm and "worst-case" winds in 8 cardinal directions. The predicted noise levels are adjusted to account for their dominant characteristics and then assessed against the criteria set by the Regulations.

Wind directions have significant impact on the noise propagation. Risk analysis is undertaken to determine the percentages of different wind speeds under 8 cardinal directions in the Geraldton Port and surrounding area. Then the analysis results are used in the compliance assessments to determine the percentage occurrence of noise exceedance during the construction and operations.

The compliance assessments conclude that:

- For the daytime constructions on Monday to Saturday, exceedance is predicted with occurrence percentage of ≤16.2% at:
  - R2 and R7 (two noise-sensitive receivers) and most of the commercial receivers for scenario 1.
  - R7 (one noise-sensitive receiver) and most of the commercial receivers for scenarios 2, 4, 5 and 8.
  - R1, R2 and R7 (three noise-sensitive receivers) and most of the commercial receivers for scenario 3.

  - R8 to R10 (three commercial receivers) for scenario 6.
  - R10 (marginal exceedance at one commercial receiver) for scenario 7.
- For the daytime constructions on Sunday and Public holidays, exceedance is predicted at most receivers except for R2, R5 and R11. The exceedance occurrence percentage is ≤16.2%.
- For the worst-case evening and night-time dredging operations (scenario 8), exceedance is predicted at:
  - R1, R2 and R6 to R10 for the evening with the occurrence percentage of ≤16.4.
  - R1, R2 and R4 to R10 for the night with the occurrence percentage of ≤19.4.
- For the operations of berth 1 and 8 (scenarios 9 and 10), exceedance is predicted at:
  - R10 (a commercial receiver) during the day on Monday to Saturday (for scenario 9 only);
  - R7 (a noise-sensitive receiver) and R10 (a commercial receiver) during the operations of Sunday, public holiday and evening; but
  - R2, R4, R7 (three noise-sensitive receivers) and R10 (a commercial receiver) for the night-time operations.

When the operation of berth 1 or 8/9 is included, the (current) "worst-case" port operation (for scenario 11 or 12) does not comply with the Regulations at:

- R10 (a commercial receiver) during the day on Monday to Saturday.
- R2, R7 (two noise-sensitive receivers) and R10 (a commercial receiver) for the Sunday and public holidays.
- R1 to R4, R7 (five noise-sensitive receivers) and R10 (a commercial receiver) during the evening.
- R1 to R5, R7 (all of the closest noise-sensitive receivers) and R10 (a commercial receiver) during the night.

The annual occurrence percentage of exceedance is less than 1.7% for the "worst-case" port operation.

Most items of construction equipment/plant generate high level noises. To reduce construction noises, the following noise control measures are recommended:

- Piling noise is to be managed through restricting the activity to dayshift construction hours and where feasible managing the activity away from community peak periods (example mid-day breaks). Piling should also be managed according to weather and Port operational noise conditions.
- Enclose noisy fixed plant such as diesel generators and compressors.
- In consultation with the local Council (LGA), signage will be placed in Community areas and construction site interfaces to communicate the noise hazard associated with the area.
- Implement where reasonably practicable "other" best practice" construction noise controls as outlined in the construction noise management plan (CNMP).

Where reasonably practicable, temporary and mobile barriers are recommended at locations close to noisy sources for reducing construction noise propagation towards the noise-sensitive premises.

The major noise sources in the shiploading of berth 1 or 8/9 are mobile cranes, forklifts, vacuum truck and prime movers. Management of Berth 1 and Berth 8/9 will be via the existing MWPA Operational Noise Management Plan.

In Summary

The Geraldton Port is located close to the Geraldton city centre and surrounded by commercial premises. Noises from road traffic, sea-waves, wind, commercial premises, other industries and street activities are present during the days and the night. Background noises vary and are normally high in the port and surrounding area. The noise emitted from the port operations may therefore be masked and inaudible due to high level background noises in many scenarios.

While construction and vessel noise within the Port are exempt, where managed within the applicable regulations, the impacts from construction and operational noise from the Port that is related to PMaxP will be managed via:

- Construction Noise Management Plan; and
- The existing MWPA Operational Noise Management Plan.

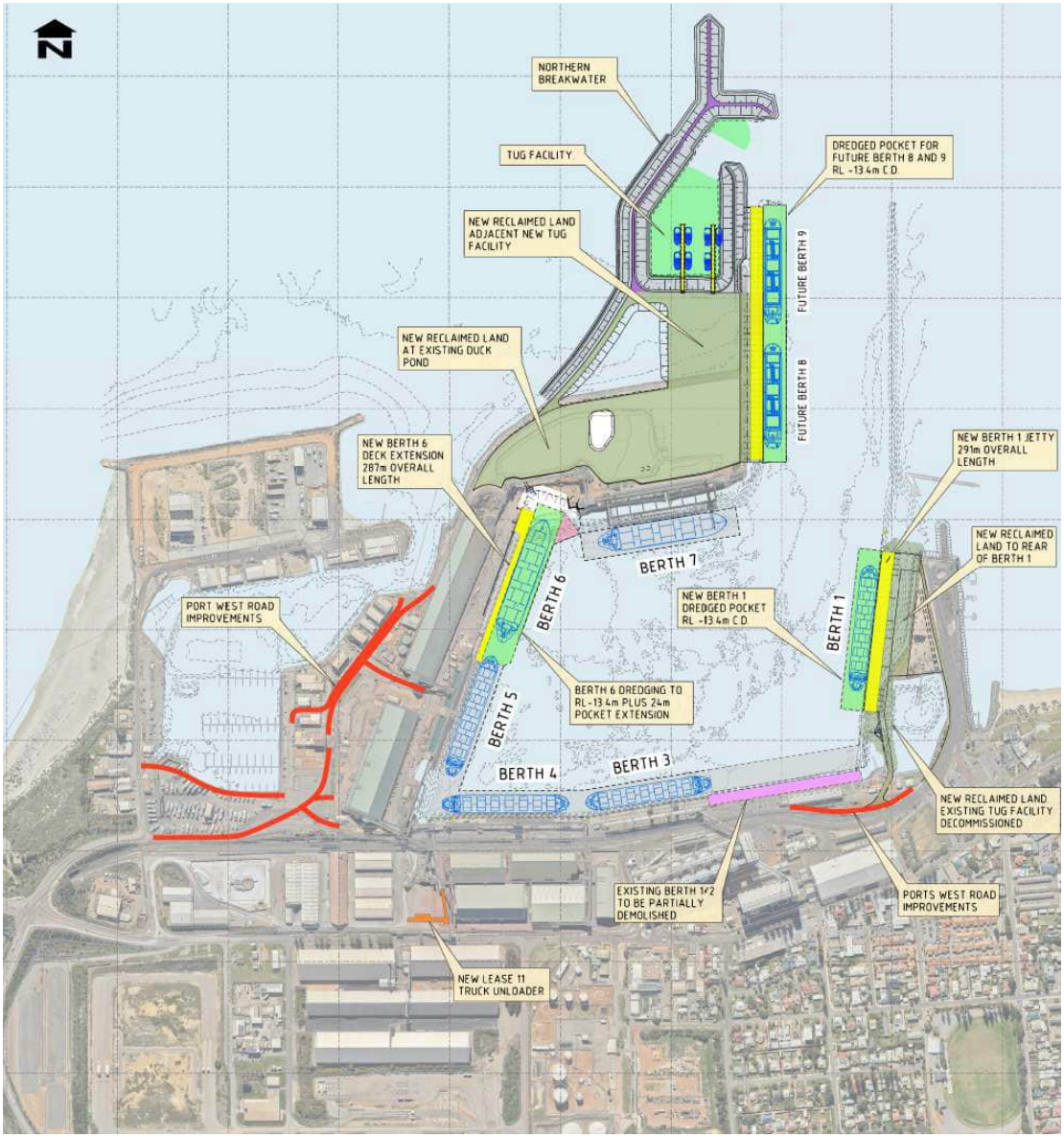

Figure 1: Upgraded Geraldton Port Layout.

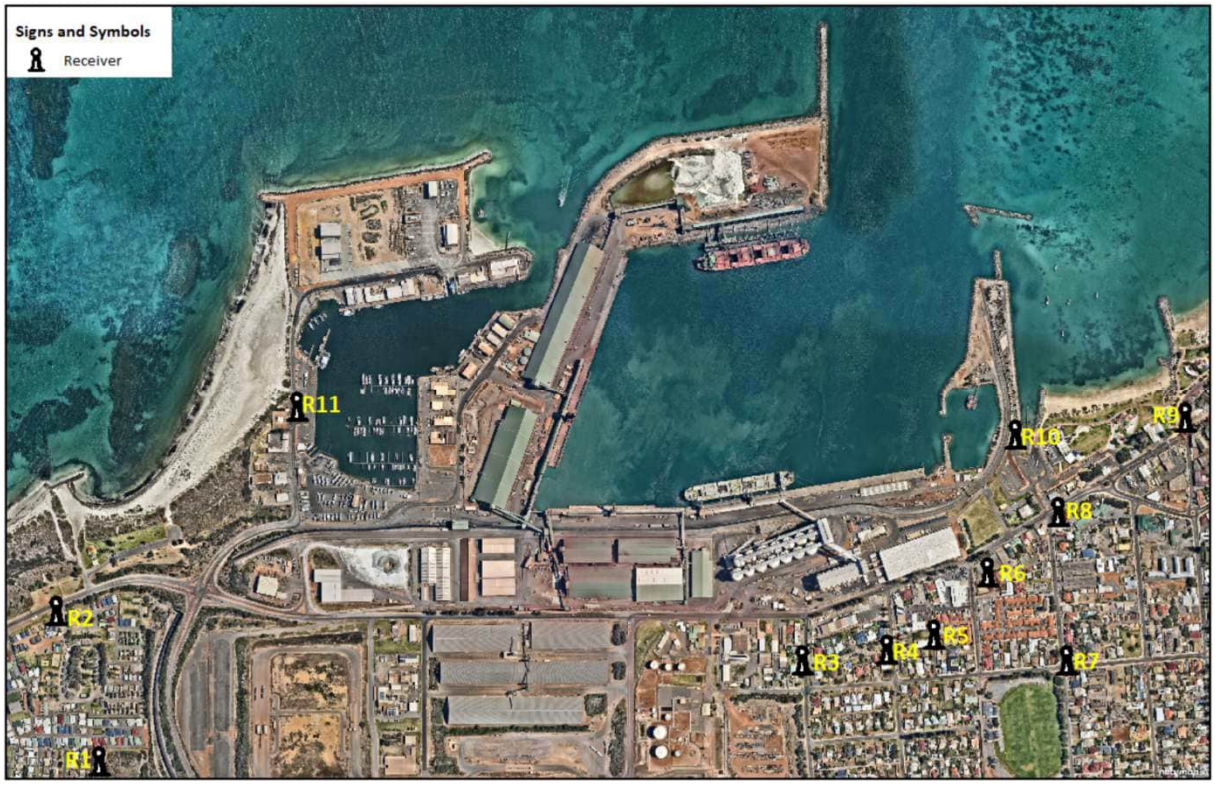

Figure 2: Locations of selected noise-sensitive receivers.

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1.0 INTRODUCTION

The Geraldton Port is operated by Mid West Ports Authority (MWPA) and located close to the city centre of Geraldton. The Geraldton Port is a multi-user port consisting of a multiple-berth inner harbour, port related infrastructure and storage sheds/tanks.

MWPA plans to upgrade the Port to facilitate increased utilisation, efficiency and infrastructure improvements. The Port Maximisation Project (PMaxP) will upgrade the marine based infrastructure at the Geraldton Port including:

- Capital Dredging at Berth 1 and Berth 6.
- Maintenance Dredging at Berth 1 and Tug Harbour.
- Construction of a New Berth 1 including an access causeway.
- Upgrade to Berth 6 – widening and lengthening of the existing berth.
- Construction of a New Tug Harbour.
- Capital Dredging at Berth 8/9 and Construction of New Berth 8/9.

Acoustic Engineering Solutions (AES) has been commissioned by MWPA to undertake environmental noise impact assessments of the proposed constructions and operations of PMaxP marine based infrastructure. The objectives of assessments are to determine whether or not the proposed constructions and operations would comply with the Environmental Protection (Noise) Regulations 1997 (the Regulations).

To achieve the objectives, the following activities are undertaken:

- Review provided information including the site layouts, construction phases and schedules, equipment model/list and utilisation;
- Develop an acoustic model;
- Predict the worst-case noise emissions at the closest noise sensitive receivers;
- Generate noise contours for the port and surrounding area under the 8 "worst-case" cardinal wind conditions;
- Undertake risk assessments based on the past 5-year weather conditions;
- Undertake compliance assessments of the worst-case noise emissions from:
  - the construction activities at different phases.
  - the individual operations of new berth 1 or 8.
- Recommend noise control options if required.

Figure 1 in APPENDIX A presents the upgraded Geraldton Port layout and its surrounding area including the proposed new berths and Tug harbour. Figure 2 in APPENDIX A presents the closest residential/commercial receivers selected for the detailed assessments of noise impact.

2.0 NOISE CRITERIA

Environmental noise management in Western Australia is implemented through the Environmental Protection (Noise) Regulations 1997 (the Regulations). The Regulations set noise limits which are the highest noise levels that can be received at noise-sensitive (residential), commercial and industrial premises. These noise limits are defined as 'assigned noise levels' at receiver locations. Regulation 7 requires that "noise emitted from any premises or public place when received at other premises must not cause, or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind".

Table 2-1 presents the assigned noise levels at various premises.

Table 2-1: Assigned noise levels in dB(A)

Type of Premises Receiving Noise	Time of Day	Assigned Noise Levels in dB(A)[1]		
		$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
Noise sensitive premises: highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + Influencing factor	55 + Influencing factor	65 + Influencing factor
	0900 to 1900 hours Sunday and public holidays	40 + Influencing factor	50 + Influencing factor	65 + Influencing factor
	1900 to 2200 hours all days	40 + Influencing factor	50 + Influencing factor	55 + Influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays	35 + Influencing factor	45 + Influencing factor	55 + Influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90

[1] Assigned level L_{A1} is the A-weighted noise level not to be exceeded for 1% of a delegated assessment period. Assigned level L_{A10} is the A-weighted noise level not to be exceeded for 10% of a delegated assessment period. Assigned level L_{Amax} is the A-weighted noise level not to be exceeded at any time.

For highly noise sensitive premises, an "influencing factor" is incorporated into the assigned noise levels. The influencing factor depends on road classification and land use zonings within circles of 100 metres and 450 metres radius from the noise receiver locations.

2.1 CORRECTIONS FOR CHARACTERISTICS OF NOISE

Regulation 7 requires that that "noise emitted from any premises or public place when received at other premises must be free of:

(i) tonality;
(ii) impulsiveness; and
(iii) modulation.

when assessed under Regulation 9".

If the noise exhibits intrusive or dominant characteristics, i.e. if the noise is impulsive, tonal, or modulating, noise levels at noise-sensitive premises must be adjusted. Table 2-2 presents the adjustments incurred for noise exhibiting dominant characteristics. That is, if the noise is assessed as having tonal, modulating or impulsive characteristics, the measured or predicted noise levels have to be adjusted by the amounts given in Table 2-2. Then the adjusted noise levels must comply with the assigned noise levels. Regulation 9 sets out objective tests to assess whether the noise is taken to be free of these characteristics.

Table 2-2: Adjustments for dominant noise characteristics

Adjustment where noise emission is not music. These adjustments are cumulative to a maximum of 15 dB.			Adjustment where noise emission is music	
Where tonality is present	Where Modulation is present	Where Impulsiveness is present	Where Impulsiveness is not present	Where Impulsiveness is present
+5 dB	+5 dB	+10 dB	+10 dB	+15 dB

2.2 CUMULATIVE NOISE

Regulation 7(2) states that "for the purposes of subregulation (1)(a), a noise emission is taken to ***significantly contribute to*** a level of noise if the noise emission as determined under subregulation (3) exceeds a value which is 5 dB below the assigned level at the point of reception".

The Guideline for the Assessment of Environmental Noise Emissions[2] (the Guideline) states that "*for an application for new industry or expansion of an existing one which is part of a large industrial estate, the department would require the applicant to achieve noise targets*

[2] Guideline: Assessment of Environmental Noise Emissions, Draft for Consultation, May 2021.

set below the '5 dB below' level in order to contain cumulative noise and meet the EPA's objectives".

2.3 CONSTRUCTION NOISE

Noise associated with the construction activities in WA is managed through Regulation 13, which presents the definitions of construction site and construction work, and provides management procedures for the construction noise.

2.3.1 Normal Construction Hours

Regulation 13(2) states that *Regulation 7 does not apply to noise emitted from a construction site as a result of construction work carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if the occupier of the premises or public place, shows that —*

(a) the construction work was carried out in accordance with control of environmental noise practices set out in section 4 of AS 2436-2010 Guide to noise and vibration control on construction, maintenance and demolition sites; and
(b) the equipment used on the premises was the quietest reasonably available; and
(c) if the occupier was required to prepare a noise management plan under subregulation (4) in respect of the construction site —
    (i) the noise management plan was prepared and given in accordance with the requirement, and approved by the CEO; and
    (ii) the construction work was carried out in accordance with the noise management plan, excluding any ancillary measure.

2.3.2 Out-of-Hours Construction

Regulation 13(3) states that *Regulation 7 does not apply to noise emitted from a construction site as a result of construction work carried out other than between the hours specified in subregulation (2) if the occupier of the construction site shows that —*

(a) the construction work was carried out in accordance with control of environmental noise practices set out in section 4 of AS 2436-2010 Guide to noise and vibration control on construction, maintenance and demolition sites; and
(b) the equipment used on the premises was the quietest reasonably available; and
(c) the construction work was carried out in accordance with a noise management plan, excluding any ancillary measure, in respect of the construction site —
    (i) prepared and given to the CEO not later than 7 days before the construction work commenced; and
    (ii) approved by the CEO;
    and
(d) at least 24 hours before the construction work commenced, the occupier of the construction site gave written notice of the proposed construction work to the

occupiers of all premises at which noise emissions received were likely to fail to comply with the standard prescribed under regulation 7; and

(e) it was reasonably necessary for the construction work to be carried out at that time.

2.4 EXEMPTIONS UNDER THE REGULATIONS

Regulation 3(1) states that *nothing in these regulations applies to the following noise emissions* —

(a) Noise emissions from the propulsion and braking systems of motor vehicles operating on a road;

(c) Noise emissions from trains or aircraft (other than model aircraft and trains operating on railways with a gauge of less than 70 cm);

(d) Noise emissions from a safety warning device fitted to a train or vessel;

(f) Noise emissions from the propulsion system or the movement through the water of a vessel operating in water other than water on private premises;

(g) Noise emissions —

(iv) for the purpose of giving a warning required under the *Mines Safety and Inspection Regulations 1995* regulation 8.26,

If every reasonable and practicable measure has been taken to reduce the effect of the noise emission consistent with providing an audible warning to people;

(h) Noise emissions from —

(i) a reversing alarm fitted to a motor vehicle, mobile plant, or mining or earthmoving equipment; or

(ii) a startup or movement alarm fitted to plant,

If —

(iii) it is a requirement under another written law that such an alarm be fitted; and

(iv) it is not practicable to fit an alarm that complies with the written law under which it is required to be fitted and emits noise that complies with these regulations;

(i) Noise emissions from an engine, equipment, machinery or plant on a vessel while the vessel is in a port.

All of the roads inside the Port including the access roads (such as Gillam Road) are managed and used by the Port only and not open to public. The Guideline[2] states that Regulation 3(1)(a) *does not apply to vehicles operating within any premises as the vehicles are not on a "road that is open to or used by the public"*.

2.5 INFLUENCING FACTORS

Eleven receivers surrounding the Geraldton Port are selected, as shown in Figure 2 in APPENDIX A, by consulting with the MWPA representative for detailed assessments of noise impact. Five of them (R6 and R8 to R11) are commercial receivers and the others represent noise-sensitive premises.

Influencing factor varies from residence to residence depending on the surrounding land use. No roads in the vicinity of the selected noise sensitive locations are sufficient to be classified as either the major or secondary roads and therefore no transport factors apply.

Table 2-3 presents the calculated assigned noise levels for the selected receivers.

Table 2-3: Calculated assigned noise levels in dB(A).

Closest Residents	Influencing Factor in dB	Assigned Noise levels in dB(A)			
		Day[3] Monday to Saturday	Day[4] for Sunday & Public Holiday	Evening[5]	Night[6]
L_{A10}					
R1	3	48	43	43	38
R2	2	47	42	42	37
R3	12	57	52	52	47
R4	7	52	47	47	42
R5	8	53	48	48	43
R6	N/A	60	60	60	60
R7	2	47	42	42	37
R8	N/A	60	60	60	60
R9	N/A	60	60	60	60
R10	N/A	60	60	60	60
R11	N/A	60	60	60	60
L_{AMax}					
R1	3	68	68	58	58
R2	2	67	67	57	57
R3	12	77	77	67	67
R4	7	72	72	62	62
R5	8	73	73	63	63

[3] 0700 to 1900 hours for Monday to Saturday.
[4] 0900 to 1900 hours for Sunday and public holidays.
[5] 1900 to 2200 hours for all days.
[6] 2200 to 0700 hours for Monday to Saturday and to 0900 hours for Sunday and public holidays.

Closest Residents	Influencing Factor in dB	Assigned Noise levels in dB(A)			
		Day[3] Monday to Saturday	Day[4] for Sunday & Public Holiday	Evening[5]	Night[6]
R6	N/A	80	80	80	80
R7	2	67	67	57	57
R8	N/A	80	80	80	80
R9	N/A	80	80	80	80
R10	N/A	80	80	80	80
R11	N/A	80	80	80	80

3.0 THE PORT MAXIMISATION PROJECT

The Port Maximisation Project is to construct and upgrade marine based infrastructure at the Geraldton Port including:

- Capital Dredging at Berth 1 and Berth 6.
- Maintenance Dredging at Berth 1 and Tug Harbour.
- Construction of a New Berth 1 including an access causeway.
- Upgrade to Berth 6 – widening and lengthening of the existing berth.
- Construction of a New Tug Harbour.
- Capital Dredging at Berth 8/9 and Construction of New Berth 8/9.

3.1 PROPOSED CONSTRUCTION HOURS

The construction activities take place 7 days a week over a two-year period.

Most of the construction activities are planned during the day (between 7am and 7pm) only, but a 24/7 operation is proposed for the dredging operations due to the significant costs associated with starting and stopping the dredge operation on a daily basis. The capital dredging occurs at:

- Berth 1 for 3 weeks in April 2026.
- Berth 6 for 6 weeks in May and June 2026.
- Berth 8/9 for 6 weeks in June to August 2026.

3.2 PROPOSED CONSTRUCTION ACTIVITIES

Broadly the construction scope is divided into Dredging, Tug Harbour construction, Civil Works, Piling and Structural Works. Piling will be intermittent during the day with expected 1 to 3 piles per day at berths B1, B6 or B8 and 4 piles per day at Tug Harbour. The pile driving time is about 20 to 40 minutes per pile.

Table A1 in APPENDIX A presents the construction schedule and plant utilisation. The main construction activities are detailed in the followings.

3.2.1 Dredging

Dredging activities include:

- Berth 1 Maintenance dredge pocket – 3 week period.
- Berth 1 Capital dredge pocket – 6 week period.
- Berth 6 Capital dredge pocket – 3 week period.
- Tug Harbour (Maintenance dredge) – 3 week period.
- Berth 8 Capital dredge pocket – 6 week period.

The equipment used during the maintenance dredging work is:

- 1 X Trailer Suction Hopper Dredge.

The equipment used for the daytime capital dredging works includes:

- 1 X BHD (Backhoe dredge (2000kW) or similar) with Excavator (Komatsu PC5500 or equivalent);
- 2 X Split Hopper Barge (650m3);
- 2 X 14T Bollard Pull tugs;
- 1 X Survey Vessel Class 1C;
- 2 X Articulated Dump Truck;
- 1 X 45T Excavator (CAT 350);
- 1 X WA 500 Front End Loader (CAT 980); and
- 1 X D10 Bulldozer.

The evening/night-time capital dredging will operate the following equipment:

- 1 X Conditioning Seabed Hyrdro Hammer; OR
- 1 X Trailer Suction Hopper Dredge.

3.2.2 Tug Harbor Seawall & Reclamation

The equipment used during this stage includes:

- 3 X Articulated Dump Truck (ADT);
- 1 X 140T Excavator;
- 2 X 45T Excavator (CAT 350);
- 1 X 30T Excavator with rock breaker;
- 1 X WA 500 Front End Loader (CAT 980);
- 1 X D10 Bulldozer;
- 1 X Grader;
- 1 X 20T Telehandler/Franna Crane;
- 1 X 600cfm Compressor;
- 1 X 150kva Generator (silenced);
- 1 X 5T Roller/Compactor; and
- 1 X 8-Wheel Dump Truck.

3.2.3 Civil/Earthworks at Berth 1, 6 or 8

The equipment used during this stage includes:

- 3 X Articulated Dump Truck (ADT);
- 1 X 140T Excavator;
- 1 X 100T Excavator (Landside "dredge") - Berth 6 ONLY;
- 1 X 45T Excavator (CAT 350);
- 1 X 30T Excavator with Rock Bbreaker;
- 1 X WA 500 Front End Loader (CAT 980);
- 1 X D10 Bulldozer;
- 1 X Grader;
- 1 X 5T Roller/Compactor; and
- 1 X Plate Compactor.

3.2.4 Piling (Tug and Berth 1, 6, 8 and 9)

The equipment used during the piling includes:

- 1 X 200T Mobile Crane;
- 1 X IHC S200 Piling Hammer;
- 1 X ABI 13/16 Sheet Piling Rig;
- 2 X 600cfm Compressor; and
- 2 X 150kva Generator (silenced).

3.2.5 B2 Berth Deck Removal and Pile Cutoff

The equipment used during B2 berth removal includes:

- 2 X Construction Saws (1500mm (60inch) Diesel 74HP);
- 1 X 30T Excavator with rock breaker;
- 2 X 200T Mobile Crane; and
- 2 X 8 Wheel Dump Trucks.

3.2.6 Structural Works at Berth 1, 6 or 8

The equipment used during the structural works includes:

- 1 X Concrete Delivery Truck;
- 1 X Concrete Pump (Putzmeister M56-5);
- 1 X 20T Front End Loader (FEL CAT 972);
- 1 X 200T Mobile Crane;
- 1 X 300T Mobile Crane (Manitwoc Crawler);
- 1 X 20T Telehandler;
- 1 x 40T Franna Crane;
- 3 X Elevated Work Platforms;
- 1 X Plate Compactor;
- 4 X Lincoln Welding Generator;
- 2 X 600cfm Compressor; and
- 2 X 150kva Generator (silenced).

3.2.7 All Construction Stages

For all of the above construction stages, the following mobile equipment and hand tools will operates intermittently:

- 2 X Forklifts;
- 2 X 20T Telehandler/Franna Crane;
- 2 X Bobcat loaders;
- 2 X Delivery Trucks;
- 2 X Service Trucks;
- 1 X Fuel Delivery Truck;
- 2 X Watercarts;

- 4 X Angle Grinders;
- 4 X Circular Saws;
- 4 X Impact Drivers; and
- 4 X Hammer Drill.

3.3 NEW BERTH OPERATONS

For new berths 1 and 8/9, no ship Loader and conveyor systems will be constructed. Un/loading in these berths is undertaken using mobile harbour cranes.

3.3.1 Berth 1

The equipment operated during the un/loading operation at new berth 1 includes:

- One mobile harbour Crane (Liebherr LHM 550 or similar).
- Four road trains/trucks: two driving inside the port, one idling on the new berth (1 or 8/9) being un/loaded and one idling waiting for un/loading on the new berth.
- Mobile equipment including one EWP, one forklift and one vacuum truck. The utilisation time is 30% for EWP, 100% for forklift and 15% for vacuum truck.

3.3.2 Berths 8 and 9

Berths 8 and 9 are designed for wind farm un/loading. The equipment operated at new berths 8 and 9 includes:

- 2 X Liebehrr 280 Mobile Harbour Cranes.
- 1 X 15T Forklift (eg Hyster/Hyundai).
- 1 X 3T Forklift.
- 2 X Sany SC1500A-5 Creeper Cranes.
- 2 X Snorkel A46JRT 35ft EWPs.
- 1 X Panoramic P25.6 Telehandler.
- 2 X Prime Movers with power packs, typically Kenworth K104; Volvo Fh16; Mercedes-Benz Actros 2660.

All of them are assumed to have utilisation of 100%.

4.0 NOISE MODELLING

4.1 METHODOLOGY

An acoustic model has been developed using SoundPlan v8.0 program, and the CONCAWE[7,8] prediction algorithms are selected for this study. The acoustic model is used to predict noise levels at the selected receivers and generate noise contours for the area surrounding the Geraldton Port.

The acoustic model does not include noise emissions from any sources other than from the construction and operations of PMaxP Marine Infrastructure. Therefore, noise emissions from nearby road traffic, aircraft, neighbouring industrial and commercial premises, sea waves, etc are excluded from the modelling.

4.2 INPUT DATA

4.2.1 Topography

Topographical data for the Geraldton Port and surrounding area was provided by MWPA in Auto-CAD dxf format. A reflective surface is assumed for (sea) water and port area while averaged absorptive coefficient of 0.6 is assumed for the other area.

The existing buildings and sheds in the port and surrounding area of interest are considered in the acoustic model.

4.2.2 Noise Sensitive Premises

In consultation with the MWPA representatives, eleven (11) closest noise-sensitive and commercial receivers are selected for the detailed assessment of noise impacts, as shown in Figure 2 in APPENDIX A.

Receivers R1 to R5 and R7 represent the noise-sensitive premises while the others (R6, R8 to R11) represent the commercial receivers.

4.2.3 Source Sound Power Levels

Table 4-1 presents the source sound power levels. Some of the source sound power levels are calculated from the information provided by MWPA while some of them are obtained from the measurements for the previous AES projects[9,10] in the Geraldton Port. Some (overall levels) of the construction equipment and hand tools are suggested by the Australian

[7] CONCAWE (Conservation of Clean Air and Water in Europe) was established in 1963 by a group of oil companies to carry out research on environmental issues relevant to the oil industry.
[8] The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, CONCAWE Report 4/81, 1981.
[9] Occupational noise survey of the Geraldton Port operations, AES Report (AES-890351-R01-A-11072024), 11 July 2024.
[10] Environmental noise impact assessment of Geraldton Port. AES Report (AES-890312-R02-0-21112023), 21 November 2023.

Standard 2436:2010[11] and their spectra are fitted from the AES database for similar equipment.

Table 4-1: Source sound power levels.

Noise Sources	Overall Sound Power Levels in dB(A)
Trailer Suction Hopper Dredge	112
BHD (Backhoe dredge (2000kW) or similar)	116
Split Hopper Barge	112
14T Bollard Pull Tugs	103
Survey Vessel Class 1C	106
45T Excavator (CAT 350)	107
WA 500 Front End Loader (CAT980 FEL)	103
D10 Bulldozer	113
Service Truck	97
Fuel Delivery Truck	97
Water Cart	107
Articulated Dump Truck (ADT)	97
140T Excavator	113
100T Excavator (Landside “dredge”)	111
30T Excavator with Rock Breaker	118
Grader	104
200T Mobile Crane	106
300T Mobile Crane (Manitwoc Crawler)	106
IHC S200 Piling Hammer L_{Amax}	137
ABI 13/16 Sheet Piling Rig	111
20T Telehandler	94

[11] AS2436-2010, Guide to Noise and Vibration Control on Construction, Demolition and Maintenance Sites, Standards Australia.

Noise Sources	Overall Sound Power Levels in dB(A)
600cfm Compressor	101
150kva Generator (silenced)	97
5T Roller / compactor	109
Plate Compactor	109
Bobcat loader	102
8-Wheel Dump Truck	107
Construction Saws	108
Concrete Delivery Truck	108
Concrete Pump (Putzmeister M56-5)	98
20T Front End Loader (FEL CAT 972)	109
40T Franna Crane	104
Elevated Work Platform (EWP)	100
Hyundai Forklift 35DT-7	102
Lincoln Welding Generator	100
Liebherr LHM 550 Crane	109
Driving Road Train	98
Idling Road Train	91
Vacuum Truck	109
Liebehrr 280 Mobile Harbour Crane	106
Sany SC1500A-5 Creeper Crane	106
3T Forklift	91
Prime Movers with power pack	102
Angle Grinder	108
Circular Saw	107
Impact Driver	102

Noise Sources	Overall Sound Power Levels in dB(A)
Hammer Drill	110

4.3 METEOROLOGY

SoundPlan calculates noise levels for defined meteorological conditions. In particular, temperature, relative humidity, wind speed and direction data are required as input to the model. For this study the default "worst-case" meteorological conditions[12] are assumed, as shown in Table 4-2. Since the evening and night have the same worst-case meteorological conditions, their predicted noise levels will be the same if the noise sources are the same.

Table 4-2: Worst-case meteorological conditions.

Time of day	Temperature Celsius	Relative Humidity	Wind speed	Pasquill Stability Category
Evening (0700 --- 1900)	20 Celsius	50%	4m/s	E
Evening (1900 --- 2200)	15 Celsius	50%	3m/s	F
Night (2200 --- 0700)	15 Celsius	50%	3m/s	F

4.4 OPERATIONAL SCENARIOS

By consulting with the MWPA representative and based on the provided information and construction schedule shown in Table A1 in APPENDIX A, twelve (12) construction and operational scenarios are modelled as followings:

Scenario 1: Represents the following daytime construction activities in April 2026:

- Berth 1 Capital Dredge;
- Tug Harbour Seawalls and Reclamation; and
- Berth 1 Civil/Earthworks.

Scenario 2: Represents the following daytime construction activities in July & August 2026:

- Berth 8/9 Capital Dredge;
- Tug Harbour Seawalls and Reclamation;
- Berth 6 Civil/Earthworks;
- Berth 1 Piling; and

[12] Guideline: Assessment of Environmental Noise Emissions, Draft for Consultation, May 2021.

- Berth 1 Structural (Deck Install).

Scenario 3: Represents the Piling Hammer operation for Berth 1 Piling. Piling Hammer generates high impact noise L_{AMax}.

Scenario 4: Represents the following daytime construction activities in October to December 2026:

- Tug Harbour Seawalls and Reclamation;
- Tug Harbour Piling; and
- Berth 1 Structural (Deck Install).

Scenario 5: Represents the following daytime construction activities in May 2027:

- Maintenance Dredging Works at Tug Harbour;
- Berth 6 Piling; and
- Berth 6 Structural (Deck Install).

Scenario 6: Represents the following daytime construction activities in August 2027:

- Berth 8 Civil/Earthworks;
- Berth 2 Berth Demolition;
- Berth 8 Piling; and
- Berth 6 Structural.

Scenario 7: Represents the following daytime construction activities in November 2027 to March 2028:

- Berth 8 Structural.

Scenario 8: Represents the worst-case day and evening/night-time dredging operations in April 2026:

- Berth 1 Capital Dredge.

Scenario 9: Represents the worst-case operation of new berth 1.

Scenario 10: Represents the worst-case operation of new berth 8.

Scenario 11: Scenario 9 plus the current worst-case Geraldton Port Operation[13].

Scenario 12: Scenario 10 plus the current worst-case Geraldton Port Operation[13].

Scenarios 1 to 7 represent the construction activities occurring during the day only (between 7am and 7pm) while scenario 8 represents the construction activities occurring during the day, the evening and the night (24 hours a day). Scenarios 9 to 12 are the operational scenarios.

The number and utilisation percentages of equipment operating in each of the construction scenarios are listed in Table A1 in APPENDIX A. For all of the daytime construction scenarios (1, 2 and 4 to 7), the following mobile equipment and hand tools are considered:

Mobile equipment: 2 X Forklifts;
2 X 20T Telehandlers/Franna Cranes;
2 X Bobcat loaders;

[13] Worst-case operational scenarios 1 (for the day) and 1A (for the night) in the acoustic report of "Environmental Noise Assessment of the Geraldton Port" AES report (NO: AES-890312-R02-0-21112023).

	2 X Delivery Trucks; 2 X Service Trucks; and 1 X Fuel Delivery Trucks.
Hand tools:	4 X Angle Grinders; 4 X Circular Saws; 4 X Impact Drivers; and 4 X Hammer Drills.

Scenario 3 considers the Piling Hammer impact noise in isolation for its maximum noise L_{AMax} emission during Berth 1 piling, which is the worst-case piling location to R3 to R10.

The noises from capital/maintaince dredge operations are exempted from the Regulations because the dredging equipment operates on vessels in the water of the port (see section 2.4). They are included in the construction scenarios because MWPA wants to assess their noise impacts on the surrounding community.

Scenarios 9 and 10 represent the individual shiploading operations at New Berth 1 and 8. As stated in section 3.3, shiploading in new berths 1 and 8/9 is undertaken using mobile harbour crane (not via conveyor system). The shiploading equipment is listed in section 3.3.

5.0 MODELLING RESULTS

5.1 POINT CALCULATIONS

Noise levels for the 12 operational scenarios are predicted at the 11 noise-sensitive and commercial receivers for calm and worst-case winds in 8 cardinal directions. The full point prediction results for different wind conditions are presented in Table B1 to Table B17 in APPENDIX B. Those tables indicate that wind direction has a big impact on the noise levels received at the selected receivers.

Table 5-1 and Table 5-2 summarise the predicted worst-case noise levels in dB(A) at the selected receivers. For construction scenarios 1 to 7, the predicted noise levels are the daytime A-weighting noise levels. For scenario 3, the predicted noise levels are the daytime A-weighting maximum noise levels L_{AMax}. For construction scenario 8 and operational scenarios 9 to 12, the day and night-time A-weighting noise levels are predicted.

Table 5-1: Predicted worst-case daytime construction noise levels in dB(A).

Receivers	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
	Day	Day	Day	Day	Day	Day	Day
R1	41.5	37.7	56.6	36.6	32.5	39.2	28.3
R2	42.2	40.4	56.0	38.4	31.9	39.1	33.5
R3	36.9	37.7	50.9	32.1	32.3	40.2	29.0
R4	43.0	46.6	56.9	39.8	39.2	45.3	41.3
R5	41.6	40.6	55.9	36.5	35.9	38.4	32.5
R6	59.9	55.8	74.5	54.6	49.7	47.5	47.0
R7	50.8	48.0	66.7	45.9	43.6	40.1	40.1
R8	56.8	54.4	75.9	52.2	52.7	51.0	46.4
R9	57.8	55.7	74.2	52.1	51.0	51.3	49.0
R10	65.4	61.6	82.1	60.2	57.7	59.6	50.8
R11	49.6	47.8	63.5	45.8	39.7	46.3	40.2

Table 5-2: Predicted worst-case noise levels in dB(A).

Receivers	Scenario 8		Scenario 9		Scenario 10		Scenario 11		Scenario 12	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
R1	38.3	38.8	31.9	32.4	28.2	28.6	42.5	42.8	42.3	42.5
R2	38.5	38.9	32.0	32.3	33.8	34.2	44.7	44.4	44.8	44.6
R3	33.9	33.9	28.4	28.5	28.8	28.9	49.1	48.8	49.2	48.8
R4	38.9	39.0	33.9	34.0	38.9	39.0	45.1	44.9	45.8	45.6
R5	38.4	38.5	32.6	32.6	32.2	32.3	41.5	41.3	41.5	41.3
R6	56.2	56.3	49.8	49.9	46.2	46.4	51.5	51.5	49.4	49.5
R7	48.0	48.1	41.9	42.0	39.4	39.7	44.0	44.1	42.7	42.8
R8	55.4	55.5	45.5	45.6	46.7	46.9	52.7	52.6	52.9	52.9
R9	55.0	55.0	49.8	49.8	47.6	47.7	53.9	53.8	53.2	53.1
R10	62.6	62.6	56.4	56.5	50.0	50.1	59.4	59.4	57.4	57.2
R11	46.0	46.3	39.9	40.2	39.9	40.1	52.6	51.7	52.6	51.7

Comparison between scenarios 9 and 11 (or 10 and 12) indicates that the operational noise in berth 1 (or 8/9) is much below the noise radiated from the current worst-case Geraldton Port Operation at most of the representative receivers.

5.2 NOISE CONTOURS

Noise contours are generated for the default "worst-case" meteorological conditions of 8 cardinal wind directions and presented in Figure 3 to Figure 138 in APPENDIX C. These noise contours represent the noise propagation envelops at 1.5m above the ground.

Figure 3 to Figure 138 show that wind direction has a big impact on the noise propagation. North-easterly to south-easterly winds enhance the noise propagations towards R1, R2 and R11 while westerly to northerly winds increase the noise levels at R3 to R10.

6.0 RISK ASSESSMENT

The noise modelling results presented in Table B1 to Table B17 in APPENDIX B show that the predicted noise levels at any given receiving location vary significantly depending on the prevailing weather conditions. In order to assess the actual noise impact on the receiving locations, 4.5 year (mid-2018 to 2022) meteorological data are analysed to determine the frequency of occurrence of specific weather conditions.

6.1 REVIEW OF METEOROLOGICAL CONDITIONS

Wind speed and direction data provided by MWPA are analysed to determine the percentage occurrence that exceedance could occur at the selected receiving locations. Historical data dating back over 4.5 years was used in the analysis. Table 6-1 to Table 6-3 present the percentage occurrence of worst-case wind speeds (4m/s for day time and 3m/s for evening/night time) for 8 cardinal wind directions.

Detailed percentage occurrence for different wind speeds and directions is presented in Table E1 and Table E2 in APPENDIX D.

Table 6-1: Percentage occurrence of wind-speeds from 3.5m/s to 4.5m/s during the day (7am to 7pm).

Month	Percentage Occurrence for Windspeed of 4m/s During the Day								Total
	N	NE	E	SE	S	SW	W	NW	
Jan	0.1%	0.3%	0.9%	0.8%	3.4%	4.8%	0.2%	0.0%	10.5%
Feb	0.2%	0.2%	1.6%	1.0%	4.6%	6.0%	1.1%	0.0%	14.7%
Mar	0.3%	0.9%	2.8%	1.3%	4.6%	5.3%	1.1%	0.0%	16.2%
Apr	0.2%	0.3%	3.7%	2.2%	3.9%	5.2%	0.9%	0.0%	16.2%
May	0.6%	1.8%	4.3%	1.7%	3.1%	2.8%	0.9%	0.0%	15.4%
Jun	0.9%	2.0%	6.1%	1.5%	2.1%	2.2%	1.1%	0.0%	15.9%
Jul	0.7%	1.6%	4.2%	0.9%	2.7%	3.1%	1.0%	0.0%	14.2%
Aug	0.8%	1.2%	4.9%	2.3%	2.4%	2.5%	1.4%	0.0%	15.6%

Month	Percentage Occurrence for Windspeed of 4m/s During the Day								Total
	N	NE	E	SE	S	SW	W	NW	
Sep	0.9%	0.8%	2.9%	1.5%	2.8%	6.0%	1.4%	0.0%	16.2%
Oct	0.2%	0.2%	0.7%	1.5%	3.1%	6.9%	1.7%	0.0%	14.4%
Nov	0.3%	0.2%	0.7%	1.0%	2.7%	6.2%	1.6%	0.1%	12.7%
Dec	0.3%	0.3%	1.0%	1.0%	2.9%	6.4%	1.2%	0.0%	13.0%
Annum	0.5%	0.8%	2.8%	1.4%	3.2%	4.8%	1.1%	0.0%	14.6%

Table 6-2: Percentage occurrence of wind-speeds from 2.5m/s to 3.5m/s during the evening (7pm to 10pm).

Month	Percentage Occurrence for Windspeed of 3m/s During the Evening								Total
	N	NE	E	SE	S	SW	W	NW	
Jan	0.1%	0.0%	0.2%	0.5%	2.6%	3.1%	0.2%	0.0%	6.8%
Feb	0.4%	0.5%	0.6%	1.1%	5.0%	3.1%	0.1%	0.0%	10.7%
Mar	0.0%	0.1%	1.0%	3.2%	5.0%	2.8%	0.1%	0.0%	12.2%
Apr	0.2%	0.0%	2.1%	4.8%	4.3%	4.5%	0.6%	0.0%	16.4%
May	0.4%	0.9%	5.5%	9.7%	1.6%	0.8%	0.5%	0.0%	19.5%
Jun	1.0%	1.1%	11.4%	8.3%	0.9%	1.6%	0.8%	0.0%	25.2%
Jul	0.3%	1.1%	5.2%	6.7%	1.6%	1.4%	0.4%	0.1%	16.8%
Aug	0.4%	0.2%	5.1%	8.1%	2.3%	2.9%	1.1%	0.1%	20.2%
Sep	0.9%	0.3%	0.9%	5.7%	4.1%	4.1%	0.6%	0.0%	16.6%

Month	Percentage Occurrence for Windspeed of 3m/s During the Evening								Total
	N	NE	E	SE	S	SW	W	NW	
Oct	0.4%	0.2%	0.0%	0.5%	3.2%	4.2%	1.9%	0.0%	10.4%
Nov	0.0%	0.0%	0.0%	1.1%	2.6%	3.9%	0.2%	0.0%	7.9%
Dec	0.4%	0.1%	0.3%	0.7%	2.8%	2.9%	0.6%	0.1%	8.0%
Annum	0.4%	0.4%	2.7%	4.2%	3.0%	2.9%	0.6%	0.0%	14.2%

Table 6-3: Percentage occurrence of wind-speeds from 2.5m/s to 3.5m/s during the night (10pm to 7am).

Month	Percentage Occurrence for Windspeed of 3m/s During the Night								Total
	N	NE	E	SE	S	SW	W	NW	
Jan	0.2%	0.2%	0.7%	4.4%	5.2%	2.4%	0.4%	0.0%	13.5%
Feb	0.7%	0.4%	2.3%	5.4%	4.3%	1.9%	0.2%	0.0%	15.2%
Mar	0.4%	0.7%	3.6%	6.2%	4.8%	2.0%	0.4%	0.0%	18.0%
Apr	0.2%	0.2%	6.8%	8.9%	1.7%	1.1%	0.5%	0.0%	19.4%
May	0.7%	2.2%	8.4%	6.7%	0.3%	0.4%	0.4%	0.0%	19.0%
Jun	0.4%	1.6%	14.9%	3.1%	0.6%	0.7%	0.4%	0.0%	21.8%
Jul	0.2%	2.2%	9.4%	3.4%	0.5%	0.7%	0.5%	0.0%	17.0%
Aug	0.5%	0.8%	10.5%	4.5%	0.9%	1.3%	0.9%	0.1%	19.4%
Sep	0.5%	1.1%	6.0%	7.8%	1.9%	2.2%	1.1%	0.0%	20.6%
Oct	0.1%	0.2%	3.2%	8.2%	3.4%	2.8%	1.6%	0.1%	19.6%

Month	Percentage Occurrence for Windspeed of 3m/s During the Night								Total
	N	NE	E	SE	S	SW	W	NW	
Nov	0.1%	0.0%	2.0%	6.8%	4.8%	3.2%	1.0%	0.1%	18.1%
Dec	0.5%	0.3%	1.7%	5.6%	4.6%	3.0%	0.3%	0.0%	15.9%
Annum	0.4%	0.8%	5.8%	5.9%	2.7%	1.8%	0.6%	0.0%	18.1%

6.2 WIND INDUCED NOISES

The Regulations assess the noise impact only for wind speeds of:

- 4m/s for daytime operations; and
- 3m/s for evening/night-time operations.

The Guideline indicates that the wind speeds exceeding the above speed values may elevate background noise levels from local vegetation and can dominate the noise emissions. Therefore, for wind speeds above 4m/s during the days or 3m/s during the evening or the night, it is possible that the port noise emissions may exceed the assigned levels; however it is unlikely that the port noises would be audible above wind induced noises.

7.0 COMPLIANCE ASSESSMENT

As indicated in section 2.3, construction noise is not required to comply with the assigned noise levels. But MWPA wants to assess the construction noises for determining if a construction noise management plan is required.

New berths 1 and 8/9 are "expansion of an existing one which is part of a large industrial estate" (the Geraldton Port). As indicated in section 2.2, the Guideline requires that *"the applicant to achieve noise targets set below the '5 dB below' level in order to contain cumulative noise and meet the EPA's objectives*". The construction activities represented by scenarios 1 to 8 are for the new expansion and occur within the Geraldton Port. Therefore, for all of the construction scenarios (1 to 8) and for operational scenarios 9 to 10, the compliance assessments are undertaken based on the noise limits, which is 5 dB below the assigned noise levels shown in Table 2-3.

Scenarios 11 and 12 consider the worst-case operations of whole Geraldton Port and they are assessed against the assigned noise levels L_{A10}.

7.1 TONALITY ADJUSTMENT

According to Table 2-2, before the compliance assessment the predicted noise levels shown in Table 5-1 and Table 5-2 should be adjusted by:

- 5 dB if the noise received exhibits tonality; or
- 10 dB if the noise received exhibits impulsiveness.

Mechanical plant may radiate tonal noise components while piling hammer noise exhibits impulsiveness. High background noises are present in the Geraldton Port and surround area. When the overall noise received at a receiver is much below background levels, its tonality or impact characteristics will be masked and inaudible. Therefore, the above adjustments will not apply.

Both the the 2015[14] and 2023[15] measurement results indicate that the night-time background noise levels are above 45 dB(A) at the selected receivers. The daytime background levels are expected to be 10 dB(A) higher. It is expected that tonality will be masked at the receiver when the predicted mechanical noise level is below 50 dB(A) for the day and below 40 dB(A) for the evening and the night.

Scenario 3 considers piling noise only and a 10dB impact adjustment applies while the other scenarios consider mechanical noises and a 5dB tonality adjustment applies to the noise levels above 50 dB(A) for the day and 40 dB(A) for the evening and the night.

Table 7-1 and Table 7-2 present the adjusted worst-case A-weighted noise levels. The adjusted noise levels for different wind conditions are presented in Table B1 to Table B17 in APPENDIX B. The adjusted levels are expressed in ***italic bold***.

[14] Environmental noise impact assessment of Geraldton Port operations. SVT Report (Rpt01-1370822-Rev1-12 February 2015), 12 February 2015.
[15] Environmental Noise Assessment of the Geraldton Port, AES report (NO: AES-890312-R02-0-21112023), 21 Nov. 2023.

Table 7-1: Adjusted construction noise levels in dB(A).

Receivers	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
	Day	Day	Day	Day	Day	Day	Day
R1	41.5	37.7	***66.6***	36.6	32.5	39.2	28.3
R2	42.2	40.4	***66.0***	38.4	31.9	39.1	33.5
R3	36.9	37.7	***60.9***	32.1	32.3	40.2	29.0
R4	43.0	46.6	***66.9***	39.8	39.2	45.3	41.3
R5	41.6	40.6	***65.9***	36.5	35.9	38.4	32.5
R6	***64.9***	***60.8***	***84.5***	***59.6***	49.7	47.5	47.0
R7	***55.8***	48.0	***76.7***	45.9	43.6	40.1	40.1
R8	***61.8***	***59.4***	***85.9***	***57.2***	***57.7***	***56.0***	46.4
R9	***62.8***	***60.7***	***84.2***	***57.1***	***56.0***	***56.3***	49.0
R10	***70.4***	***66.6***	***92.1***	***65.2***	***62.7***	***64.6***	***55.8***
R11	49.6	47.8	***73.5***	45.8	39.7	46.3	40.2

Table 7-2: Adjusted operational noise levels in dB(A).

Receivers	Scenario 8		Scenario 9		Scenario 10		Scenario 11		Scenario 12	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
R1	38.3	38.8	31.9	32.4	28.2	28.6	42.5	***47.8***	42.3	***47.5***
R2	38.5	38.9	32.0	32.3	33.8	34.2	44.7	***49.4***	44.8	***49.6***
R3	33.9	33.9	28.4	28.5	28.8	28.9	49.1	***53.8***	49.2	***53.8***
R4	38.9	39.0	33.9	34.0	38.9	39.0	45.1	***49.9***	45.8	***50.6***
R5	38.4	38.5	32.6	32.6	32.2	32.3	41.5	***46.3***	41.5	***46.3***
R6	***61.2***	***61.3***	49.8	***54.9***	46.2	***51.4***	***56.5***	***56.5***	49.4	***54.5***
R7	48.0	***53.1***	41.9	***47.0***	39.4	39.7	44.0	***49.1***	42.7	***47.8***

Receivers	Scenario 8		Scenario 9		Scenario 10		Scenario 11		Scenario 12	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
R8	***60.4***	***60.5***	45.5	***50.6***	46.7	***51.9***	***57.7***	***57.6***	***57.9***	***57.9***
R9	***60.0***	***60.0***	49.8	***54.8***	47.6	***52.7***	***58.9***	***58.8***	***58.2***	***58.1***
R10	***67.6***	***67.6***	***61.4***	***61.5***	***55.0***	***55.1***	***64.4***	***64.4***	***62.4***	***62.2***
R11	46.0	***51.3***	39.9	***45.2***	39.9	***45.1***	***57.6***	***56.7***	***57.6***	***56.7***

7.2 COMPLIANCE ASSESSMENT

In the following sections, the occurrence percentage of exceedance is calculated based on the following two factors:

- For all of the construction and operational scenarios, the annual percentage occurrence for the worst-case wind-speeds (4m/s during the day and 3m/s during the evening and the night) in different wind directions shown in Table 6-1 to Table 6-3.
- For operational scenarios 11 and 12, the (additional) annual percentage of worst-case operation of Geraldton Port of 9.4%[15].

In the following tables (Table 7-3 to Table 7-11):

- Blank cell represents the adjusted noise levels are below the noise limits for scenarios 1 to 10 (or assigned noise levels for scenarios 11 and 12).
- N represents "worst-case" northerly wind.
- NE represents "worst-case" north-easterly wind.
- E represents "worst-case" easterly wind.
- SE represents "worst-case" south-easterly wind.
- S represents "worst-case" southerly wind.
- SW represents "worst-case" south-westerly wind.
- W represents "worst-case" westerly wind.
- NW represents "worst-case" north-westerly wind.
- ALL represents all of the 8 "worst-case" cardinal winds.

7.2.1 Construction Noises

Construction scenarios 1 to 7 occur during the day only. Therefore only the daytime assessment is undertaken for scenarios 1 to 7. Scenario 8 represents the 24-hours construction activities of Berth 1 Capital Dredge and its noise emissions are assessed against the day and evening/night-time limits.

Scenario 3 represents piling hammer impact noise L_{Amax} and its predicted noise levels are assessed against the noise limits L_{Amax}. For the other construction scenarios (1, 2, and 4 to

8), noise limits L_{A10} apply.

Monday to Saturday

Table 7-3 and Table 7-4 present the day-time compliance assessments on Monday to Saturday excluding public holidays. It is shown that exceedance is predicted for every construction scenario. For the daytime constructions, exceedance is predicted at:

- R2 and R7 (two noise-sensitive receivers) and most of the commercial receivers for scenario 1.
- R7 (one noise-sensitive receiver) and most of the commercial receivers for scenarios 2, 4, 5 and 8.
- R1, R2 and R7 (three noise-sensitive receivers) and most of the commercial receivers for scenario 3.
- R8 to R10 (three commercial receivers) for scenario 6.
- R10 (marginal exceedance at one commercial receiver) for scenario 7.

The daytime exceedance occurrence percentage is ≤16.2%.

Table 7-3: Daytime compliance assessment on Monday to Saturday.

Receivers	5dB Below Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 1	Scenario 2	Scenario 4	Scenario 5	Scenario 6
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	43					
R2	42	0.2 (NE – E) 4.0%				
R3	52					
R4	47					
R5	48					
R6	55	1.0 — 9.9 ALL 16.2%	3.8 — 5.8 (W – NE) 3.4%	2.3 — 4.6 (W – NE) 2.0%		
R7	42	0.6 — 13.8 (SW – NE) 10.2%	5.0 — 6.0 (W – NE) 3.4%	3.3 — 3.9 (W – NE) 2.0%	0.4 — 1.6 (W – NE) 3.4%	

Receivers	5dB Below Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 1	Scenario 2	Scenario 4	Scenario 5	Scenario 6
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R8	55	0.4 — 6.8 ALL 16.2%	0.6 — 4.4 (W – NE) 3.4%	1.9 — 2.2 (W – N) 1.8%	2.5 — 2.7 (W – N) 1.5%	1.0 (W – NW) 1.5%
R9	55	0.9 — 7.8 (S – NE) 10.3%	3.5 — 5.7 (SW – N) 4.8%	0.6 — 2.1 (SW – N) 8.3%	0.6 — 1.0 (SW – NW) 3.7%	0.9 — 1.3 (SW – NW) 4.0%
R10	55	9.3 — 15.4 ALL 16.2%	2.0 — 11.6 ALL 14.9%	1.2 — 10.2 ALL 13.4%	1.9 — 7.7 ALL 15.4%	0.1 — 9.6 (SE – N) 9.5%
R11	55					

Table 7-4: Daytime compliance assessment Monday to Saturday.

Receivers	5dB Below Daytime Assigned Noise Levels L_{Amax} in dB(A)	Scenario 3	5dB Below Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 7	Scenario 8
		Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	63	3.2 — 3.6 (N – SE) 7.6%	43		
R2	62	3.5 — 4.0 (N – SE) 7.6%	42		
R3	72		52		
R4	67		47		
R5	68		48		

Receivers	5dB Below Daytime Assigned Noise Levels L_{Amax} in dB(A)	Scenario 3	5dB Below Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 7	Scenario 8
		Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R6	75	2.9 — 9.5 ALL 15.4%	55		1.2 — 6.2 (W – E) 5.0%
R7	62	6.5 — 14.7 ALL 15.4%	42		5.5 — 6.0 (W – NE) 1.3%
R8	75	4.8 — 10.9 ALL 15.4%	55		0.1 — 5.4 (SW – E) 10.2%
R9	75	2.9 — 9.2 ALL 15.4%	55		3.9 — 5.0 (SW – N) 6.2%
R10	75	12.8 — 17.1 ALL 15.4%	55	0.4 — 0.8 (W – N) 1.3%	8.1 — 12.6 ALL 16.2%
R11	75		55		

Sunday and Public Holidays

Table 7-5 and Table 7-6 present the day-time compliance assessments for Sunday and public holidays. It is shown that exceedance is predicted for every scenario at most receivers except for R2, R5 and R11. The daytime exceedance occurrence percentage is ≤16.2%.

Table 7-5: Daytime compliance assessment on Sunday.

Receivers	5dB Below Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 1	Scenario 2	Scenario 4	Scenario 5	Scenario 6
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	38	3.1 — 3.5 (N – SE) 6.3%				0.8 — 1.2 (N – SE) 9.2%
R2	37	4.5 — 5.2 (N – SE) 6.3%	1.8 — 3.4 (N – SE) 8.3%	1.0 — 1.4 (N – E) 1.3%		1.8 — 2.1 (NE – SE) 8.4%
R3	47					
R4	42	0.6 — 1.0 (NW – NE) 0.4%	3.0 — 4.6 (W – NE) 3.4%			1.3 — 3.3 (W – NE) 3.5%
R5	43					
R6	55	1.0 — 9.9 ALL 16.2%	3.8 — 5.8 (W – NE) 3.4%	2.3 — 4.6 (W – NE) 2.0%		
R7	37	4.2 — 18.8 ALL 16.2%	0.8 — 11.0 (SW – E) 10.8%	8.3 — 8.9 (W – NE) 2.0%	5.4 — 6.6 (W – NE) 3.4%	2.9 — 3.1 (W – N) 2.3%
R8	55	0.4 — 6.8 ALL 16.2%	0.6 — 4.4 (W – NE) 3.4%	1.9 — 2.2 (W – N) 1.8%	2.5 — 2.7 (W – N) 1.5%	1.0 (W – NW) 1.5%
R9	55	0.9 — 7.8 (S – NE) 10.3%	3.5 — 5.7 (SW – N) 4.8%	0.6 — 2.1 (SW – N) 8.3%	0.6 — 1.0 (SW – NW) 3.7%	0.9 — 1.3 (SW – NW) 4.0%
R10	55	9.3 — 15.4 ALL 16.2%	2.0 — 11.6 ALL 14.9%	1.2 — 10.2 ALL 13.4%	1.9 — 7.7 ALL 15.4%	0.1 — 9.6 (SE – N) 9.5%
R11	55					

Table 7-6: Daytime compliance assessment on Sunday.

Receivers	5dB Below Daytime Assigned Noise Levels L_{Amax} in dB(A)	Scenario 3	5dB Below Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 7	Scenario 8
		Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	63	3.2 — 3.6 (N – SE) 7.6%	38		0.1 — 0.3 (N – E) 4.1%
R2	62	3.5 — 4.0 (N – SE) 7.6%	37		1.0 — 1.5 (N – SE) 6.3%
R3	72		47		
R4	67		42		
R5	68		43		
R6	75	2.9 — 9.5 ALL 15.4%	55		1.2 — 6.2 (W – E) 5.0%
R7	62	6.5 — 14.7 ALL 15.4%	37	2.6 — 3.1 (W – NE) 1.6%	2.9 — 11 ALL 16.2%
R8	75	4.8 — 10.9 ALL 15.4%	55		0.1 — 5.4 (SW – E) 10.2%
R9	75	2.9 — 9.2 ALL 15.4%	55		3.9 — 5.0 (SW – N) 6.2%
R10	75	12.8 — 17.1 ALL 15.4%	55	0.4 — 0.8 (W – N) 1.3%	8.1 — 12.6 ALL 16.2%
R11	75		55		

The Evening and The Night

As indicated in section 4.4, scenario 8 happens during the day, the evening and the night. Table 7-7 presents the evening and night-time compliance assessments for scenario 8. Exceedance is predicted at:

- R1, R2 and R6 to R10 for the evening with the occurrence percentage of ≤16.4.
- R1, R2 and R4 to R10 for the night with the occurrence percentage of ≤19.4.

Table 7-7: Compliance assessment for scenario 8.

Receivers	5dB Below Evening Assigned Levels L_{A10} in dB(A)	Exceedance (Non-compl Wind Direction) Occurrence Percentage	5dB Below Night-time Assigned Levels L_{A10} in dB(A)	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	38	0.8 (N – SE) 7.1%	33	0.2 — 5.8 (NW – S) 17.8%
R2	37	1.8 — 1.9 (N – SE) 7.1%	32	1.2 — 6.9 (NW – S) 17.8%
R3	47		42	
R4	42		37	1.5 — 2.0 (NW – E) 7.2%
R5	43		38	0.5 (NW – NE) 0.4%
R6	55	0.6 — 6.3 ALL 16.4%	55	0.6 — 6.3 ALL 19.4%
R7	37	10.1 — 16.1 ALL 16.4%	32	15.1 — 21.1 ALL 19.4%
R8	55	0.7 — 5.5 ALL 16.4%	55	0.7 — 5.5 ALL 19.4%

Receivers	5dB Below Evening Assigned Levels L_{A10} in dB(A)	Exceedance (Non-compl Wind Direction) Occurrence Percentage	5dB Below Night-time Assigned Levels L_{A10} in dB(A)	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R9	55	0.1 — 5.0 ALL 16.4%	55	0.1 — 5.0 ALL 19.4%
R10	55	8.4 — 12.6 ALL 16.4%	55	8.4 — 12.6 ALL 19.4%
R11	55		55	

7.2.2 Operation Noises

Scenarios 9 to 12 are operational scenarios. Scenarios 9 and 10 consider individual new berth operations and they are assessed against the noise limits L_{A10} (5dB below the assigned noise levels L_{A10}). Scenarios 11 and 12 consider the worst-case operations of the whole Geraldton Port and they are assessed against the assigned noise levels L_{A10}.

Table 7-8 to Table 7-11 presents the compliance assessments. For scenarios 9 and 10, exceedance is predicted at:

- R10 during the day on Monday to Saturday (for scenario 9 only);
- R7 and R10 during the operations of Sunday, public holiday and evening; but
- R2, R4, R7 and R10 for the night-time operations.

The annual percentage of operation of berth 1 or 8/9 is unknown. If only the weather condition is considered, the predicted exceedance occurrence percentage for scenario 9 or 10 is less than:

- 7.2% during the daytime operation;
- 11.3% during the evening-time operation; and
- 18.1% during the night-time operation.

Without including the operation of new berth 1 or 8/9, the worst-case port operation does not comply with the Regulations[15] at:

- R10 during the day on Monday to Saturday;
- R2 and R10 during Sunday and public holidays;
- R2 to R4 and R10 during the evening; and
- R1 to R4, R7 and R10 during night.

By including the operation of new berth 1 or 8/9, the worst-case port operations (scenarios 11 and 12) not only increase the exceedance levels at the above receiver locations but also do not comply at the following additional receivers:

- R7 during Sunday and public holidays;
- R1 and R7 during the evening; and
- R5 during the night.

The annual percentage of the "worst-case" port operation is 9.4%. The predicted exceedance occurrence percentage of scenarios 11 and 12 is less than:

- 0.7% for the "worst-case" daytime port operation;
- 1% for "worst-case" evening-time port operation; and
- 1.7% for "worst-case" night-time port operation.

Table 7-8: Daytime compliance assessment for Monday to Saturday.

Receivers	5dB Below daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 9	Scenario 10	Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 11	Scenario 12
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	43			48		
R2	42			47		
R3	52			57		
R4	47			52		
R5	48			53		
R6	55			60		
R7	42			47		
R8	55			60		
R9	55			60		
R10	55	0.1 — 6.4 (SW – NE) 7.2%		60	0.9 — 4.4 (SW – NE) 0.7%	1.4 — 2.4 (SW – NW) 0.6%
R11	55			60		

Table 7-9: Daytime compliance assessment for Sunday.

Receivers	5dB Below daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 9	Scenario 10	Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 11	Scenario 12
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	38			43		
R2	37			42	0.6 — 2.7 (N – SE) 0.5%	0.8 — 2.8 (N – SE) 0.5%
R3	47			52		
R4	42			47		
R5	43			48		
R6	55			60		
R7	37	4.3 — 4.9 (W – NE) 2.4%	1.9 — 2.4 (W – NE) 2.4%	42	0.3 — 2.0 (W – NE) 0.2%	0.5 — 0.7 (W – N) 0.1%
R8	55			60		
R9	55			60		
R10	55	0.1 — 6.4 (SW – NE) 7.2%		60	0.9 — 4.4 (SW – NE) 0.7%	1.4 — 2.4 (SW – NW) 0.6%
R11	55			60		

Table 7-10: Evening-time compliance assessment.

Receivers	5dB Below daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 9	Scenario 10	Daytime Assigned Noise Levels L_{A10} in dB(A)	Scenario 11	Scenario 12
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	38			43	0.4 — 4.8 (NW – SE) 0.7%	0.4 — 4.5 (NW – SE) 0.7%
R2	37			42	1.5 — 7.4 (NW – S) 1.0%	1.9 — 7.6 (NW – S) 1.0%
R3	47			52	1.3 — 1.8 (SW – N) 0.4%	1.3 — 1.8 (SW – N) 0.4%
R4	42			47	0.2 — 2.9 (SW – NE) 0.4%	1.5 — 3.6 (SW – NE) 0.4%
R5	43			48		
R6	55			60		
R7	37	0.7 — 1.0 (W – S) 11.3%	2.6 — 2.7 (W – NE) 1.4%	42	2.0 — 7.1 (SW – E) 0.7%	3.3 — 5.8 (SW – NE) 0.4%
R8	55			60		
R9	55			60		
R10	55	0.4 — 6.5 (S – E) 10.0%	0.1 (W – N) 1.0%	60	1.1 — 4.4 (S – NE) 0.7%	0.6 — 2.2 (SW – N) 0.4%
R11	55			60		

Table 7-11: Night-time compliance assessment.

Receivers	5dB Below Night-time Assigned Levels L_{A10} in dB(A)	Scenario 9	Scenario 10	Night-time Assigned Noise Levels L_{A10} in dB(A)	Scenario 11	Scenario 12
		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage		Exceedance (Non-compl Wind Direction) Occurrence Percentage	Exceedance (Non-compl Wind Direction) Occurrence Percentage
R1	33			38	1.3 — 9.8 ALL 1.7%	1.2 — 9.5 ALL 1.7%
R2	32	0.3 (N – SE) 12.9%	2.0 — 2.2 (N – SE) 12.9%	37	3.8 — 12.4 ALL 1.7%	3.9 — 12.6 ALL 1.7%
R3	42			47	0.5 — 6.8 ALL 1.7%	0.5 — 6.8 ALL 1.7%
R4	37		1.6 — 2.0 (W – NE) 1.9%	42	0.8 — 7.9 ALL 1.7%	1.3 — 8.6 ALL 1.7%
R5	38			43	1.0 — 3.3 (SW – NE) 0.3%	1.0 — 3.3 (SW – NE) 0.3%
R6	55			60		
R7	32	5.7 — 15.0 ALL 18.1%	1.9 — 7.7 (SW – E) 9.5%	37	3.5 — 12.1 ALL 1.7%	2.0 — 10.8 ALL 1.7%
R8	55			60		
R9	55			60		
R10	55	0.4 — 6.5 (S – E) 12.2%	0.1 (W – N) 1.0%	60	1.1 — 4.4 (S – NE) 0.6%	0.6 — 2.2 (SW – N) 0.3%
R11	55			60		

8.0 DISCUSSIONS AND RECOMMENDATIONS

8.1 MODEL LIMITATIONS

Noise emissions from either the construction activities or the port operations vary on a day to day basis depending on the activities being undertaken. The acoustic model does not model real-time port operations; it models snapshots of the assumed worst-case construction activities/operations and also considers the utilisation (occurrence percentage) of operating equipment/plant. The predicted noise levels represent averaged noise levels for the assumed construction/operational conditions.

8.2 HIGH LEVEL BACKGROUND NOISES

The Geraldton Port is located close to the Geraldton city centre and surrounded by commercial premises. Noises from road traffic, sea-waves, commercial premises, other industries and street activities are present during the days and the night. Background noises vary and are normally high in the port and surrounding area.

The assigned noise levels do not consider the effect of local background noises. At some noise sensitive premises, background noises are higher than the assigned noise levels. For example, at R1 and R2 the measured background noise was above 45 dB(A) during nights, which are higher than the night-time assigned noise levels. The noise emitted from the port operations may be masked and inaudible due to high level background noises.

8.3 NOISE CONTROLS

The compliance assessments in section 7.2 show none of the construction or operational scenarios achieves compliance with the Regulations.

8.3.1 Construction Noises

Most items of construction equipment/plant generate high level noises. To reduce construction noises, the following noise control measures are recommended:

- Enclose noisy fixed plant such as diesel generators and compressors.
- Piling noise is to be managed through restricting the activity to dayshift construction hours and where feasible managing the activity away from community peak periods (example mid-day breaks). Piling should also be managed according to weather and Port operational noise conditions.
- Signage, in consultation with the Local Council (LGA), will be placed in Community areas and construction site interfaces to communicate the noise hazard associated with the area.
- Implement where reasonably practicable "other" "best practice" construction noise controls as outlined in the CNMP.

Where reasonably practicable, temporary or mobile fences are recommended at locations close to noisy sources for reducing construction noise propagations towards the noise-sensitive premises.

8.3.2 Operational Noises

The major noise sources in the shiploading of new berth 1 or 8/9 are mobile cranes, forklifts, vacuum truck and prime movers. Management of Berth 1 and Berth 8/9 noise will be via the existing MWPA Operational Noise Management Plan.

APPENDIX A AERIAL VIEW

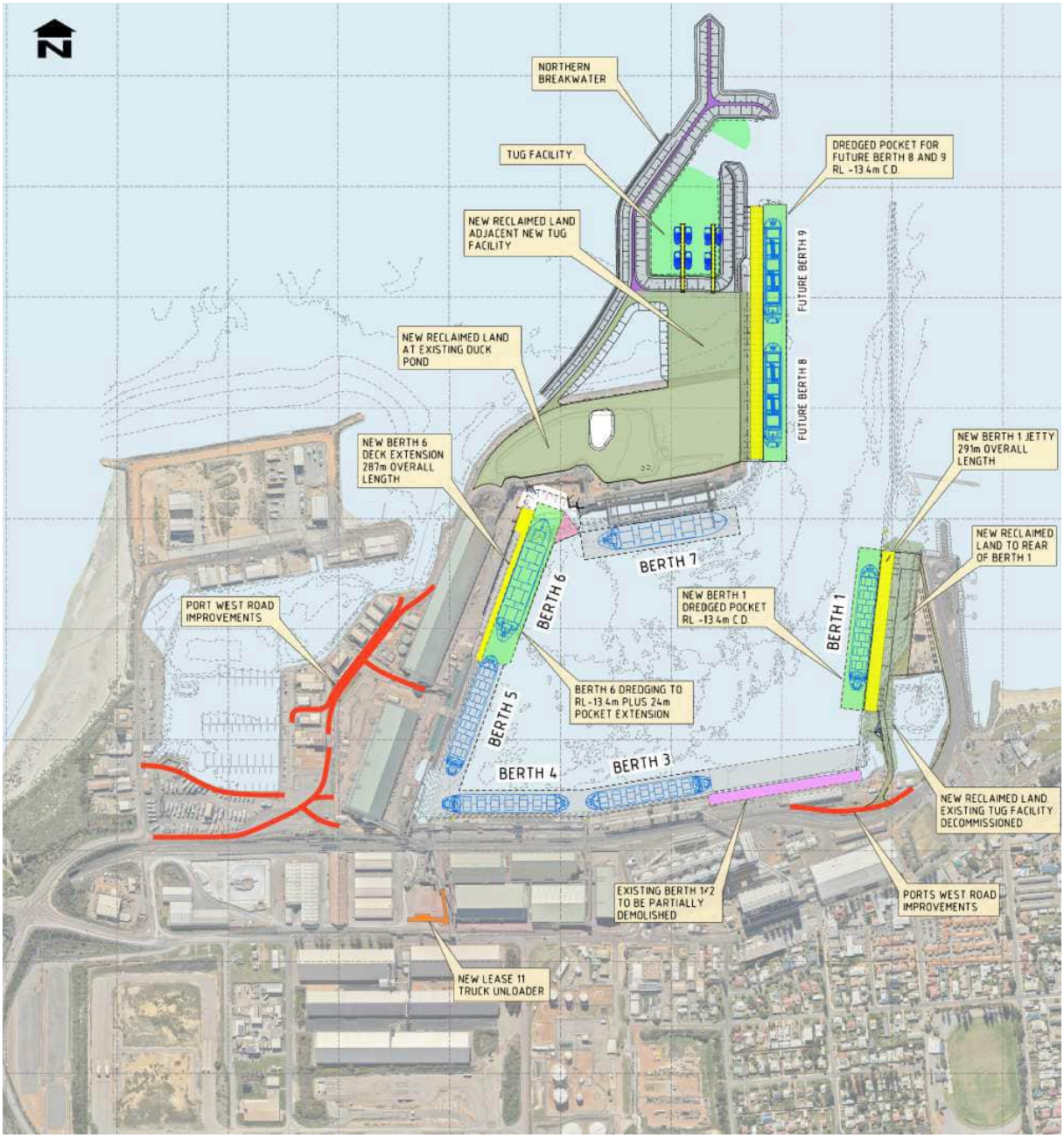

Figure 1: Upgraded Geraldton Port Layout.

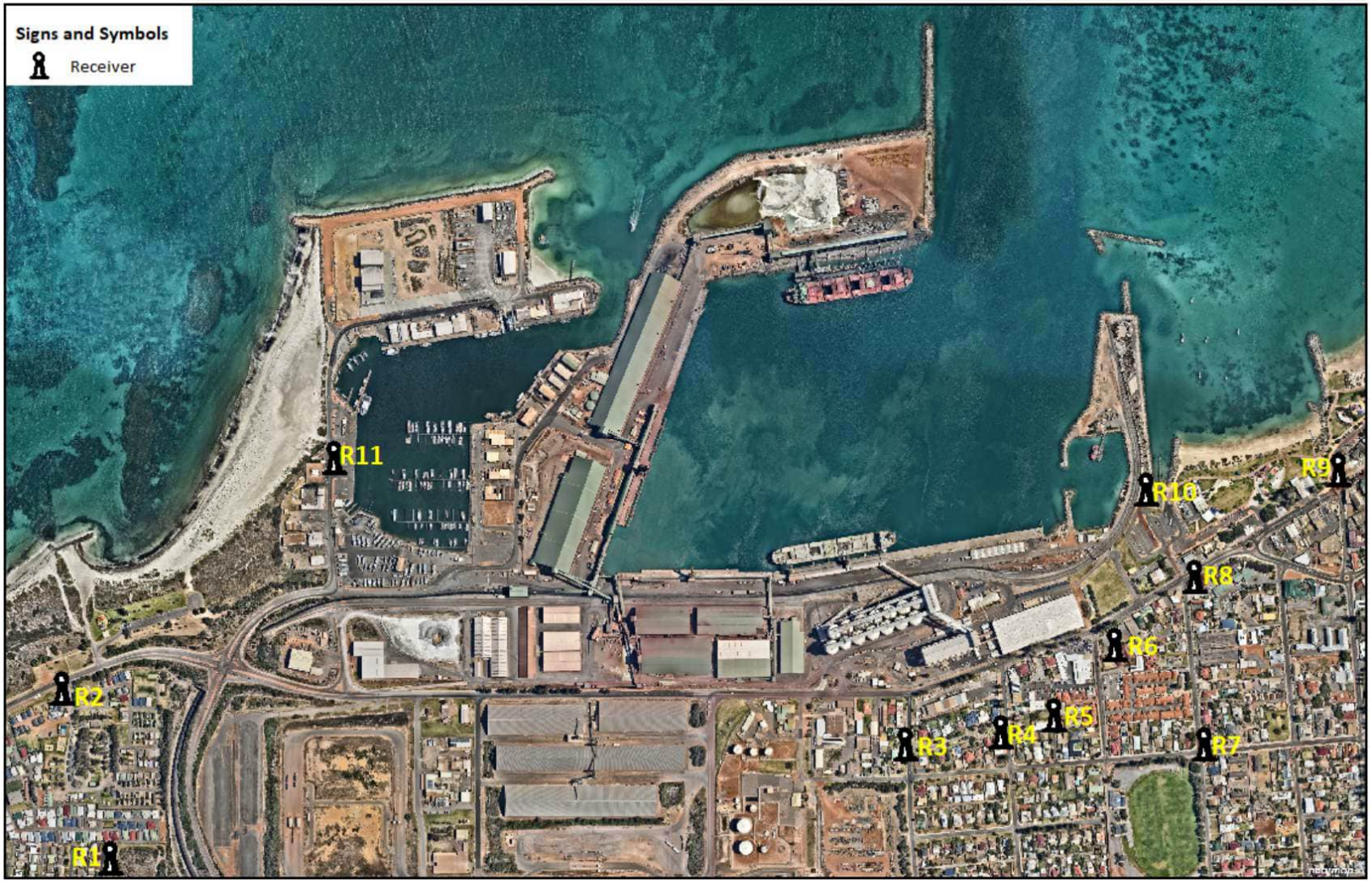

Figure 2: Locations of selected noise-sensitive receivers.

Table A1: Construction schedule and plant utilisation.

PMaxP - Marine Construction - Plant Utilisation 18/06/2024

PHASE	INDICATIVE EQUIPMENT LIST (or similar)	ESTIMATED NUMBER of Plant	Notes	Jan-26	Feb-26	Mar-26	Apr-26	N	May-26	N	Jun-26	N	Jul-26	Aug-26	Sep-26	Oct-26	Nov-26	Dec-26	Jan-27	Feb-27	Mar-27	Apr-27	May-27	Jun-27	Jul-27	Aug-27	Sep-27	Oct-27	Nov-27	Dec-27	Jan-28	Feb-28	Mar-28	Apr-28	May-28	Jun-28
				Q1 2026			Q2 2026						Q3 2026			Q4 2026			Q1 2027			Q2 2027			Q3 2027			Q4 2027			Q1 2028			Q2 2028		
Summary Schedule																																				
Dredge																																				
Berth 1 Maint Dredge Pocket																																				
Berth 1 Capital Dredge																																				
Berth 6 Marine																																				
B6 Land side "dredge"																																				
Berth 8 *(not dredging - still need to model)*																																				
Tug Harbour (Nxt Port Maint Dredge)																																				
Construction																																				
Tug Harbour Seawalls / Breakwaters																																				
Tug Harbour Piling (40 Piles)																																				
B1 Causeway & Revetment																																				
B1 Piling (#120 piles)																																				
B1 Structural (Deck Install)																																				
B6 Piling - #120 *(including Sheet Piles - Land side 60m)*																																				
B6 Structural																																				
B2 Berth Demolition																																				
B8 Piling																																				
B8 Structural																																				
Maintenance Dredging Works																																				
Berth 1 & Tug Harbour	Trailer Suction Hopper Dredge	1			B1 Maint - 75% (3 weeks)																															
Capital Dredging Works	BHD- Backhoe / Excavator (2000kW) or similar - remove seabed rock	1					50%																													
(– Berth 1, 6, 8)	Conditioning Seabed - Hyrdro Hammer	1	Nightshift scenario - 7 nights a week nights (7pm - 7am)					50%																												
	Split Hopper Barge (650m3)	2					50%																													
	14T Bollard Pull tugs	2					10%																													
	Survey Vessel Class 1C	1					10%																													
	Articulated Dump Truck	2				25%																														
	45t Excavator (CAT 350)	1				25%																														
	WA 500 Front End Loader (CAT 980)	1				25%																														
	D10 Bulldozer	1					20%																													
Berth 1																																				
Berth 6																																				
Berth 8 / 9																																				
Tug Harbour																																				
Tug Harbour Seawall & Reclamation																																				
	Articulated Dump Truck (ADT)	3			80%																															
	140T Excavator	1			50%																															
	45t Excavator (CAT 350)	2			50%																															
	30t Excavator with rock breaker	1			10%																															
	WA 500 Front End Loader (CAT 980)	1			25%																															
	D10 Bulldozer	1			10%																															
	Grader	1			5%																															
	20T Telehandler / Franna Crane	1			20%																															
	600cfm Compressor	1			10%																															
	150kva Generator (silenced)	1			80%																															
	8t Roller / compactor	1			20%																															
	8-Wheel Dump Truck	1			10%																															
Civil / Earthworks Berth 1, 6, 8																																				
	Articulated Dump Truck (ADT)	3			75%								50%											10%		10%										
	140T Excavator	1			40%								30%																							
	100T Excavator (Landside "dredge") - Berth 6 ONLY	1											50%																							
	45t Excavator (CAT 350)	1			20%								40%											20%		20%										
	30t Excavator with rock breaker	1			10%								20%																							
	WA 500 Front End Loader (CAT 980)	1			40%								20%																							
	D10 Bulldozer	1			20%																															
	Grader	1			20%																															
	8t Roller / compactor	1			20%								5%													5%										
	Plate Compactor	1			5%								5%											5%		5%										
Piling (1,6, Tug, 8/9))	200T Mobile Crane	1									50%		50%																							
	IHC S200 Piling Hammer	1									25%		25%																							
	ABI 13/16 Sheet piling rig	1									25%		25%																							
	600cfm Compressor	2									10%		10%																							

	150kva Generator (silenced)	2							75%		75%																									
Berth 2																																			
(B2 Berth Deck Removal & Pile cutoff	Construction Saws (1500mm (60Inch) Diesel 74HP)	2																					50%	30%												
	30T Excavator with rock breaker	1																					50%	30%												
	200T Mobile Crane	1																					10%	20%	30%											
	6 Wheel Dump Truck	2																					50%	30%												
Structural Works Berth 1, 8 and 8																																				
	Concrete Delivery Truck 6m3	1									10%	10%	20%	20%							10%	10%	20%	20%			10%	20%								
	Concrete Pump (Putzmeister M56-5)	1									10%	10%	20%								10%	10%	20%				10%	20%								
	20T Front End Loader (FEL CAT 972)	1									20%										20%						20%									
	200T Mobile Crane	1									50%										50%						50%									
	300T Mobile Crane (Manitwoc Crawler)	1									30%										30%						30%									
	20T Telehandler	1									20%										20%						20%									
	40T Franna Crane	1									20%										20%						20%									
	Elevated Work Platforms	3									20%										20%						20%									
	Plate Compactor	1									5%										5%						5%									
	Lincoln Welding Generator	4									20%										20%						20%									
	600cfm Compressor	2									50%										50%						50%									
	150kva Generator (silenced)	2									80%										80%						80%									
Across 2 years	Forklift	2	20%								20%																									
	20T Telehandler / Franna Crane	2	25%								25%																									
	Bobcat loader	2	20%								20%																									
	Delivery Trucks	2	20%								20%																									
	Service Truck	2	10%								20%										10%															
	Fuel Delivery Truck	1	10%								20%										10%															
	Water Cart	2	30%								20%										10%															
HandTools (Across Project)																																				
	Angle Grinder	4		25%							25%										25%						25%									
	Circular Saw	4		10%							10%										10%						10%									
	Impact Driver	4		10%							25%										25%						25%									
	Hammer Drill	4		10%							10%										10%						10%									

APPENDIX B POINT MODELLING RESULTS

Table B1: ***Predicted worst-case daytime noise levels in dB(A) for scenario 1.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 1								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	41.3	41.5	41.5	41.1	31.0	29.2	29.2	32.1	36.0
R2	41.7	42.2	42.2	41.5	32.6	30.5	30.5	32.7	36.4
R3	36.9	36.9	36.0	29.0	27.8	27.8	29.1	36.0	31.9
R4	43.0	42.9	40.3	34.3	33.8	33.8	36.9	42.6	38.2
R5	41.6	41.5	37.6	33.6	33.4	33.5	36.8	41.4	37.0
R6	***64.9***	***64.6***	***59.0***	***56.0***	***56.0***	***56.5***	***62.3***	***64.9***	***60.3***
R7	***55.8***	***55.3***	42.9	41.2	41.2	42.6	***55.1***	***55.8***	46.4
R8	***61.8***	***59.3***	***55.7***	***55.4***	***55.5***	***56.9***	***61.5***	***61.8***	***57.7***
R9	***62.0***	***55.9***	49.5	49.5	***56.1***	***62.0***	***62.8***	***62.8***	***58.8***
R10	***70.4***	***68.8***	***64.8***	***64.4***	***64.3***	***66.0***	***70.1***	***70.4***	***66.6***
R11	46.6	49.6	49.6	48.9	41.9	38.1	38.1	39.7	43.7

Table B2: ***Predicted worst-case daytime noise levels in dB(A) for scenario 2.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 2								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	37.5	37.7	37.7	36.6	26.5	25.0	25.1	29.0	32.0
R2	40.1	40.4	40.4	38.8	30.1	28.6	28.7	32.0	34.8
R3	37.7	37.5	34.1	28.3	27.6	28.0	33.0	37.4	32.3

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 2								
	N	NE	E	SE	S	SW	W	NW	Calm
R4	46.6	45.2	38.9	34.3	34.1	36.9	45.0	46.5	40.9
R5	40.6	39.4	33.9	30.0	29.9	31.9	38.4	40.5	35.2
R6	***60.8***	***60.3***	47.8	43.9	44.0	45.1	***58.8***	***60.8***	***55.7***
R7	47.9	47.0	37.8	35.7	35.8	38.9	47.4	48.0	42.8
R8	***59.2***	***55.6***	43.1	42.5	42.9	49.8	***59.1***	***59.4***	49.3
R9	***60.0***	48.2	44.1	44.0	45.9	***58.5***	***60.6***	***60.7***	***55.3***
R10	***66.4***	***63.8***	***57.6***	***57.0***	***57.6***	***62.7***	***66.3***	***66.6***	***62.5***
R11	46.5	47.8	47.8	46.5	39.1	36.4	36.4	39.2	42.3

Table B3: ***Predicted worst-case daytime noise levels in dB(A) for scenario 3.***

Closest Residences	Worst-case Daytime Noise Levels L_{AMax} in dB(A) for Scenario 3								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	***66.3***	***66.6***	***66.6***	***66.2***	46.5	44.5	44.5	47.4	***61.4***
R2	***65.5***	***66.0***	***66.0***	***65.7***	47.1	44.5	44.5	46.1	***60.6***
R3	***60.9***	***60.9***	***60.1***	43.3	42.1	42.1	43.3	***60.1***	45.9
R4	***66.9***	***66.9***	***64.1***	49.2	48.7	48.7	***61.2***	***66.6***	***62.4***
R5	***65.9***	***65.9***	***61.7***	48.6	48.5	48.6	***61.6***	***65.8***	***61.6***
R6	***84.5***	***84.0***	***79.1***	***77.9***	***77.9***	***78.3***	***82.5***	***84.5***	***80.2***
R7	***76.7***	***76.2***	***70.0***	***68.5***	***68.5***	***69.9***	***76.1***	***76.7***	***72.8***

Closest Residences	Worst-case Daytime Noise Levels L_{AMax} in dB(A) for Scenario 3								
	N	NE	E	SE	S	SW	W	NW	Calm
R8	***85.9***	***83.3***	***80.0***	***79.8***	***79.8***	***80.9***	***85.4***	***85.9***	***81.6***
R9	***83.2***	***78.6***	***77.9***	***77.9***	***79.0***	***83.5***	***84.2***	***84.2***	***80.9***
R10	***92.1***	***88.9***	***87.8***	***87.8***	***87.8***	***87.8***	***91.9***	***92.1***	***87.8***
R11	***69.5***	***73.5***	***73.5***	***73.2***	***66.5***	***62.2***	***62.2***	***62.8***	***67.7***

Table B4: ***Predicted worst-case daytime noise levels in dB(A) for scenario 4.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 4								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	36.4	36.6	36.6	35.8	25.1	23.3	23.4	27.4	30.8
R2	38.0	38.4	38.4	36.7	27.5	25.7	25.7	29.5	32.4
R3	32.1	32.1	30.9	22.7	21.0	21.1	23.6	31.4	26.9
R4	39.8	39.7	36.4	28.8	28.1	28.3	34.0	39.5	34.6
R5	36.5	36.4	31.7	26.1	25.8	26.0	31.9	36.3	31.4
R6	***59.6***	***59.2***	46.7	42.2	42.2	43.3	***57.3***	***59.6***	49.6
R7	45.9	45.4	35.4	32.9	32.9	35.0	45.3	45.9	40.8
R8	***57.2***	49.2	41.5	40.9	41.0	46.2	***56.9***	***57.2***	47.5
R9	***56.0***	43.8	39.4	39.3	42.5	***55.6***	***57.0***	***57.1***	46.9
R10	***65.0***	***62.5***	***56.7***	***56.2***	***56.8***	***61.5***	***64.9***	***65.2***	***61.5***
R11	44.0	45.8	45.8	44.2	37.0	33.3	33.3	37.0	39.9

Table B5: ***Predicted worst-case daytime noise levels in dB(A) for scenario 5.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 5								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	32.4	32.5	32.5	32.2	22.0	19.9	19.9	23.1	27.5
R2	31.5	31.9	31.9	31.6	22.7	20.1	20.1	21.8	26.6
R3	32.3	31.4	27.2	22.5	21.9	23.5	30.7	32.2	27.2
R4	39.2	37.4	31.8	27.7	27.4	30.9	38.1	39.2	34.0
R5	35.9	33.1	28.2	25.8	25.7	29.3	34.8	35.9	30.7
R6	49.7	49.3	43.7	41.5	41.6	42.4	47.9	49.7	45.3
R7	43.5	42.4	35.0	33.3	33.4	37.0	43.3	43.6	39.2
R8	***57.5***	49.0	44.4	44.0	44.3	49.4	***57.5***	***57.7***	48.0
R9	49.9	42.8	41.7	41.7	43.9	***55.6***	***56.0***	***56.0***	46.8
R10	***62.5***	***59.1***	***57.0***	***56.9***	***57.0***	***59.3***	***62.6***	***62.7***	***58.3***
R11	36.6	39.7	39.7	39.5	32.6	28.2	28.2	29.0	34.3

Table B6: ***Predicted worst-case daytime noise levels in dB(A) for scenario 6.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 6								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	38.8	39.2	39.2	38.8	28.6	26.0	26.0	28.3	33.4
R2	36.5	39.1	39.1	38.8	30.4	26.1	26.1	27.4	33.0
R3	40.2	40.1	37.6	30.4	29.5	29.9	34.8	39.8	35.6

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 6								
	N	NE	E	SE	S	SW	W	NW	Calm
R4	45.3	44.6	37.4	33.8	33.8	35.2	43.3	45.3	40.6
R5	38.4	36.3	28.8	27.4	27.4	31.1	37.8	38.4	33.6
R6	47.5	45.0	38.8	38.1	38.2	41.8	47.1	47.5	43.2
R7	39.9	36.3	28.3	27.6	28.0	34.8	39.9	40.1	34.7
R8	***55.0***	42.8	38.9	38.7	41.2	49.9	***56.0***	***56.0***	45.7
R9	47.2	40.0	38.7	39.4	47.1	***55.9***	***56.3***	***56.1***	45.9
R10	***58.5***	49.8	48.9	***55.1***	***63.1***	***64.4***	***64.6***	***64.1***	***59.9***
R11	39.7	46.1	46.3	46.3	42.4	34.3	33.6	33.9	40.3

Table B7: ***Predicted worst-case daytime noise levels in dB(A) for scenario 7.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 7								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	28.2	28.3	28.2	24.0	16.2	15.7	15.7	21.2	22.4
R2	33.3	33.5	33.5	32.3	22.0	20.7	20.7	24.2	27.7
R3	29.0	29.0	24.2	18.5	18.2	18.3	23.0	28.9	23.5
R4	41.3	41.1	34.1	28.4	28.4	29.2	38.2	41.3	36.2
R5	32.5	32.0	24.0	21.2	21.2	22.1	30.5	32.5	27.0
R6	47.0	46.4	36.6	34.3	34.3	36.2	46.3	47.0	41.4
R7	40.1	39.6	29.0	26.7	26.7	29.5	39.7	40.1	34.9

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 7								
	N	NE	E	SE	S	SW	W	NW	Calm
R8	46.4	44.6	35.0	33.8	33.8	37.5	46.0	46.4	40.9
R9	48.8	41.5	35.8	35.8	36.6	45.5	49.0	49.0	43.5
R10	***55.8***	48.8	39.3	38.2	38.2	42.0	***55.4***	***55.8***	45.4
R11	39.8	40.2	40.2	39.5	29.3	27.6	27.6	30.3	34.7

Table B8: ***Predicted worst-case Day-time noise levels in dB(A) for scenario 8.***

Closest Residences	Worst-case Day-time Noise Levels in dB(A) for Scenario 8								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	38.1	38.3	38.3	38.0	28.5	26.9	26.9	29.3	33.1
R2	38.0	38.5	38.5	38.3	30.0	28.0	28.0	29.2	33.2
R3	33.9	33.9	33.1	27.0	26.1	26.1	27.0	33.0	29.1
R4	38.9	38.9	36.2	32.2	31.8	31.8	33.8	38.6	34.7
R5	38.4	38.3	34.7	32.0	31.9	32.0	34.3	38.3	34.5
R6	***61.2***	***60.9***	***56.2***	49.5	49.5	49.9	***59.4***	***61.2***	***57.1***
R7	48.0	47.5	41.3	39.9	39.9	41.3	47.5	48.0	44.2
R8	***60.4***	***57.7***	***55.1***	49.9	***55.0***	***56.1***	***60.2***	***60.4***	***56.6***
R9	***58.9***	49.2	48.4	48.4	49.8	***59.4***	***60.0***	***60.0***	***56.6***
R10	***67.5***	***65.4***	***63.3***	***63.1***	***63.1***	***64.4***	***67.3***	***67.6***	***63.8***
R11	42.2	46.0	46.0	45.8	39.1	35.5	35.5	36.0	40.3

Table B9: ***Predicted worst-case night-time noise levels in dB(A) for scenario 8.***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 8								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	38.8	38.8	38.8	38.8	33.2	30.3	30.6	34.2	38.5
R2	38.8	38.9	38.9	38.9	34.5	31.0	30.7	33.2	38.5
R3	33.9	33.9	33.9	29.3	27.6	27.6	29.1	33.8	32.9
R4	39.0	39.0	38.5	34.2	33.1	33.6	36.5	39.0	38.2
R5	38.5	38.5	37.4	33.7	33.0	33.7	37.3	38.5	37.5
R6	***61.3***	***61.3***	***58.5***	***56.0***	***55.6***	***56.6***	***60.9***	***61.3***	***60.4***
R7	***53.1***	***53.1***	***49.4***	***47.1***	***47.1***	***49.2***	***53.1***	***53.1***	***52.6***
R8	***60.5***	***59.7***	***56.3***	***55.7***	***56.0***	***58.4***	***60.5***	***60.5***	***59.6***
R9	***59.9***	***56.5***	***54.9***	***55.1***	***57.1***	***60.0***	***60.0***	***60.0***	***59.2***
R10	***67.6***	***66.6***	***63.8***	***63.4***	***63.4***	***66.0***	***67.6***	***67.6***	***66.9***
R11	***50.8***	***51.3***	***51.3***	***51.3***	***49.0***	38.7	37.7	39.3	***50.5***

Table B10: ***Predicted worst-case daytime noise levels in dB(A) for scenario 9.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 9								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	31.8	31.9	31.9	31.7	20.3	18.4	18.4	21.4	26.3
R2	31.7	32.0	32.0	31.8	21.6	19.3	19.3	20.8	26.0
R3	28.4	27.9	27.2	18.9	17.2	19.7	21.9	27.6	23.3

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 9								
	N	NE	E	SE	S	SW	W	NW	Calm
R4	33.9	33.8	31.8	23.3	22.4	22.7	26.2	33.5	28.9
R5	32.6	32.5	28.1	22.3	22.0	22.5	27.7	32.4	27.7
R6	49.8	49.5	42.9	37.8	37.8	38.8	46.7	49.8	44.9
R7	41.9	41.5	32.1	29.2	29.2	31.1	41.3	41.9	37.0
R8	45.4	44.2	35.8	34.6	35.0	38.1	45.1	45.5	40.9
R9	49.1	39.9	37.8	37.8	40.4	49.2	49.8	49.8	45.0
R10	***61.3***	***60.4***	48.0	47.0	48.3	***55.1***	***61.0***	***61.4***	***57.3***
R11	36.2	39.9	39.9	39.8	32.9	27.5	27.4	28.0	34.0

Table B11: ***Predicted worst-case night-time noise levels in dB(A) for scenario 9.***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 9								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	32.4	32.4	32.4	32.4	26.2	22.5	22.9	27.6	32.2
R2	32.3	32.3	32.3	32.3	27.4	22.9	22.5	25.8	32.1
R3	28.5	28.2	28.0	23.4	20.3	22.1	24.2	28.4	27.6
R4	34.0	34.0	33.6	27.7	25.0	26.1	30.9	34.0	33.2
R5	32.6	32.6	31.6	25.8	24.1	25.8	31.1	32.6	31.7
R6	***54.9***	***54.8***	***52.6***	***47.0***	***45.7***	***48.3***	***54.3***	***54.9***	***54.1***
R7	***47.0***	***47.0***	37.8	33.2	32.7	36.4	***46.9***	***47.0***	***46.4***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 9								
	N	NE	E	SE	S	SW	W	NW	Calm
R8	***50.6***	***50.2***	***45.0***	37.3	38.3	***47.2***	***50.6***	***50.6***	***49.8***
R9	***54.8***	***50.0***	***46.1***	***46.1***	***50.1***	***54.8***	***54.8***	***54.8***	***54.0***
R10	***61.3***	***61.1***	***56.6***	***54.6***	***55.4***	***58.3***	***61.5***	***61.5***	***60.7***
R11	39.6	***45.2***	***45.2***	***45.2***	37.9	31.6	30.1	32.5	39.6

Table B12: ***Predicted worst-case daytime noise levels in dB(A) for scenario 10.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 10								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	28.1	28.2	28.2	24.2	16.2	15.7	15.7	21.1	22.5
R2	33.6	33.8	33.8	32.8	22.4	21.2	21.2	24.3	28.1
R3	28.8	28.8	24.0	18.3	18.0	18.1	23.1	28.7	23.5
R4	38.9	38.6	31.5	26.6	26.6	27.4	35.7	38.9	33.6
R5	32.2	31.7	23.7	21.2	21.2	22.1	30.5	32.2	26.9
R6	46.2	45.6	35.9	33.9	33.9	35.9	45.6	46.2	40.8
R7	39.4	38.9	28.2	26.2	26.2	29.2	39.1	39.4	34.2
R8	46.7	44.5	35.0	34.0	34.0	38.1	46.4	46.7	41.2
R9	47.3	39.4	34.6	34.6	35.6	44.9	47.6	47.6	42.1
R10	***55.0***	47.4	38.4	37.5	37.5	41.9	49.6	***55.0***	44.6
R11	39.4	39.9	39.9	39.3	29.0	27.1	27.1	29.5	34.3

Table B13: ***Predicted worst-case night-time noise levels in dB(A) for scenario 10.***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 10								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	28.6	28.6	28.6	28.4	21.0	18.6	20.2	27.0	28.3
R2	34.2	34.2	34.2	34.0	27.5	24.4	25.1	30.3	33.8
R3	28.9	28.9	28.1	21.7	20.0	21.5	27.6	28.9	28.1
R4	39.0	39.0	36.7	30.8	29.4	32.1	38.6	39.0	38.3
R5	32.3	32.3	28.5	24.1	23.4	26.1	31.9	32.3	31.3
R6	***51.4***	***51.4***	***45.9***	37.1	37.1	***45.8***	***51.4***	***51.4***	***50.6***
R7	39.7	39.6	33.9	30.1	30.4	35.1	39.7	39.7	39.3
R8	***51.9***	***51.5***	39.9	36.9	38.0	***48.6***	***51.9***	***51.9***	***51.1***
R9	***52.7***	***49.9***	39.0	37.7	***45.7***	***52.3***	***52.7***	***52.7***	***52.0***
R10	***55.1***	***54.6***	***48.2***	***45.3***	***46.5***	***52.1***	***55.1***	***55.1***	***54.2***
R11	***45.1***	***45.1***	***45.1***	***45.0***	34.1	30.5	30.8	35.0	39.5

Table B14: ***Predicted worst-case daytime noise levels in dB(A) for scenario 11.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 11								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	42.1	42.5	42.5	41.9	32.8	31.0	31.0	33.6	37.6
R2	42.6	44.7	44.7	44.4	37.2	33.1	33.1	34.2	39.6
R3	48.7	43.8	41.1	40.9	41.7	47.4	49.1	49.1	45.0

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 11								
	N	NE	E	SE	S	SW	W	NW	Calm
R4	44.3	40.5	37.0	35.3	37.0	43.2	44.7	45.1	40.6
R5	40.3	37.6	32.9	31.3	33.6	39.1	40.9	41.5	36.6
R6	***56.4***	***55.3***	43.9	40.3	40.8	43.6	49.5	***56.5***	46.5
R7	43.9	42.3	34.0	32.3	32.8	37.6	43.6	44.0	39.0
R8	***56.1***	46.5	41.9	41.8	45.3	***56.0***	***57.6***	***57.7***	47.6
R9	***56.4***	43.5	42.3	42.7	48.5	***58.6***	***58.9***	***58.8***	48.8
R10	***62.8***	***60.9***	***55.1***	49.8	***59.8***	***62.2***	***64.4***	***64.4***	***59.8***
R11	46.6	***56.1***	***57.6***	***57.5***	***56.0***	47.3	42.4	42.0	47.8

Table B15: ***Predicted worst-case night-time noise levels in dB(A) for scenario 11.***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 11								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	***47.8***	***47.8***	***47.8***	***47.7***	37.5	34.3	34.6	38.4	***47.2***
R2	***49.1***	***49.4***	***49.4***	***49.4***	***46.5***	36.6	35.8	38.5	***48.8***
R3	***53.7***	***50.8***	***48.0***	***47.5***	***49.3***	***53.3***	***53.7***	***53.8***	***53.0***
R4	***49.8***	***47.2***	39.4	37.8	***45.3***	***48.8***	***49.7***	***49.9***	***49.0***
R5	***46.1***	39.0	35.8	34.0	37.1	39.8	***46.2***	***46.3***	***45.4***
R6	***56.5***	***56.2***	***53.3***	***48.7***	***48.7***	***52.0***	***56.2***	***56.5***	***55.7***
R7	***49.1***	***48.5***	39.0	35.5	36.3	***45.7***	***49.0***	***49.1***	***48.4***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 11								
	N	NE	E	SE	S	SW	W	NW	Calm
R8	***57.4***	***54.2***	***50.1***	***49.8***	***54.2***	***56.9***	***57.6***	***57.6***	***56.9***
R9	***57.9***	***52.8***	***50.1***	***51.1***	***56.2***	***58.8***	***58.8***	***58.8***	***58.0***
R10	***63.4***	***62.1***	***58.2***	***57.5***	***61.1***	***63.0***	***64.4***	***64.4***	***63.5***
R11	***53.9***	***56.6***	***56.7***	***56.7***	***55.7***	***51.5***	***48.5***	***49.3***	***55.9***

Table B16: ***Predicted worst-case daytime noise levels in dB(A) for scenario 12.***

Closest Residences	Worst-case Daytime Noise Levels in dB(A) for Scenario 12								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	41.9	42.3	42.3	41.6	32.7	30.9	30.9	33.6	37.4
R2	42.8	44.8	44.8	44.5	37.2	33.2	33.2	34.4	39.7
R3	48.7	43.8	41.0	40.9	41.7	47.4	49.1	49.2	45.0
R4	45.1	42.1	36.9	35.6	37.3	43.3	45.1	45.8	41.1
R5	40.3	37.4	31.9	31.2	33.5	39.1	41.1	41.5	36.5
R6	49.3	47.4	39.6	38.6	39.3	42.8	49.0	49.4	44.1
R7	42.5	40.3	32.0	31.0	31.7	37.3	42.5	42.7	37.5
R8	***56.5***	46.7	41.8	41.7	45.3	***56.0***	***57.9***	***57.9***	47.7
R9	***55.5***	43.3	41.4	41.9	48.1	***57.4***	***58.2***	***58.1***	47.8
R10	***59.3***	***55.1***	46.5	47.0	***58.8***	***61.4***	***62.4***	***62.2***	***57.0***
R11	47.0	***56.1***	***57.6***	***57.5***	***56.0***	47.3	42.4	42.1	47.8

Table B17: ***Predicted worst-case night-time noise levels in dB(A) for scenario 12.***

Closest Residences	Worst-case Night-time Noise Levels in dB(A) for Scenario 12								
	N	NE	E	SE	S	SW	W	NW	Calm
R1	***47.5***	***47.5***	***47.5***	***47.5***	37.3	34.2	34.5	38.4	***47.0***
R2	***49.3***	***49.6***	***49.6***	***49.5***	***46.5***	36.7	35.9	38.9	***49.0***
R3	***53.7***	***50.8***	***48.0***	***47.5***	***49.3***	***53.3***	***53.8***	***53.8***	***53.0***
R4	***50.5***	***48.5***	***45.4***	38.3	***45.6***	***49.1***	***50.5***	***50.6***	***49.8***
R5	***46.1***	39.0	34.9	33.7	37.0	39.8	***46.2***	***46.3***	***45.4***
R6	***54.5***	***54.0***	***48.5***	***46.0***	***47.2***	***51.1***	***54.5***	***54.5***	***53.6***
R7	***47.8***	***46.9***	36.4	34.0	35.5	***45.3***	***47.8***	***47.8***	***47.2***
R8	***57.7***	***54.7***	***50.1***	***49.7***	***54.1***	***57.1***	***57.9***	***57.9***	***57.1***
R9	***57.0***	***52.8***	***49.4***	***50.3***	***55.5***	***58.0***	***58.1***	***58.1***	***57.3***
R10	***60.6***	***57.8***	***54.2***	***54.9***	***59.9***	***61.7***	***62.2***	***62.2***	***61.3***
R11	***54.0***	***56.6***	***56.7***	***56.7***	***55.6***	***51.5***	***48.6***	***49.6***	***55.9***

APPENDIX C NOISE CONTOURS

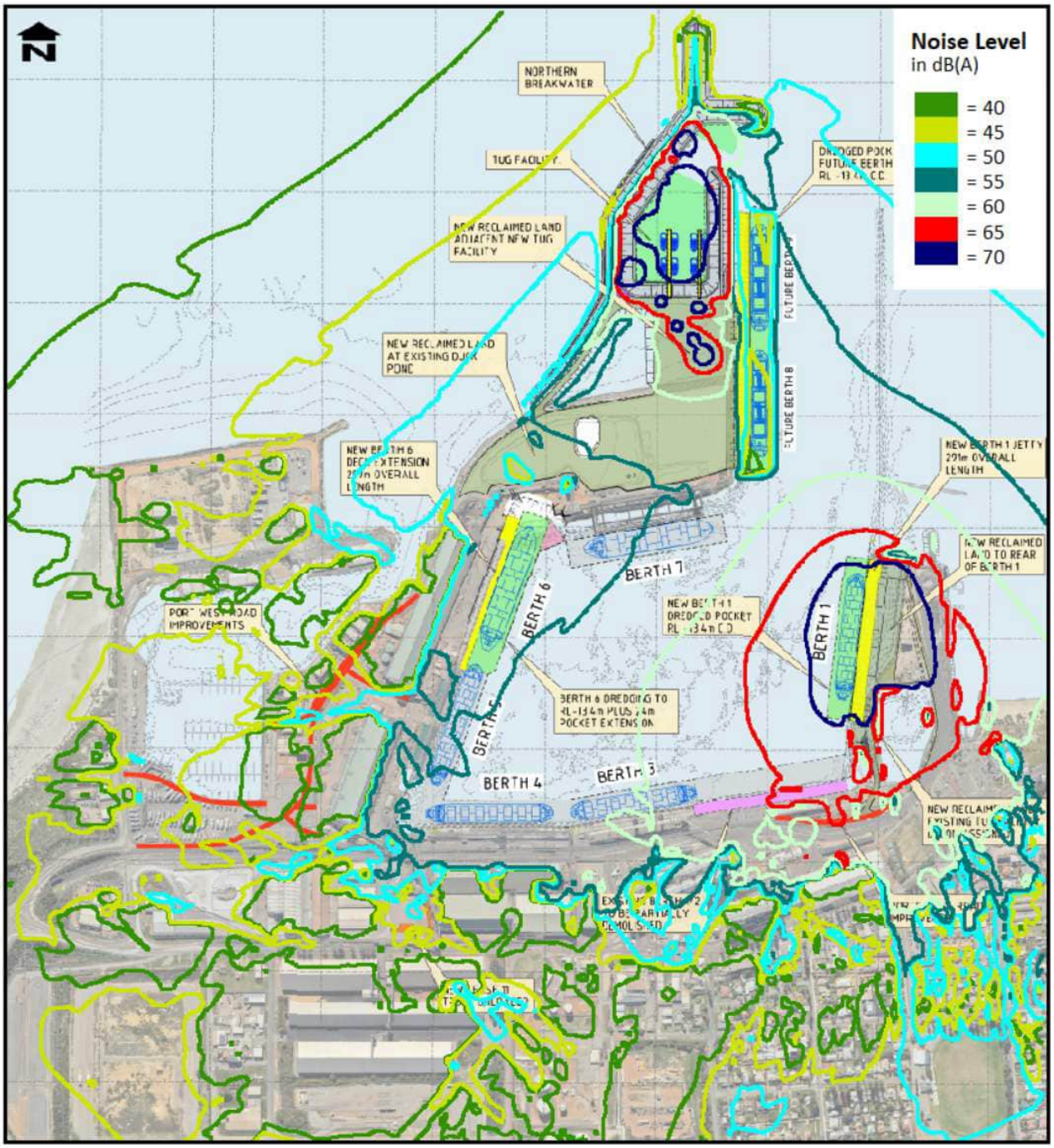

Figure 3: Daytime noise contours for scenario 1 under northerly wind.

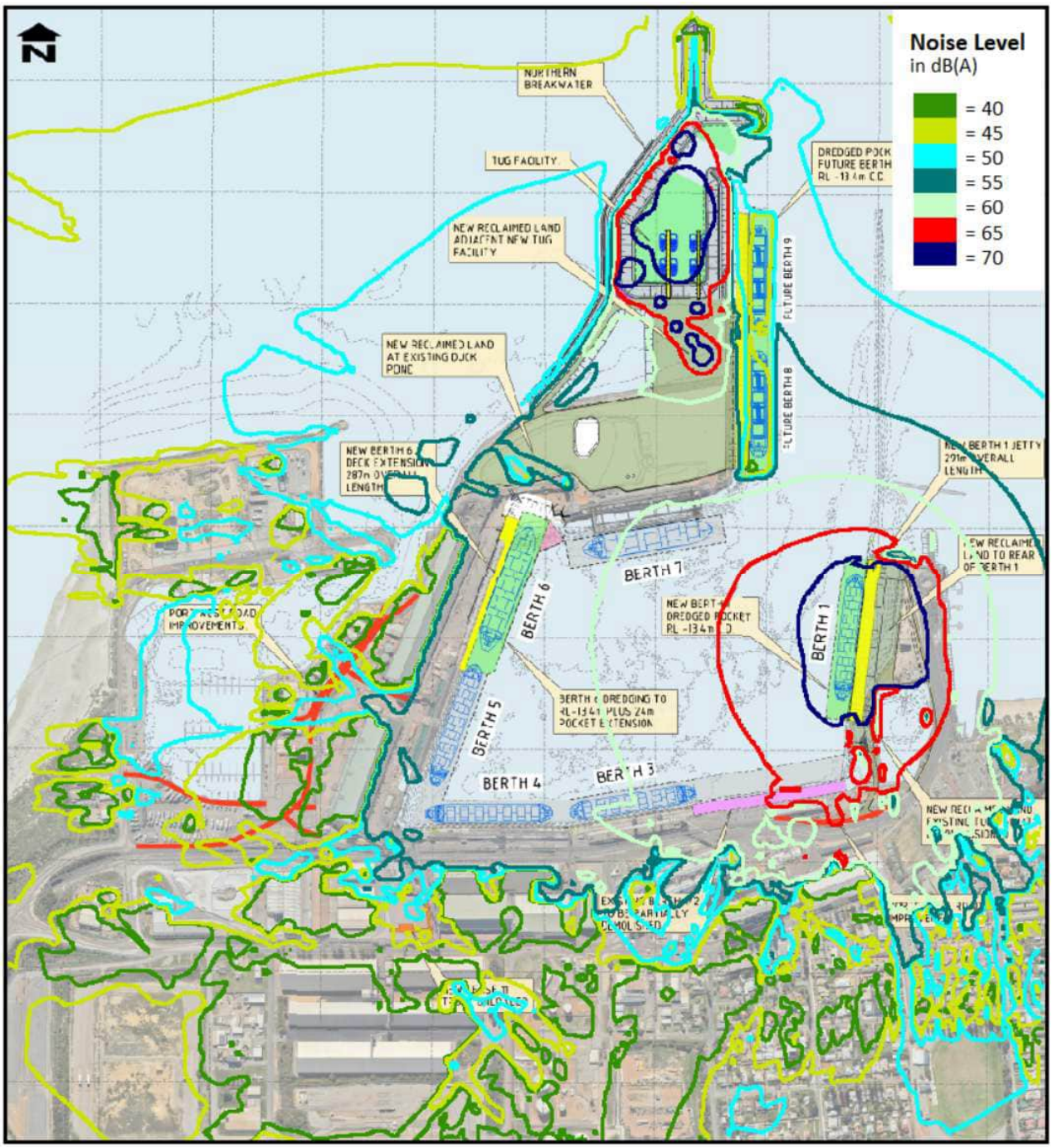

Figure 4: Daytime noise contours for scenario 1 under north-easterly wind.

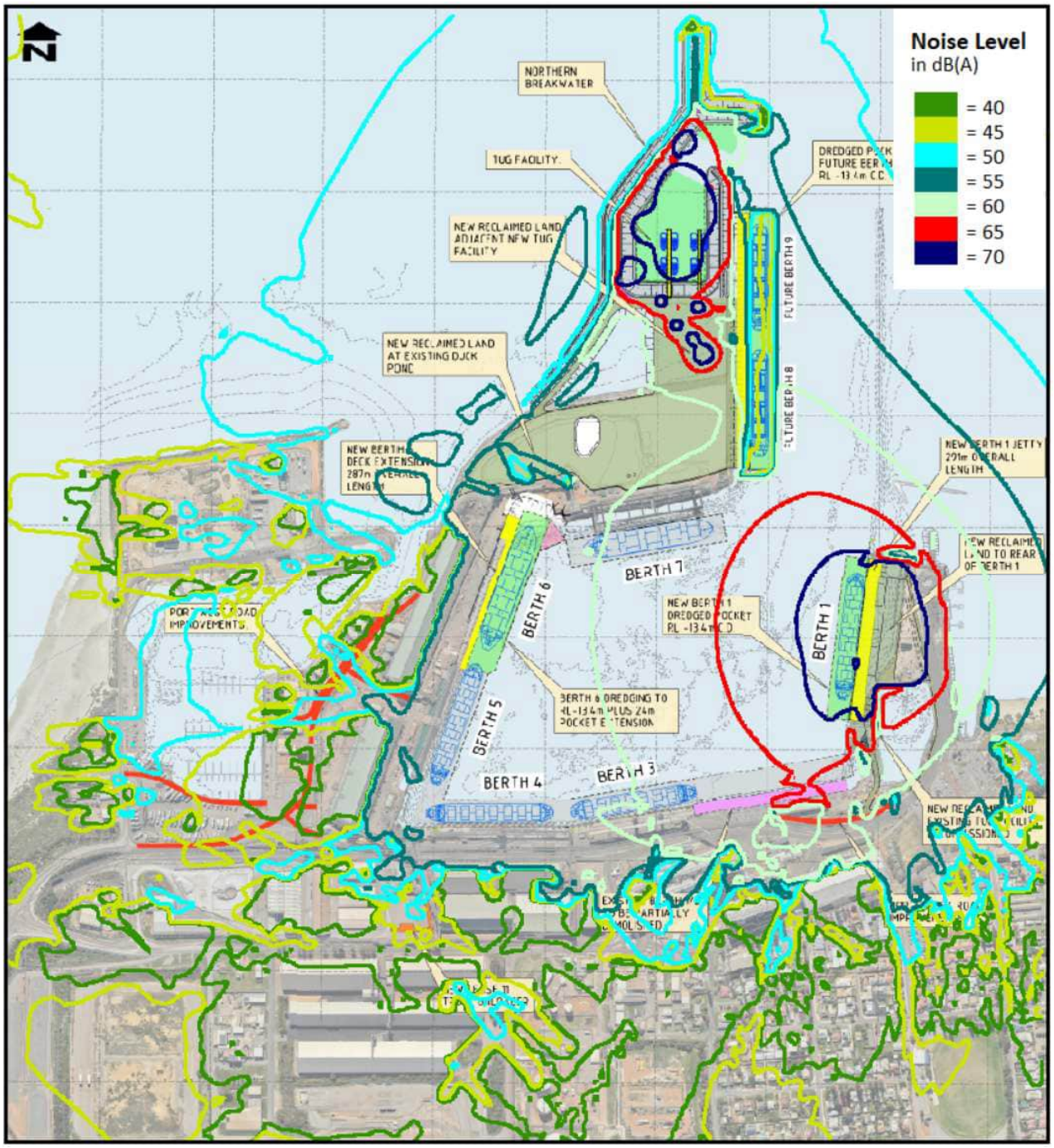

Figure 5: Daytime noise contours for scenario 1 under easterly wind.

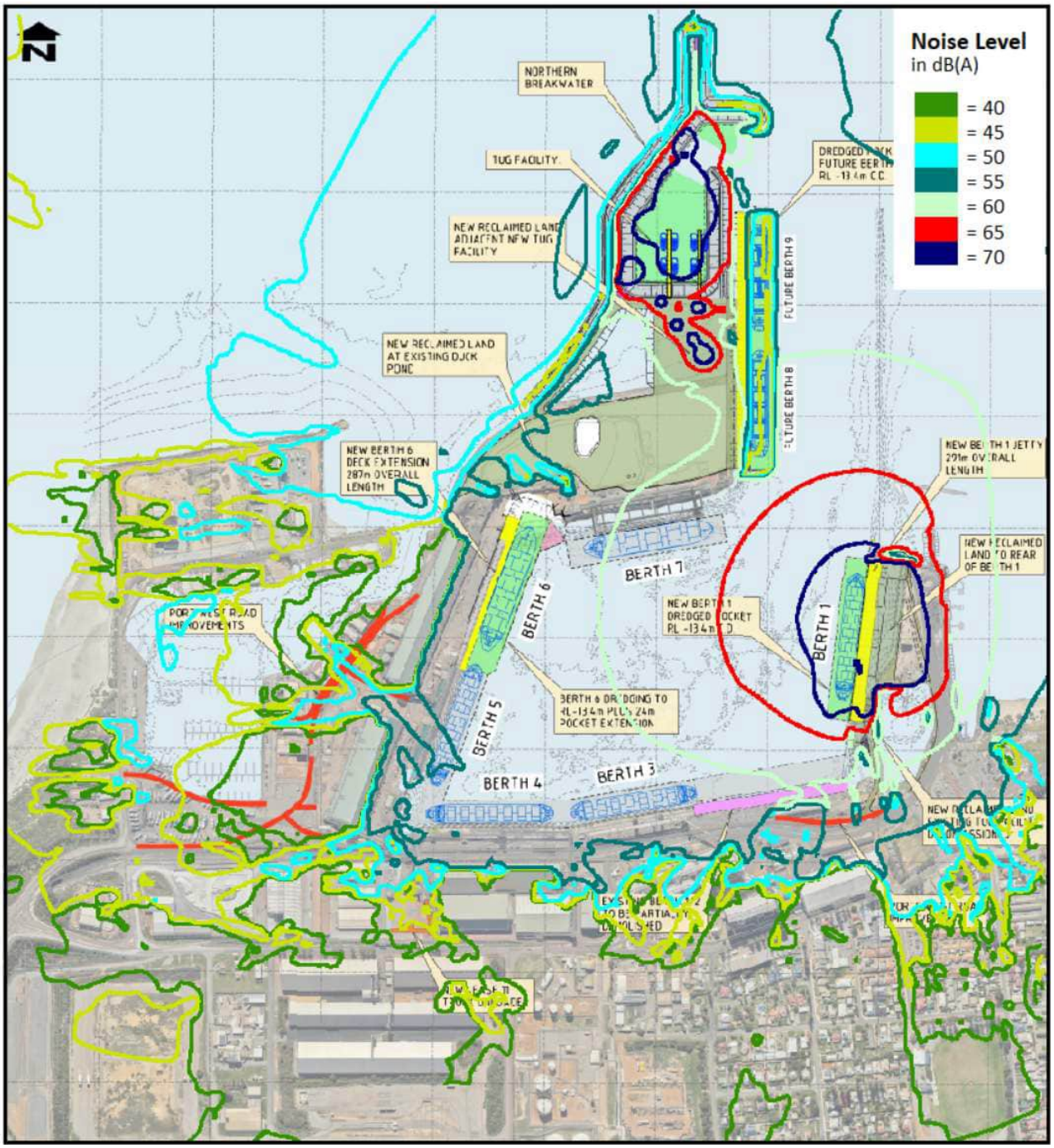

Figure 6: Daytime noise contours for scenario 1 under south-easterly wind.

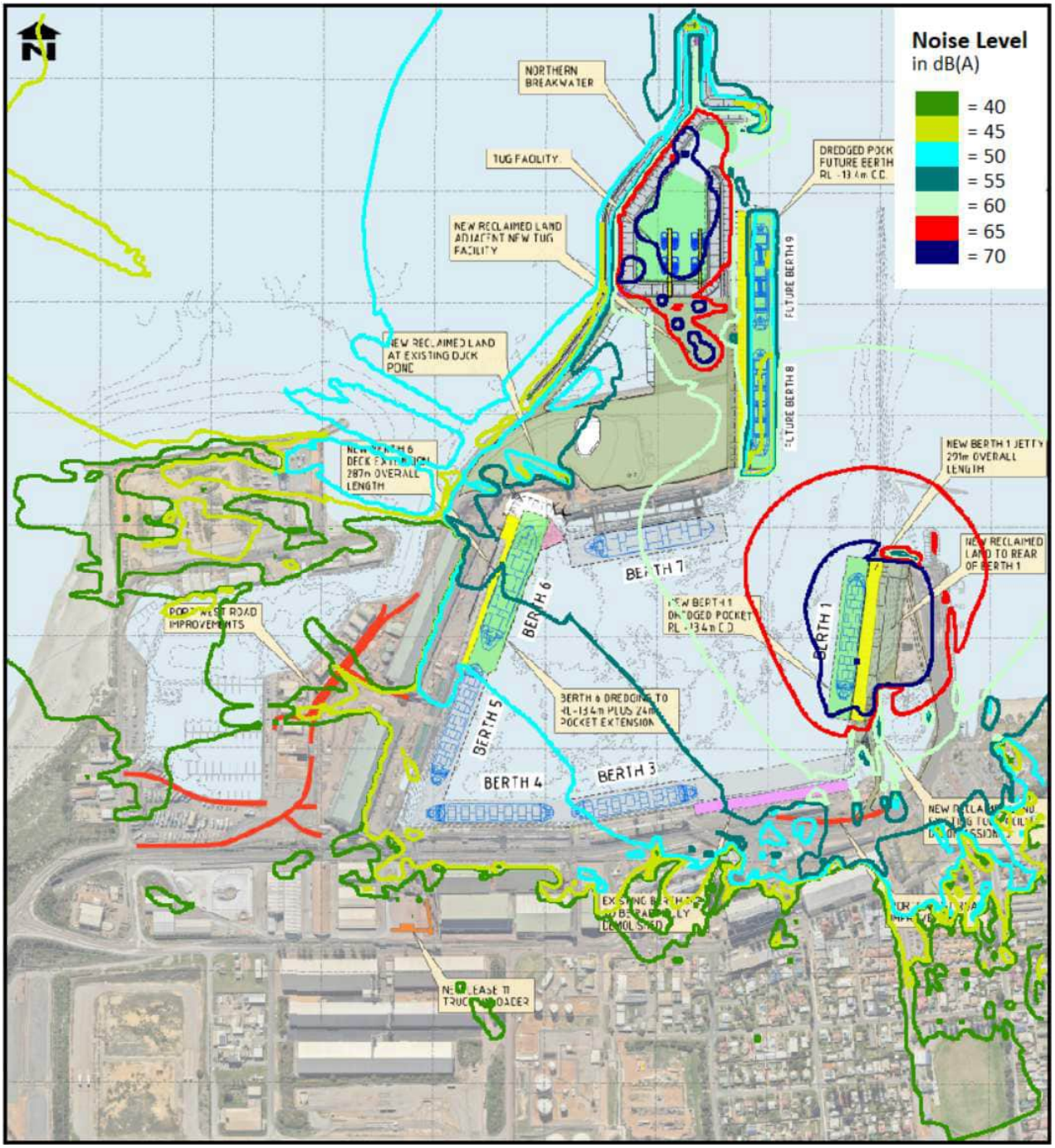

Figure 7: Daytime noise contours for scenario 1 under southerly wind.

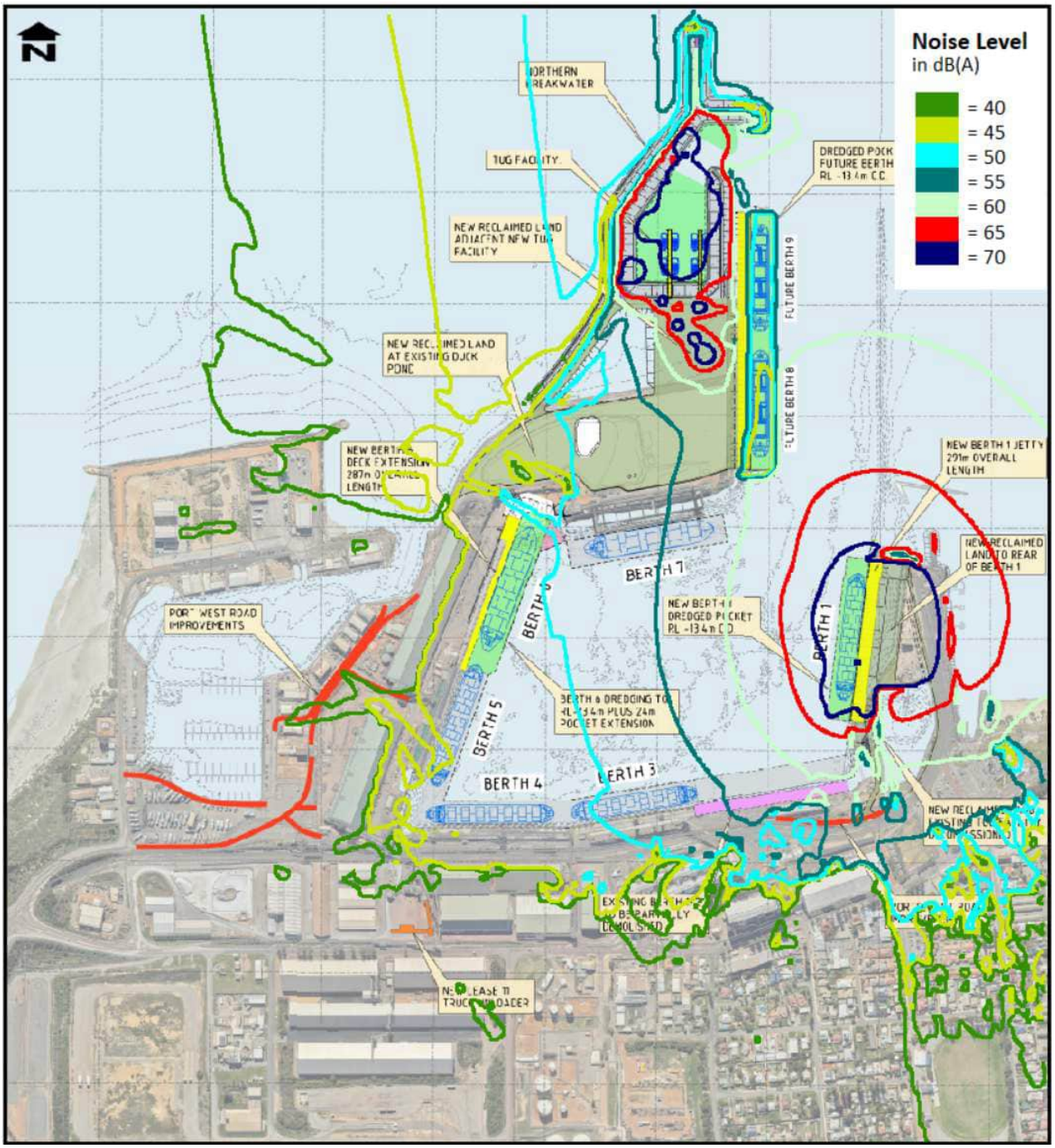

Figure 8: Daytime noise contours for scenario 1 under south-westerly wind.

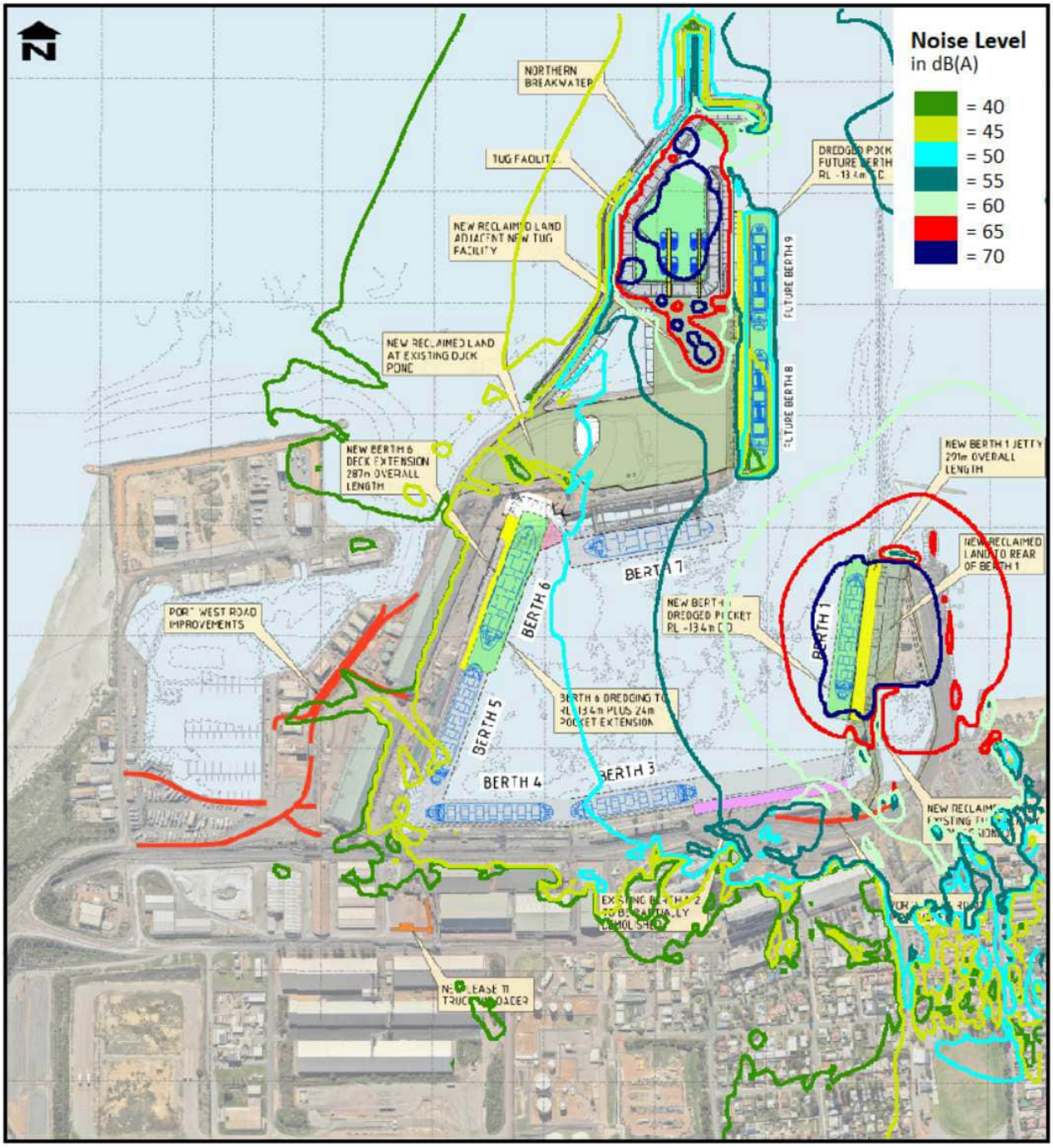

Figure 9: Daytime noise contours for scenario 1 under westerly wind.

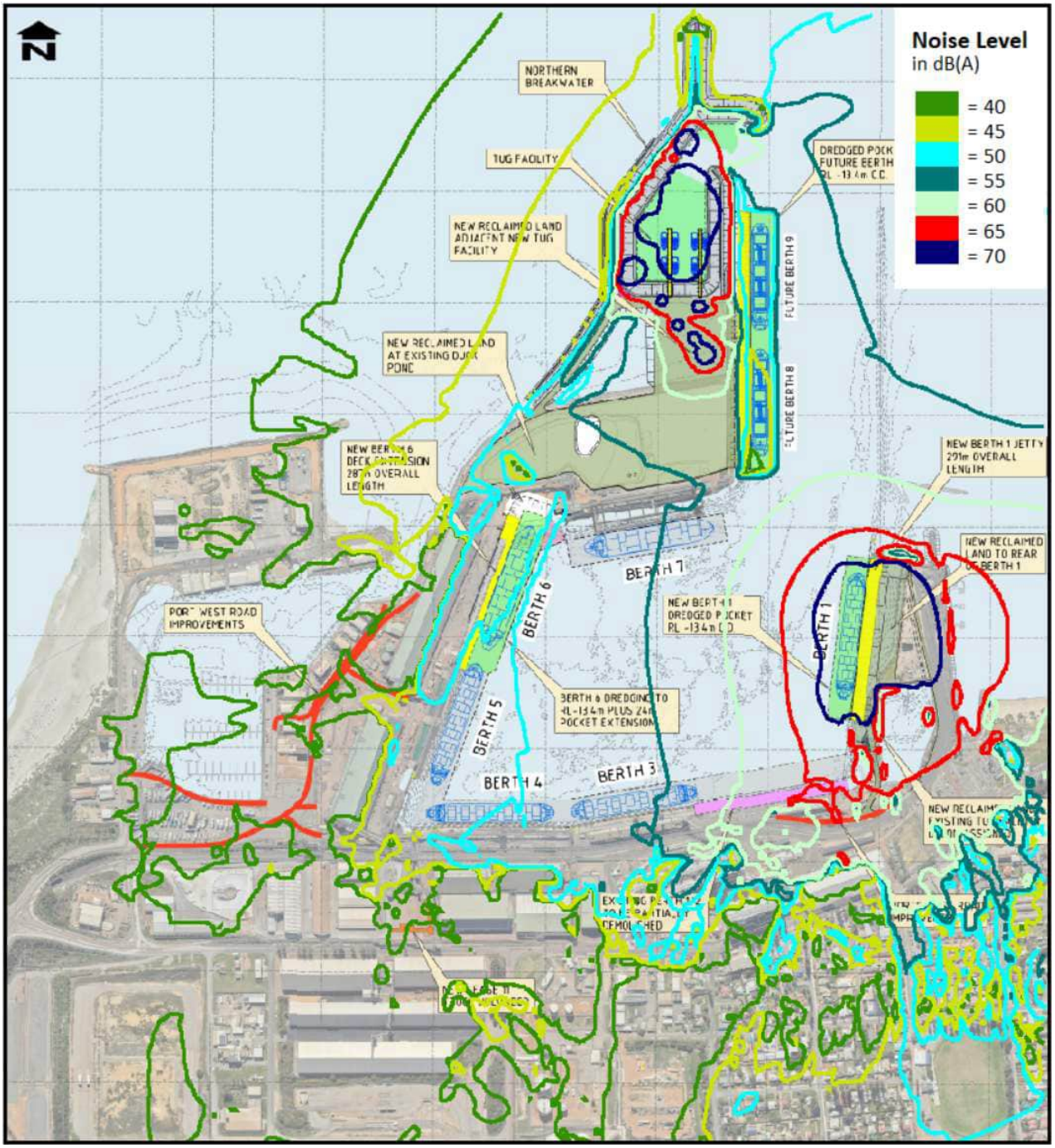

Figure 10: Daytime noise contours for scenario 1 under north-westerly wind.

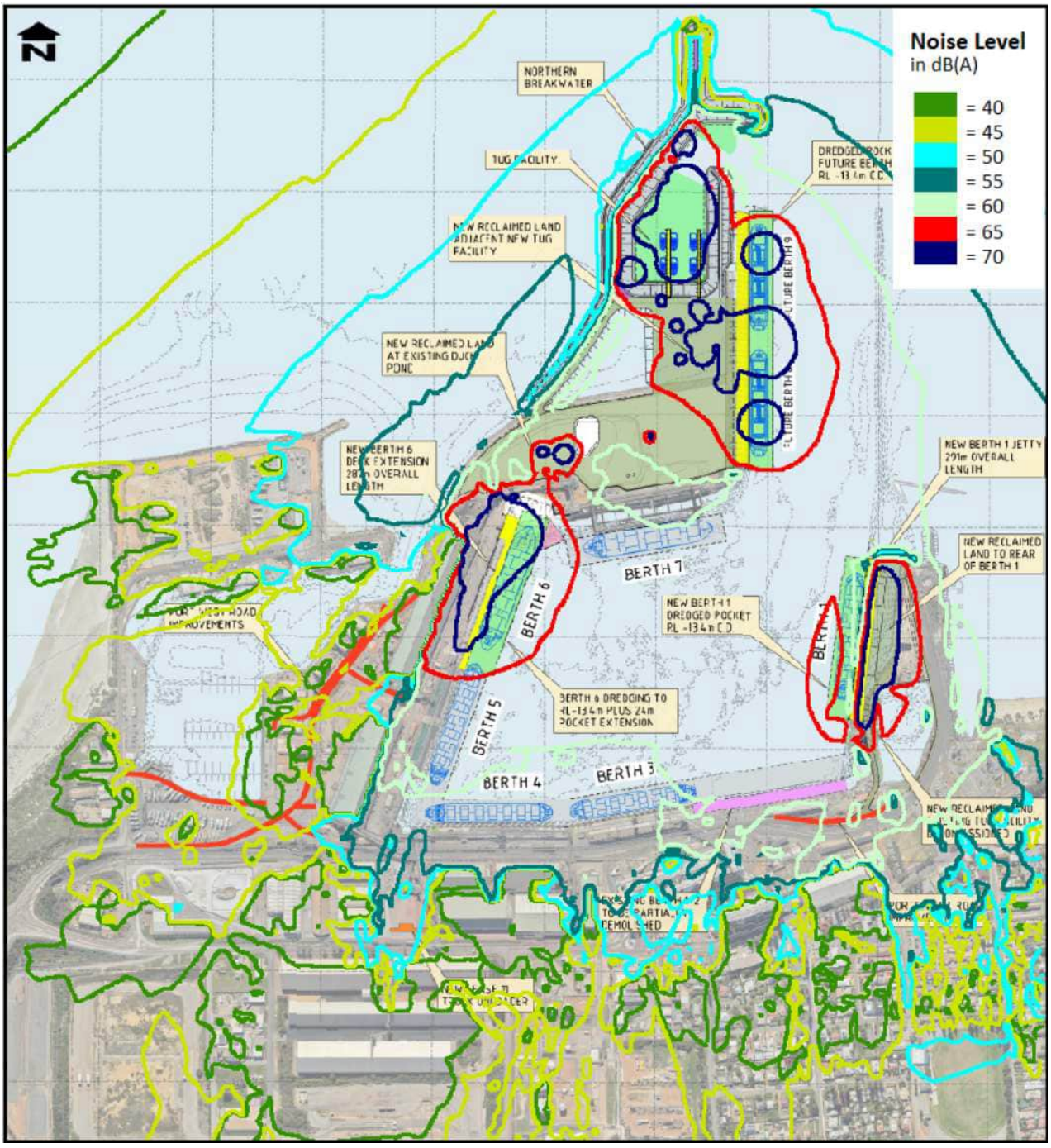

Figure 11: Daytime noise contours for scenario 2 under northerly wind.

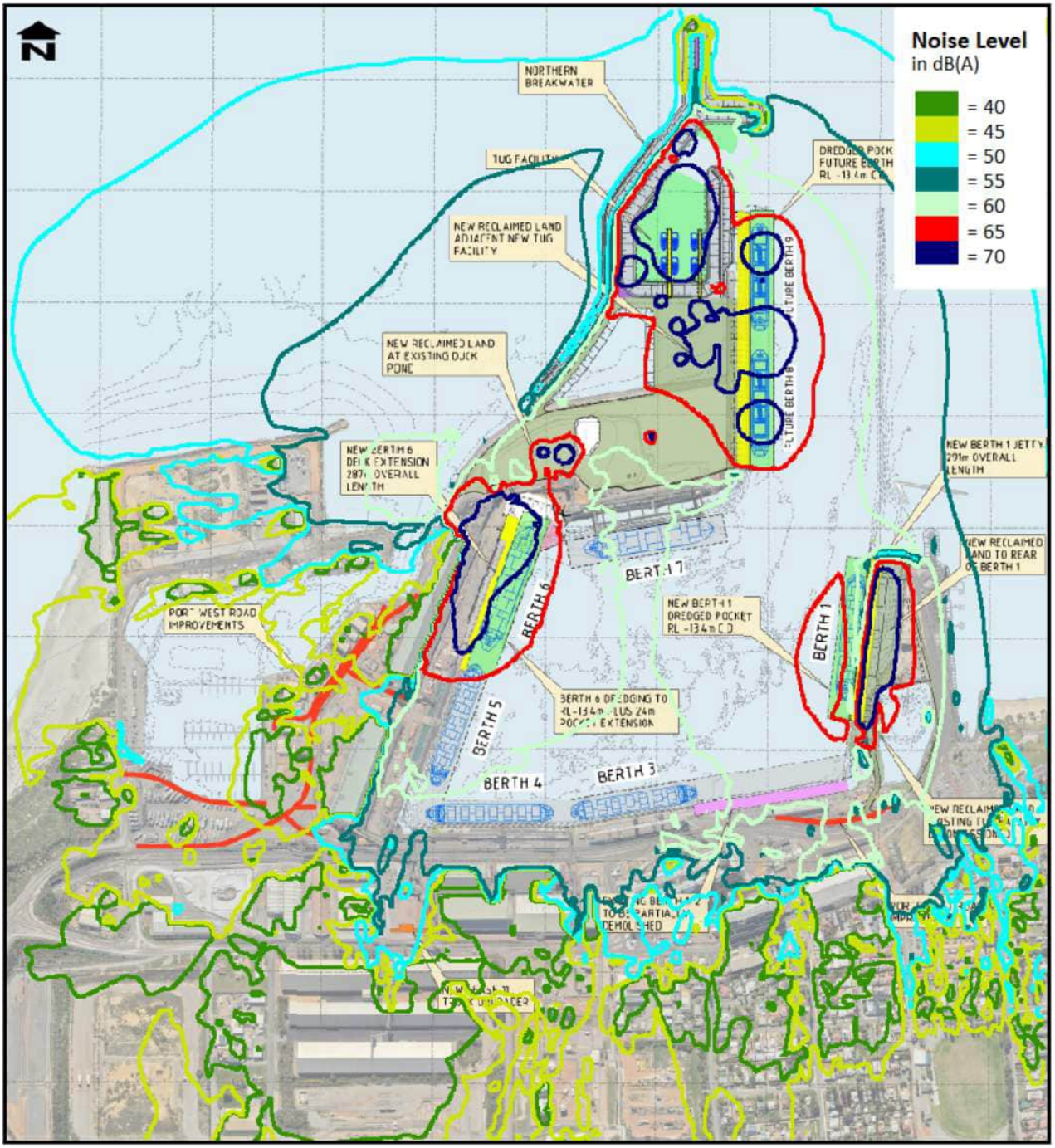

Figure 12: Daytime noise contours for scenario 2 under north-easterly wind.

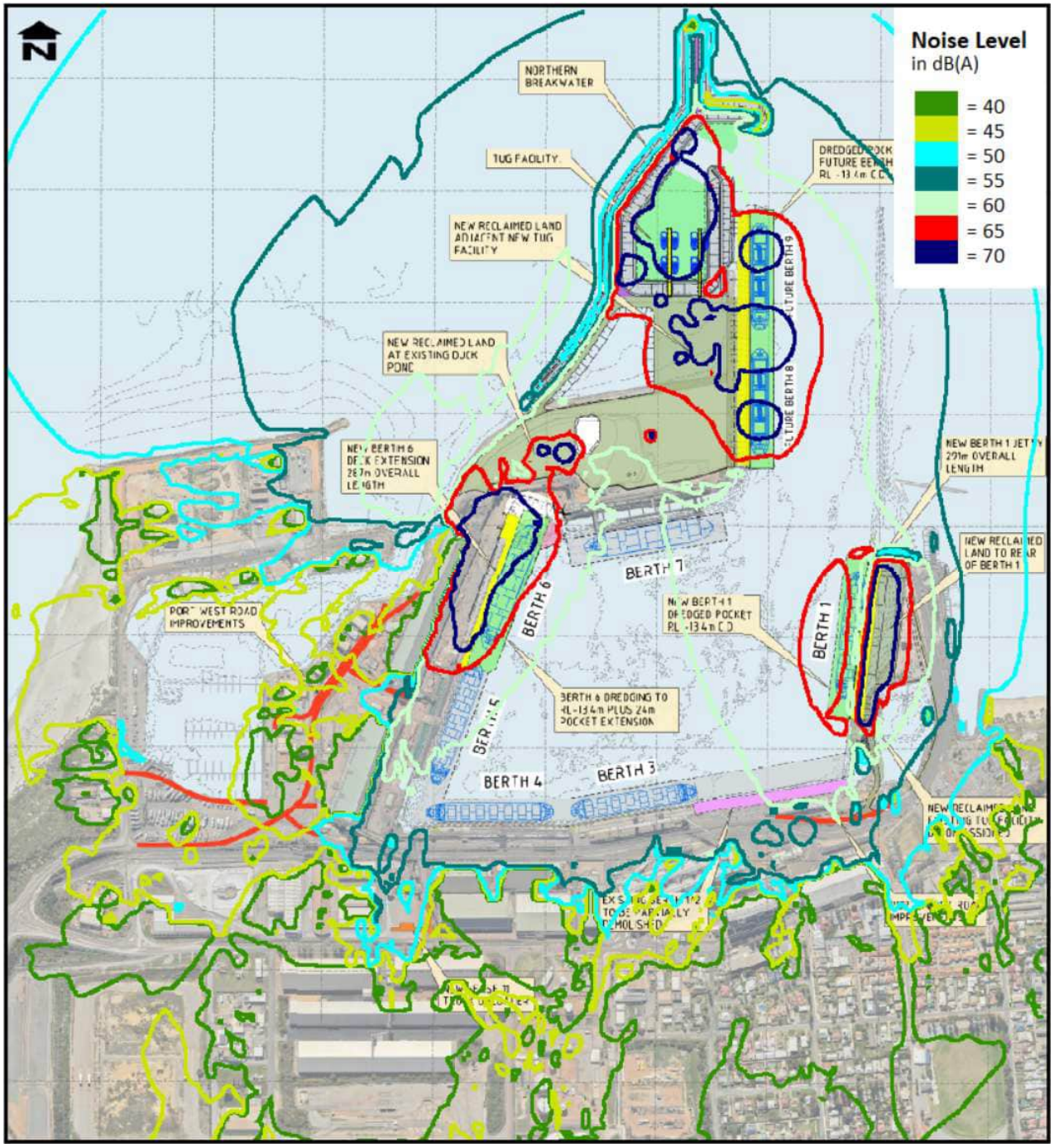

Figure 13: Daytime noise contours for scenario 2 under easterly wind.

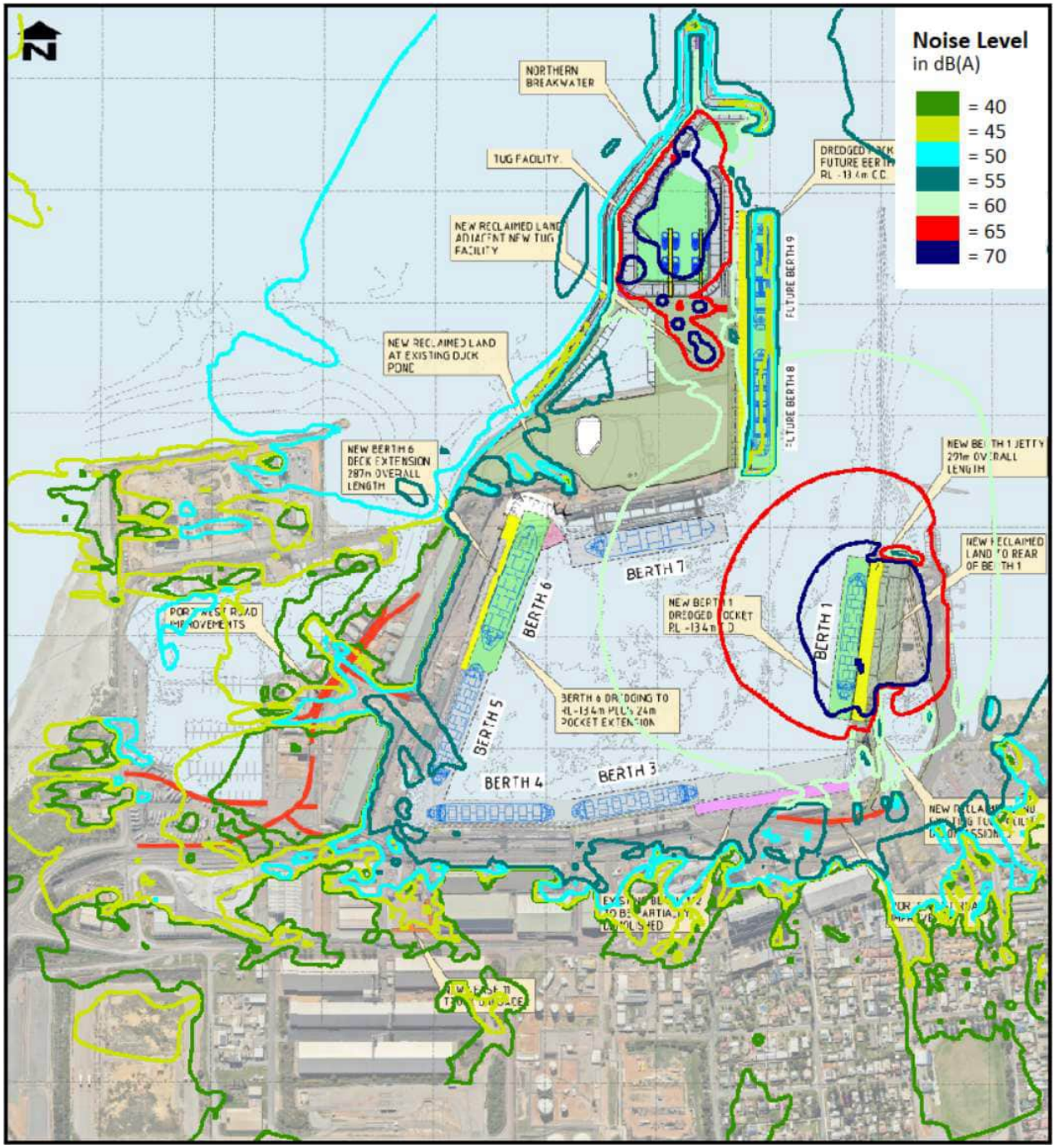

Figure 14: Daytime noise contours for scenario 2 under south-easterly wind.

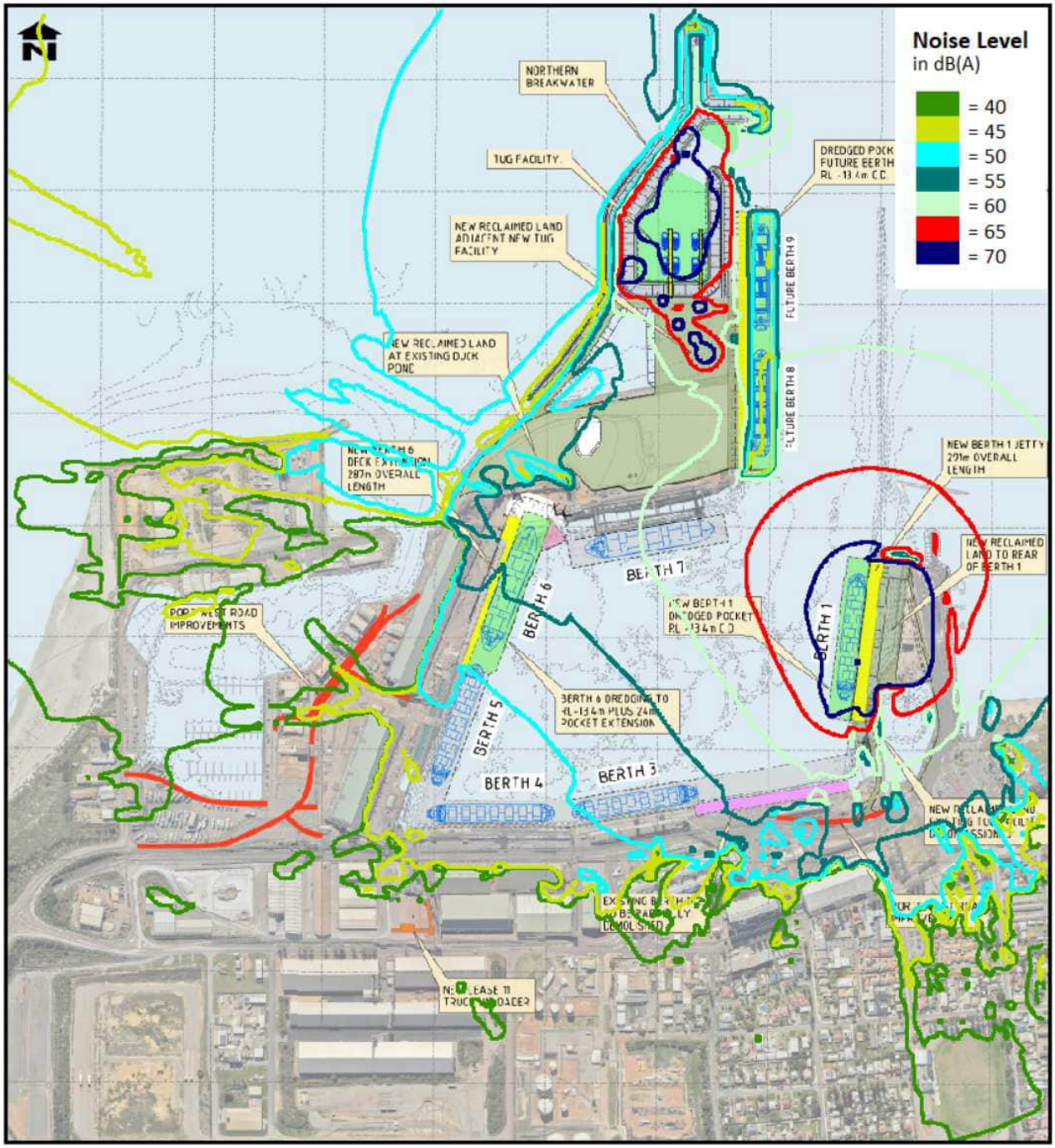

Figure 15: Daytime noise contours for scenario 2 under southerly wind.

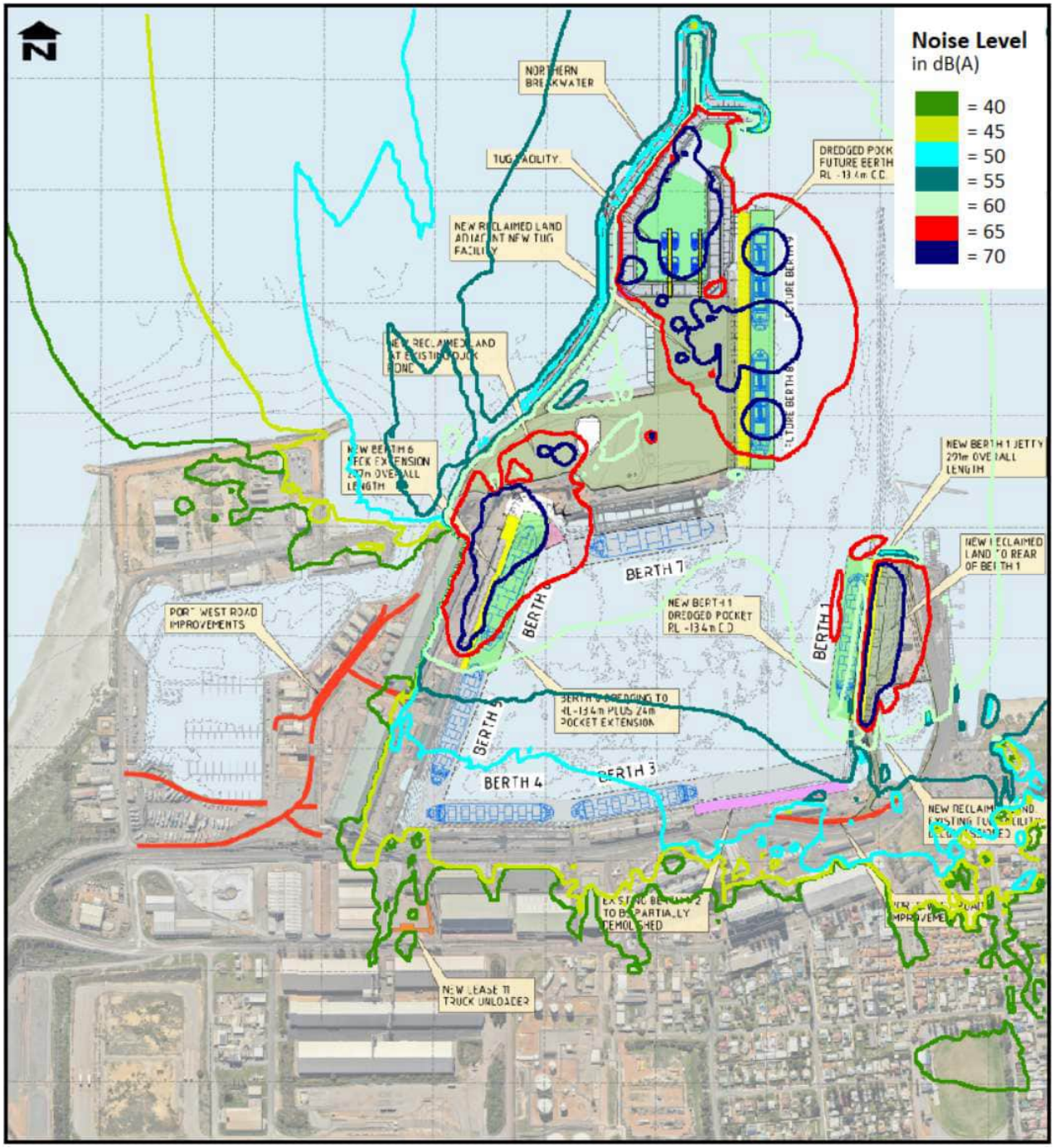

Figure 16: Daytime noise contours for scenario 2 under south-westerly wind.

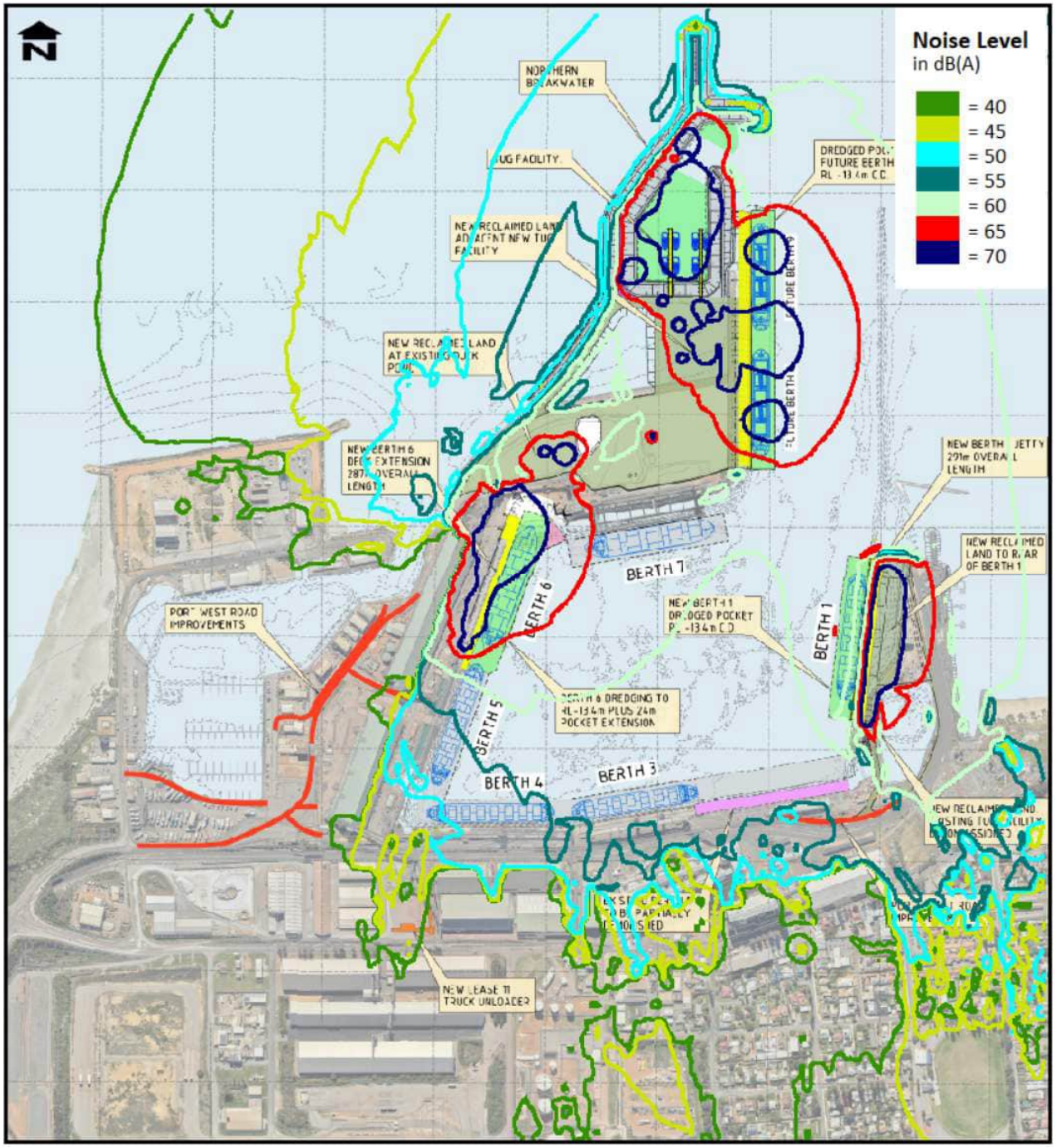

Figure 17: Daytime noise contours for scenario 2 under westerly wind.

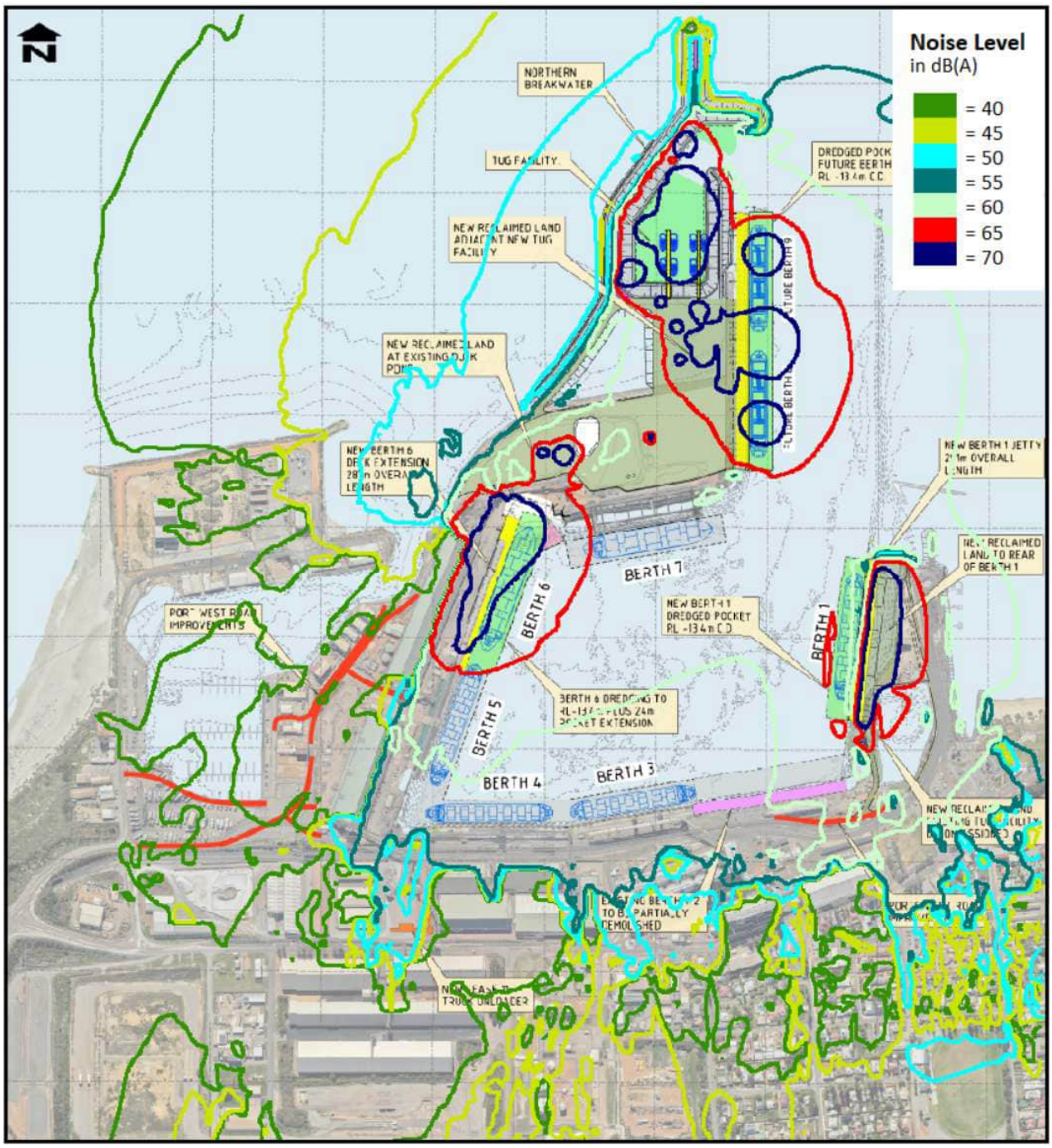

Figure 18: Daytime noise contours for scenario 2 under north-westerly wind.

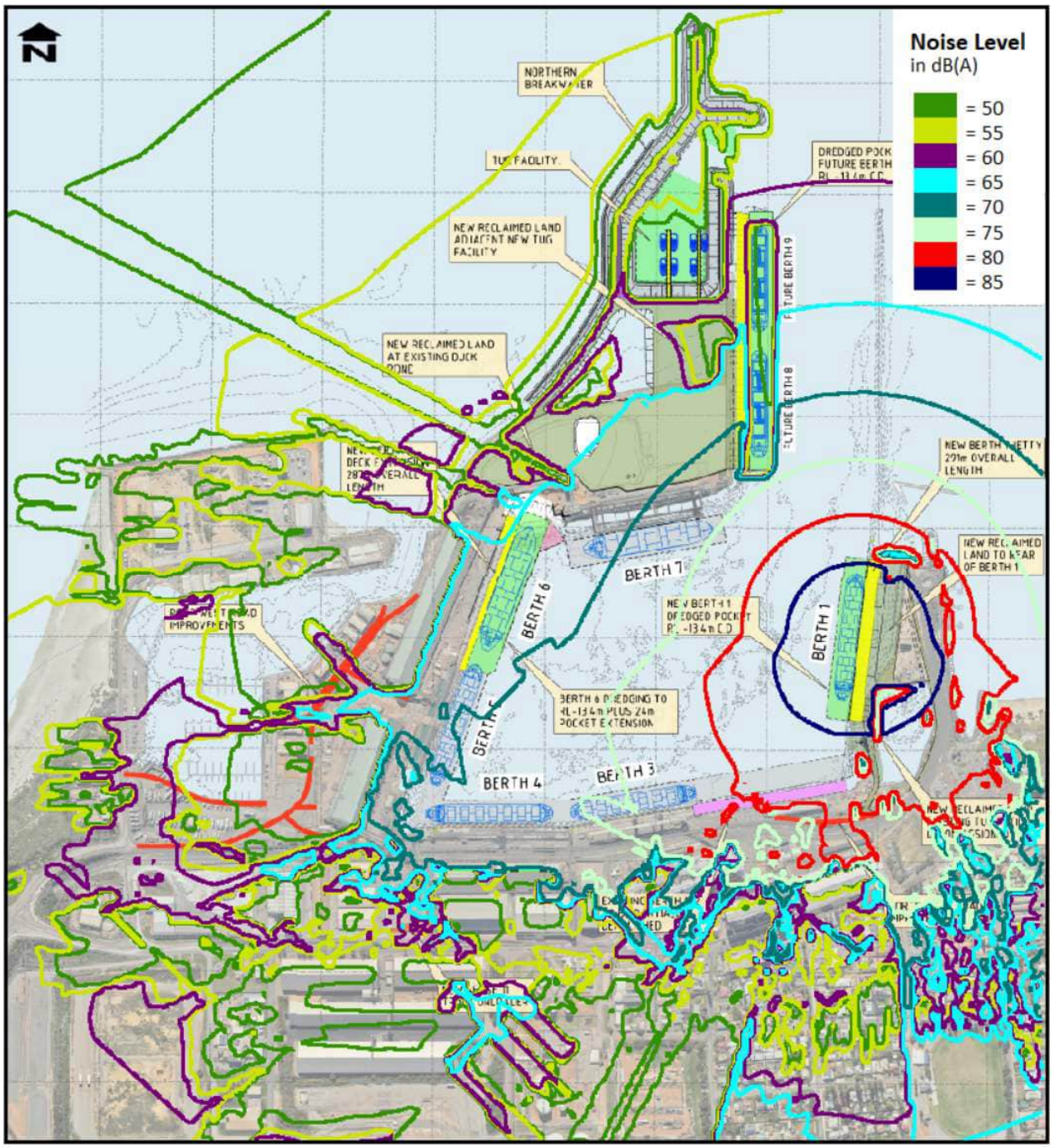

Figure 19: Daytime noise L_{AMax} contours for scenario 3 under northerly wind.

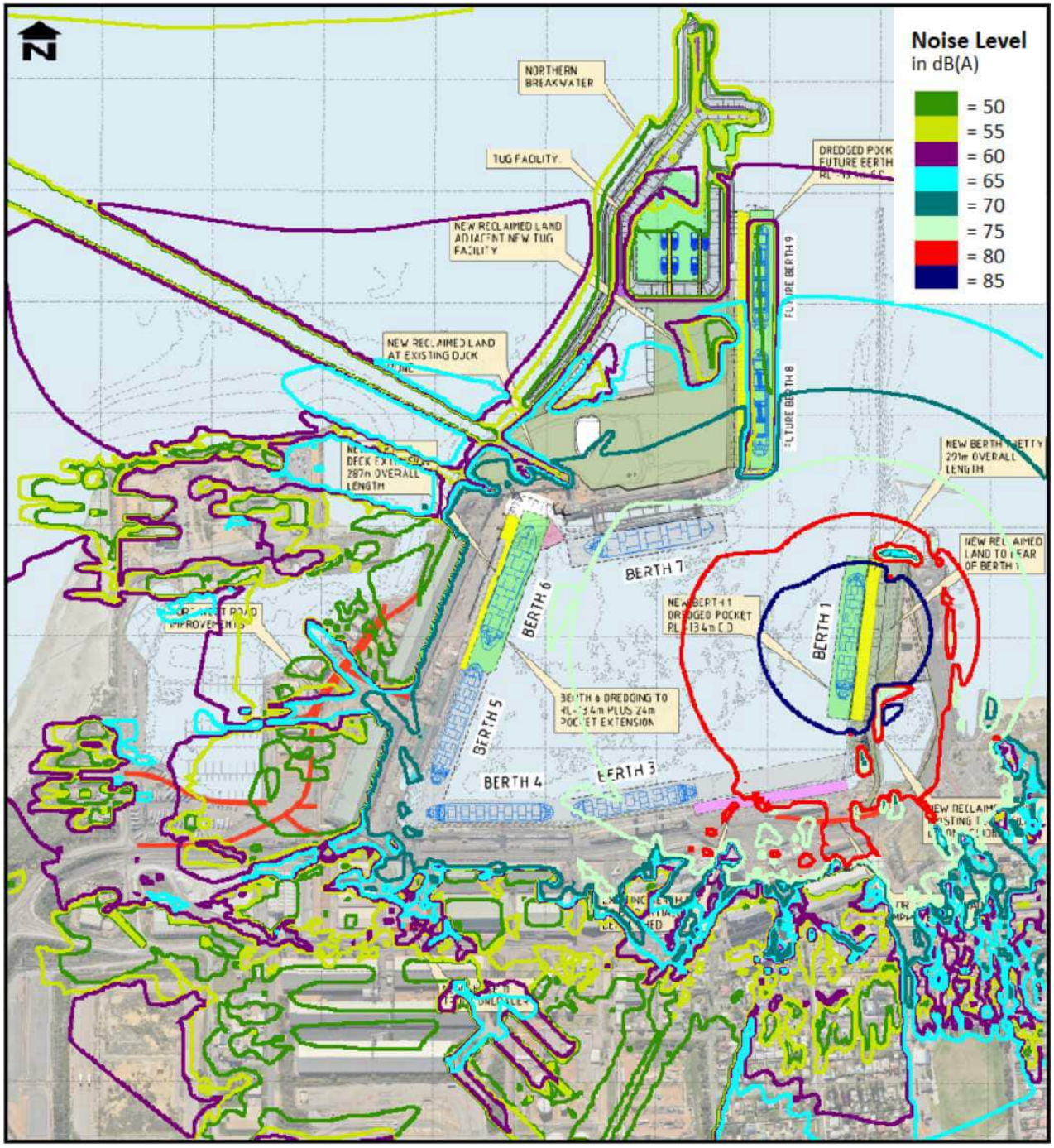

Figure 20: Daytime noise L_{AMax} contours for scenario 3 under north-easterly wind.

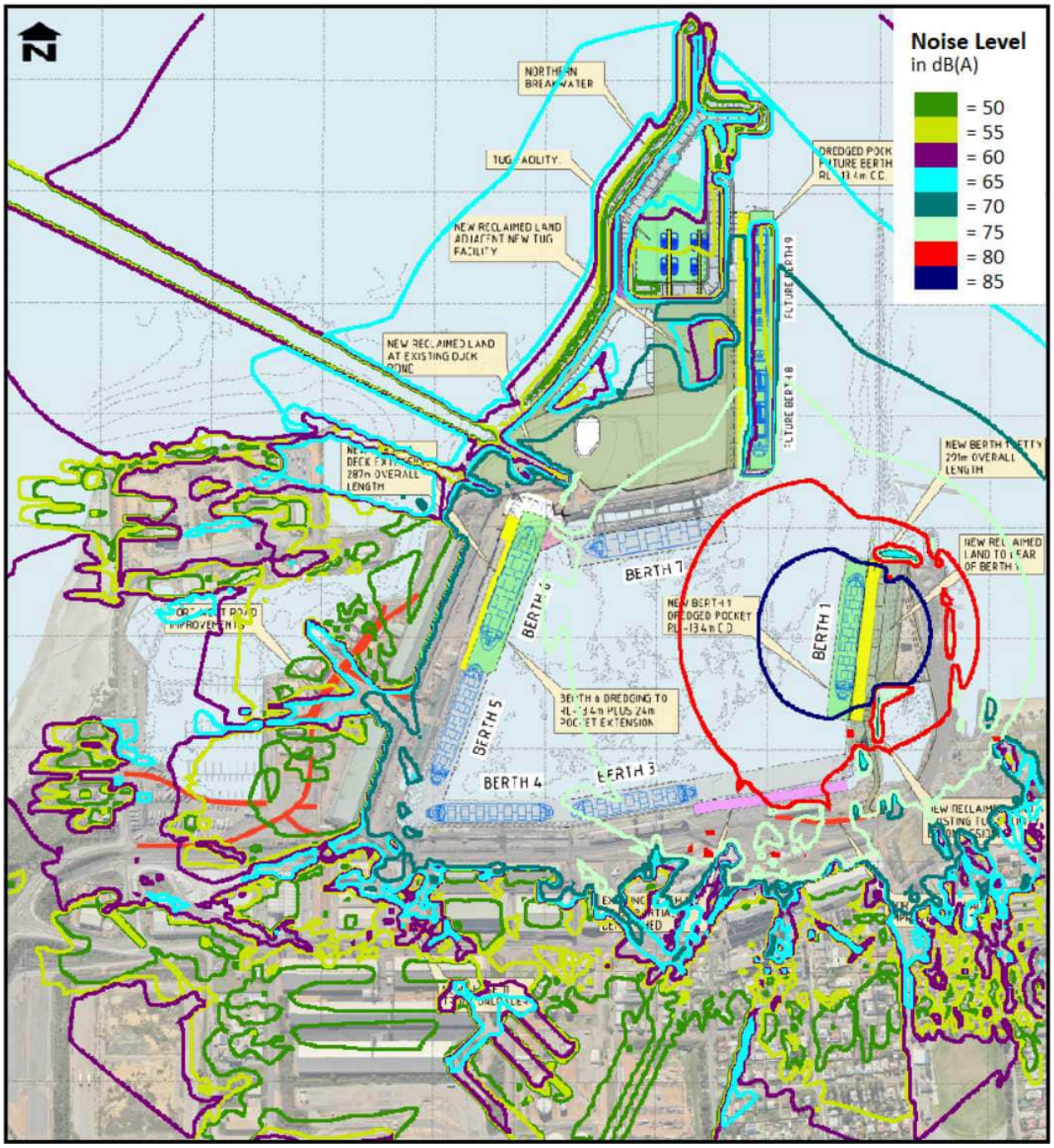

Figure 21: Daytime noise L_{AMax} contours for scenario 3 under easterly wind.

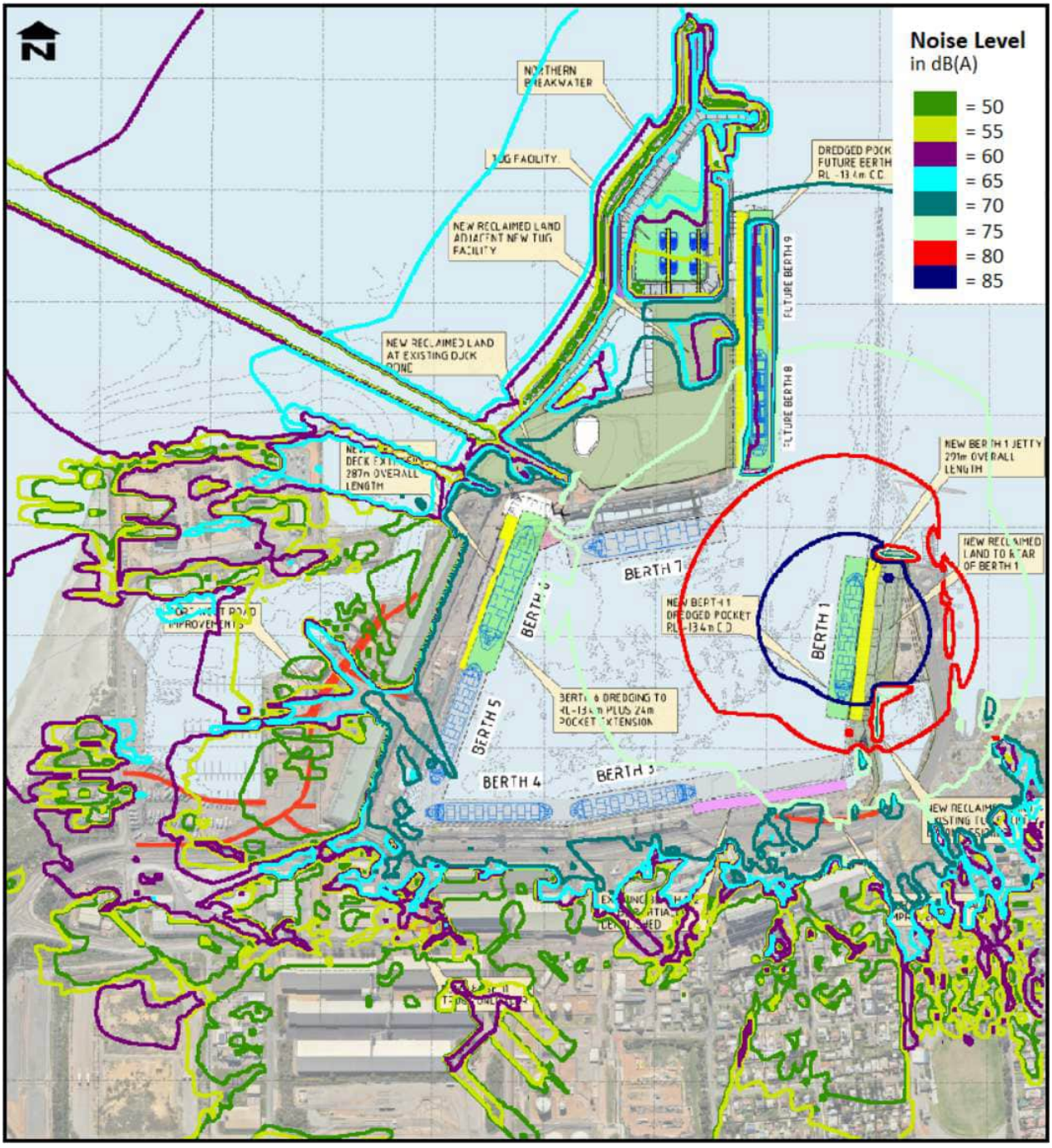

Figure 22: Daytime noise L_{AMax} contours for scenario 3 under south-easterly wind.

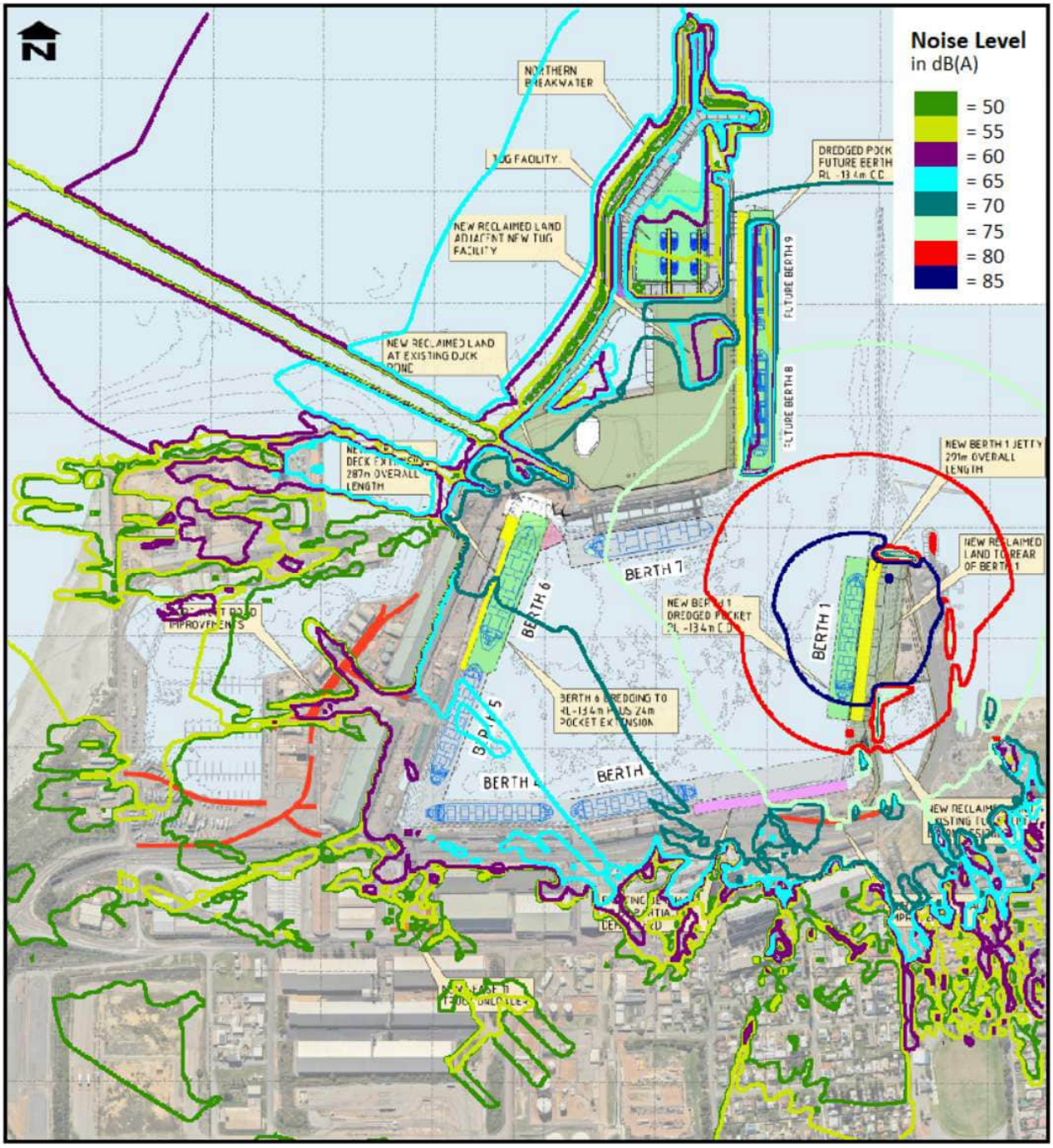

Figure 23: Daytime noise L_{AMax} contours for scenario 3 under southerly wind.

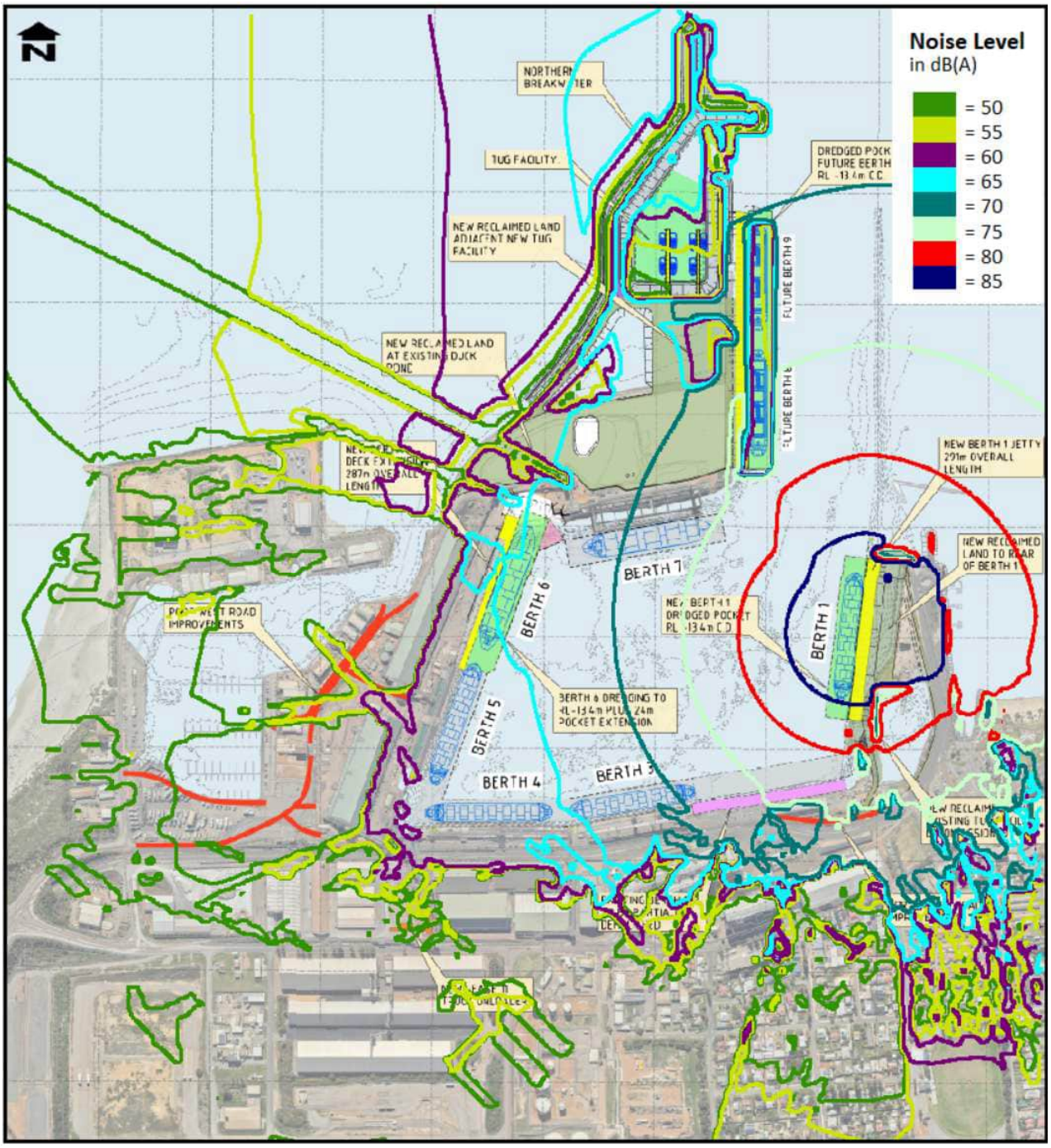

Figure 24: Daytime noise L_{AMax} contours for scenario 3 under south-westerly wind.

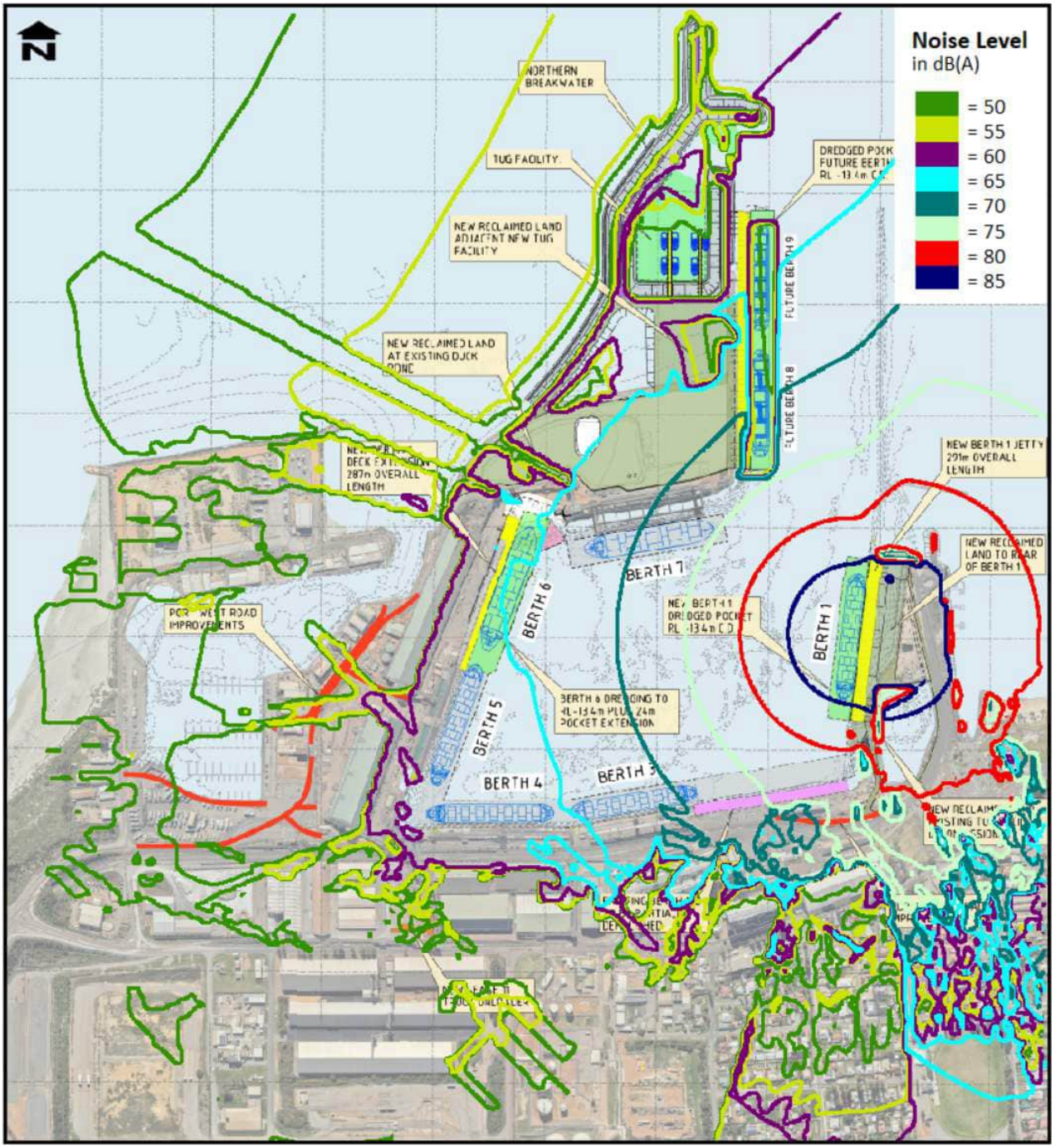

Figure 25: Daytime noise L_{AMax} contours for scenario 3 under westerly wind.

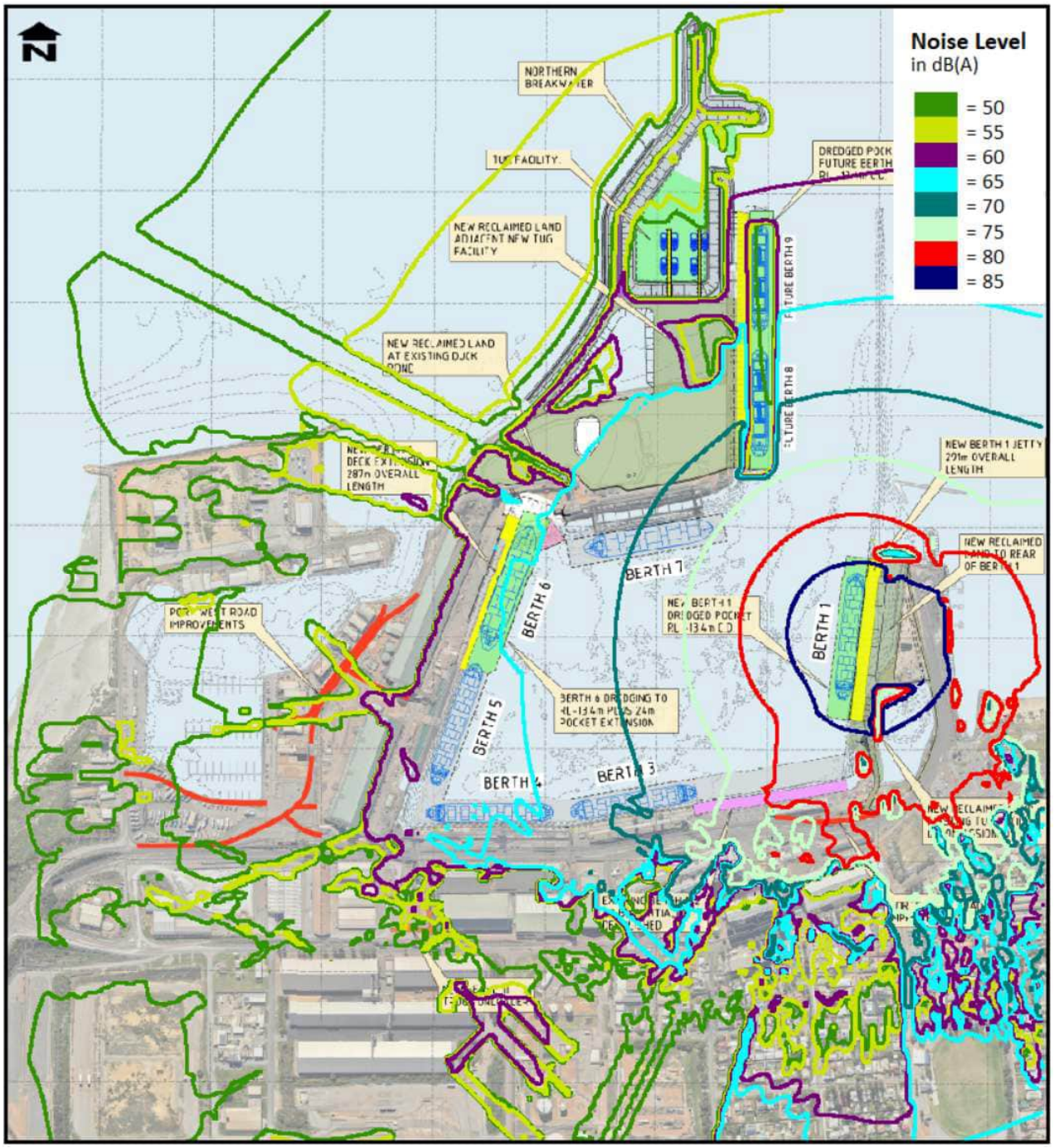

Figure 26: Daytime noise L_{AMax} contours for scenario 3 under north-westerly wind.

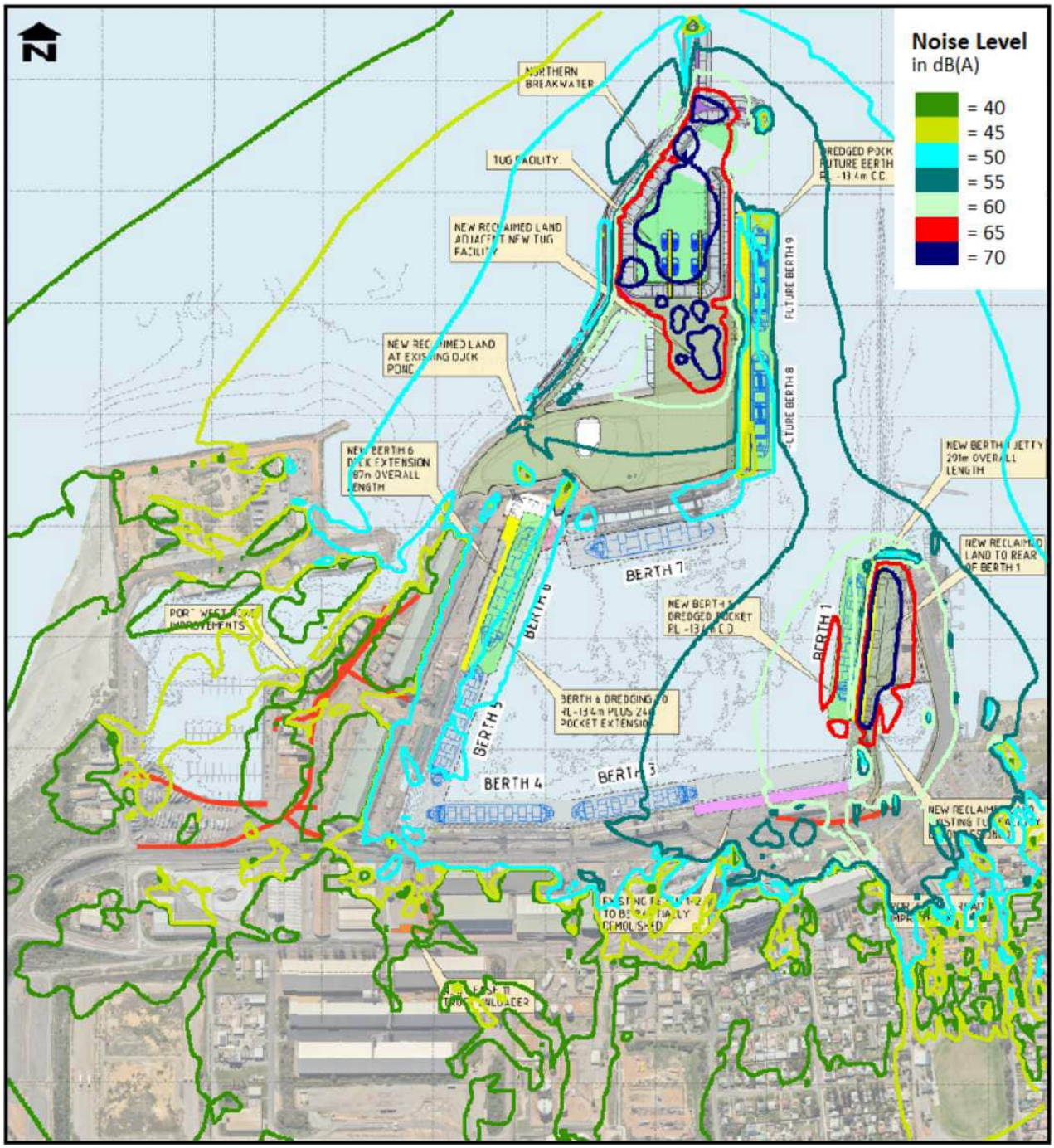

Figure 27: Daytime noise contours for scenario 4 under northerly wind.

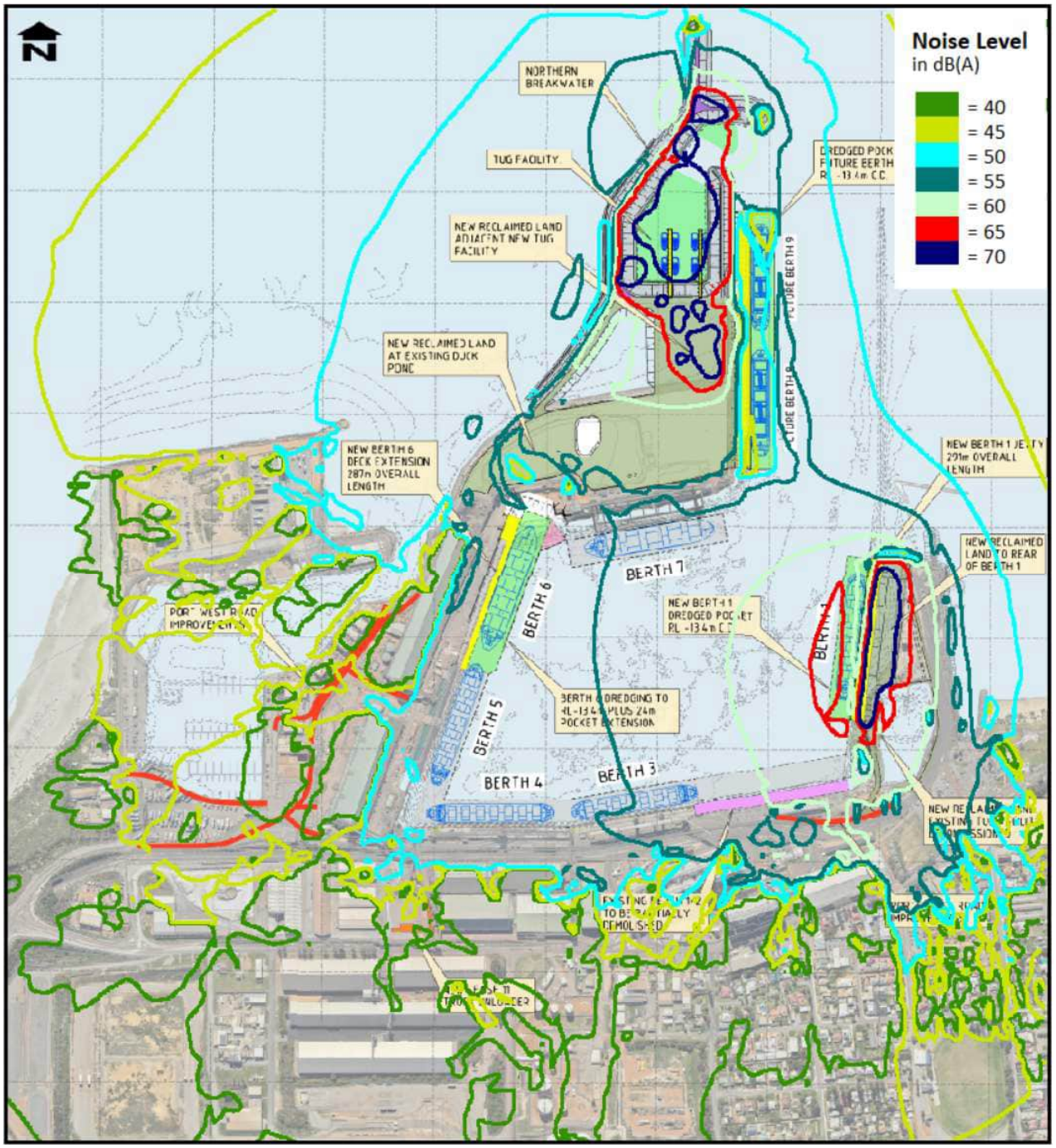

Figure 28: Daytime noise contours for scenario 4 under north-easterly wind.

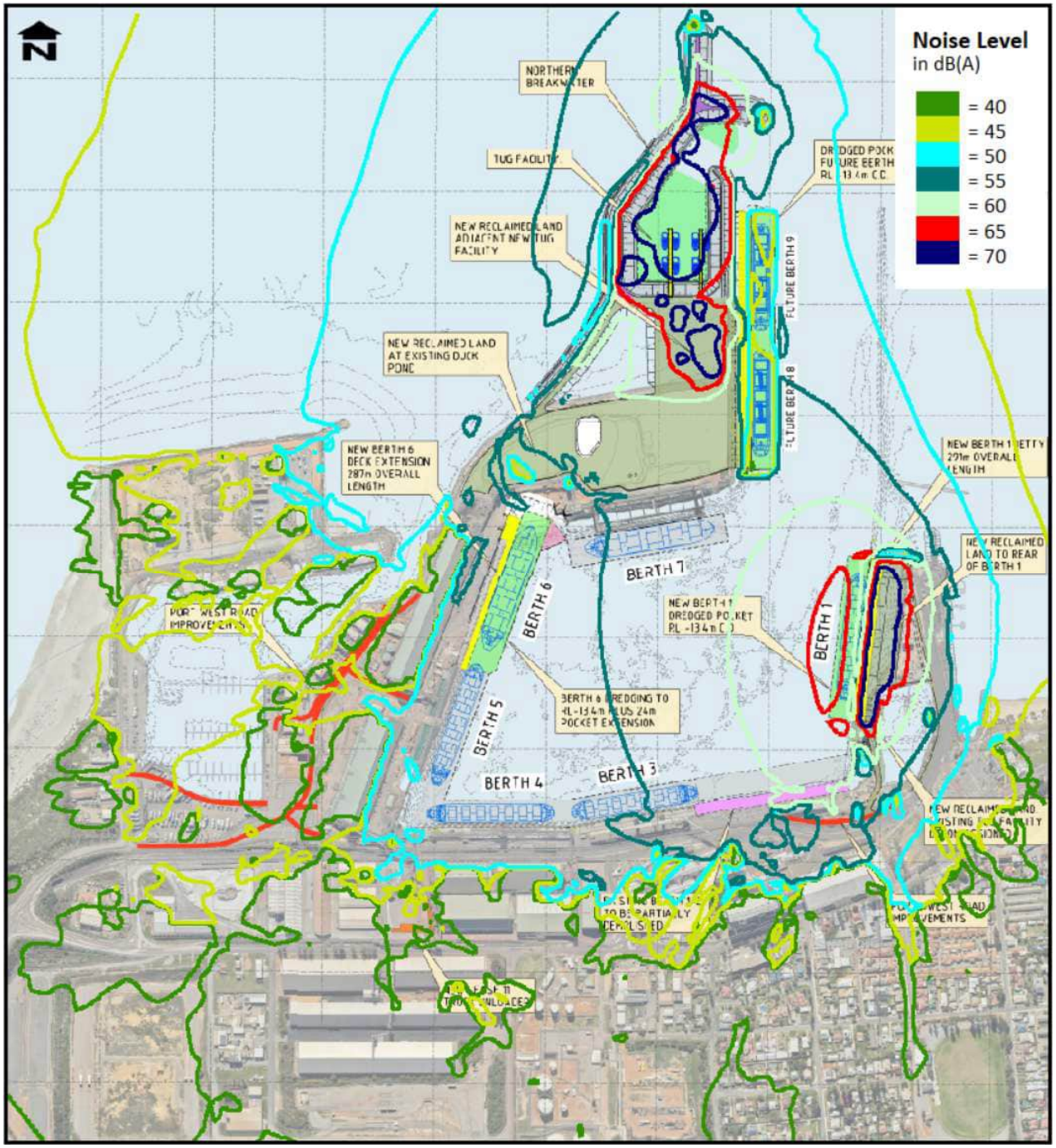

Figure 29: Daytime noise contours for scenario 4 under easterly wind.

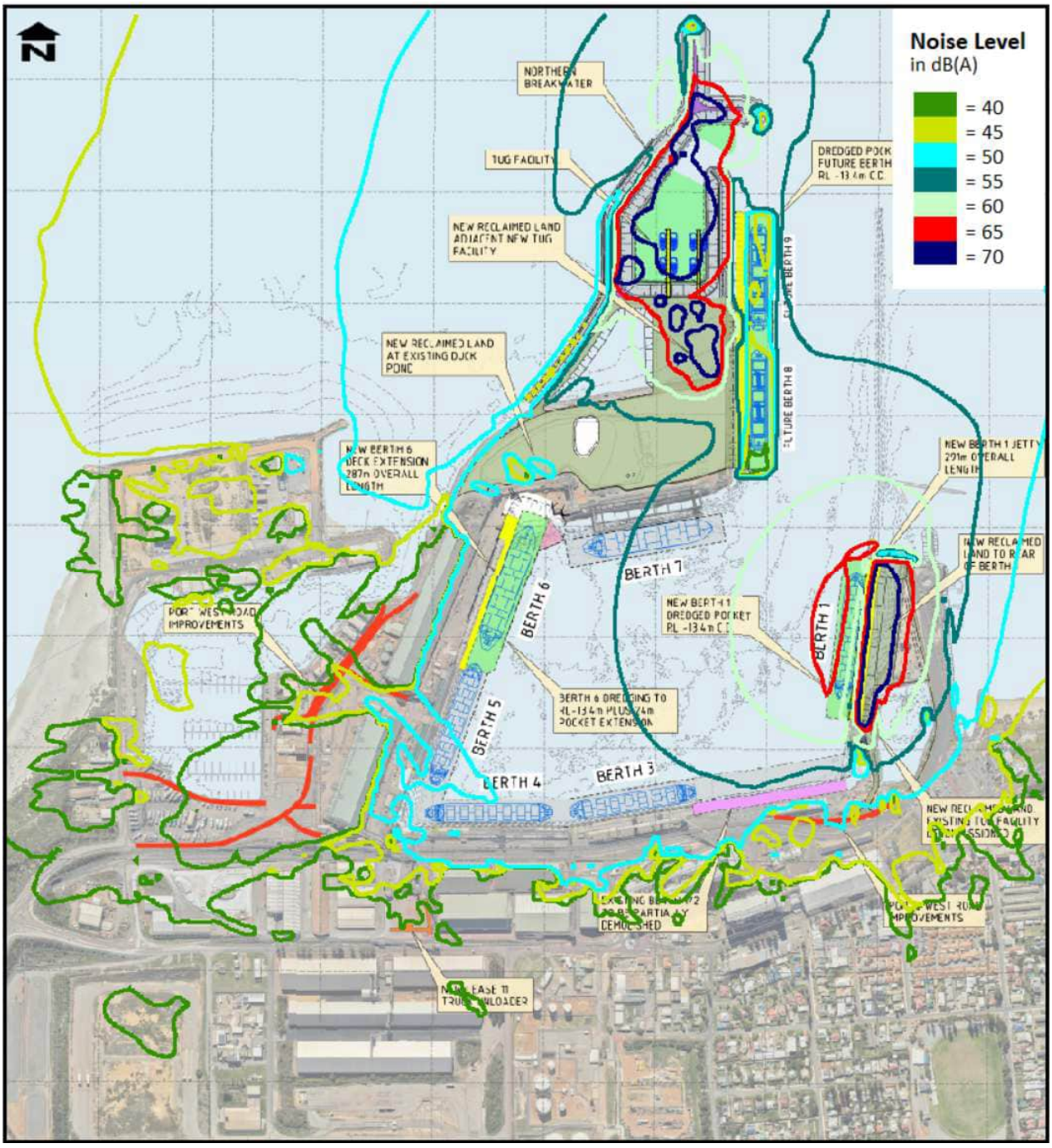

Figure 30: Daytime noise contours for scenario 4 under south-easterly wind.

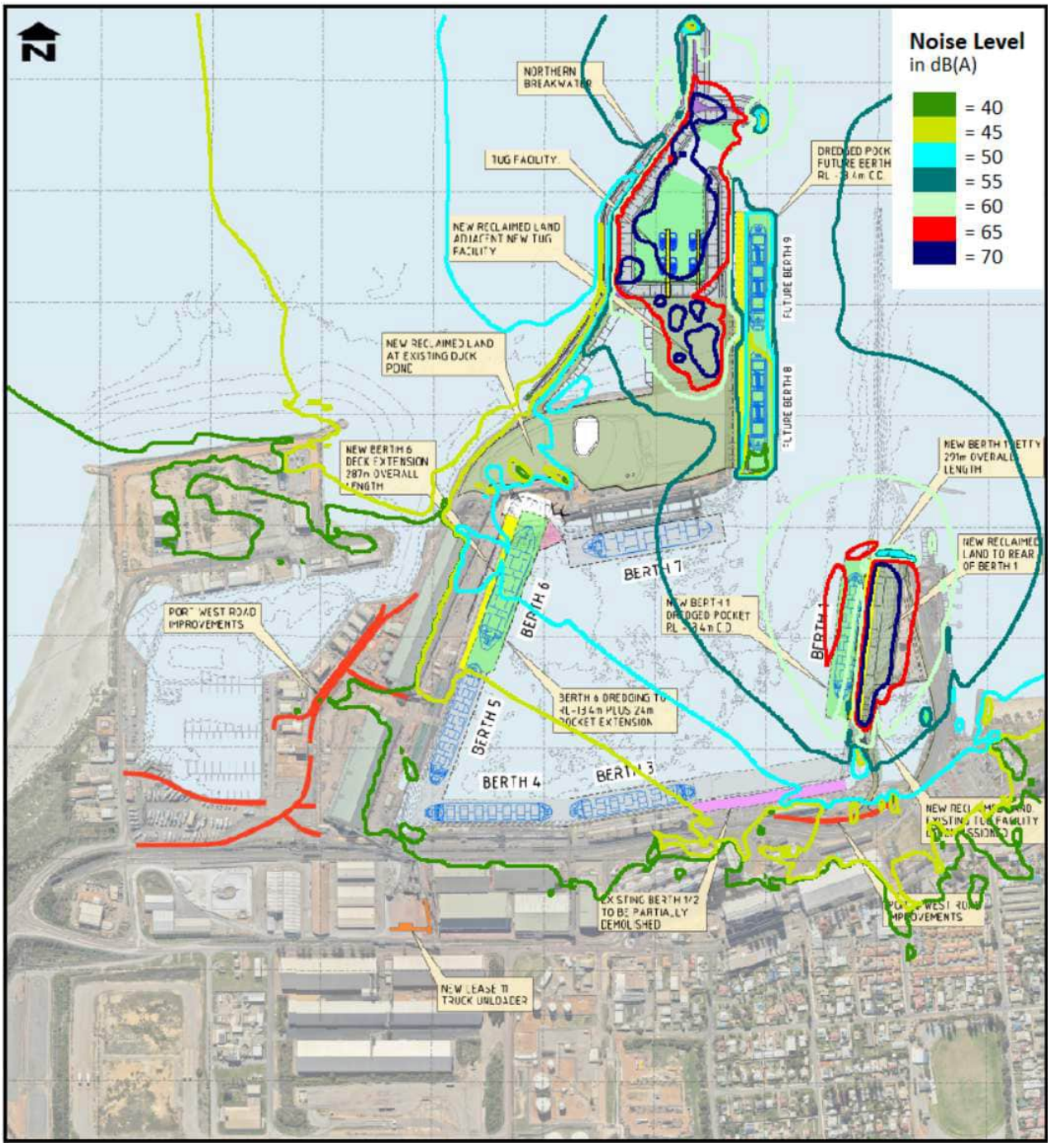

Figure 31: Daytime noise contours for scenario 4 under southerly wind.

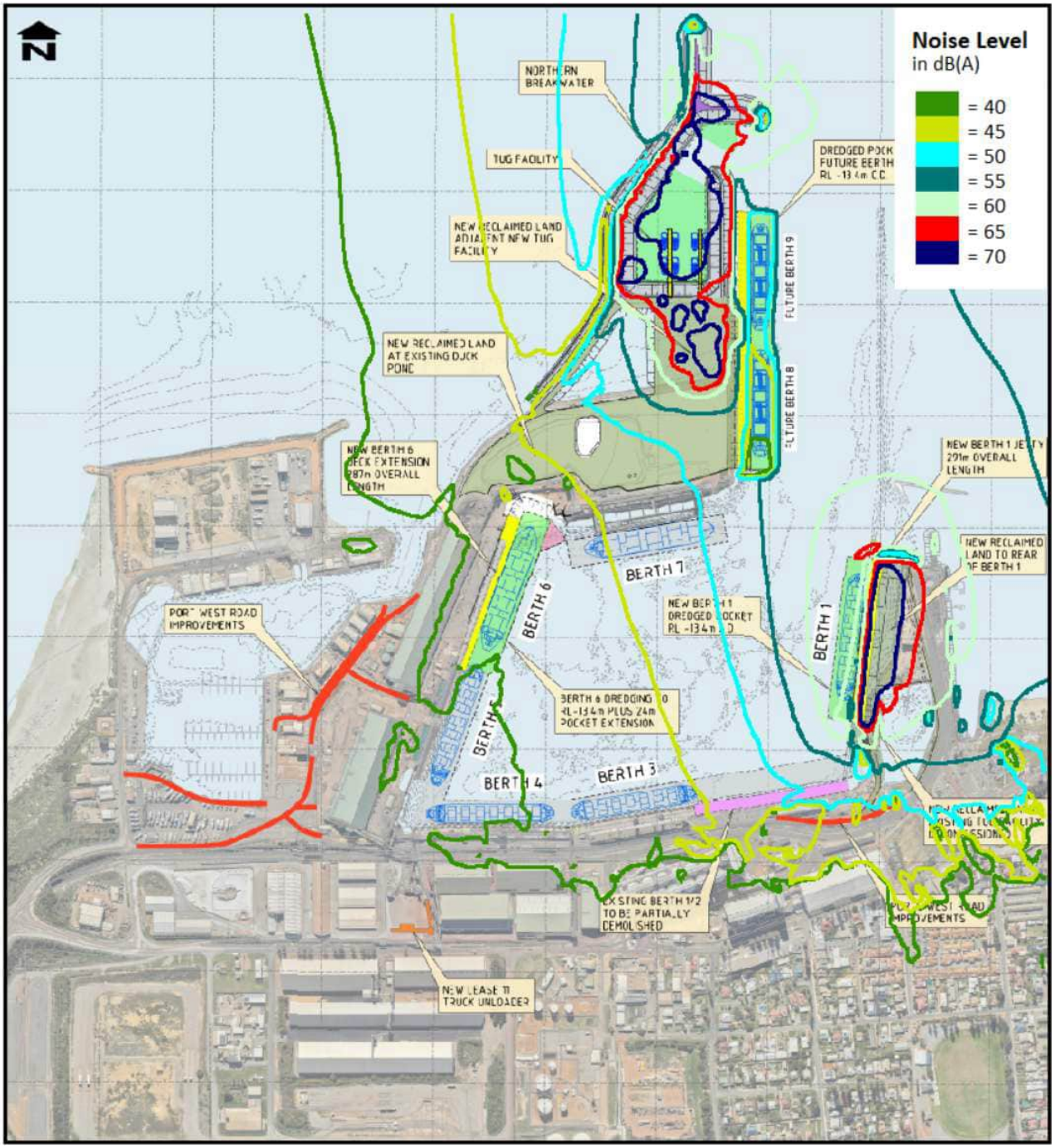

Figure 32: Daytime noise contours for scenario 4 under south-westerly wind.

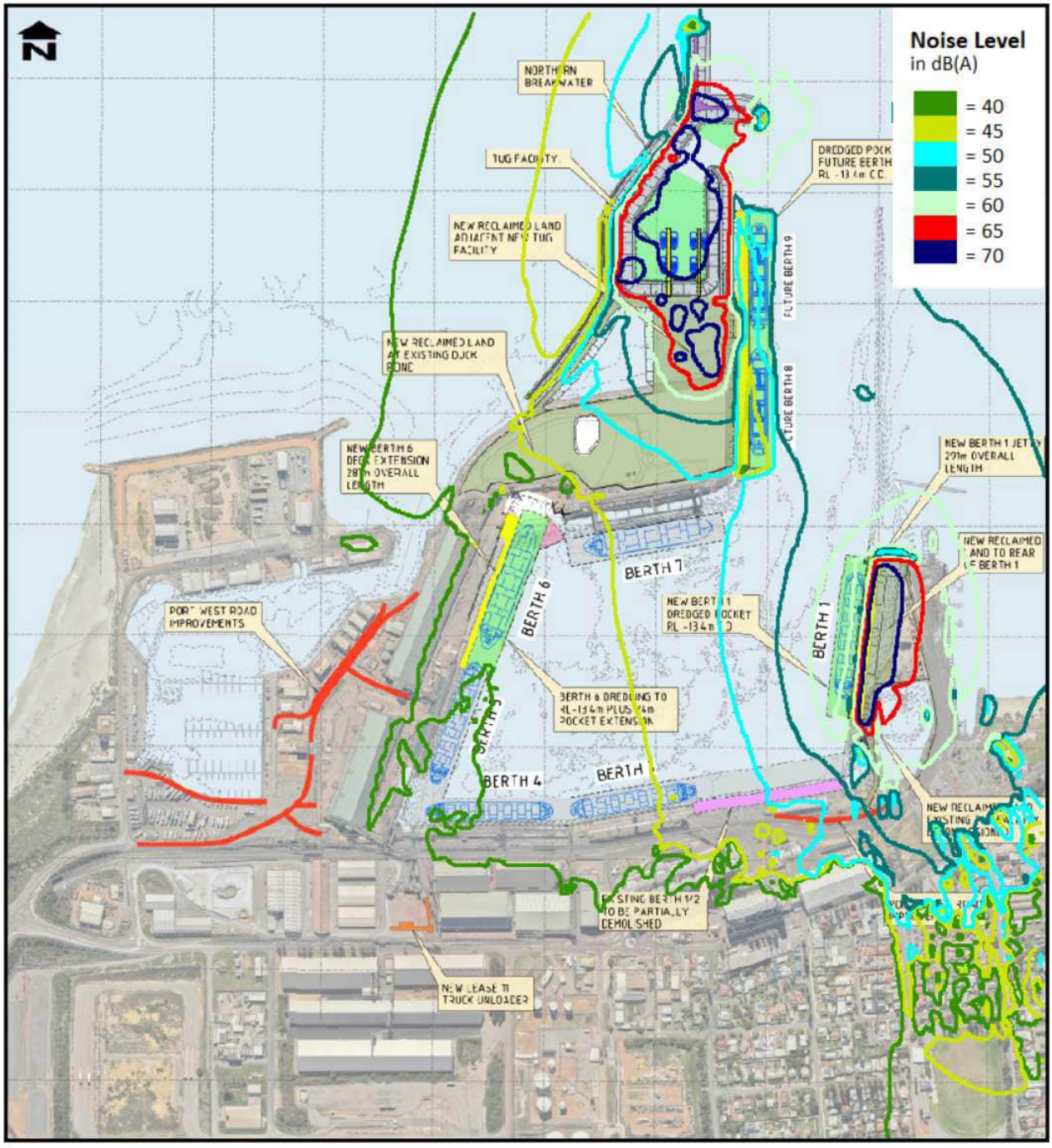

Figure 33: Daytime noise contours for scenario 4 under westerly wind.

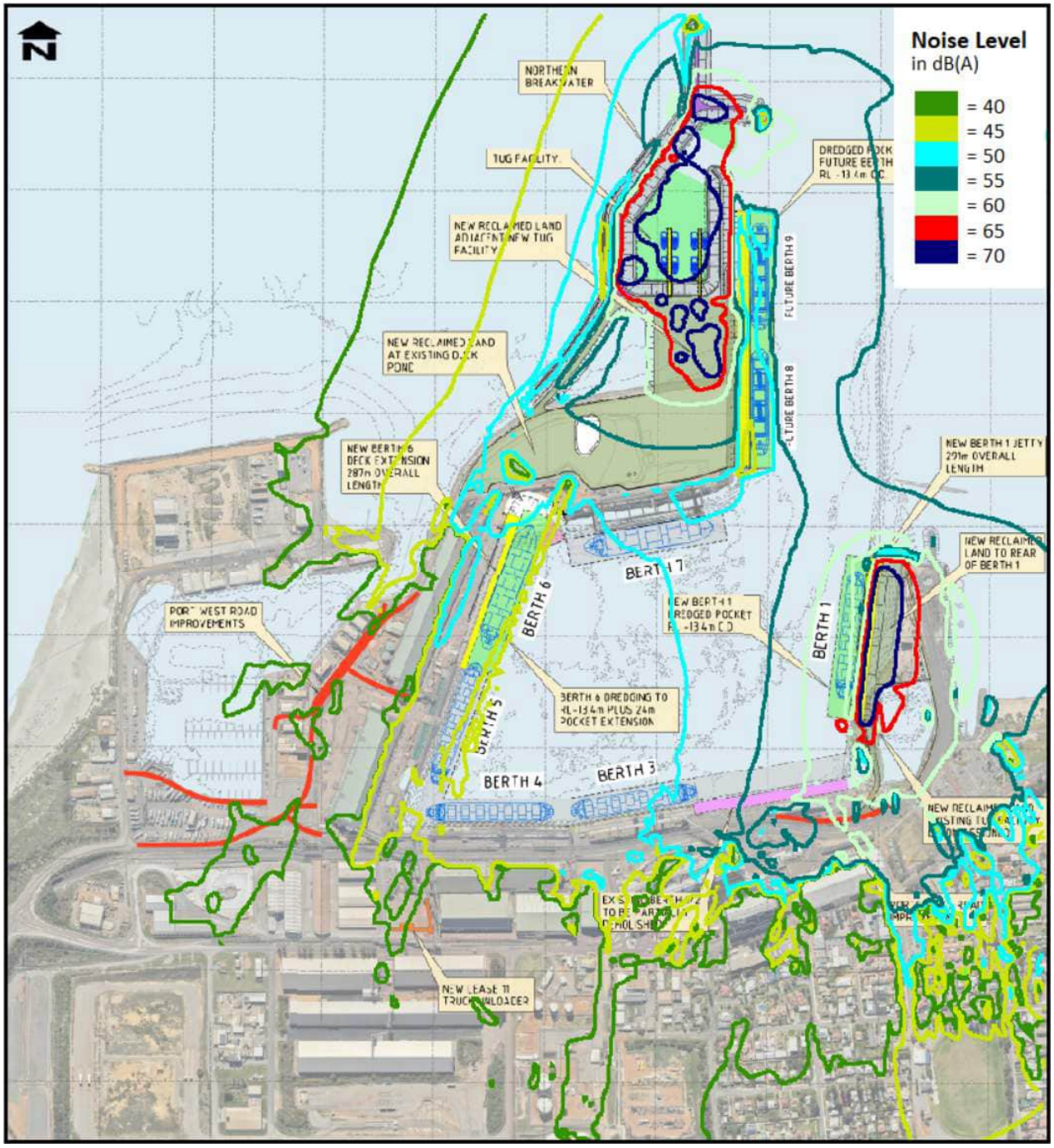

Figure 34: Daytime noise contours for scenario 4 under north-westerly wind.

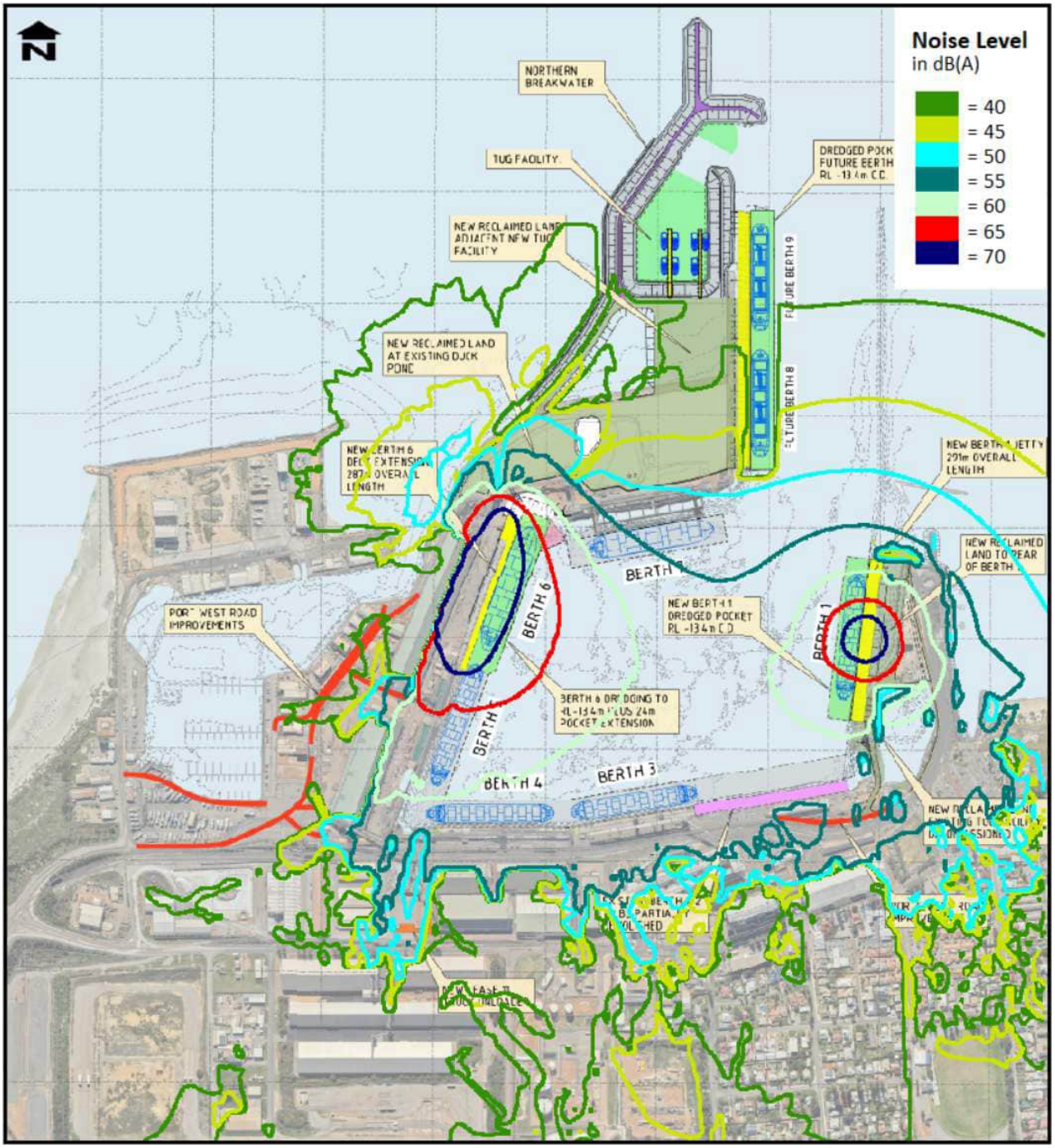

Figure 35: Daytime noise contours for scenario 5 under northerly wind.

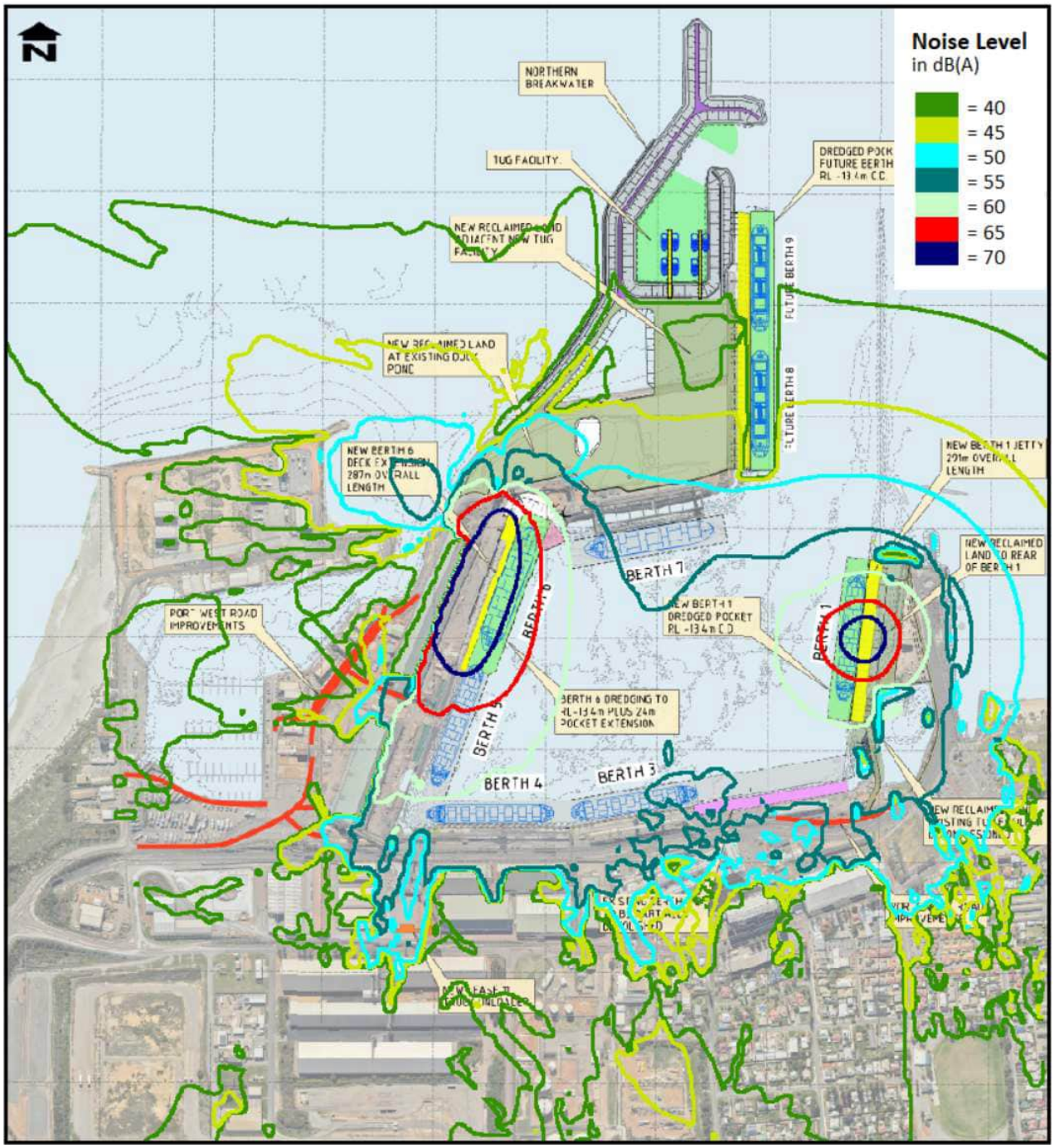

Figure 36: Daytime noise contours for scenario 5 under north-easterly wind.

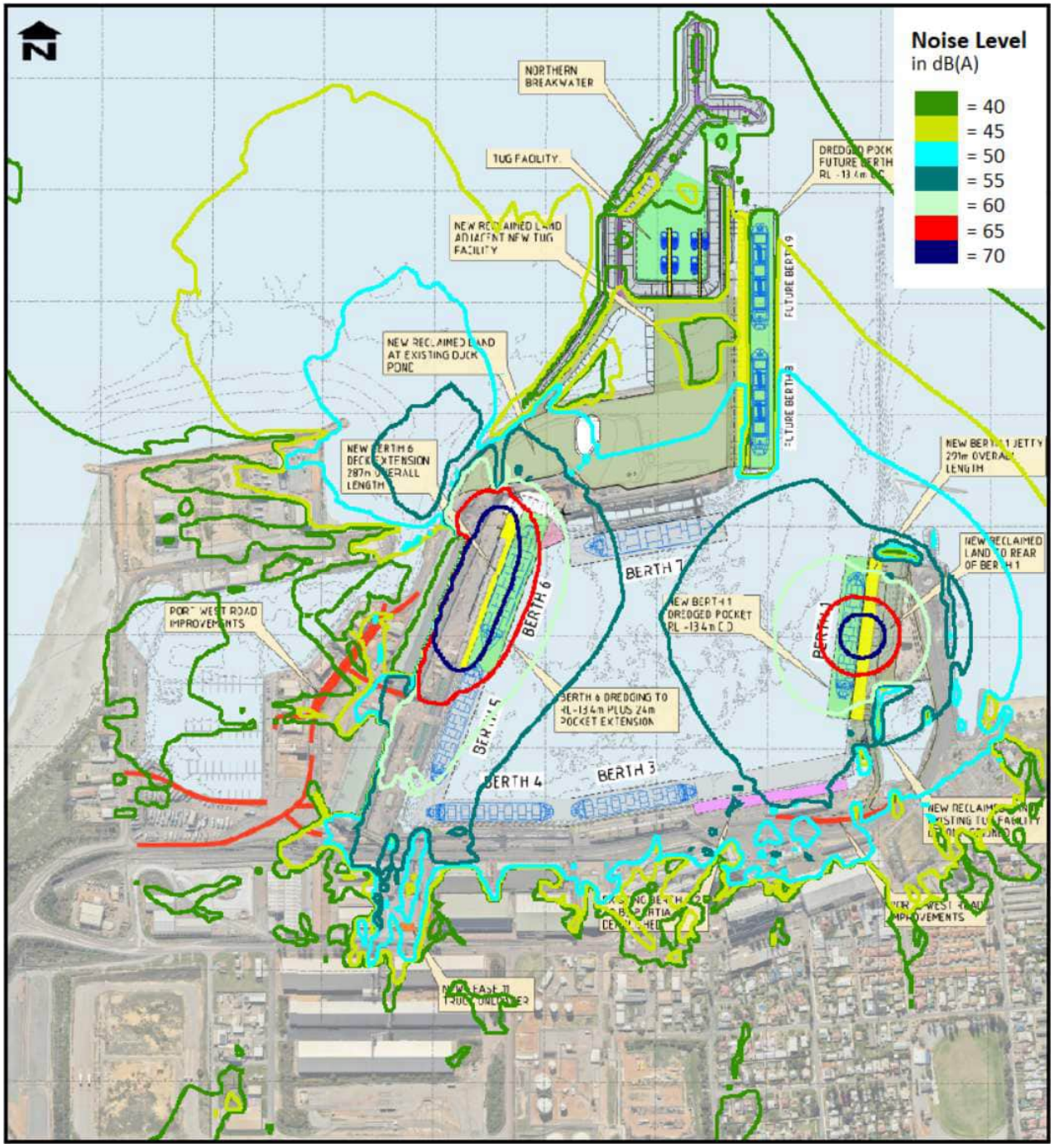

Figure 37: Daytime noise contours for scenario 5 under easterly wind.

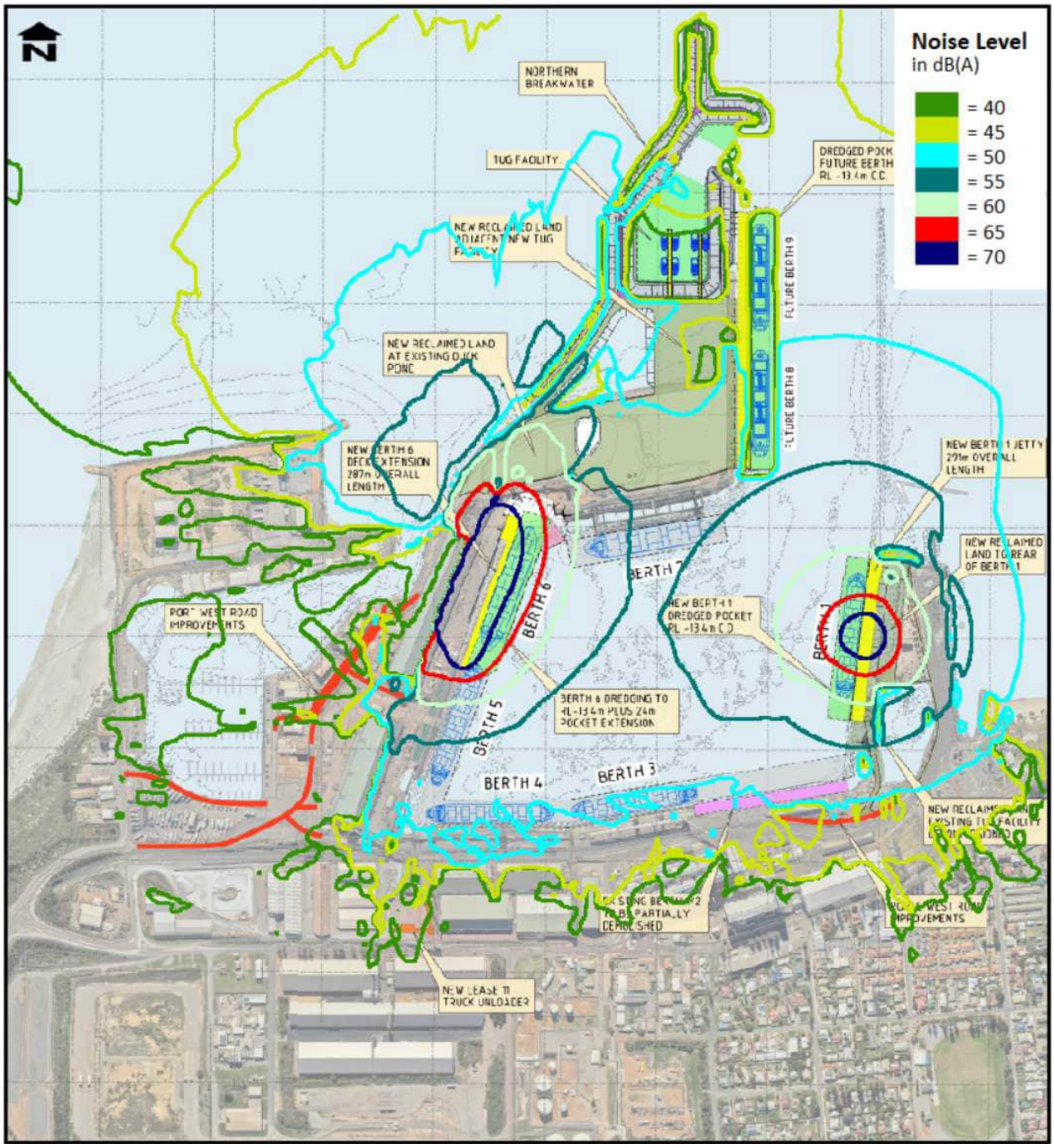

Figure 38: Daytime noise contours for scenario 5 under south-easterly wind.

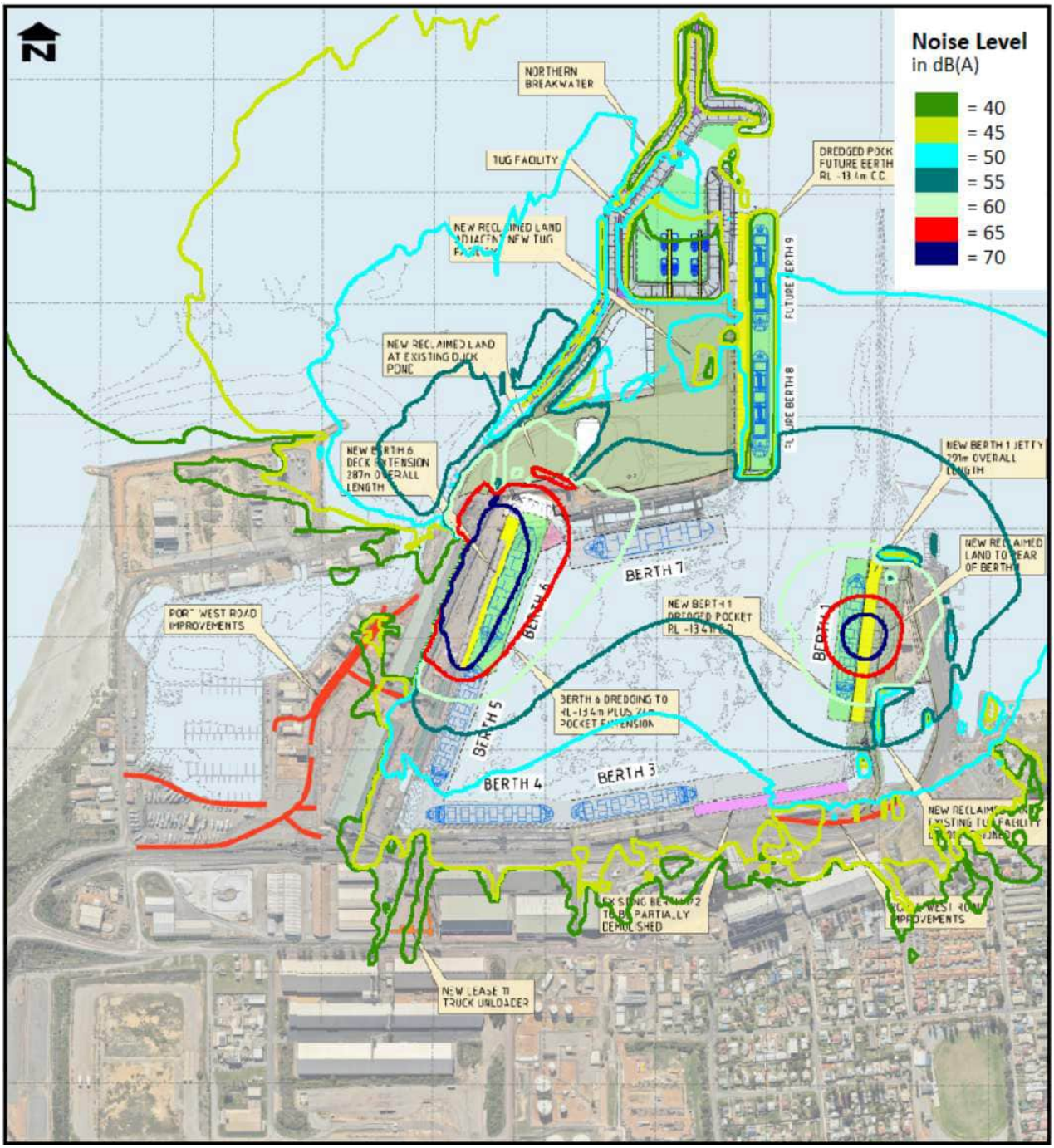

Figure 39: Daytime noise contours for scenario 5 under southerly wind.

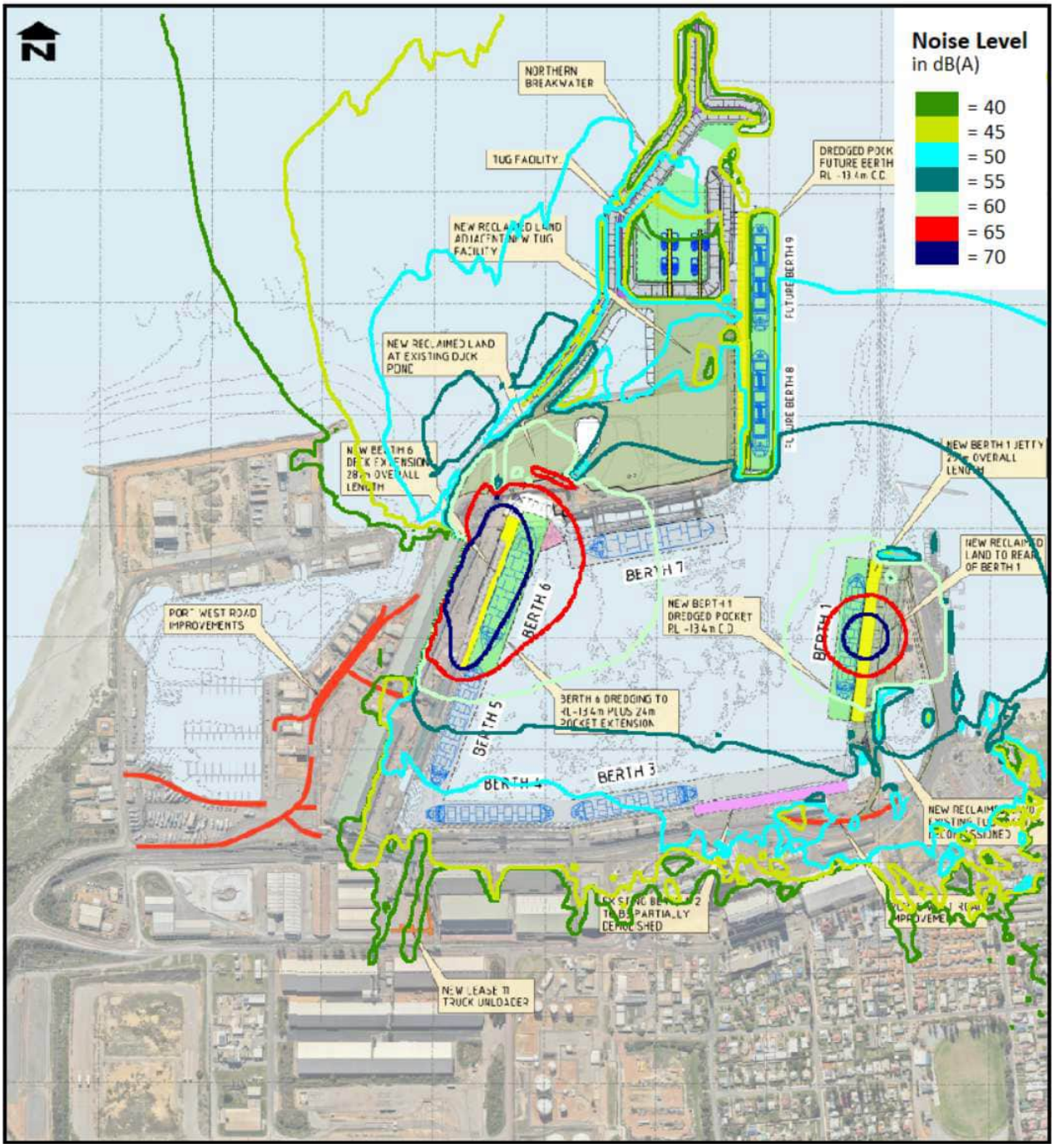

Figure 40: Daytime noise contours for scenario 5 under south-westerly wind.

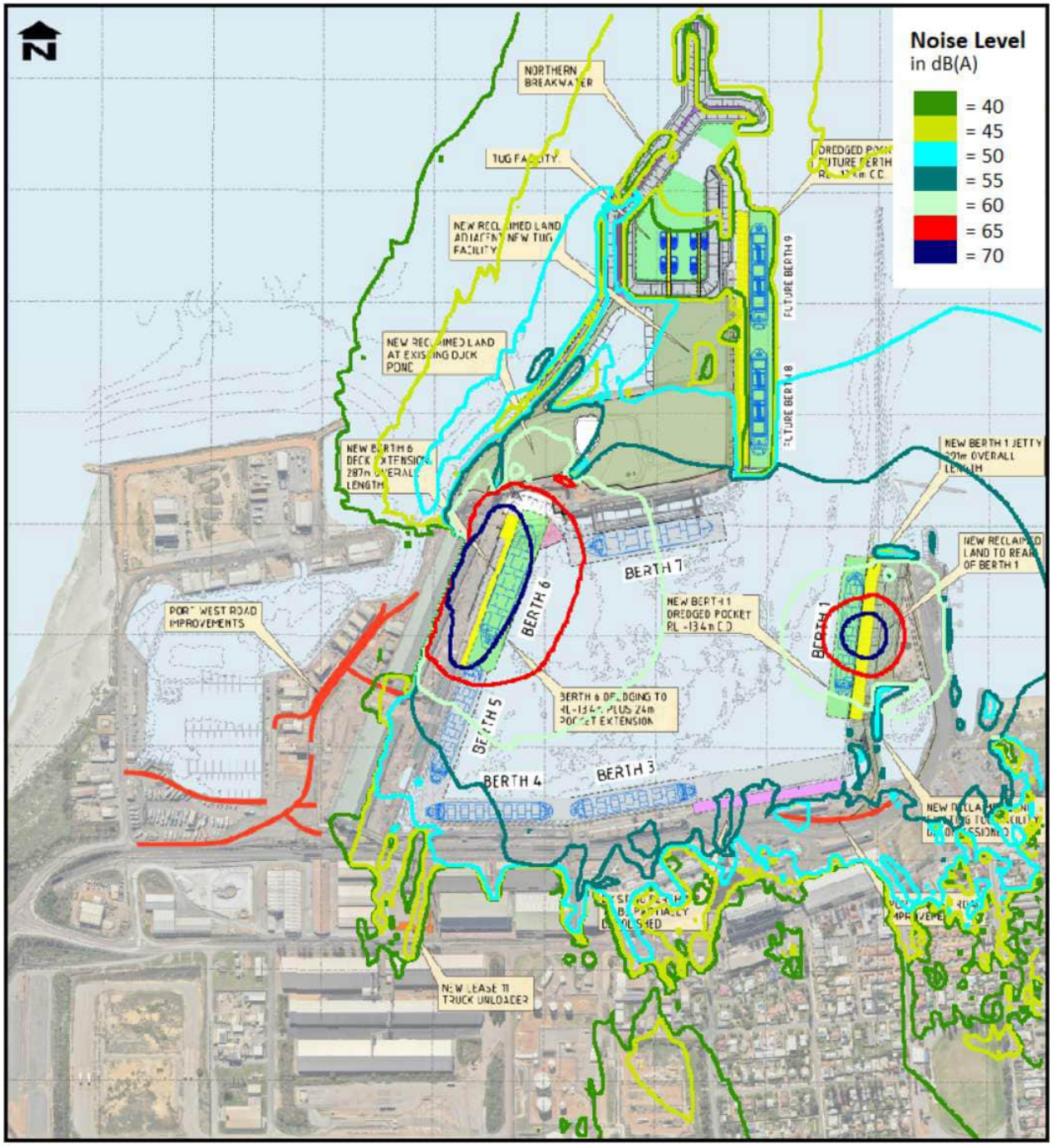

Figure 41: Daytime noise contours for scenario 5 under westerly wind.

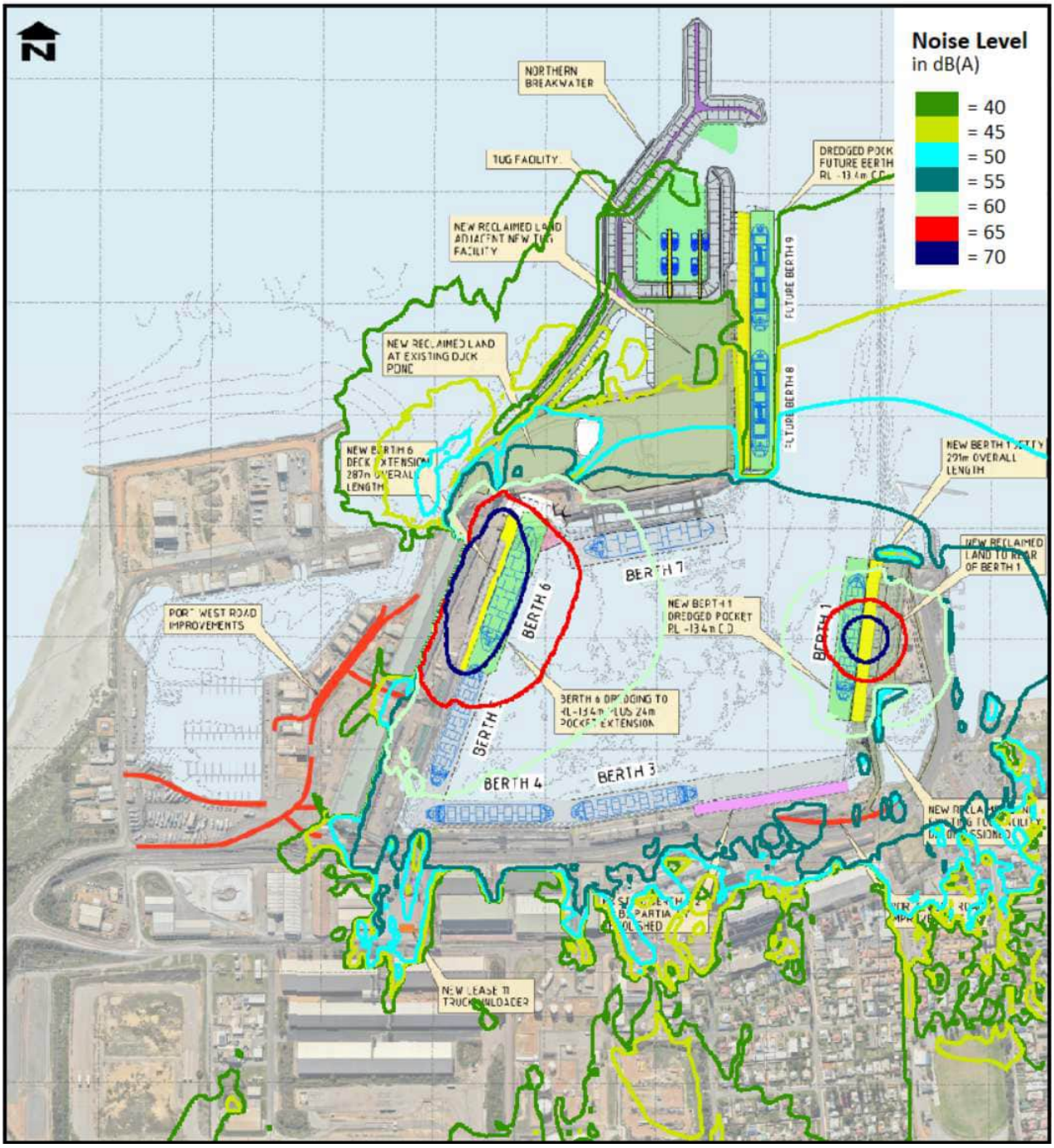

Figure 42: Daytime noise contours for scenario 5 under north-westerly wind.

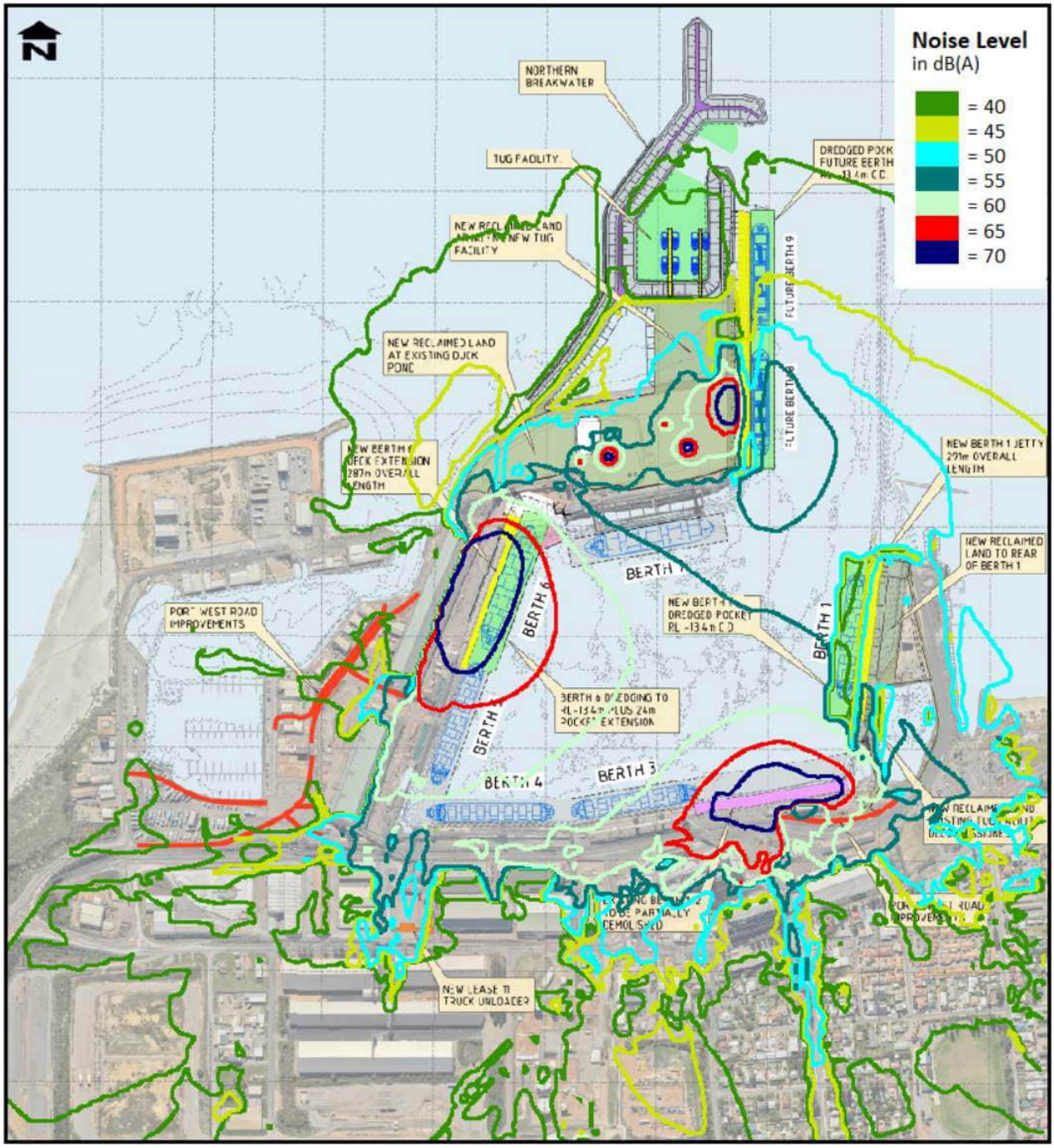

Figure 43: Daytime noise contours for scenario 6 under northerly wind.

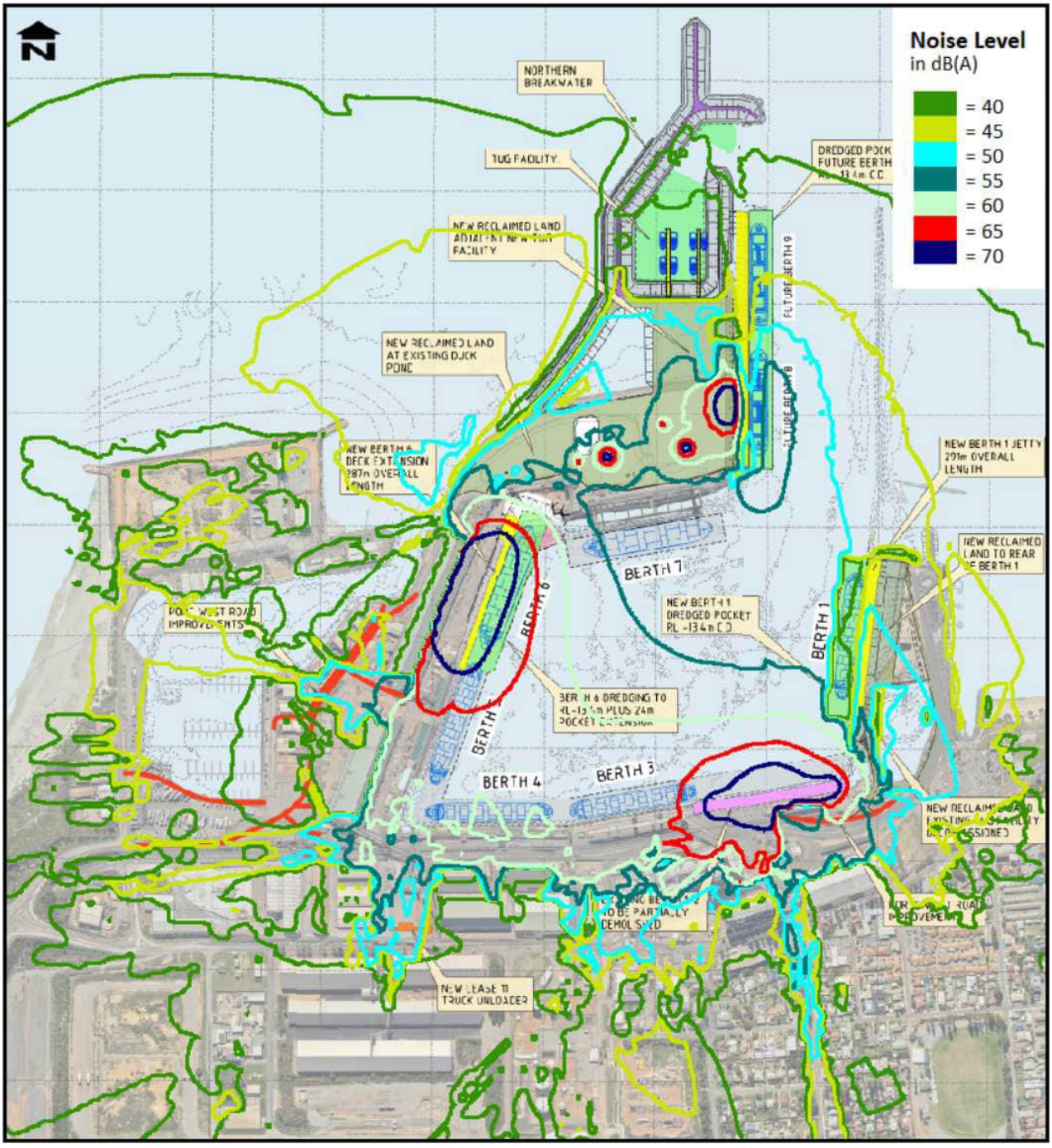

Figure 44: Daytime noise contours for scenario 6 under north-easterly wind.

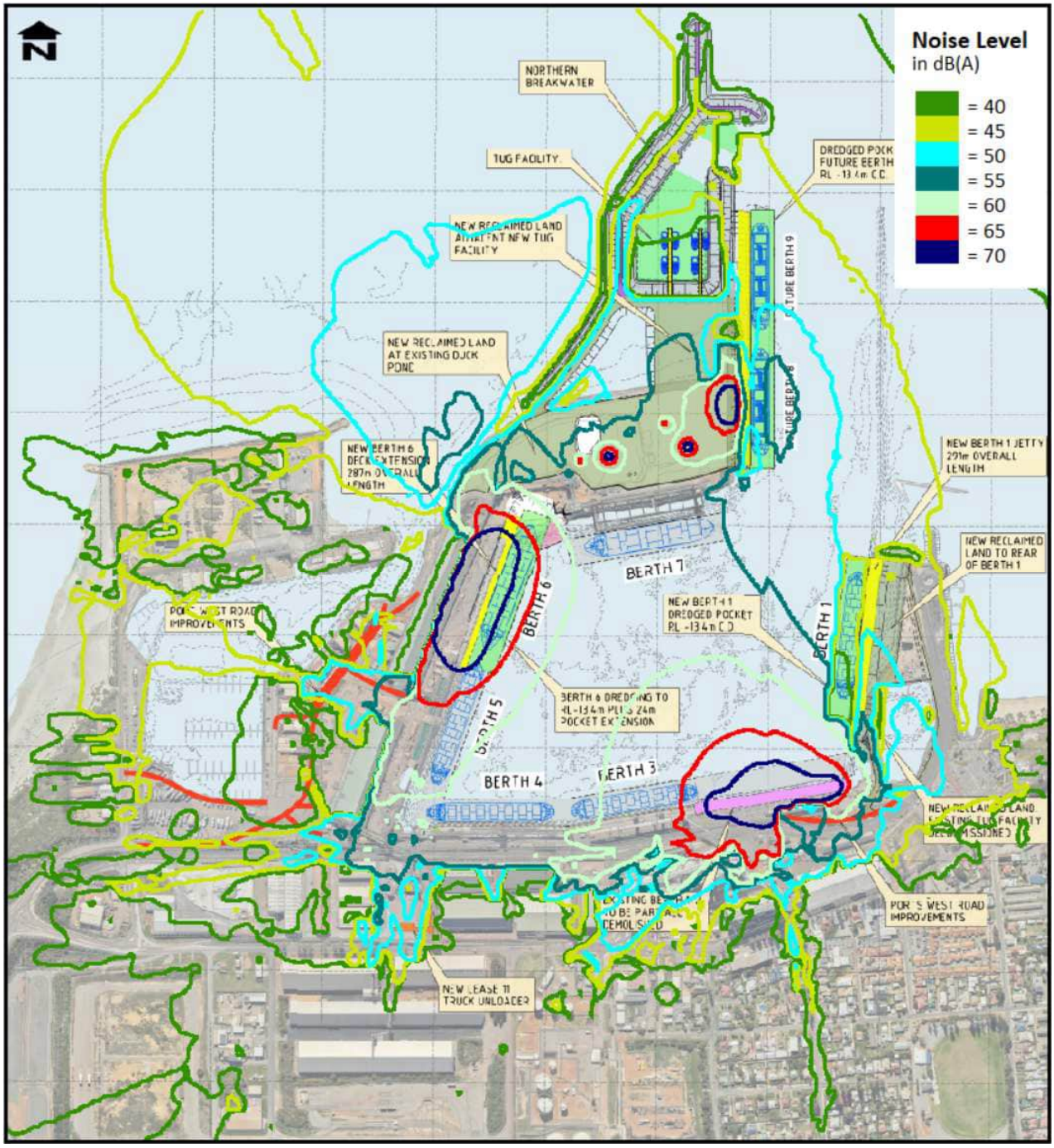

Figure 45: Daytime noise contours for scenario 6 under easterly wind.

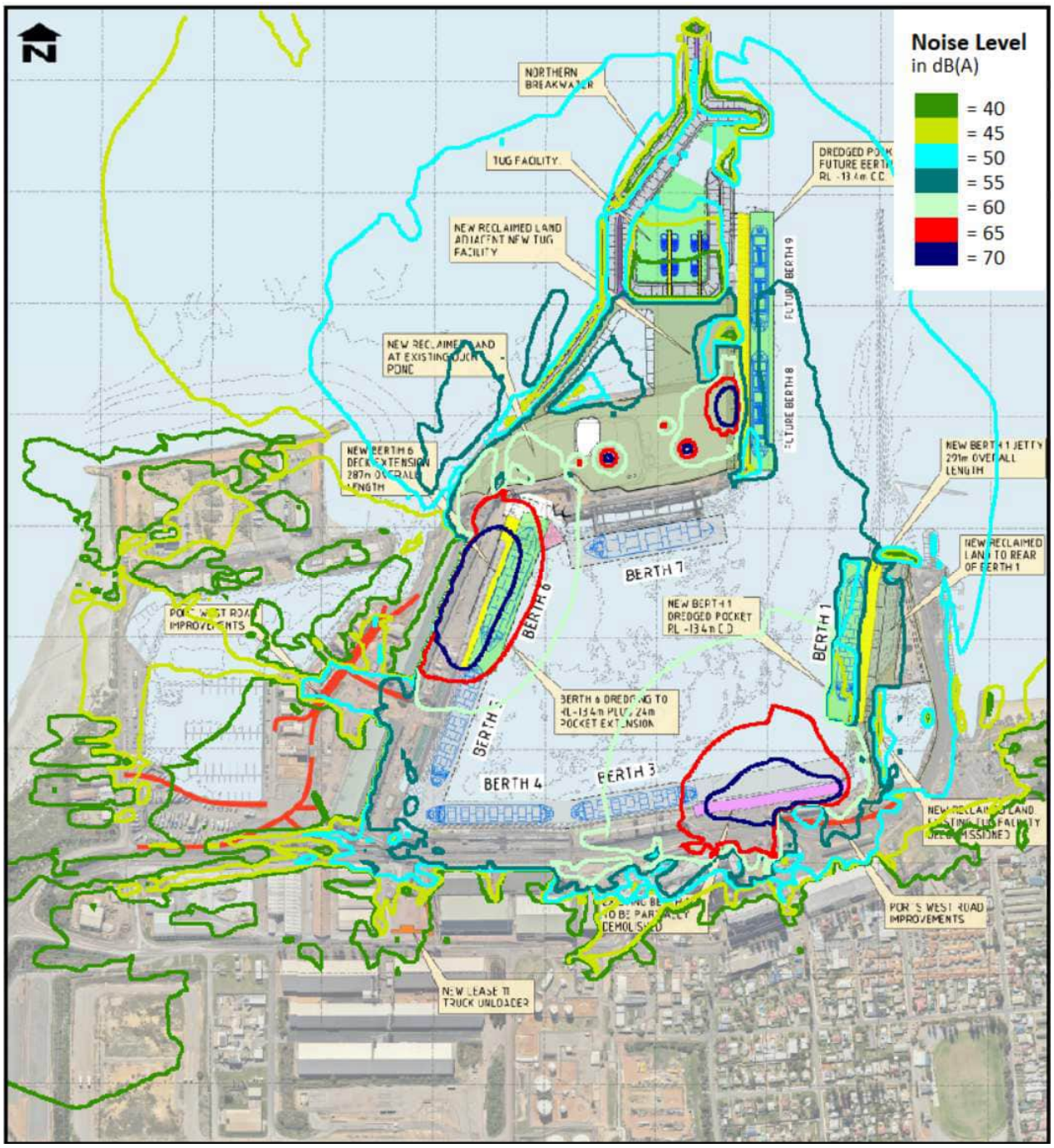

Figure 46: Daytime noise contours for scenario 6 under south-easterly wind.

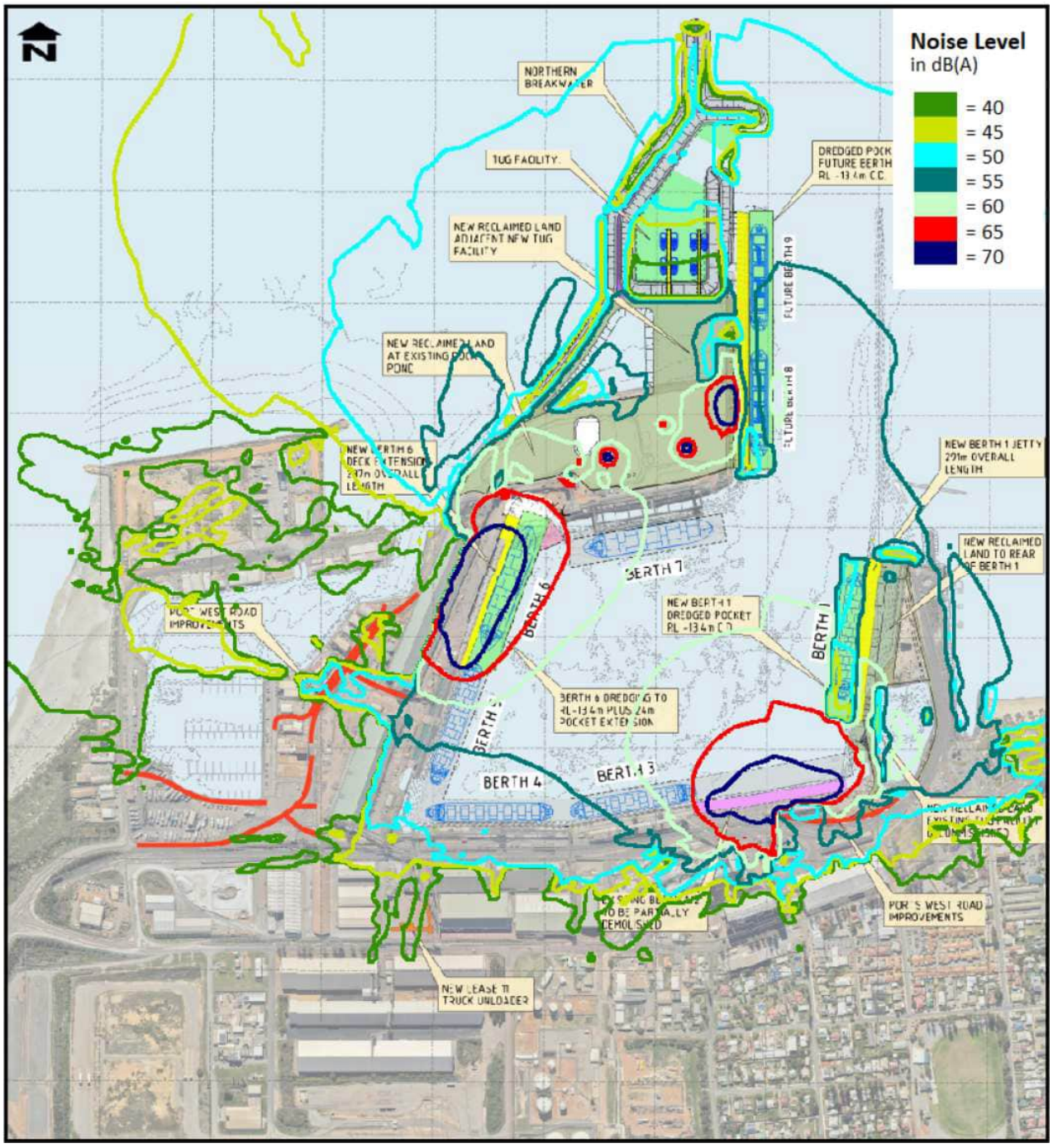

Figure 47: Daytime noise contours for scenario 6 under southerly wind.

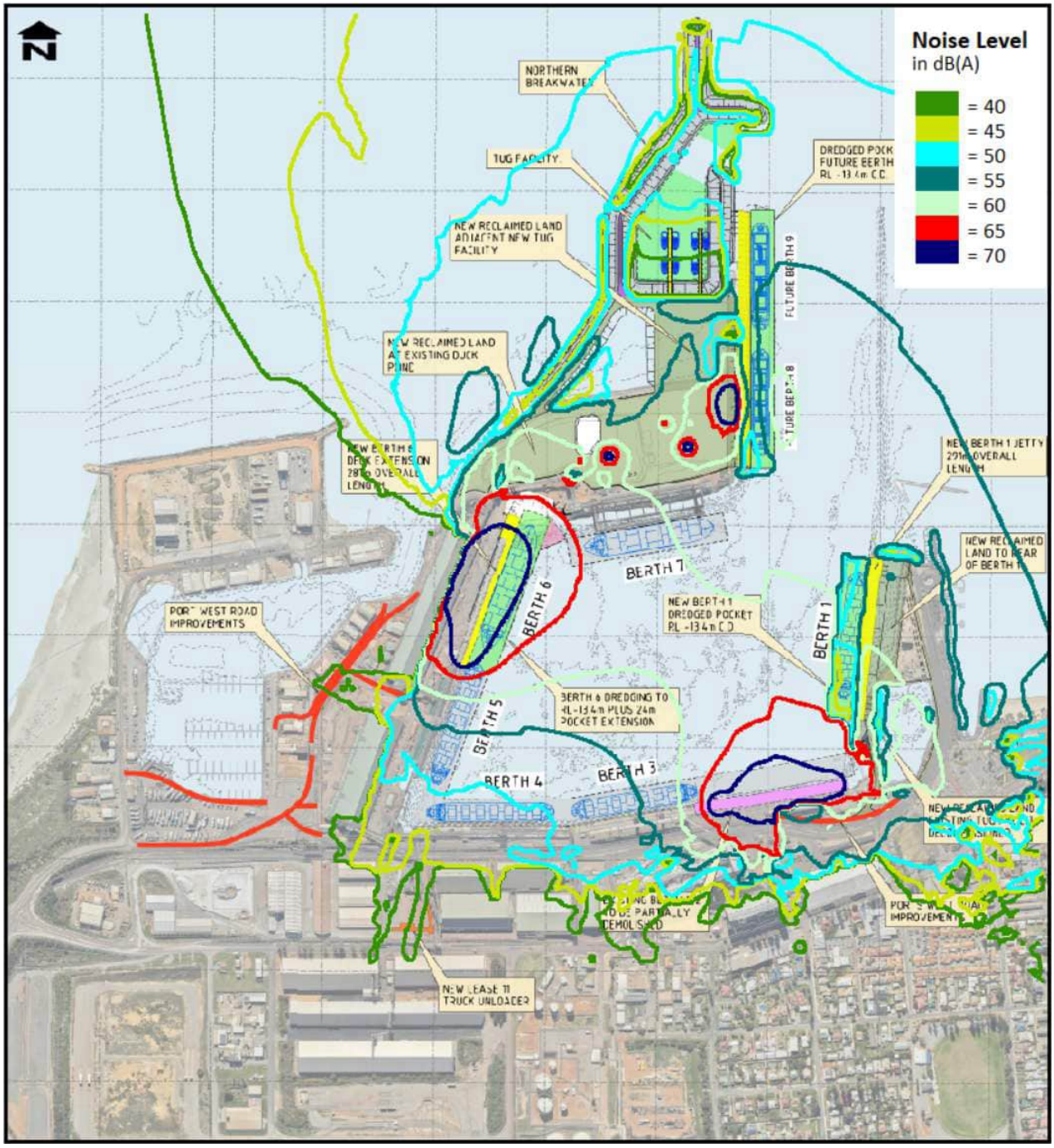

Figure 48: Daytime noise contours for scenario 6 under south-westerly wind.

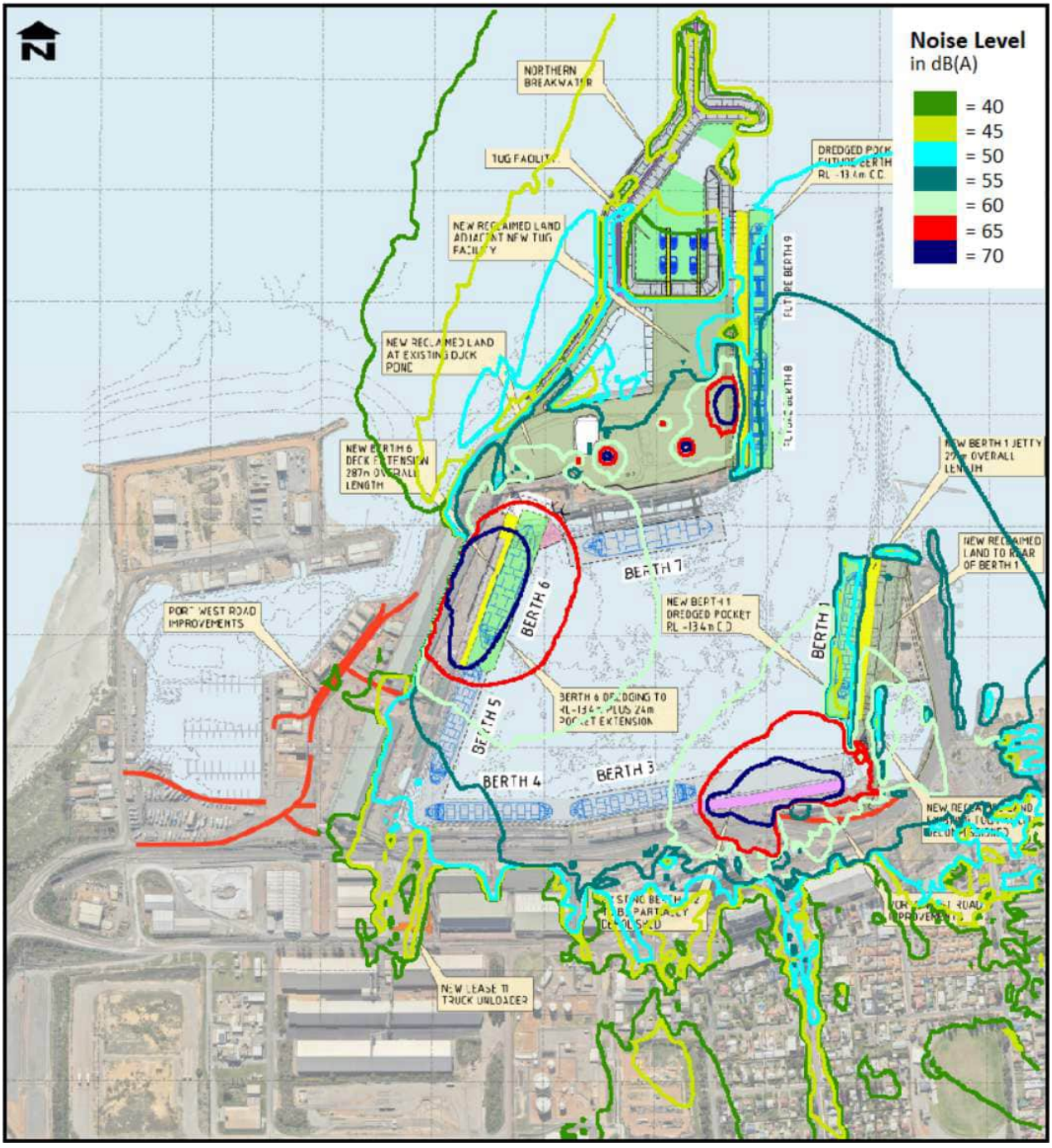

Figure 49: Daytime noise contours for scenario 6 under westerly wind.

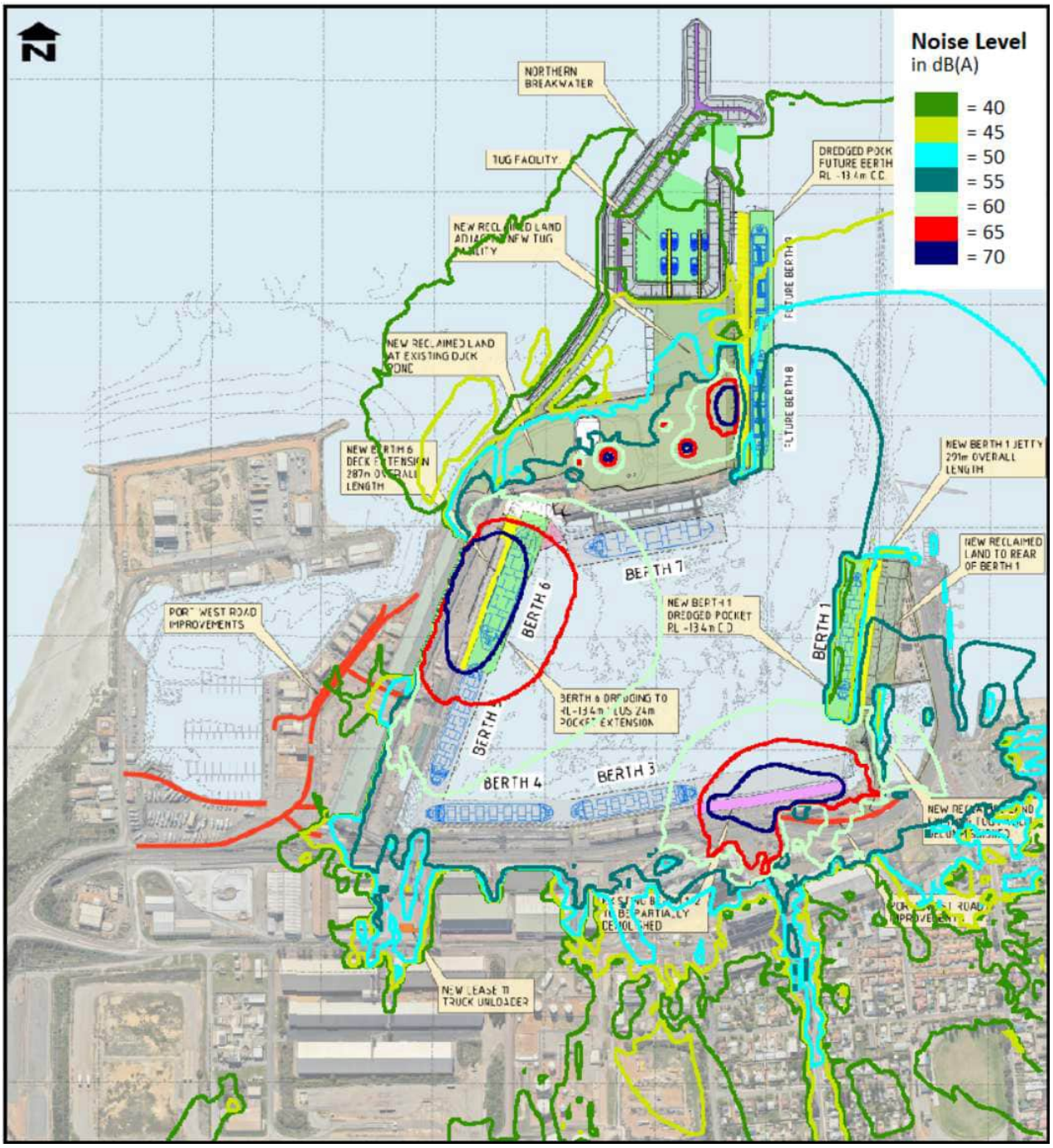

Figure 50: Daytime noise contours for scenario 6 under north-westerly wind.

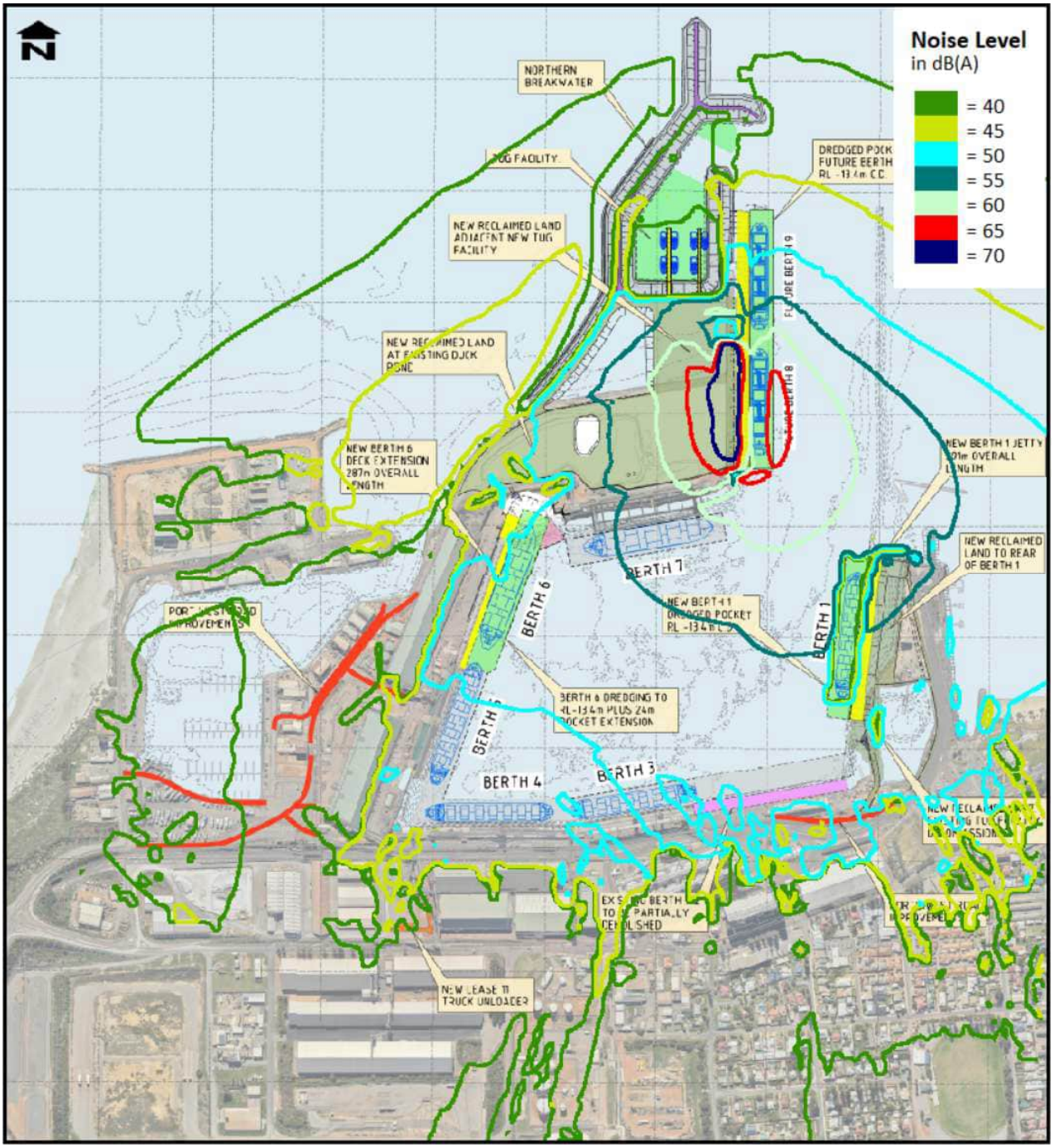

Figure 51: Daytime noise contours for scenario 7 under northerly wind.

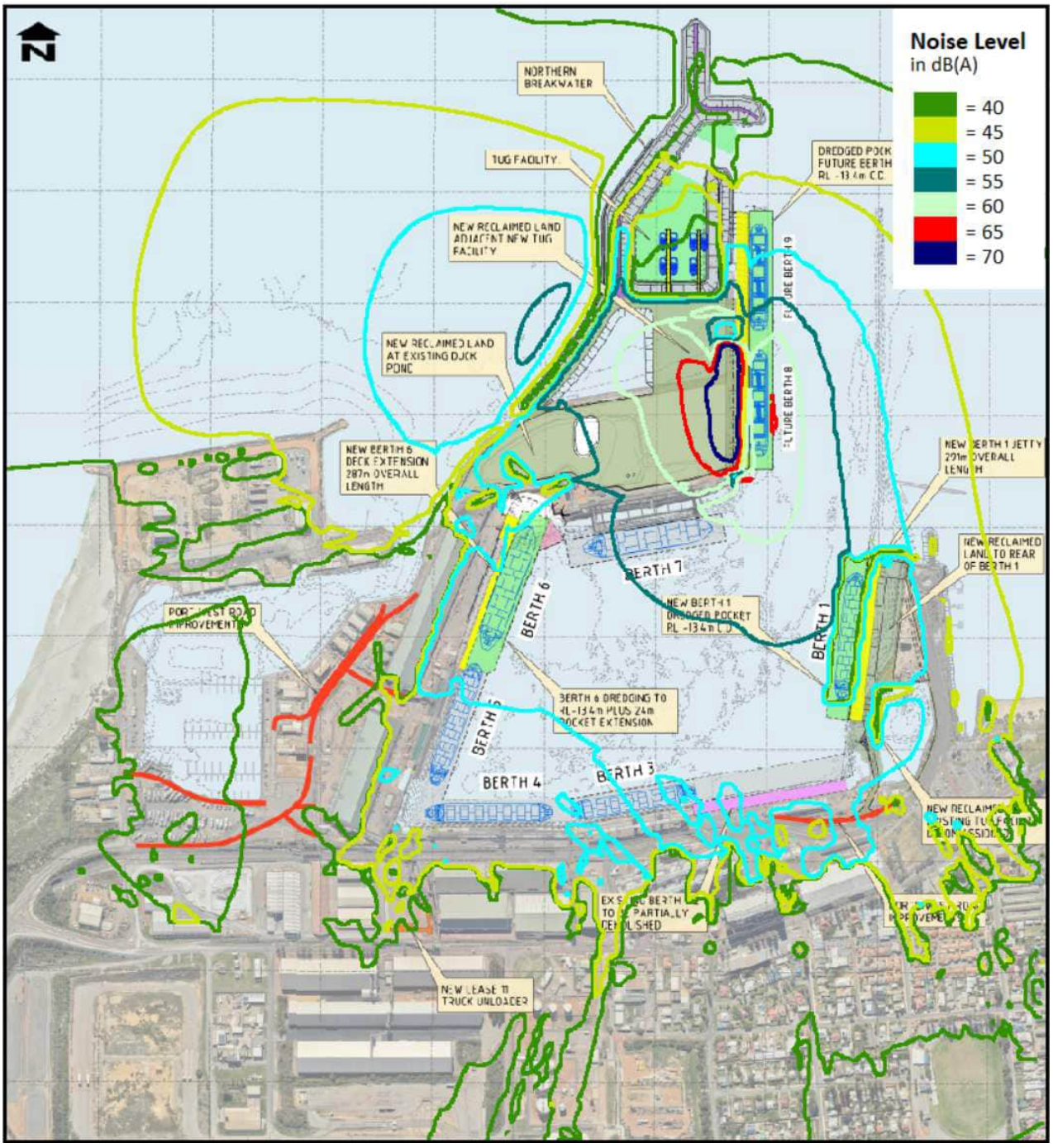

Figure 52: Daytime noise contours for scenario 7 under north-easterly wind.

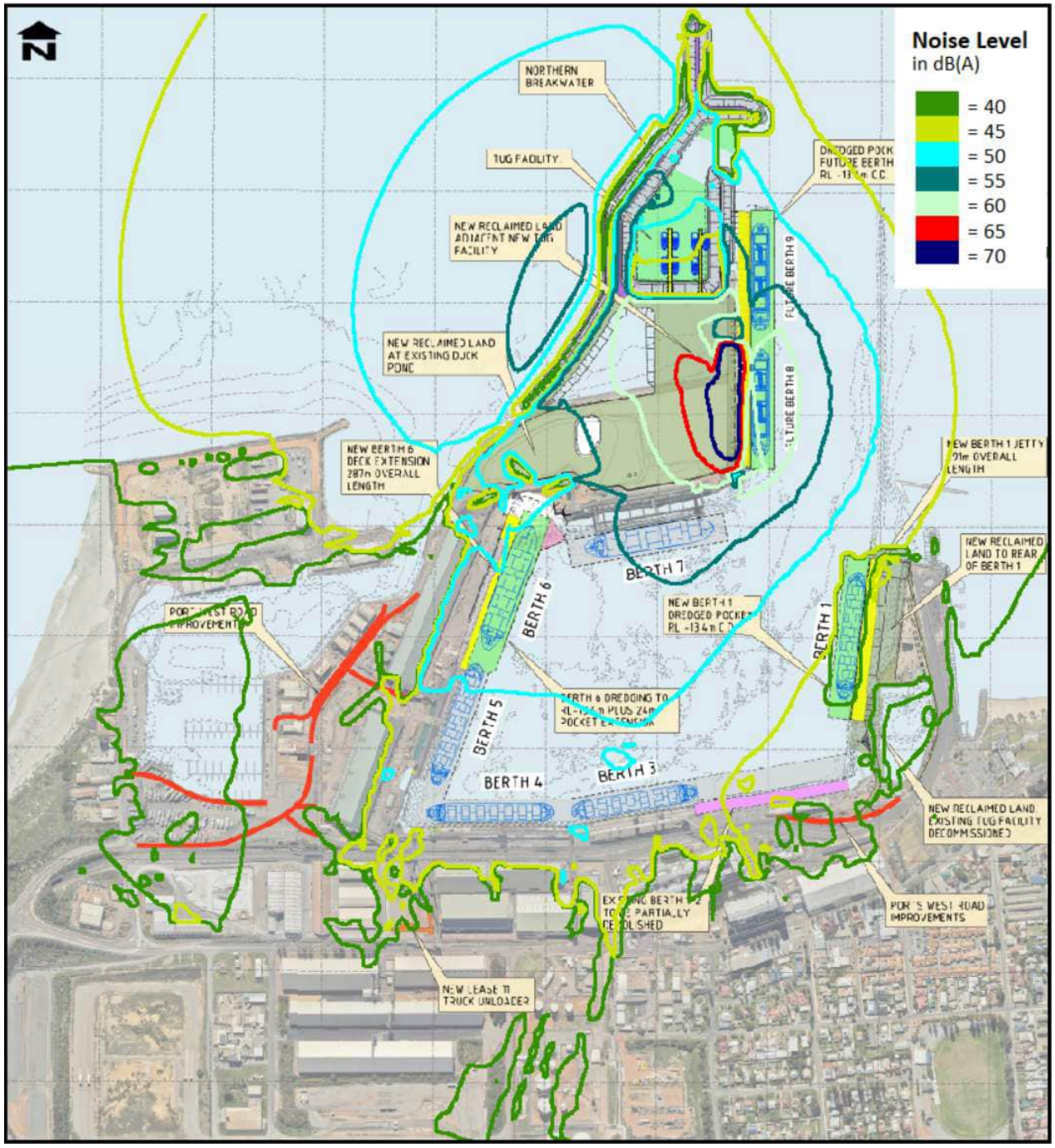

Figure 53: Daytime noise contours for scenario 7 under easterly wind.

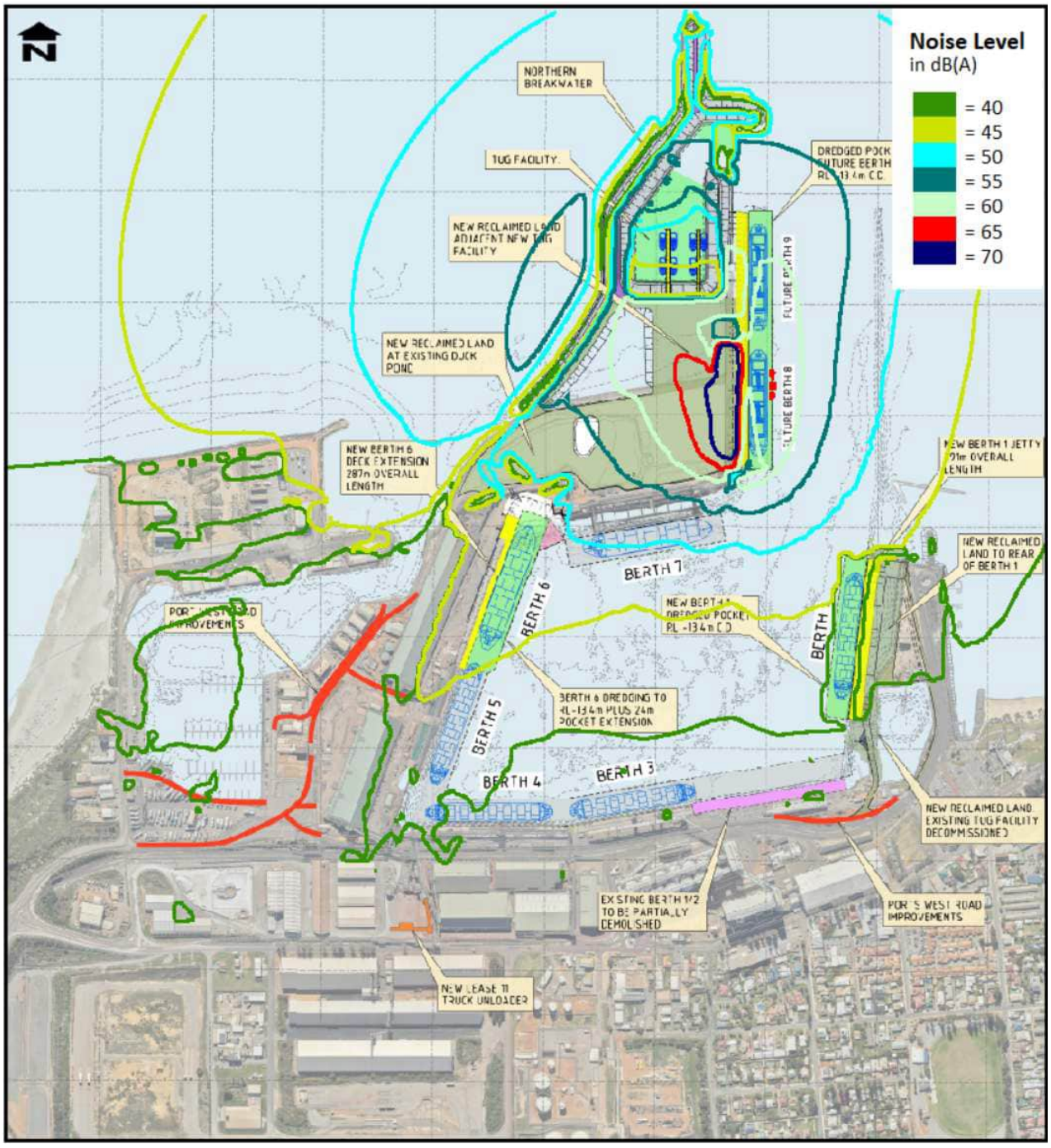

Figure 54: Daytime noise contours for scenario 7 under south-easterly wind.

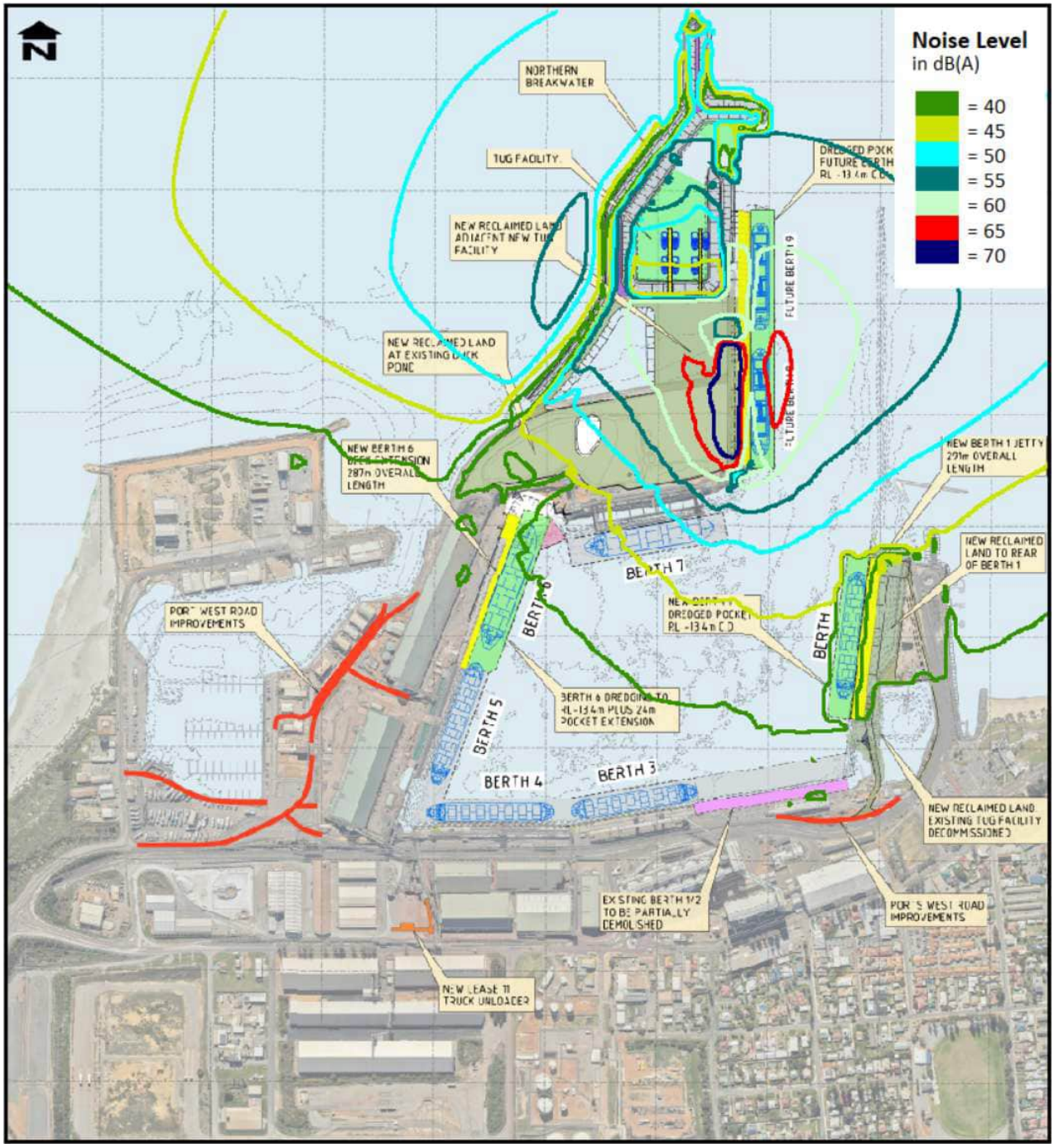

Figure 55: Daytime noise contours for scenario 7 under southerly wind.

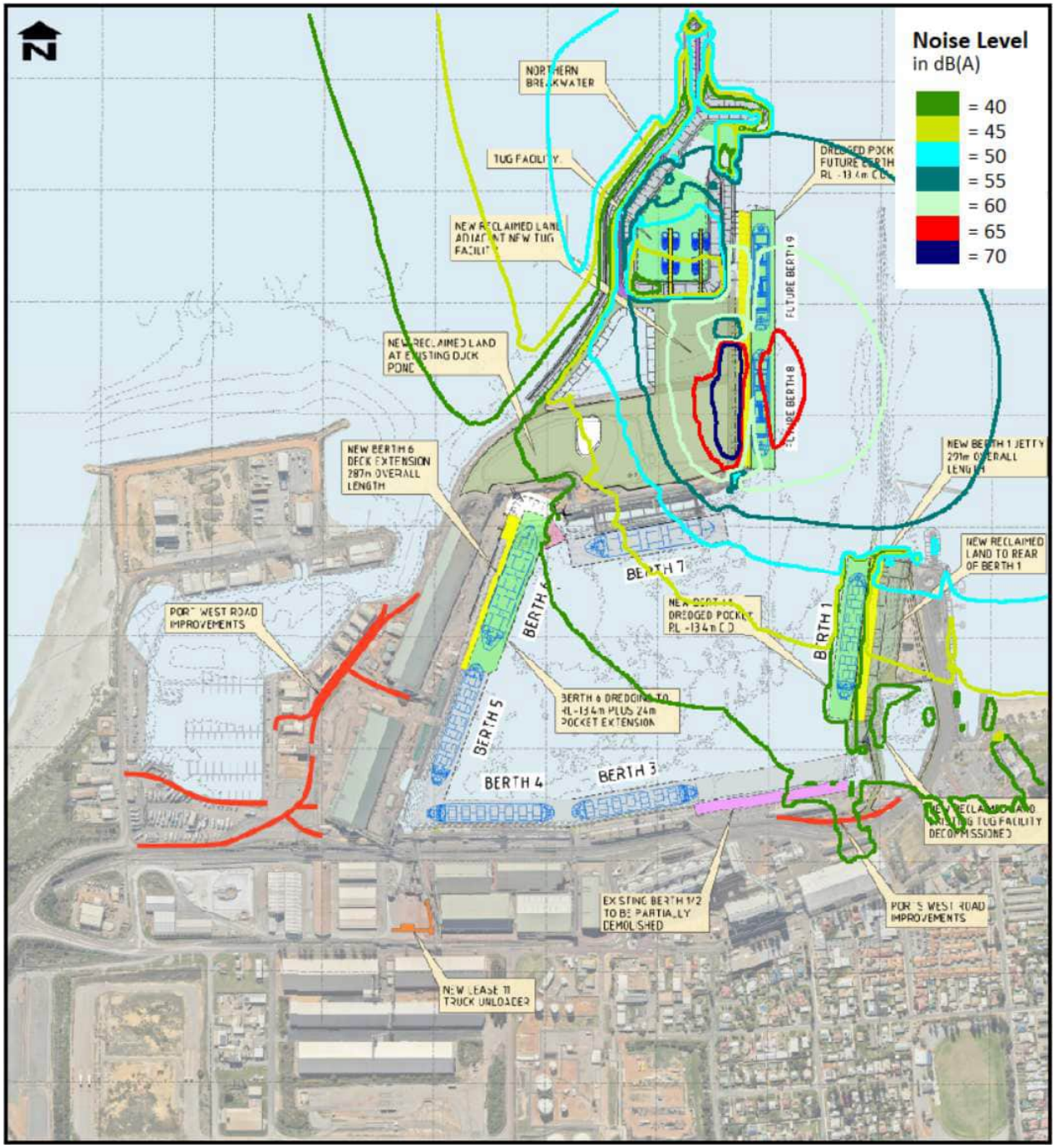

Figure 56: Daytime noise contours for scenario 7 under south-westerly wind.

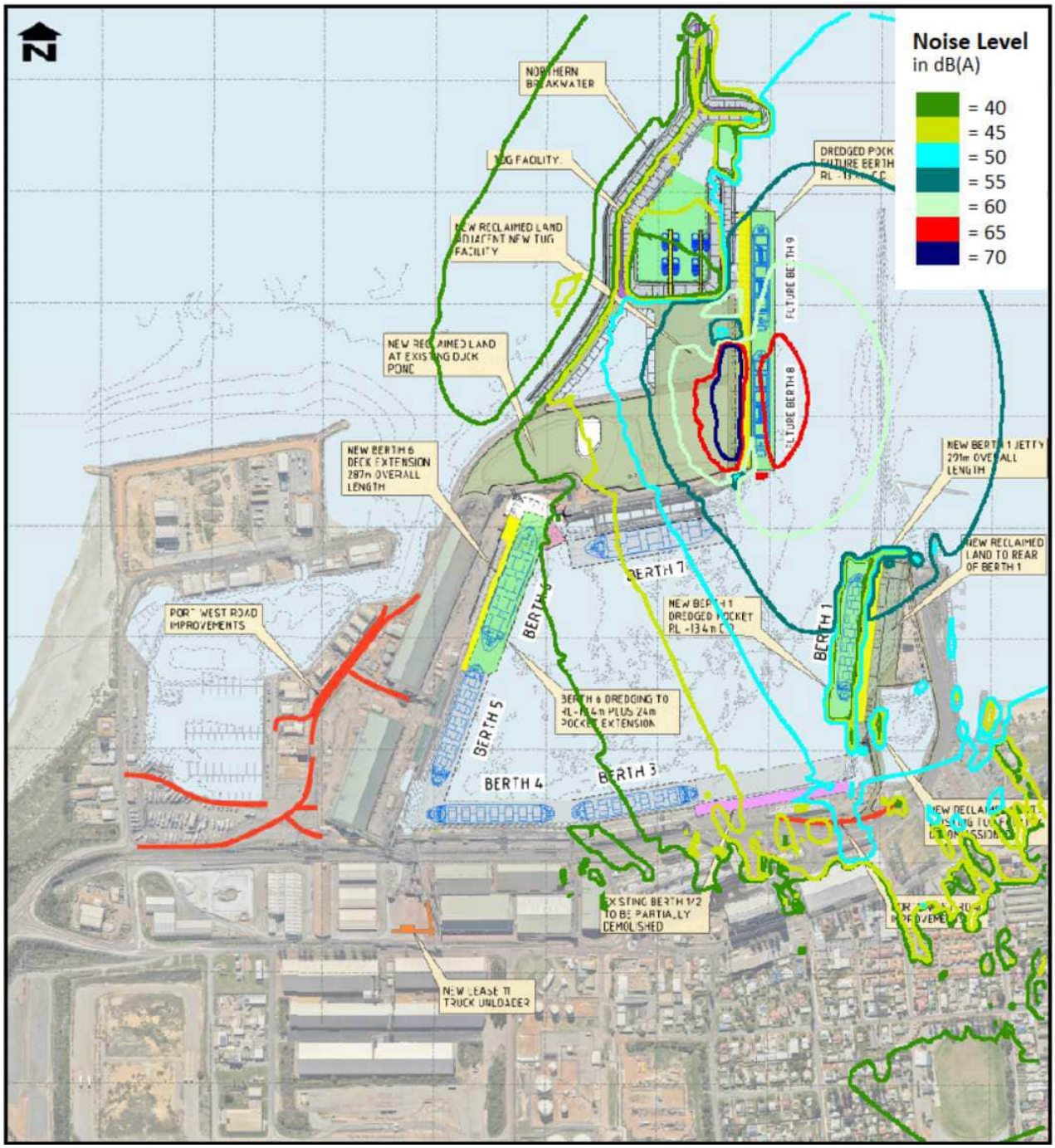

Figure 57: Daytime noise contours for scenario 7 under westerly wind.

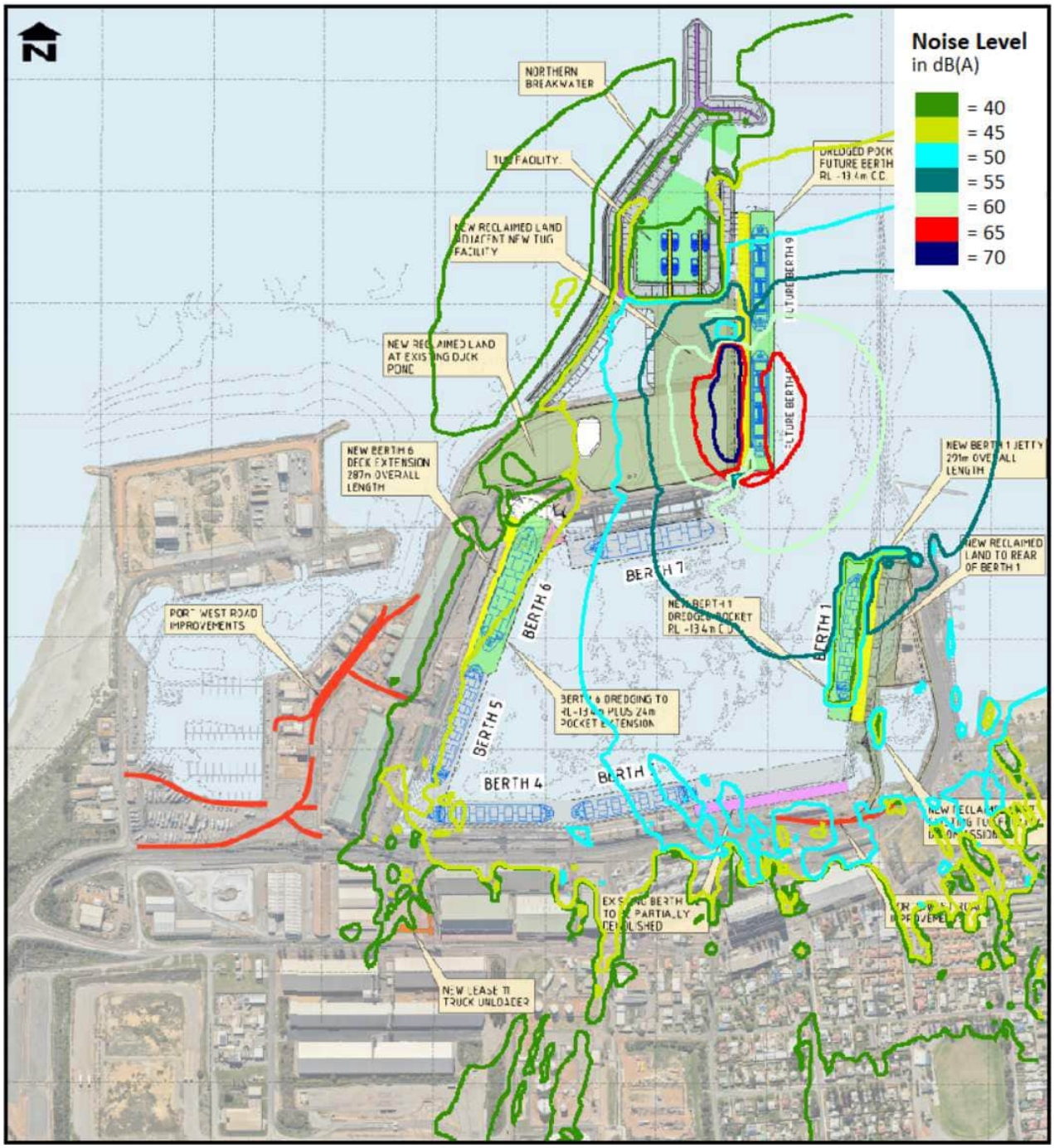

Figure 58: Daytime noise contours for scenario 7 under north-westerly wind.

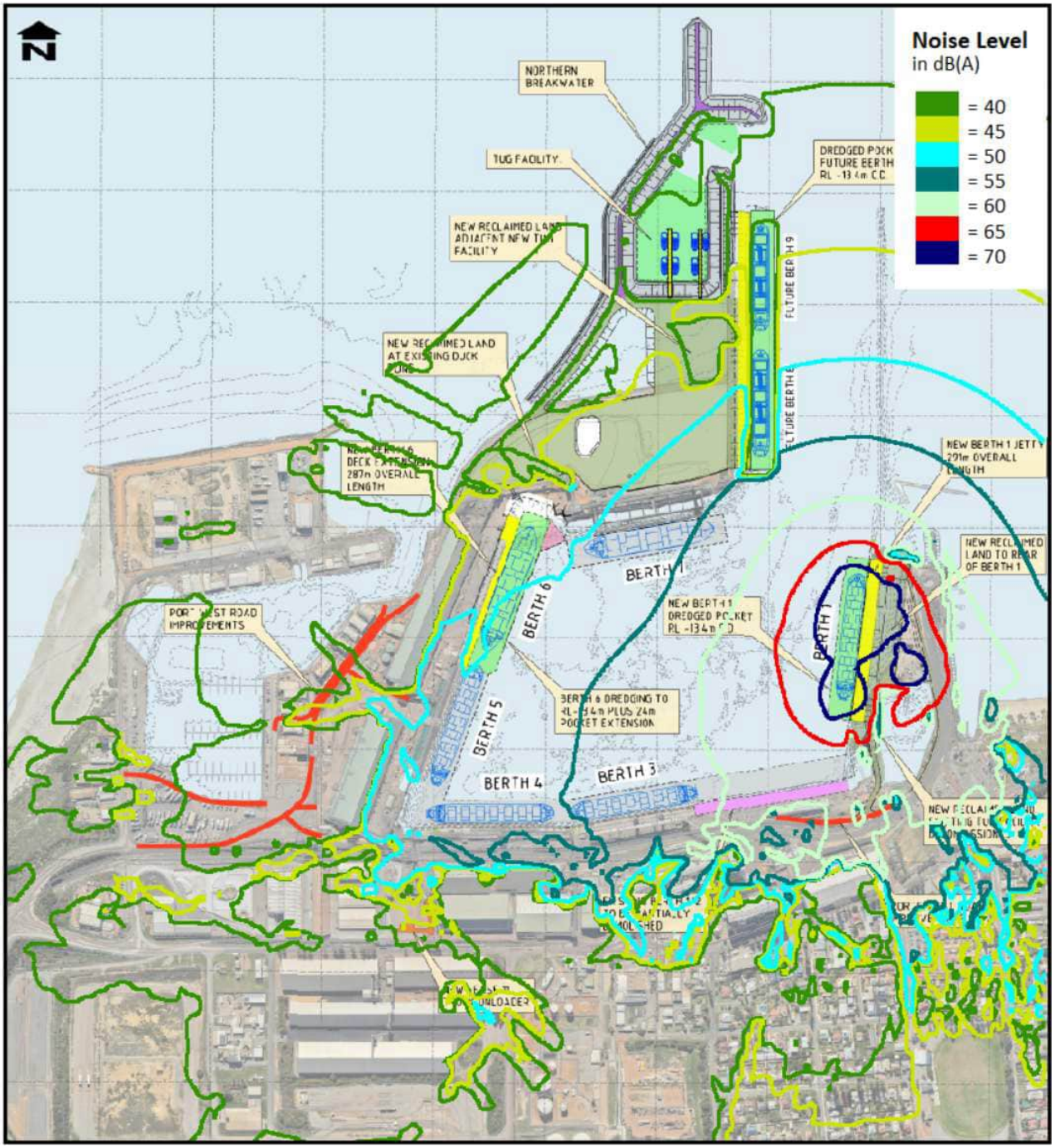

Figure 59: Day-time noise contours for scenario 8 under northerly wind.

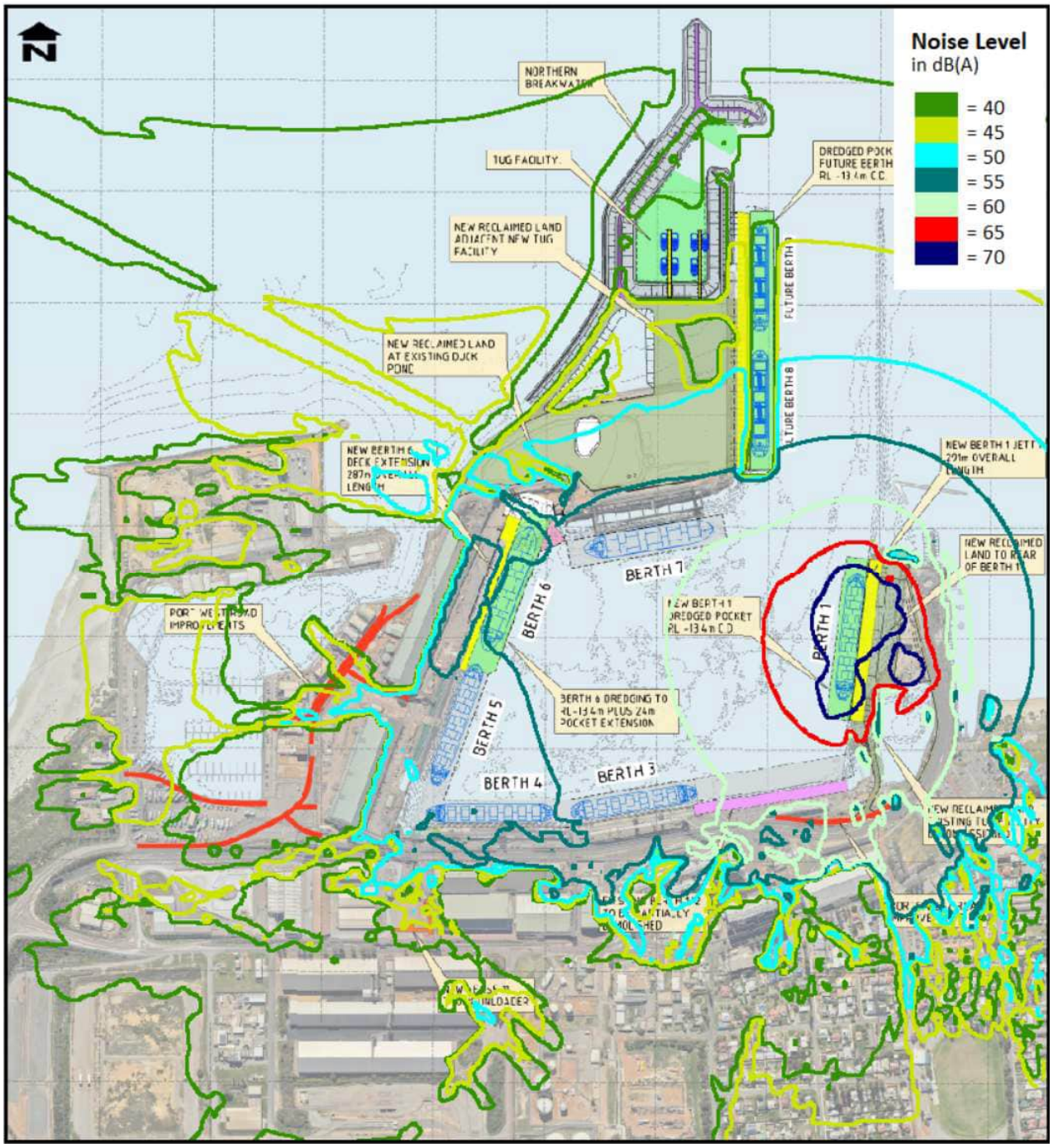

Figure 60: Day-time noise contours for scenario 8 under north-easterly wind.

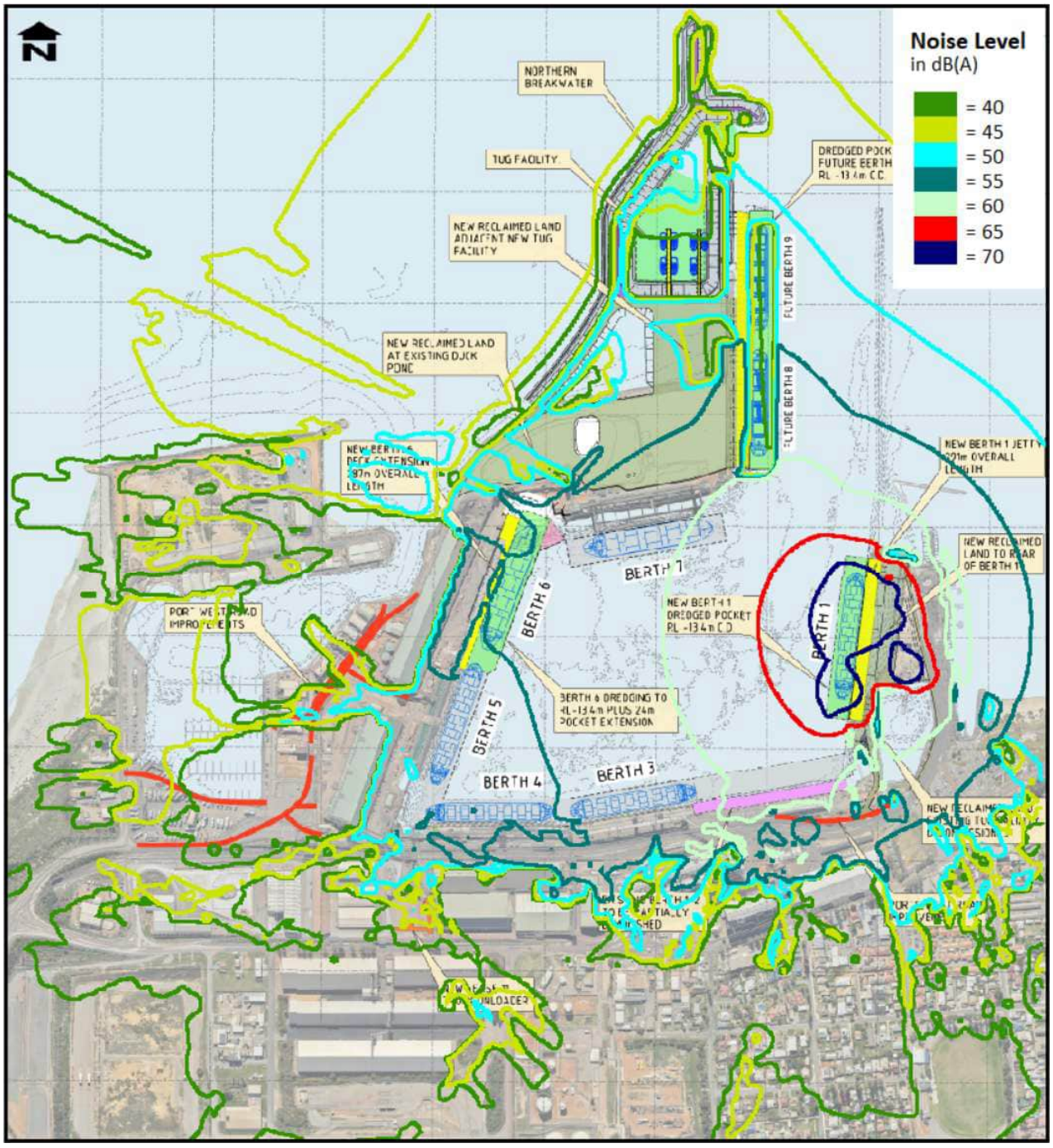

Figure 61: Day-time noise contours for scenario 8 under easterly wind.

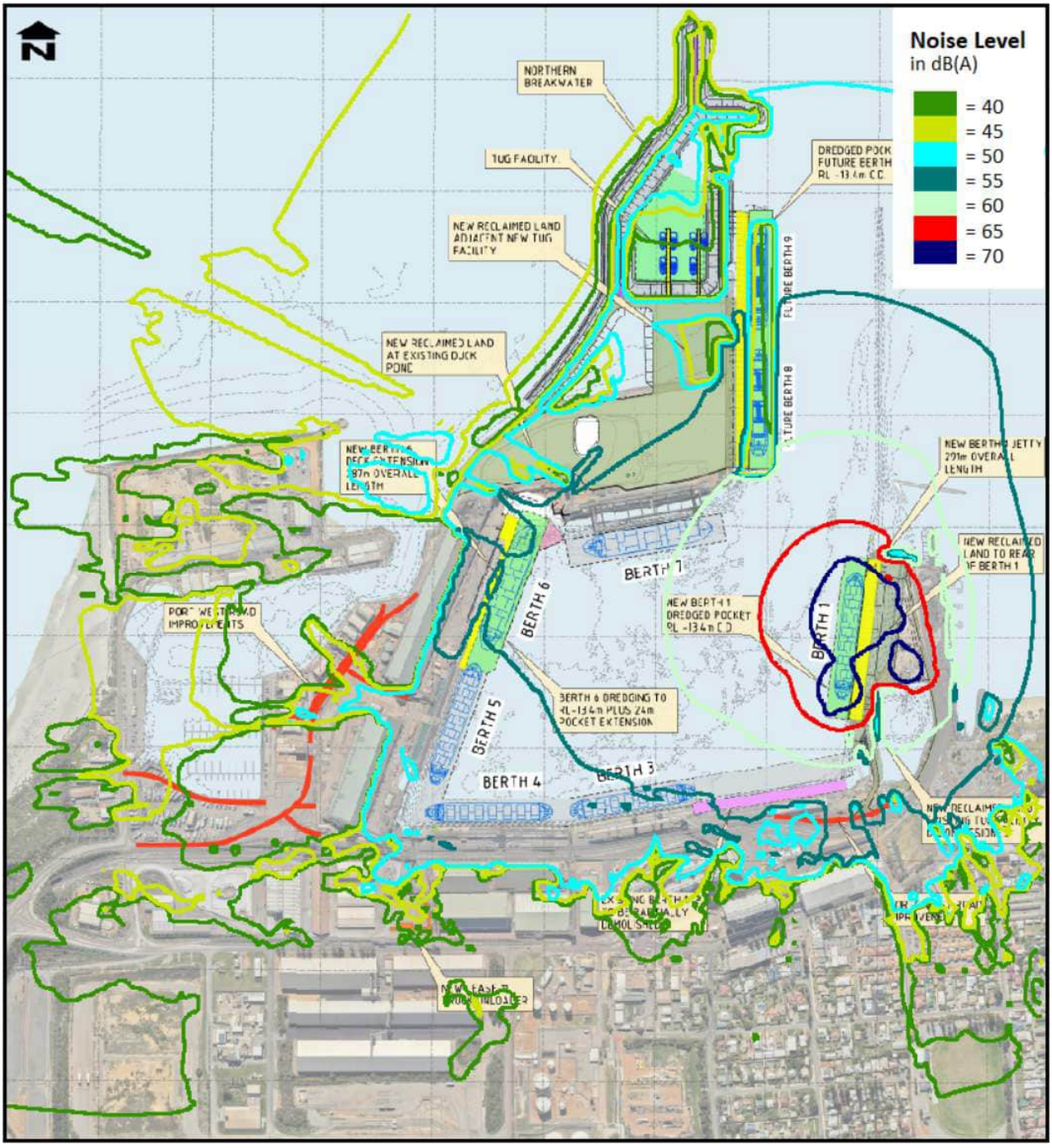

Figure 62: Day-time noise contours for scenario 8 under south-easterly wind.

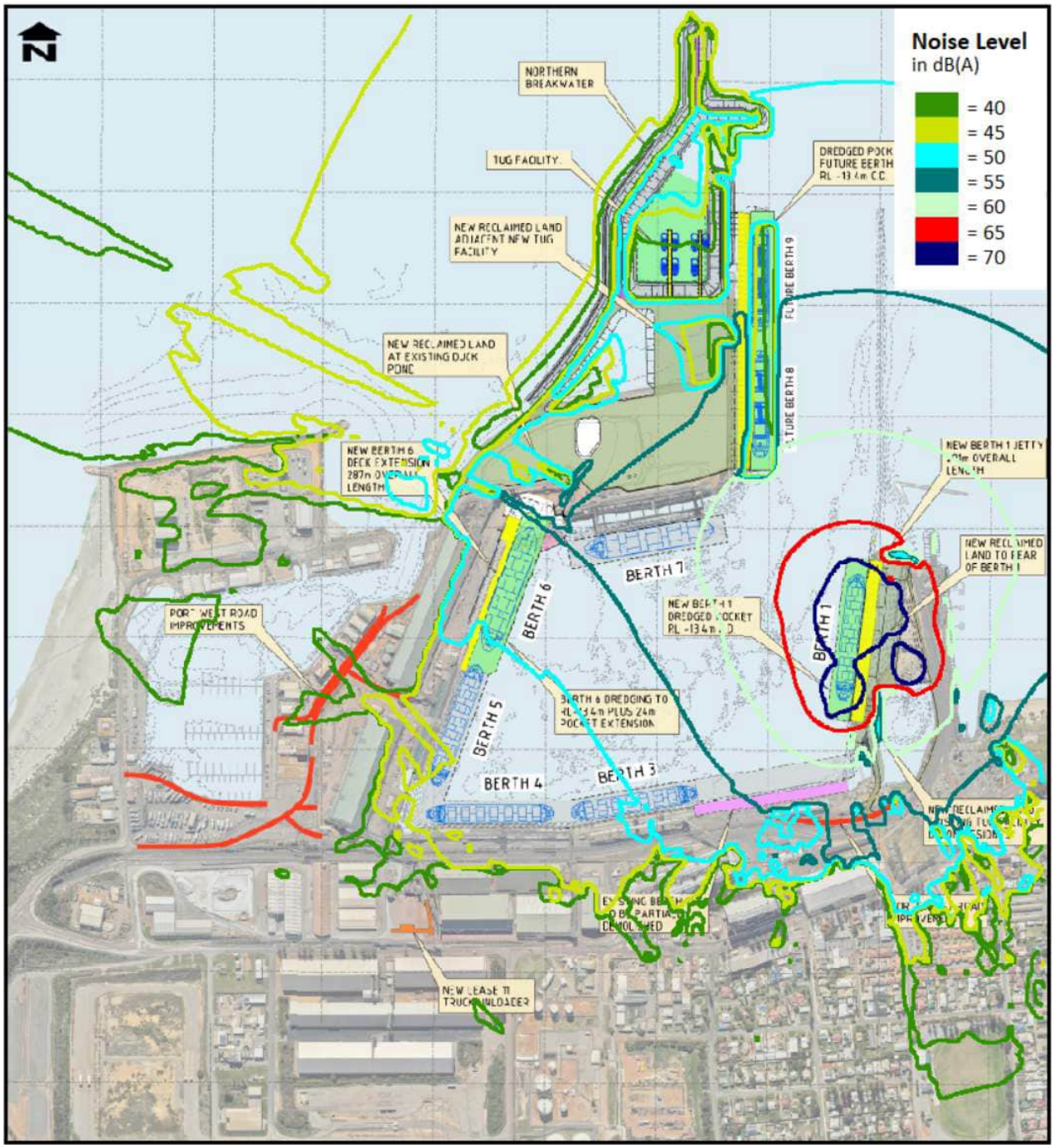

Figure 63: Day-time noise contours for scenario 8 under southerly wind.

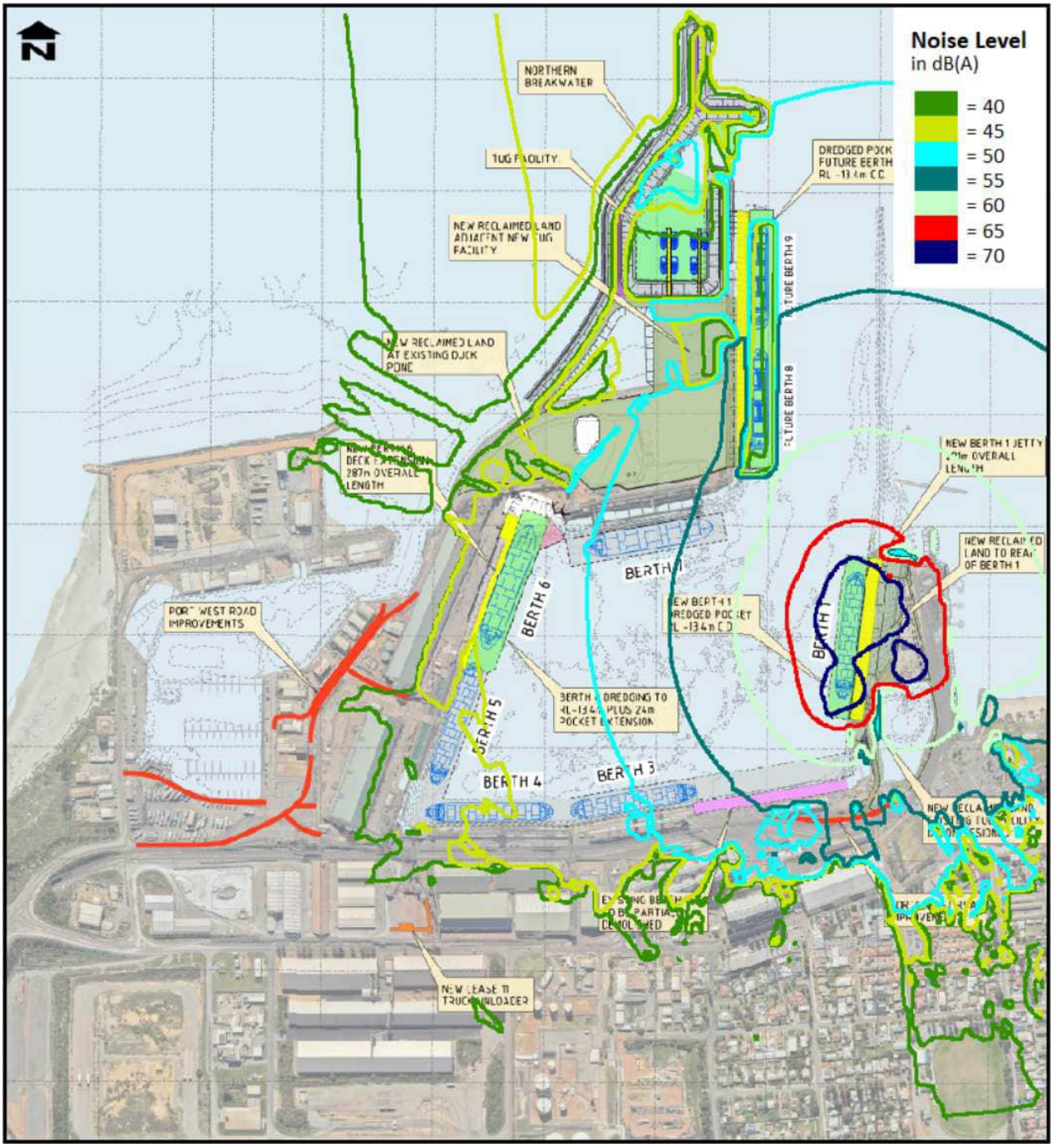

Figure 64: Day-time noise contours for scenario 8 under south-westerly wind.

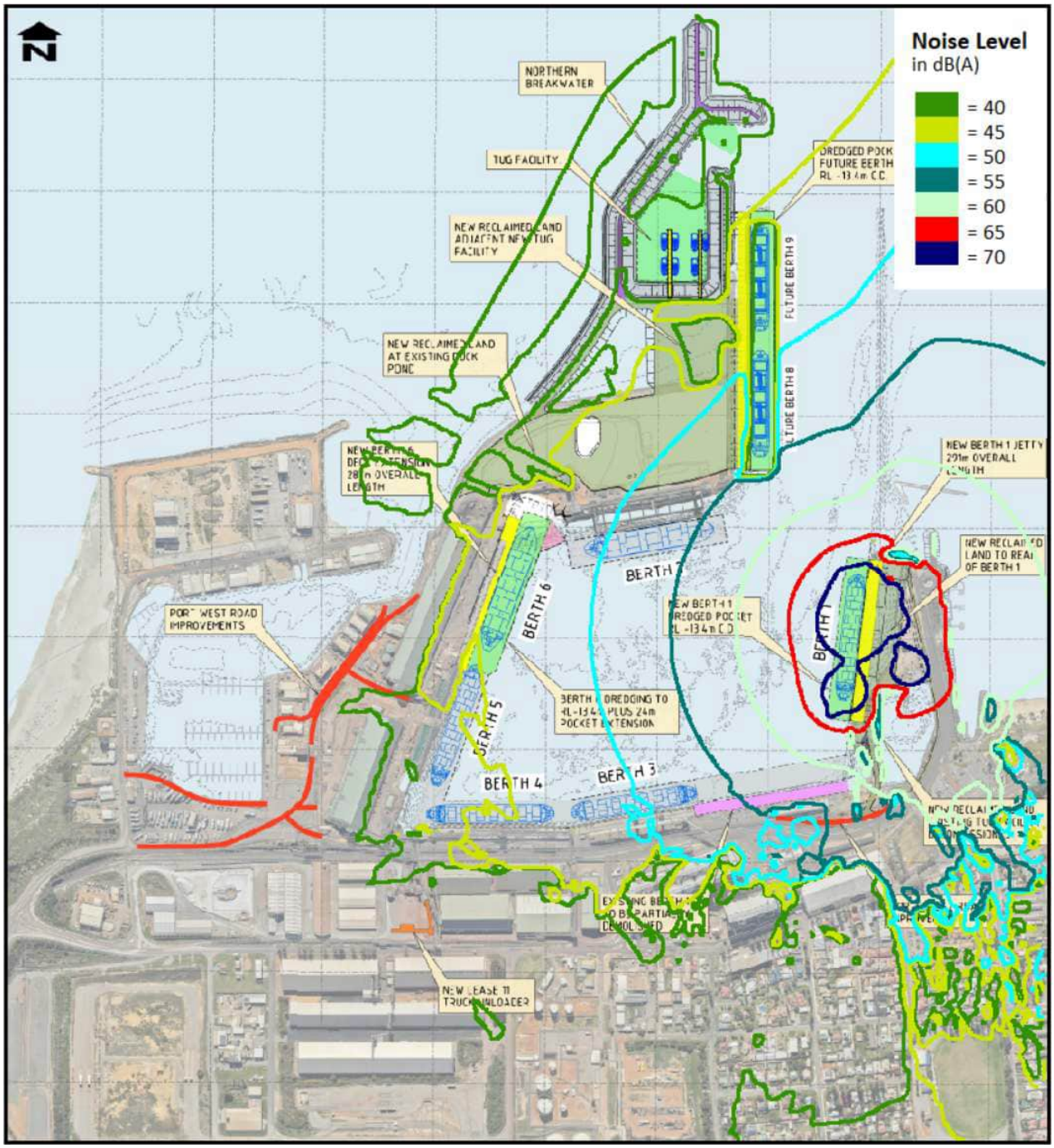

Figure 65: Day-time noise contours for scenario 8 under westerly wind.

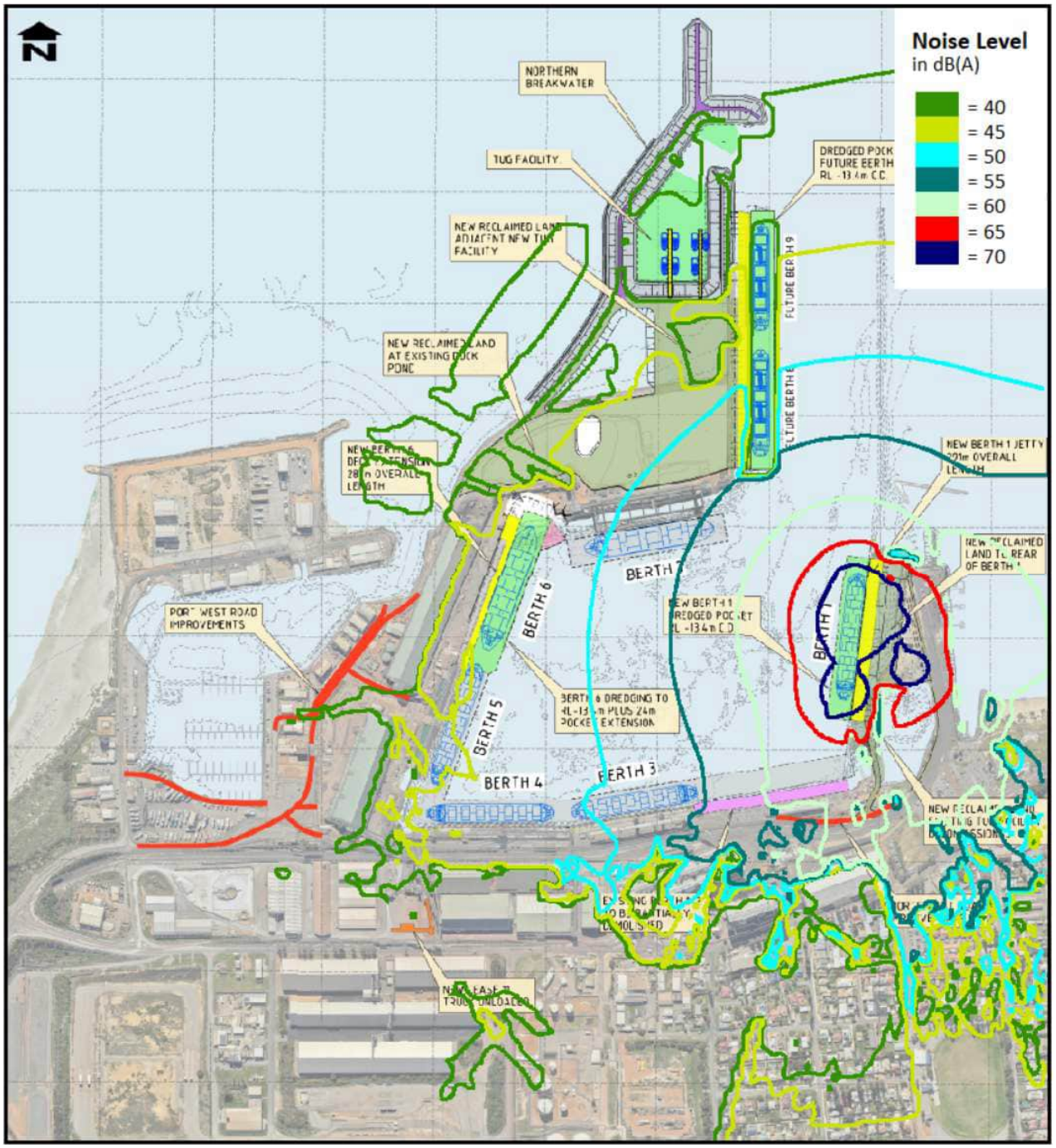

Figure 66: Day-time noise contours for scenario 8 under north-westerly wind.

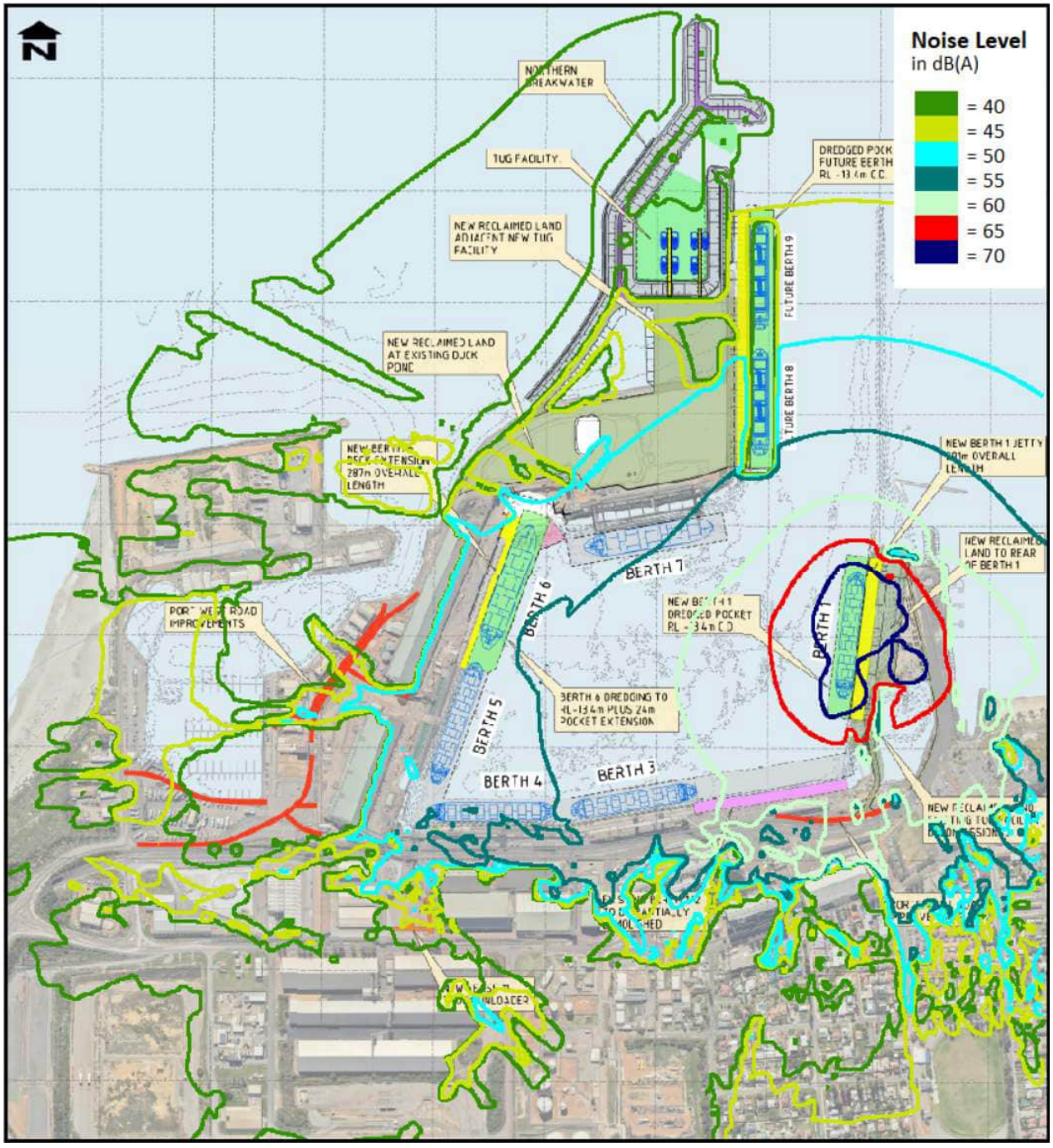

Figure 67: Night-time noise contours for scenario 8 under northerly wind.

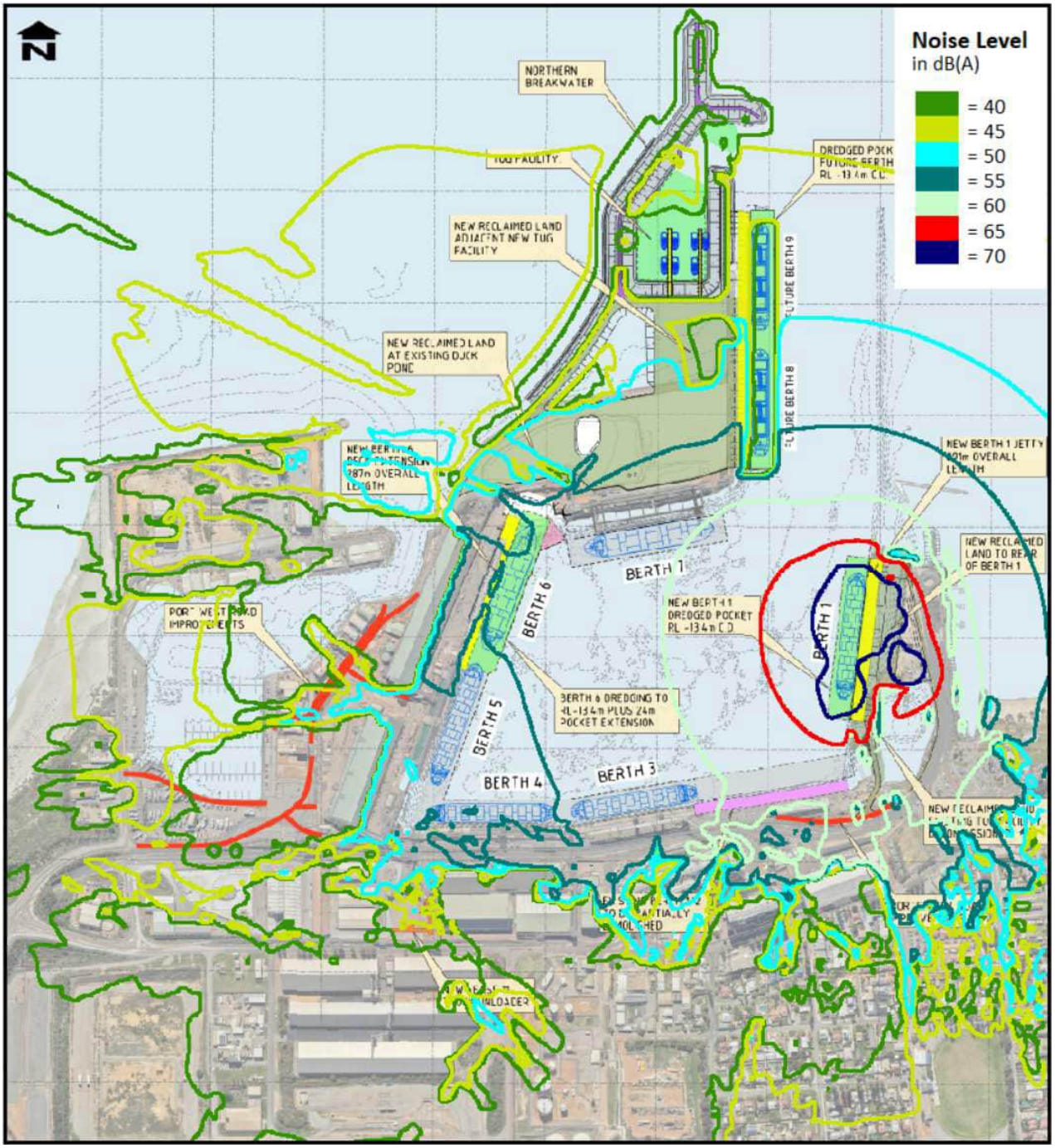

Figure 68: Night-time noise contours for scenario 8 under north-easterly wind.

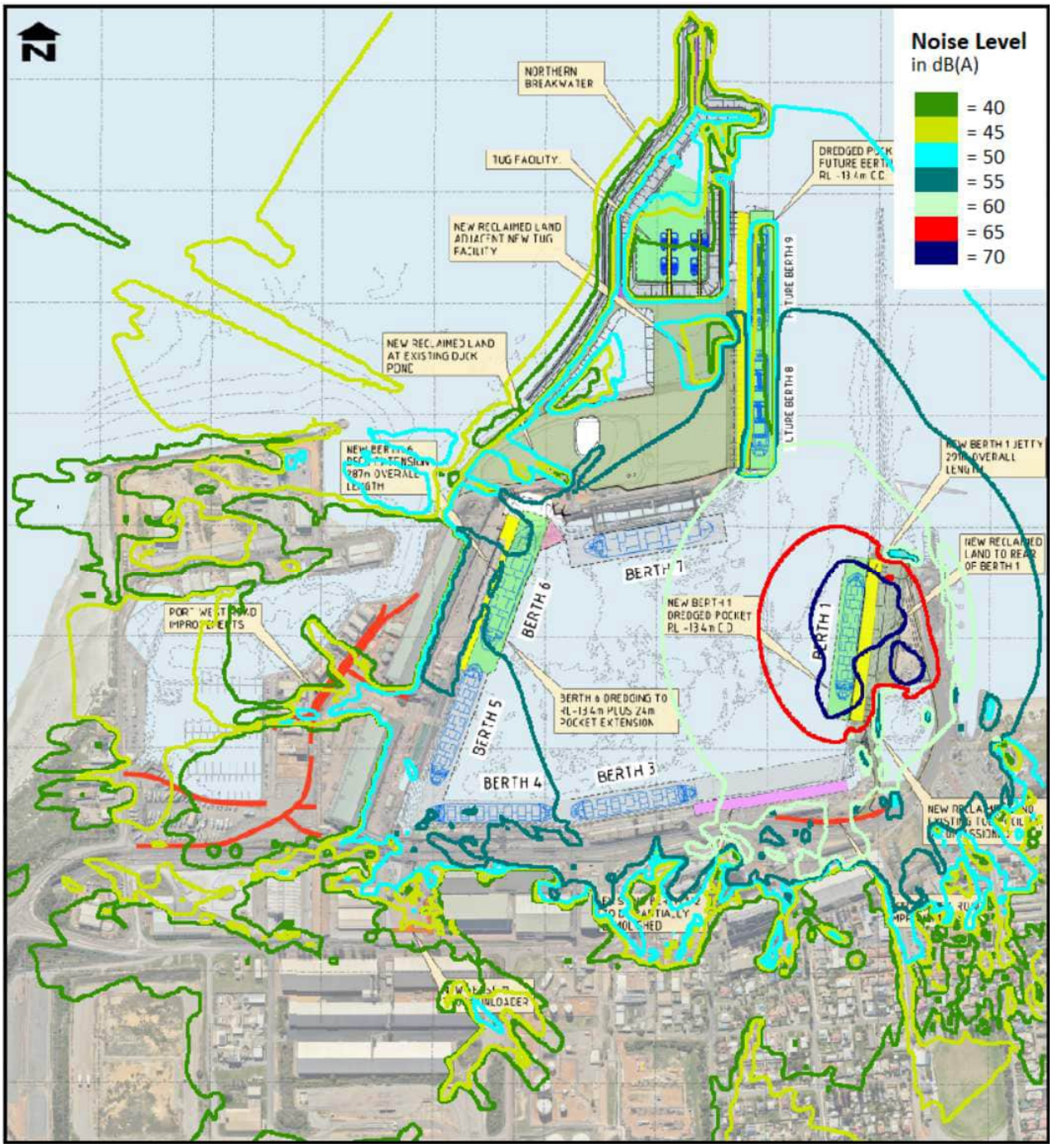

Figure 69: Night-time noise contours for scenario 8 under easterly wind.

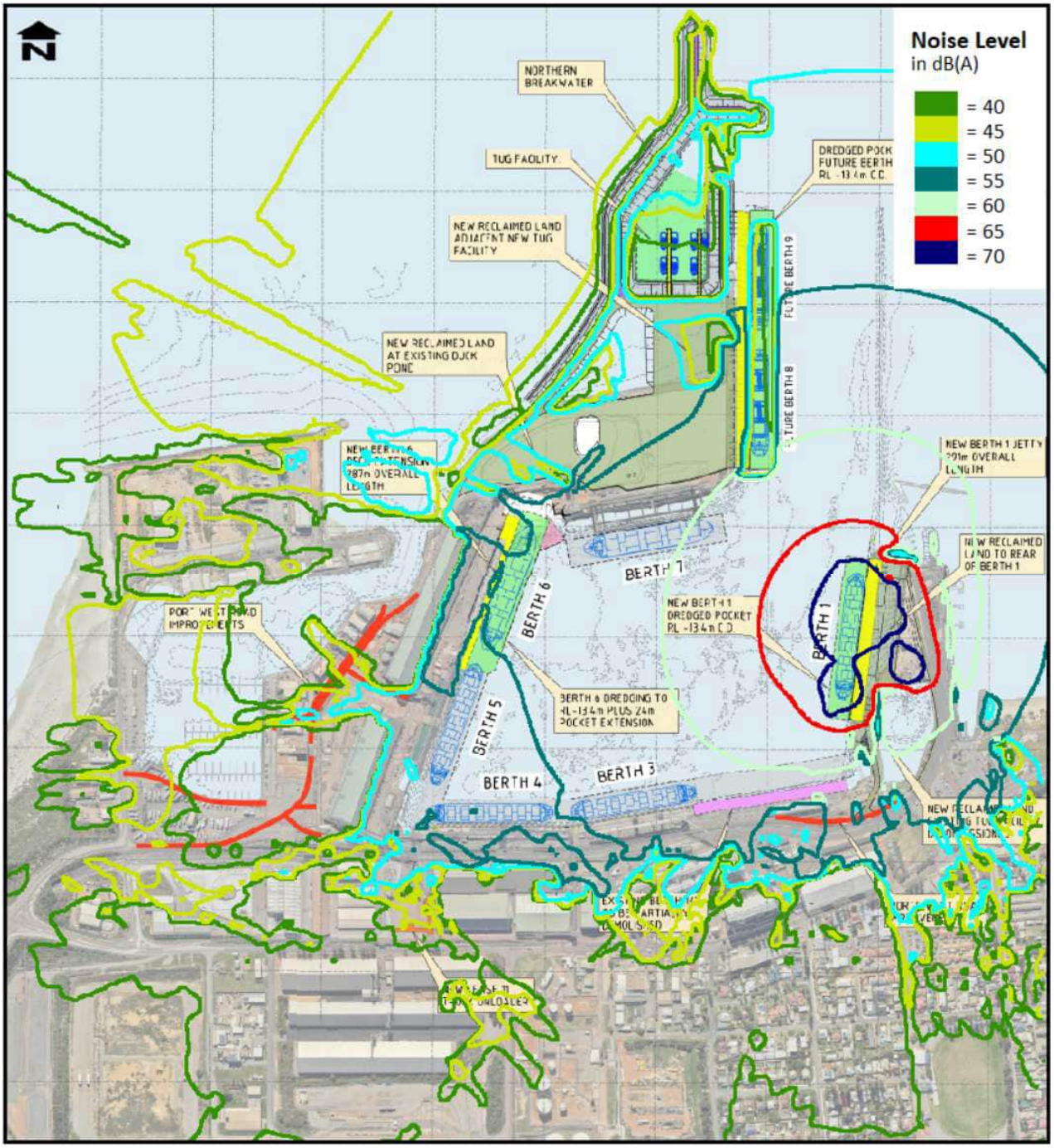

Figure 70: Night-time noise contours for scenario 8 under south-easterly wind.

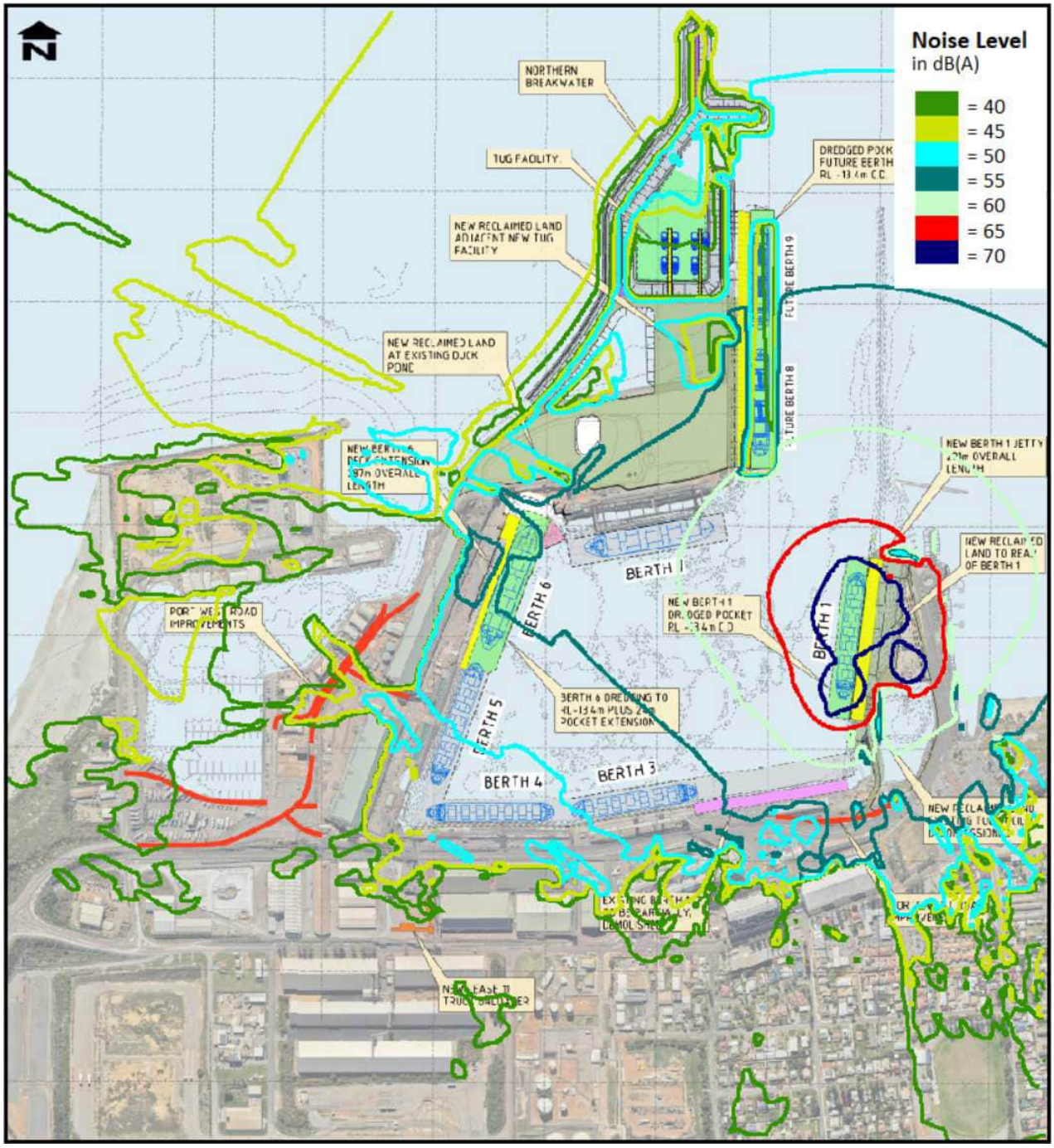

Figure 71: Night-time noise contours for scenario 8 under southerly wind.

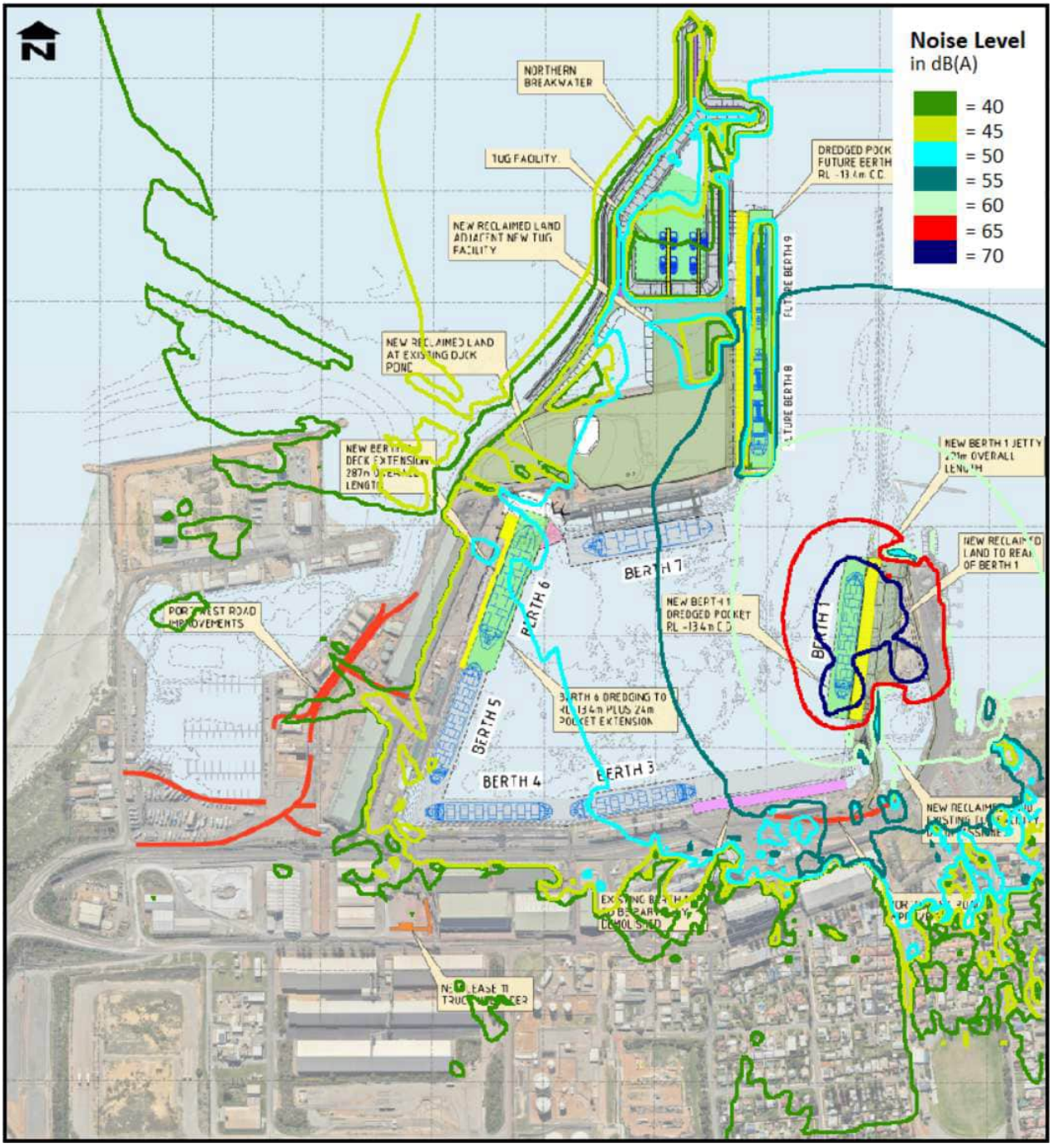

Figure 72: Night-time noise contours for scenario 8 under south-westerly wind.

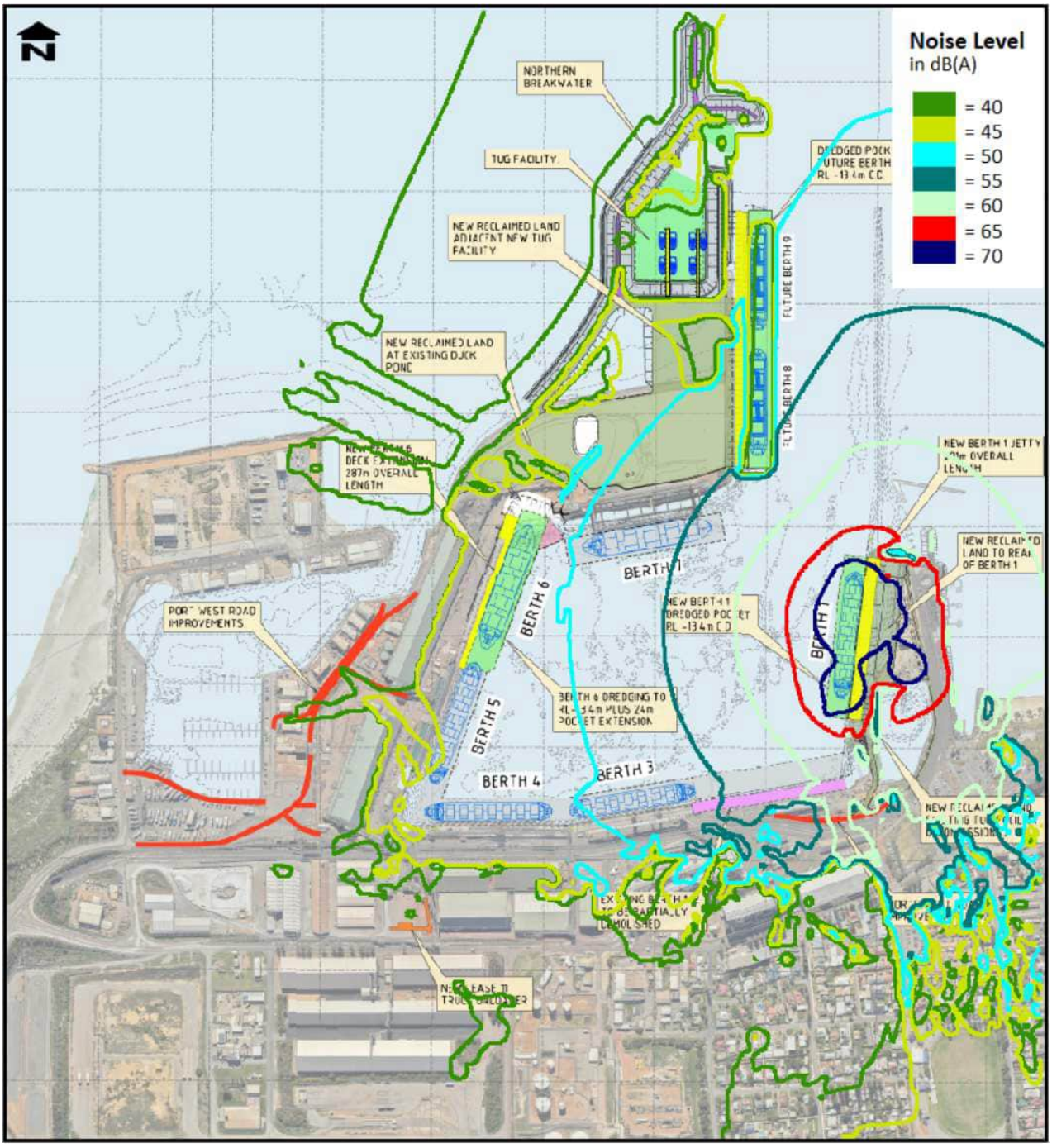

Figure 73: Night-time noise contours for scenario 8 under westerly wind.

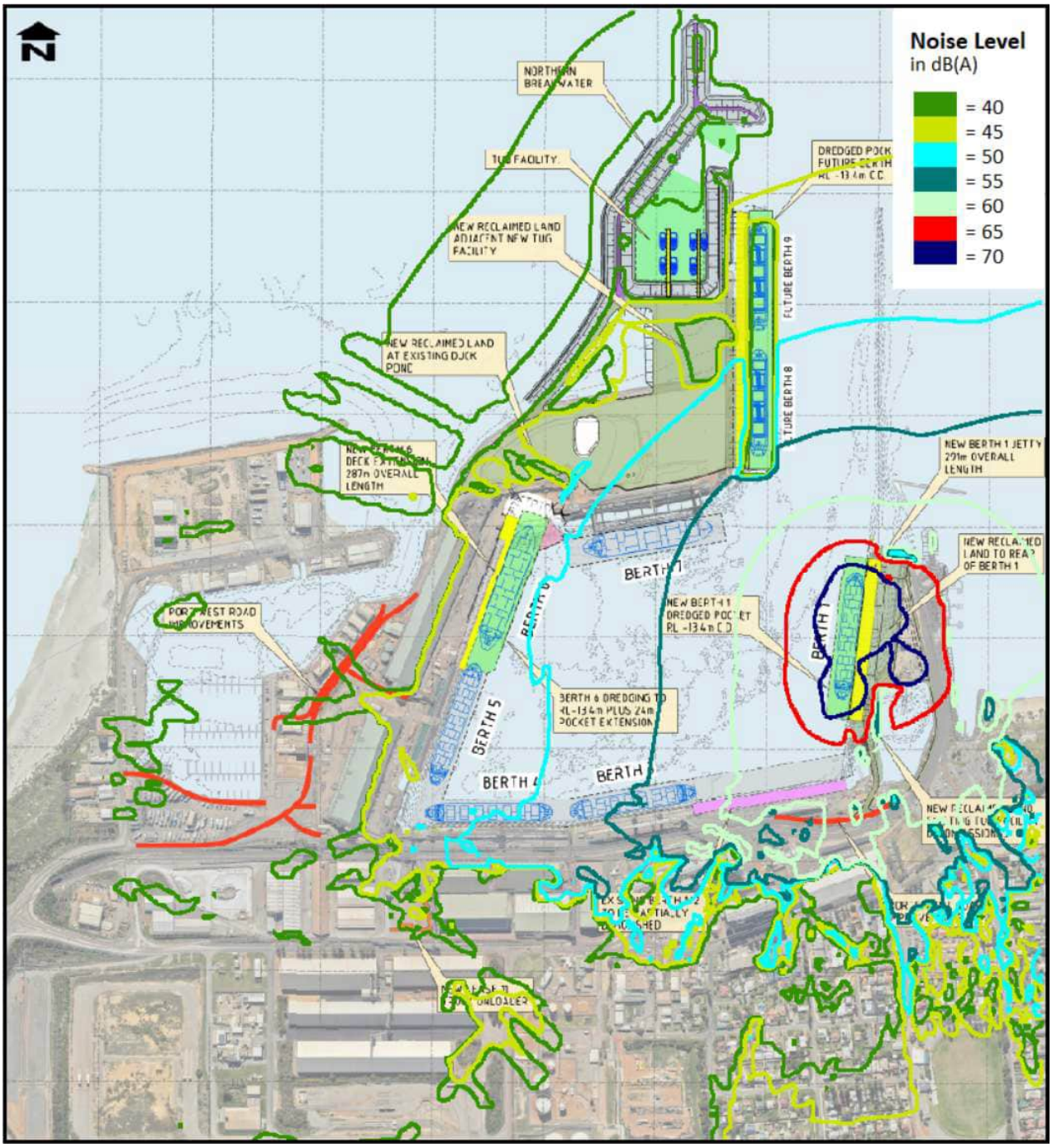

Figure 74: Night-time noise contours for scenario 8 under north-westerly wind.

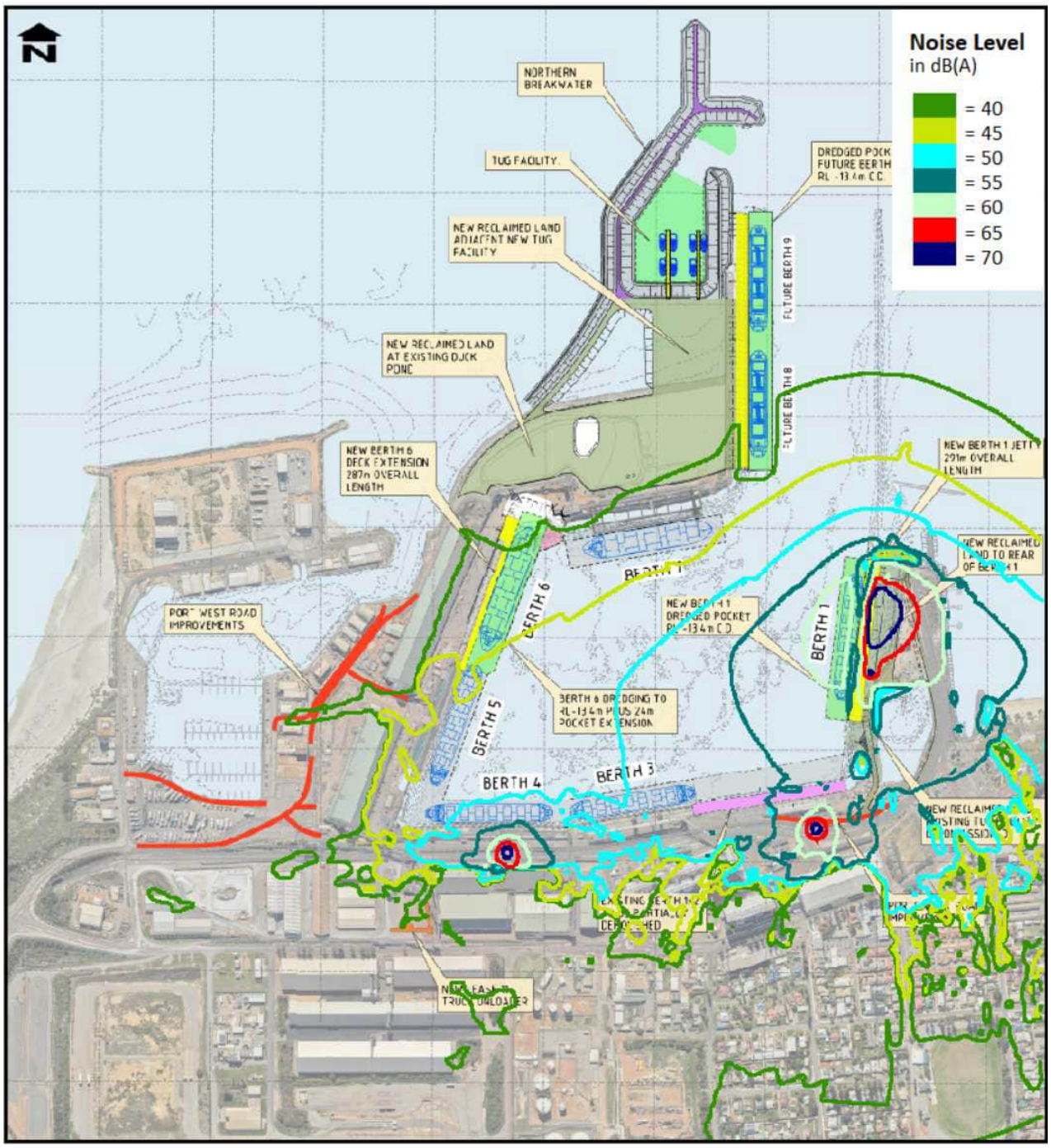

Figure 75: Daytime noise contours for scenario 9 under northerly wind.

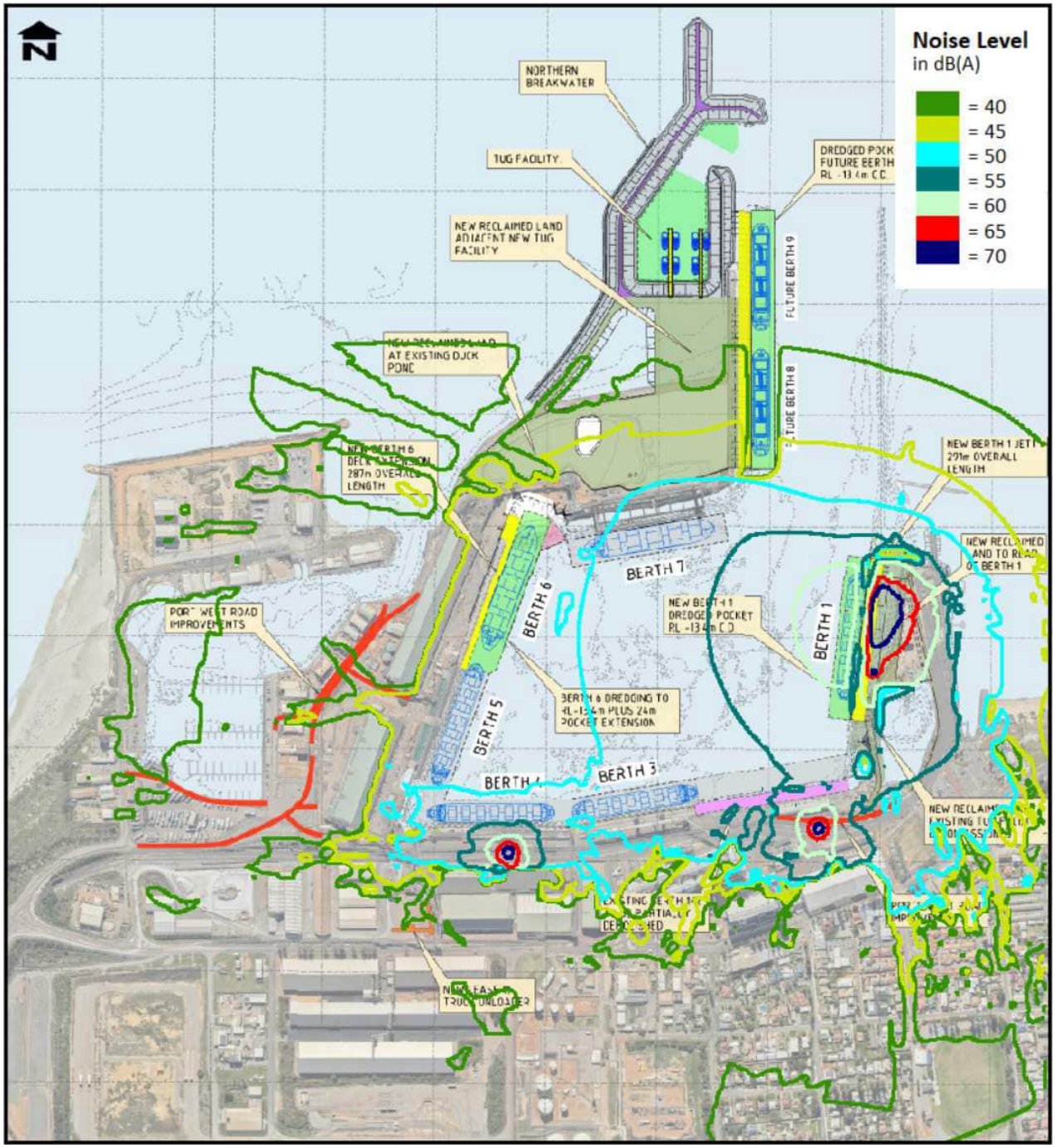

Figure 76: Daytime noise contours for scenario 9 under north-easterly wind.

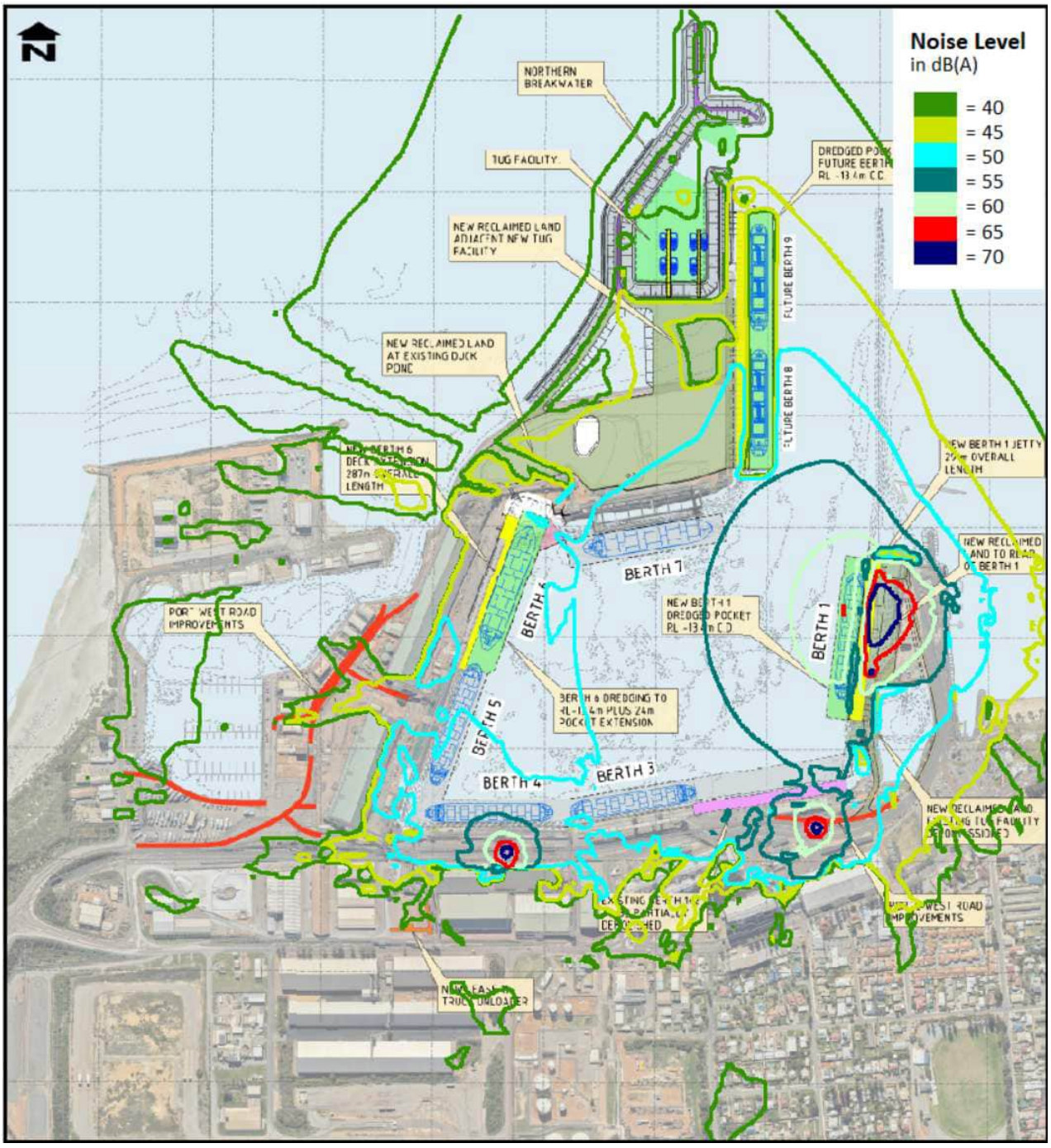

Figure 77: Daytime noise contours for scenario 9 under easterly wind.

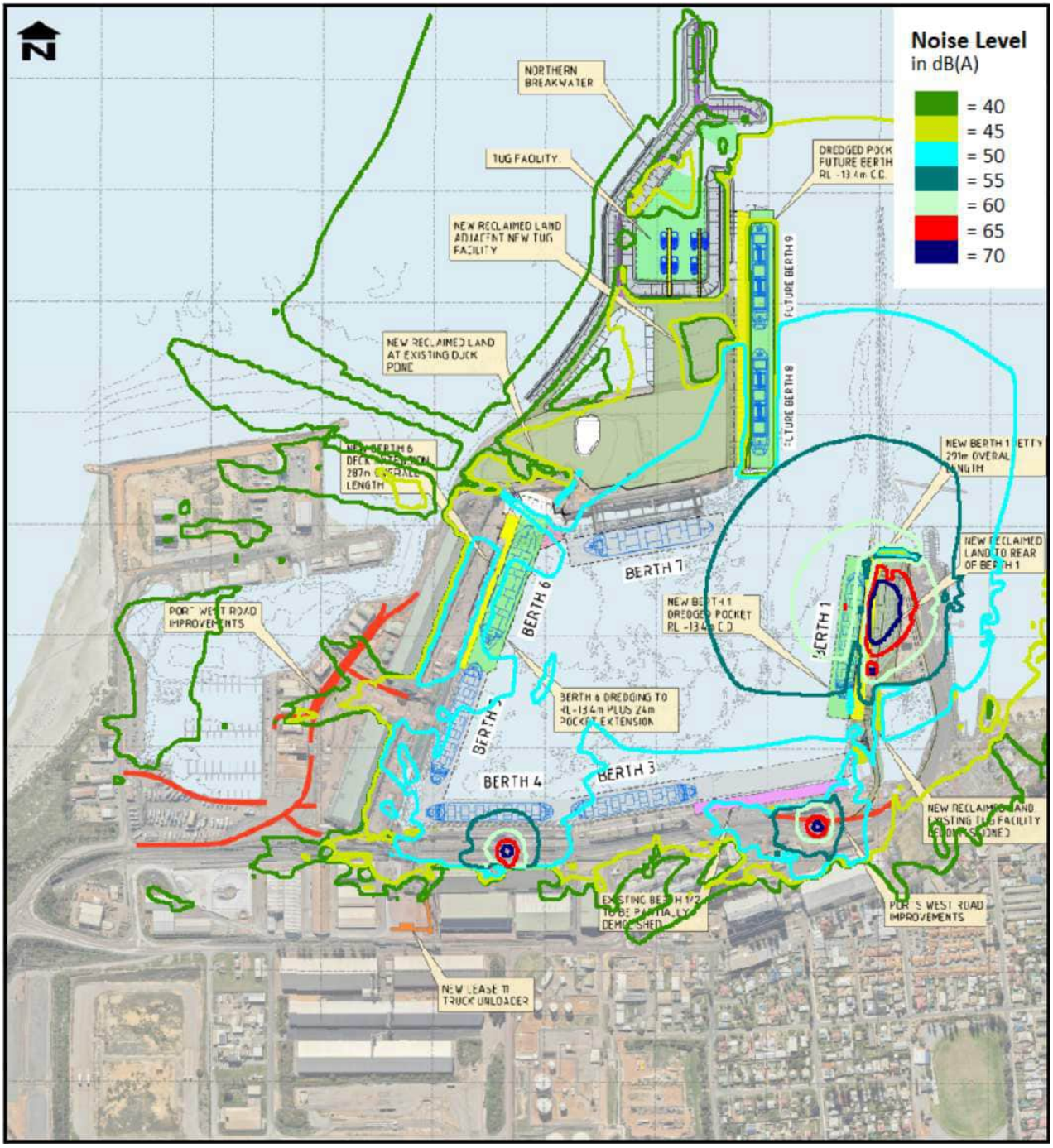

Figure 78: Daytime noise contours for scenario 9 under south-easterly wind.

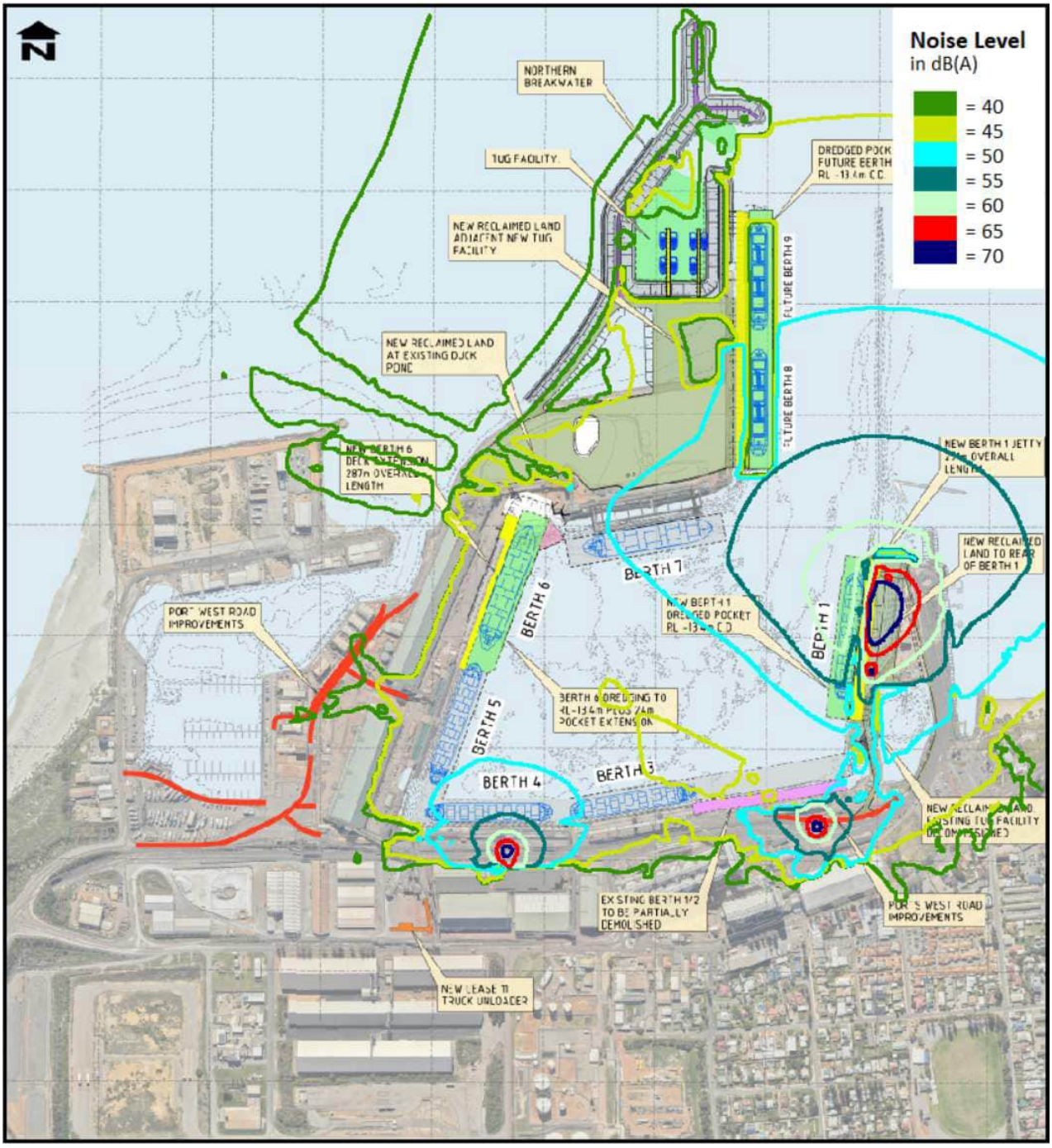

Figure 79: Daytime noise contours for scenario 9 under southerly wind.

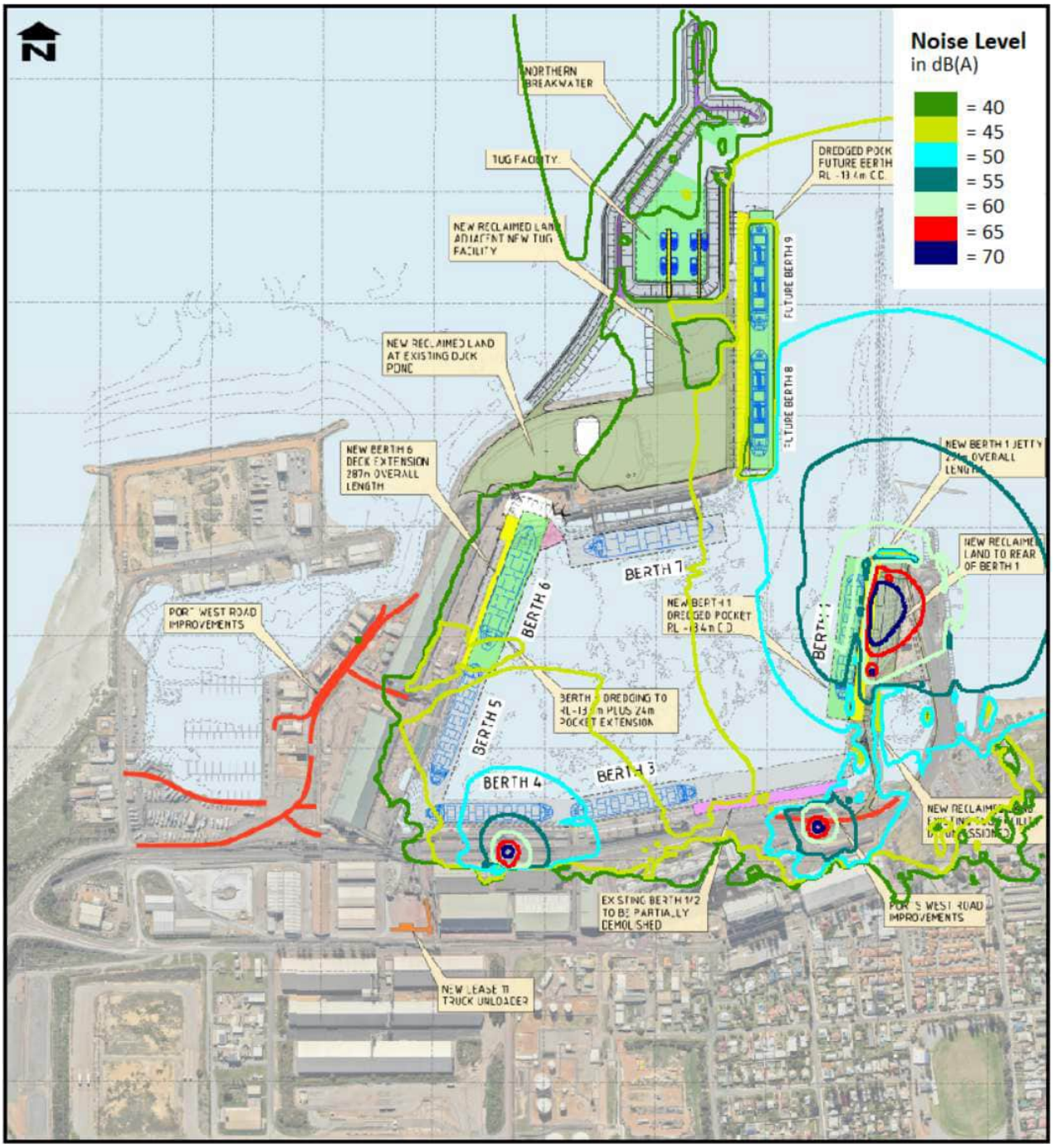

Figure 80: Daytime noise contours for scenario 9 under south-westerly wind.

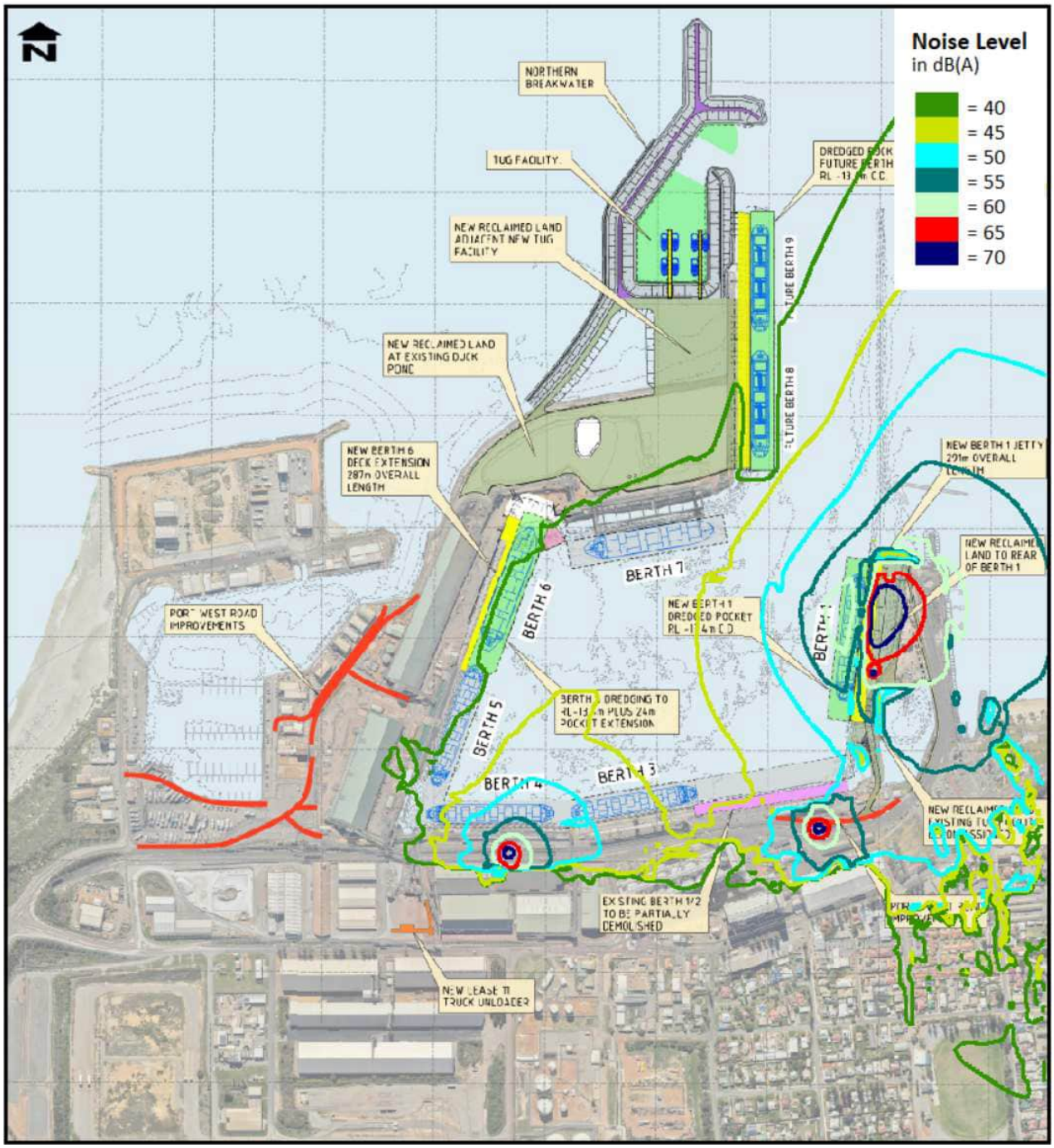

Figure 81: Daytime noise contours for scenario 9 under westerly wind.

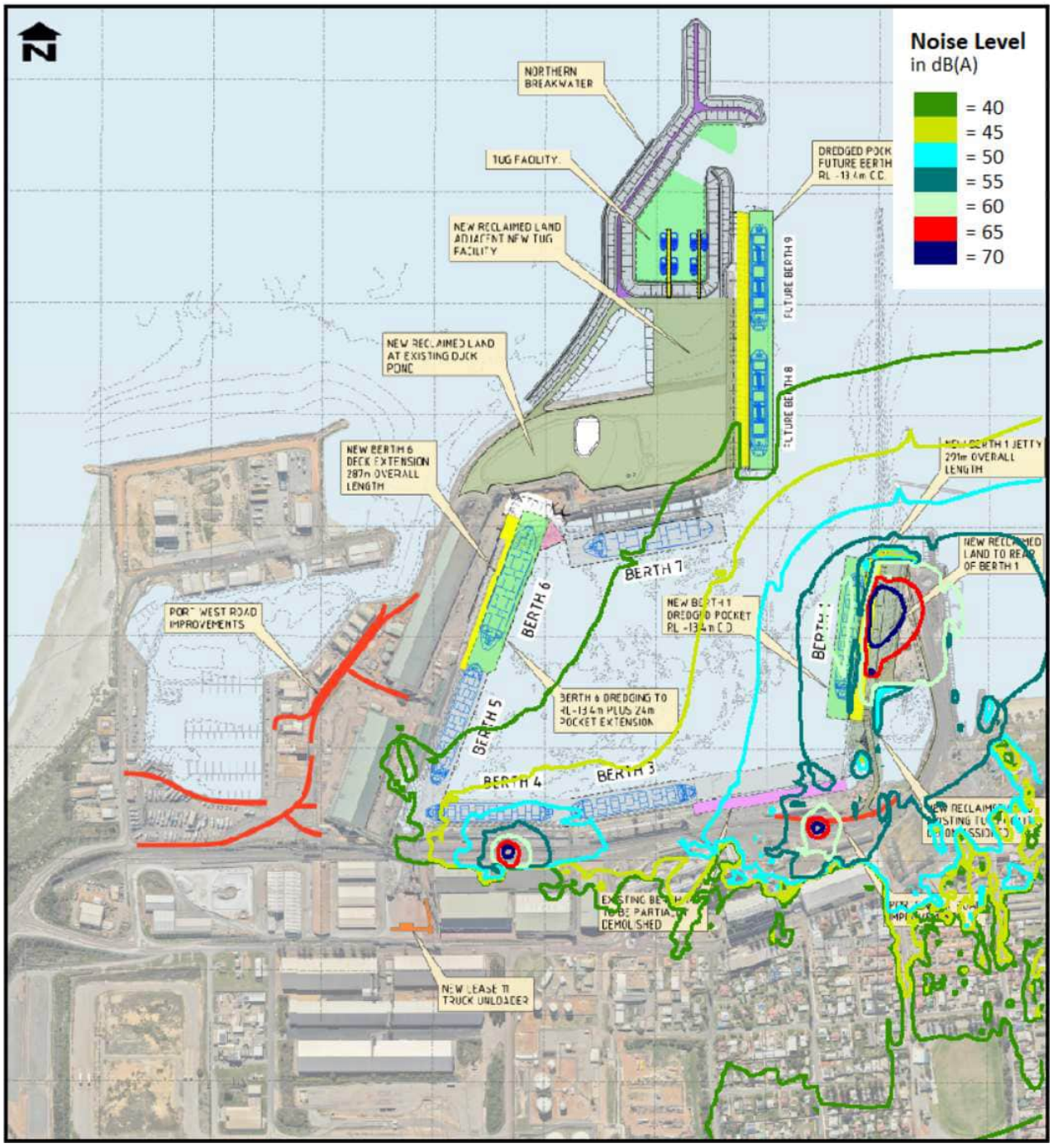

Figure 82: Daytime noise contours for scenario 9 under north-westerly wind.

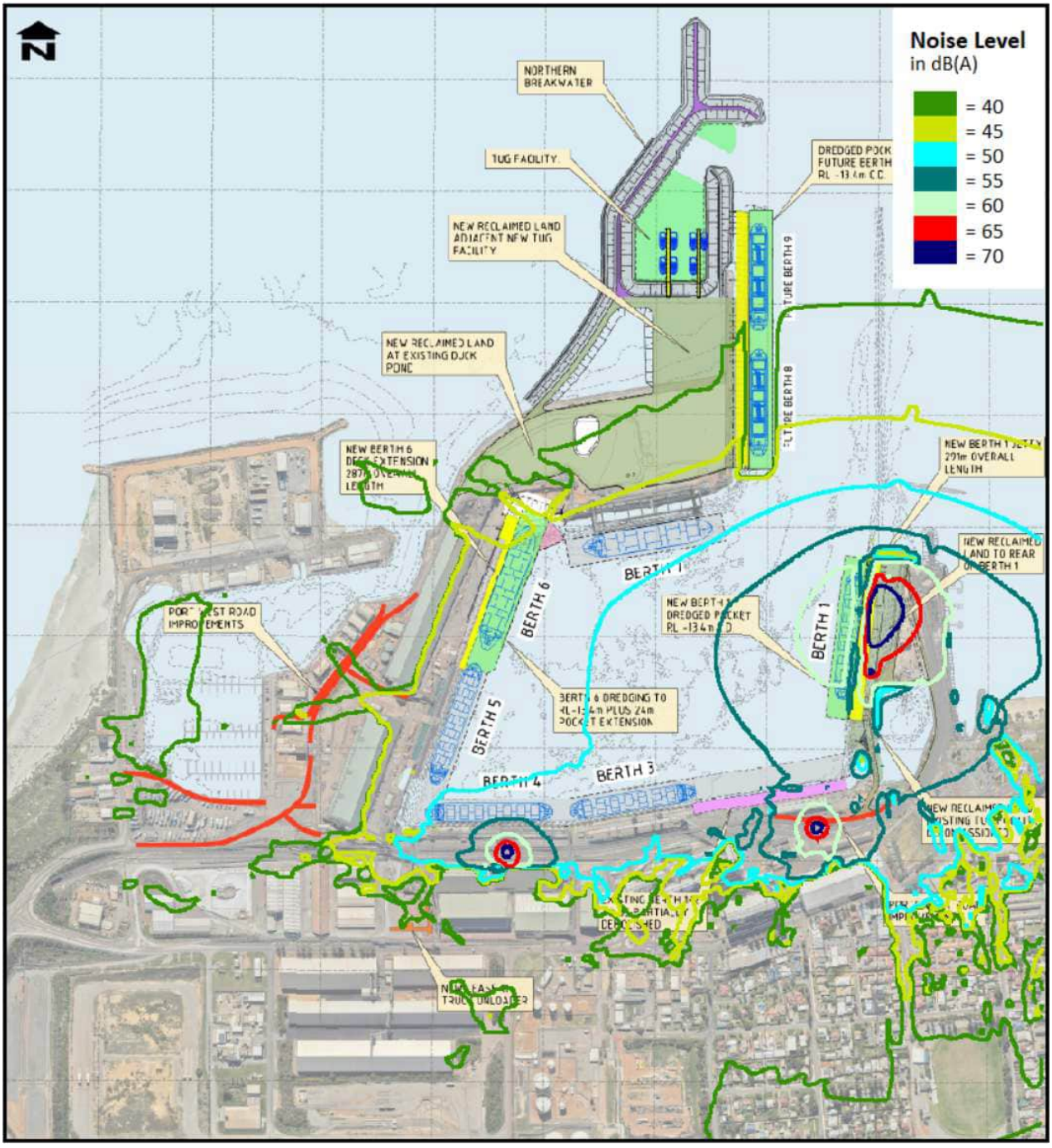

Figure 83: Night-time noise contours for scenario 9 under northerly wind.

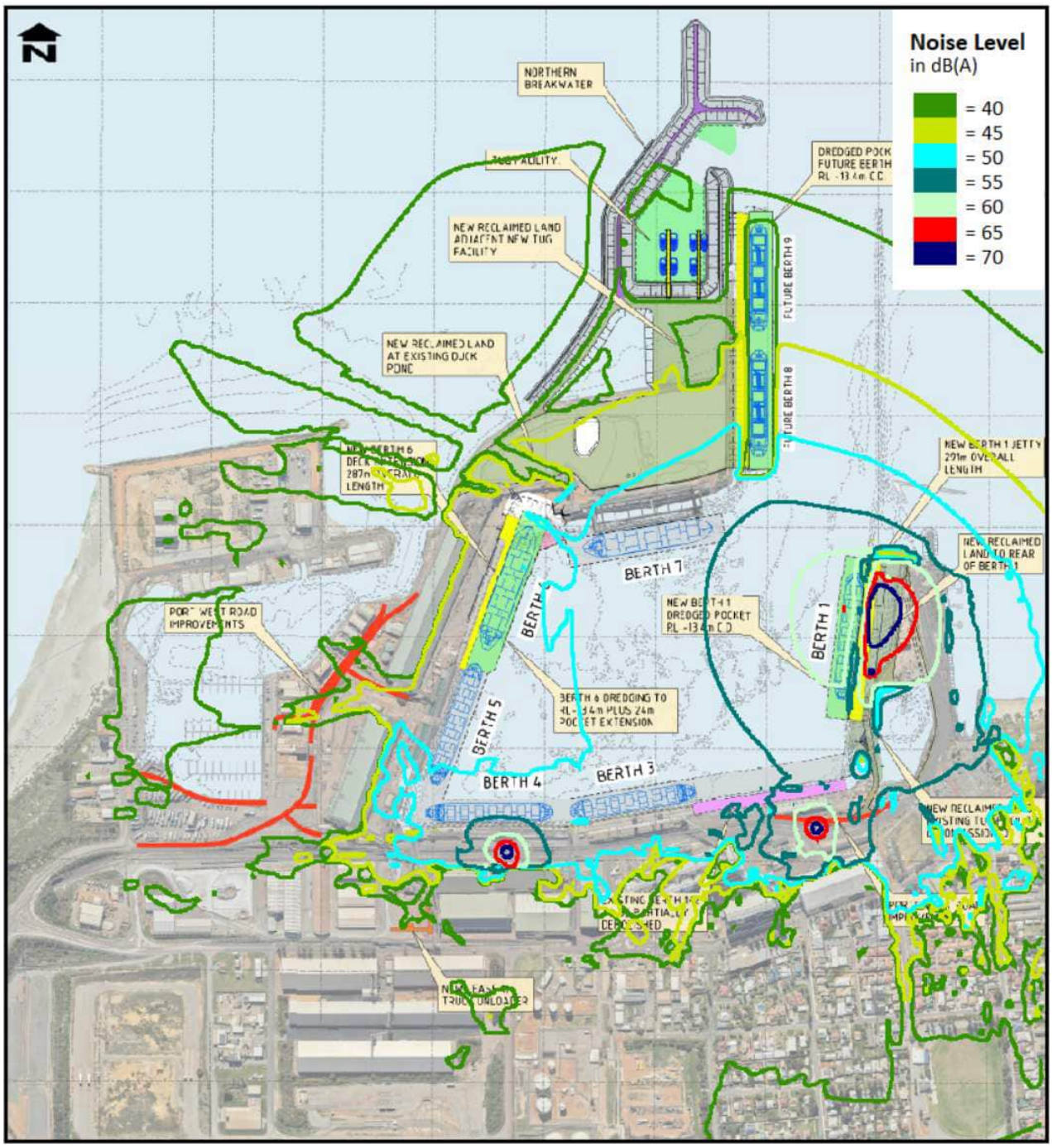

Figure 84: Night-time noise contours for scenario 9 under north-easterly wind.

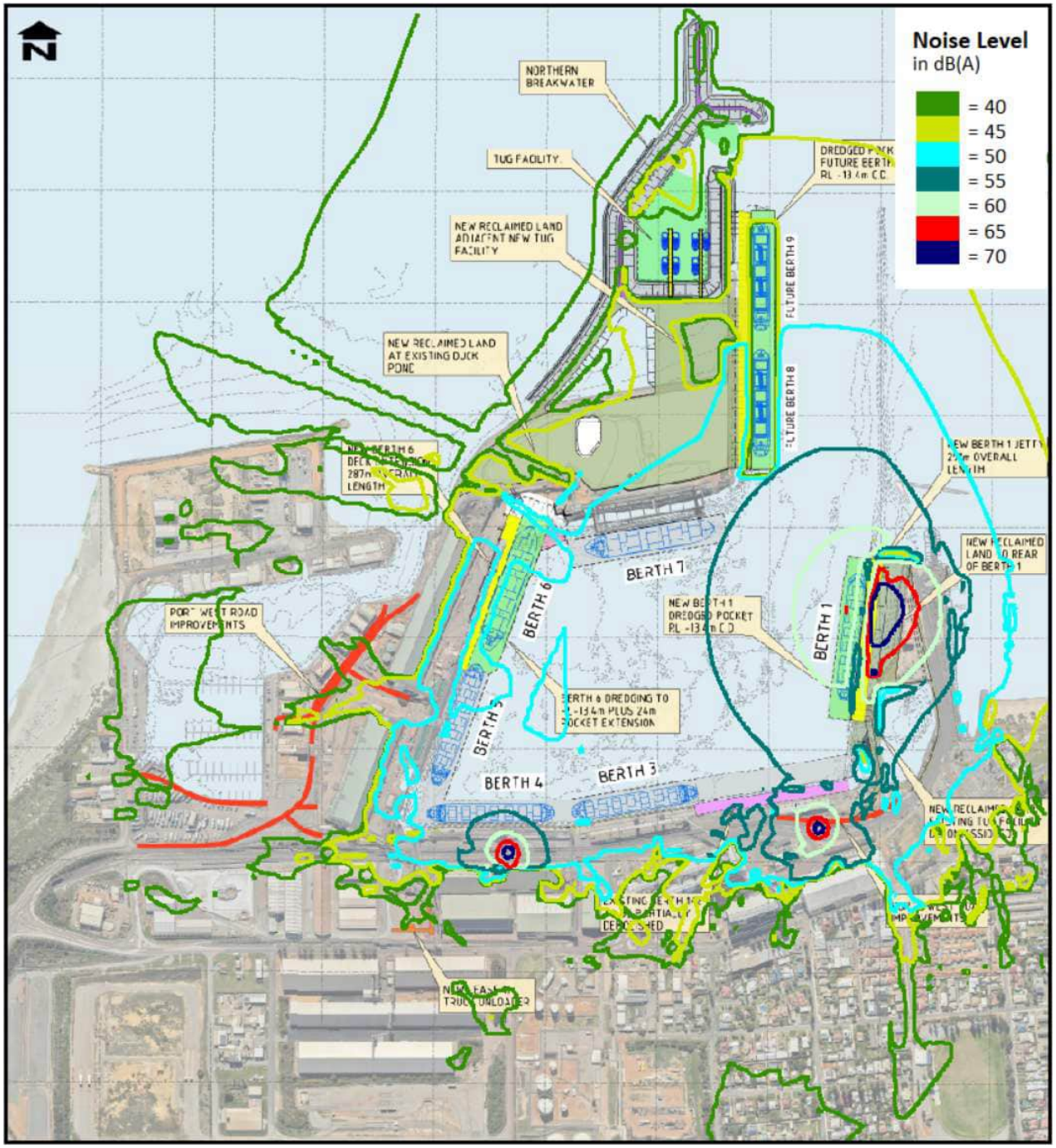

Figure 85: Night-time noise contours for scenario 9 under easterly wind.

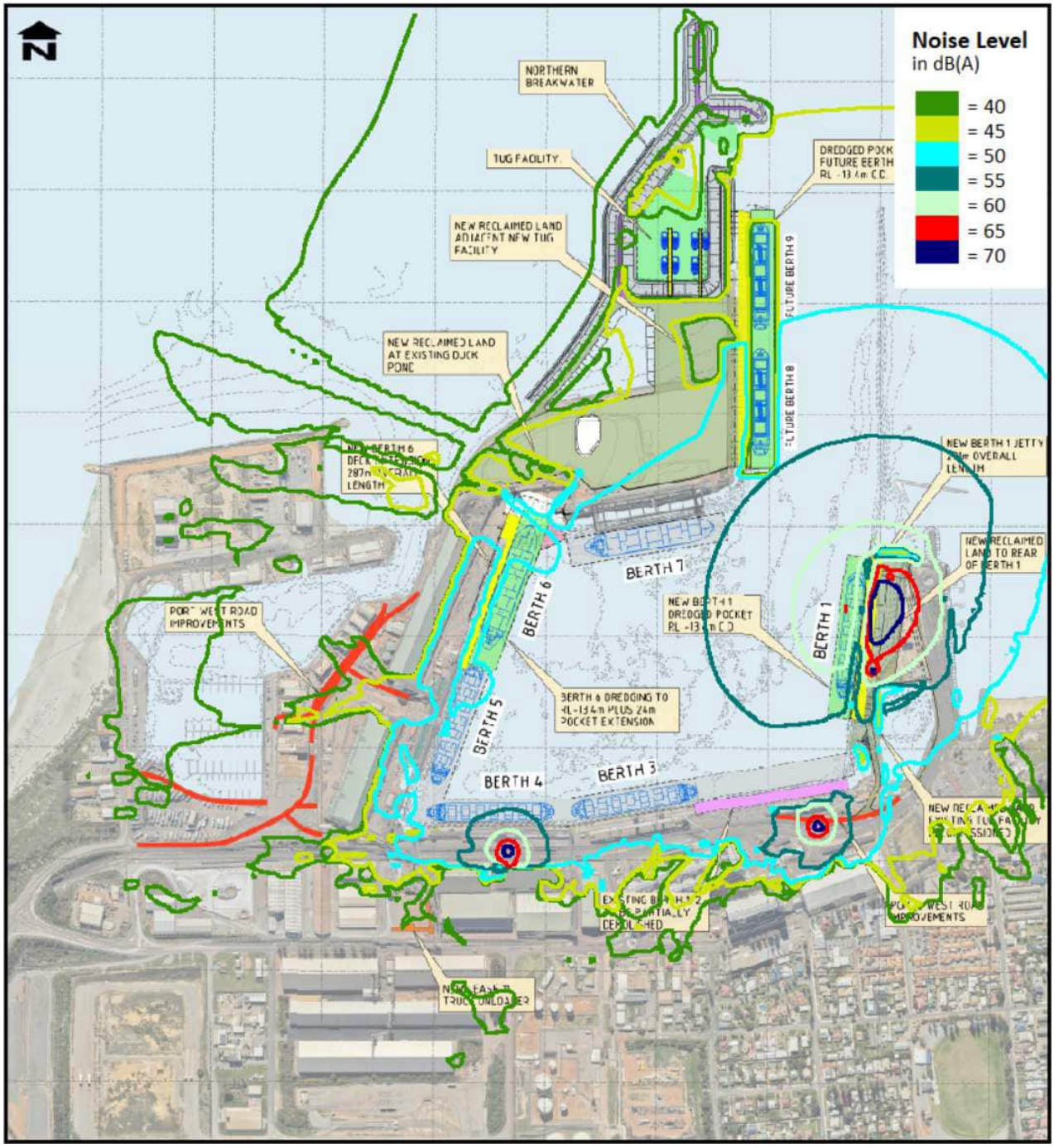

Figure 86: Night-time noise contours for scenario 9 under south-easterly wind.

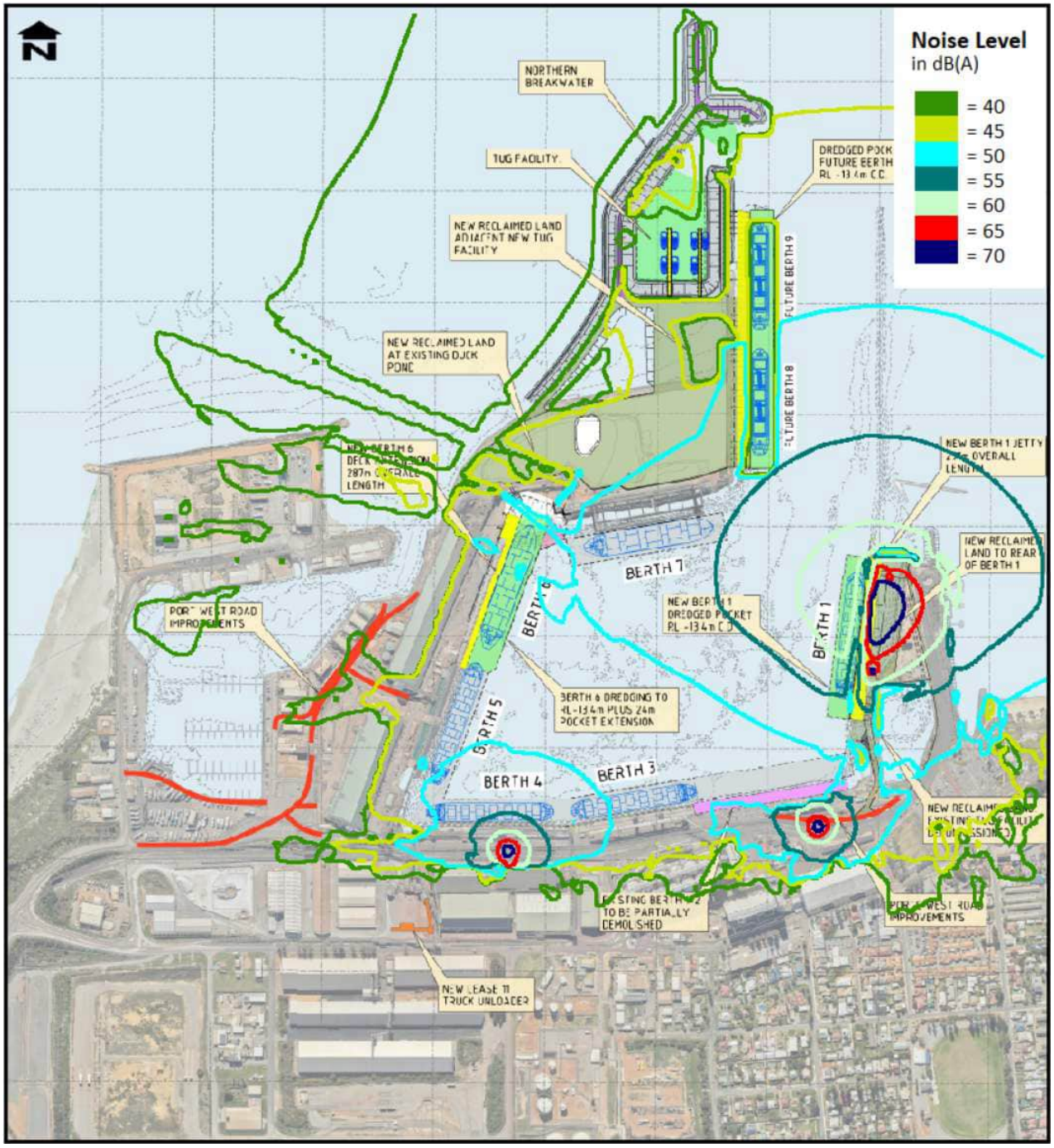

Figure 87: Night-time noise contours for scenario 9 under southerly wind.

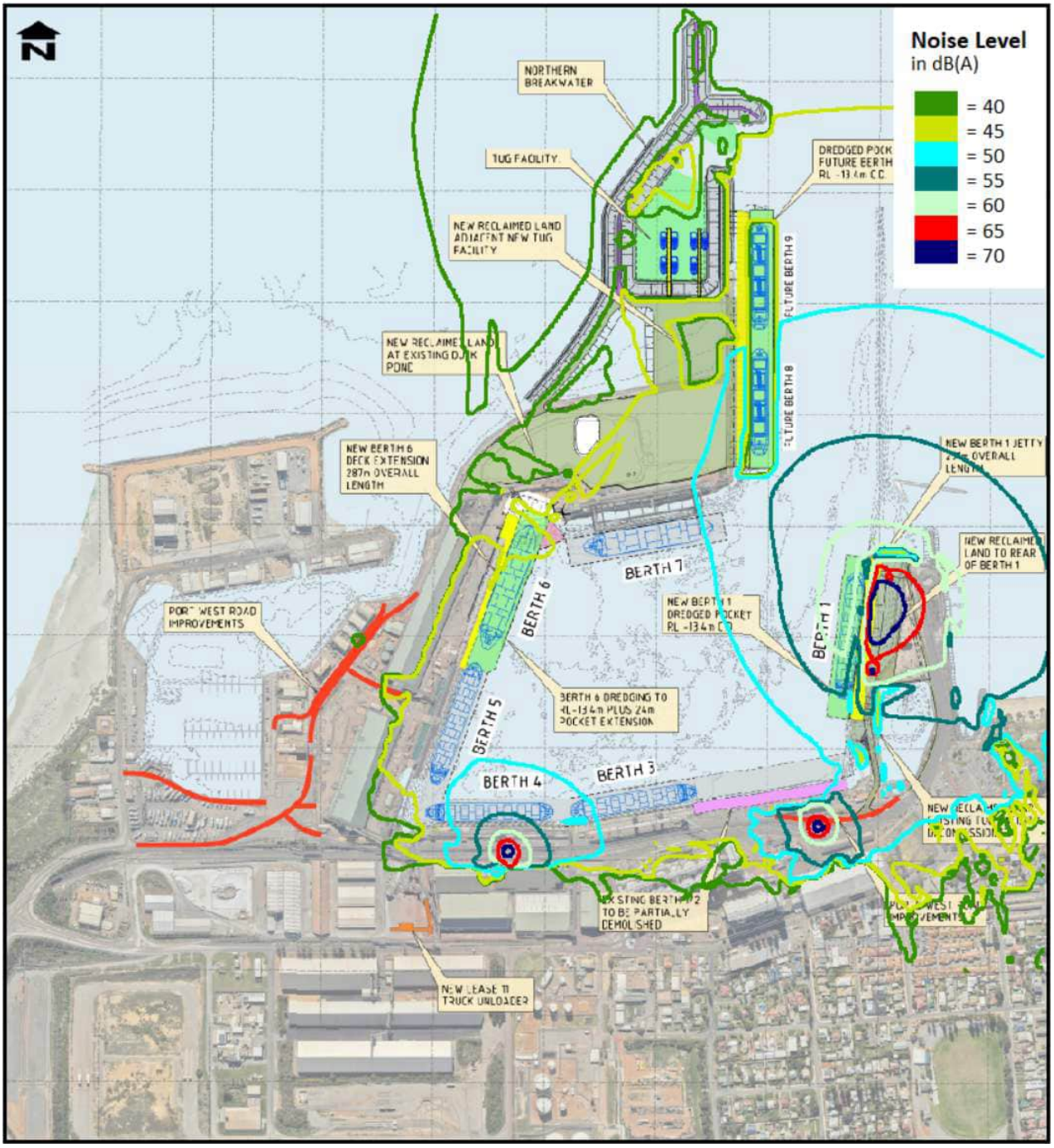

Figure 88: Night-time noise contours for scenario 9 under south-westerly wind.

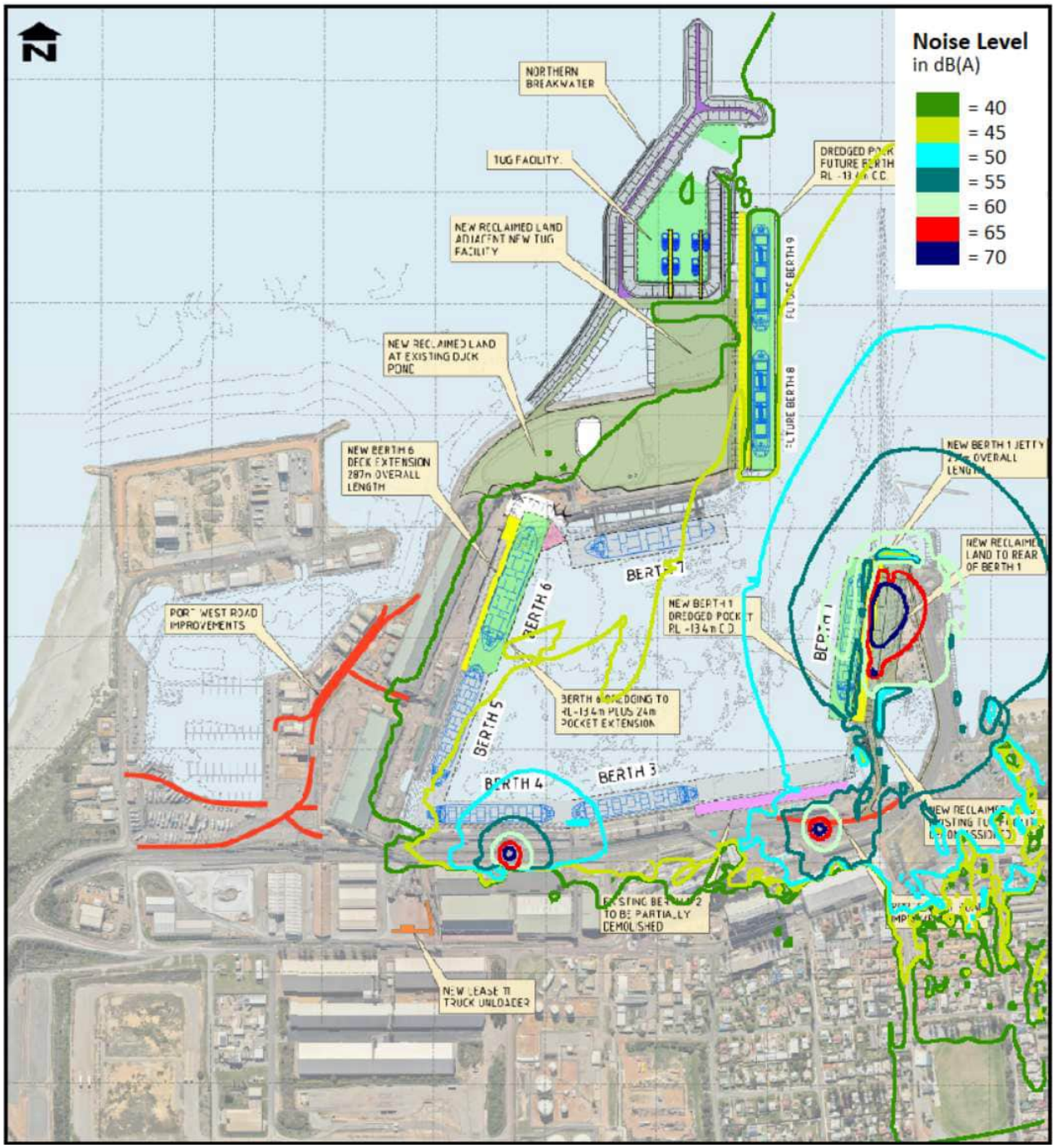

Figure 89: Night-time noise contours for scenario 9 under westerly wind.

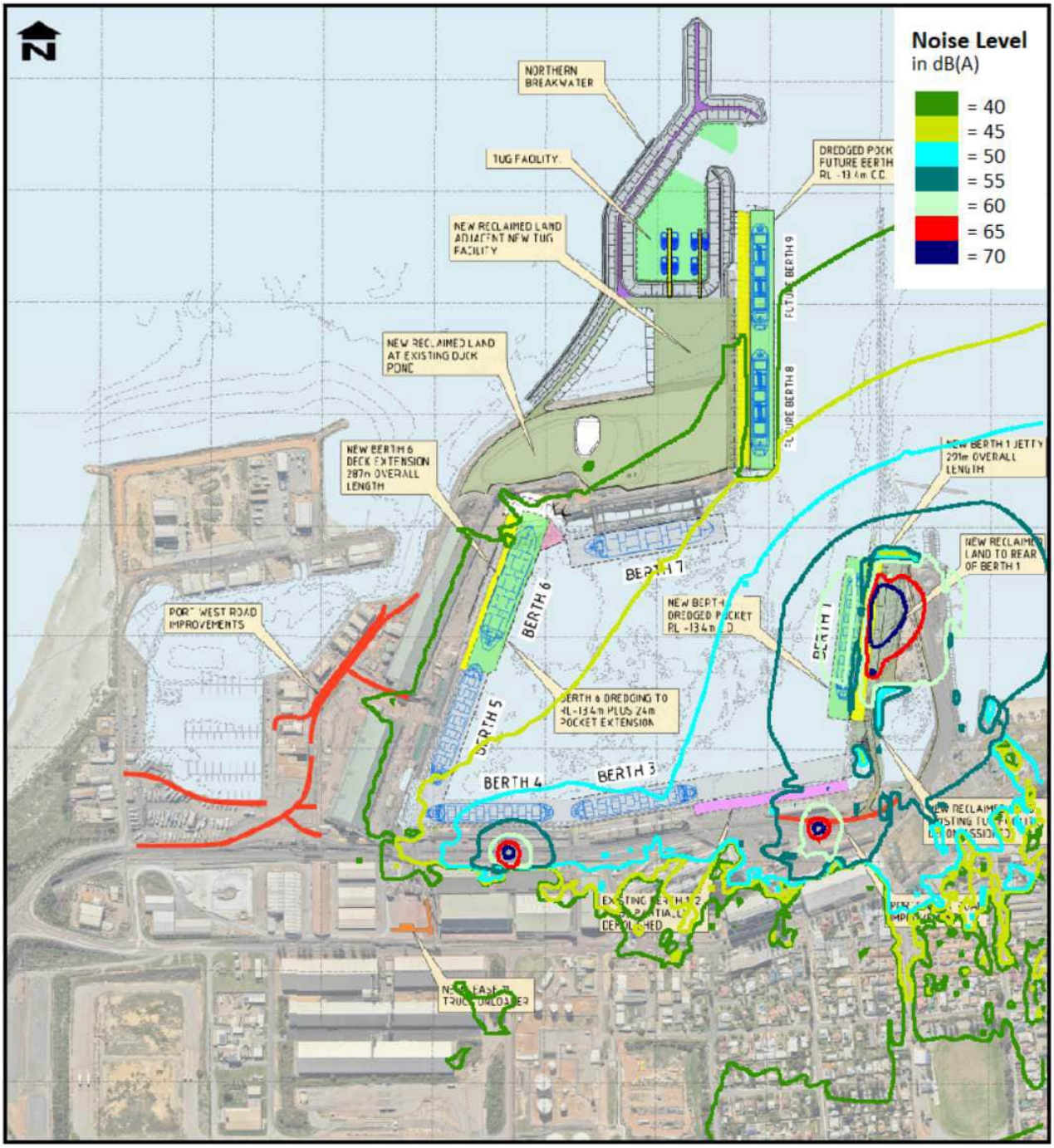

Figure 90: Night-time noise contours for scenario 9 under north-westerly wind.

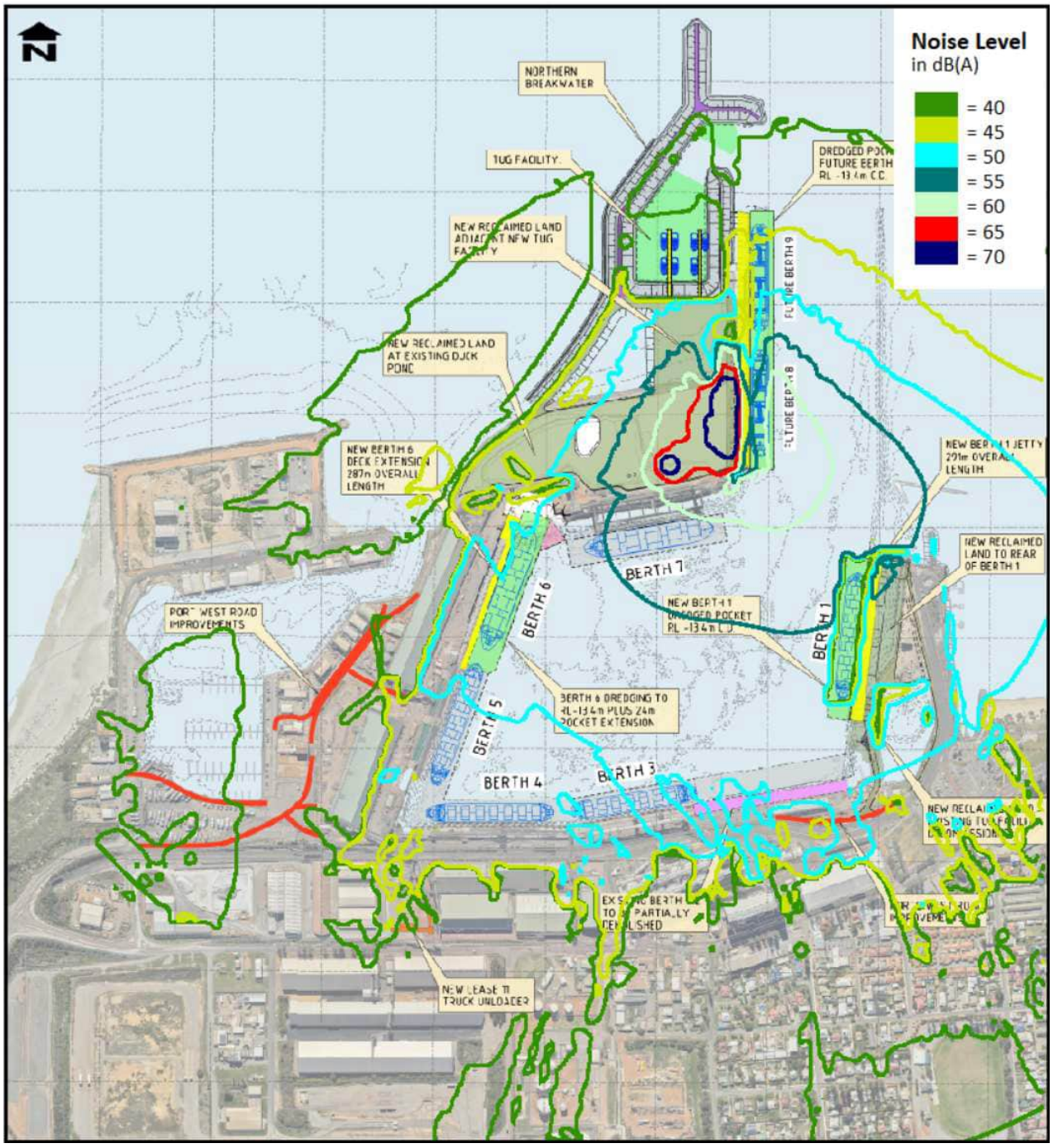

Figure 91: Daytime noise contours for scenario 10 under northerly wind.

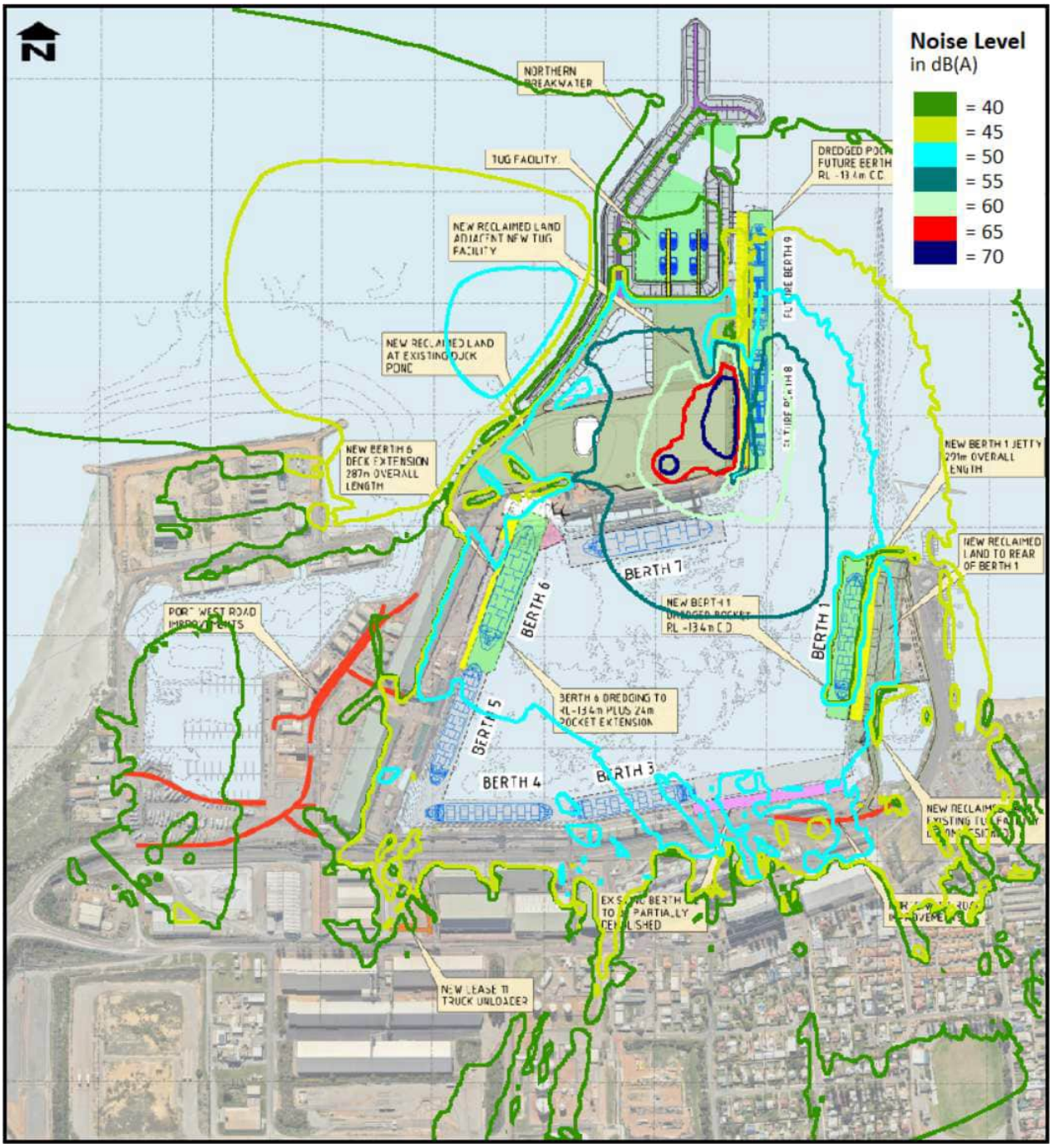

Figure 92: Daytime noise contours for scenario 10 under north-easterly wind.

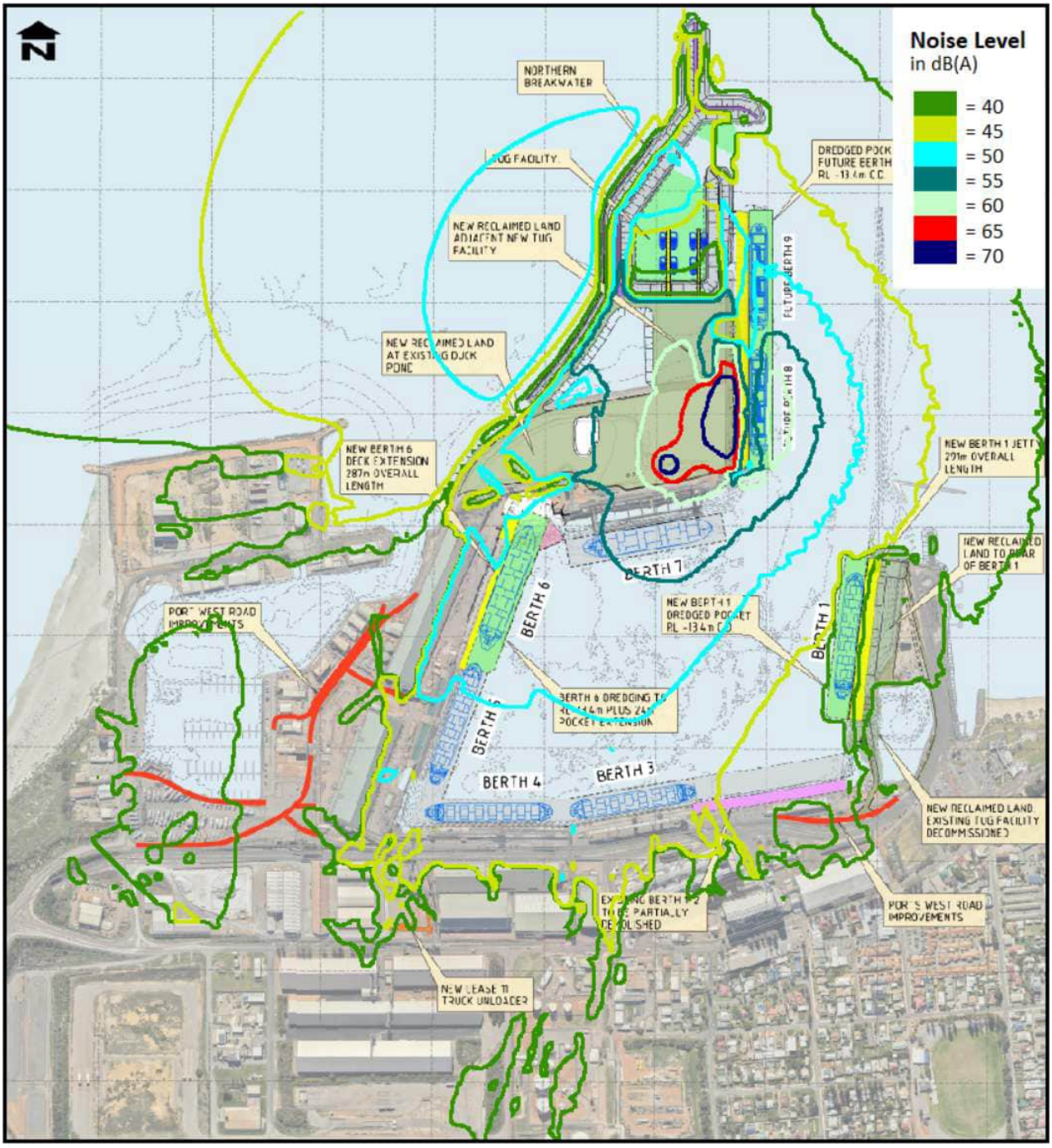

Figure 93: Daytime noise contours for scenario 10 under easterly wind.

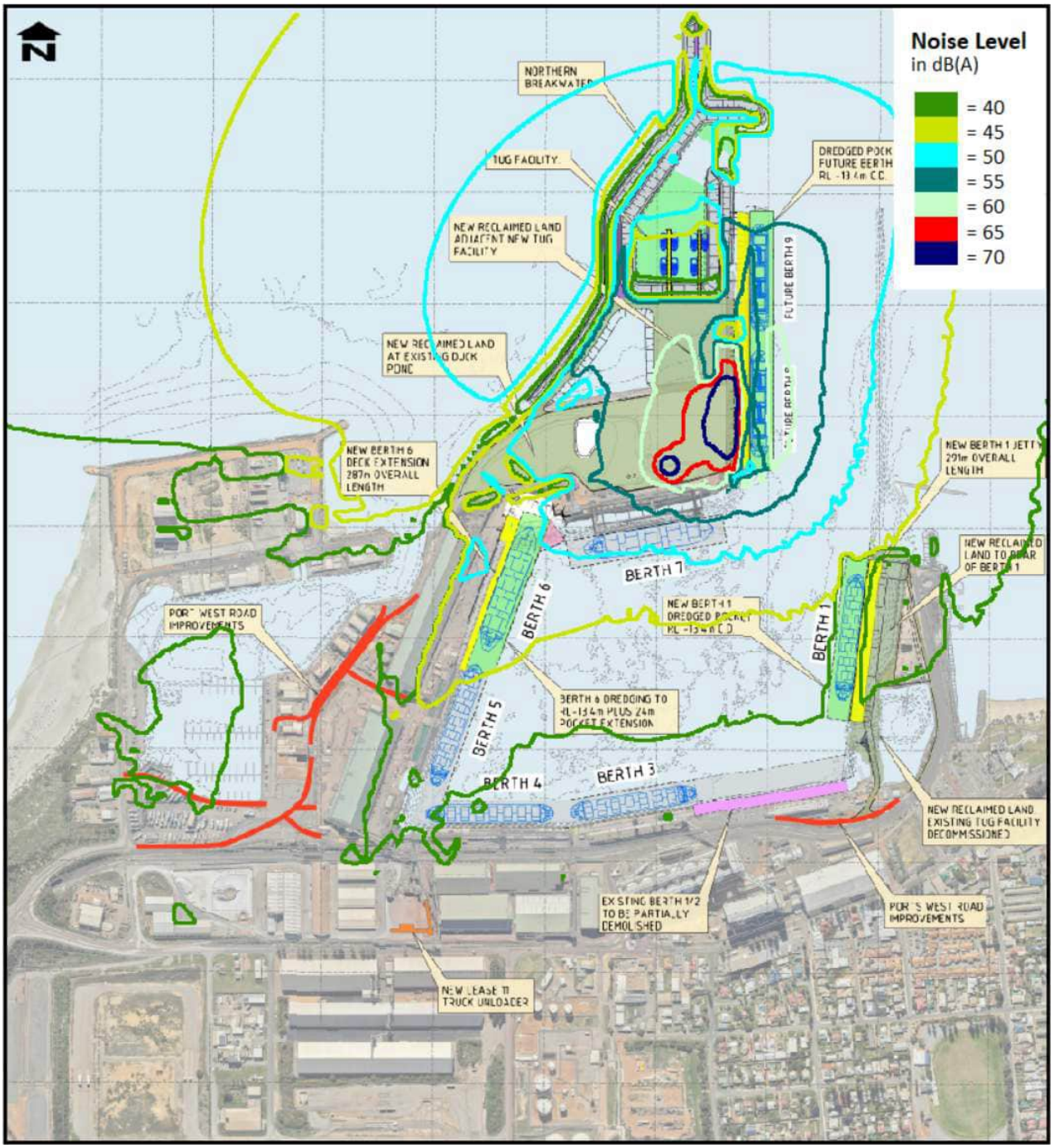

Figure 94: Daytime noise contours for scenario 10 under south-easterly wind.

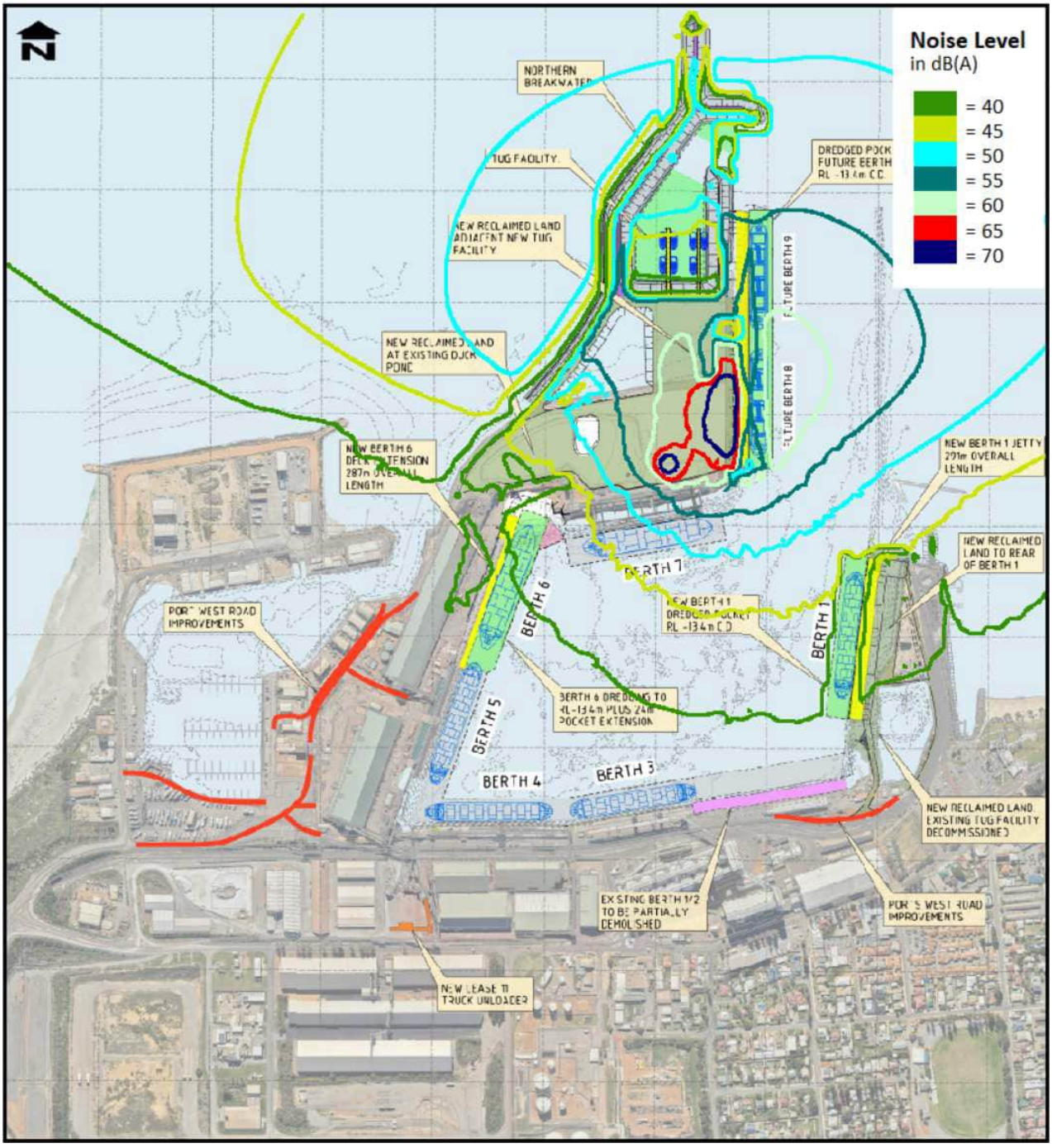

Figure 95: Daytime noise contours for scenario 10 under southerly wind.

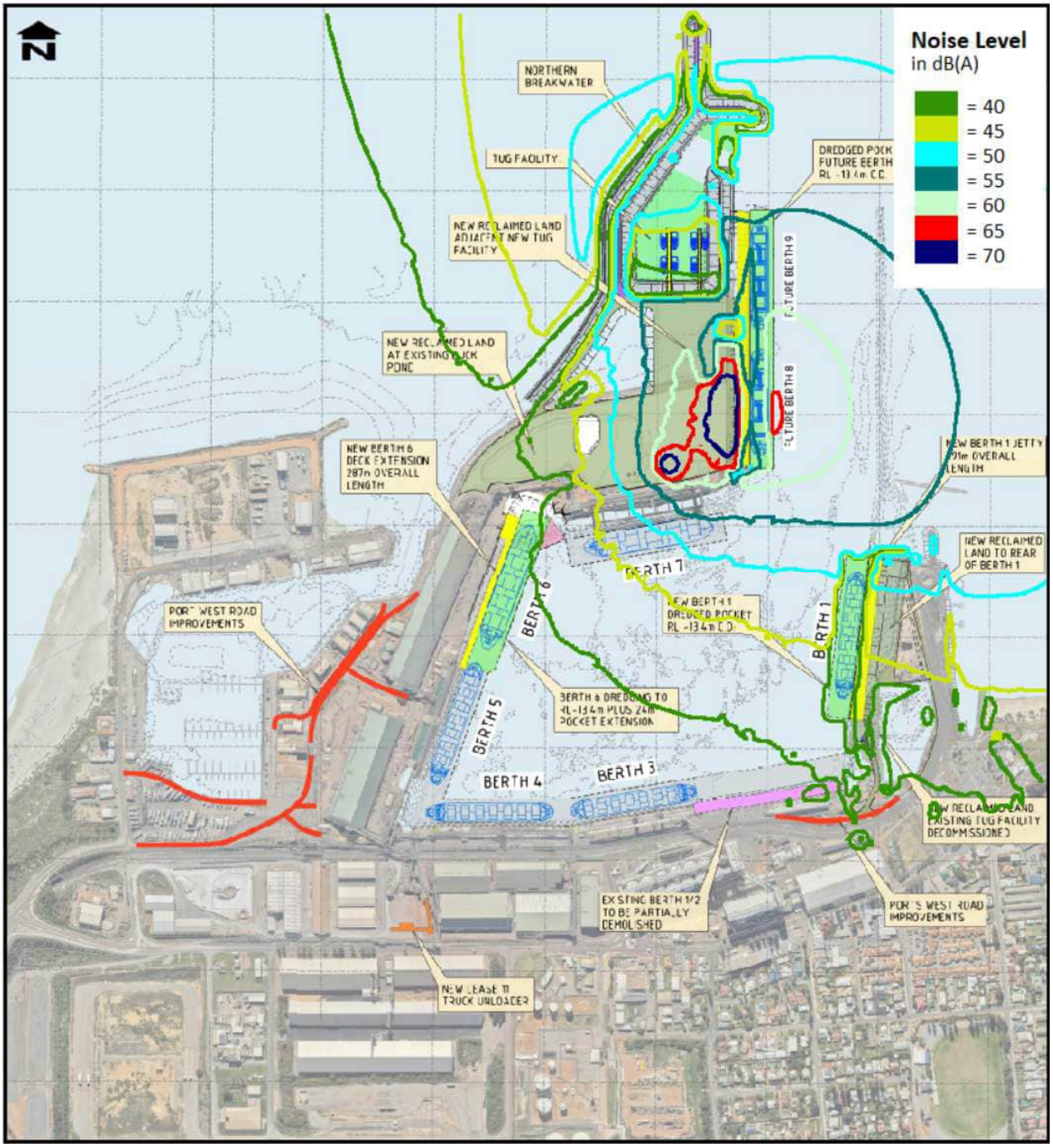

Figure 96: Daytime noise contours for scenario 10 under south-westerly wind.

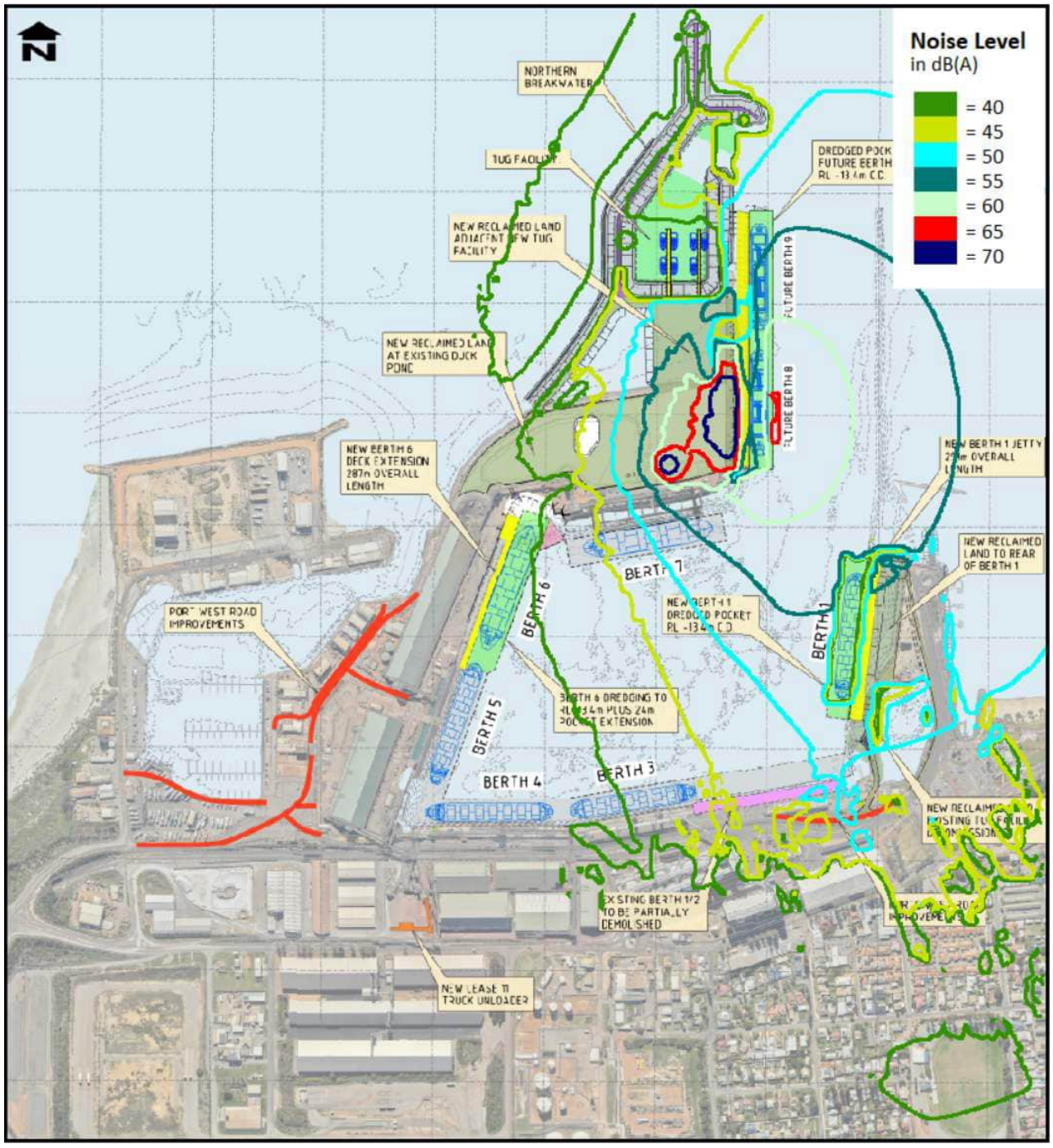

Figure 97: Daytime noise contours for scenario 10 under westerly wind.

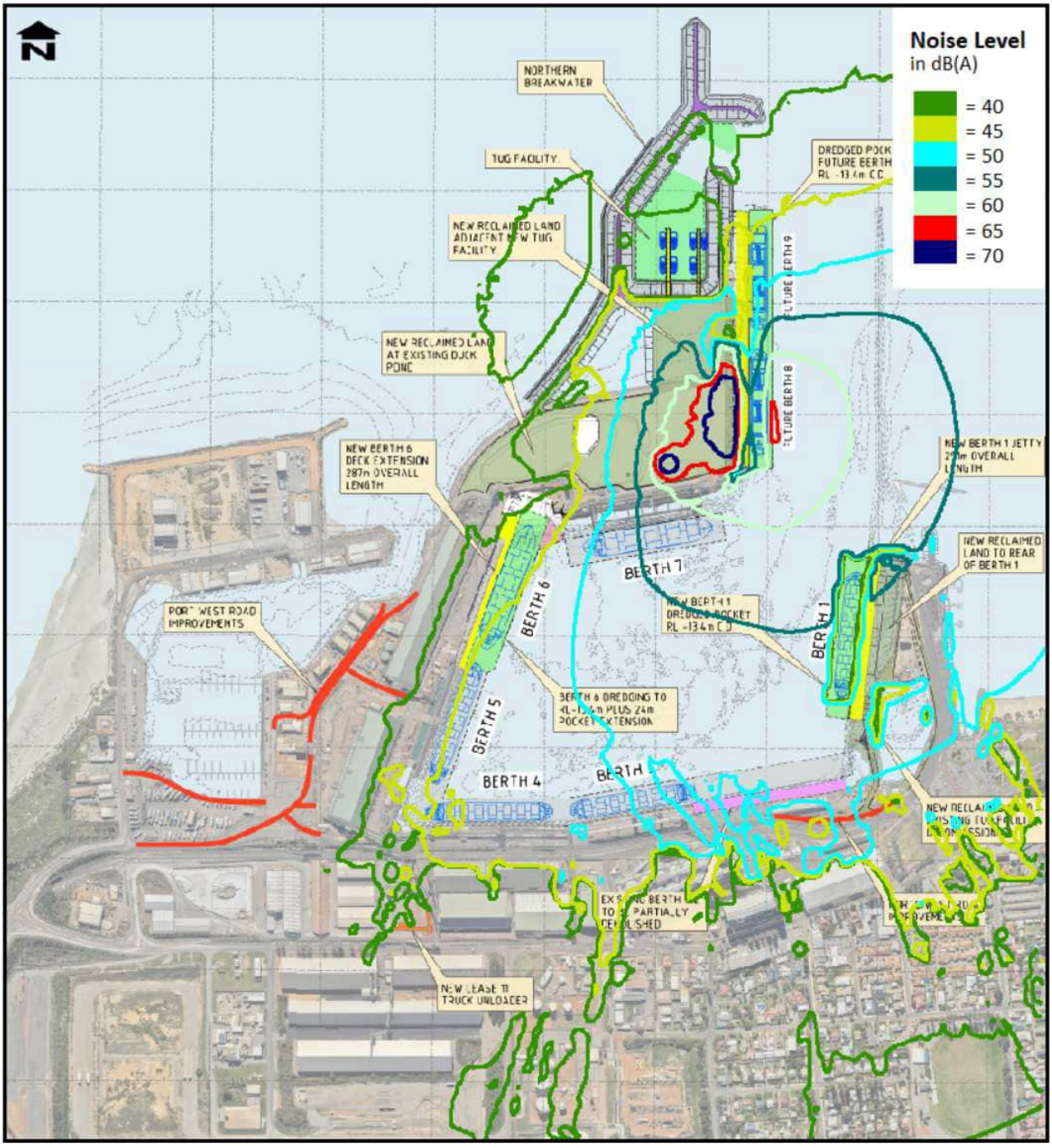

Figure 98: Daytime noise contours for scenario 10 under north-westerly wind.

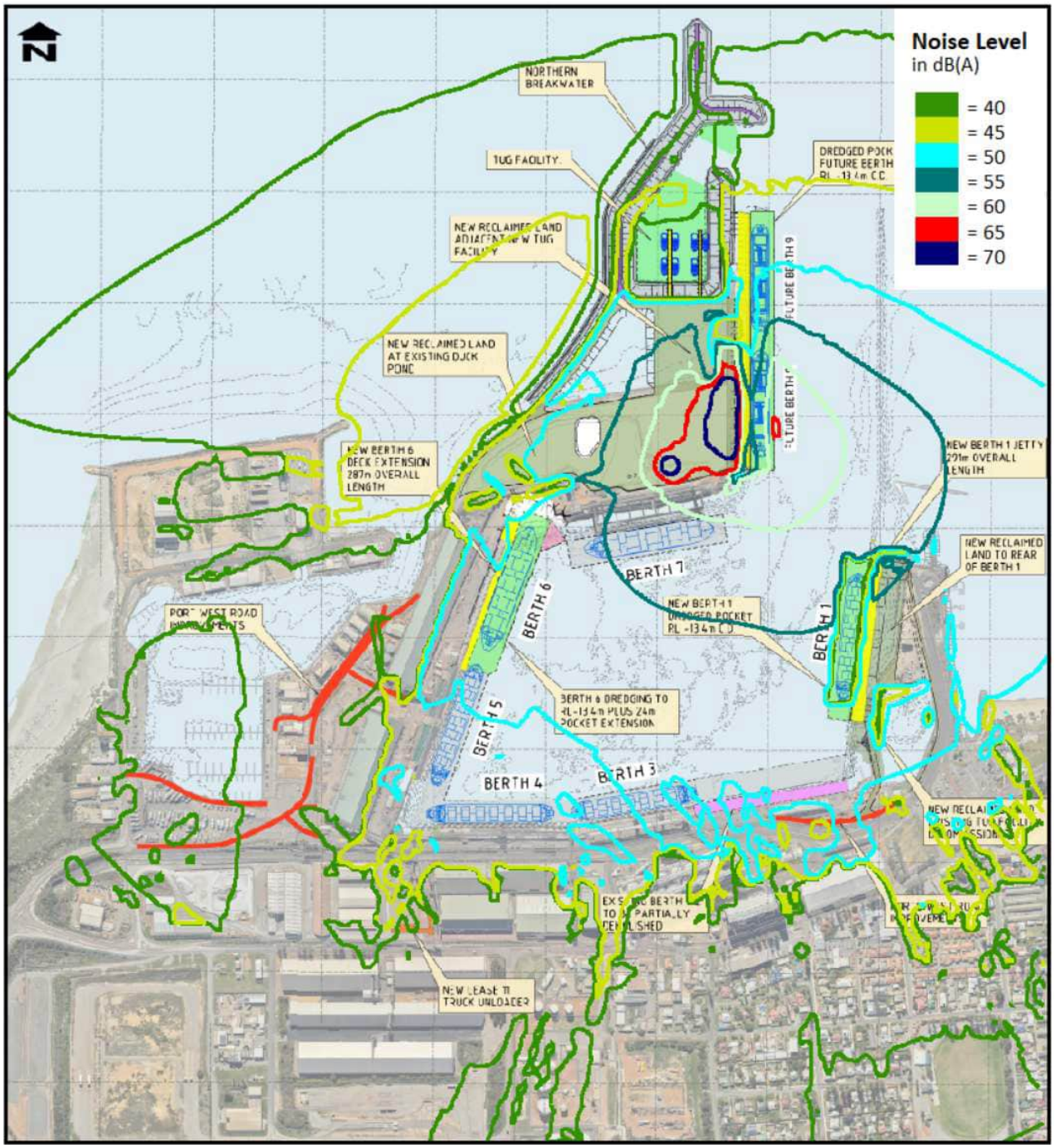

Figure 99: Night-time noise contours for scenario 10 under northerly wind.

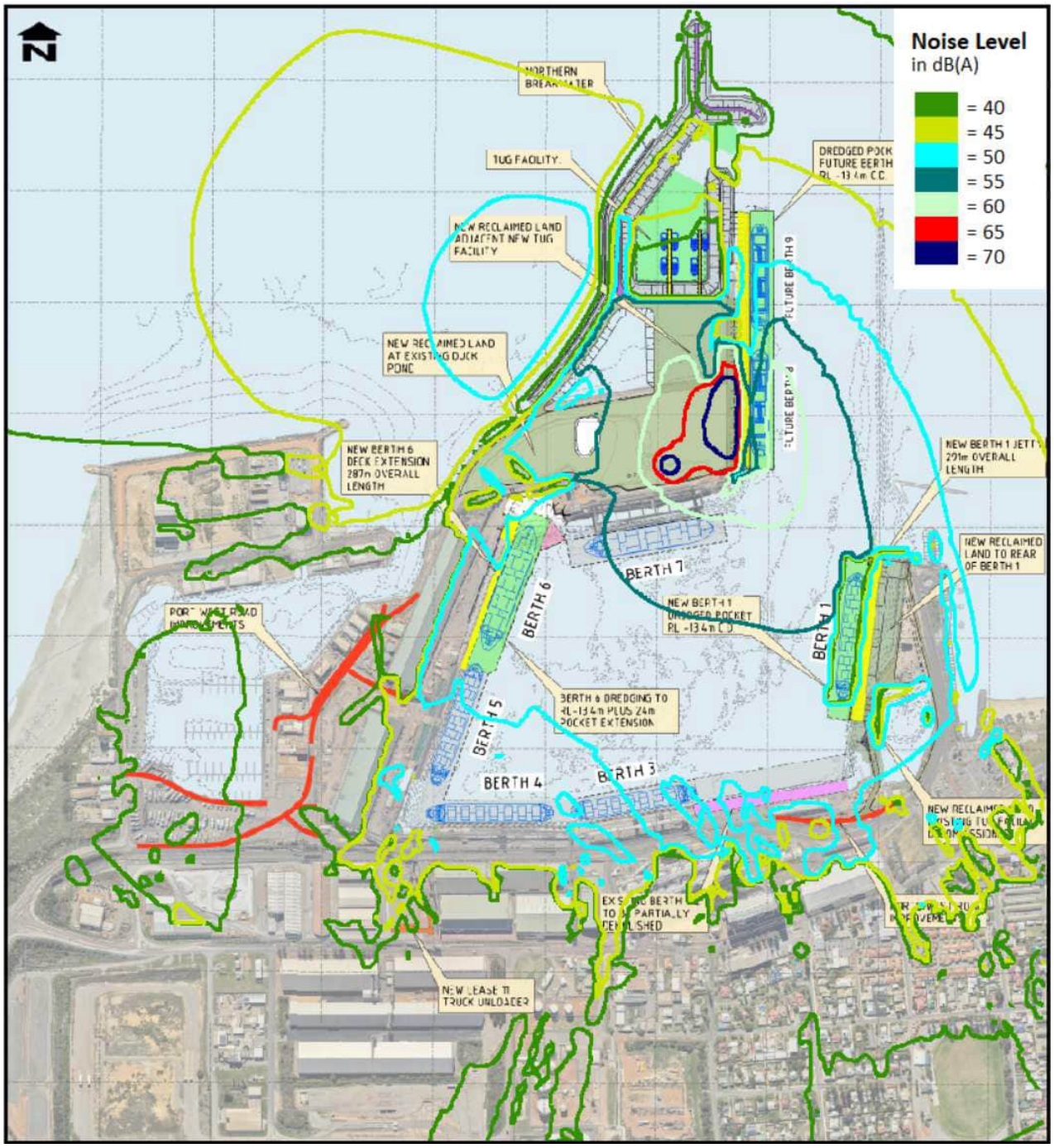

Figure 100: Night-time noise contours for scenario 10 under north-easterly wind.

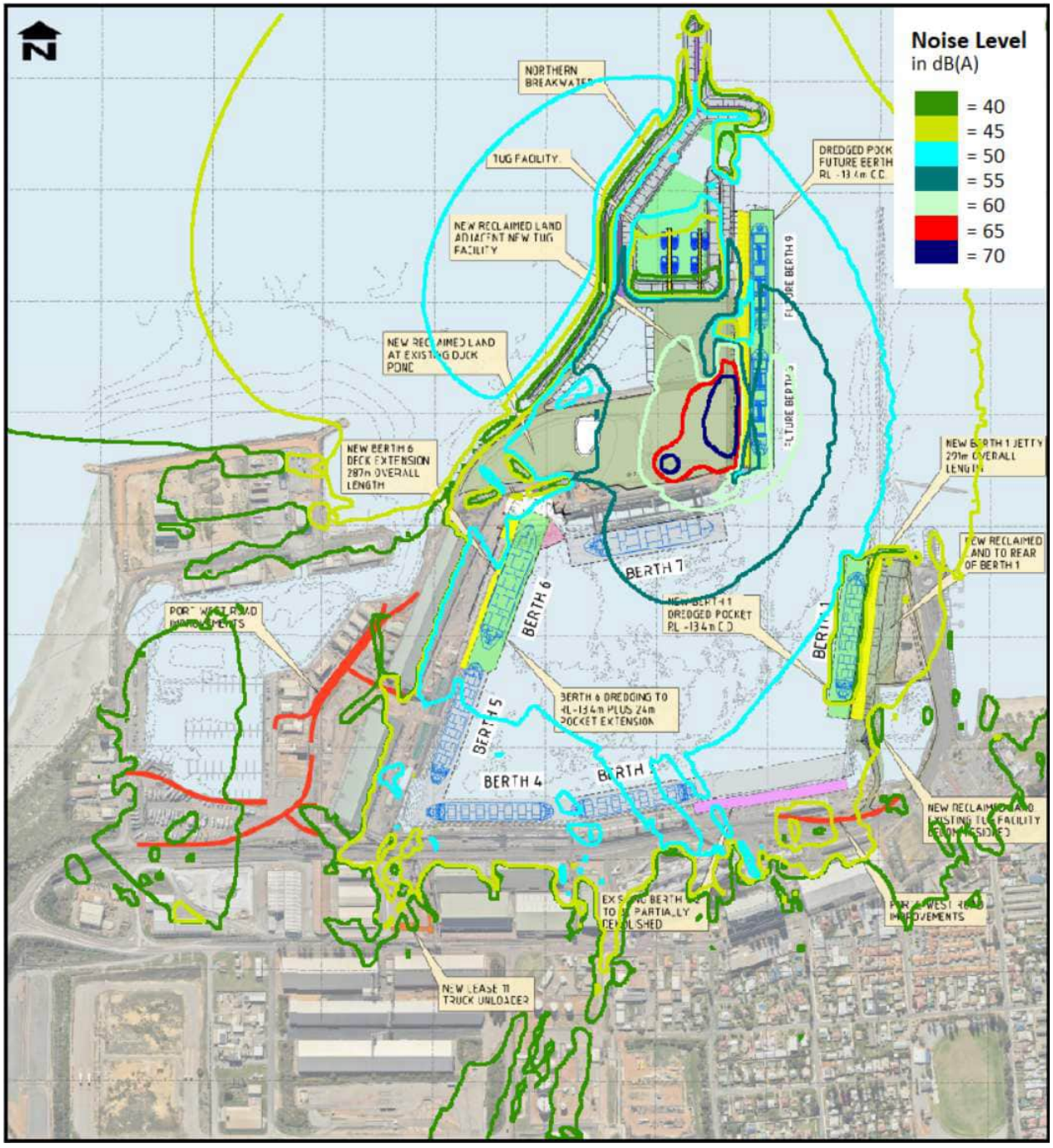

Figure 101: Night-time noise contours for scenario 10 under easterly wind.

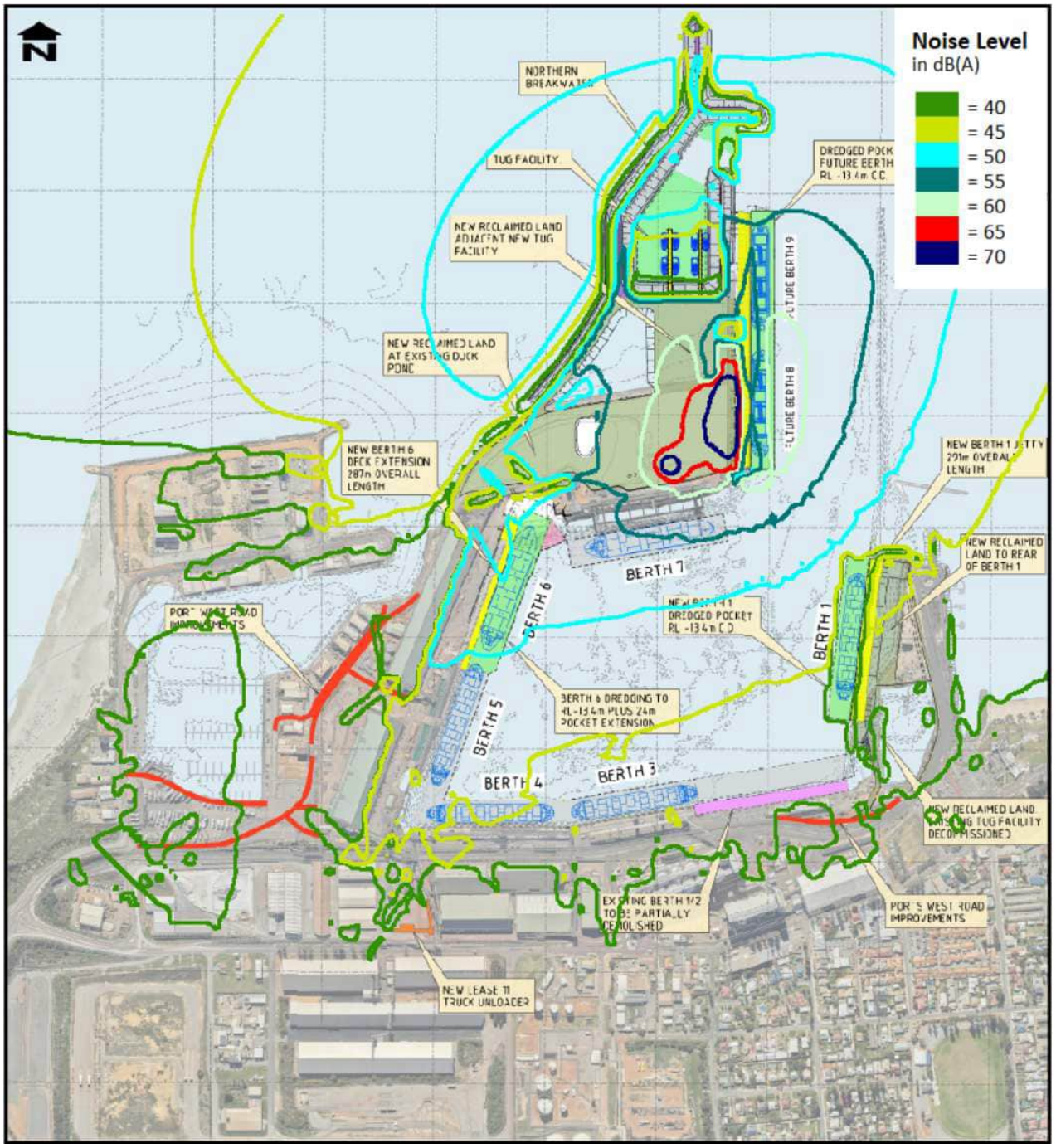

Figure 102: Night-time noise contours for scenario 10 under south-easterly wind.

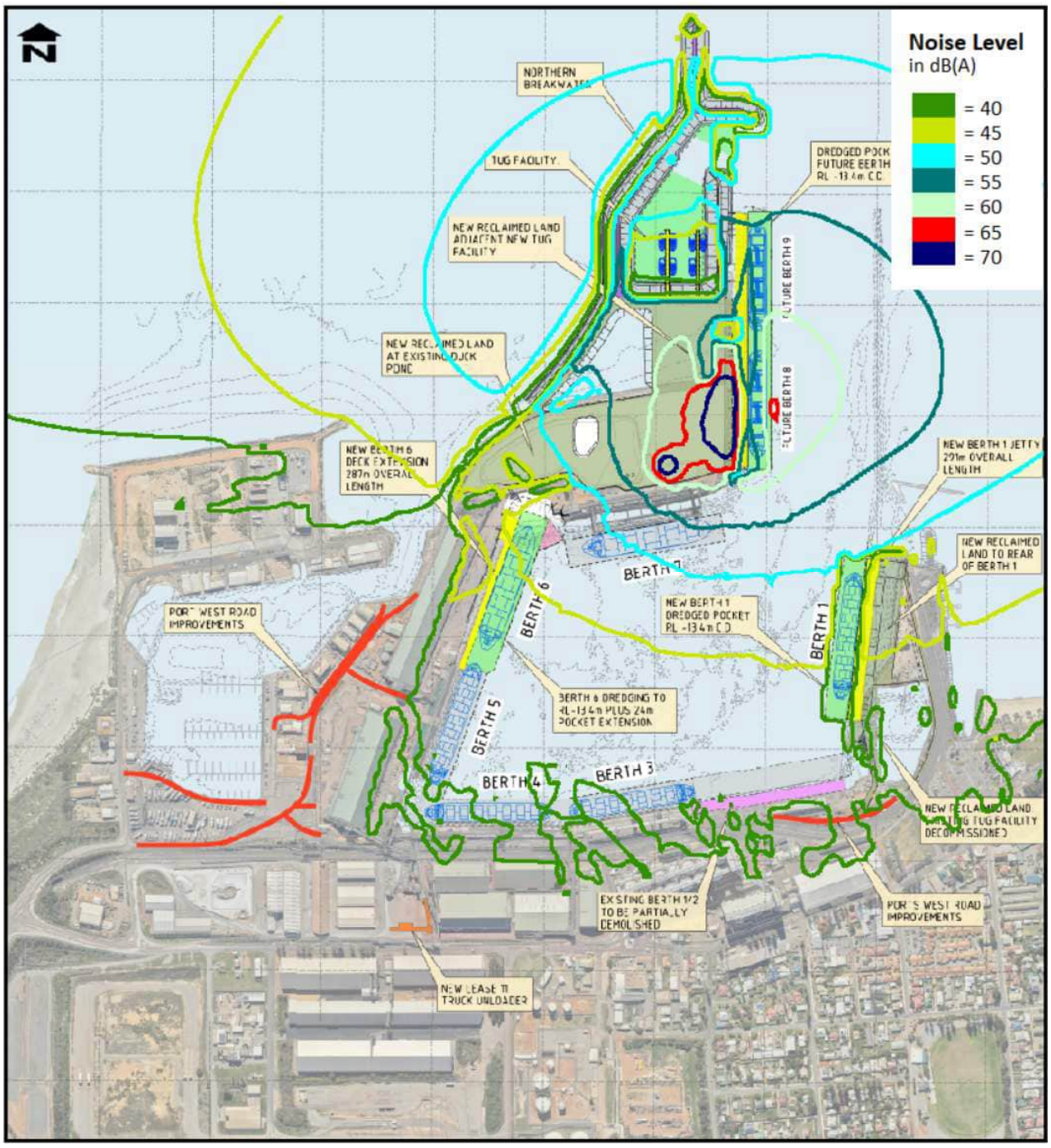

Figure 103: Night-time noise contours for scenario 10 under southerly wind.

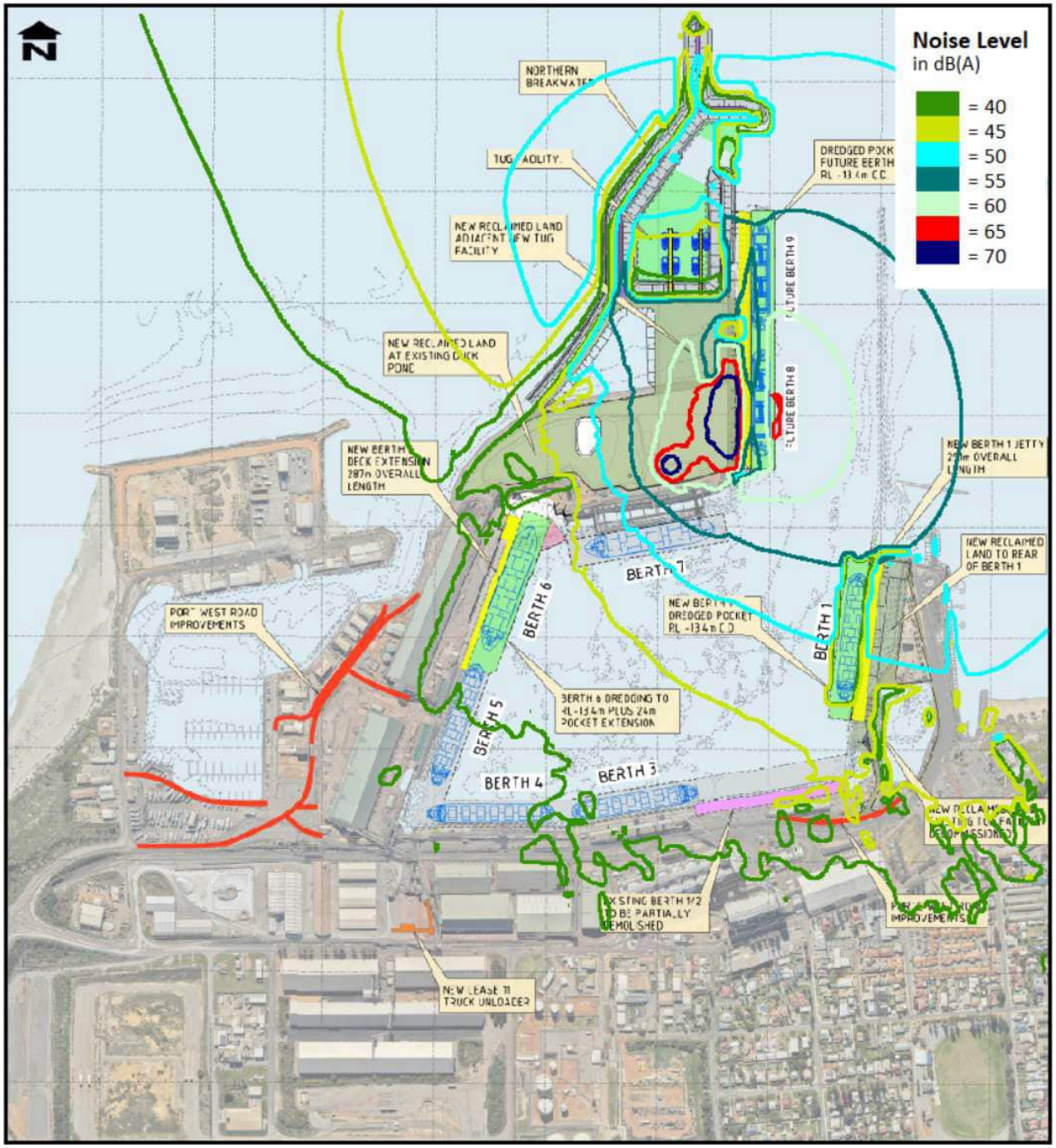

Figure 104: Night-time noise contours for scenario 10 under south-westerly wind.

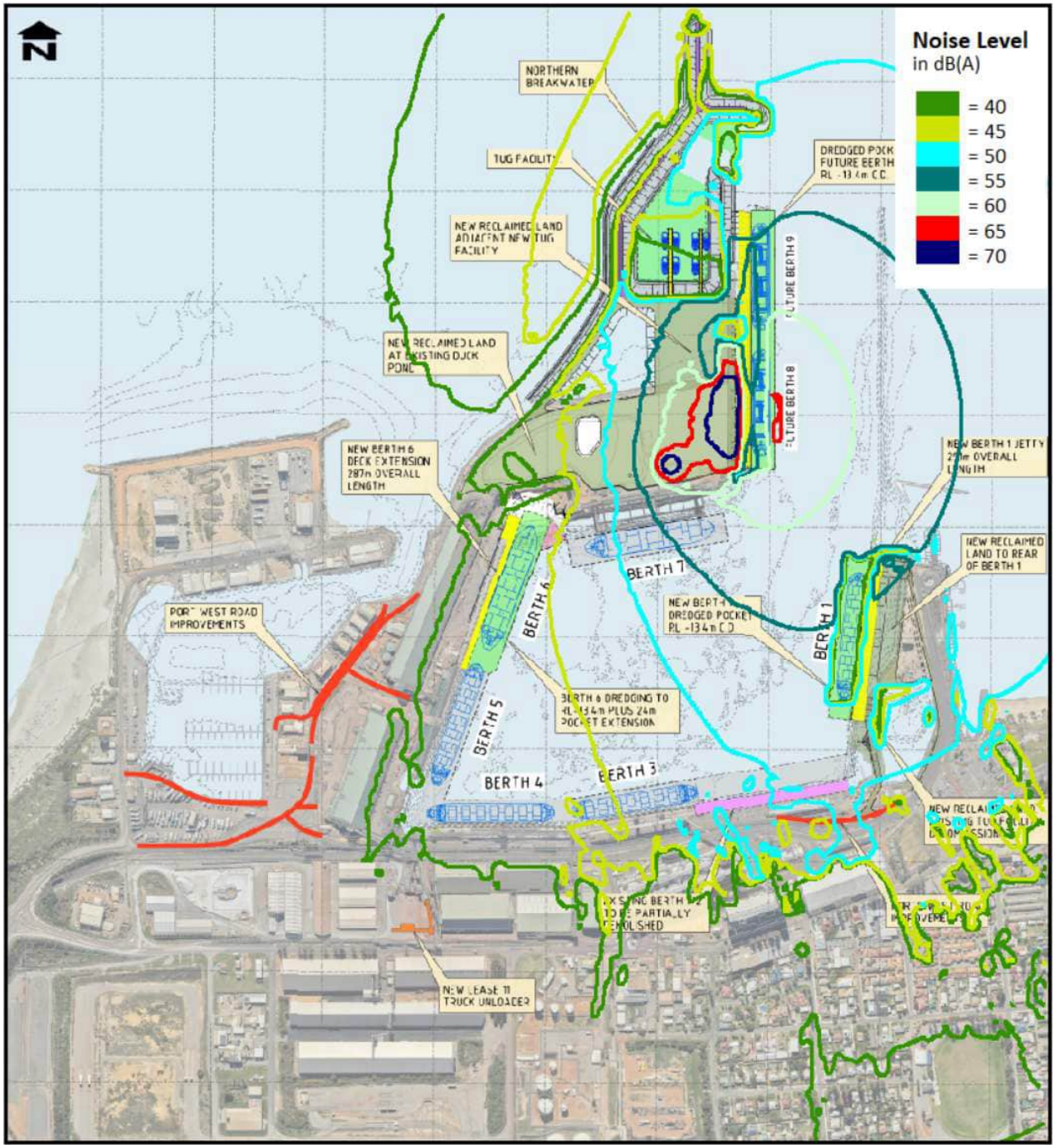

Figure 105: Night-time noise contours for scenario 10 under westerly wind.

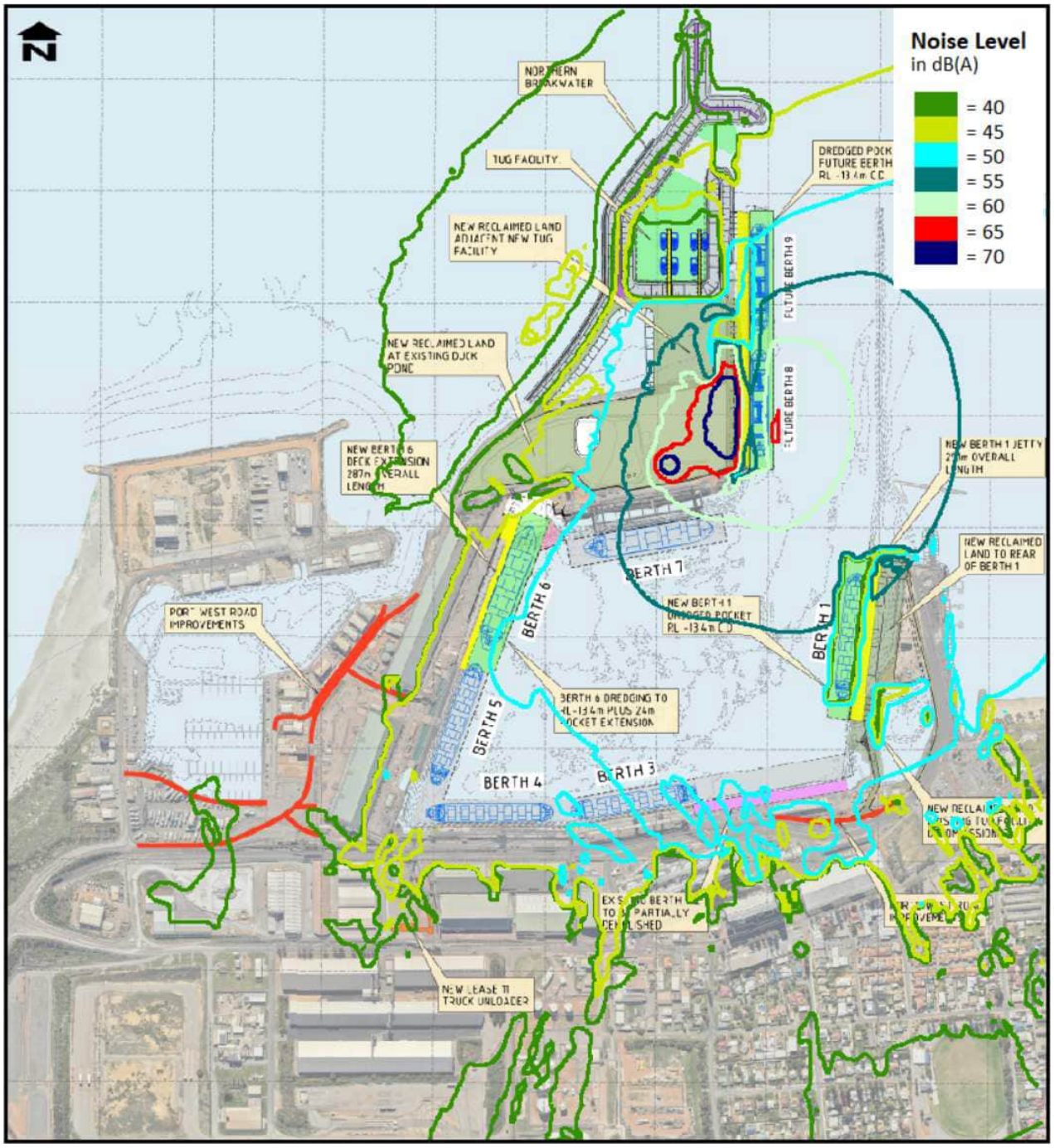

Figure 106: Night-time noise contours for scenario 10 under north-westerly wind.

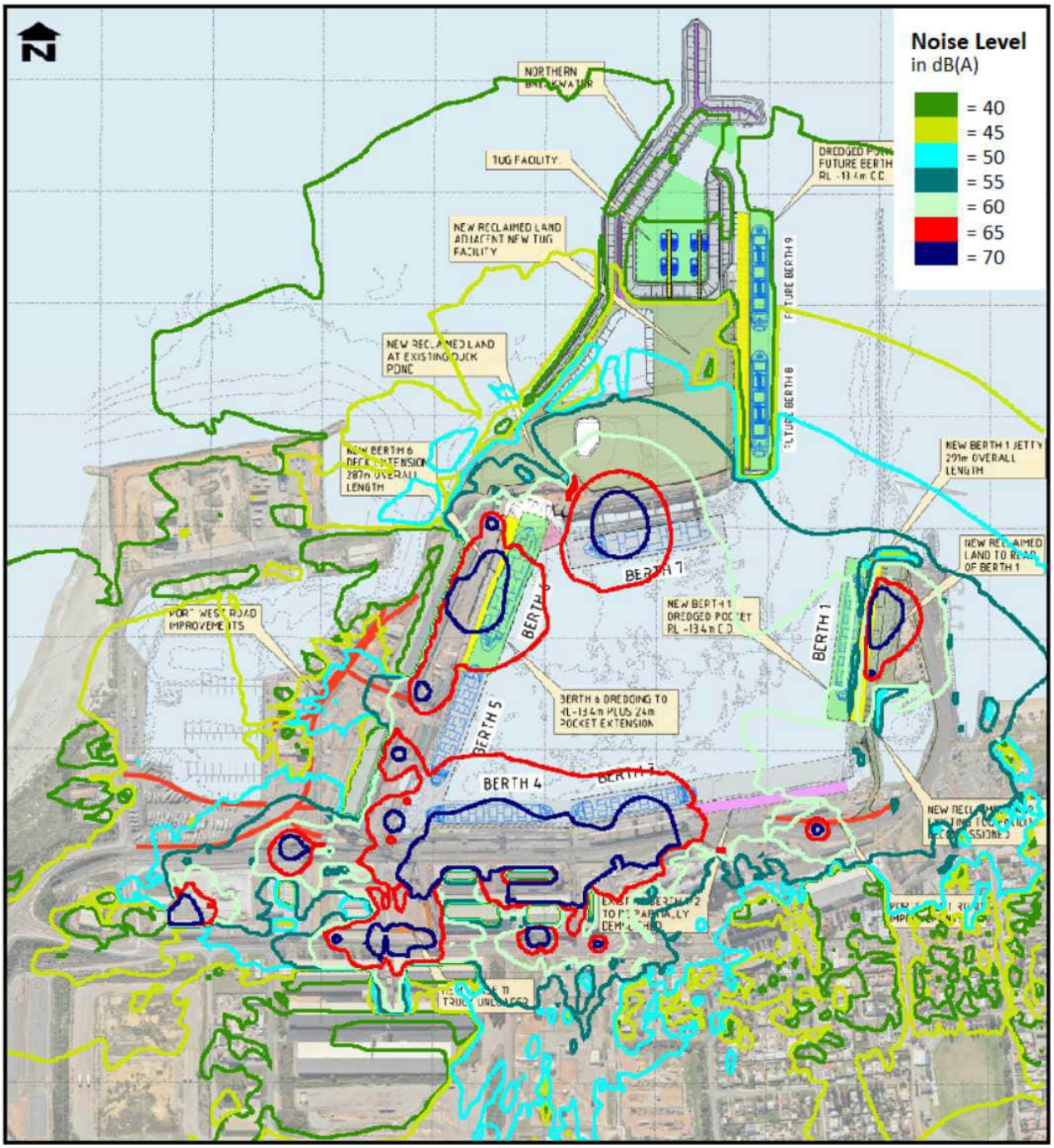

Figure 107: Daytime noise contours for scenario 11 under northerly wind.

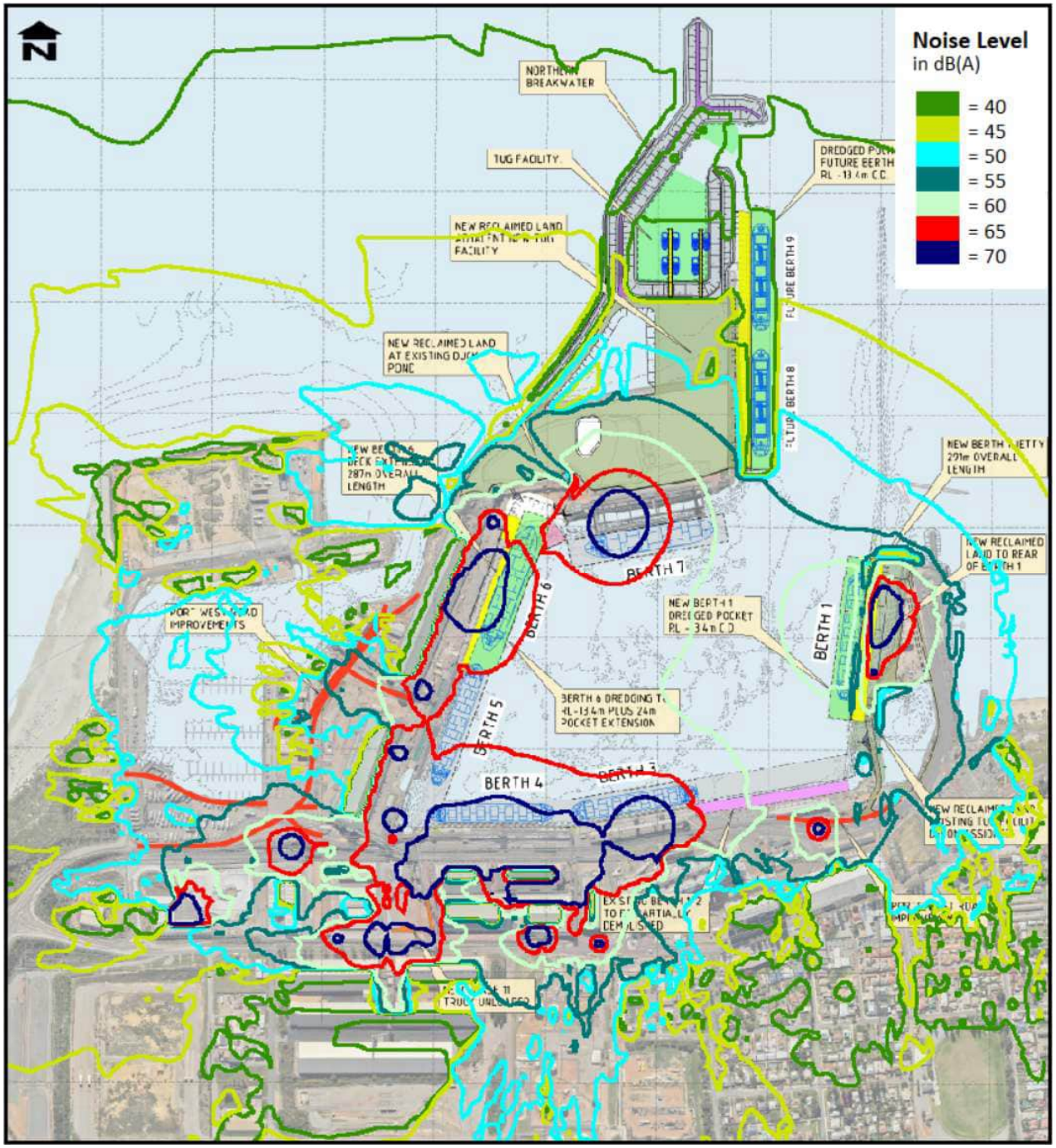

Figure 108: Daytime noise contours for scenario 11 under north-easterly wind.

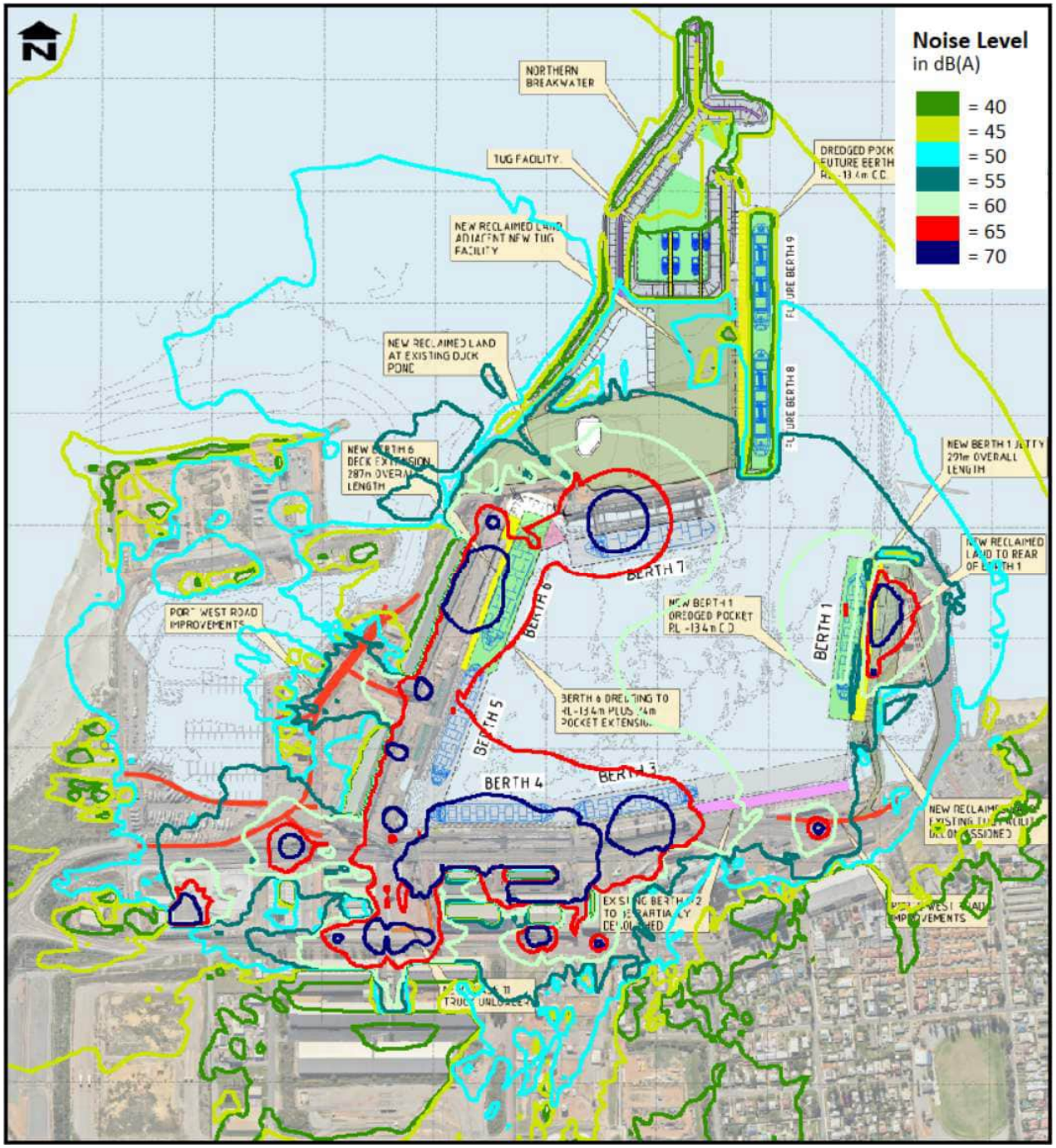

Figure 109: Daytime noise contours for scenario 11 under easterly wind.

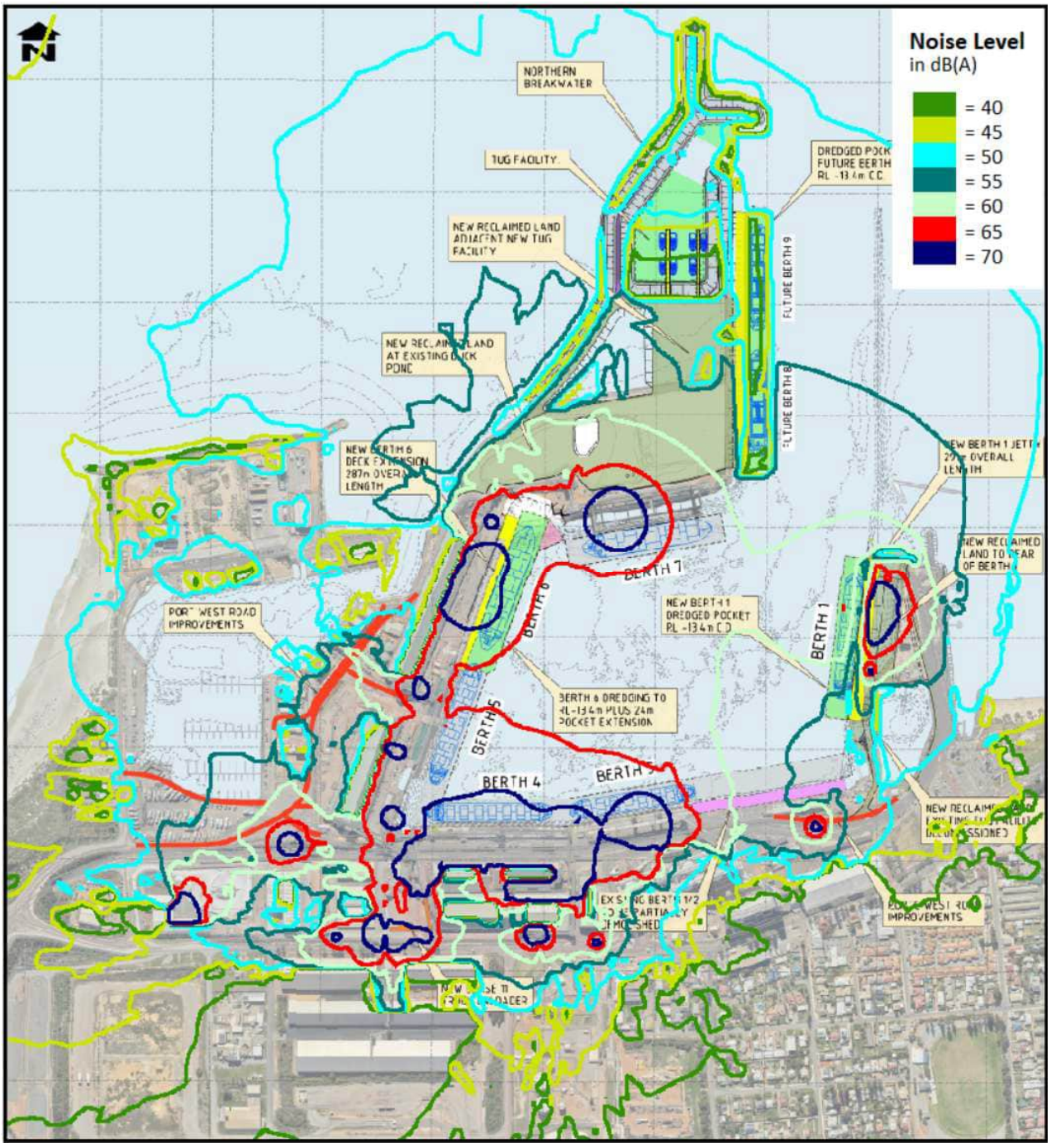

Figure 110: Daytime noise contours for scenario 11 under south-easterly wind.

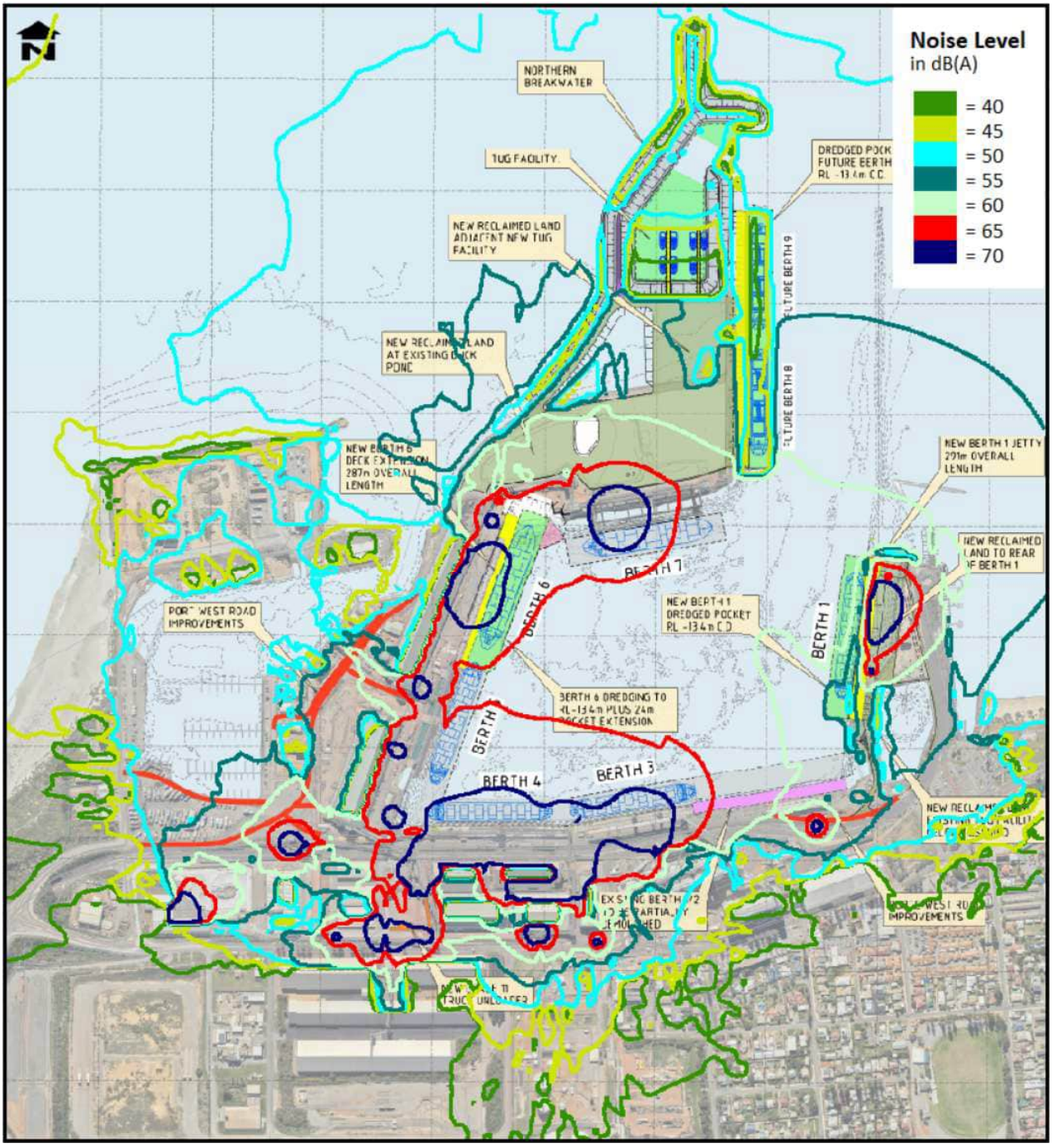

Figure 111: Daytime noise contours for scenario 11 under southerly wind.

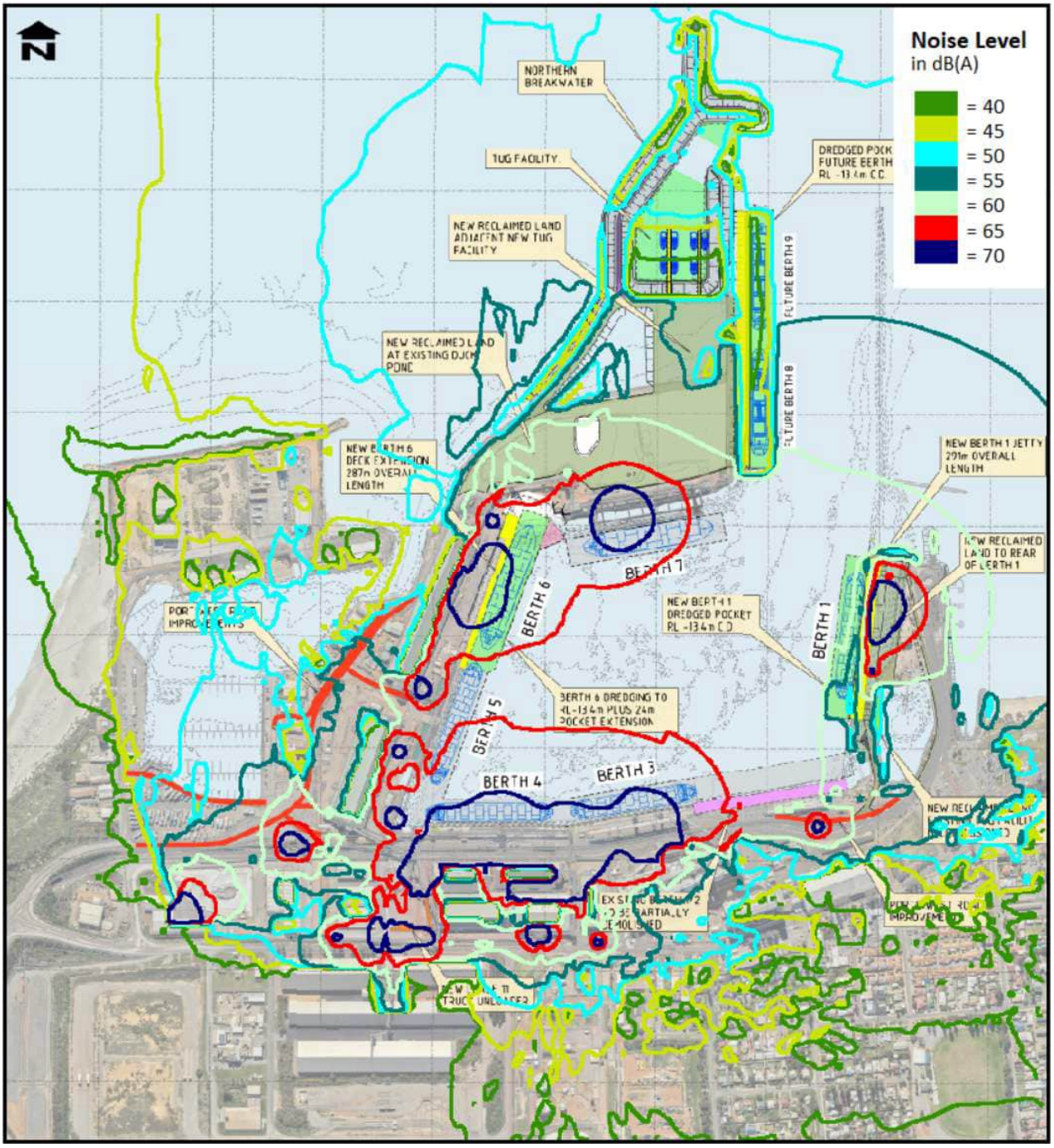

Figure 112: Daytime noise contours for scenario 11 under south-westerly wind.

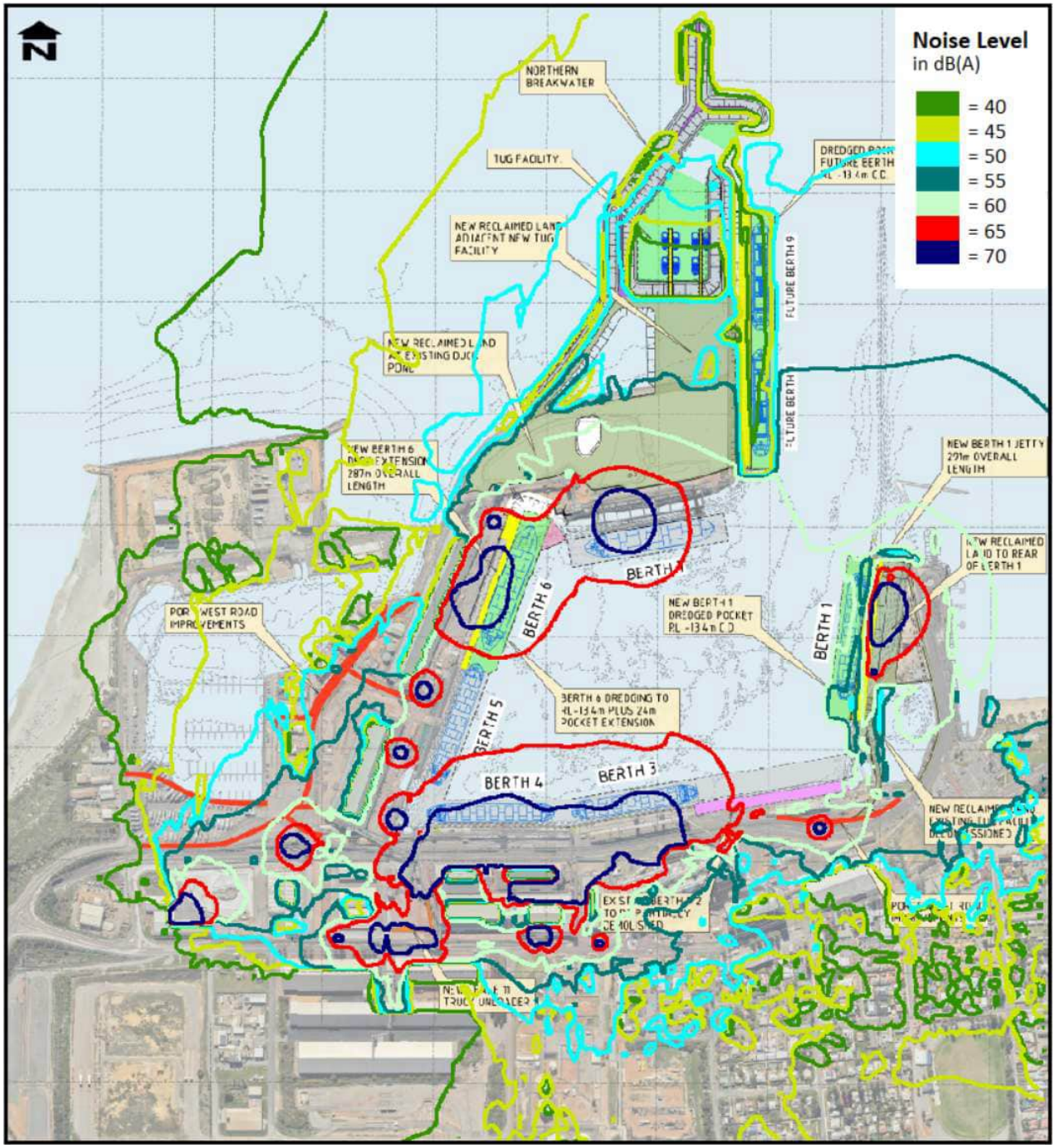

Figure 113: Daytime noise contours for scenario 11 under westerly wind.

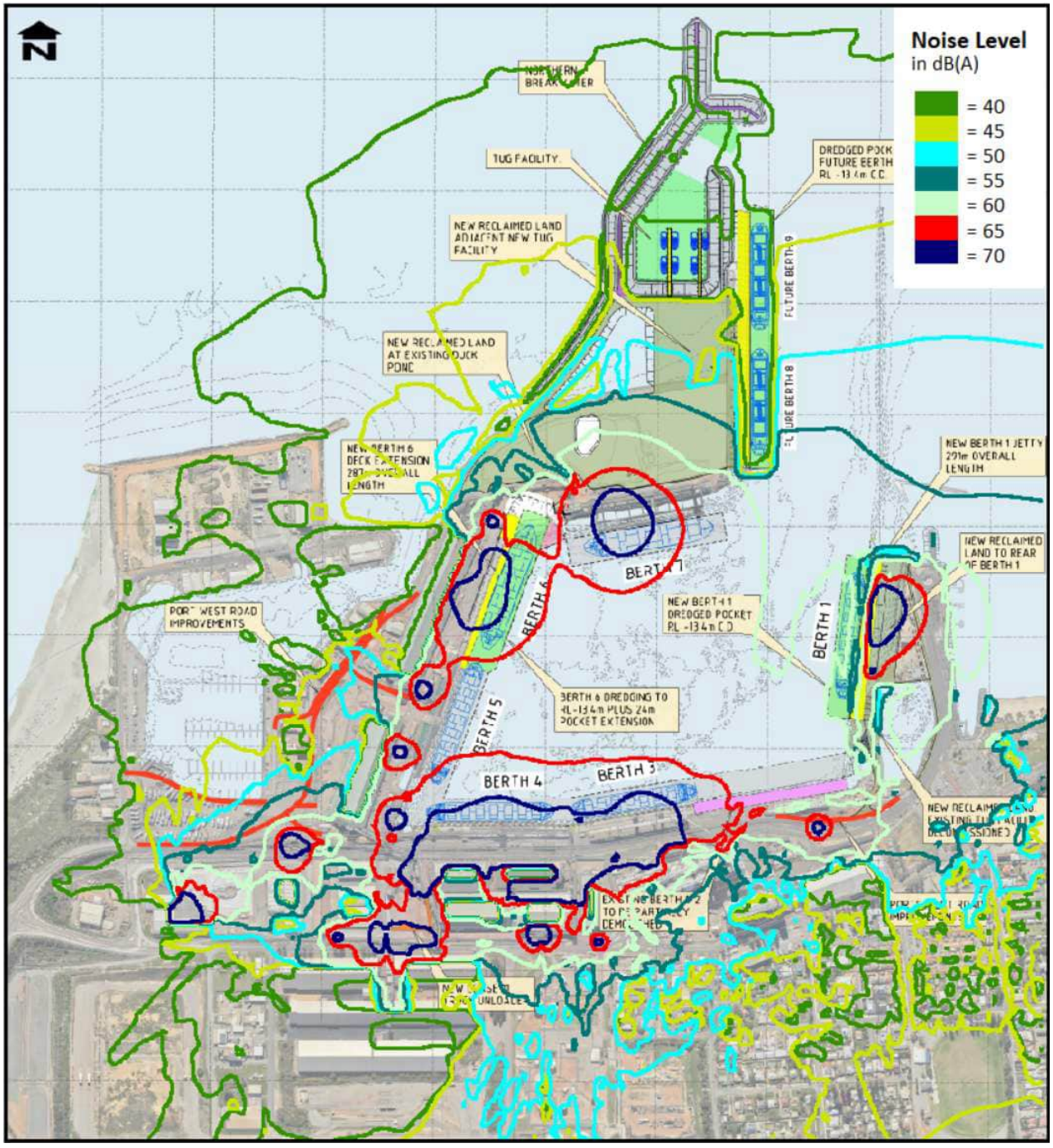

Figure 114: Daytime noise contours for scenario 11 under north-westerly wind.

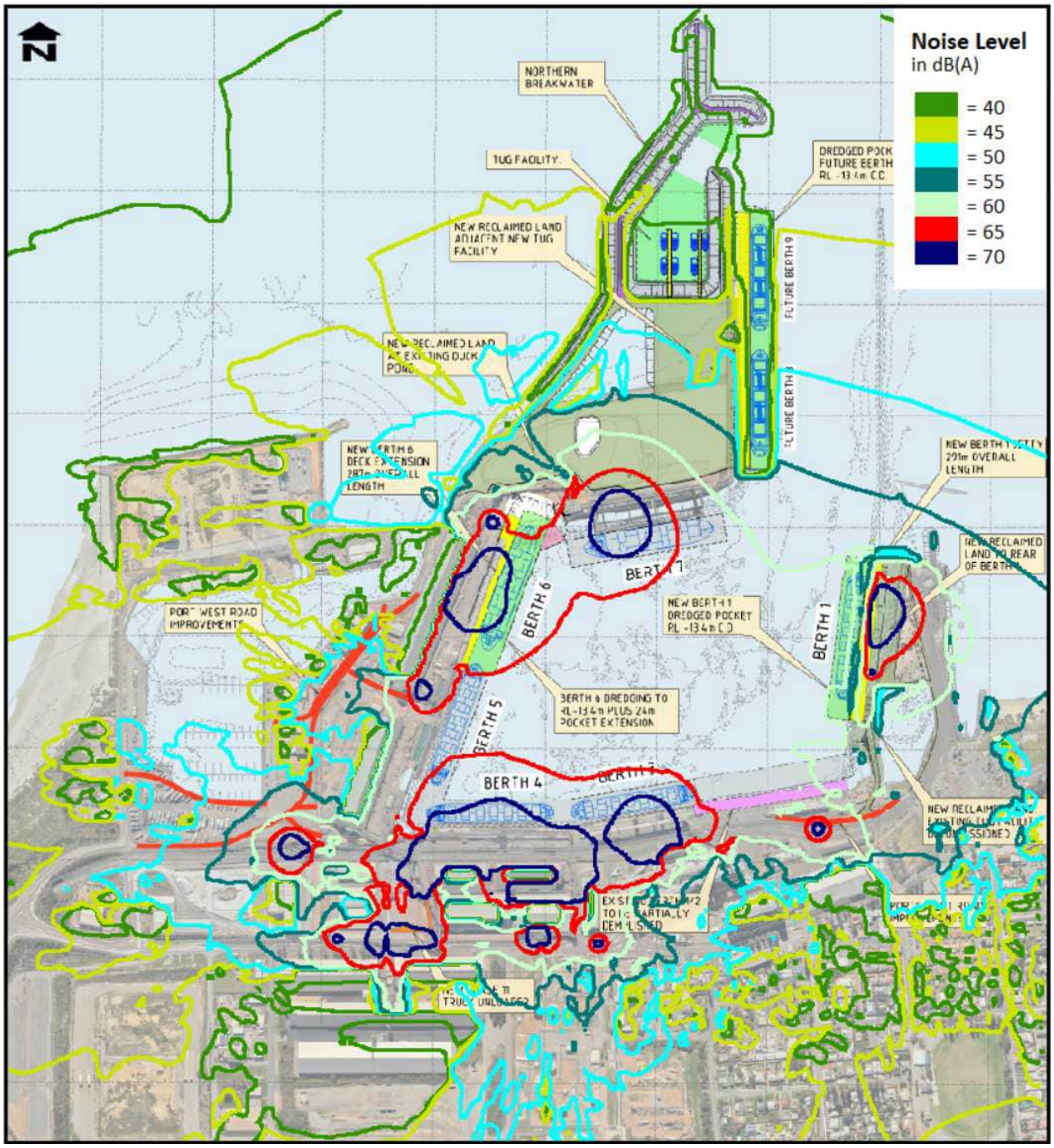

Figure 115: Night-time noise contours for scenario 11 under northerly wind.

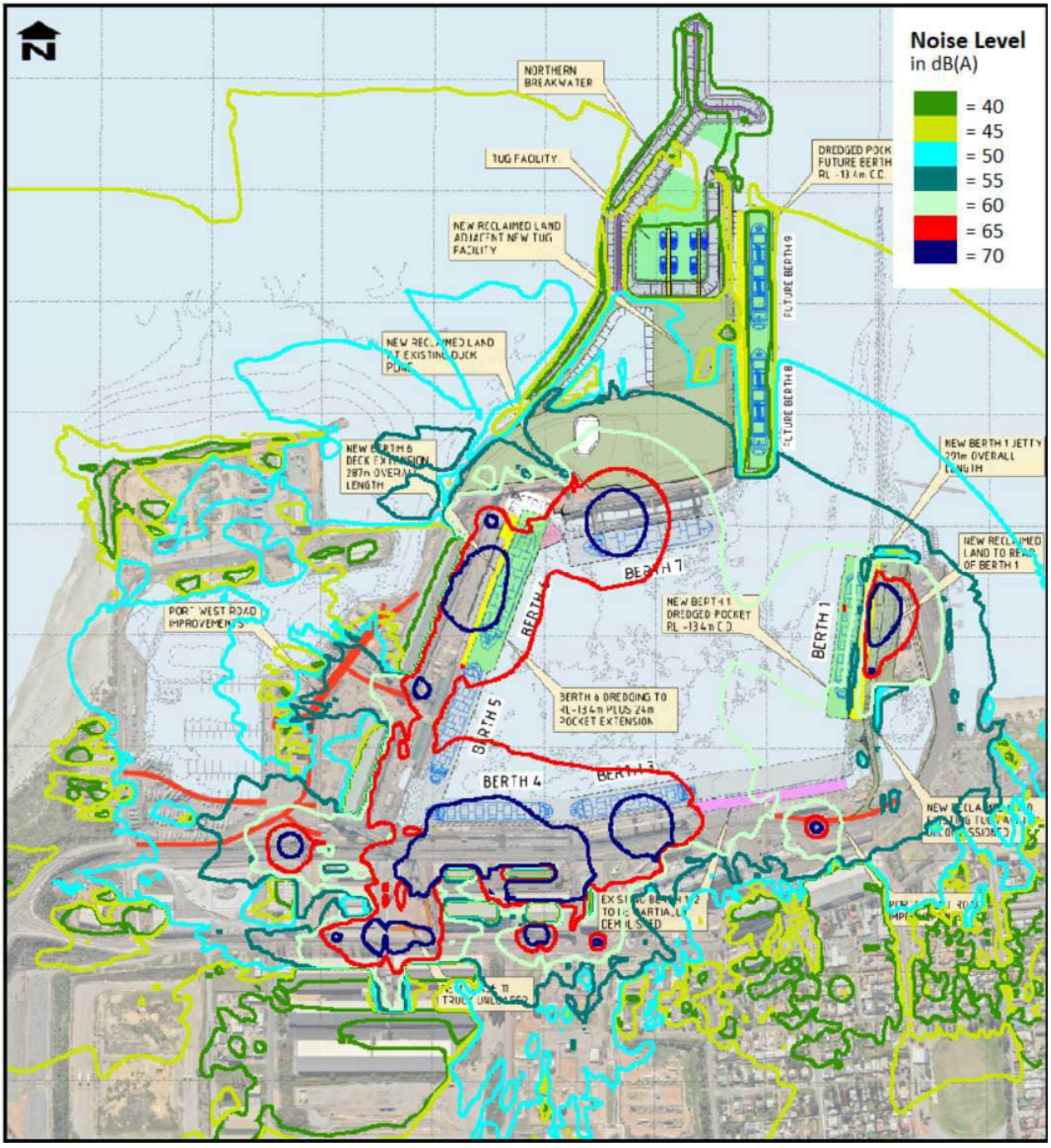

Figure 116: Night-time noise contours for scenario 11 under north-easterly wind.

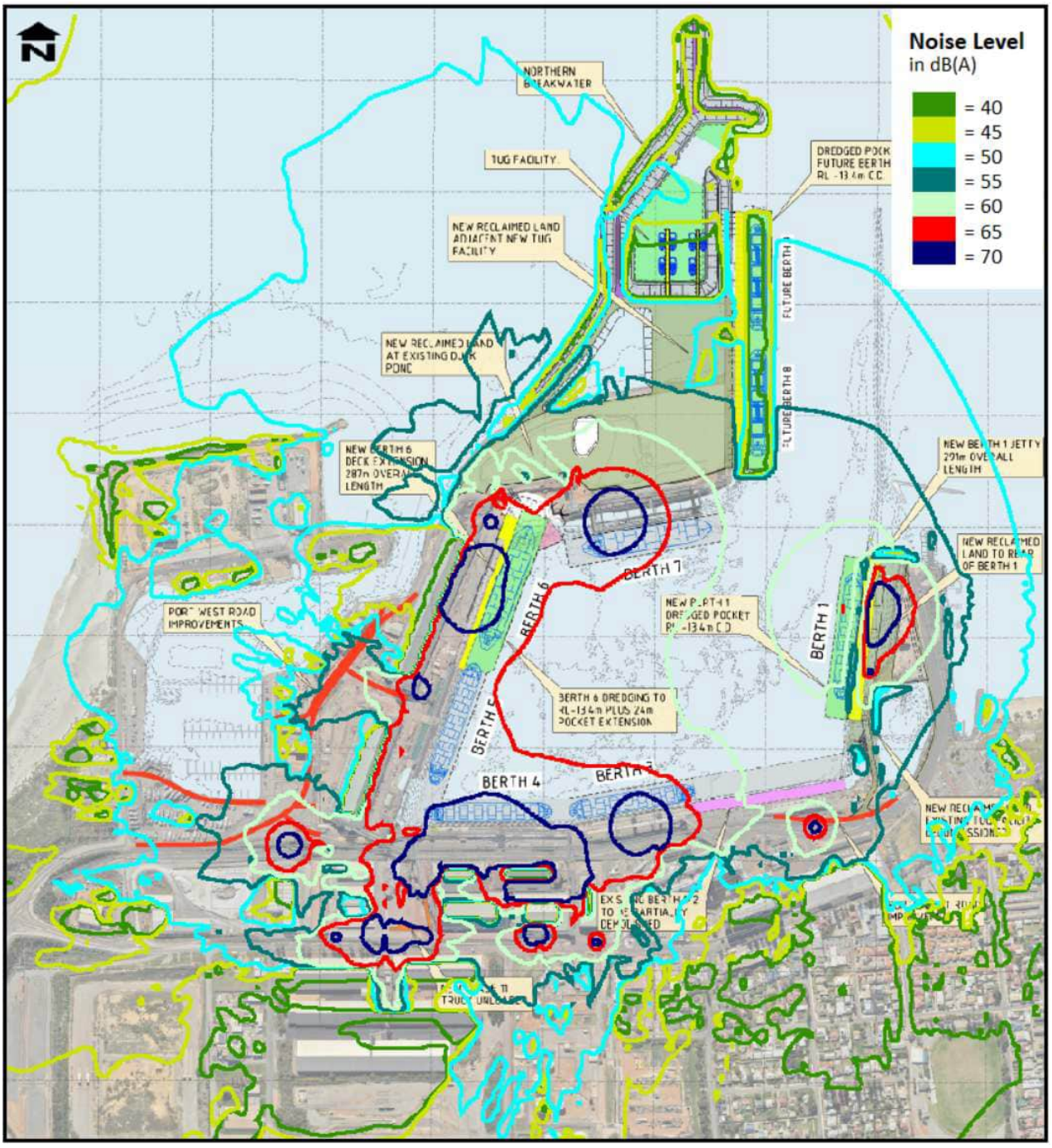

Figure 117: Night-time noise contours for scenario 11 under easterly wind.

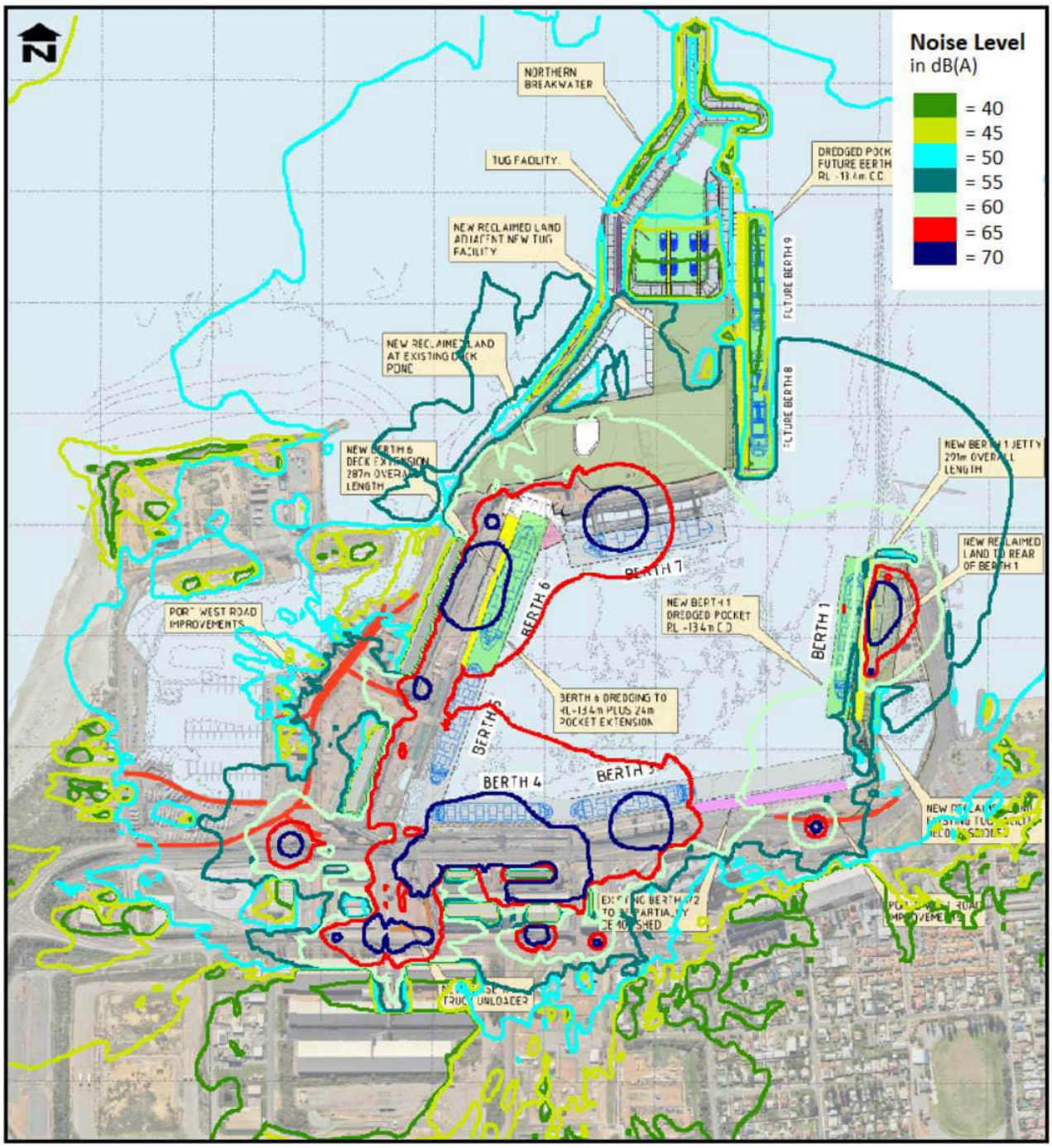

Figure 118: Night-time noise contours for scenario 11 under south-easterly wind.

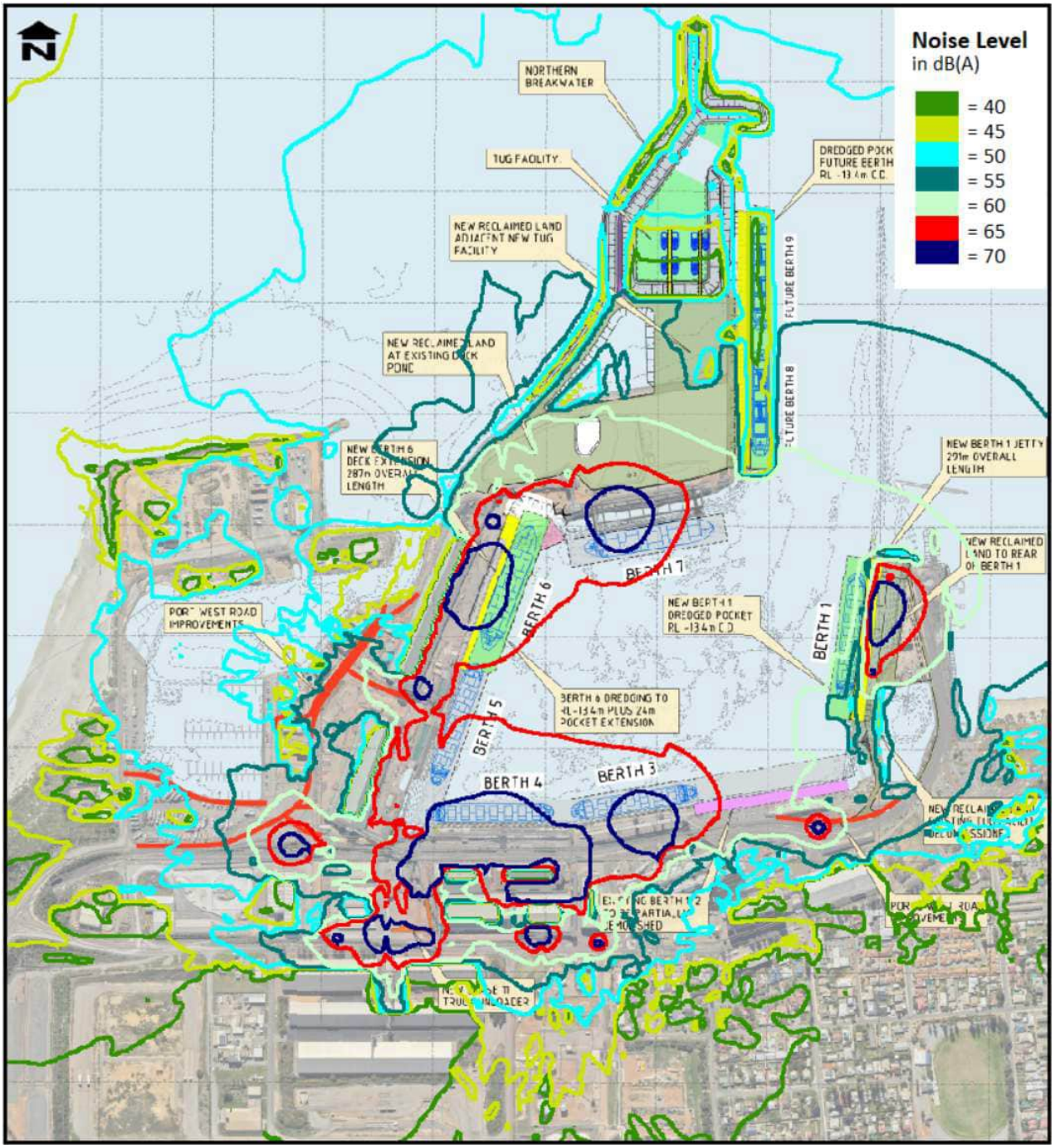

Figure 119: Night-time noise contours for scenario 11 under southerly wind.

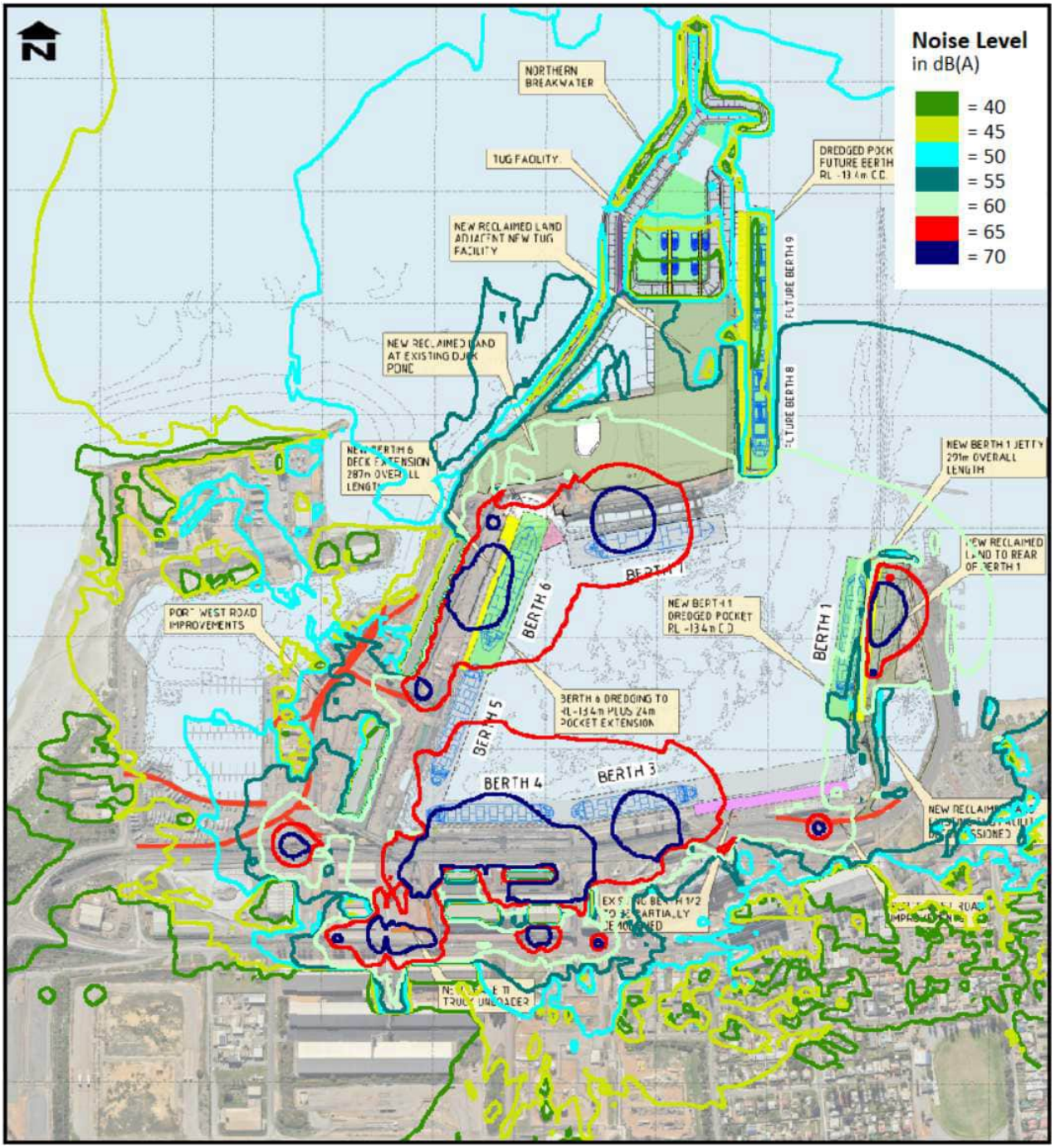

Figure 120: Night-time noise contours for scenario 11 under south-westerly wind.

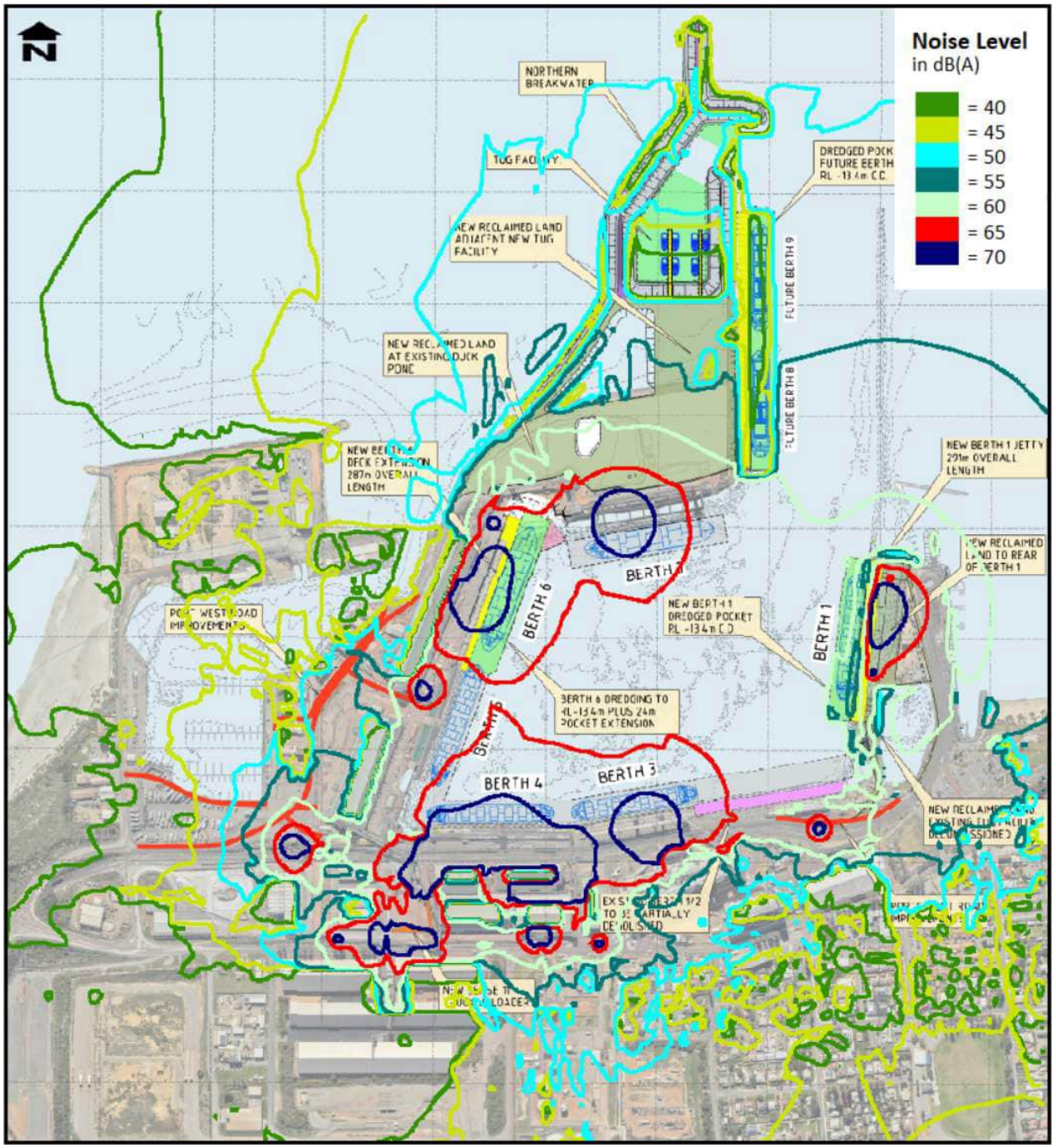

Figure 121: Night-time noise contours for scenario 11 under westerly wind.

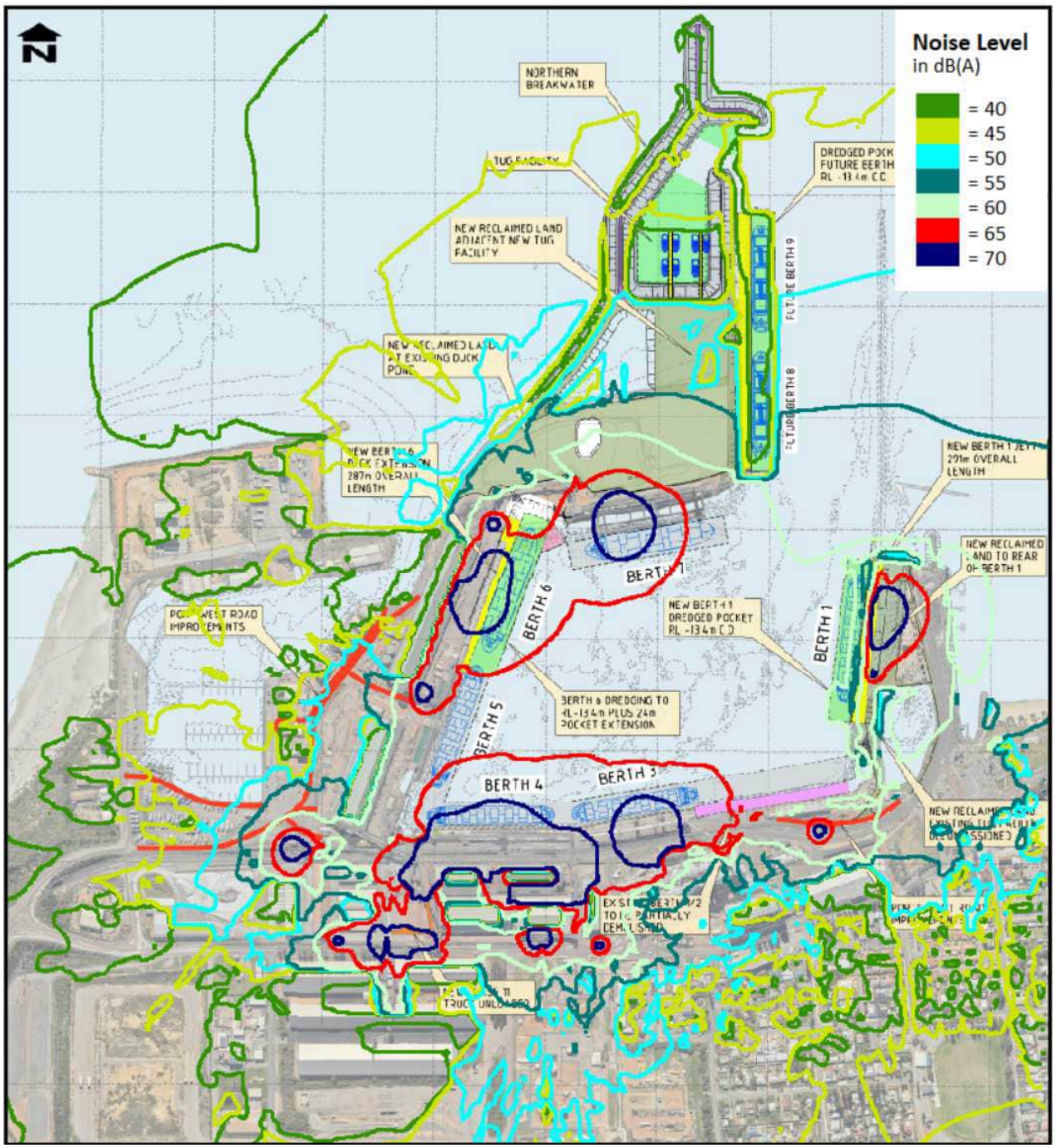

Figure 122: Night-time noise contours for scenario 11 under north-westerly wind.

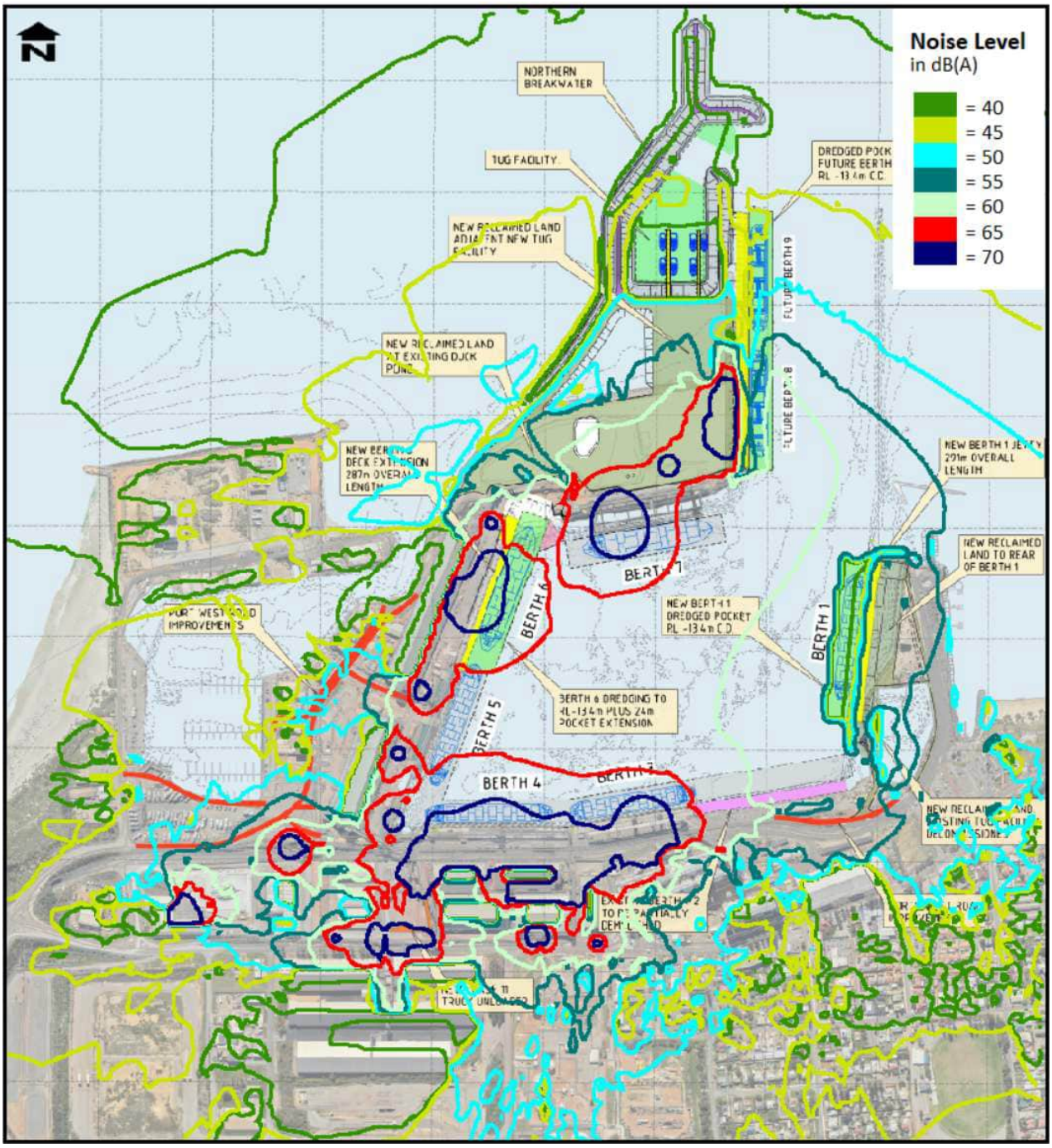

Figure 123: Daytime noise contours for scenario 12 under northerly wind.

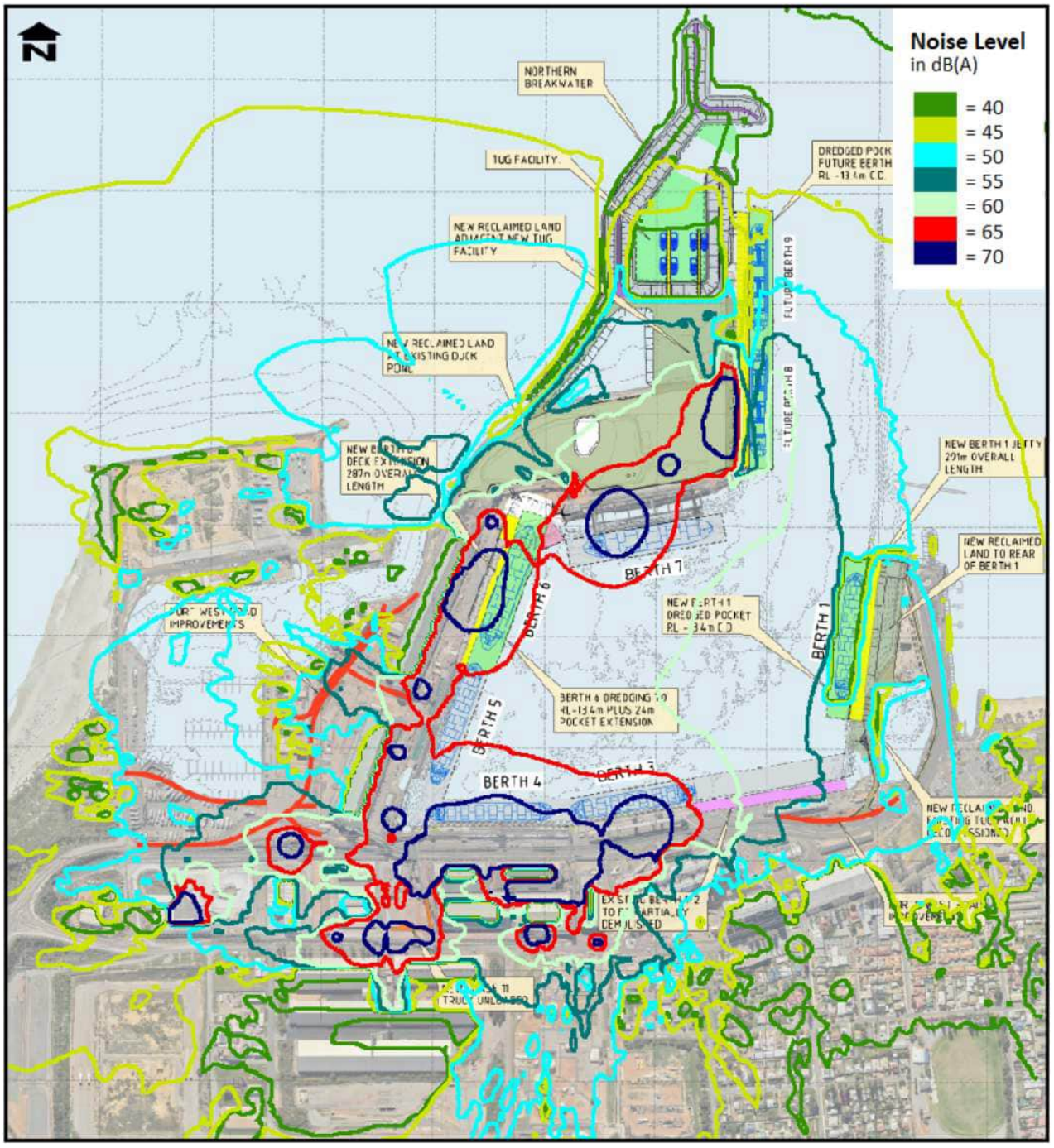

Figure 124: Daytime noise contours for scenario 12 under north-easterly wind.

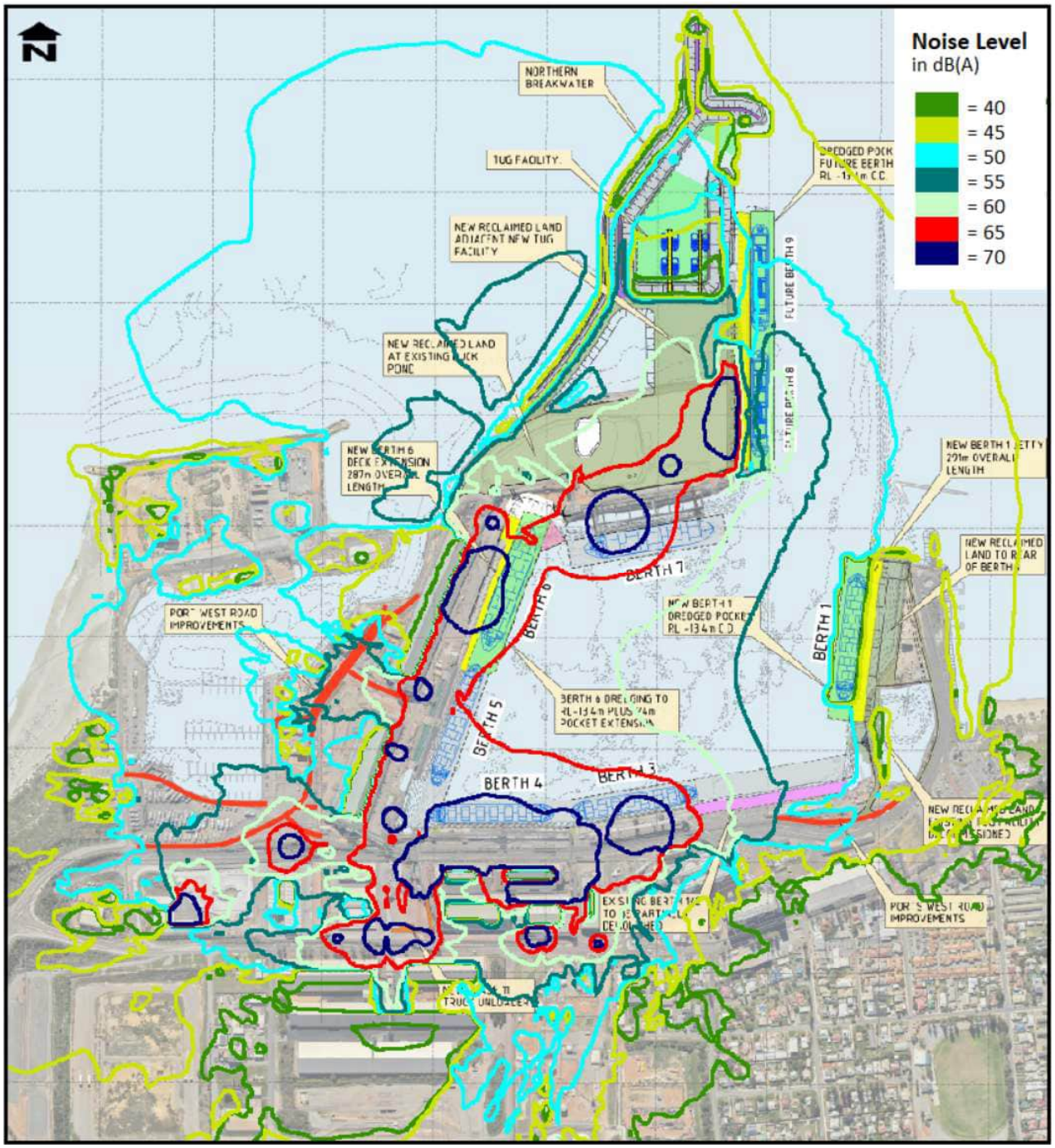

Figure 125: Daytime noise contours for scenario 12 under easterly wind.

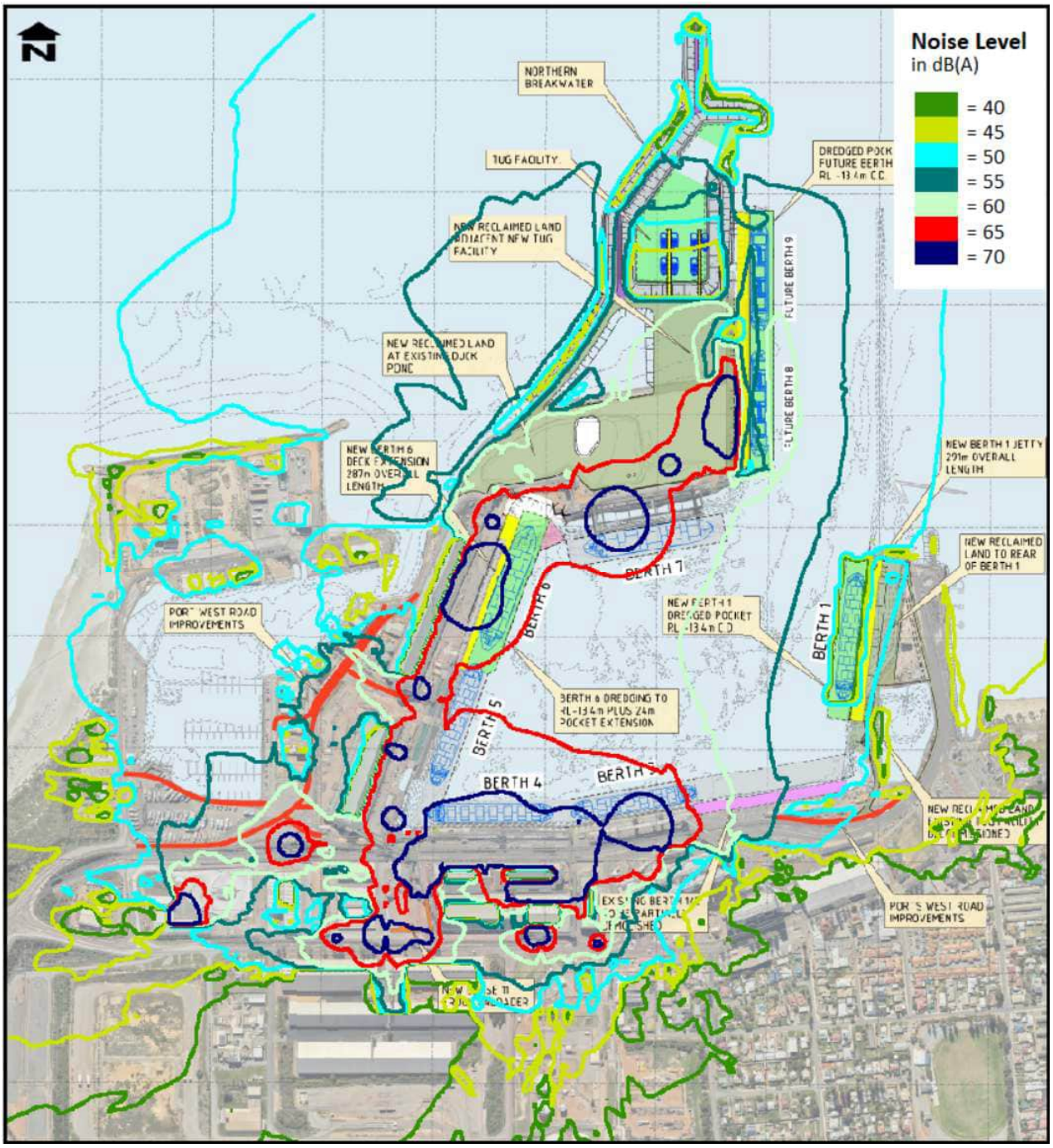

Figure 126: Daytime noise contours for scenario 12 under south-easterly wind.

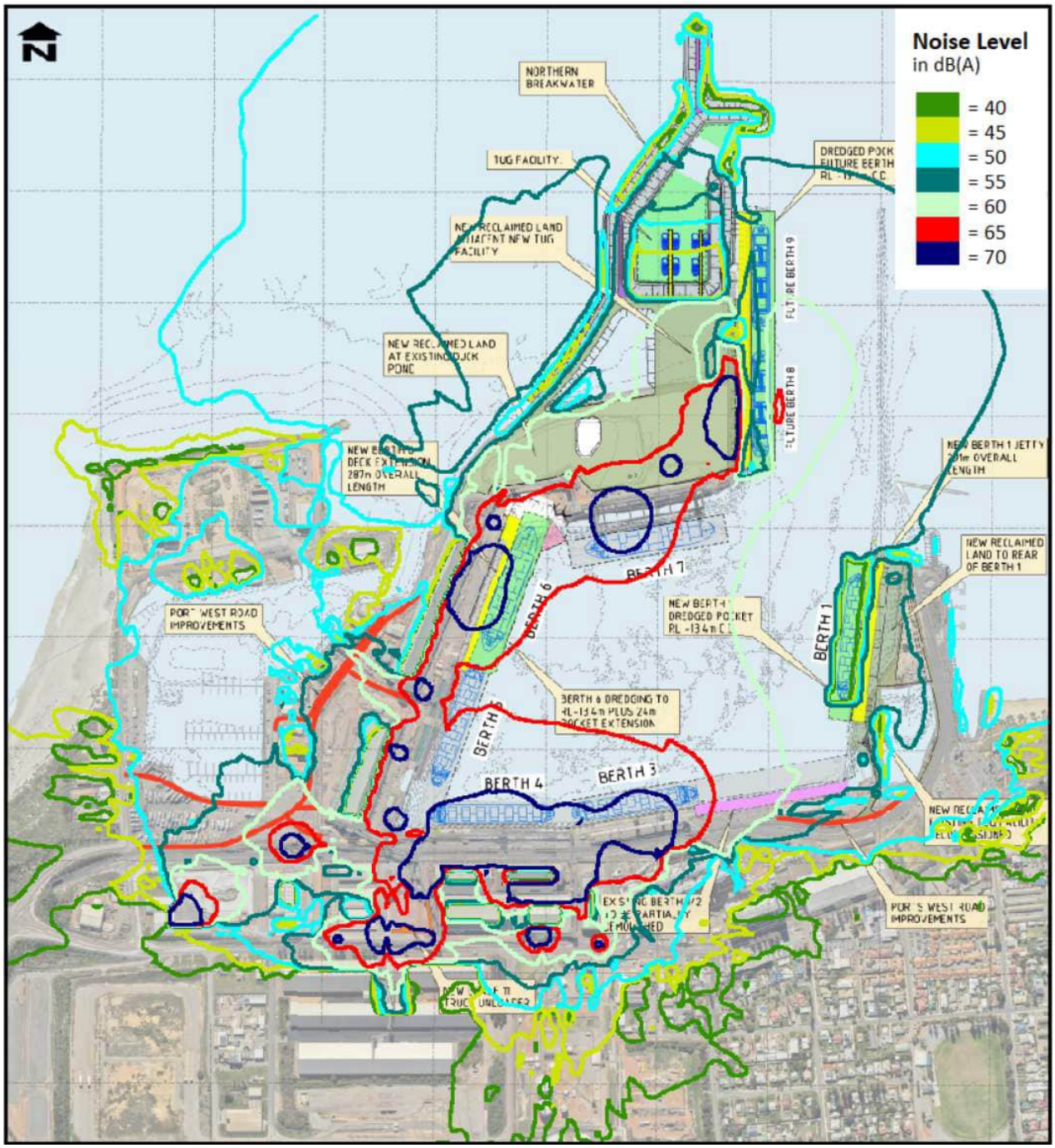

Figure 127: Daytime noise contours for scenario 12 under southerly wind.

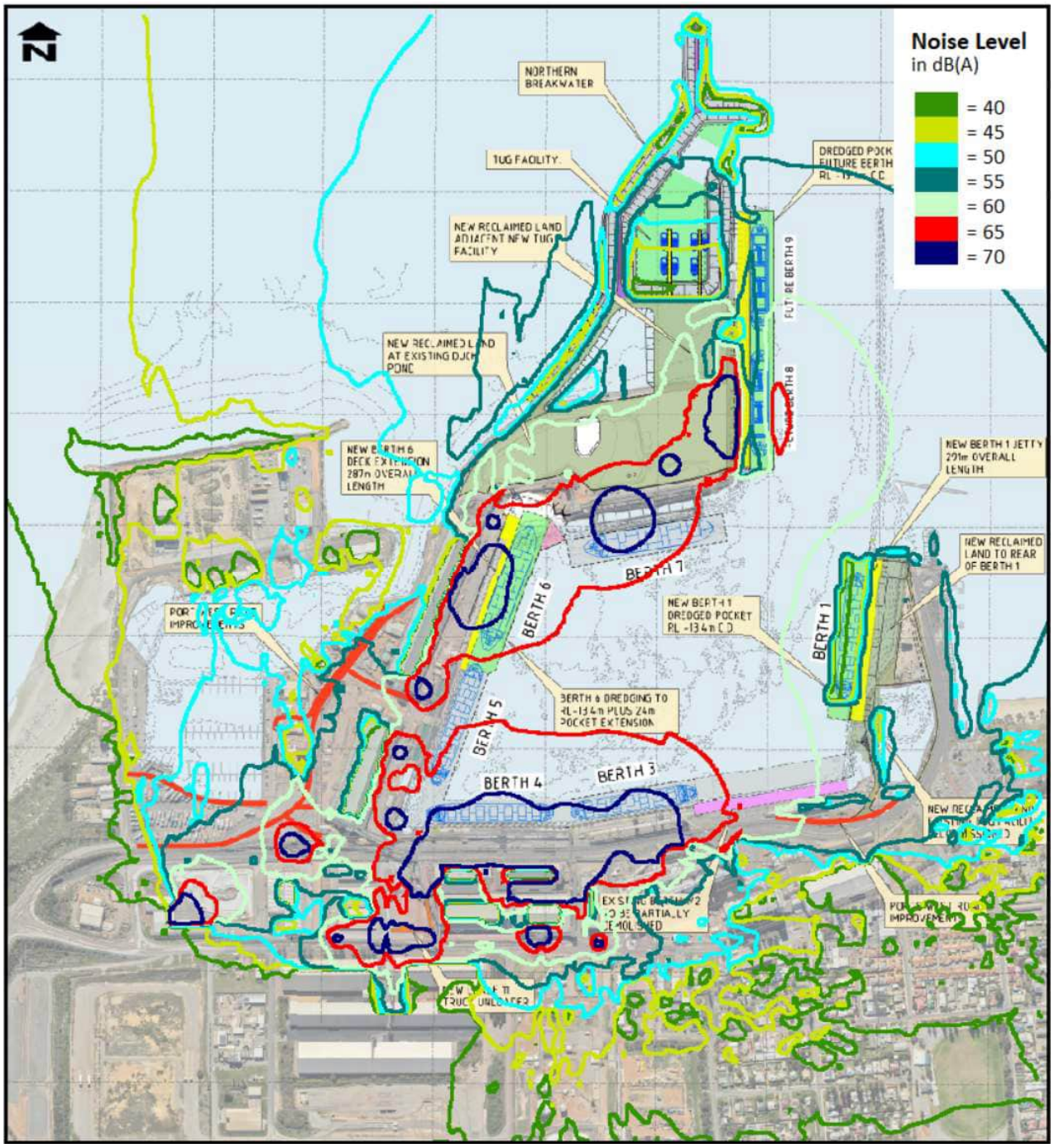

Figure 128: Daytime noise contours for scenario 12 under south-westerly wind.

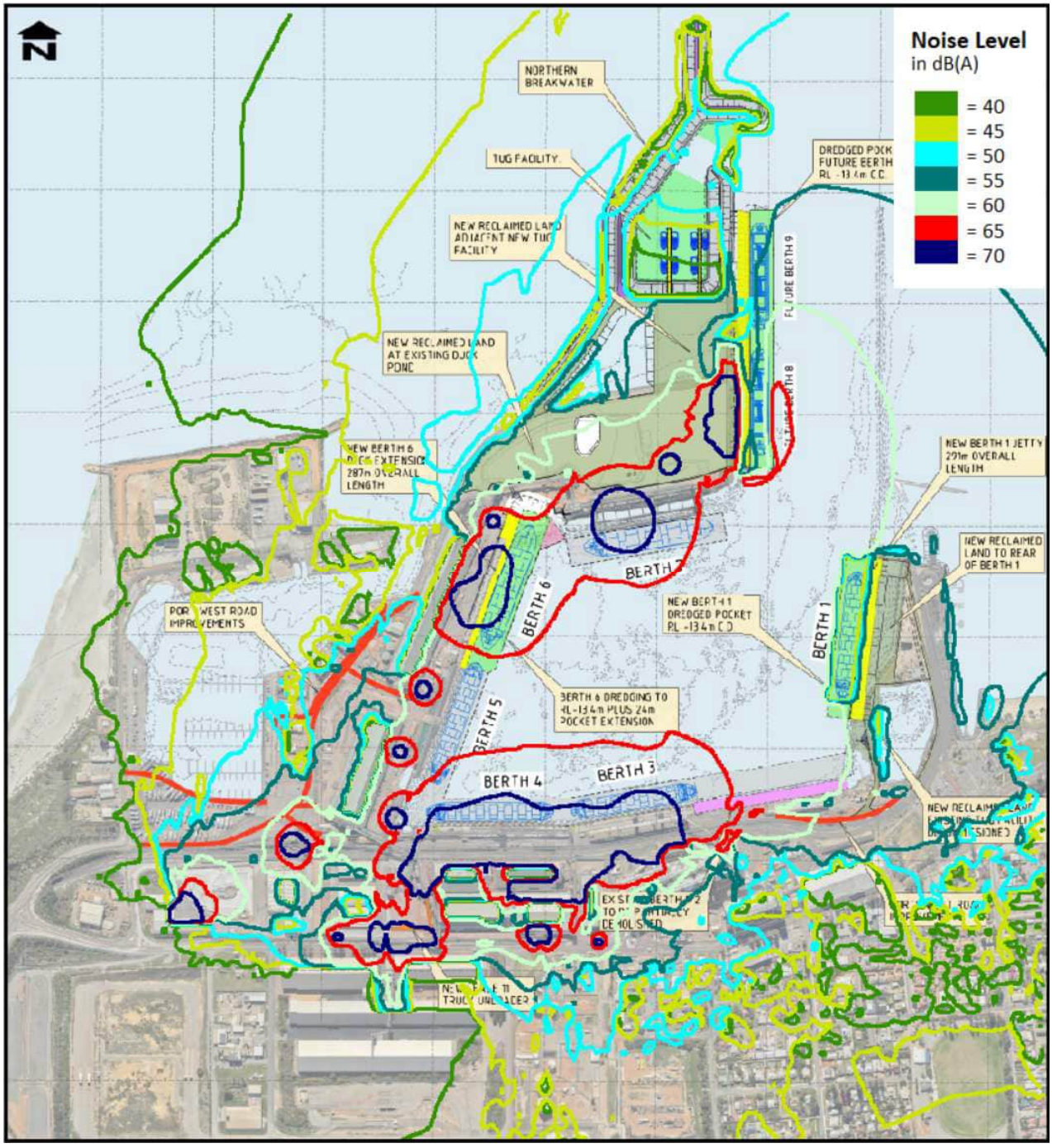

Figure 129: Daytime noise contours for scenario 12 under westerly wind.

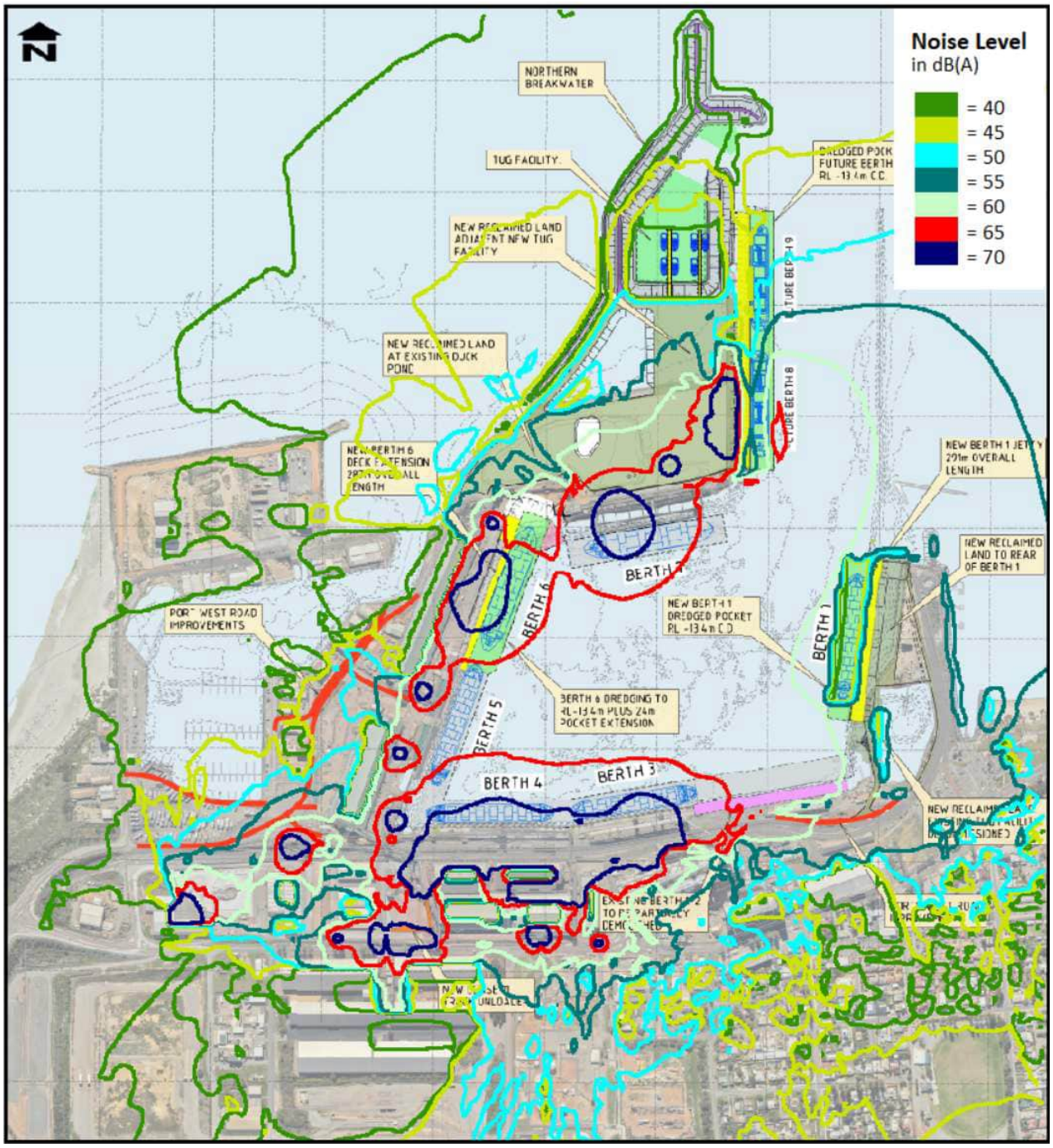

Figure 130: Daytime noise contours for scenario 12 under north-westerly wind.

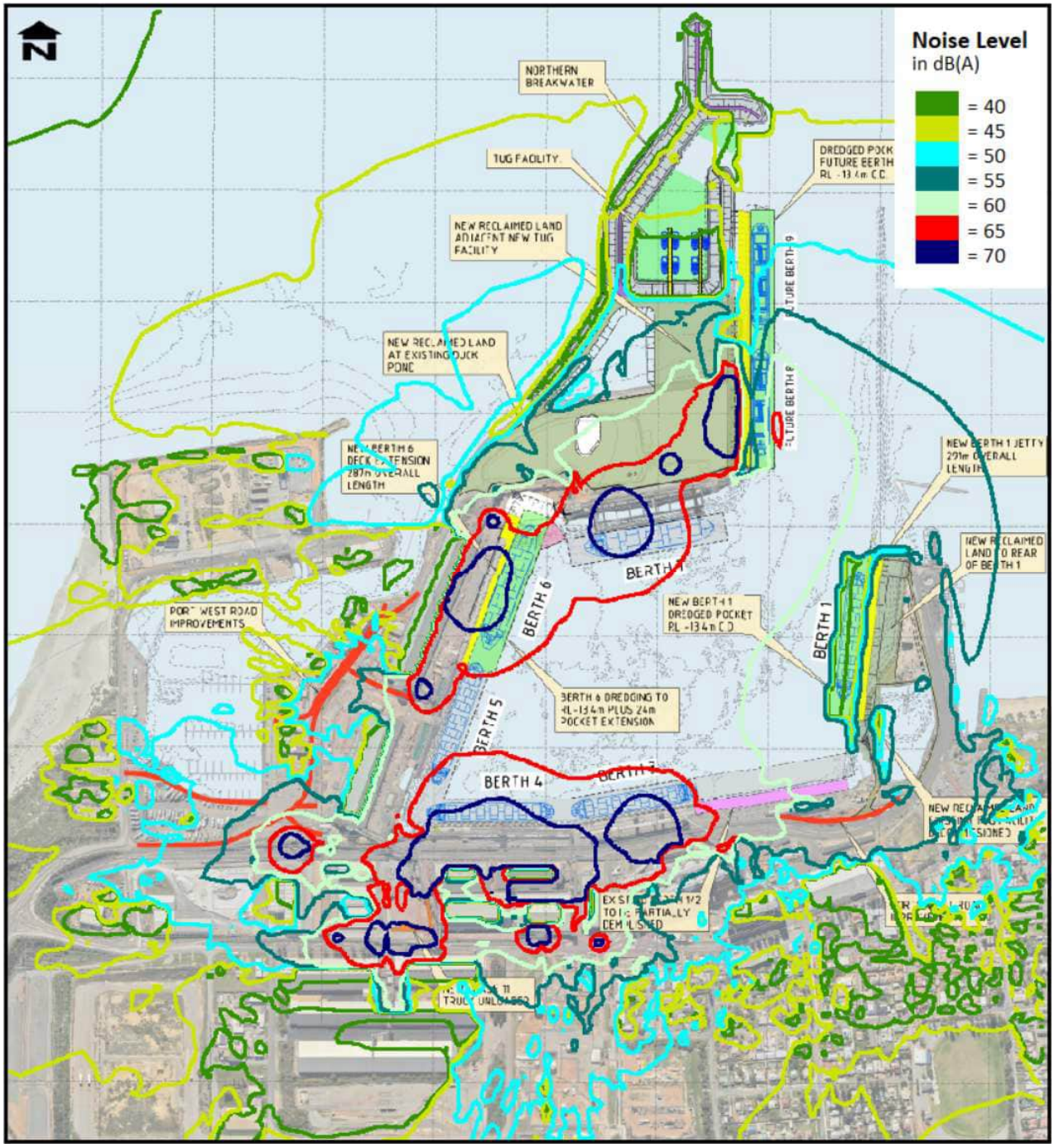

Figure 131: Night-time noise contours for scenario 12 under northerly wind.

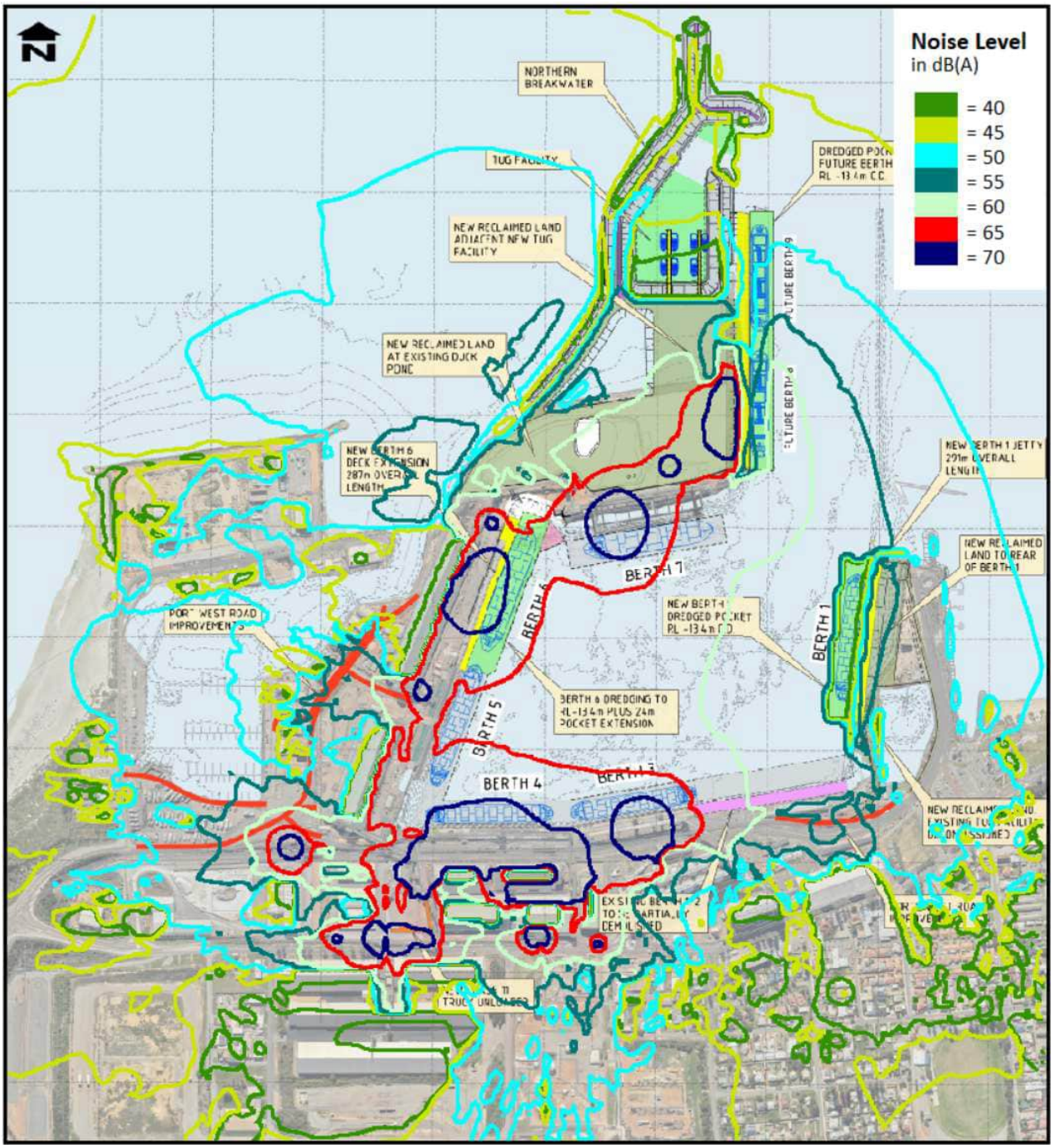

Figure 132: Night-time noise contours for scenario 12 under north-easterly wind.

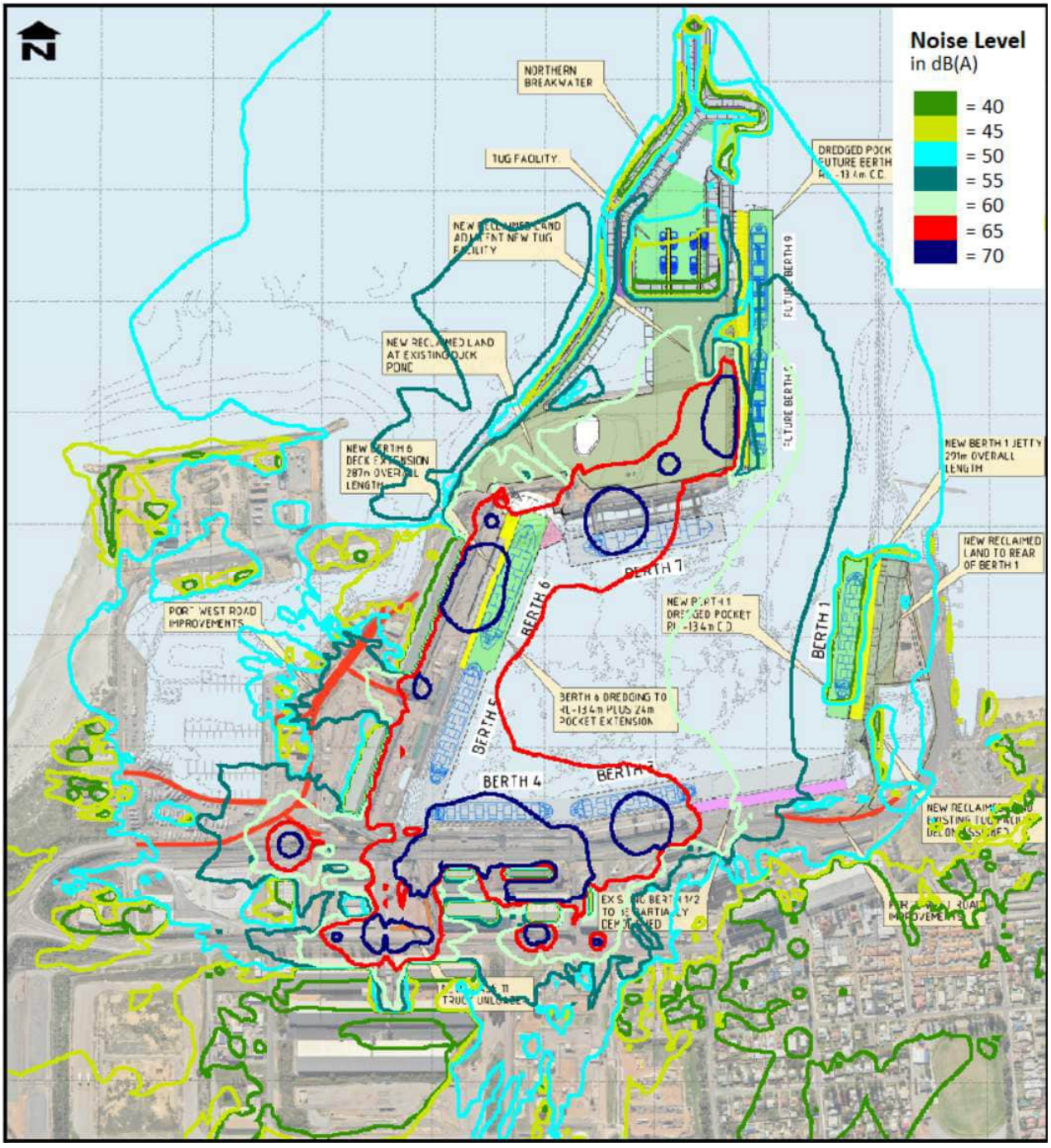

Figure 133: Night-time noise contours for scenario 12 under easterly wind.

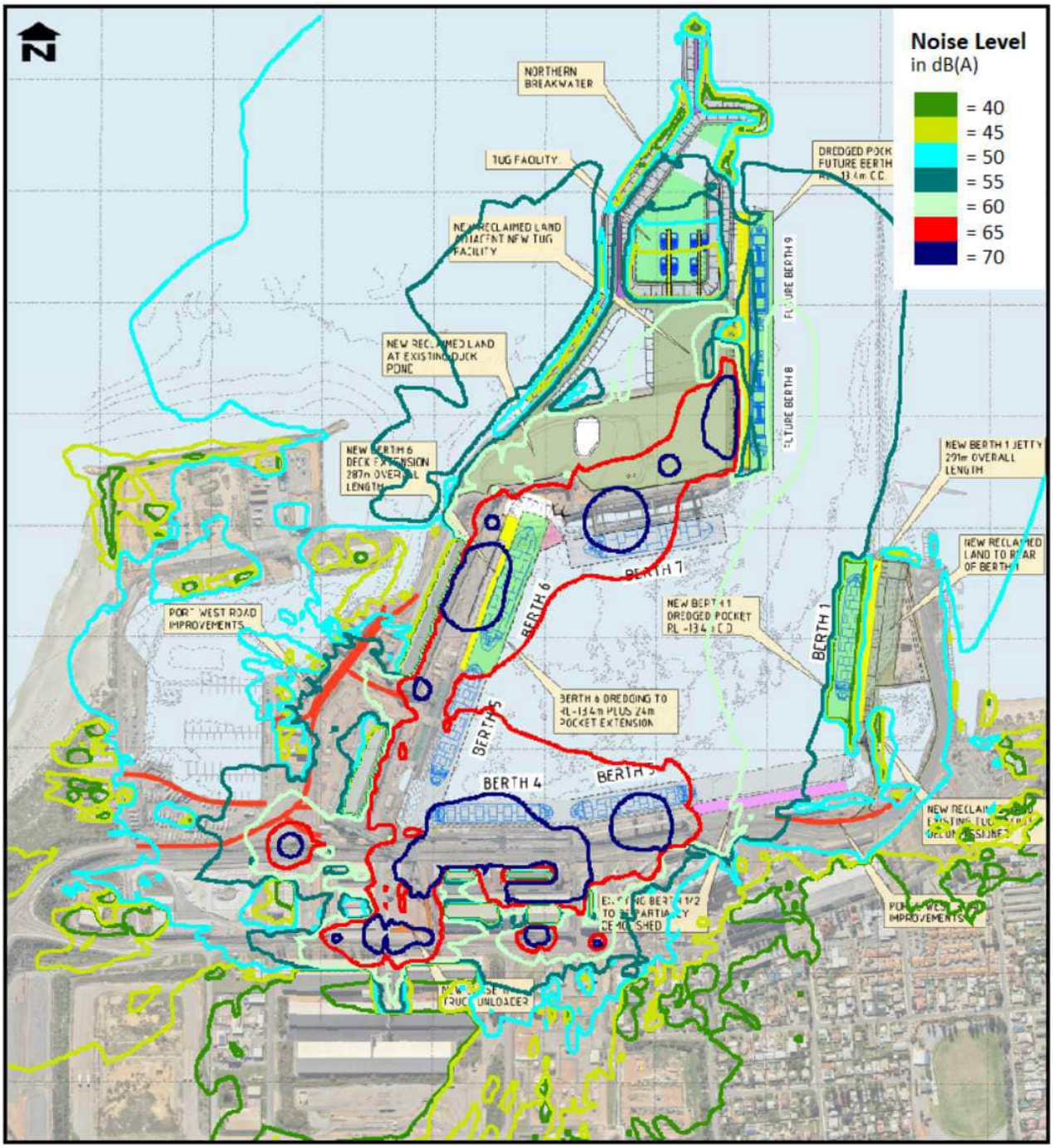

Figure 134: Night-time noise contours for scenario 12 under south-easterly wind.

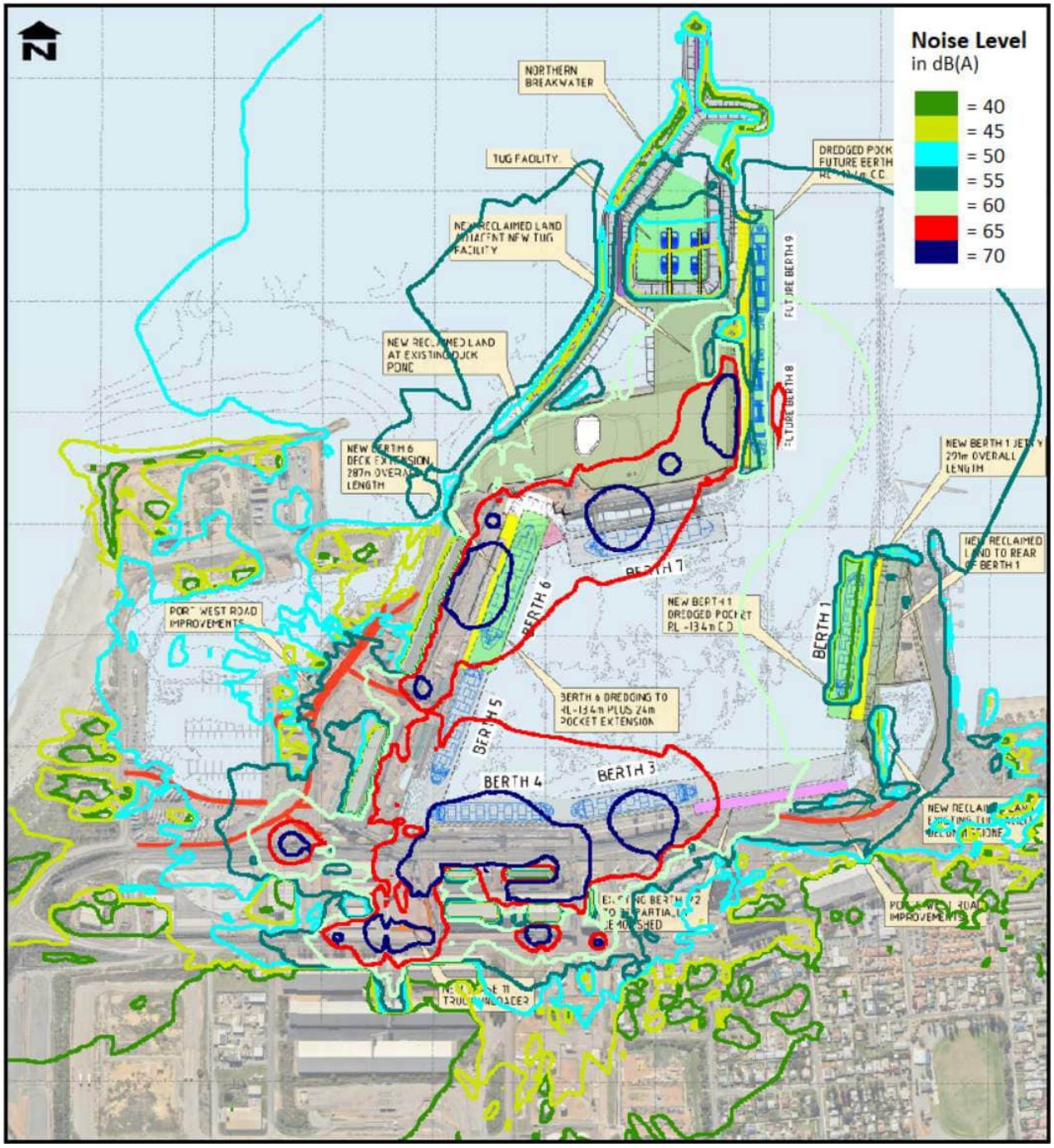

Figure 135: Night-time noise contours for scenario 12 under southerly wind.

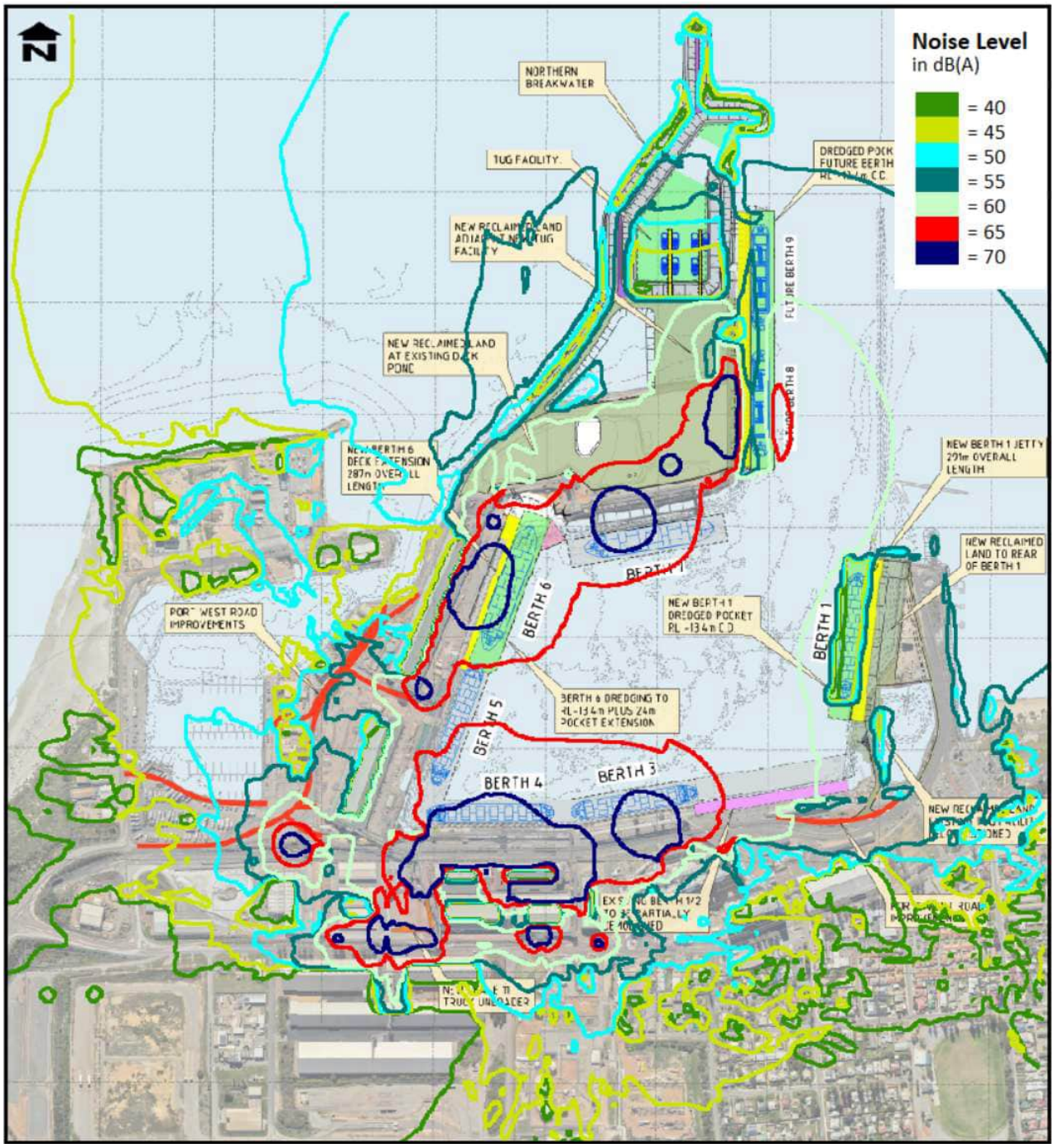

Figure 136: Night-time noise contours for scenario 12 under south-westerly wind.

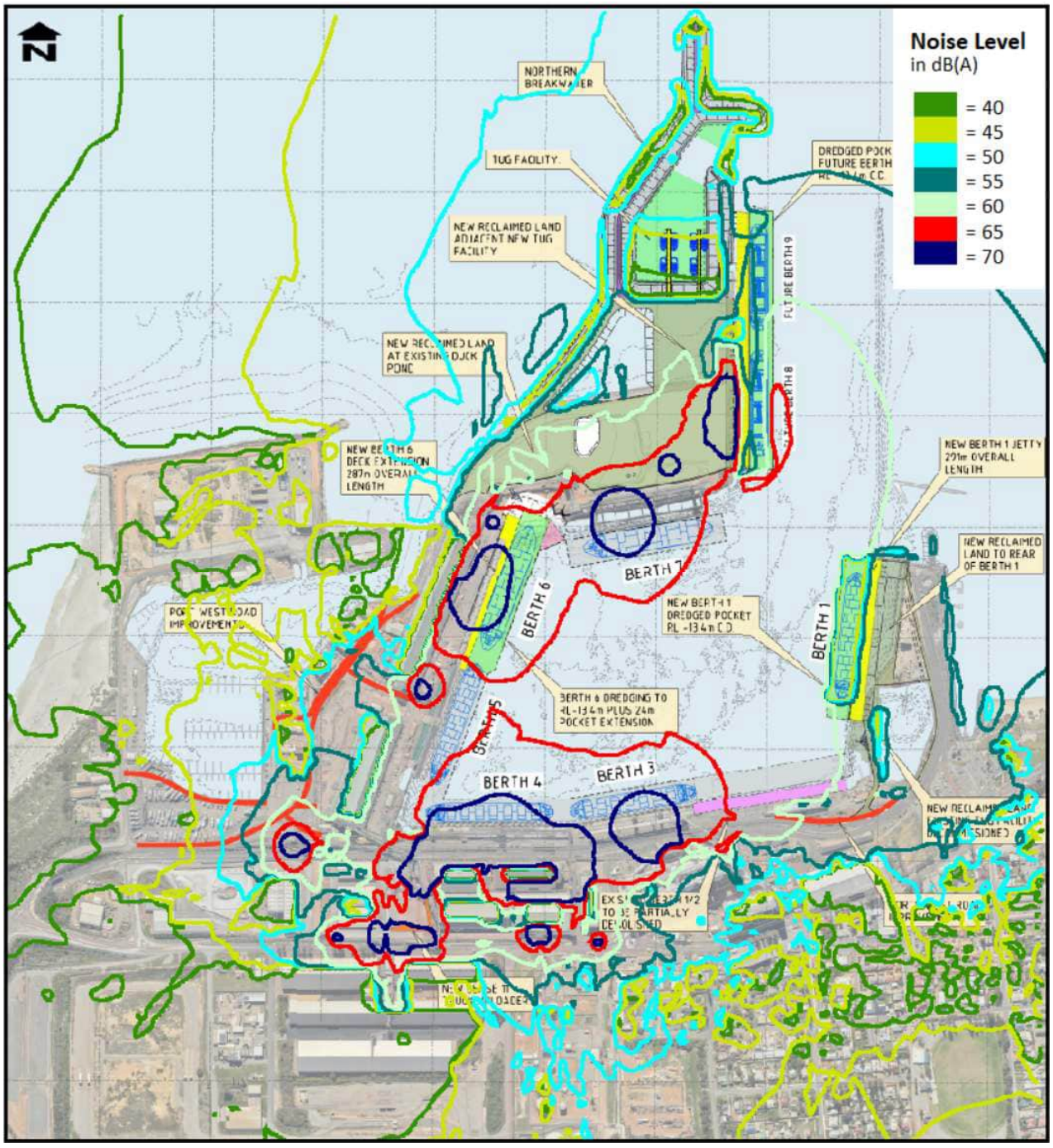

Figure 137: Night-time noise contours for scenario 12 under westerly wind.

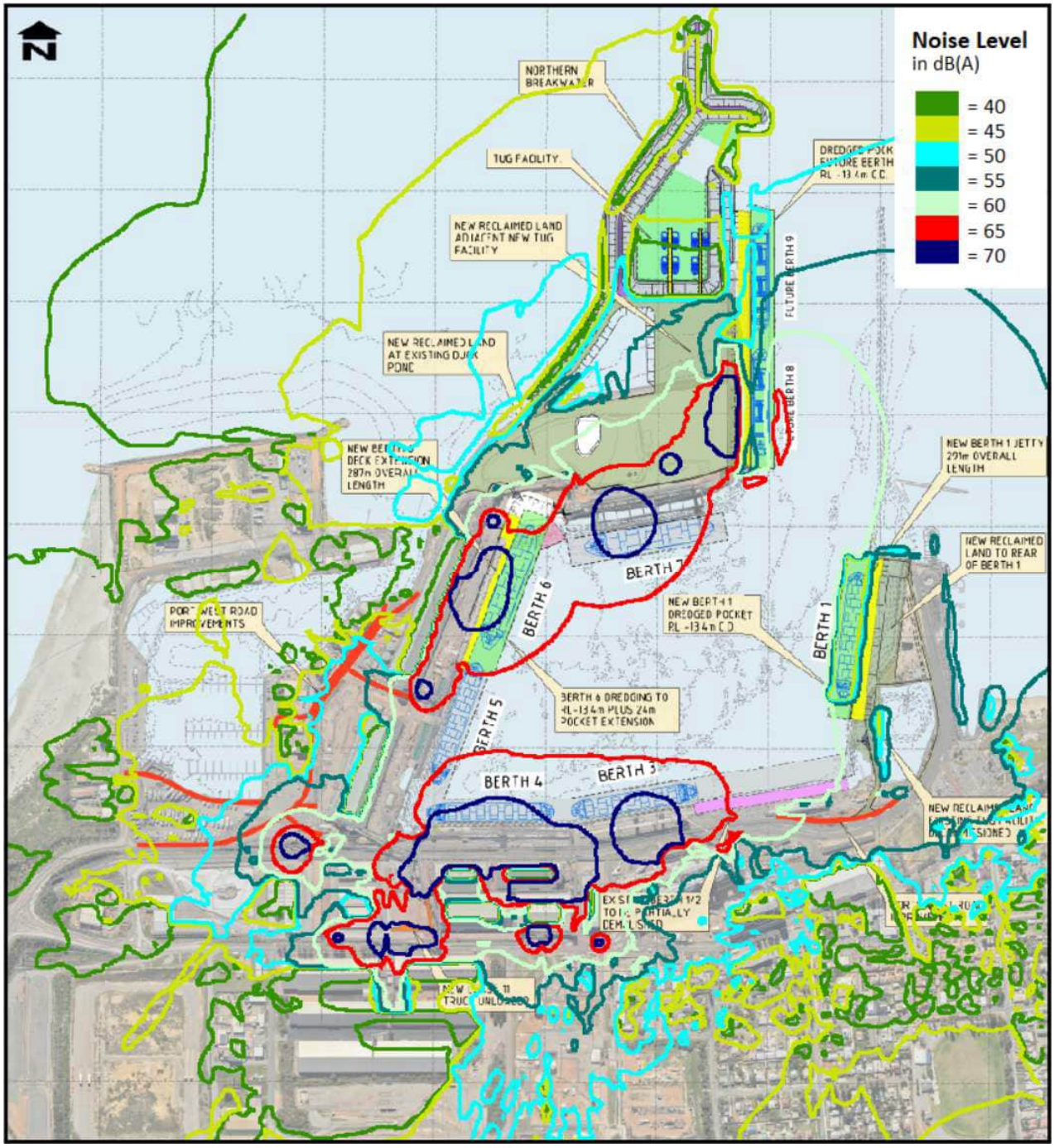

Figure 138: Night-time noise contours for scenario 12 under north-westerly wind.

APPENDIX D WEATHER DATA ANALYSIS

Table E1: **Percentage occurrence for different wind speeds and directions.**

Month	Period	Wind Speeds	Percentage Occurrence of Winds from different Directions								
			Calm	N	NE	E	SE	S	SW	W	NW
January	Day	Calm	0.0%								
		1 m/s		0.1%	0.2%	0.1%	0.2%	0.4%	0.3%	0.2%	0.1%
		2 m/s		0.1%	0.2%	0.3%	0.5%	1.0%	0.6%	0.4%	0.0%
		3 m/s		0.1%	0.3%	0.8%	0.6%	1.6%	2.6%	0.3%	0.0%
		4 m/s		0.1%	0.3%	0.9%	0.8%	3.4%	4.8%	0.2%	0.0%
		≥5 m/s		0.1%	1.2%	4.1%	1.7%	45.4%	24.8%	0.9%	0.1%
	Evening	Calm	0.0%								
		1 m/s		0.1%	0.0%	0.1%	0.3%	0.3%	0.2%	0.0%	0.0%
		2 m/s		0.1%	0.0%	0.1%	1.5%	1.8%	1.0%	0.1%	0.0%
		3 m/s		0.1%	0.0%	0.2%	0.5%	2.6%	3.1%	0.2%	0.0%
		≥4 m/s		0.2%	0.8%	1.6%	1.5%	61.1%	21.9%	0.5%	0.0%
	Night	Calm	0.3%								
		1 m/s		0.2%	0.3%	0.6%	2.4%	3.2%	0.7%	0.2%	0.1%
		2 m/s		0.3%	0.2%	0.4%	4.0%	5.2%	1.2%	0.4%	0.0%
		3 m/s		0.2%	0.2%	0.7%	4.4%	5.2%	2.4%	0.4%	0.0%
		≥4 m/s		0.2%	0.3%	5.2%	7.1%	39.5%	13.7%	0.7%	0.0%
February	Day	Calm	0.1%								
		1 m/s		0.4%	0.2%	0.3%	0.6%	1.0%	0.7%	0.4%	0.2%
		2 m/s		0.8%	0.5%	0.7%	1.1%	1.3%	0.8%	0.9%	0.1%
		3 m/s		0.6%	0.4%	1.0%	1.0%	2.8%	3.3%	0.8%	0.0%
		4 m/s		0.2%	0.2%	1.6%	1.0%	4.6%	6.0%	1.1%	0.0%
		≥5 m/s		0.1%	1.7%	5.5%	4.5%	34.9%	16.7%	2.1%	0.0%
	Evening	Calm	0.2%								
		1 m/s		0.3%	0.4%	0.1%	1.0%	0.9%	0.8%	0.6%	0.3%
		2 m/s		0.5%	0.3%	0.3%	1.9%	3.0%	1.5%	0.6%	0.1%
		3 m/s		0.4%	0.5%	0.6%	1.1%	5.0%	3.1%	0.1%	0.0%
		≥4 m/s		0.7%	1.1%	2.3%	5.7%	56.8%	8.8%	0.9%	0.0%
	Night	Calm	0.7%								
		1 m/s		0.7%	0.6%	1.4%	3.6%	3.6%	1.5%	0.7%	0.2%
		2 m/s		0.6%	0.7%	1.8%	6.5%	4.4%	1.5%	0.5%	0.0%
		3 m/s		0.7%	0.4%	2.3%	5.4%	4.3%	1.9%	0.2%	0.0%
		≥4 m/s		0.5%	1.1%	7.8%	11.2%	29.4%	5.2%	0.5%	0.0%
March	Day	Calm	0.1%								
		1 m/s		0.2%	0.4%	0.7%	0.8%	0.7%	0.5%	0.4%	0.1%
		2 m/s		0.5%	0.7%	1.2%	1.5%	1.9%	1.3%	0.9%	0.1%
		3 m/s		0.4%	0.6%	1.9%	1.4%	2.8%	3.4%	1.1%	0.0%
		4 m/s		0.3%	0.9%	2.8%	1.3%	4.6%	5.3%	1.1%	0.0%
		≥5 m/s		0.4%	2.9%	5.4%	2.5%	34.9%	13.3%	0.8%	0.0%
	Evening	Calm	0.7%								
		1 m/s		0.4%	1.1%	1.1%	2.8%	3.0%	0.8%	0.5%	0.3%
		2 m/s		0.0%	0.3%	1.1%	4.6%	6.0%	2.0%	0.3%	0.0%

Month	Period	Wind Speeds	Percentage Occurrence of Winds from different Directions								
			Calm	N	NE	E	SE	S	SW	W	NW
		3 m/s		0.0%	0.1%	1.0%	3.2%	5.0%	2.8%	0.1%	0.0%
		≥4 m/s		0.0%	0.6%	3.2%	4.5%	47.7%	6.4%	0.2%	0.0%
	Night	Calm	1.2%								
		1 m/s		0.7%	1.2%	2.4%	4.0%	3.5%	0.9%	0.3%	0.2%
		2 m/s		0.3%	0.7%	2.5%	6.8%	5.3%	1.6%	0.1%	0.0%
		3 m/s		0.4%	0.7%	3.6%	6.2%	4.8%	2.0%	0.4%	0.0%
		≥4 m/s		0.5%	1.6%	11.8%	10.3%	20.2%	5.3%	0.5%	0.0%
April	Day	Calm	0.4%								
		1 m/s		0.7%	1.3%	1.1%	0.9%	1.0%	0.5%	0.5%	0.2%
		2 m/s		0.7%	0.7%	1.5%	2.0%	2.3%	1.5%	1.1%	0.0%
		3 m/s		0.4%	0.4%	3.1%	2.2%	3.1%	4.0%	1.6%	0.0%
		4 m/s		0.2%	0.3%	3.7%	2.2%	3.9%	5.2%	0.9%	0.0%
		≥5 m/s		0.2%	1.4%	7.7%	5.8%	24.6%	12.6%	0.2%	0.0%
	Evening	Calm	0.2%								
		1 m/s		0.0%	0.1%	1.4%	3.3%	2.5%	1.0%	0.1%	0.0%
		2 m/s		0.1%	0.1%	2.0%	5.1%	3.7%	2.7%	0.5%	0.0%
		3 m/s		0.2%	0.0%	2.1%	4.8%	4.3%	4.5%	0.6%	0.0%
		≥4 m/s		0.9%	0.1%	6.2%	11.0%	32.4%	10.0%	0.2%	0.0%
	Night	Calm	1.5%								
		1 m/s		1.0%	2.2%	4.2%	4.2%	2.5%	0.6%	0.3%	0.2%
		2 m/s		0.3%	0.6%	6.4%	8.3%	2.7%	1.2%	0.5%	0.0%
		3 m/s		0.2%	0.2%	6.8%	8.9%	1.7%	1.1%	0.5%	0.0%
		≥4 m/s		0.4%	0.6%	13.5%	14.9%	8.3%	4.2%	1.9%	0.0%
May	Day	Calm	1.4%								
		1 m/s		0.8%	1.2%	1.4%	1.2%	1.6%	1.0%	0.9%	0.3%
		2 m/s		1.1%	1.7%	3.6%	2.0%	4.0%	2.0%	1.3%	0.1%
		3 m/s		0.9%	1.9%	4.8%	2.1%	3.0%	2.7%	0.9%	0.0%
		4 m/s		0.6%	1.8%	4.3%	1.7%	3.1%	2.8%	0.9%	0.0%
		≥5 m/s		1.7%	6.0%	8.2%	3.4%	15.4%	5.9%	2.4%	0.0%
	Evening	Calm	1.5%								
		1 m/s		0.6%	2.5%	3.4%	4.3%	2.4%	0.8%	0.7%	0.2%
		2 m/s		0.3%	1.3%	2.7%	8.7%	3.9%	0.5%	0.4%	0.0%
		3 m/s		0.4%	0.9%	5.5%	9.7%	1.6%	0.8%	0.5%	0.0%
		≥4 m/s		1.2%	2.9%	9.8%	15.6%	8.5%	4.3%	4.1%	0.0%
	Night	Calm	0.9%								
		1 m/s		0.3%	3.7%	4.3%	2.0%	1.0%	0.4%	0.1%	0.0%
		2 m/s		0.3%	3.3%	7.3%	5.0%	3.2%	0.3%	0.3%	0.0%
		3 m/s		0.7%	2.2%	8.4%	6.7%	0.3%	0.4%	0.4%	0.0%
		≥4 m/s		1.2%	5.4%	22.3%	11.7%	0.6%	4.6%	2.5%	0.0%
June	Day	Calm	0.5%								
		1 m/s		1.4%	1.4%	1.4%	1.2%	1.2%	0.9%	0.8%	0.5%
		2 m/s		1.2%	1.9%	6.1%	2.2%	2.2%	2.3%	1.2%	0.1%
		3 m/s		0.9%	2.0%	9.3%	2.4%	2.4%	2.3%	1.1%	0.0%

Month	Period	Wind Speeds	Percentage Occurrence of Winds from different Directions								
			Calm	N	NE	E	SE	S	SW	W	NW
		4 m/s		0.9%	2.0%	6.1%	1.5%	2.1%	2.2%	1.1%	0.0%
		≥5 m/s		4.8%	7.6%	5.0%	3.1%	3.3%	7.7%	5.4%	0.0%
	Evening	Calm	0.8%								
		1 m/s		0.6%	2.0%	4.1%	1.8%	1.3%	0.6%	0.5%	0.1%
		2 m/s		0.5%	1.6%	8.9%	6.3%	0.9%	1.1%	0.6%	0.0%
		3 m/s		1.0%	1.1%	11.4%	8.3%	0.9%	1.6%	0.8%	0.0%
		≥4 m/s		3.8%	5.1%	9.4%	7.3%	1.8%	8.5%	7.3%	0.0%
	Night	Calm	0.5%								
		1 m/s		0.5%	2.6%	3.4%	0.9%	0.3%	0.1%	0.1%	0.1%
		2 m/s		0.3%	2.8%	10.2%	2.5%	0.9%	0.3%	0.2%	0.0%
		3 m/s		0.4%	1.6%	14.9%	3.1%	0.6%	0.7%	0.4%	0.0%
		≥4 m/s		4.3%	7.9%	20.4%	3.2%	0.7%	8.5%	7.4%	0.0%
July	Day	Calm	1.0%								
		1 m/s		0.7%	1.4%	1.5%	1.0%	1.2%	0.9%	0.7%	0.2%
		2 m/s		1.1%	2.6%	4.3%	1.7%	1.8%	2.3%	1.2%	0.1%
		3 m/s		1.0%	2.1%	6.1%	1.4%	2.4%	3.1%	1.0%	0.1%
		4 m/s		0.7%	1.6%	4.2%	0.9%	2.7%	3.1%	1.0%	0.0%
		≥5 m/s		5.2%	3.2%	3.6%	3.8%	10.0%	12.2%	6.9%	0.0%
	Evening	Calm	1.6%								
		1 m/s		0.2%	1.6%	4.2%	2.7%	0.9%	0.7%	0.4%	0.0%
		2 m/s		0.1%	0.8%	6.3%	7.2%	1.7%	1.1%	0.4%	0.0%
		3 m/s		0.3%	1.1%	5.2%	6.7%	1.6%	1.4%	0.4%	0.1%
		≥4 m/s		1.7%	2.0%	5.7%	7.3%	13.7%	14.6%	8.2%	0.0%
	Night	Calm	0.9%								
		1 m/s		0.1%	3.8%	4.8%	1.1%	0.5%	0.1%	0.1%	0.1%
		2 m/s		0.1%	2.9%	8.9%	3.7%	0.8%	0.3%	0.3%	0.0%
		3 m/s		0.2%	2.2%	9.4%	3.4%	0.5%	0.7%	0.5%	0.0%
		≥4 m/s		2.4%	4.6%	13.7%	4.5%	7.1%	13.1%	9.2%	0.0%
August	Day	Calm	0.3%								
		1 m/s		0.6%	0.8%	0.7%	0.7%	1.0%	0.7%	0.5%	0.2%
		2 m/s		0.8%	1.1%	3.2%	1.9%	1.7%	1.9%	1.0%	0.1%
		3 m/s		0.9%	1.1%	5.4%	2.6%	2.4%	2.9%	1.6%	0.1%
		4 m/s		0.8%	1.2%	4.9%	2.3%	2.4%	2.5%	1.4%	0.0%
		≥5 m/s		2.1%	5.1%	5.7%	4.3%	11.6%	15.0%	5.3%	1.0%
	Evening	Calm	1.3%								
		1 m/s		0.3%	1.6%	1.8%	2.1%	2.1%	1.5%	0.5%	0.5%
		2 m/s		0.2%	0.6%	3.0%	6.2%	2.4%	2.9%	0.6%	0.1%
		3 m/s		0.4%	0.2%	5.1%	8.1%	2.3%	2.9%	1.1%	0.1%
		≥4 m/s		2.7%	1.1%	4.1%	11.2%	10.5%	14.6%	7.5%	0.4%
	Night	Calm	0.5%								
		1 m/s		0.5%	3.0%	2.5%	1.1%	0.8%	0.3%	0.2%	0.1%
		2 m/s		0.4%	2.1%	7.3%	3.6%	1.5%	0.8%	0.3%	0.0%
		3 m/s		0.5%	0.8%	10.5%	4.5%	0.9%	1.3%	0.9%	0.1%

Month	Period	Wind Speeds	Percentage Occurrence of Winds from different Directions								
			Calm	N	NE	E	SE	S	SW	W	NW
		≥4 m/s		1.8%	3.2%	16.7%	8.7%	3.4%	13.1%	8.3%	0.6%
September	Day	Calm	0.1%								
		1 m/s		0.3%	0.7%	1.0%	0.7%	1.1%	0.6%	0.4%	0.2%
		2 m/s		1.0%	0.9%	2.2%	2.0%	2.0%	1.8%	1.0%	0.3%
		3 m/s		1.0%	0.7%	2.7%	1.8%	2.2%	4.0%	1.5%	0.2%
		4 m/s		0.9%	0.8%	2.9%	1.5%	2.8%	6.0%	1.4%	0.0%
		≥5 m/s		1.1%	1.4%	4.7%	3.0%	18.4%	20.1%	4.5%	0.3%
	Evening	Calm	0.3%								
		1 m/s		0.2%	0.8%	1.2%	2.6%	2.5%	0.9%	0.8%	0.1%
		2 m/s		0.5%	0.4%	0.9%	7.0%	4.3%	2.9%	1.0%	0.1%
		3 m/s		0.9%	0.3%	0.9%	5.7%	4.1%	4.1%	0.6%	0.0%
		≥4 m/s		1.7%	0.7%	1.5%	8.6%	22.2%	18.5%	3.8%	0.0%
	Night	Calm	0.5%								
		1 m/s		0.3%	2.4%	4.2%	2.3%	1.3%	0.5%	0.3%	0.1%
		2 m/s		0.5%	2.3%	6.0%	7.0%	2.6%	1.5%	0.6%	0.0%
		3 m/s		0.5%	1.1%	6.0%	7.8%	1.9%	2.2%	1.1%	0.0%
		≥4 m/s		0.8%	1.0%	11.4%	13.5%	3.8%	12.1%	3.9%	0.6%
October	Day	Calm	0.1%								
		1 m/s		0.1%	0.2%	0.4%	0.4%	0.5%	0.3%	0.2%	0.1%
		2 m/s		0.3%	0.4%	1.1%	1.1%	1.5%	1.4%	0.7%	0.1%
		3 m/s		0.3%	0.4%	1.1%	1.6%	2.2%	3.7%	0.9%	0.0%
		4 m/s		0.2%	0.2%	0.7%	1.5%	3.1%	6.9%	1.7%	0.0%
		≥5 m/s		0.2%	0.2%	1.1%	2.5%	27.2%	29.2%	6.0%	0.1%
	Evening	Calm	0.2%								
		1 m/s		0.1%	0.1%	0.1%	0.4%	0.5%	0.3%	0.4%	0.1%
		2 m/s		0.4%	0.2%	0.1%	0.9%	1.9%	1.8%	0.8%	0.1%
		3 m/s		0.4%	0.2%	0.0%	0.5%	3.2%	4.2%	1.9%	0.0%
		≥4 m/s		0.7%	0.1%	0.1%	1.8%	46.7%	25.8%	6.0%	0.0%
	Night	Calm	0.2%								
		1 m/s		0.1%	0.5%	2.1%	1.6%	1.3%	0.6%	0.3%	0.1%
		2 m/s		0.1%	0.2%	3.7%	4.9%	2.7%	1.3%	0.6%	0.1%
		3 m/s		0.1%	0.2%	3.2%	8.2%	3.4%	2.8%	1.6%	0.1%
		≥4 m/s		0.9%	0.4%	3.4%	16.6%	18.6%	14.4%	5.3%	0.3%
November	Day	Calm	0.0%								
		1 m/s		0.2%	0.2%	0.1%	0.2%	0.3%	0.3%	0.2%	0.1%
		2 m/s		0.3%	0.2%	0.4%	0.9%	1.0%	0.9%	0.6%	0.1%
		3 m/s		0.2%	0.1%	0.9%	1.0%	1.5%	2.8%	1.2%	0.1%
		4 m/s		0.3%	0.2%	0.7%	1.0%	2.7%	6.2%	1.6%	0.1%
		≥5 m/s		0.5%	0.5%	2.5%	1.9%	33.6%	30.2%	4.0%	0.0%
	Evening	Calm	0.0%								
		1 m/s		0.3%	0.1%	0.1%	0.3%	0.4%	0.2%	0.6%	0.3%
		2 m/s		0.1%	0.0%	0.1%	1.4%	1.7%	1.7%	0.7%	0.1%
		3 m/s		0.0%	0.0%	0.0%	1.1%	2.6%	3.9%	0.2%	0.0%

Month	Period	Wind Speeds	Percentage Occurrence of Winds from different Directions								
			Calm	N	NE	E	SE	S	SW	W	NW
		≥4 m/s		0.1%	0.6%	0.1%	2.6%	53.4%	25.1%	2.2%	0.0%
	Night	Calm	0.3%								
		1 m/s		0.3%	0.2%	0.6%	1.8%	1.5%	0.5%	0.3%	0.2%
		2 m/s		0.2%	0.1%	1.3%	5.1%	3.8%	1.6%	0.6%	0.1%
		3 m/s		0.1%	0.0%	2.0%	6.8%	4.8%	3.2%	1.0%	0.1%
		≥4 m/s		0.5%	0.6%	3.3%	15.0%	23.5%	17.6%	2.9%	0.1%
December	Day	Calm	0.0%								
		1 m/s		0.2%	0.1%	0.2%	0.3%	0.6%	0.4%	0.3%	0.2%
		2 m/s		0.4%	0.3%	0.3%	0.7%	1.2%	1.0%	0.8%	0.2%
		3 m/s		0.4%	0.3%	0.8%	0.9%	1.8%	2.9%	0.8%	0.1%
		4 m/s		0.3%	0.3%	1.0%	1.0%	2.9%	6.4%	1.2%	0.0%
		≥5 m/s		0.3%	1.0%	2.2%	1.7%	37.6%	27.5%	1.5%	0.0%
	Evening	Calm	0.3%								
		1 m/s		0.2%	0.2%	0.2%	0.6%	0.9%	0.3%	0.4%	0.1%
		2 m/s		0.4%	0.3%	0.1%	1.6%	2.4%	1.2%	0.6%	0.1%
		3 m/s		0.4%	0.1%	0.3%	0.7%	2.8%	2.9%	0.6%	0.1%
		≥4 m/s		0.3%	0.1%	1.0%	1.6%	53.9%	25.1%	0.1%	0.1%
	Night	Calm	0.4%								
		1 m/s		0.5%	0.6%	0.8%	2.0%	2.6%	1.3%	0.5%	0.2%
		2 m/s		0.6%	0.5%	1.0%	4.6%	5.1%	2.3%	0.5%	0.1%
		3 m/s		0.5%	0.3%	1.7%	5.6%	4.6%	3.0%	0.3%	0.0%
		≥4 m/s		0.3%	0.6%	4.2%	7.7%	33.3%	13.6%	0.8%	0.0%

Table E2: **Annual percentage occurrence for different wind speeds and directions.**

Period	Wind Speeds	Annaul Percentage Occurrence of Winds from different Directions								
		Calm	N	NE	E	SE	S	SW	W	NW
Day	Calm	0.3%								
	1 m/s		0.5%	0.7%	0.7%	0.7%	0.9%	0.6%	0.5%	0.2%
	2 m/s		0.7%	0.9%	2.1%	1.5%	1.8%	1.5%	0.9%	0.1%
	3 m/s		0.6%	0.9%	3.2%	1.6%	2.4%	3.1%	1.1%	0.1%
	4 m/s		0.5%	0.8%	2.8%	1.4%	3.2%	4.8%	1.1%	0.0%
	≥5 m/s		1.4%	2.7%	4.6%	3.2%	24.7%	17.9%	3.3%	0.1%
Evening	Calm	0.6%								
	1 m/s		0.3%	0.9%	1.5%	1.9%	1.5%	0.7%	0.5%	0.2%
	2 m/s		0.3%	0.5%	2.1%	4.4%	2.8%	1.7%	0.6%	0.1%
	3 m/s		0.4%	0.4%	2.7%	4.2%	3.0%	2.9%	0.6%	0.0%
	≥4 m/s		1.2%	1.3%	3.8%	6.6%	34.1%	15.3%	3.4%	0.0%
Night	Calm	0.7%								
	1 m/s		0.4%	1.8%	2.6%	2.3%	1.8%	0.6%	0.3%	0.1%

Period	Wind Speeds	Annaul Percentage Occurrence of Winds from different Directions								
		Calm	N	NE	E	SE	S	SW	W	NW
	2 m/s		0.3%	1.4%	4.7%	5.2%	3.2%	1.2%	0.4%	0.0%
	3 m/s		0.4%	0.8%	5.8%	5.9%	2.8%	1.8%	0.6%	0.0%
	≥4 m/s		1.2%	2.3%	11.1%	10.4%	15.7%	10.5%	3.7%	0.1%