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Prepared for: **Chancery Green on behalf of Refining NZ**

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Title: **Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects**

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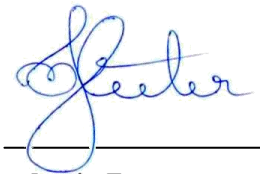

Jamie Exeter

Executive Summary

Styles Group has been engaged by The New Zealand Refining Company (RNZ) to undertake an acoustic assessment for the proposed crude shipping project (CSP), comprising a proposal to realign and deepen the entrance to the Whangarei Harbour and the Marsden Point berthing area to allow more fully-laden tankers to berth and manoeuvre in front of the jetty. The project involves capital dredging and disposal, maintenance dredging and disposal and the construction of new and relocation of existing navigation aids.

This assessment comprises an investigation into the airborne noise levels and effects arising from the CSP for the project extent identified in Channel Option 4-2 of the proposal. Potential receivers have been limited to the Northport industrial site and residential properties along the coastline of the Whangarei Heads (from Reotahi Bay to Urquharts Bay).

Potentially affected sites have been identified as the residential areas along the coast of the Whangarei Heads, specifically, those at Reotahi Bay, Little Munroe Bay, McGregors Bay, Taurikura Bay, McKenzie Bay and Urquharts Bay. Residential properties at Marsden Bay have not been included as potentially affected sites as the nearest dwelling is approximately 1700m from the proposed dredging area and is outside the area that is predicted to be affected by dredging noise. Dredging activities taking place at the eastern limit of the Dredging Extent (shown in purple in Appendices A - G) are most likely to generate adverse noise effects for coastal dwellings on Whangarei Heads.

The project area covers several zones as set out in the NRCP maps, including dredging and installation of navigational aids in the Marine 2 (Conservation) Management Area and the Marine 5, (Port Facilities) Management Area. Rules 31.4.13 and 31.7.12 set out the noise controls for permitted activities for those zones, and cite the same content for both zones. Subsection (a)(iii) of both rules clearly devolves the determination of the permitted activity criteria to the Whangarei District Plan. Rule *NAV.6.2 Construction Noise* of the District Plan therefore sets the noise limits for permitted activities for the project. This rule requires compliance with the provisions of NZS6803:1999 *Acoustics – Construction Noise.*

To characterise the ambient noise environment on the north side of the harbour, noise measurements have been undertaken (MDA 2016) over two week-long periods in October 2015 utilising noise loggers. The noise measurements show that during the day time, ambient L_{Aeq} noise levels vary but are typically between 45dB to 50dB L_{Aeq} when the wind direction is from the west or south, and between 40dB and 45dB when the wind is offshore, or from the north or east. In our opinion, the measured ambient noise levels describe an area subject to a reasonably high level of acoustic amenity.

The CSP could utilise three common types of dredgers: a trailing suction hopper dredger (TSHD), a cutter-suction dredger (CSD) and a mechanical backhoe dredger (BHD). TSHDs are

self-propelled vessels coupled with hoppers and articulated dredging pipes that extend onto the sea-floor, while CSDs and BHDs are stationary systems that use either hydraulic pumps or mounted excavators, respectively (RHDHV 2016).

The final selection and procurement of the dredging plant and equipment has not been undertaken and will not be until closer to the commencement of the project. The selection of any particular vessel will be dependent many factors, including its availability. We have therefore based our assessment on published data for the types of dredging methods and vessels that are likely to be used.

Styles Group has used the globally recognised Bruel & Kjaer Predictor^{tm} acoustic modelling software to prepare predictions of the noise levels likely to be generated based on compliance with ISO9613-1/2 *Attenuation of sound during propagation outdoors*. Dredging and disposal activities outside of the harbour have not been modelled due to the noise emissions being so low at receivers that it will likely be inaudible and not measureable for all or most of the time. Only dredging inside the harbour (generally north of Busby Head) is included in this assessment.

A number of possible wind conditions have been utilised in the predictions based on the wind rose from the Marsden Point area (MetOceanSolutions, 2015) to demonstrate how wind from different directions will influence the propagation of noise from the dredging equipment. For the purpose of assessing the noise effects, and having regard to the uncertainty of the time of year that dredging may be undertaken, we recommend that the neutral to slightly positive meteorological conditions represented by the C0=0 modelling outputs are relied on.

The noise modelling shows that comfortable compliance with the relevant noise limits in Rules 31.4.13 and 31.7.12 of the NRCP for permitted activities is achieved for dredging inside the harbour, except when dredging is undertaken generally north of the No. 18 navigation buoy when the 45dB L_{Aeq} noise limit applies (at night and on Sundays and Public Holidays) and when the wind is blowing from any direction other than the northern quarter. We have therefore recommended that dredging work in these conditions is not undertaken in order to ensure that compliance is achieved, unless noise measurements of the dredging vessels commissioned show that compliance can be achieved. The predicted noise levels for all other dredging positions under various meteorological conditions show that compliance with all of the relevant noise limits at all times of the day can be achieved, in most cases by a large margin.

The noise effects of the dredging project will be unnoticeable for a large proportion of the project for the receivers on the northern side of the harbour. Dredging and disposal activities will be inaudible and not measureable when the vessels are outside of the harbour or generally east of Busby Head. For all other locations within the harbour, the dredging activity will be audible to some receivers but generally at noise levels less than 45dB L_{Aeq}. The ambient noise level during the day is generally considerably higher than this level and in such cases the dredging

will likely be inaudible over other sources in the environment such as traffic, birds, insects, wind in the trees or waves on the shore.

We recommend that the dredging operations are subject to a noise management plan (NMP). The NMP should include provisions for noise monitoring at the commencement of dredging for each dredge to determine actual noise emissions, and based on these noise measurements, a recalibration of the computer noise models for each dredging vessel to determine whether any change or refinement of the restrictions on dredging being required. Ongoing noise monitoring should be undertaken to ensure compliance and in response to reasonable complaints. A draft NMP is attached to this report at Appendix H. In our opinion, and if the recommendations in this report are adhered to, we consider that the noise effects arising from the CSP will be reasonable in terms of s16 of the Act and less than minor.

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Appendices:

1. Introduction

Styles Group has been engaged by The New Zealand Refining Company (RNZ) to undertake an acoustic assessment of the proposed crude shipping project (CSP), comprising a proposal to realign and deepen the entrance to the Whangarei Harbour and the Marsden Point berthing area to allow more fully-laden tankers to berth and manoeuvre in front of the jetty.

1.1 The Proposal

RNZ has identified the need to expand the berthing and channel capacity up to the Marsden Point oil refinery to allow more fully-laden ships to dock and manoeuvre at the refinery. It is proposed to deepen an 8.5km section of the existing channel from the 20m depth contour up to and including the berthing pocket at the RNZ refinery site on Marsden Point. RNZ has investigated multiple options for the dredging project and Channel Option 4-2 has been selected as the preferred option. The proposal estimates that the removal of 3,700,000m^3 of material is required to achieve a channel depth of 19 - 16.5m below the chart datum. Two marine disposal areas are proposed to accommodate the displaced material. Maintenance dredging may also need to be carried out every 2 - 5 years to maintain a sufficient clearance in the channel and berth pocket area. Similar dredging equipment is likely to be utilised for the maintenance dredging although a shorter works duration is expected.

It is anticipated that a Trailing Suction Hopper Dredger (TSHD) will be used for the majority of the CSP in conjunction with a Backhoe Dredger (BHD) for dredging works in close proximity to the berthing jetty and sections of the inner and mid channel areas. A Cutter Suction Dredger (CSD) may also be used for some sections of the alignment. For the majority of the dredging operation (using a TSHD), the estimated cycle time is 110 - 180 minutes and involves loading of the vessel, sailing to a marine disposal site, unloading and returning to the dredge site to recommence work. A TSHD is capable of operating 24/7 and the expected duration of the main dredging activity is around 6 months, with allowance for inoperable weather conditions. Several new navigation aids will also be installed and several of the existing aids will be relocated. These activities will be completed generally over six days per navigational aid by relatively low noise barge and lifting equipment, except that some piling work will be required for the installation of Taurikura Leads.

The use of a BHD for dredging in the berthing pocket is estimated to enable two barge sailings per day with works taking place during daylight hours only, seven days a week. In this case, a BHD would be used to load a barge to transfer the dredged material from the dredging site to a disposal area. Works in the berthing pocket area are projected to take up to 2 to 3 months to complete using this method. A CSD may also be used for dredging in the berthing pocket, inner / mid-channel areas and for maintenance dredging. A CSD may utilise a barge or a discharge pipeline for transport of dredged material. Production rates for a CSD are higher than a BHD but

lower than a TSHD. An assortment of smaller support vessels will also be required for surveying, crew transfer and for towing the barge to and from the disposal locations.

1.2 The Existing Acoustic Environment and Potential Receivers

Noise measurements carried out by Marshall Day Acoustics for other RNZ projects (MDA 2016) have been used to characterise the ambient noise environment for receivers on the northern side of the harbour. The receivers of noise are limited to occupied buildings on the Northport site and all occupied buildings on the northern side of the harbour.

1.3 Scope of Assessment

This assessment comprises an investigation into the airborne noise levels and effects arising from the CSP for the dredging extent identified in Channel Option 4-2 of the proposal. Potential receivers have been limited to the Northport industrial site and residential properties along the coastline of the Whangarei Heads (from Reotahi Bay to Urquharts Bay).

A detailed computer noise model has been prepared and analysed for a number of likely and worst case dredging positions. Multiple weather conditions have been included for each dredging location to predict the effect of different wind directions on noise propagation. A number of assumptions were necessary to construct the noise model.

2. Potentially Affected Sites

Potentially affected sites have been identified as the residential areas along the coast of the Whangarei Heads, specifically, those at Reotahi Bay, Little Munroe Bay, McGregors Bay, Taurikura Bay, McKenzie Bay and Urquharts Bay. Residential properties at Marsden Bay have not been included as potentially affected sites as the nearest dwelling is approximately 1700m from the proposed dredging area and is outside the area that is predicted to be affected by dredging noise. Dredging activities taking place at the eastern limit of the Dredging Extent (shown in purple) are most likely to generate adverse noise effects for coastal dwellings on Whangarei Heads.

The industrial site at Northport has been assessed as a potentially affected site. Dredging activities in the proximity of the Marsden Point berthing jetty are most likely to affect this site.

3. Noise Performance Criteria

The noise levels that are anticipated to be generated by the CSP have been assessed in accordance with New Zealand standards against the requirements of the Northland Regional Coastal Plan, (NRCP), the Whangarei District Plan (the District Plan), the Resource Management Act (the Act) and NZS 6803:1999 - *Acoustics: Construction Noise* (NZS6803).

We consider that the capital dredging works are deemed to be within the definition of construction as defined by NZS6803. Construction work is defined in section 3.1 of NZS6803 as (emphasis added):

> *CONSTRUCTION WORK means any work in connection with the construction, erection, installation, carrying out, repair, maintenance, cleaning, painting, renewal, removal, alteration, dismantling, or demolition of:*
>
> *a) Any building, erection, edifice, structure, wall, fence or chimney, whether constructed wholly or in part above or below ground level;*
>
> *b) Any road, motorway, harbour or foreshore works, railway, cableway, tramway, canal or aerodrome;*
>
> *c) Any drainage, irrigation or river control work;*
>
> *d) Any electricity, water, gas or telecommunications reticulation;*
>
> *e) Any bridge, viaduct, dam, reservoir, earthworks, pipeline, aqueduct, culvert, drive, shaft, tunnel or reclamation; or*
>
> *f) Any scaffolding.*
>
> *Construction work includes:*
>
> *g) Any work in connection with any excavation, site preparation, or preparatory work, carried out for the purpose of construction work;*
>
> *h) The use of any plant, tools, gear, or materials for the purpose of any construction work;*
>
> *i) Any construction work carried out underwater, including work on ships, wrecks, buoys, rafts, and obstructions to navigation; and*
>
> j) *Any inspection or other work carried out for the purpose of determining whether construction work should be carried out.*

Accordingly, we have referred to the relevant sections of the NRCP and District Plan to determine the criteria for permitted activities.

3.1 District Plan / Regional Coastal Plan

The area to be dredged covers several zones as set out in the NRCP maps, including Marine 2 (Conservation) Management Area and Marine 5, (Port Facilities) Management Area.

Rules 31.4.13 and 31.7.12 set out the noise controls for permitted activities for those zones, and cite the same content for both zones. Rules 31.4.13 and 31.7.12 state:

The following standards shall apply to all specified permitted, controlled, restricted discretionary and discretionary activities, and to all non-complying activities, listed in the (Marine 2 (Conservation) Management Area and Marine 5 (Port Facilities) Management Area)*:*

(a) Noise generated as a result of activity within the coastal marine area shall comply with the following standards:

(i) the activity shall not cause excessive noise as defined in section 326 of the Resource Management Act; and

(ii) any construction or maintenance activity near coastal subdivisions or other urban areas shall comply with the noise standards of the district council which is responsible for the use of the adjoining land.

Subsection (a)(iii) clearly devolves the determination of the permitted activity criteria to the Whangarei District Plan. Rule *NAV.6.2 Construction Noise* of the District Plan therefore sets the noise limits for permitted activities for the project.

NAV.6.2 Construction Noise

Noise from demolition and construction, including that undertaken as part of temporary military training activities, shall comply with the guidelines and recommendations of NZS 6803: 1999 "Acoustics - Construction Noise". Noise levels shall be measured and assessed in accordance with New Zealand Standard NZS 6803: 1999 "Acoustics - Construction Noise". NAV.6.2 shall not apply to permitted maintenance or utility works undertaken within the road carriageway of a road where:

a) It has been demonstrated to Council that these works cannot reasonably comply with the referenced noise guidelines at the time when they must be carried out; and

b) A construction noise and vibration management plan, as prepared by a Recognised Acoustician, has been provided to Council.

3.2 New Zealand Standard NZS6803:1999

Rule NAV6.2 of the District Plan prescribes compliance with the provisions of NZS6803 for permitted activities. We understand that the proposed dredging activity is expected to take slightly longer than 20 weeks to complete. Therefore, construction noise arising from dredging activities is assessed under the long-term duration criteria set out in Tables 2 and 3 of Table NZS6803:1999 (Tables 1 and 2 of this document). These noise limits apply at 1m from the most exposed facade of any occupied building used for activities which may be affected by construction noise.

Table 1 - Recommended upper limits for construction noise received in residential zones and dwellings in rural areas

Time of Week	Time Period	Long-term duration (dBA)	
		L_{eq}	L_{max}
Weekdays	0630-0730	55	75
	0730-1800	70	85
	1800-2000	65	80
	2000-0630	45	75
Saturdays	0630-0730	45	75
	0730-1800	70	85
	1800-2000	45	75
	2000-0630	45	75
Sundays and public holidays	0630-0730	45	75
	0730-1800	55	85
	1800-2000	45	75
	2000-0630	45	75

Table 2 - Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year

Time Period	Long-term duration
	L_{eq} (dBA)
0730-1800	70
1800-0730	75

As set out later in this report, the noise emissions affecting the majority of the receivers of noise on the northern and eastern sides of the harbour will be subject to compliance with the criteria in Table 1 above, whereas noise affecting the commercial receivers on the western side of the harbour is subject to the limits in Table 2.

The noise levels at any occupied building are assessed typically over a 15 minute period. There is no averaging or other adjustment over the day, night or any other period. The noise

limits set out in NZS6803 must be complied with for every 15 minute period during which works are undertaken.

Clause 7.2.6 of NZS6803 states that when setting noise limits for construction activities, a major factor which should be considered is:

> *"...whether there is a relatively high background sound level (L_{90}) due to noise from sources other than construction work at the location under investigation. In such cases, limits should be based on a determination of the existing level of noise in the area (a "background plus" approach)*.

Based on the noise measurements undertaken by MDA (MDA 2016) the background sound level at the noise measurement locations is relatively high depending on the meteorological conditions. However, we do not consider that it would be appropriate to seek resource consent for higher noise limits at night, Sundays or Public Holidays or any other period for this project.

In our opinion, the adoption of the provisions of NZS6803 is appropriate and accords with the approach taken for numerous other projects around the country, including large scale infrastructure and roading and private projects. We consider that compliance with the noise limits in NZS6803 will provide a good balance of allowing higher noise limits to enable works to progress without undue delay whilst providing a good degree of protection of amenity at critical times such as night and on Sundays and Public Holidays.

3.3 Resource Management Act 1991

The dredging works are also subject to comply with the duties of s16 of the Act. Subsection (1) states:

> *Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, shall adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level.*

This section introduces the duty that requires the occupier of land (and any coastal marine area) to ensure that the Best Practicable Option (BPO) is adopted such that the levels of noise and vibration generated by the construction activities are no greater than reasonable.

Importantly, the BPO is defined in the interpretations section of the Act (s2), which states:

> *Best practicable option, in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to -*

(a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

(b) the financial implications, and the effects on the environment, of that option when compared with other options; and

(c) the current state of technical knowledge and the likelihood that the option can be successfully applied.

3.4 New Zealand Standards

NZS6803 requires that noise level measurements are undertaken in accordance with the requirements of NZS6801:2008 *Acoustics – Measurement of Environmental Sound*. The pertinent provisions relate to accuracy and calibration requirements for instrumentation used for measurement, measurement positions and duration, meteorological effects, noise level descriptors and uncertainty. The provisions of this standard need not be referenced in this report as they are generally only relevant for the measurement of noise from the project once works commence. Notwithstanding, our assessment has been prepared on the basis that the relevant provisions of this standard are complied with at all times.

4. Ambient Noise Environment

To characterise the ambient noise environment on the north side of the harbour, noise measurements have been undertaken by MDA (MDA 2016). Unattended noise measurements were carried out at two properties over two week-long periods in October 2015 utilising noise loggers. One noise logger was placed at 14 The Heights (Reotahi Bay), which had a direct view of the refinery and port areas, and the other at 73 Bay View Road (Little Munroe Bay), which had a direct view of the refinery but the port was obscured from view by Lort Point. Attended noise measurements were also taken at Taurikura and Urquharts Bay. The noise measurements show that during the day time, ambient L_{Aeq} noise levels vary but are typically between 45dB to 50dB L_{Aeq} when the wind direction is from the west or south, and between 40dB and 45dB when the wind is offshore, or from the north or east. The variation in noise level is to be expected for an environment such as this, with noise sources such as the Refining New Zealand and NorthPort sites and waves on the shore and in the harbour being more noticeable when the receivers are downwind. Conversely, when the wind is blowing offshore and towards the RNZ and Northport sites, the noise levels at the receivers are correspondingly lower.

By observation of the data obtained by MDA, noise levels at the measurement locations are up to 10dB higher when the measurement locations are downwind of the Refining New Zealand and NorthPort sites when compared to upwind conditions. This suggests a variation of +/- 5dB between upwind or downwind and neutral meteorological conditions over a distance of approximately 1.2km to 1.4km depending on the exact location of the noise source.

The noise levels on some days were considerably higher at up to approximately 60dB L_{Aeq}. Localised contamination is expected to be the cause of such high levels, including traffic, birds and insects, construction or other anthropogenic sources.

In our opinion, the measured ambient noise levels describe an area subject to a reasonably high level of acoustic amenity.

5. Noise Level Predictions

5.1 Dredging Methods and Equipment

The CSP could utilise three common types of dredgers: a trailing suction hopper dredger (TSHD), a cutter-suction dredger (CSD) and a mechanical backhoe dredger (BHD). TSHDs are self-propelled vessels coupled with hoppers and articulated dredging pipes that extend onto the sea-floor, while CSDs and BHDs are stationary systems that use either hydraulic pumps or mounted excavators, respectively (RHDHV 2016). Full descriptions and explanations of the operating mechanisms for each dredger-type are provided in RHDHV (2016).

The methods and dredging equipment that are proposed are based on the project team's evaluation of the best practicable methods and equipment available. The evaluation has taken into account a large number of advantages and disadvantages of each option and from an acoustical perspective the evaluation forms the majority of the determination of the BPO.

The final selection and procurement of the dredging plant and equipment has not been undertaken and will not be until closer to the commencement of the project. The selection of any particular vessel will be dependent many factors, including its availability. We have therefore based our assessment on published data for the types of dredging methods and vessels that are likely to be used. There may therefore be some variation between the noise levels predicted and those measured once the project commences, although we do not expect any difference to be appreciable.

Dredging of Channel Option 4-2 comprises the following general methods and equipment:

(i) A BHD may be utilised to dredge the Marsden Point berthing area. A BHD consists of an excavator mounted on a dredging pontoon and is usually anchored using spud poles to maintain a constant position while dredging. For the purpose of assessing noise levels a BHD generally remains stationary while an area is dredged.

(ii) A TSHD is likely to be used for the majority of the project, especially the outer channel section. A TSHD is a vessel that uses trailing arms to vacuum material from the seafloor while following a predetermined dredge route. Material is deposited onto the TSHD as it moves forward until the fill capacity is reached at which point the arms are lifted and the TSHD travels to the designated disposal area where the dredged material is deposited.

(iii) A CSD is a more efficient alternative to a BHD but is less precise for dredging around marine obstacles. A CSD is anchored using spud poles while a cutting head, fixed to the end of a suction arm, draws material onto a barge. For the purpose of assessing noise levels the CSD remains generally stationary while an area is dredged and once the barge reaches capacity it is towed to a disposal site.

No specific noise measurements were able to be undertaken for this project as the dredge type, size and specific vessel details are yet to be confirmed at this time. However, noise emission data from measurements undertaken by Delta, of BHD vessel MJØLNER R, has been used as a noise source input for the dredger within the computer noise model. Delta has published noise emission data, from two instances of measurements, of the same BHD vessel MJØLNER R made in 2006 (Delta 2006) and in 2011 (Delta 2011) which show good agreement (within 1dB) in the measured sound power levels. We understand that MJØLNER R, which is capable of excavating to depths of up to 22m below ocean surface level, is adequately sized and a realistic choice for the proposed works. Noise data for the TSHD vessel BRAGE R was also available (Delta 2005) and in this case the measurements show that the BHD vessel MJØLNER R is the louder of the two dredgers. As there is uncertainty over the exact equipment to be used for the dredging operations at this stage in the project, the louder BHD emission data has been used for the noise modelling of all dredging operations.

The noise data for MJØLNER R shows measured sound pressure levels of 66dBA at 100m from the vessel and 46dBA at 1km from the BHD, which equate to a sound power level (SWL) of 114dBA. The emission spectrum used in the computer noise model has been reproduced in Table 3 - Emission spectrum reproduced from the Delta Report for use in the noise model.

Table 3 - Emission spectrum reproduced from the Delta Report for use in the noise model

A-weighted sound power levels [dB re 1pW]									
	63Hz	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**Total**
MJØLNER R	91.3	104.3	106.4	106.6	108.6	108.2	102.4	95.7	114.4

The BHD emission spectrum comprises a relatively strong low frequency component which will be a fundamental component of the noise received onshore. The noise model has been calibrated using the supplied noise emission values for a BHD to a level of 66dB L_{Aeq} at 100m from the source.

To model the path of the faster moving TSHD dredge, a track has been used in the noise modelling predictions which assumes a dredging speed of approximately 2-3 knots. At this speed the dredge will cover a distance of up to approximately 1400m in any 15 minute period. The BHD advances at a much slower rate and for the purpose of this assessment has been assumed to remain stationary over a given 15 minute period.

5.2 Noise Modelling

Styles Group has used the globally recognised Bruel & Kjaer Predictor[tm] acoustic modelling software to prepare predictions of the noise levels likely to be generated based on compliance with ISO9613-1/2 *Attenuation of sound during propagation outdoors*. The noise level predictions

are based on meteorological conditions that slightly enhance propagation in all directions in accordance with NZS6802:2008 *Acoustics – Environmental Noise*, and further noise level predictions have been prepared to show the effects of specific meteorological conditions which enhance or impede the propagation of noise towards receivers. The B&K Predictor^{tm} software has been successfully implemented on a large number of projects in New Zealand. Table 4 displays the input parameters used in our model.

Digital terrain data for use in the noise model has been provided to us by the Northern Regional Council in the form of 1m height contours around residential areas on Whangarei Heads and the Marsden Point area. Height data for the remaining area has been sourced from LINZ as 20m contours.

Dredging and disposal activities outside of the harbour have not been modelled due to the noise emissions being so low at receivers that it will likely be inaudible and not measureable for all or most of the time. Only dredging inside the harbour (generally north of Busby Head) is included in this assessment. We understand that including the work around the jetty, the works and movement of construction-related vessels inside the harbour will likely be less than half of the six months to complete the entire capital dredging phase of the project.

Dredging locations used in the noise model have been selected to represent the typical and worst case dredging locations within the proposed dredging extents, the latter being closest to receivers on the north and eastern sides of the harbour. See Appendices A to G for the dredging positions used for the prediction of noise levels. The noise levels arising from dredging in all other positions will be lower.

The noise level predictions for the piling associated with the installation of navigational aids has been undertaken using empirical data from a large number of noise measurements undertaken by Styles Group of piling operations around New Zealand. For the drop hammer or vibro-piling methods, a reference sound power level (SWL) of 118dBA has been used (equivalent to 90dB L_{Aeq} at 10m). This equates to a minimum separation distance of 100m to achieve compliance with the day time (Monday to Friday) noise limit of 70dB L_{Aeq}.

All noise modelling work has been undertaken in accordance with the requirements of NZS 6802:2008 - Environmental Noise.

Table 4 - Predictor noise model input parameters

Parameters/calculation settings	Details
Software	Brüel & Kjær Predictor
Calculation method	ISO 9613.1/2
Meteorological parameters (CONCAWE)	Single value, C0 = 0 or as otherwise described
Ground attenuation over land	General method, ground factor 0.9
Ground attenuation over water	Ground factor 0
Air temperature	293.15K
Atmospheric pressure	101.33kPa
Air humidity	60%
Source height (relative)	10-16m above sea level
Receiver heights (relative)	1.5m above ground

5.3 Meteorological Effects

A number of possible wind conditions have been utilised in the predictions based on the wind rose from the Marsden Point area (MetOceanSolutions, 2015) to demonstrate how wind from different directions will influence the propagation of noise from the dredging equipment.

For each dredging position or track that has been modelled, four probable wind directions (from the north, east, south and west) have been input into the model using a typical wind speed of 3-6ms^{-1} (6-12 knots). Other wind speeds have been tested but showed no appreciable variation in the model outputs. At higher wind speeds, a greater degree of masking of any dredging noise as a result of tree leaves rustling and wavelets crashing on the shore can be expected. The Pasquill Stability Category used in these prediction models is D based on the likely weather conditions although other stability criteria were tested in the model with no noticeable difference in the model outputs.

Although we have implemented four different wind conditions in our noise predictions, we note that the wind conditions are likely to be extremely variable. It is common practice to give weight to the effects of local weather conditions where any particular condition prevails for at least 30% of the assessment period. In this case, the most common wind direction prevails for only 15% of the time, based on annual wind observations. It is therefore our opinion that the most appropriate meteorological conditions for the prediction of noise levels are those that (theoretically) enhance propagation in all directions.

For this reason, we have included noise modelling results based on meteorological conditions that enhance the propagation of sound in all directions as an additional (and conservative) model for each dredging position or track. The meteorological correction term (C0) for this model is 0. The CONCAWE method has been utilised in all noise modelling. This method has been integrated into the noise modelling software.

5.4 Modelling Results

The noise modelling shows that comfortable compliance with the relevant noise limits is achieved for dredging inside the harbour, except when dredging is undertaken generally north of the existing No. 18 navigation buoy and including works in the jetty area when the 45dB L_{Aeq} noise limit applies (at night and on Sundays and Public Holidays) and when the wind is blowing from any direction other than the northern quarter (>315º and <45º). Appendices B, C and D show the noise level contours for this scenario.

The predicted noise levels for all other positions under various meteorological conditions show that compliance with all of the relevant noise limits at all times of the day can be achieved, in most cases by a large margin.

In general terms, and using a distance of 800m between the dredge and the receiver, the assessment of noise levels when the wind is blowing towards the dredge shows that the noise level will reduce by approximately 3.5dB compared to neutral or slightly positive meteorological conditions (C0=0). Conversely, the noise levels will increase by approximately the same amount when the wind is blowing generally from the dredge to the receiver.

Because the ambient noise levels rise and fall under the same meteorological conditions (where noise levels are generally higher during onshore winds) the slightly higher noise levels from dredging arising during downwind conditions will be somewhat masked. Conversely, when the wind is offshore for the receivers on the northern side of the harbour (generally) and the ambient noise levels lower, the noise from dredging will also be lower.

For the purpose of assessing the noise effects, and having regard to the uncertainty of the time of year that dredging may be undertaken, we have relied on the neutral to slightly positive meteorological conditions represented by the C0=0 modelling outputs. These modelling outputs represent the noise levels that could be expected during conditions that slightly enhance propagation in a hypothetical case where every receiver is downwind of the noise source. This represents a conservative assessment approach in that noise levels will be much less than those predicted when the receivers are not downwind of the source.

The prediction of noise from piling operations is comparatively simple, where the point source is stationary and known with a high degree of certainty. The noise level from piling activities will be compliant with the day time noise limit of 70dB L_{Aeq} at a distance of 100m. Given that the

piling will be no closer than approximately 400m from land, the noise levels will be compliant by a considerable margin and generally less than 55-60dB L_{Aeq}.

5.5 Assessment of Noise Effects – Capital and Maintenance Dredging

The noise effects of the dredging project will be unnoticeable for a large proportion of the project for the receivers on the northern side of the harbour. Dredging will be inaudible and not measureable when the vessels are outside of the harbour or generally east of Busby Head.

When dredging is undertaken inside the harbour, noise from the vessels will comply with the relevant noise limits by a significant margin except when dredging is undertaken generally north of the No. 18 navigation buoy at when the 45dB L_{Aeq} noise limit applies (at night and on Sundays and Public Holidays) and when the wind is blowing from any direction other than the northern quarter. Appendices B, C and D show the noise level contours for this scenario.

For all other locations within the harbour, the dredging activity will be audible to some receivers but generally at noise levels less than 45dB L_{Aeq}. The ambient noise level during the day is generally considerably higher than this level and in such cases the dredging will likely be inaudible over other sources in the environment such as traffic, birds, insects, wind in the trees or waves on the shore.

The noise effects for maintenance dredging will be generally less than that associated with the capital dredging phase as the volumes (and therefore timeframes) are less. Provided the maintenance dredging is undertaken in accordance with the conditions applied to the capital dredging, we consider that the effects will be less than minor and reasonable in terms of s16 of the Act also.

5.6 Assessment of Noise Effects – Piling Associated with Navigation Aids

The noise effects associated with the placement of navigation aids will be of short duration and relatively low noise level. The noise levels from piling activities will be the loudest of all activities associated with constructing or relocating navigational aids, and will generally be low 55-60dB L_{Aeq} at any receiver. The noise from other (non-piling) activities associated with the construction or relocation of navigational aids is expected to be very low, and likely inaudible and not measureable (with any reasonable degree of certainty) from shore. Provided the works are undertaken only when the noise limit of 70dB L_{Aeq} applies (Monday to Saturday 0730 to 1800) the noise levels will be readily compliant and reasonable in terms of s16 of the Act.

5.7 Assessment of Cumulative Noise Effects

Because the noise effects will only be temporary in nature, and generally over a very short term compared to the overall duration of the project, the utility of an assessment of cumulative noise effects is limited. It is our view that the cumulative effects are only a potential issue at night when the noise emissions from the CSP are permitted to be similar to that generated by the operation of the refinery generally.

The operational noise levels generated by the refinery are limited to a level of 45dB L_{Aeq} between the hours of 10pm to 7am at any receiver by NAV Rule 6.1 of the District Plan. This is the same noise limit that applies during the night[1] to the CSP as set out in Section 3.2 above. These noise limits are the same numerically, and theoretically this could allow for a combined noise level of 48dB L_{Aeq} to be received by the most exposed receivers. However, this would require the noise emissions of the refinery and the CSP to generating noise levels precisely at the maximum permitted which is very unlikely. Even if both activities were generating noise levels at their maximum respective limits at the same receiver, the combined noise level would be 48dB L_{Aeq}, being 3dB more than the respective noise limits. A difference of 3dB in this context would be just perceptible to the receiver.

When considering the very temporary nature of CSP activities which may approach the night time noise limit, the low probability that both the refinery and the CSP will be generating noise levels very close to their respective noise limits at the same time, and the very small potential increase in noise level, it is our opinion that the potential cumulative effects are negligible and no mitigation is required to address this issue.

5.8 Assessment of Noise Effects – Overall

The nature and scale of the CSP is similar to many large roading projects that have been or are being undertaken around the country in terms of earthworks volumes and timeframes. It is our opinion that the CSP will generate a significantly lesser degree of noise effects for the receivers than almost any other construction project of its size and nature undertaken on land. Compliance with the relevant noise limits for permitted activities will be achieved generally by a large margin.

In our opinion and based on our assessment, if the recommendations in this report are implemented, we consider that the noise effects arising from the CSP will be less than minor and reasonable in terms of s16 of the Act.

[1] Between the hours of 8pm and 6.30am Monday to Friday and 6pm to 6am on Saturdays, Sundays and Public Holidays.

6. Recommended Mitigation Measures

Our assessment has shown that during the day time, all potential methods of dredging will comply with the relevant noise limits by a considerable margin. During the night time and when the 45dB L_{Aeq} noise limit applies, dredging should not be undertaken inside the harbour north of the No. 18 navigation buoy when the wind direction is outside the northern quarter (>315º and <45º) i.e. from the east, west or south. Outside the harbour dredging can be undertaken at any time and without restriction for the purpose of managing noise effects.

Notwithstanding the above, we recommend that the noise emissions from dredging operations be monitored and managed throughout the project to ensure that the actual noise levels are no greater than what the relevant permitted activity noise limits allow.

We also recommend that the dredging operations are subject to a noise management plan (NMP) which should as a minimum address the following matters:

i) Noise monitoring at the commencement of dredging for each dredge to determine actual noise emissions;

ii) Based on these noise measurements, recalibration of the computer noise models for each dredge to determine whether any change to the restrictions on dredging are required;

iii) Ongoing noise monitoring to ensure compliance and in response to complaints (with a trigger to be defined);

iv) Promotion of awareness of the management of noise for the crew of the dredging vessels, including the maintenance of any unusually or unnecessarily noisy plant or equipment on the vessels that may be giving rise to unreasonable noise effects onshore;

v) A procedure for the receipt, response and management of any noise-related complaints that RNZ may receive during the project.

A draft NMP is attached at Appendix H of this report. It is our opinion that if the NMP is adopted and adhered to the noise levels and effects of the project will be no greater than what we have predicted.

7. Recommended Monitoring

We recommend that monitoring of noise emissions is undertaken during the project to confirm whether compliance with the relevant noise limits is being achieved and to ensure that the restrictions and allowances on the times and locations of works being undertaken remain valid. The noise monitoring requirements, including the timing and location will be highly variable and

dependent on the activity taking place at the time and also the meteorological conditions during the works.

As set out in Section 6 of this report, we recommend that noise monitoring is undertaken at the commencement of use of the dredging vessels as they arrive to determine whether any updates are required to the restrictions that are noted in this assessment. Such restrictions may relate to a combination of the time of day, location and weather conditions under which a particular vessel may be operated within in order to maintain compliance with the relevant noise limits.

Noise level monitoring should be used in conjunction with updating the noise prediction models (based on the actual measured levels) to assist with the determination of compliance under any particular scenario.

We also recommend that noise monitoring be undertaken throughout the project on a periodic basis and during times when dredging is being undertaken closest to the shoreline on the northern side of the harbour and also in response to any complaints. Whilst it would be inappropriate to require noise level measurements in response to *any* complaint, we do consider it reasonable to undertake noise level measurements in response to a reasonably justified complaint. For the purpose of determining whether monitoring should be undertaken, reference to 'the reasonable request of the Council' is often made in conditions of consent and could be used in this instance also.

8. Summary and Conclusions

Styles Group has been engaged by Refining NZ to undertake an acoustic assessment of the proposed crude shipping project (CSP), to determine the airborne noise levels and effects arising from the CSP. Potential receivers have been limited to the NorthPort industrial site and residential properties along the coastline of the Whangarei Heads (from Reotahi Bay to Urquharts Bay).

Rules 31.4.13 and 31.7.12 of the NRCP (indirectly) requires compliance with the provisions of NZS6803:1999 *Acoustics – Construction Noise.* It is our view that compliance with the noise limits contained in NZS6803 will ensure that the noise effects are less than minor and reasonable in terms of s16 of the Act. We have used the sophisticated acoustic modelling software to prepare predictions of the noise levels likely to be generated by the CSP and to determine what, if any restrictions are necessary to ensure compliance with these provisions.

The noise modelling shows that comfortable compliance with the relevant noise limits is achieved for dredging inside the harbour, except when dredging is undertaken generally north of the No. 18 navigation buoy when the 45dB L_{Aeq} noise limit applies (at night and on Sundays and Public Holidays) and, during unfavourable wind conditions, when the wind is blowing from any direction other than the northern quarter. The predicted noise levels for all other dredging

positions under various meteorological conditions show that compliance with all of the relevant noise limits at all times of the day can be achieved, in most cases by a large margin. We have recommended that dredging activities are not undertaken north of the No. 18 buoy during unfavourable wind conditions (identified above) at times when the 45dB L_{Aeq} noise limit applies. This limitation is subject to refinement or removal (if justified) based on the collection of noise measurement data from the dredges that are commissioned for the project.

The noise effects of the dredging project will be unnoticeable for a large proportion of the project for the receivers on the northern side of the harbour. Dredging will be inaudible and not measureable when the vessels are outside of the harbour or generally east of Busby Head. For all other locations within the harbour, the dredging activity will be audible to some receivers but generally at noise levels less than 45dB L_{Aeq}.

We recommend that the dredging operations are subject to a noise management plan (NMP) including provisions for noise monitoring at the commencement of dredging for each dredge to determine actual noise emissions and to determine whether any change to the restrictions on dredging are required. Ongoing noise monitoring should be undertaken to ensure compliance and in response to reasonable complaints.

The noise levels from piling works associated with the construction and relocation of navigational aids will be compliant with the relevant noise limits by a considerable margin provided they are undertaken between 0730 and 1800 Monday to Friday when the higher noise limit of 70dB L_{Aeq} applies.

In our opinion, and if the recommendations in this report are adhered to, we consider that the noise effects arising from the CSP will be reasonable in terms of s16 of the Act.

9. Literature Cited

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Delta. 16 February 2006 (Delta 2006). Technical Note: Noise Emission from Backhoe Aquadigger MJØLNER R. Journal No. AV 114/06.

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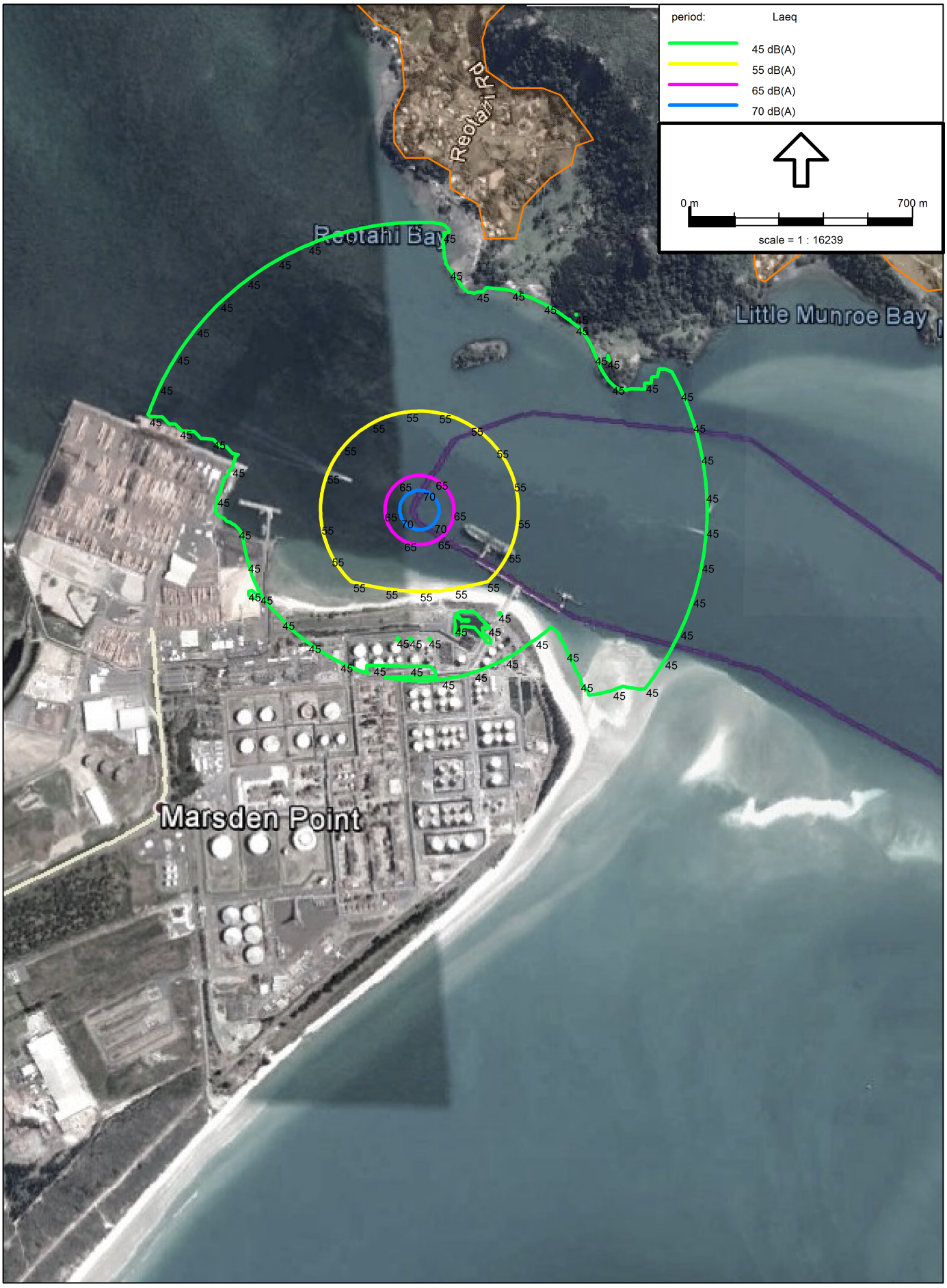
Appendix A

Noise Level Predictions - BHD Jetty Area

BHD Inner Channel: Jetty Area

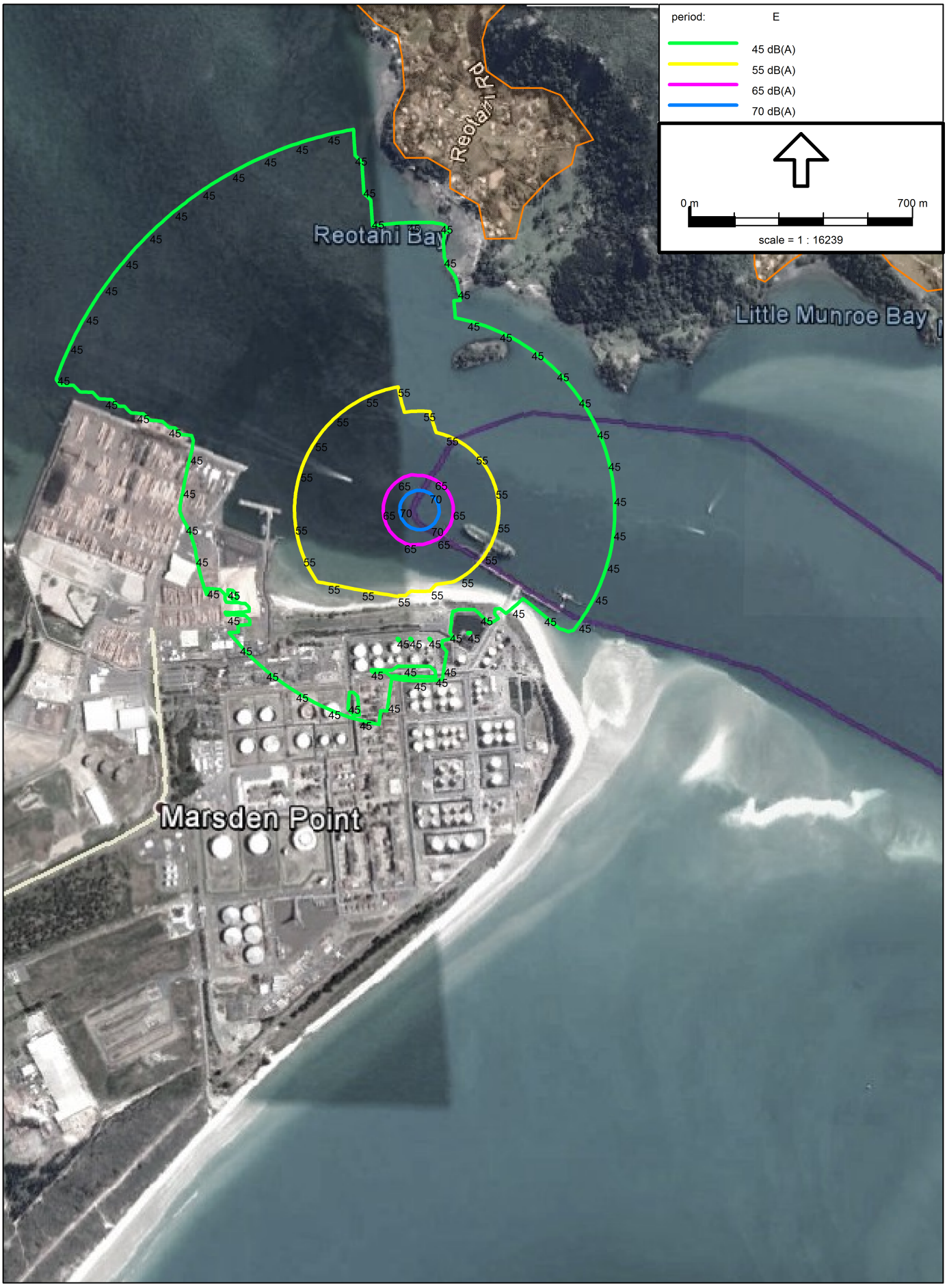
Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Weather - Inner_NorthPort C0] , Predictor V11.10

BHD Inner Channel: Jetty Area

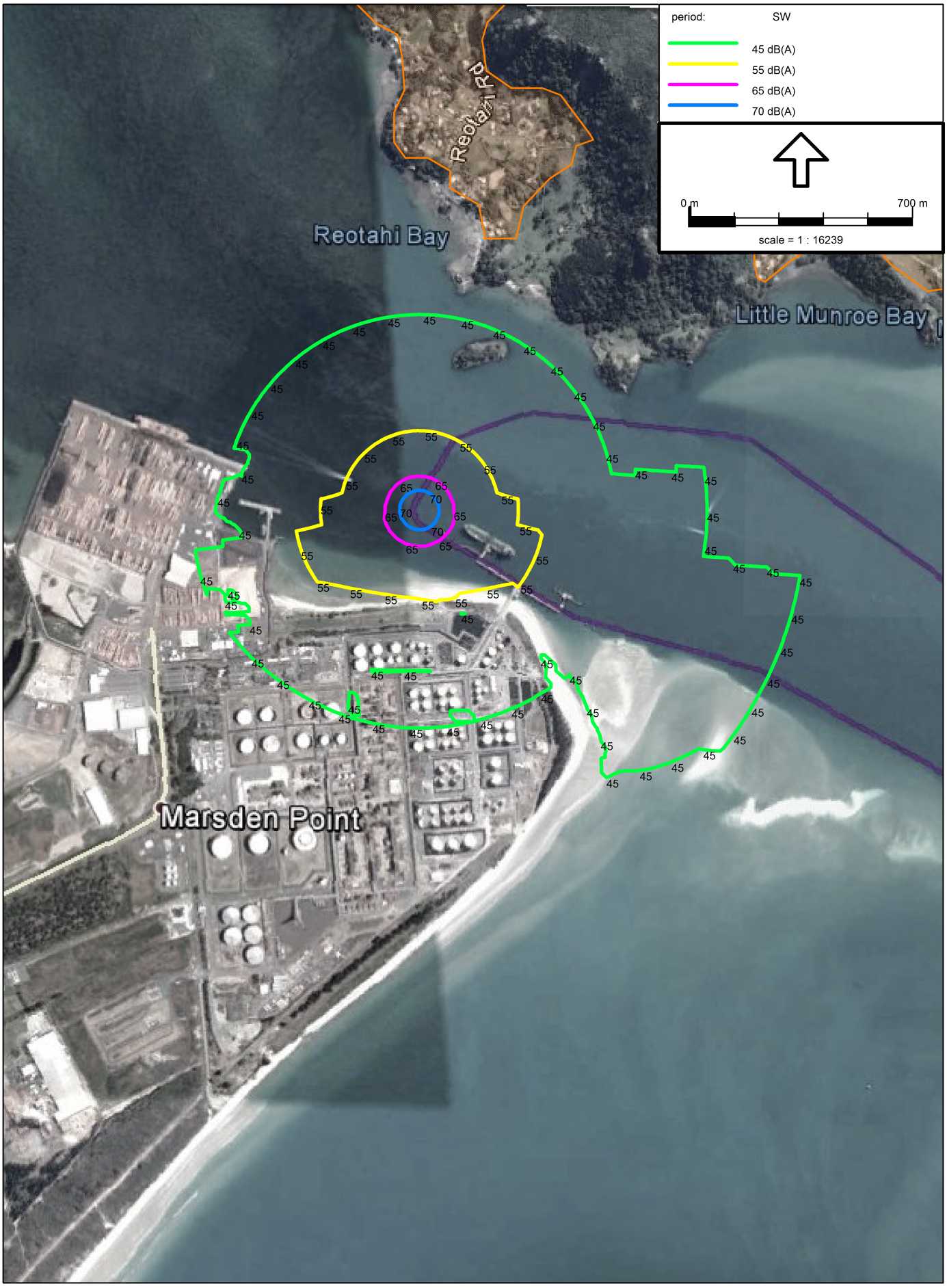
Easterly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_NorthPort 3m/s] , Predictor V11.10

BHD Inner Channel: Jetty Area

Northerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_NorthPort 3m/s] , Predictor V11.10

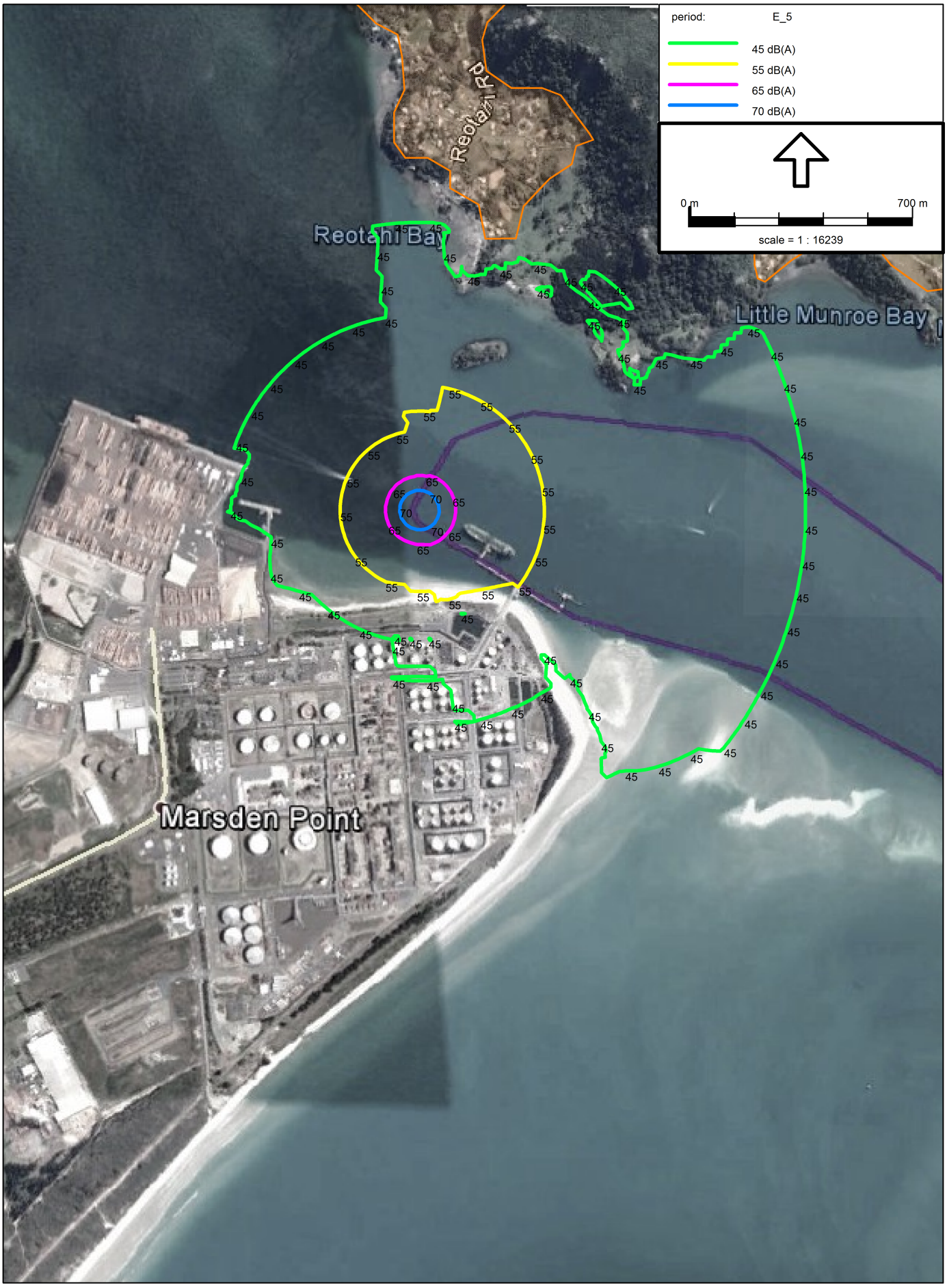
BHD Inner Channel: Jetty Area

Southerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Inner_NorthPort 3m/s] , Predictor V11.10

BHD Inner Channel: Jetty Area

Westerly Wind



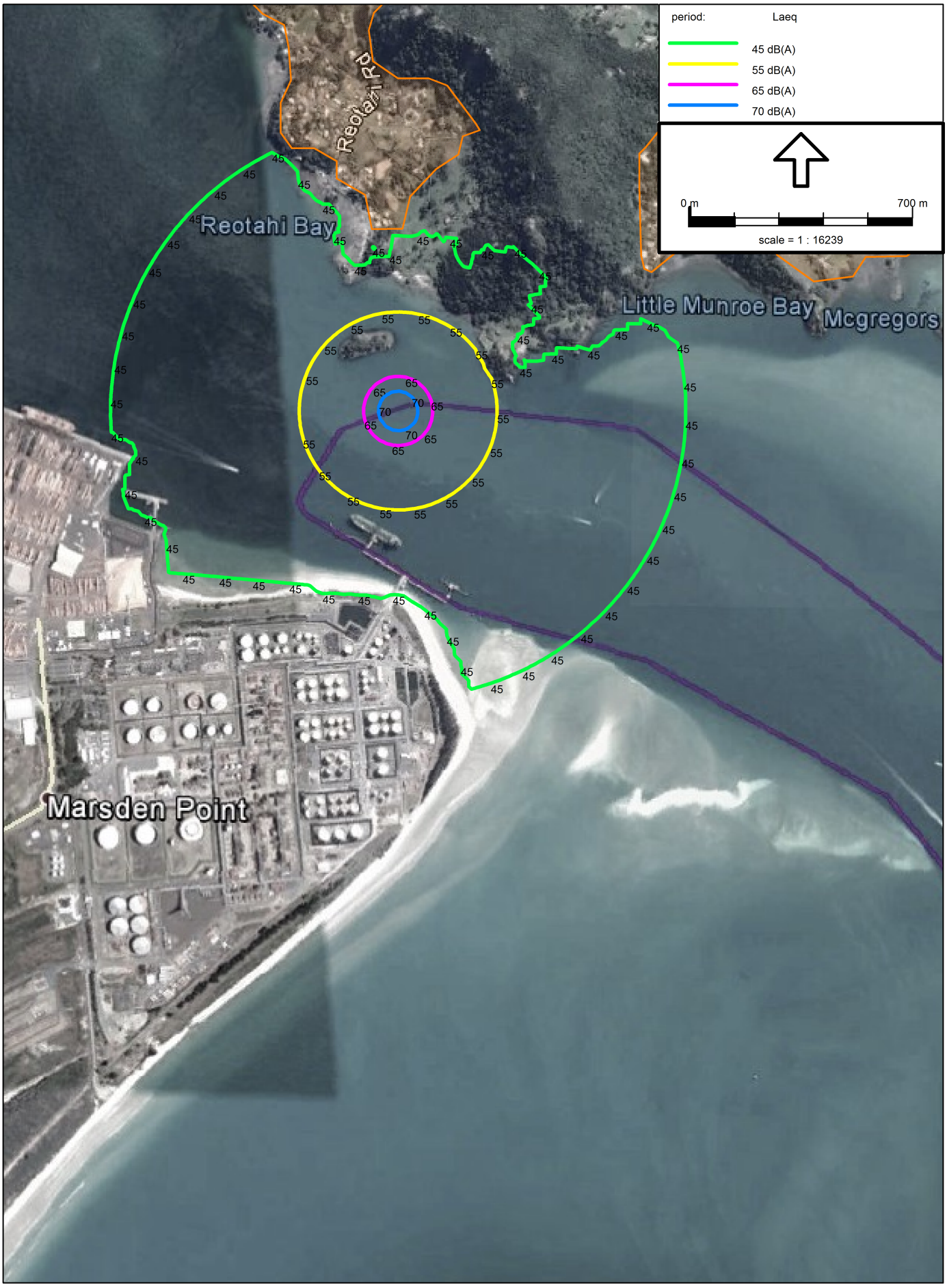
Industrial noise - ISO 9613.1/2, [Weather - Inner_NorthPort 3m/s] , Predictor V11.10

Appendix B

Noise Level Predictions - BHD No. 17 Navigational Buoy

BHD Inner Channel: No.17 Buoy

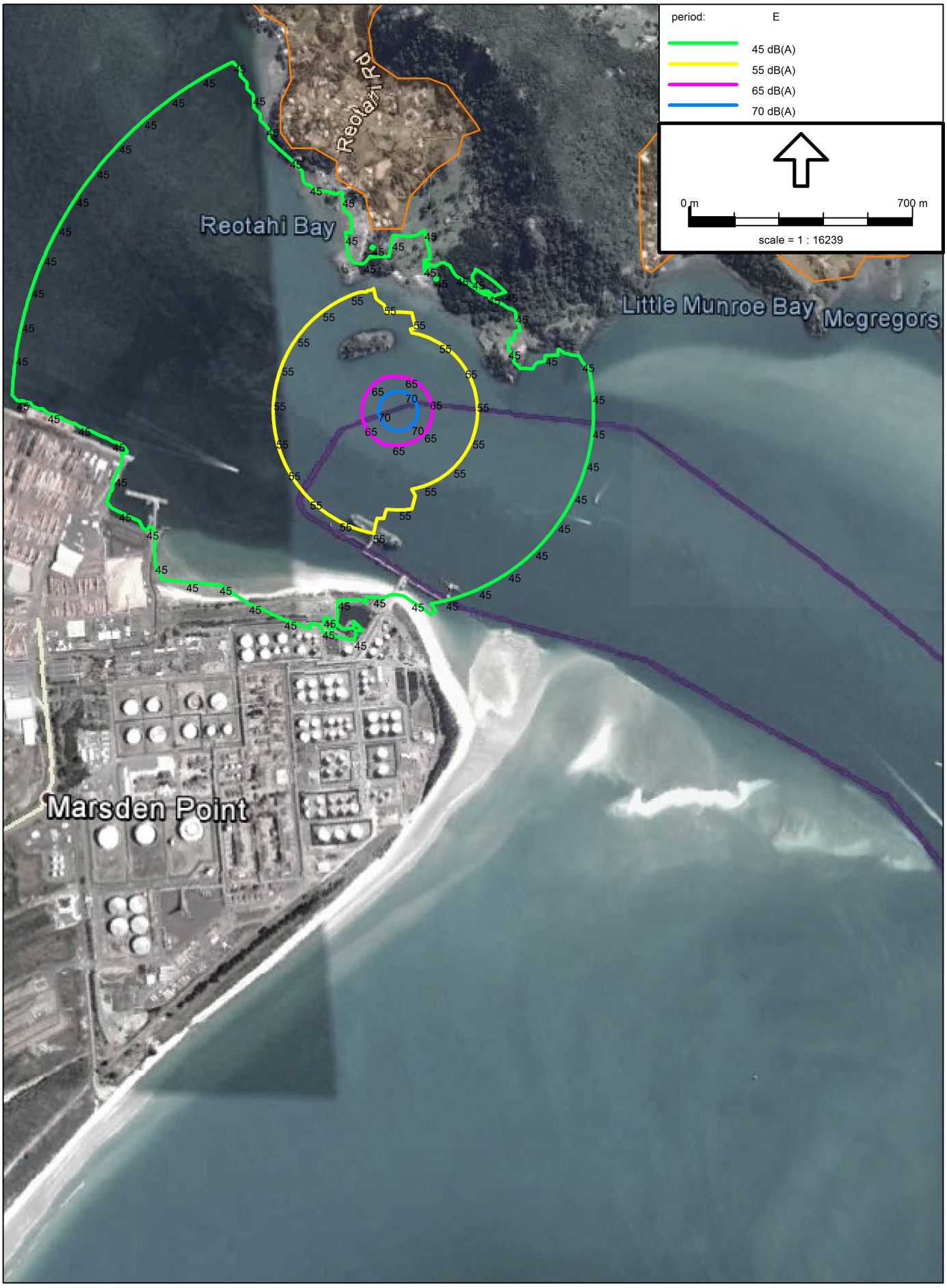
Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos1a_C0] , Predictor V11.10

BHD Inner Channel: No.17 Buoy

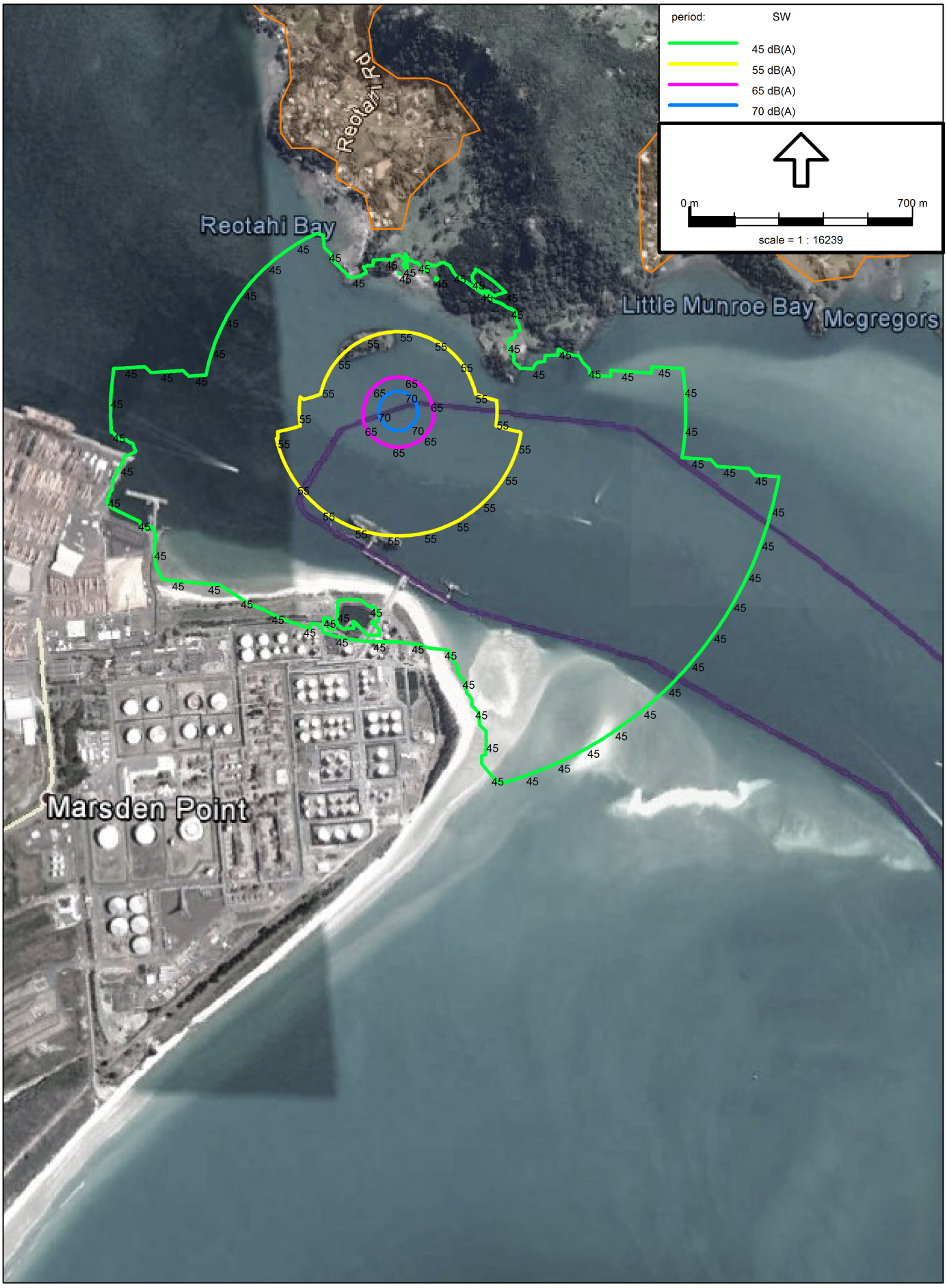
Easterly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos1a] , Predictor V11.10

BHD Inner Channel: No.17 Buoy

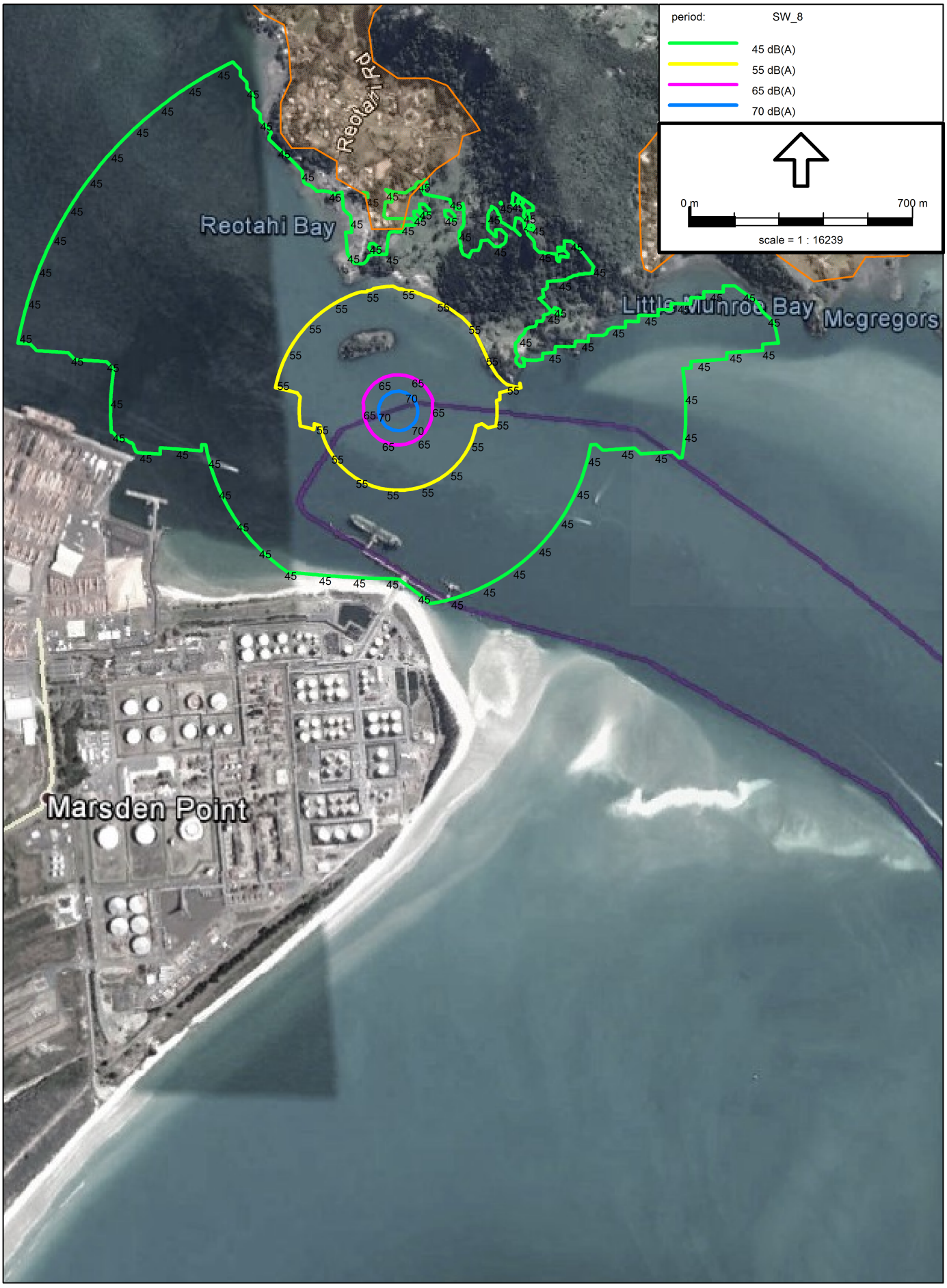
Northerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos1a] , Predictor V11.10

BHD Inner Channel: No.17 Buoy

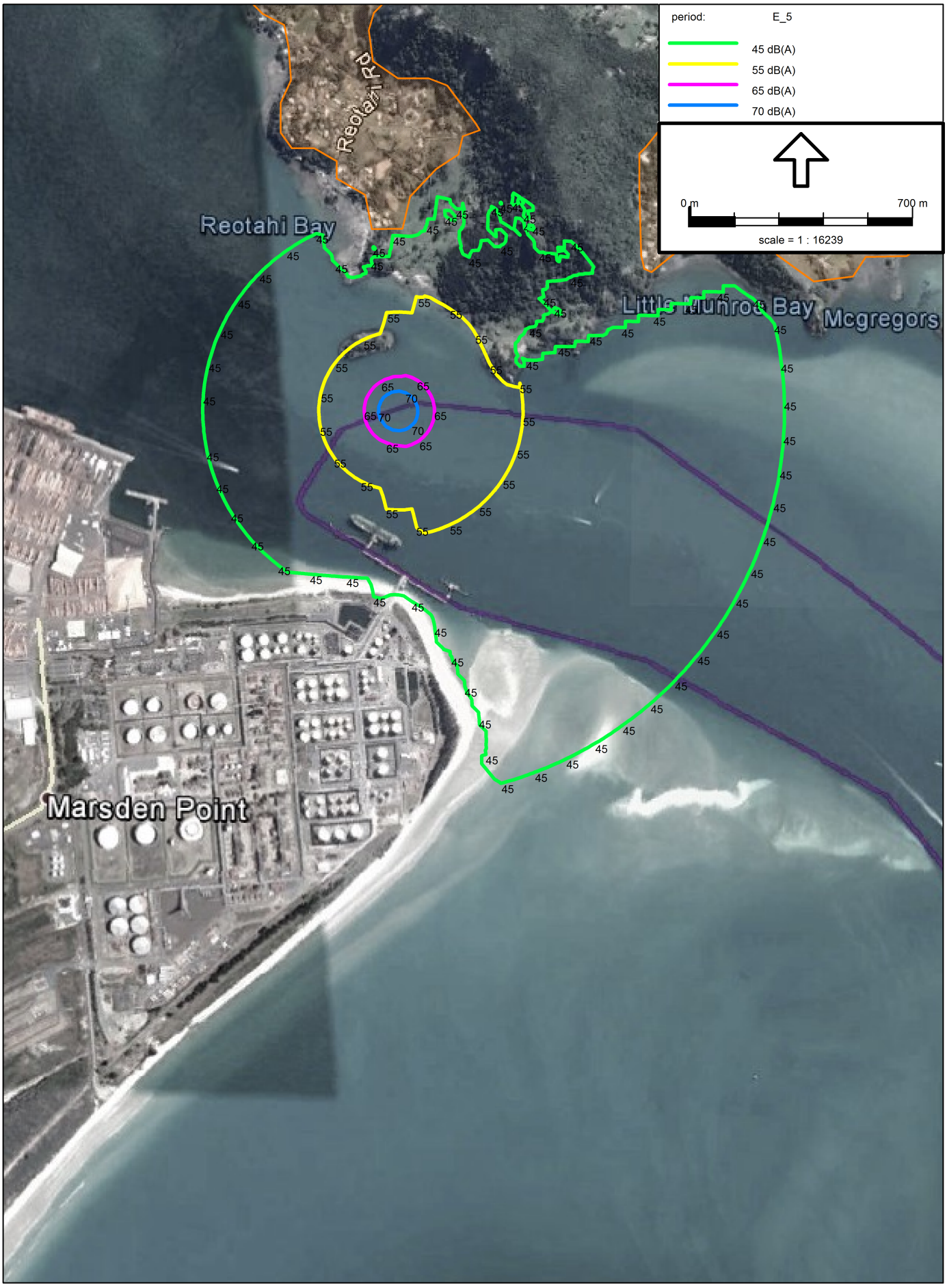
Southerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos1a] , Predictor V11.10

BHD Inner Channel: No.17 Buoy

Westerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos1a] , Predictor V11.10

Appendix C

Noise Level Predictions - BHD No. 15 Navigational Buoy

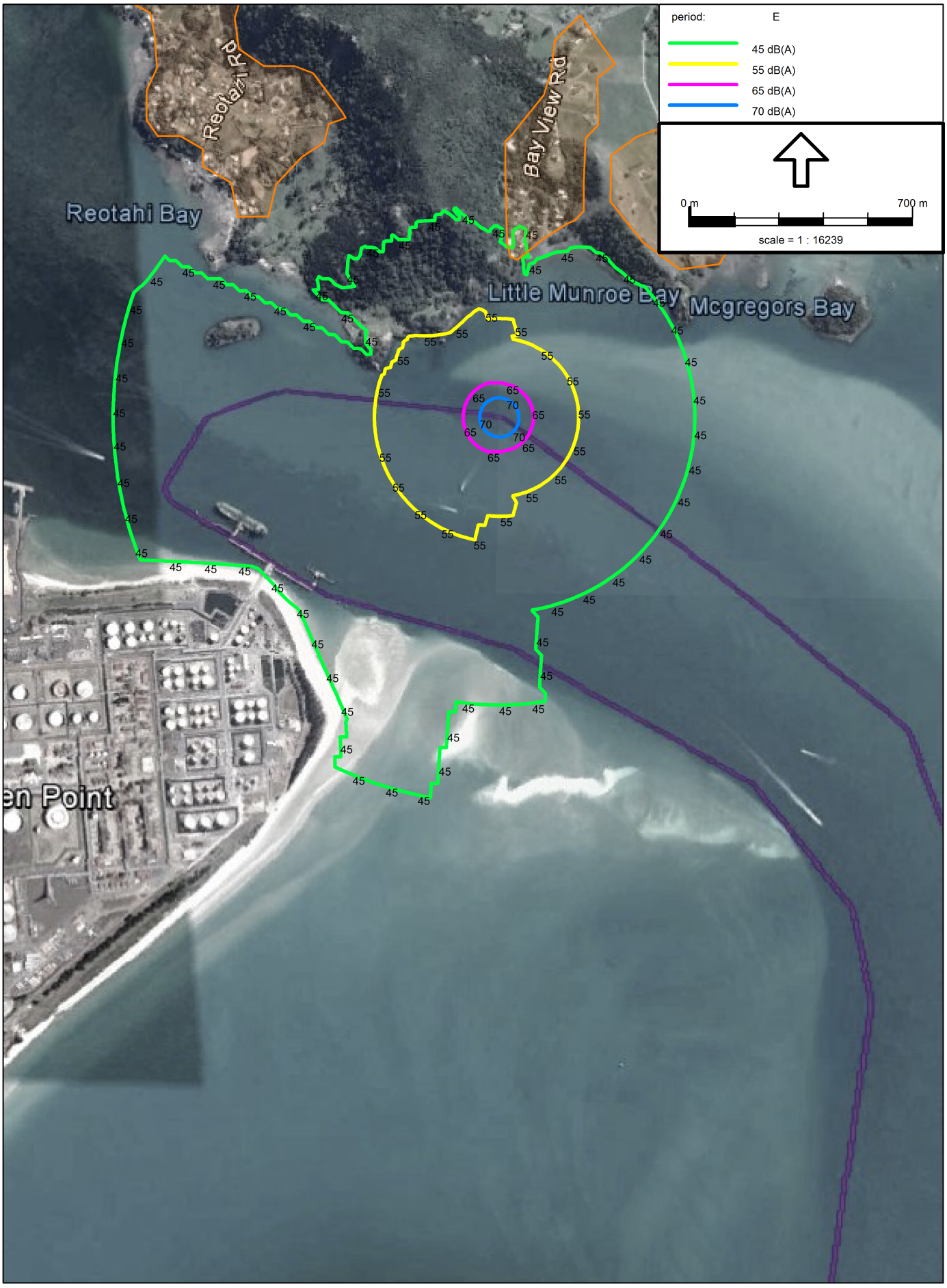
BHD Inner Channel: No.15 Buoy

Weather Condition: C0 = 0

Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos2a_C0] , Predictor V11.10

BHD Inner Channel: No.15 Buoy

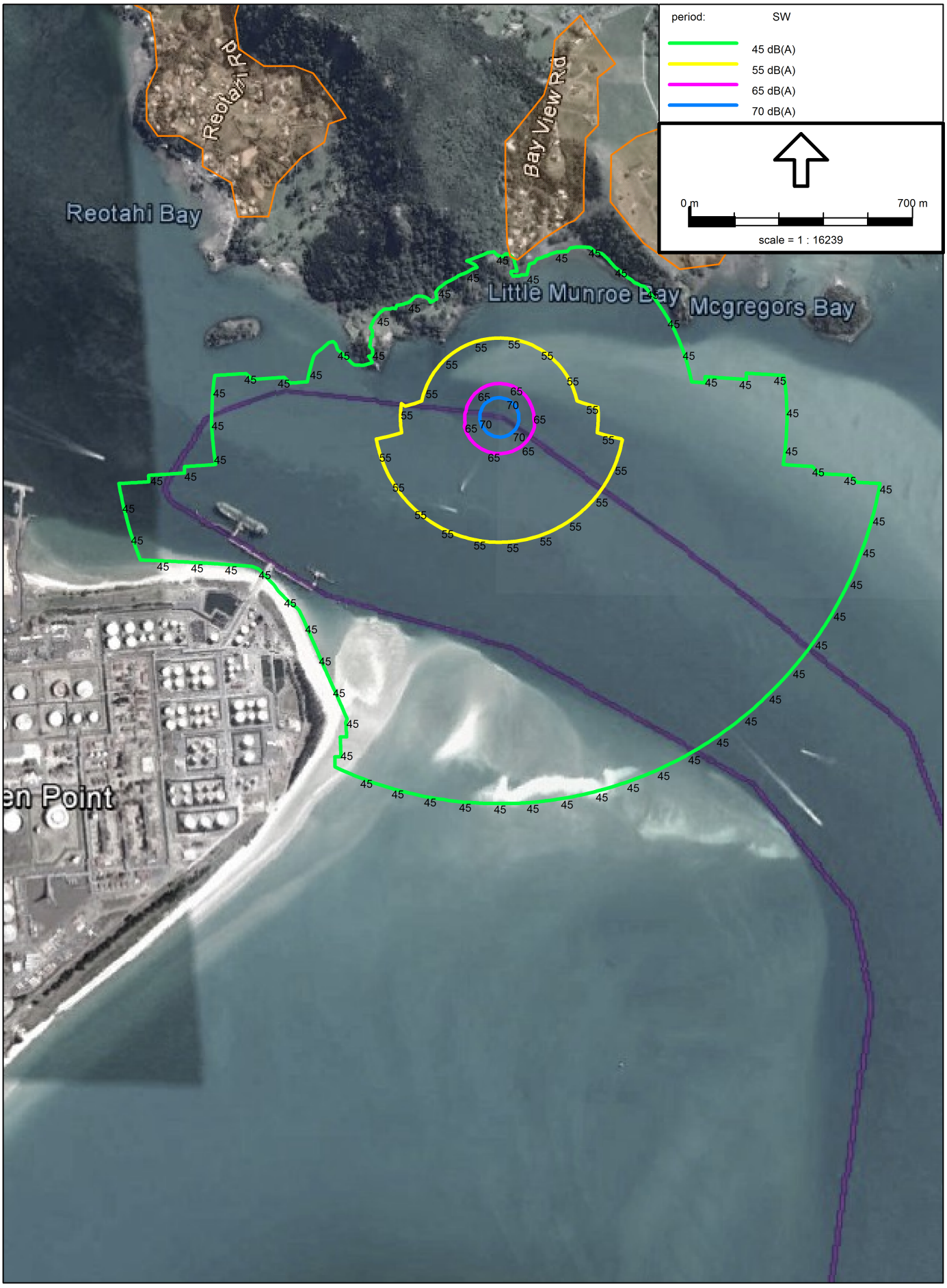
Easterly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos2a] , Predictor V11.10

BHD Inner Channel: No. 15 Buoy

Northerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos2a] , Predictor V11.10

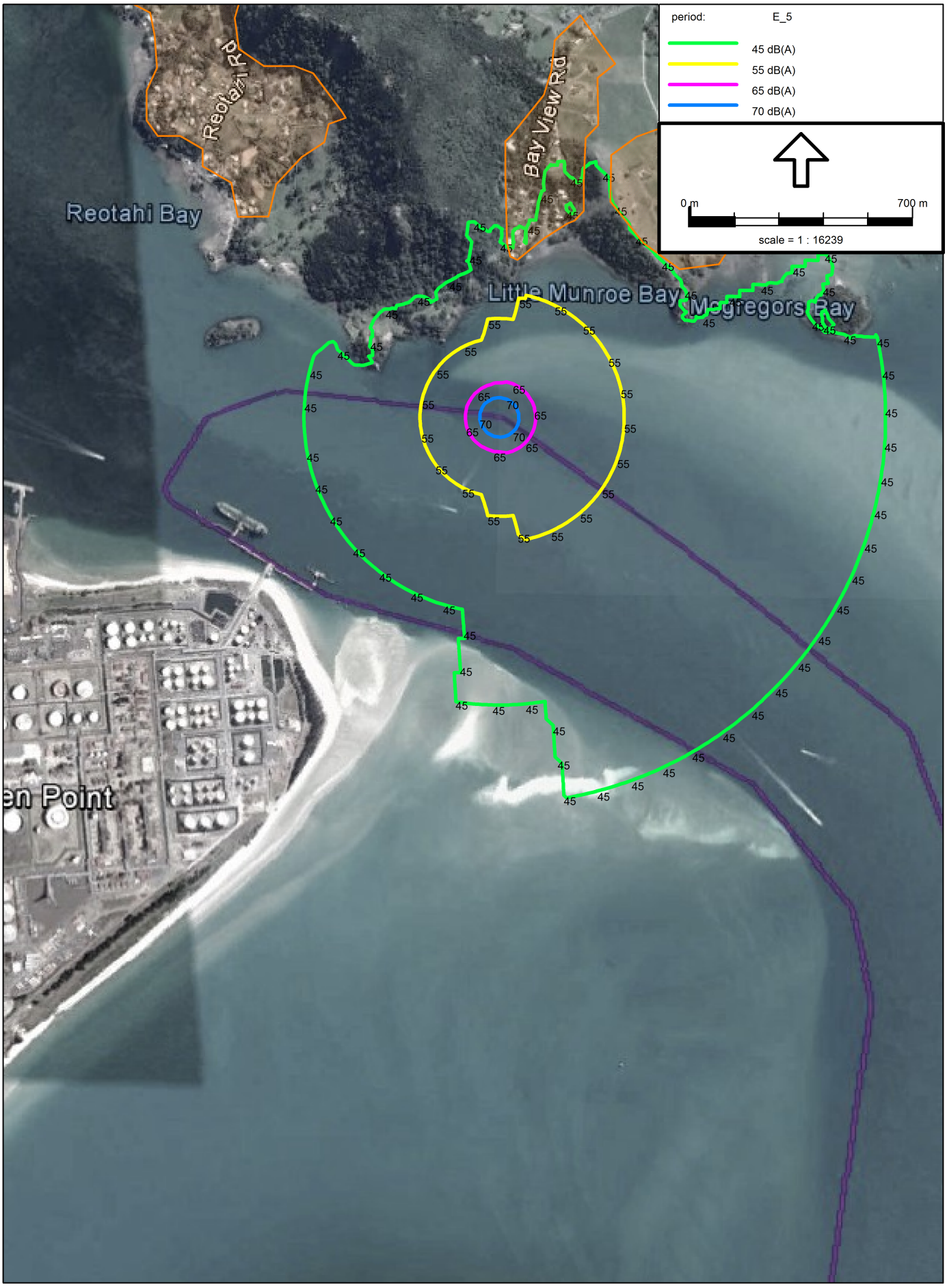
BHD Inner Channel: No.15 Buoy

Southerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos2a] , Predictor V11.10

BHD Inner Channel: No.15 Buoy

Westerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Inner_Pos2a] , Predictor V11.10

Appendix D

Noise Level Predictions - TSHD No. 18 Navigational Buoy

TSHD Inner Channel (Marsden Point): Average Channel Position Weather Condition: C0 = 0

Industrial noise - ISO 9613.1/2, [Centre(C0) - Copy of LInes_1] , Predictor V11.10

TSHD Inner Channel (Marsden Point): Worst Case Channel Position Weather Condition: C0 = 0

Industrial noise - ISO 9613.1/2, [Centre(C0) - LInes_1] , Predictor V11.10

TSHD Inner Channel (Marsden Point): Worst Case Channel Position Easterly Wind

Industrial noise - ISO 9613.1/2, [Weather - Lines_1_3m/s] , Predictor V11.10

TSHD Inner Channel (Marsden Point): Worst Case Channel Position Northerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Lines_1_3m/s] , Predictor V11.10

TSHD Inner Channel (Marsden Point): Worst Case Channel Position Southerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Lines_1_3m/s] , Predictor V11.10

TSHD Inner Channel (Marsden Point): Worst Case Channel Position Westerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Lines_1_3m/s] , Predictor V11.10

Appendix E

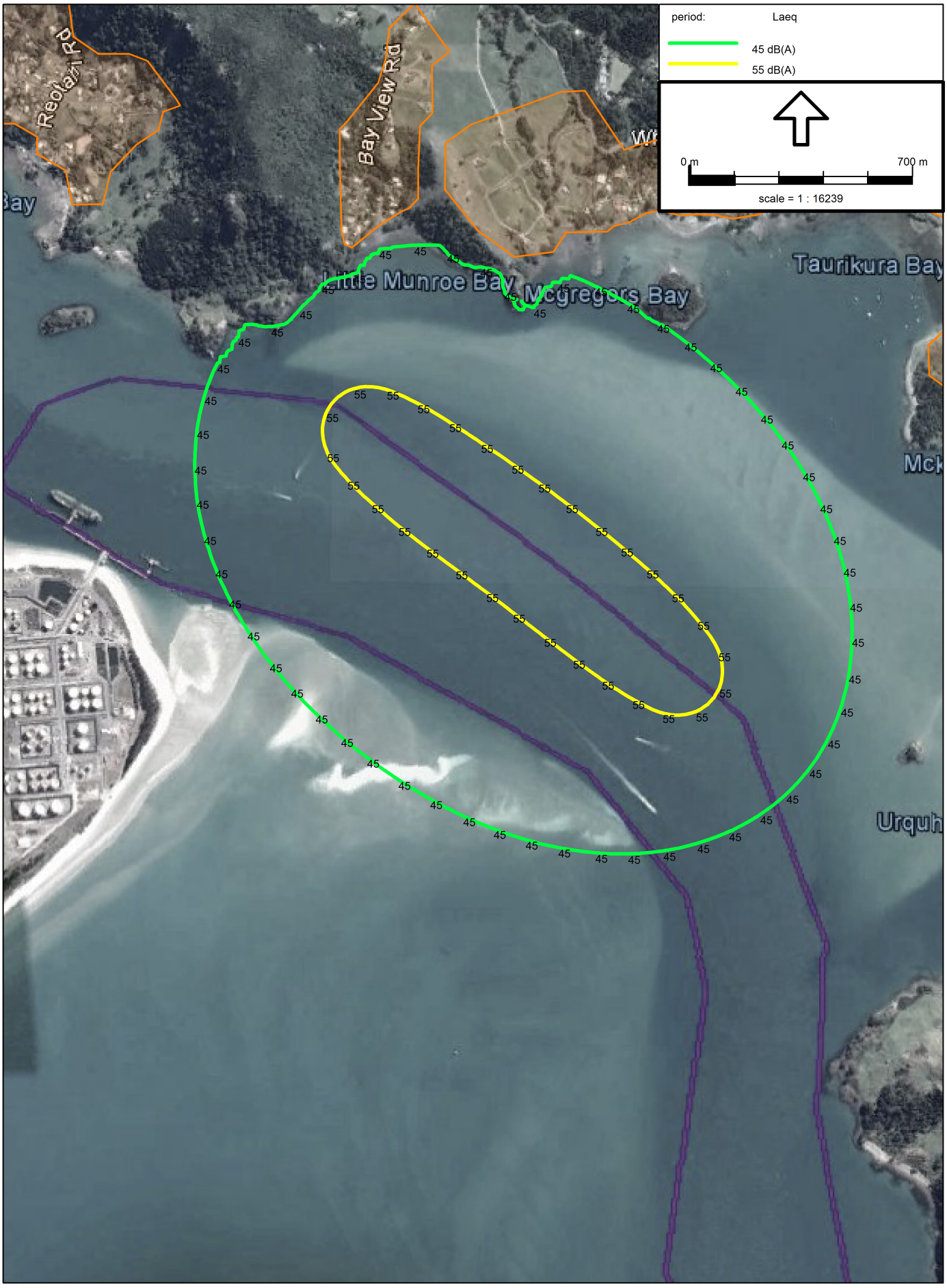
Noise Level Predictions - TSHD No. 13 Navigational Buoy

TSHD Inner Channel (Mair Bank): Average Channel Position

Weather Condition: C0 = 0

Industrial noise - ISO 9613.1/2, [Centre(C0) - Copy of LInes_2] , Predictor V11.10

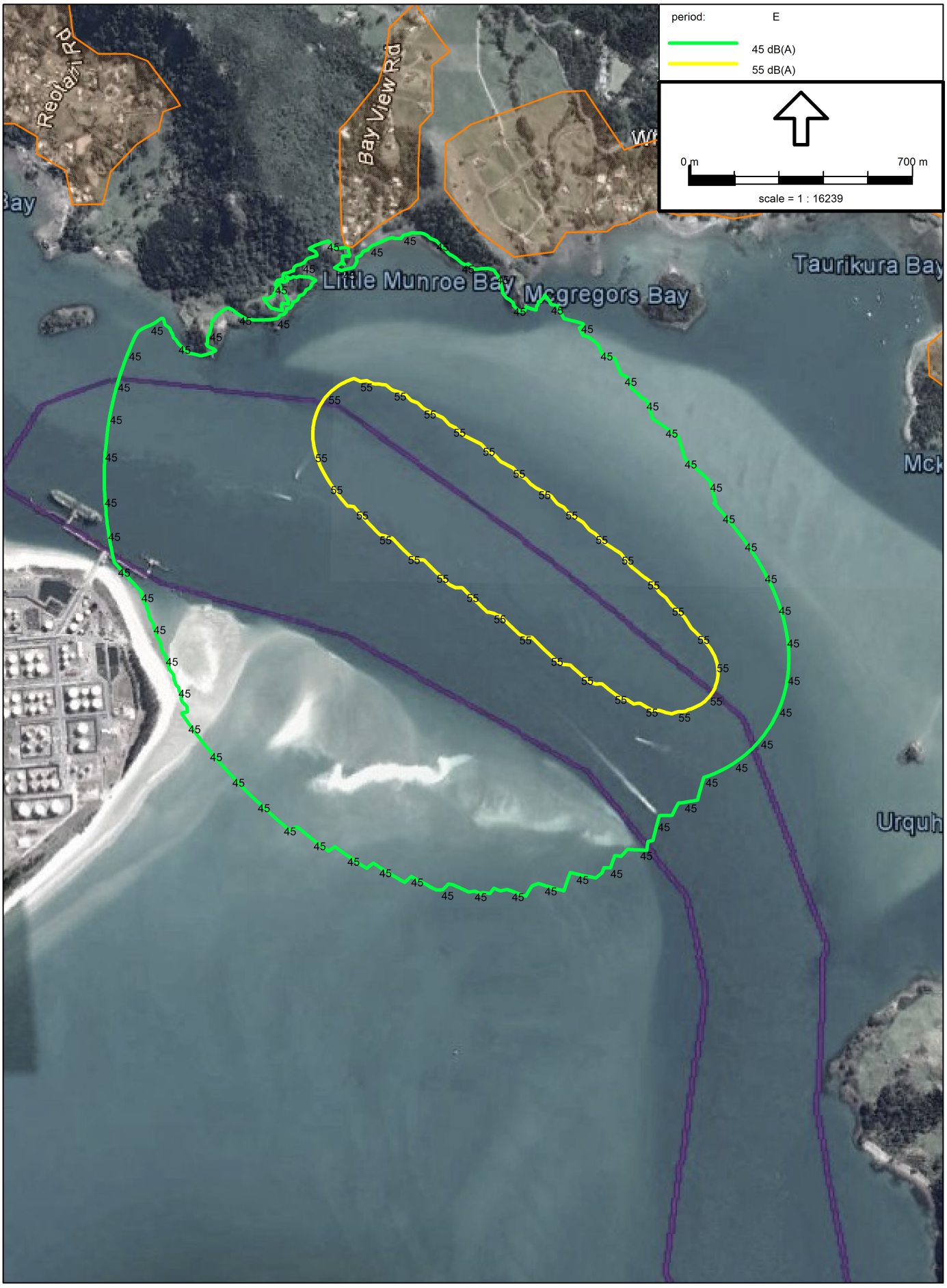
TSHD Inner Channel (Mair Bank): Worst Case Channel Position Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Centre(C0) - LInes_2] , Predictor V11.10

TSHD Inner Channel (Mair Bank): Worst Case Channel Position

Easterly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_2_3m/s] , Predictor V11.10

TSHD Inner Channel (Mair Bank): Worst Case Channel Position

Northerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Lines_2_3m/s] , Predictor V11.10

TSHD Inner Channel (Mair Bank): Worst Case Channel Position

Southerly Wind

Industrial noise - ISO 9613.1/2, [Weather - Lines_2_3m/s] , Predictor V11.10

TSHD Inner Channel (Mair Bank): Worst Case Channel Position

Westerly Wind

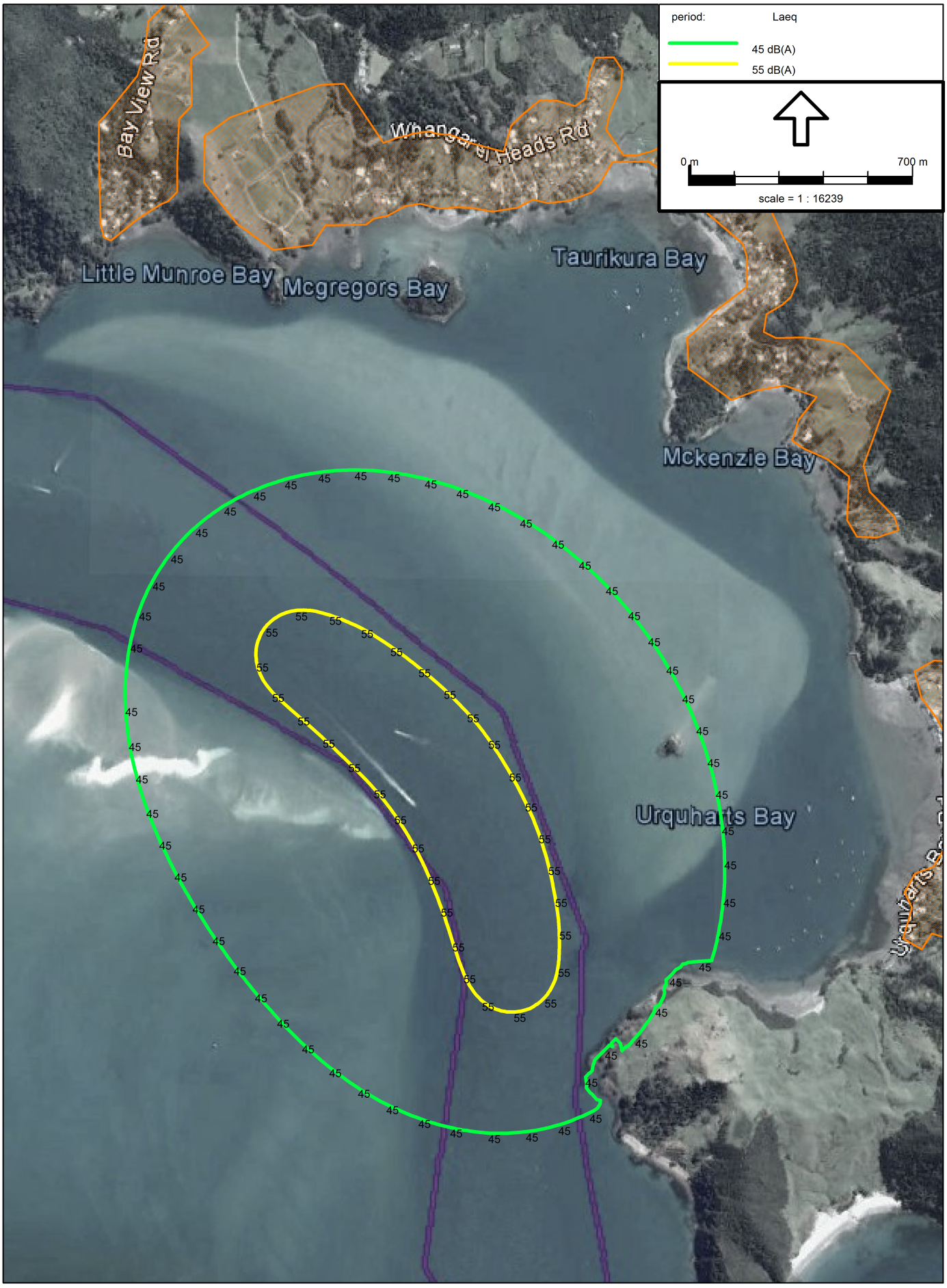
Industrial noise - ISO 9613.1/2, [Weather - Lines_2_3m/s] , Predictor V11.10

Appendix F

Noise Level Predictions - TSHD No. 11 Navigational Buoy

TSHD Mid Channel (Mair Bank): Average Channel Position

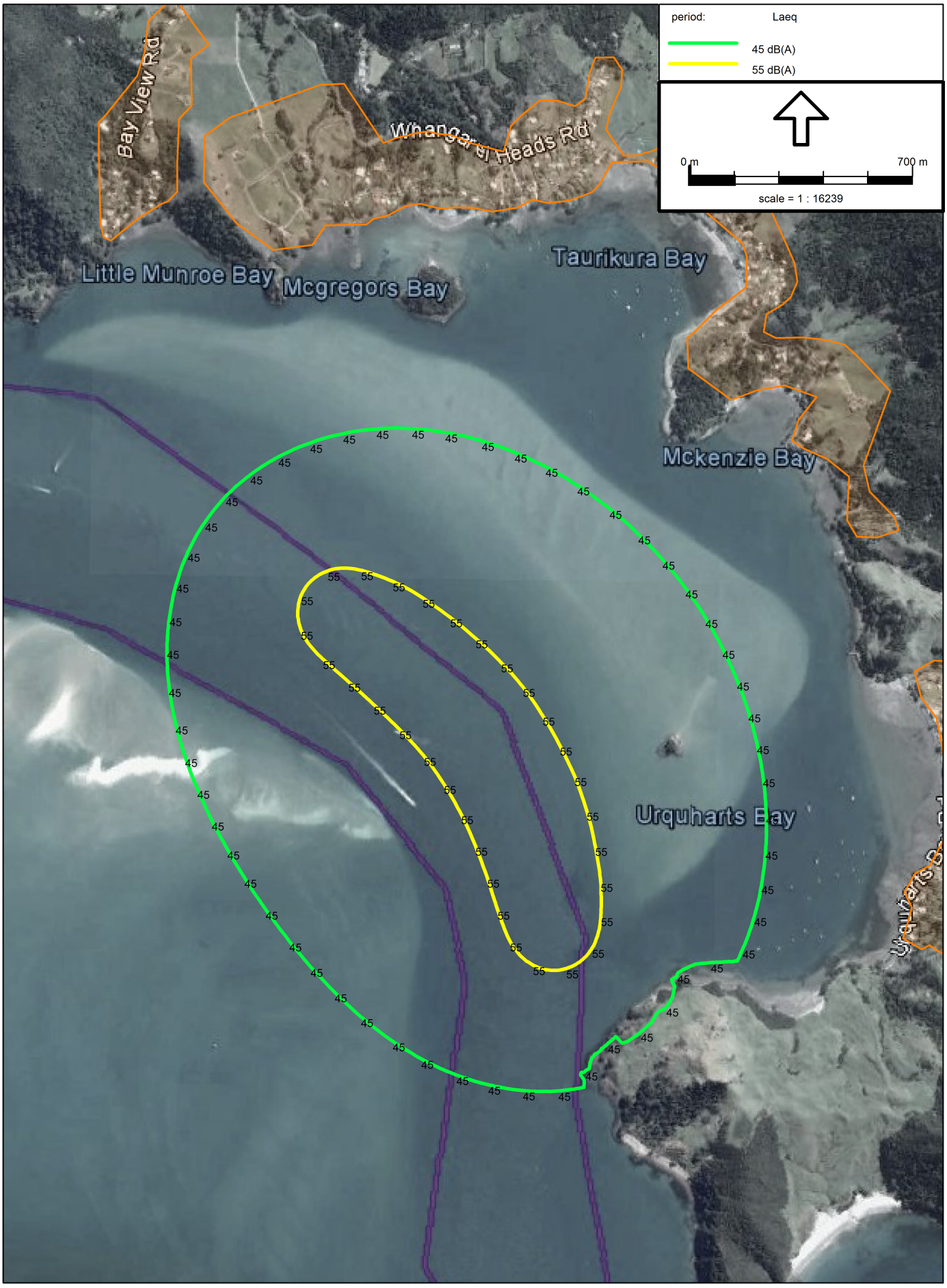
Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Centre(C0) - Copy of LInes_3] , Predictor V11.10

TSHD Mid Channel (Mair Bank): Worst Case Channel Position

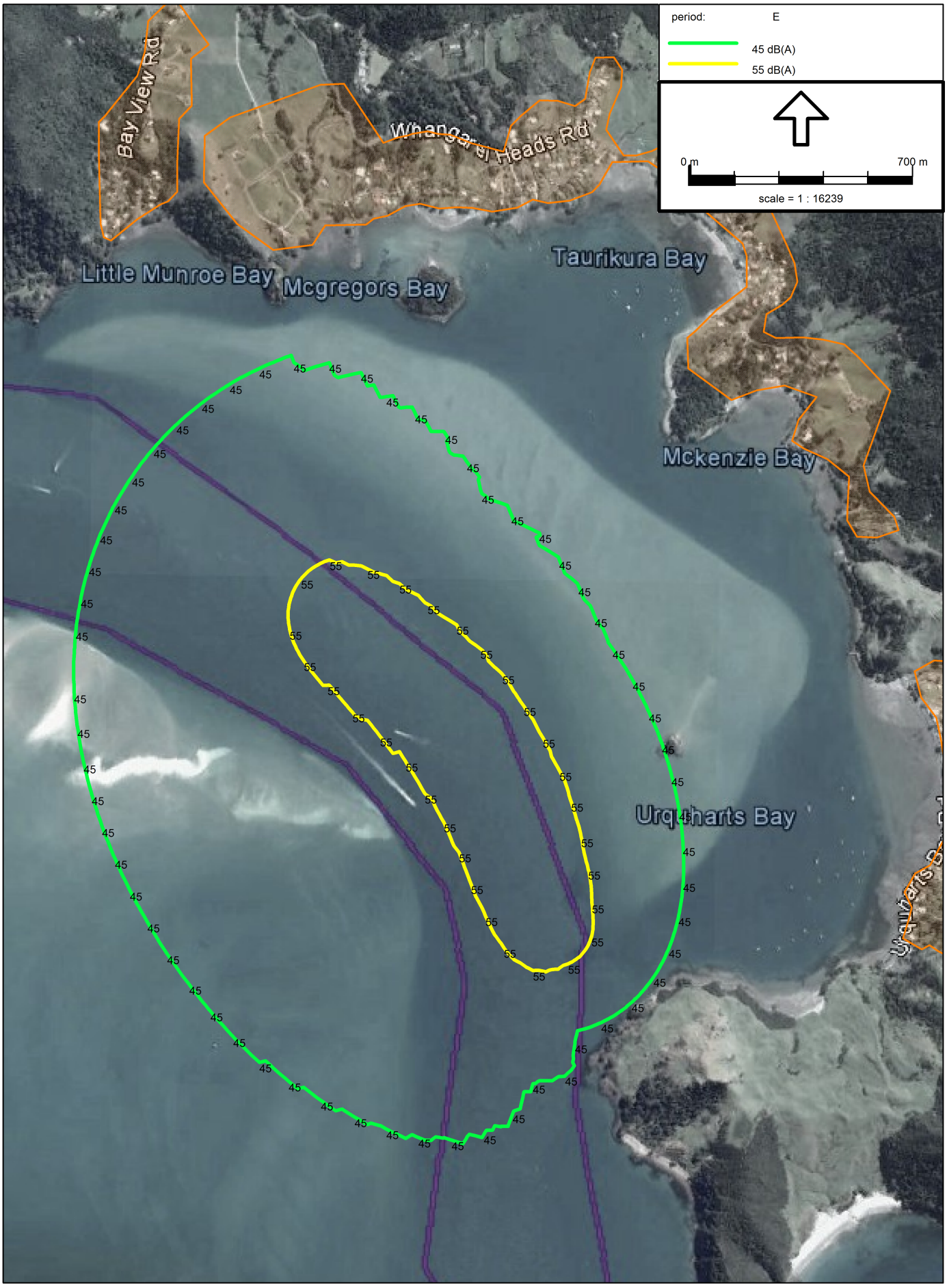
Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Centre(C0) - LInes_3] , Predictor V11.10

TSHD Mid Channel (Mair Bank): Worst Case Channel Position

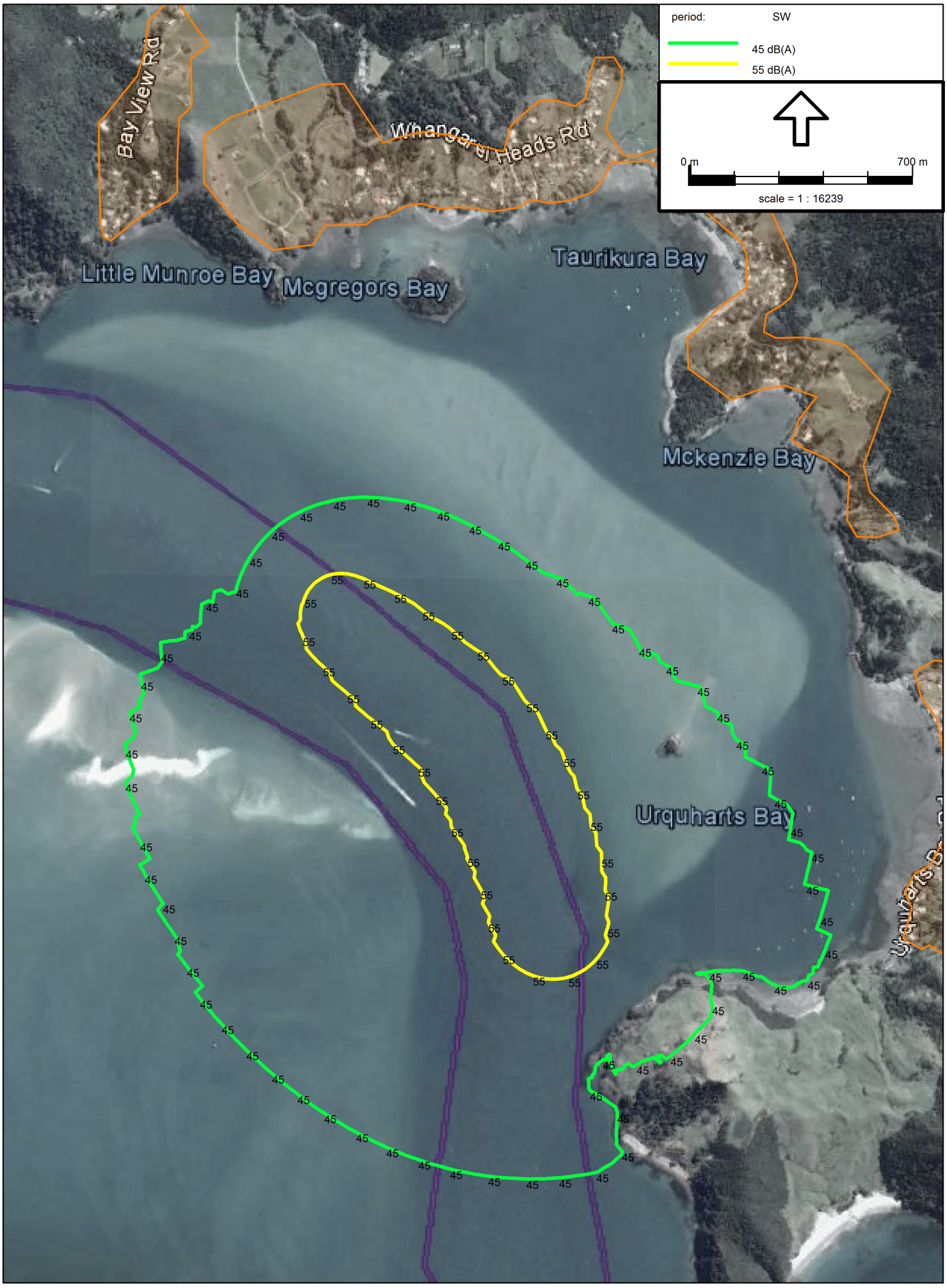
Easterly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_3_3m/s] , Predictor V11.10

TSHD Mid Channel (Mair Bank): Worst Case Channel Position

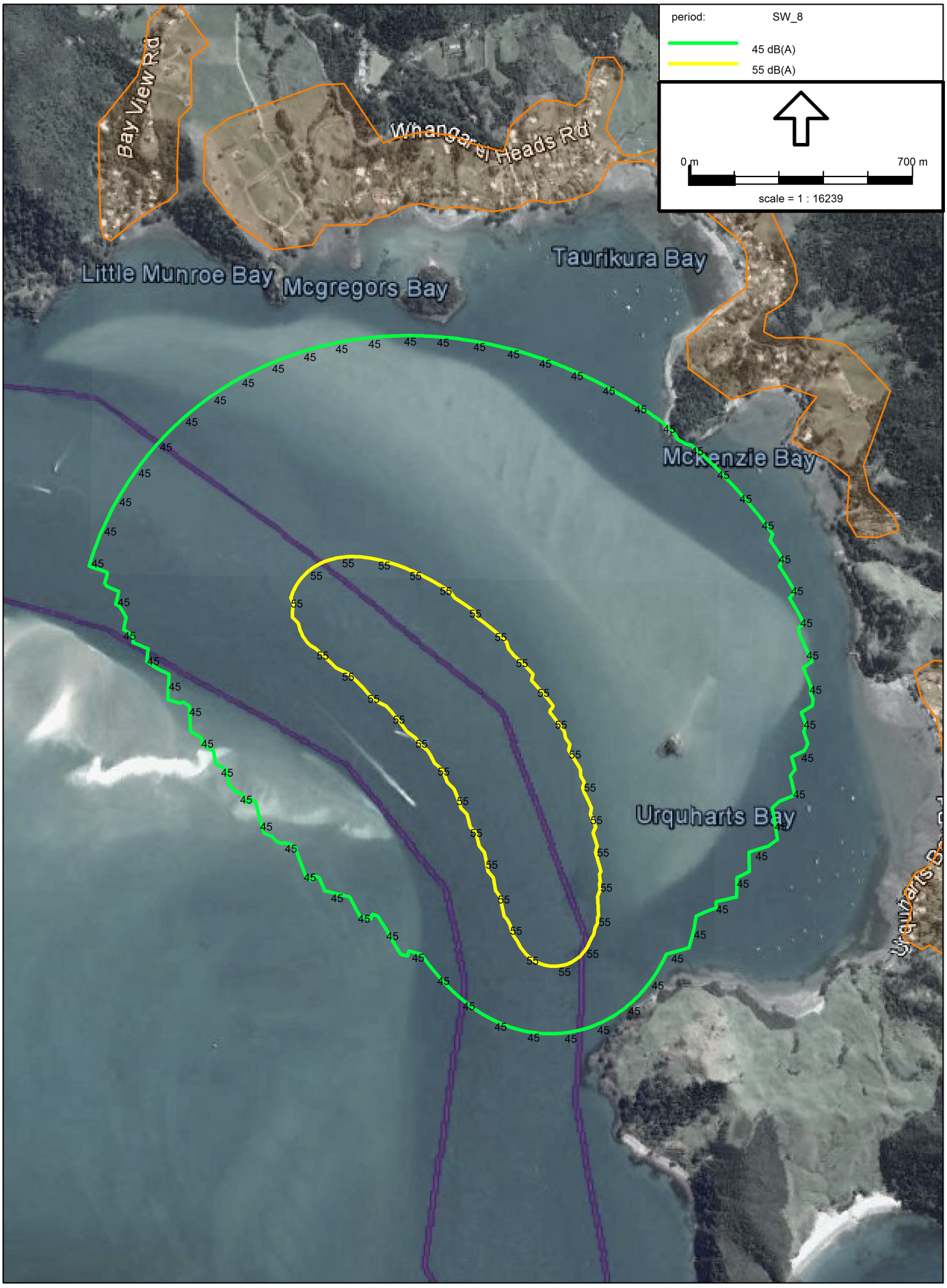
Northerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_3_3m/s] , Predictor V11.10

TSHD Mid Channel (Mair Bank): Worst Case Channel Position

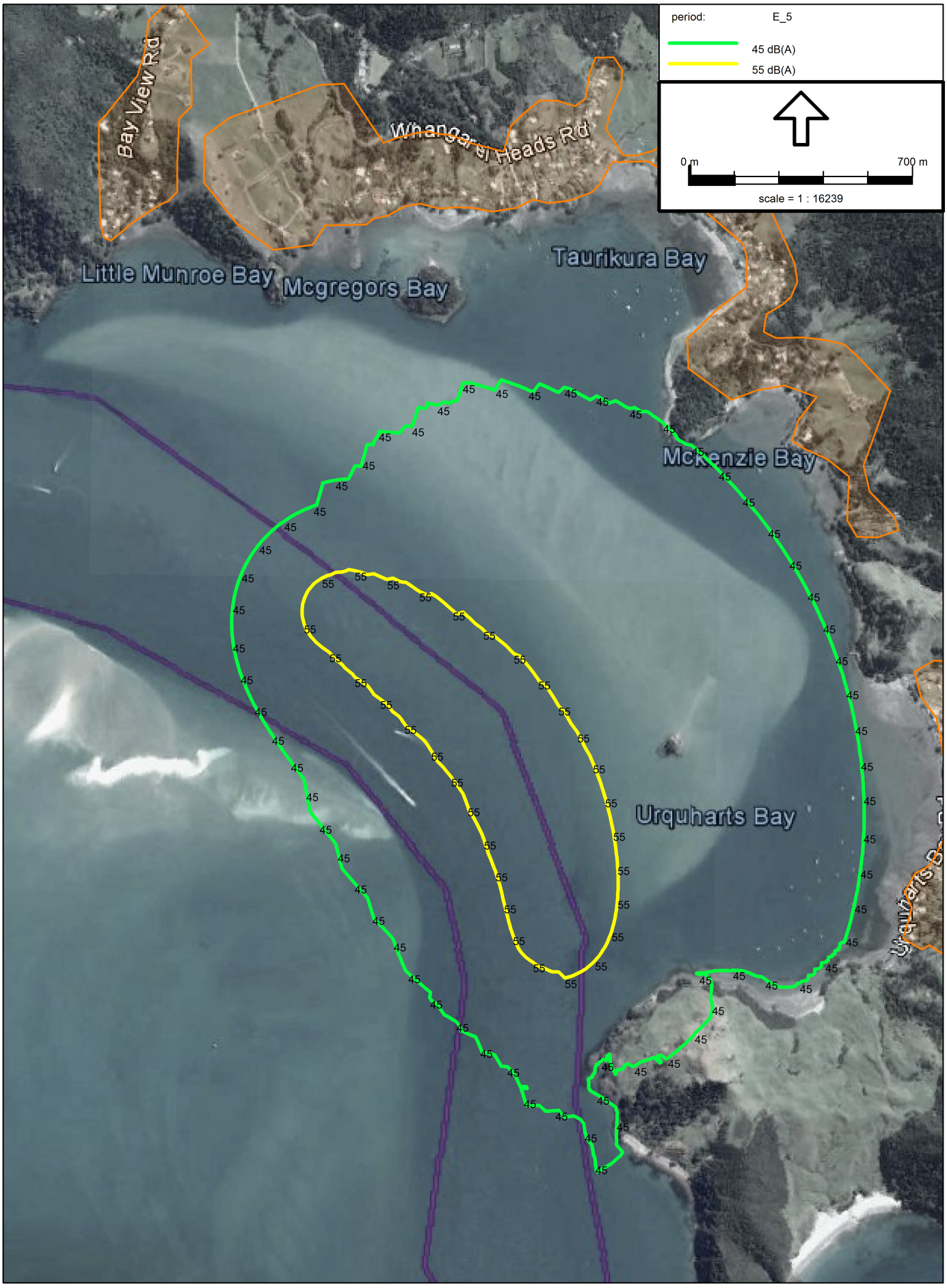
Southerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_3_3m/s] , Predictor V11.10

TSHD Mid Channel (Mair Bank): Worst Case Channel Position

Westerly Wind



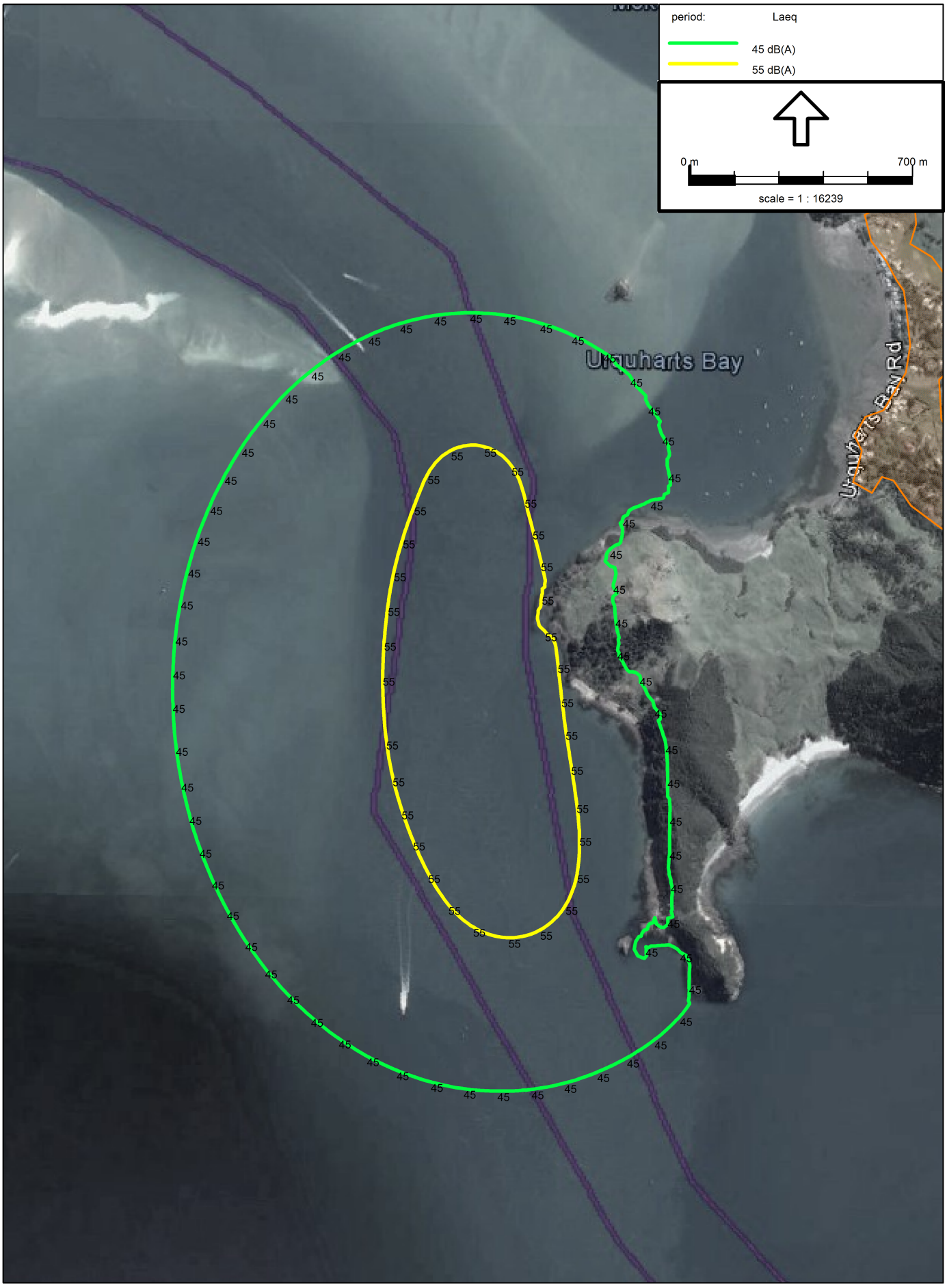
Industrial noise - ISO 9613.1/2, [Weather - Lines_3_3m/s] , Predictor V11.10

Appendix G

Noise Level Predictions - TSHD No. 07 Navigational Buoy

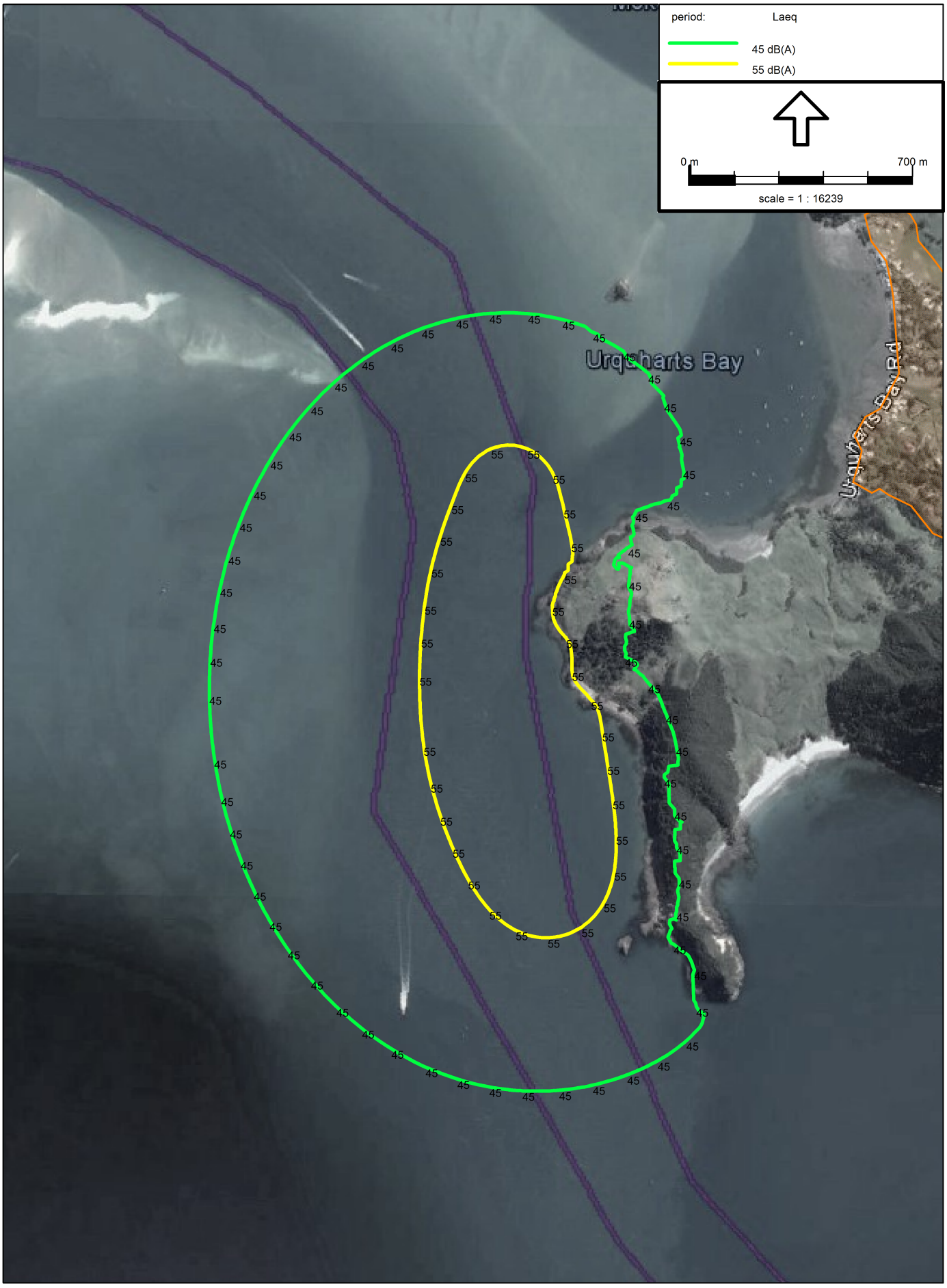
TSHD Mid Channel (Home Point): Average Channel Position

Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Centre(C0) - Copy of LInes_4] , Predictor V11.10

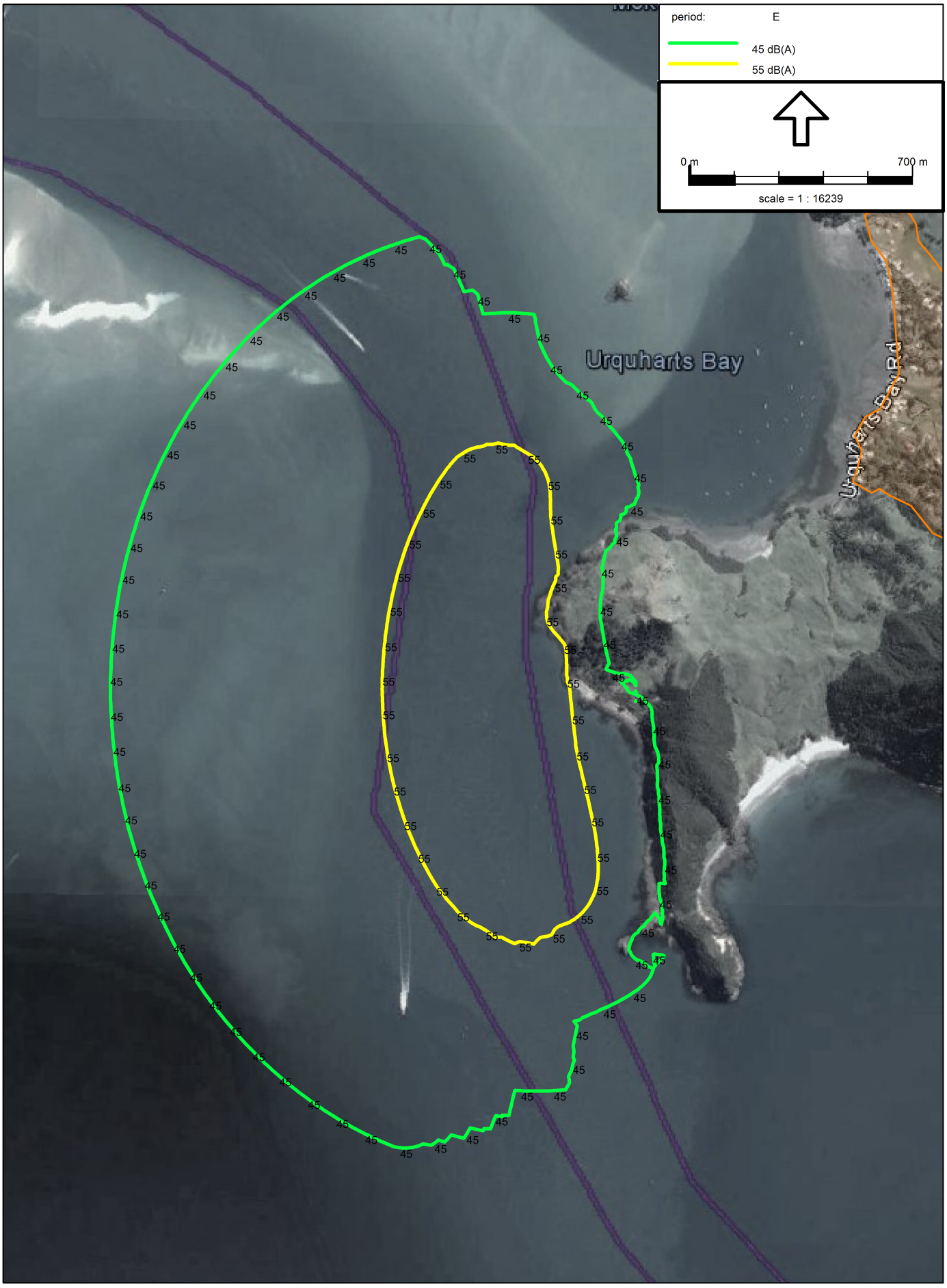
TSHD Mid Channel (Home Point): Worst Case Channel Position Weather Condition: C0 = 0



Industrial noise - ISO 9613.1/2, [Centre(C0) - LInes_4] , Predictor V11.10

TSHD Mid Channel (Home Point): Worst Case Channel Position

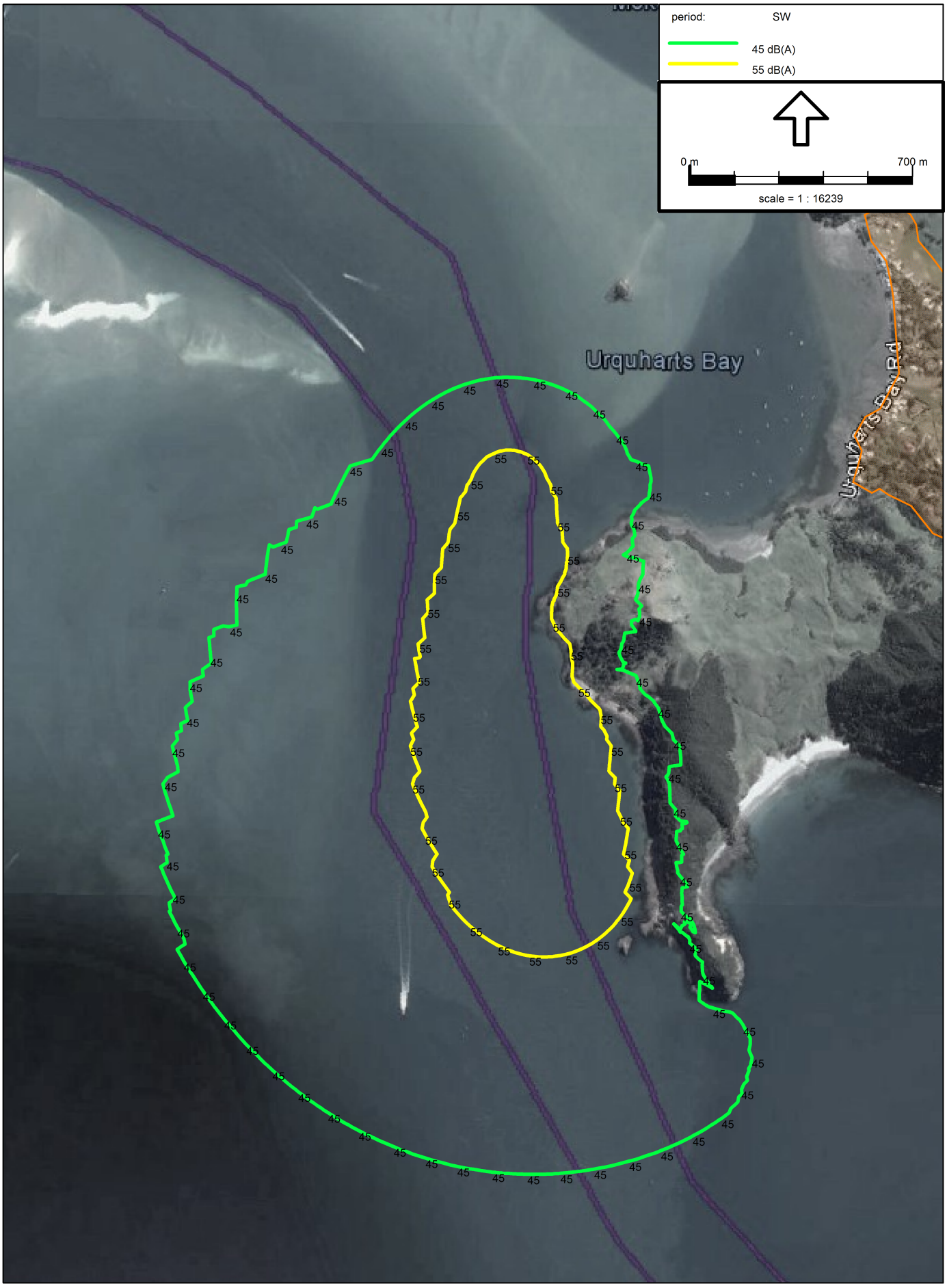
Easterly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_4_3m/s] , Predictor V11.10

TSHD Mid Channel (Home Point): Worst Case Channel Position

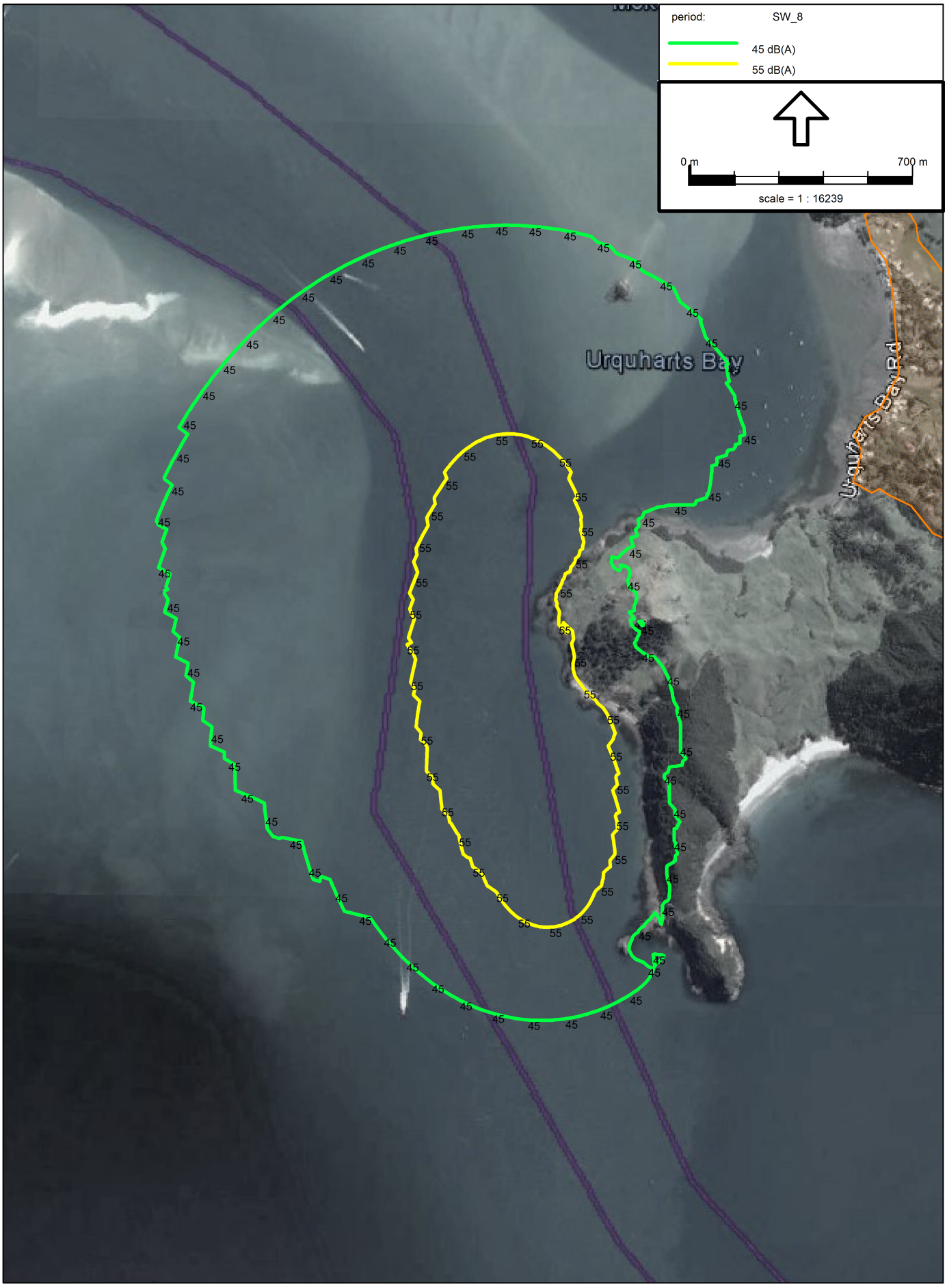
Northerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_4_3m/s] , Predictor V11.10

TSHD Mid Channel (Home Point): Worst Case Channel Position

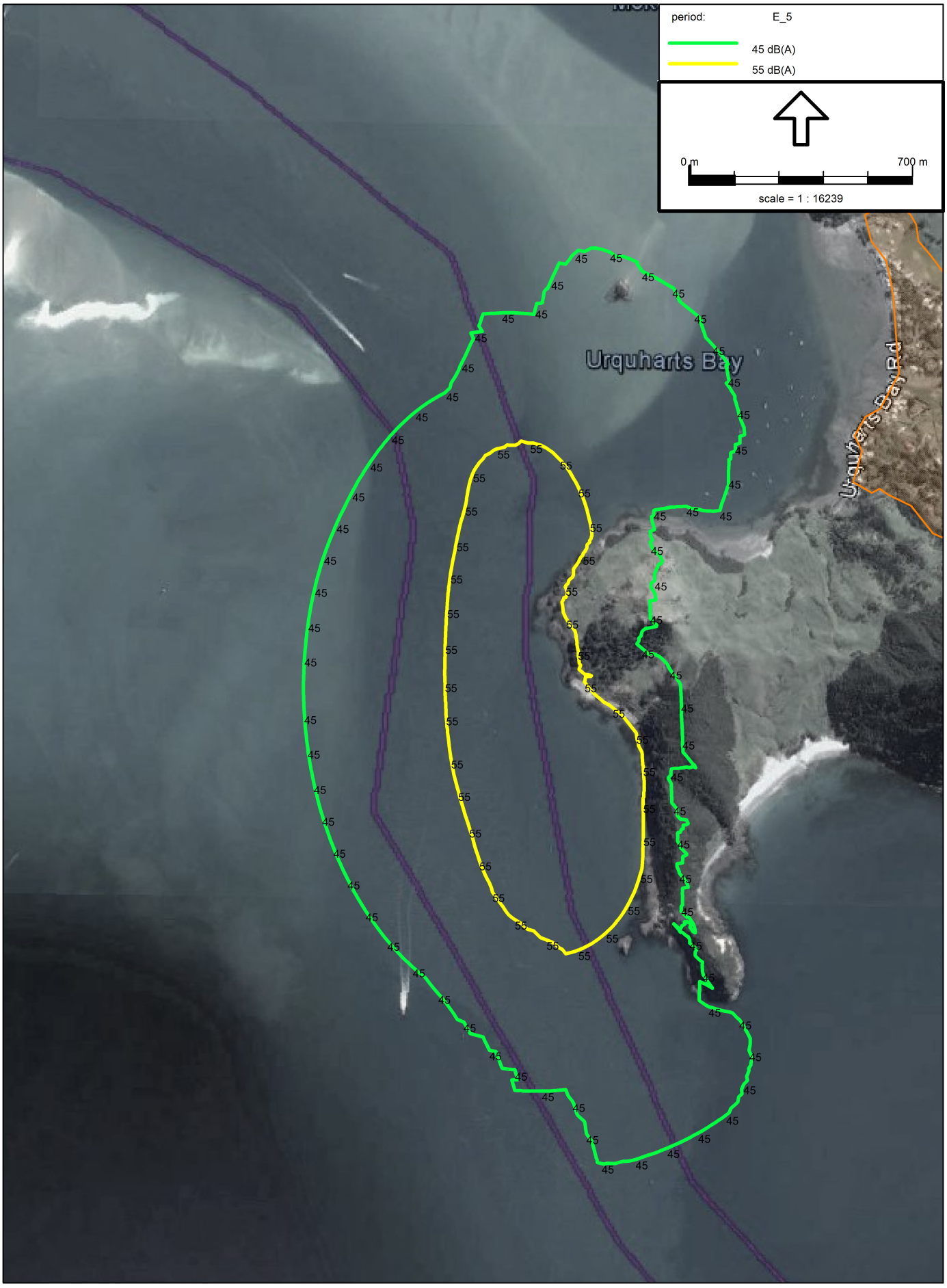
Southerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_4_3m/s] , Predictor V11.10

TSHD Mid Channel (Home Point): Worst Case Channel Position

Westerly Wind



Industrial noise - ISO 9613.1/2, [Weather - Lines_4_3m/s] , Predictor V11.10