Appendix I

Noise Assessment Report

N2 Monaghan Town to Emyvale, County Monaghan Proposed Pavement and Minor Improvement Scheme

Corracrin to Emyvale

Report of Noise Assessment

For

Monaghan County Council
N2 Monaghan to Emyvale Road Improvements
Phase 3

by

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1. Introduction

Q.E.D. Engineering Ltd was commissioned in early 2011 by Monaghan County Council to undertake a Noise Assessment for the N2 Monaghan to Emyvale Road Improvements. The road improvements entail widening the road cross-section, easing bends and undertaking localised minor realignments of the existing road. The road improvement works are divided into 4 phases.

Phase 1 works are already under construction from the townland of Kilnadreen to Coolkill East on the N2 Road North of Monaghan Town, which is approximately 1.5 Km in length. Phase 2 and 4 are contiguous sections of road, which together comprise a length of approximately 5.3km extending from the townland of Coolkill to the townland of Gortmoney at the settlement of Corracrin. Phase 3 extends from Gortmoney in the settlement of Corracrin to the village of Emyvale which is approx. 2.05kms in length. The location of all phases is shown in the map in Appendix A.

This Noise Assessment and report deals with Phase 3 only. Arup have been engaged by Monaghan County Council to prepare a Part 8 application for Phase 3 (Corracrin to Emyvale) of the N2 Monaghan Town to Emyvale Road Improvement scheme and a request was made to complete the Noise Assessment of Phase 3 in January 2012.

The level of traffic noise at a receptor point (House) is influenced by a number of factors including traffic flow, speed, composition (% HGV), gradient, type of road surface, distance from the road and the presence of any obstructions between the road and the receptor. Wet conditions will also increase road noise.

To determine the impact of the road upgrades on Phases 3 of the N2 between Monaghan and Emyvale, a number of assessments were undertaken, as detailed in this report;

1) Baseline noise surveys were undertaken at noise sensitive receptors along Phase 3 of the N2 in April 2011. One long term 24 hour noise measurements and six short-term noise measurements were made.
2) Noise modelling was undertaken to show the existing noise climate of the area and to predict noise at sensitive dwellings as a result of the upgrade works.
3) Results of both surveys were compared to the NRA guidelines to determine if noise mitigation is necessary along Phase 3.
4) Construction noise and vibration issues are also discussed in this report.

2. Standards and Guidelines

The work was undertaken in line with the NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes (2004). This guideline was designed for noise assessments for all new roadways in Ireland (on Greenfield sites), but it is also applied to existing road upgrades. Regard was also made to;

- The Monaghan County Development Plan 2007-2013
- Calculation of Road Traffic Noise (CRTN), HMSO (1988)
- ISO1996, Parts 1 & 2, Acoustics – Description, Measurement and Assessment of Environmental Noise
- EPA Environmental Noise Survey Guidance Document (2003)

The NRA Guidelines specify that all future national road schemes should be designed, where feasible to meet the following;

- **Day-evening-night 60dB Lden (free field residential façade criterion)**

This design goal has been shown to be significantly more onerous than the 68dBA $L_{10(18\ Hour)}$ value previously employed on national road schemes. This design goal is applied to new road schemes only, at existing sensitive receptors in respect of both the year of opening (2012 in this case) and the design year (i.e. 15 years after projected year of opening), which is 2027.

The NRA Guideline further specify that noise mitigation measures are deemed necessary when the following three conditions are satisfied.

a) the combined expected maximum traffic noise level i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal (i.e.L_{den} 60dB)
b) the relevant noise level is at least 1dB more than the expected traffic noise without the proposed road scheme in place.
c) the contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

The predicted values are then assessed against the three conditions to assess the need for mitigation measures.

3. Existing Noise Environment

3.1 Noise Surveys

Noise surveys were undertaken along Phase 3 of the roadway in April 2011 to quantify the existing noise environment. Phase 3 of the road improvement works are approximately 2.05km in length. In Phase 3 there are twenty two houses close to the existing road.

Following NRA Guidelines, one 24-hour noise measurement and six short term measurements were made along this stretch of road.

Noise monitoring was carried out using the following instruments;

1. B&K 2250 Light Hand Held Analyser, Serial No. 2638881 with Microphone 4950 Serial No. 2626990. The instrument was last calibrated on 08/07/2009. A B&K Type 4231 Calibrator, Serial No. 2460008 was used to calibrate the sound level meter and this was last calibrated on 28/05/2010.
2. Rion NA-27 Real Time 1/1, 1/3 Octave Band Logging SLM, Serial No. 00380685. This meter was last calibrated on 01/06/10. A GA607 Dual Level Calibrator, Serial No. 036341 was used to calibrate the sound level meter and this was last calibrated on 01/06/10.
3. Castle GA123 Integrated Data-logging Octave Band Sound Level Meter, Serial No. 036015 and microphone Serial No. 27101. This meter was last calibrated on 01/06/10. A GA607 Dual Level Calibrator, Serial No. 036023 was used to calibrate the sound level meter and this was also last calibrated on 01/06/10

The B&K instrument was used for the 24 hour noise measurement, in conjunction with an outdoor protection kit, tripod and microphone extension cable. The other two instruments were used for the short term noise measurements and a standard windshield was used on both. All instruments were calibrated before measurement and checked for calibration after measurement and found to be satisfactory.

Monitoring was undertaken by Patricia Murtagh of Q.E.D Engineering Ltd, BSc, MSc, AMIOA between 20th and 21st April 2011. Weather conditions during monitoring were dry, sunny and warm, with no wind.

Table 1 provides the locations of noise monitoring and these are also shown in Appendix B. Note there are other houses labelled in the map in Appendix B as these were used for noise prediction purposes, as further explained in Section 4.3 and Table 4.

Table 1. Phase 3 Noise Monitoring Locations

Phase	Date	Ref.	Description	Grid Ref
3	21/04/2011	P3-1	Yellow bungalow along road	E667436, N841626
3	21/04/2011	P3-2	Two storey house along road	E667499, N842176
3	21/04/2011	P3-3*	Bungalow (two together), along road	E667587, N842576
3	21/04/2011	P3-4	Two storey house, split level at back	E667692, N842956
3	21/04/2011	P3-5	Bungalow, mushroom houses behind	E667728, N843156
3	21/04/2011	P3-6	Bungalow, elevated site, across from mushroom houses	E667538, N843360

* 24 hour measurement location

3.2 Noise Calculations

Traffic noise varies from moment to moment. In order to asses the overall noise level produced by traffic, a statistical single-figure index designated $L_{A10(18\ Hour)}$ is used. This is calculated by taking the arithmetic average of the eighteen hourly samples $L_{A10(1hr)}$ between 06:00 – 24:00 from the measured 24hour data.

A second indicator, L_{den} is also used for road traffic noise assessment. L_{den} (termed L_{day}, $L_{evening}$ and L_{night}) is the average sound level (L_{Aeq}) over a 24 hour period, with a penalty of 5 dB added for the evening hours or 19:00 to 22:00, and a penalty of 10 dB added for the nighttime hours of 22:00 to 07:00. It is calculated by the following formula;

$L_{den}=10xLog_{10}(1/24)(12x10^{Lday/10})+4x10(^{5+Levening)/10}) + 8x10(^{10+Lnight)/10})$dBA where
L_{day} = 07:00 – 19:00 hours
$L_{evening}$ = 19:00 – 23:00 hours
L_{night} = 23:00-07:00 hours

Short term noise measurements were made at each chosen location over three consecutive hours between 10:00 and 17:00 hours, for at least 15 minutes at each location. The $L_{10(18\ Hour)}$ is calculated by subtracting 1dB from the arithmetic mean of the L_{A10} values measured during the three sample periods. The L_{den} value is calculated following Method B in the NRA Guideline;
L_{den} = 0.86 x $L_{A10(18\ hour)}$+9.86dB

3.3 Noise Results

The survey results are presented in terms of the following parameters;

L_{Aeq} is the A weighted equivalent continuous steady sound level during the sample period and effectively represents the average sound.

L_{A90} is the A weighted sound level that is exceeded for 90% of the measurement time and generally represents the background noise.

L_{A10} is the A weighted sound level that is exceeded for 10% of the measurement time and generally represents higher fluctuating noise such as traffic.

The results for all locations, as well as the derived $L_{10(18\ Hour)}$ and L_{den} is presented in Tables 2 & 3.

Table 2. Short Term Measurement Results

House Ref	Start Time	Stop Time	L_{Aeq}	L_{A90}	L_{A10}	$L_{A10(18\ Hour)}$	L_{den}
P3-1	10.08	10.26	62	44	65	65	65
	11.09	11.25	61	43	65		
	12.01	12.16	63	42	67		
P3-2	10.19	10.34	66	42	70	69	70
	11.01	11.16	66	42	71		
	12.07	12.22	66	43	70		
P3-3	10.31	10.46	65	42	70	68	69
	11.38	11.53	64	41	69		
	12.38	12.55	65	45	70		
P3-4	10.41	10.56	57	38	61	61	62
	11.20	11.35	58	37	62		
	12.27	12.42	58	36	63		
P3-5	10.51	11.06	58	44	62	61	62
	11.29	11.45	59	43	63		
	12.20	12.35	58	45	62		
P3-6	14.45	15.00	65	53	68	66	67
	15.43	15.59	63	51	67		
	16.40	16.52	63	50	67		

Table 3. Phase 3 - 24 Hour Measurement Result (P3-3)

Start time	L_{Aeq} dBA	L_{A10} dBA	L_{A90} dBA
00:00:00	52	46	29
01:00:00	48	42	29
02:00:00	48	37	30
03:00:00	50	34	29
04:00:00	56	38	28
05:00:00	60	43	27
06:00:00	64	49	31
07:00:00	65	53	37
08:00:00	64	56	42
09:00:00	59	54	38
10:00:00	60	55	35
11:00:00	64	59	38
12:00:00	62	54	36
13:00:00	69	59	42
14:00:00	68	54	37
15:00:00	69	50	35
16:00:00	69	58	41
17:00:00	70	59	43
18:00:00	69	57	40
19:00:00	66	52	37
20:00:00	58	51	35
21:00:00	57	51	35
22:00:00	56	51	33
23:00:00	53	49	32
Value of $L_{A10(18\ hour)}$			**54**
Value of L_{den}			**68**

3.4 Discussion of Results

P3-1
House P3-1 is located along the roadway not far from the school and a house is located across the road at this location also. Road traffic is the predominant noise source here. The L_{Aeq} noise level ranged from 61-63dBA and the L_{A10} noise level between 65-67dBA. The derived L_{den} at this location is 65dBA.

P3-2
House P3-2 is a farmhouse located at along the roadway and traffic noises is the predominant noise source here. The L_{Aeq} noise level was 66dBA and the L_{A10} noise level ranged between 70-71dBA. The derived L_{den} at this location is 70dBA.

P3-3
House P3-3 is beside the road and is a semi-detached bungalow. Traffic noise is the predominant noise source here. The L_{Aeq} noise level ranged from 64-65dBA and the L_{A10} noise level between 69-70dBA. The derived L_{den} at this location is 69dBA.

This was also the location of the continuous 24 hour measurement in Phase 3. Daytime L_{Aeq} noise levels (07:00-19:00) with the continuous monitor ranged from 60-70dBA and the L_{A10} noise level ranged from 50-59dBA. Evening time L_{Aeq} noise levels (19:00-23:00) with the continuous monitor ranged from 53-58dBA and the L_{A10} noise level ranged from 49-51dBA. Night time L_{Aeq} noise levels (23:00-07:00) with the continuous monitor ranged from 48-65dBA and the L_{A10} noise level ranged from 34-56dBA. The measured L_{den} at this location is 68dBA.

P3-4
House P3-4 is a large split level house along the road, with a high hedge between it and the road. Traffic noise is the predominant noise source here. The L_{Aeq} noise level ranged from 57-58dBA and the L_{A10} noise level between 61-63dBA. The derived L_{den} at this location is 62dBA.

P3-5
House P3-5 is a bungalow and mushroom houses are located behind it. Traffic noise is the predominant noise source at the front of the house and noise from the mushroom farm (mainly vehicles) is audible at the back of the house. The L_{Aeq} noise level ranged from 58-59dBA and the L_{A10} noise level ranged from 62-63dBA. The derived L_{den} at this location is 62dBA.

P3-6
House P3-6 is a bungalow on an elevated site, and a mushroom farm is located across the road here. Road traffic noise along with noise from the mushroom farm (fans / forklift) is the predominant noise source here. The L_{Aeq} noise level ranged from 63-65dBA and the L_{A10} noise level ranged from 67-68dBA. The derived L_{den} at this location is 67dBA.

4. Noise Predictions

4.1 Noise Model

A computer based noise model, Bruel & Kjaer's *Type 7810 Predictor, Versions 8.01 & 8.11* software was used to predict the impact of noise from the upgraded road on the nearest noise sensitive locations. Predictor is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. *Predictor* predicts noise levels in different ways depending on the selected prediction standard. In general however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound including;

- The magnitude of the noise source in terms of sound power or traffic flow and average velocity
- The distance between the source and receiver
- The presence of obstacles in terms of screens or barriers in the propagation path
- The presence of reflecting surfaces
- The hardness of the ground between the source and the receiver.

The noise model was prepared using the following data;

- Current road alignments and topographical data supplied by Monaghan County Council, Roads Section.
- Proposed road alignments and topographical data supplied by Arup, Dublin.
- Traffic Flow data from the NRA Aughnacloy N02-1 Traffic Counter N2 south of Monaghan/Tyrone border (IG: 266748E 349585N). This was the only long term reliable traffic data nearest the proposed road upgrade available for use. Year 2010 data was used, with an AADT (Annual Average Daily Traffic) estimate of 5389 and a HCV volume of 12%.
- Traffic speeds from the current existing road, which will be the same as the upgraded road.

Predictor calculates noise levels for a set of receiver locations specified by the user. The results include an overall level L_{den} in dB.

4.2 Calibration of Noise Model

The purpose of noise model calibration is to ensure that the software is correctly interpreting the input data and providing results that are valid for the scenario under consideration. The Noise Model is calibrated by comparing the measured 24 hour noise levels at relevant locations with the model predictions, to ensure that the variance was no greater than ±3dBA at any assessment location. The measured and predicted L_{den} levels for Phase 3 fall within this range so the model is deemed satisfactory.

4.3 Noise Predictions at Noise Sensitive Locations

Free field traffic noise levels have been predicted at a number of properties in the vicinity of the proposed and existing road upgrade. The details of all these receiver locations are provided in Table 4 and detailed in the map in Appendix B.

Table 4. Details of Noise Sensitive Locations

Phase	Ref.	Description	Grid Ref
3	P3-1	Yellow bungalow along road	E667436, N841626
3	P3-1a	Storey and half house across from P3-1	E667485, N841611
3	P3-1b	Two storey house along road opposite crossroad	E667468, N841708
3	P3-1c	New tow storey red brick house at cross road	E667434, N841760
3	P3-1d	Two storey house beside farm buildings	E667563, N841892
3	P3-2	Two storey house along road beside farm buildings	E667499, N842176
3	P3-2a	Two storey house, car scrap yard behind it	E667512, N842417
3	P3-2b	Two storey house	E667542, N842552
3	P3-3	Bungalow (two together), along road	E667587, N842576
3	P3-3a	House up laneway	E667556, N842734
3	P3-4	Two storey house, split level at back	E667736, N842936
3	P3-4a	House across from P3-4	E667623, N843011
3	P3-4b	Bungalow near road	E667695, N843052
3	P3-4c	Bungalow near road	E667698, N843068
3	P3-5	Bungalow, mushroom houses behind	E667728, N843156
3	P3-6	Bungalow, elevated site, across from mushroom houses	E667538, N843360
3	P3-6a	House up laneway, elevated site	E667556, N843268
3	P3-6b	Two storey house along road	E667639, N843558
3	P3-6c	House at cross roads	E667587, N843668
3	P3-6d	House at cross roads	E667590, N843700
3	P3-6e	House near river	E667681, N843730

As per NRA guidelines, the noise model is used to show the existing noise level (Do Minimum) and the Predicted noise level (Do-Something) in terms of L_{den} for opening (2012) and design years. Two scenarios have been modelled as follows;

- Existing Noise Levels (on current road) (2012)
- Predicted Noise Levels (on upgraded road) (2012) based on the same traffic volume as currently exist on the road, but with the new road alignment.

For the design year (2027) the increase in traffic volume on the current road (assuming no upgrade as of 2027) will equal the increase in traffic volume on the upgraded road at this time, so it is not necessary to model this scenario as the same differences as currently exist (2012 figures) will apply. Modelling the design year is generally only relevant for new roads on Greenfield sites, where no traffic currently exists.

The results of current and predicted noise levels are provided in Tables 5. Noise levels are also illustrated graphically in Appendix C.

Table 5. Predicted Noise Levels at Noise Sensitive Locations

Location Ref.	Predicted Noise Level L_{den} dBA		Mitigation Required
	Existing "Do Minimum"	Proposed "Do Something"	
P3-1	66	66	No
P3-1a	65	65	No
P3-1b	66	66	No
P3-1c	56	56	No
P3-1d	65	65	No
P3-2	66	66	No
P3-2a	67	67	No
P3-2b	69	69	No
P3-3	69	69	No
P3-3a	58	58	No
P3-4	62	62	No
P3-4a	60	60	No
P3-4b	62	62	No
P3-4c	62	62	No
P3-5	59	55	No
P3-6	58	58	No
P3-6a	53	53	No
P3-6b	66	66	No
P3-6c	65	65	No
P3-6d	65	65	No
P3-6e	59	59	No

5. Mitigation

As outlined in Section 2 of this report, the NRA Guidelines specify that if all three conditions outlined below are satisfied, noise mitigation is required at noise sensitive locations.

a) the combined expected maximum traffic noise level i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal (i.e.L_{den} 60dB)
b) the relevant noise level is at least 1dB more than the expected traffic noise without the proposed road scheme in place.
c) the contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

The combined expected traffic noise levels from the proposed road upgrade, together with other traffic currently existing in the area (i.e. Do Something Scenario) is greater than 60dB L_{den} at 15 of the 21 noise sensitive locations, therefore Condition (a) of the Design goals is satisfied for these 15 locations.

The Do Something levels are less than or equal to the Do Minimum noise in these 15 noise sensitive locations, therefore Condition (b) of the Design Goals is not satisfied so no mitigation measures are required at these locations.

The Do something levels for 15 locations include a contribution of less than 1dB from the proposed development. Therefore condition c of the Design Goals is not satisfied so no mitigation measures are required at these locations.

Because all three of the NRA conditions are not satisfied at any sensitive receptors, noise mitigation measures are not required as part of this development.

6. Construction Noise

During road upgrade works, construction noise will take the form of plant such as excavators, loading shovels, dumper trucks, compressors and generators, which will be present in the area of construction for a period of time and then move as the road upgrades progress.

There is no published Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local Authorities should control construction activities by imposing limits on the hours of operation and consider noise limits at their discretion. The NRA Guidance document specifies indicative noise levels that it typically deems acceptable in terms of construction noise. These limits are provided in Table 6.

Table 6. Maximum permissible noise levels at the façade of dwellings during construction

Days & Times	$L_{Aeq(1hr)}$ dB	$L_{pA(Max)slow}$ dB
Monday to Friday 07:00 to 19:00	70	80*
Monday to Friday 19:00 to 22:00	60*	65*
Saturday 08:00 to 16:30	65	75
Sundays and Bank Holidays 08:00 to 16:30	60*	65*

* Construction activities at these times, other than that required in respect of emergency works, will normally require the explicit permission of the relevant local authority.

7. Vibration

The vibration level of the current existing road is not expected to increase in magnitude when the road is upgraded as the same traffic volume is expected to use the road.

Vibration can be caused during construction activities. There is no published Irish guidance relating to vibration during construction activities. However, in order to ensure that there is no potential for vibration damage during construction the NRA guidance document provides acceptable limits that should be met. These are provided in Table 7.

Table 7. Allowable vibration during road construction in order to minimise the risk of building damage

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less that 10Hz	10 to 50Hz	50 to 100 Hz (and above)
8mm/s	12.5mm/s	20mm/s

8. Conclusion

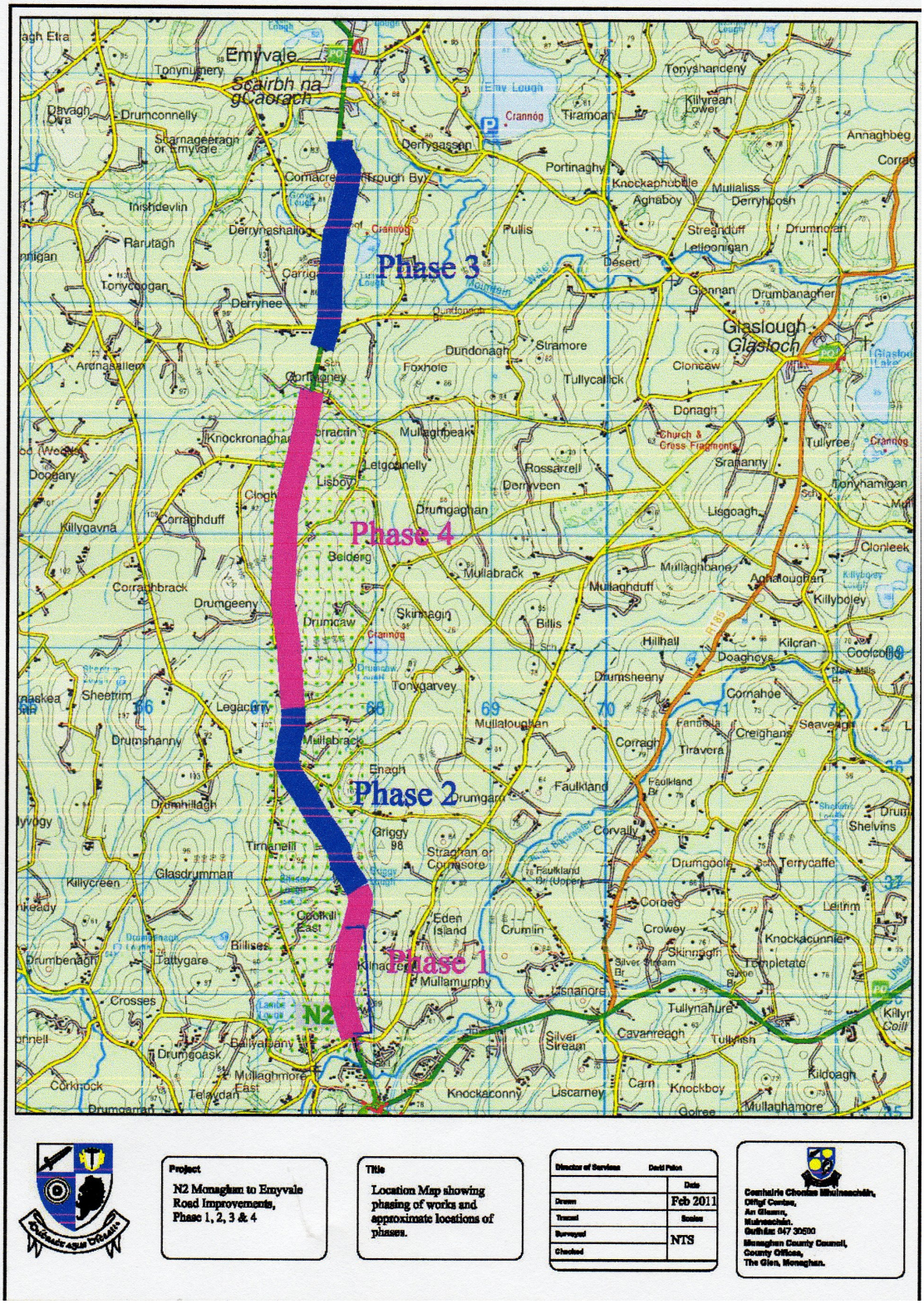
The current level of traffic on Phase 3 of the N2 is not expected to increase or decrease significantly as a result of the road upgrade works. Therefore the current level of noise experienced from road traffic to houses along the roadway is not predicted to significantly increase or decrease.

The three NRA Design Goals for requiring mitigation at noise sensitive locations was not met at any of the dwellings along the N2 route. Therefore no specific mitigation measures are required at any dwelling along Phase 3 of the route.

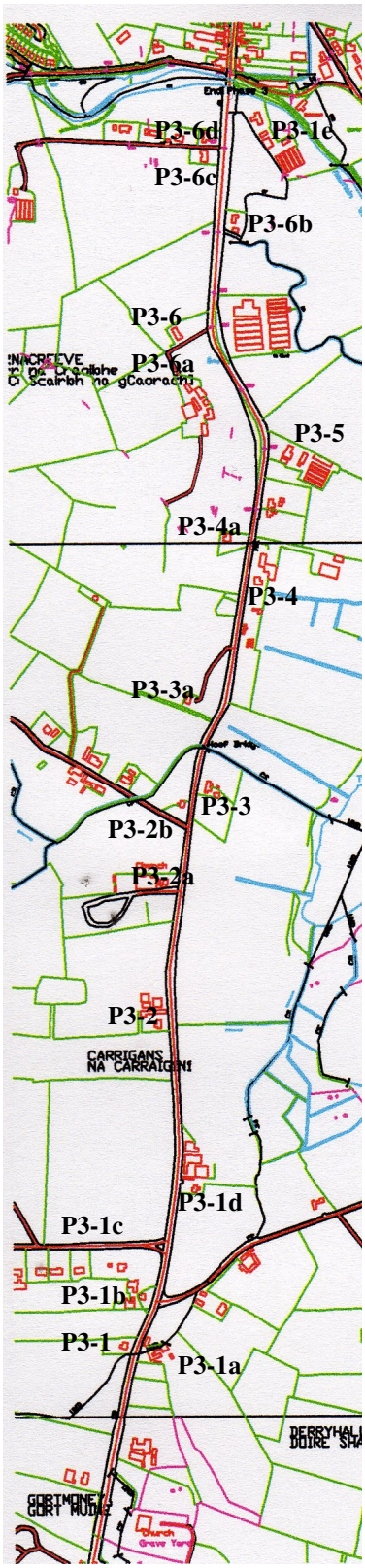
During construction, noise and vibration levels are to be kept to the acceptable levels specified in the NRA guidelines.

Therefore the road upgrade works on Phase 3 of the N2 between Monaghan and Emyvale are not expected to pose a Noise Impact.

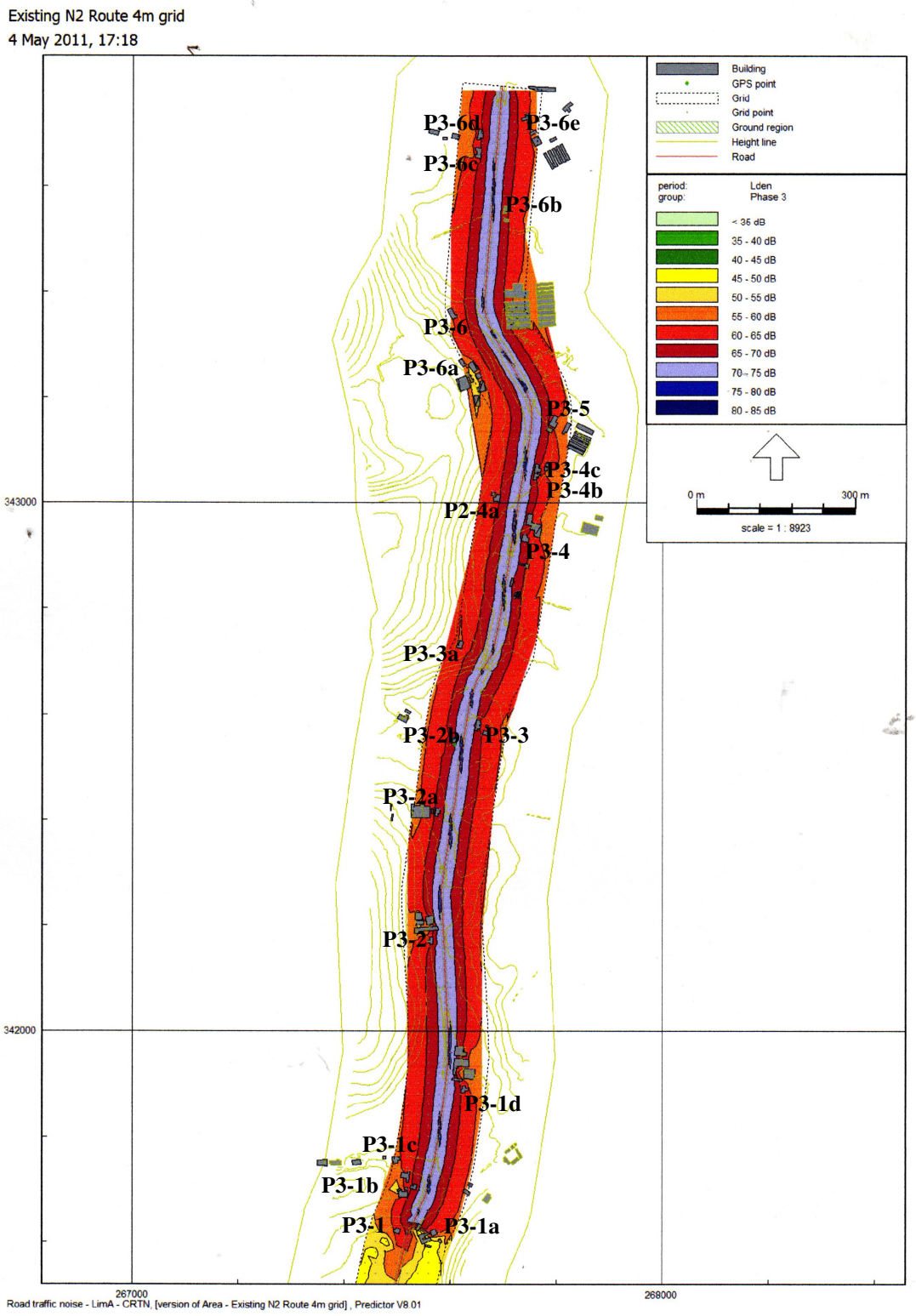
Appendix A: Site Location Maps



Appendix B. Phase 3 Noise Monitoring Locations



Appendix C1. Noise Model Contours for Phase 3 Existing Road



Appendix C2. Noise Model Contours for Phase 3 Proposed Road