MARSHALL DAY Acoustics

MLC FLOW IMPROVEMENT PROJECT
CONSTRUCTION NOISE ASSESSMENT

Rp 001 R01 20220817 | 19 December 2023

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Project: **MLC Flow Conveyance Improvement Project**

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SUMMARY

Marshall Day Acoustics has been engaged to predict noise levels associated with construction noise related to the Manapouri Lake Control Improvement project, and to assess the likely noise effects arising from this activity. Meridian proposes to improve flow conveyance and reliability by constructing a new and deeper channel adjacent to and parallel to the Waiau Arm and removing accumulated gravel and bed material.

The project will involve the construction of a new channel which is parallel to, and largely offline, from the current bed and channel of the Waiau Arm. Approximately 225,000 m^3 of gravel and bed material will be excavated and disposed of on Meridian owned land near the new channel.

While night-time works will be avoided, if possible, it is anticipated that in order to complete the project within the necessary timeframes night-time work may be required. Accordingly, we have focussed on the prediction and assessment of night-time noise at nearby dwellings, using a range of assessment criteria including both the Southland District Plan noise standards and guidance from NZS 6803:1999 *Acoustics – Construction Noise* amongst others.

At most dwellings night-time noise standards will be achieved, with only two dwellings potentially subjected to noise levels at or slightly greater than typical guidance for short periods if night-time works prove necessary during those stages.

Noise levels within bedrooms are expected to be acceptable for preservation of sleep amenity, and on this basis, we consider that the predicted noise levels are reasonable and any adverse noise effects will be less than minor.

Daytime noise levels are predicted to be similar to night-time activity, with excavation stages potentially being up to 3 dB greater than at night, thus comfortably complying with the daytime noise standards and guidelines.

We recommend that a project specific Construction Noise Management Plan is developed that addresses criteria triggering the requirement for night-time works, communication and consultation with potentially affected neighbours, and mitigation of noise by application of best practicable options.

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1.0 INTRODUCTION

Meridian Energy Limited (Meridian) releases flows through the Manapōuri Lake Control Structure (MLC) to the Lower Waiau River (LWR) in accordance with existing resource consent conditions. The types of flow released include minimum flows, lake and flood flows, recreational flows, and flushing flows. Each of these assists with managing nuisance periphyton growth and has benefits for river health. However, the current channel depth and alignment, and gravel accumulation in the Waiau Arm immediately upstream of the MLC, have been identified as the primary physical constraints affecting flow conveyance and reliability, particularly for flushing flows.

The aim of this Project is to reduce these constraints by constructing a new and deeper channel adjacent and parallel to the Waiau Arm by removing accumulated gravel; and to provide for any necessary maintenance of the new channels. Following construction of the new and deeper channel, more reliable conveyance of consented flows into the LWR is expected.

A more comprehensive description of the Project, and the proposed methodology, is included in the AEE, and the construction methodology report prepared by Damwatch Engineering Ltd.

Marshall Day Acoustics has been engaged to undertake an assessment of construction noise and vibration associated with the excavation of the parallel channel upstream of the MLC.

This report summarises the environment in which the works will take place, the relevant limits in the District Plan and other applicable guidelines, the methodology used in our assessment of noise and vibration effects, and our conclusions.

A glossary of acoustical terms used in this report is provided in Appendix A.

2.0 THE SITE AND ACTIVITY DESCRIPTION

The site location and the project description are addressed in detail in the assessment of environmental effects (AEE). For ease of reference a brief summary is provided below.

2.1 Project overview

The Project will involve the construction of a new channel which is parallel to, and largely offline, from the current bed and channel of the Waiau Arm. Approximately 225,000 m^3 of gravel and bed material will be excavated and disposed of on Meridian owned land near the new channel.

Subject to obtaining resource consents, and hydrological conditions, Meridian proposes to undertake the works within a 10 month window of January to October 2025. The overall construction period within this window is envisaged to be approximately 4 - 5 months. The up and downstream cuts to connect the parallel channel to the current bed and channel requiring works in water is anticipated to take approximately 5 weeks if undertaken simultaneously. The remainder of the construction window is required for establishment, disestablishment, and rehabilitation activities. Works are proposed to occur on 7-days per week and up to 24 hours per day.

The bulk channel excavation works are targeted to the time of year when hydrological conditions are likely most favourable for safe and efficient delivery of the work. The construction window has also been identified to limit disruption to Meridian's monitoring requirements under existing resource consent conditions.

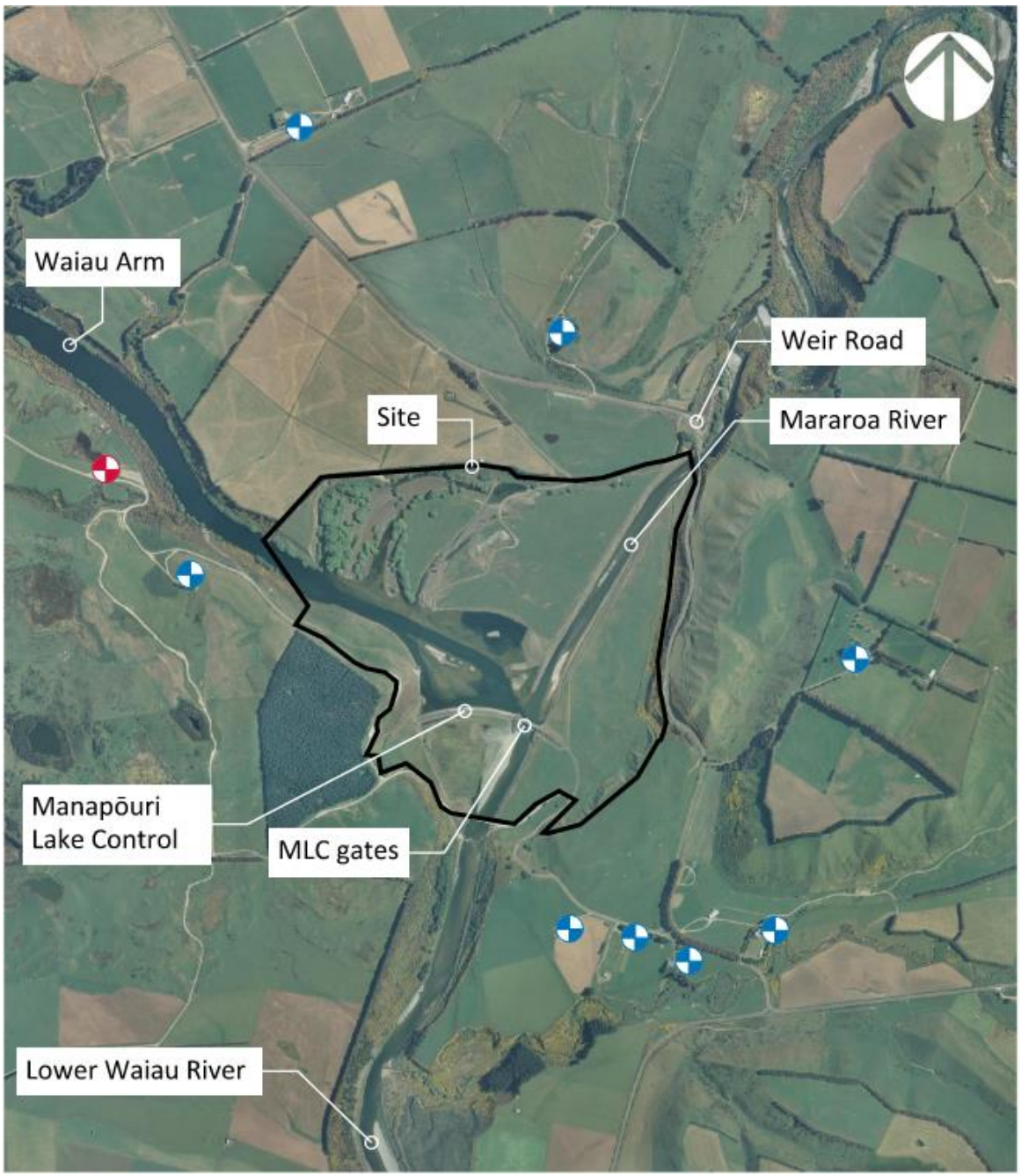
Full details of the Project, and the proposed construction methodology and sequencing, are contained in the AEE.

2.2 Site location

The MLC is located approximately 9 km south-east of Lake Manapōuri and the Manapōuri township, at the confluence of the Waiau and Mararoa Rivers. The site is located in a rural environment. The Project site is bound by the Waiau Arm and farmland to the north and west, the Lower Waiau River (LWR) and farmland to the south, and the Mararoa River to the east. It extends down the LWR to just

above the point where the Excelsior joins the main stem of the LWR. A site location plan is shown in Figure 1, with full details of the project site contained in the AEE. The site boundary is indicated in black, with dwellings shown in blue markers and an office in red. Major landmarks are indicated as mark-ups.

Figure 1: Site locality.



3.0 DISTRICT PLAN & OTHER GUIDANCE

This section summarises the relevant noise and vibration limits of the Southland District Plan, along with other applicable guidance used to inform our assessment of noise effects.

3.1 The District Plan

The site and all relevant neighbouring sites lie within the General Rural Zone (GRUZ), as defined in Southland District Plan (SDP) map 14 (revision 6, operative October 2023). We understand that Part 2 and Part 3 of the draft SDP are operative, but that the updates to the SDP are about structure and

definitions, with policies and rules being unchanged[1]. The extracts quoted below come from the draft Operative SDP.

3.1.1 Vibration

Vibration is controlled via rule NOISE-R10 – Vibration[2], which states:

> *Vibration emanating from any activity, shall not exceed the limits given in any of the following standards at any dwelling, residential activity, educational facility or office on any other property:*
>
> 1. *AS 2670.1-2001 Evaluation of human exposure to whole-body vibration - General requirements.*
> 2. *AS 2670.2-1990 Evaluation of human exposure to whole-body vibration - Continuous and shock-induced vibration in buildings (1 to 80 Hz).*
> 3. *DIN 4150-3:1999 Effects of vibration on structures.*

There are no dwellings or other noise sensitive dwellings sufficiently close to the work site to require assessment against the standards above.

3.1.2 Construction noise

Construction noise is controlled via NOISE-R12[3] – Construction Noise as a district wide matter:

> *Construction noise shall comply with NZS 6803:1999 Acoustics – Construction Noise.*

This standard is discussed in greater detail below.

3.1.3 Rural Zone noise

Noise in the GRUZ is controlled via Rule GRUZ-R7.4- Noise[4]. This rule, except as provided for in NOISE-R3 to NOISE-R11 in the district wide chapter, requires that all activities not exceed the noise limits in Table 1 below.

Table 1: GRUZ noise permitted activity noise limits.

Assessment location	Daytime (0700 to 2200)		Night-time (2200 to 0700)	
	dB $L_{Aeq\ (15\ min)}$	dB L_{AFmax}	dB $L_{Aeq\ (15\ min)}$	dB L_{AFmax}
GRUZ – Property Boundary	65	85	45	70
GRUZ – Notional Boundary	50	75	40	70

Note: The daytime noise limits are intended to provide amenity for outdoor activities. Night-time noise limits are intended to allow for sleep amenity.

Noise is to be measured in accordance with New Zealand Standard NZS 6801:2008 *Acoustics – Measurement of environmental sound* and assessed in accordance with New Zealand Standard NZS 6802:2008 *Acoustics - Environmental Noise*.

Because GRUZ-R7.4 does not reference NOISE-R12, it could be taken that both rules apply, but if so there is ambiguity as to which rule takes precedence. The 2019 National Planning Standards, section

[1] https://www.southlanddc.govt.nz/home-and-property/resource-planning/district-plan/draft-district-plan/

[2] Rule NSE.10 in prior version of the district plan

[3] Rule NSE.12 in prior version of the district plan

[4] Rule RURAL.7(4) in prior version of the district plan

15, requires that any plan rule to manage construction noise emissions be in accordance with the mandatory methods applicable in NZS 6803.

In the context of this proposal, this becomes relevant only at night, and only for a limited number of properties, as discussed in Section 4.4.

3.2 NZS 6802:2008

New Zealand Standard NZS 6802:2008 *"Acoustics - Environmental Noise"* also provides guidance on desirable upper limits for environmental noise in residential areas. This Standard is intended to provide local authorities with appropriate guidelines for the development of noise standards.

The noise levels specified in the Standard for residential areas are generally consistent with those given in the WHO guidance below. These are 55 dB $L_{Aeq\ (15\ min)}$ during the day and 45 dB $L_{Aeq\ (15\ min)}$ at night, with a maximum night-time noise level of 75 dB L_{Amax}.

3.3 NZS 6803:1999

NZS 6803 sets out procedures for the measurement and assessment of noise from construction work, including maintenance and demolition. In contrast to the SDP and NZS 6802, the assessment location used in NZS 6803 is 1 m from the façade of the receiving dwelling or building.

The relevant limits are contained with Tables 2 and 3 of NZS 6803, which are reproduced below. Long-term construction is classified as being greater than 20 weeks in duration. Given the proposed construction timeframe, this would be the applicable assessment standard for the MLC proposal (highlighted in yellow below).

Residential zones and dwellings in rural areas:

Table 2 – Recommended upper limits for construction noise received in residential zones and dwellings in rural areas

Time of week	Time period	Duration of work					
		Typical duration (dBA)		Short-term duration (dBA)		Long-term duration (dBA)	
		L_{eq}	L_{max}	L_{eq}	L_{max}	L_{eq}	L_{max}
Weekdays	0630-0730	60	75	65	75	55	75
	0730-1800	75	90	80	95	70	85
	1800-2000	70	85	75	90	65	80
	2000-0630	45	75	45	75	45	75
Saturdays	0630-0730	45	75	45	75	45	75
	0730-1800	75	90	80	95	70	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75
Sundays and public holidays	0630-0730	45	75	45	75	45	75
	0730-1800	55	85	55	85	55	85
	1800-2000	45	75	45	75	45	75
	2000-0630	45	75	45	75	45	75

Industrial or commercial areas:

Table 3 – Recommended upper limits for construction noise received in industrial or commercial areas for all days of the year

Time period	Duration of work		
	Typical duration	Short-term duration	Long-term duration
	L_{eq} (dBA)	L_{eq} (dBA)	L_{eq} (dBA)
0730-1800	75	80	70
1800-0730	80	85	75

3.4 World Health Organisation (WHO) Guidelines

The World Health Organisation (WHO) Guidelines for Community Noise provide guideline values for community noise in specific environments. The levels relevant to residential environments are based on preventing annoyance during the daytime and to preserve sleep amenity during the night-time (2200 to 0700 hours the next day) and are summarised in Table 2.

The guidelines given in Table 2 indicate that noise levels below 55 dB $L_{Aeq\,(16\,hr)}$ during the day in outdoor living areas will be acceptable, whilst levels below 45 dB $L_{Aeq\,(8\,hr)}$ at night outside bedrooms will be appropriate for the protection of sleep amenity.

Table 2: WHO Community Noise Guidelines

Specific Environment	Critical health effect(s)	dB L_{Aeq}	Time base (hours)	dB L_{Amax}
Outdoor living area	Serious annoyance, daytime & evening	55	16	-
	Moderate annoyance, daytime & evening	50	16	-
Dwellings, indoors Inside bedrooms	Speech Intelligibility and moderate annoyance, daytime & evening	35	16	-
	Sleep disturbance, night-time	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values) night-time	45	8	60

4.0 PREDICTION OF NIGHT-TIME CONSTRUCTION NOISE LEVELS

We have calculated the noise levels at sites surrounding the activity for five scenarios to reflect the five different stages of the project, during the night-time (from 1800/2000/2200 hours[5]):

1. Site Establishment
2. Excavation Stage 1
3. Excavation Stage 2
4. Excavation Stage 3
5. Site Rehabilitation

[5] NZS 6803 reduces noise levels to 45 dB L_{Aeq} at 2000 hours on weekdays and 1800 hours on Saturdays, Sundays, and Public Holidays. GRUZ-R7.4 reduces noise levels to night-time levels at 2200 hours on all days.

Because the activity is proposed to happen seven days per week for up to 24 hours per day, we have focussed on modelling the night-time noise levels. For reasons described below in Section 4.2 night-time noise levels have the potential to be louder than daytime because of provision for site lighting and associated generators.

4.1 Calculation method

Noise levels were calculated with the noise modelling software SoundPLAN 8.2. This implements calculation procedures following ISO 9613-2:1996 "*Acoustics – Attenuation of sound propagation outdoors – Part 2: General method of calculations*". This method accounts for a range of factors including:

- The magnitude of the noise source, and the distance between source and receiver
- The presence of obstacles and reflecting surfaces in the propagation path
- The hardness of the ground between source and receiver
- Attenuation due to atmospheric absorption
- Supportive meteorological propagation conditions

All noise levels are calculated as a time-average A-weighted sound pressure level over 15 minutes ($L_{Aeq\ (15\ min)}$), unless otherwise specified.

4.2 Assumptions

We have modelled the site and surrounds in accordance with plans provided to us dated November 2022. We have made the following assumptions in our model:

- Ground elevation was modelled from the NZ Terrain Contours – Topo 150K dataset from LINZ;
- Property boundaries and addressing are consistent with the LINZ data service[6,7];
- The ground absorption is mixed absorption (G = 0.6) in large areas of grass/vegetation and hard ground (G = 0.1) for areas such as water;
- All receiver noise levels are calculated at 1.5 m above the local ground level.

[6] NZ-Property Titles, Land Information New Zealand (LINZ), obtained 15 May 2023

[7] Land Information New Zealand (LINZ), obtained 15 May 2023

4.3 Noise source levels

We have used estimated source levels listed in Table 3 based on our previous experience and measurements of similar activities and information supplied to us in the construction methodology assessment. Table 4 provides the number and type of each item of equipment included in each of the five scenarios modelled in accordance with advice received from Damwatch.

Table 3: Estimated source levels

Item of equipment	Source Level
Bulldozer 40t	108 dB L_{WA}
Grader 16t	107 dB L_{WA}
Excavator 40t	103 dB L_{WA}
Dewatering pumps	101 dB L_{WA}
Haul Truck 35t (30 movements/15 min)	89 dB L_{AE} @ 10 m
Genset (for pumps and lights at night)	99 dB L_{WA}
Water Cart	103 dB L_{WA}

Table 4: Plant for each scenario

Stage	Plant
Site Establishment	2x Graders Cat 16
	2x Bulldozer Cat D8
	2x Genset (night-lighting)
Excavation Stage 1	6x 35t Dump trucks
	4x33t Excavators
	1x Water cart
	2x Genset (night-lighting)
	1x Bulldozer Cat D8 *
Excavation Stage 2	6x 35t Dump trucks
	6x35t Long Reach Excavators
	2 Dewatering Pumps and associated Genset
	2x Genset (night-lighting)
	1x Grader Cat 16 *
	2x Bulldozer Cat D8 *
Excavation Stage 3	4x 35t Dump trucks
	4x35t Long Reach Excavators
	2x Genset (night-lighting)
	1x Grader Cat 16 *
	1x Bulldozer Cat D8 *
Site Rehabilitation	2x Graders Cat 16
	2x 33t Excavators
	2x Genset (night-lighting)

** Used during the daytime only and has been excluded from prediction of night-time noise levels.*

4.4 Night-time noise levels generally comply with GRUZ-R7.4 and NZS 6803

We have predicted night-time noise levels for this assessment of effects because:

1. Night-time activity requires task lighting which necessitates the use of portable generators, thus increasing noise levels compared to the daytime activity
2. Averaging of noise levels for duration is not undertaken at night-time, so the calculated rating noise level for comparison against GRUZ-R7.4 (if required) will generally be greater at night than during the daytime
3. Given that the activity may occur at night, consideration of sleep amenity within dwellings is of greater concern than the noise level at property boundaries.

Predicted noise levels are summarised in Table 5 for each of the five scenarios at nearby dwellings[8], .

Noise contour plots for the night-time scenarios are provided in Appendix B to better illustrate the summarised results in Table 5.

Table 5: Predicted night-time noise levels at nearby dwellings.

Receiver	Predicted noise level at notional boundary, dB L_{Aeq}				
	Site Establishment	Excavation Stage 1	Excavation Stage 2	Excavation Stage 3	Site Rehabilitation
415 Weir Road	<30	35	35	36	<30
567 Weir Road	41	47	47	47	41
725 Weir Road	34	39	39	39	34
798 Weir Road	32	37	38	38	33
811 Weir Road	31	36	37	37	32
17 Duncraigen Road	34	39	40	40	35
27 Duncraigen Road	33	38	39	39	34
164 Duncraigen Road	34	41	43	43	35
Whare Creek 9679	35	40	43	43	35

Predicted residential/rural night-time noise levels complies with both the night-time guidance in NZS 6803 (45 dB L_{Aeq}) and GRUZ-R7.4 (40 dB $L_{Aeq\ (15\ min)}$) at the dwelling notional boundary for the following properties and for all scenarios:

- 415 Weir Road
- 725 Weir Road
- 798 Weir Road
- 811 Weir Road
- 17 Duncraigen Road
- 27 Duncraigen Road

[8] We understand that Whare Creek 9679 is a farm office, rather than a dwelling, and is considered a commercial building under NZS 6803.

Properties at which one or other night-time limits are exceeded are:

567 Weir Road

The GRUZ-R7.4 noise limit of 40 dB $L_{Aeq\,(15\,min)}$ is exceeded during all scenarios by 1 to 7 dB.

The NZS 6803 noise limit of 45 dB $L_{Aeq\,(15\,min)}$ is exceeded during excavation stage 1 by 2 dB.

164 Duncraigen Road

The GRUZ-R7.4 noise limit of 40 dB $L_{Aeq\,(15\,min)}$ is exceeded during excavation stages 1, 2 and 3 by 1 to 3 dB.

We understand that Whare Creek 9679 is a farm office. Given the commercial nature of this building, the noise limits of GRUZ-R7.4 do not apply. The predicted noise levels are substantially below the NZS 6803 night-time noise limit for commercial buildings (70 dB L_{Aeq}) – see Section 3.3.

Based on our experience of this activity type, we do not anticipate that the night-time L_{AFmax} noise limit in either NZS 6803 or GRUZ-R7.4 will be exceeded at any property.

4.5 Daytime noise levels will comfortably comply with GRUZ-R7.4 and NZS 6803

The daytime operating scenario is essentially the same as the night-time scenarios modelled with the following variations:

1. During the daytime site lighting and associated generators are not required.
2. As noted in Table 4, during excavation stages 1, 2, and 3 there is the addition of graders and bulldozers during the daytime only.
3. During the daytime the noise rating level calculation permits duration averaging where noise sources are not in constant operation.

Items one and three have the potential to reduce the noise rating level. Item two has the potential to increase the noise level depending upon the location at which the additional equipment is working on any given day.

Taking a conservative approach, we have assumed that items one and three do not result in any noise reduction, and that the additional equipment is operating near the work site boundary closest to a noise sensitive receiver. This conservative scenario could increase the noise rating level by a maximum of 2-3 dB. This change in noise level is not perceptible and the total noise level will be comfortably below both the GRUZ-R7.4 and NZS 6803 daytime noise standards.

5.0 ASSESSMENT OF NOISE EFFECTS

In this section we consider the likely effect of the predicted noise levels.

5.1 Daytime noise levels are acceptable and comply with all relevant guidance

The activity noise may be distantly audible at dwellings at times, especially under still or light down-wind conditions. Indoor activities such as listening to radio/music/TV/reading and conversation will not be adversely affected, even with windows open.

As site boundaries are approached, the likelihood of the activity being audible increases. As daytime noise limits under both GRUZ-R7.4 and NZS 6803 are complied with, we consider the noise level to be reasonable, and any effects arising are less than minor.

5.2 Night-time noise levels are generally acceptable although with some non-compliances

In general, the activity noise may be distantly audible at dwellings at times, especially under still or light down-wind conditions. The perception of audibility may be slightly increased compared to the daytime, as a result of generally lower residual (background) noise levels at night. Indoor activities

such as listening to radio/music/TV/reading and conversation will not be adversely affected, even with windows open.

Other than as noted below, night-time noise limits under both GRUZ-R7.4 and NZS 6803 are complied with at most dwellings. We consider the noise level to be reasonable, and any effects arising are less than minor.

The discussion below focusses on 567 Weir Road and the 164 Duncraigen Road. When considering both of these properties we have also considered that excavation stages 1 and 3 are expected to take two and five weeks respectively out of the planned 20 week work programme.

5.2.1 567 Weir Road

At 567 Weir Road construction will be more audible, particularly during excavation stages 1, 2, and 3. There is potential for sleep disturbance for light sleepers as noise levels inside bedrooms facing the site could be as high as 27 to 32 dB $L_{Aeq\ (15\ min)}$. While this noise level inside bedrooms is generally regarded as acceptable, and is often readily tolerated, there is greater potential for sleep disruption more from the pattern of activity than the level itself.

We consider the approach outlined under NZS 6803 would be appropriate. Consultation with Pamu Farms is currently underway to determine the most appropriate means of mitigating any night-time noise effect that arises.

While the night-time noise limits under both GRUZ-R7.4 or NZS 6803 are not complied with during excavation stages 1, 2, and 3, we consider the noise level to be reasonable. Any effects arising will be less than minor and amenable to mitigation at night through restrictions of equipment and work areas amongst other approaches, although the activity noise itself will likely be audible much of the time. In reaching this view we have considered the guidance provided by NZS 6802, NZS 6803, and WHO in addition to the operative draft SDP.

5.2.2 164 Duncraigen Road

Any potential adverse noise effects at this property are intermediate between those at 567 Weir Road and other dwellings assessed. The predicted noise levels comply with the night-time limits in NZS 6803 and the notional boundary limit in GRUZ-R7.4 other than for excavation stages 1, 2, and 3.

We consider that there is limited potential for sleep disruption, even if bedrooms face the site and with windows open for ventilation.

We consider the noise level to be reasonable, and any effects arising are less than minor. In reaching this view we have considered the guidance provided by NZS 6802, NZS 6803, and WHO, in addition to the operative draft SDP.

Any mitigation measures such as those discussed below for the potential benefit of 567 Weir Road, would likely benefit this property as well.

6.0 RECOMMENDATIONS

NZS 6803:1999 *Acoustics - Construction Noise* places significant emphasis of the application of best practicable option when managing construction noise. The concept is that the noise levels provided in Tables 2 and 3 of the Standard (see Section 3.3 above) are to be treated as guidelines, rather than limits, with the objective to be to achieve a lower noise level where possible, and to take all practicable steps to minimise the noise level, even if the result is greater than the guideline.

There are a number of ways in which this may be achieved in this case, ranging from temporary noise barriers close to potentially affected dwellings, reaching agreement with neighbours around respite periods during which night-time work may not occur, limiting the type of amount of equipment operating at night to achieve a lower noise level amongst other methods.

We consider it appropriate to have a Construction Noise Management Plan (CNMP).

In addition, it has been our experience on large construction sites, mines, quarries and the like, that the use of tonal reversing beepers at night is likely to cause annoyance, even where the noise level is low. We consider it appropriate for the CNMP to require that no tonal reversing alarms be used on the site.

6.1 Construction Noise Management Plan

A construction noise management plan (CNMP) shall be developed in accordance with the requirements of NZS 6803:1999 *Acoustics – Construction Noise*.

The CNMP shall address matters in Annex E of the Standard, in particular:

- Consultation
- Responsible Persons
- Complaints Procedure
- Noise performance standards
- Practicable control measures
- Noise monitoring (if required)
- Training and supervision of workers on site
- Other mitigation options
- Other matters as deemed appropriate.

Reversing Alarms

No mobile equipment on site shall use tonal reversing alarms. Any reversing alarms shall be broad band, visual, or a combination as considered appropriate by the Site Manager.

Finally, we consider that amenity will be appropriately managed during both the daytime and night-time through the application of NZS 6803 in accordance with district wide noise rule NOISE-R12.

Noise Criteria

Noise arising from the activity will be measured and assessed in accordance with NZS 6803: 1999 *Acoustics - Construction Noise*, using the 'long term' construction duration of Tables 2 and 3 of the Standard as a guideline.

Triggers for night-time work

We understand that night-time work will be undertaken only when needed to ensure that the project is achieved within the required time period. Criteria which could trigger the need to carry out night works should be developed and included in the CNMP (and any other appropriate management process). Where it becomes necessary to undertake night-works, consultation with neighbours should be carried out as soon as possible and agreed arrangements exercised.

Equipment not to be used at night

Graders and bulldozers are not to be used at night during excavation stages 1, 2, and 3, unless specific noise management processes are developed that will ensure compliance with the night-time criteria of NZS 6803.

The stockpile area in use at night may be restricted to mitigate noise effects at 567 Weir Road. This will be subject to discussions with occupants based on experience.

7.0 CONCLUSIONS

We have reached the following conclusions:

- Predicted daytime and night-time noise levels at most dwellings will comply with all relevant noise limits and guidelines.
- The predicted night-time noise levels at the 164 Duncraigen Road does not comply with the notional boundary GRUZ-R7.4 for excavation stages 1 and 3 but does comply with guidance from NZS 6803.
- Noise effects at this property are considered to be both reasonable and less than minor.
- The predicted night-time noise levels at 567 Weir Road exceed the GRUZ-R7.4 noise limit of 40 dB $L_{Aeq\,(15\,min)}$ for all scenarios by 1 to 8 dB and the NZS 6803 noise guidance of 45 dB $L_{Aeq\,(15\,min)}$ during excavation stage 1 by 3 dB.
- We have provided recommendations around the implementation of a CNMP to provide a guidance framework for this analysis.
- Overall, we consider that subject to appropriate management, noise levels will be reasonable, and potential adverse effects will be less than minor.

APPENDIX A GLOSSARY OF TERMINOLOGY

A-weighting	A set of frequency-dependent sound level adjustments that are used to better represent how humans hear sounds. Humans are less sensitive to low and very high frequency sounds. Sound levels using an "A" frequency weighting are expressed as dB L_A. Alternative ways of expressing A-weighted decibels are dBA or dB(A).
Background sound	The sound that is continuously present in a room our outdoor location. Often expressed as the A-weighted sound level exceeded for 90 % of a given time period i.e. L_{A90}.
dB	Decibel. The unit of sound level.
L_{AE}	Exposure Level. An A-weighted measure of the total sound energy over a certain time period, compressed into 1 second. Used to describe the sound energy of a single event, such as a train pass-by or an aircraft flyover.
L_{Aeq}	The equivalent continuous A-weighted sound level. Commonly referred to as the average sound level and is measured in dB.
L_{Amax}	The A-weighted maximum sound level. The highest sound level which occurs during the measurement period. Usually measured with a fast time–weighting i.e. L_{AFmax}.
L_w	Sound Power Level. The calculated level of total sound power radiated by a sound source. Usually A-weighted i.e. L_{WA}.
Noise	A subjective term used to describe sound that is unwanted by, or distracting to, the receiver.
Notional boundary	A line 20 metres from any side of a dwelling, or the legal boundary where this is closer to the dwelling. This definition is from NZS 6802:2008.
Rating level	A derived level used for comparison with a noise limit. Takes into account any and all corrections described in NZS 6801 and NZS 6802, e.g. duration, special audible character, residual sound etc. This definition is from NZS 6802:2008.
Residual sound	The total sound remaining at a given position in a given situation when the specific sounds under consideration are suppressed or are an insignificant part of the total sound. This definition is from NZS 6802:2008.

APPENDIX B PREDICTED CONSTRUCTION NOISE CONTOURS FOR SELECTED SCENARIOS

B1 – Site Establishment

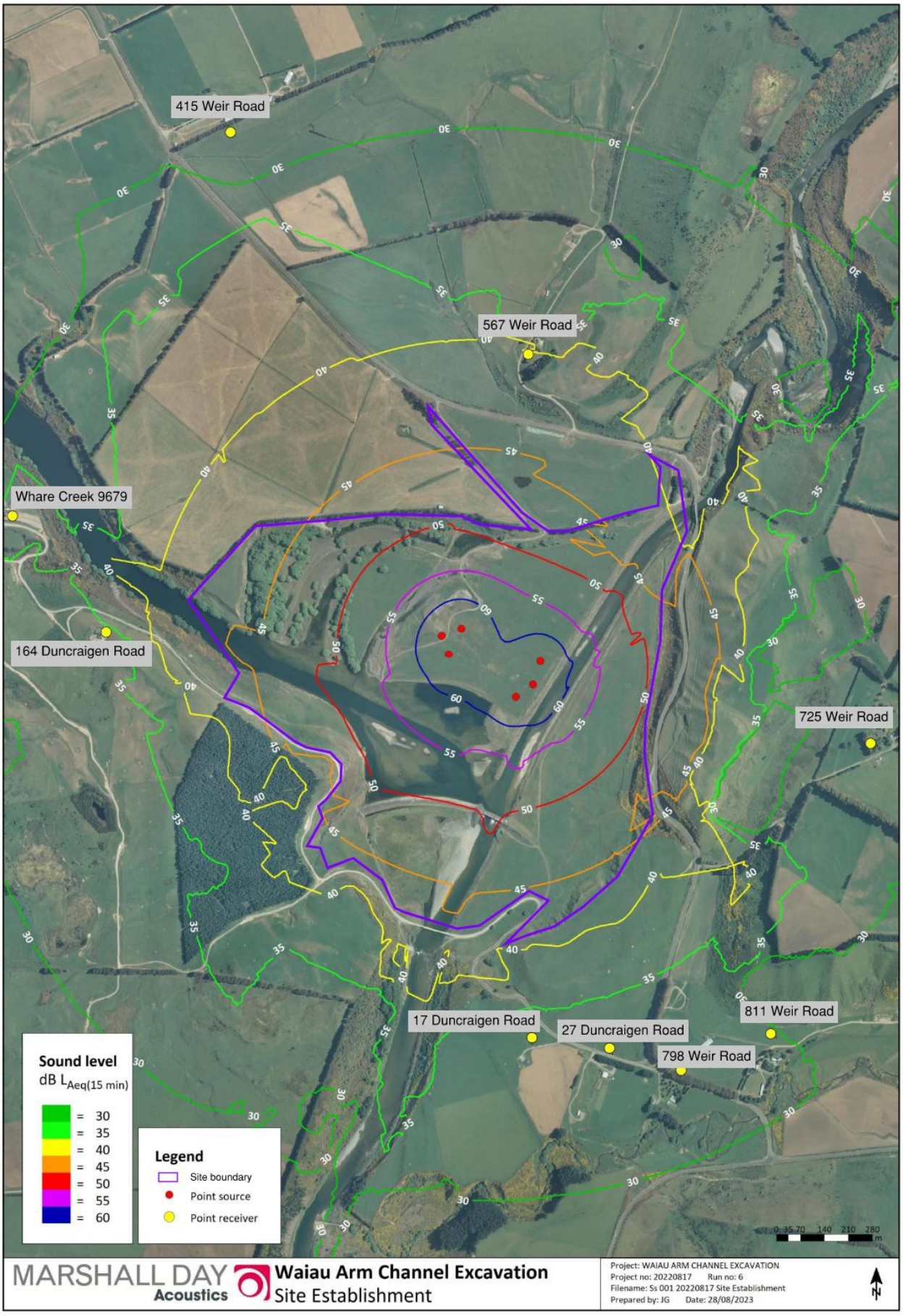
B2 – Excavation Stage 1

B3 – Excavation Stage 2

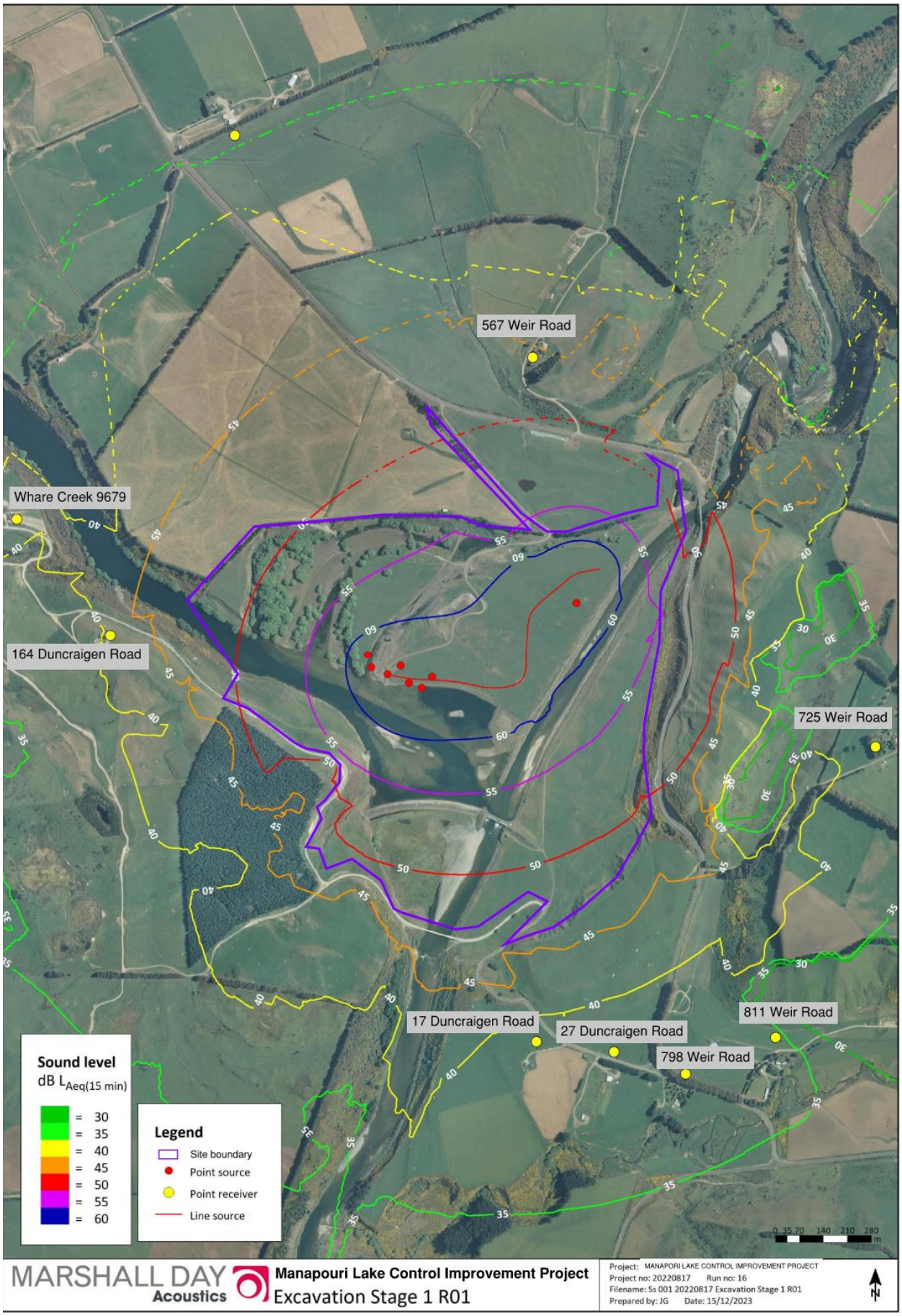
B4 – Excavation Stage 3

B5 – Site Remediation

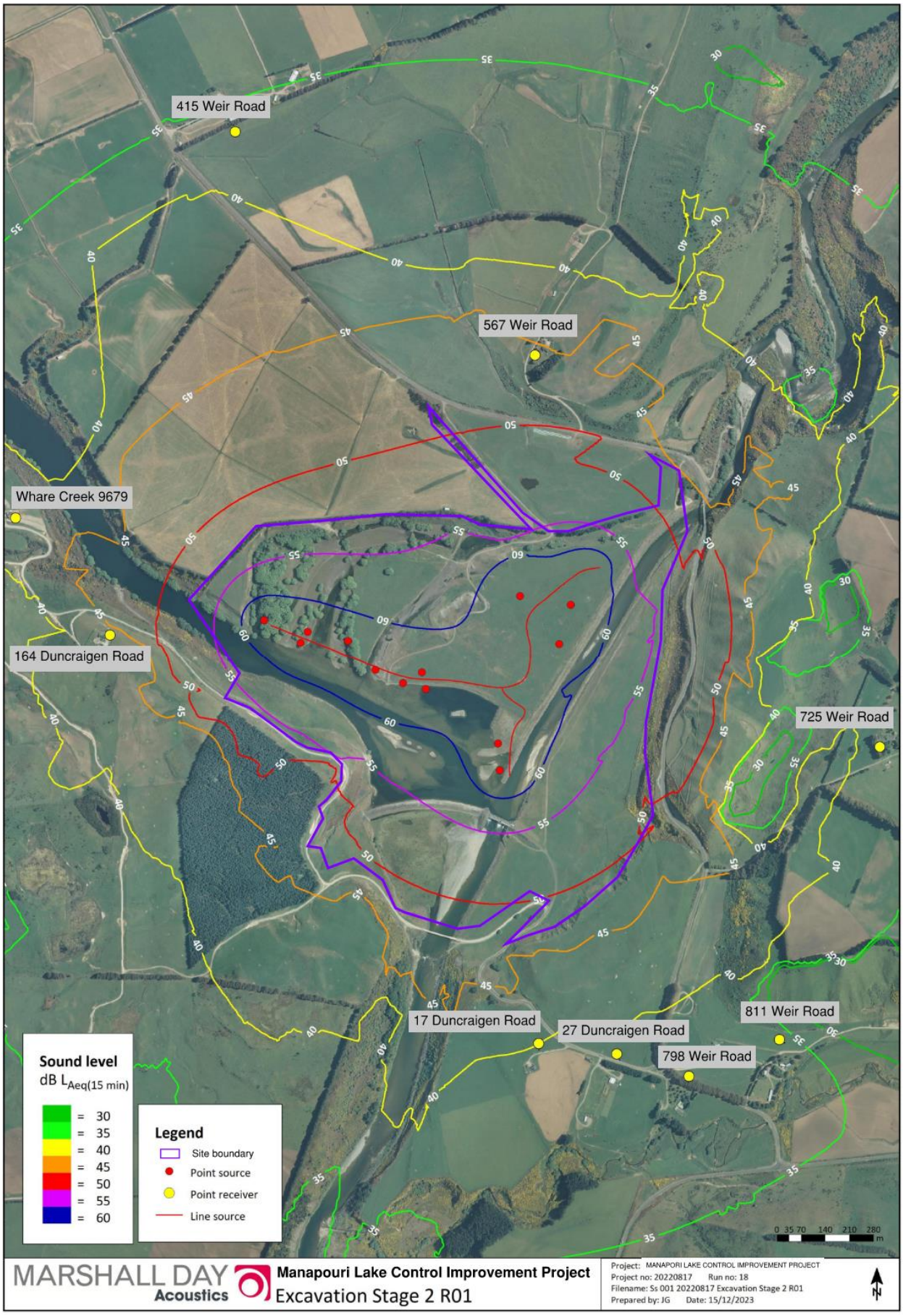
B1 Site Establishment



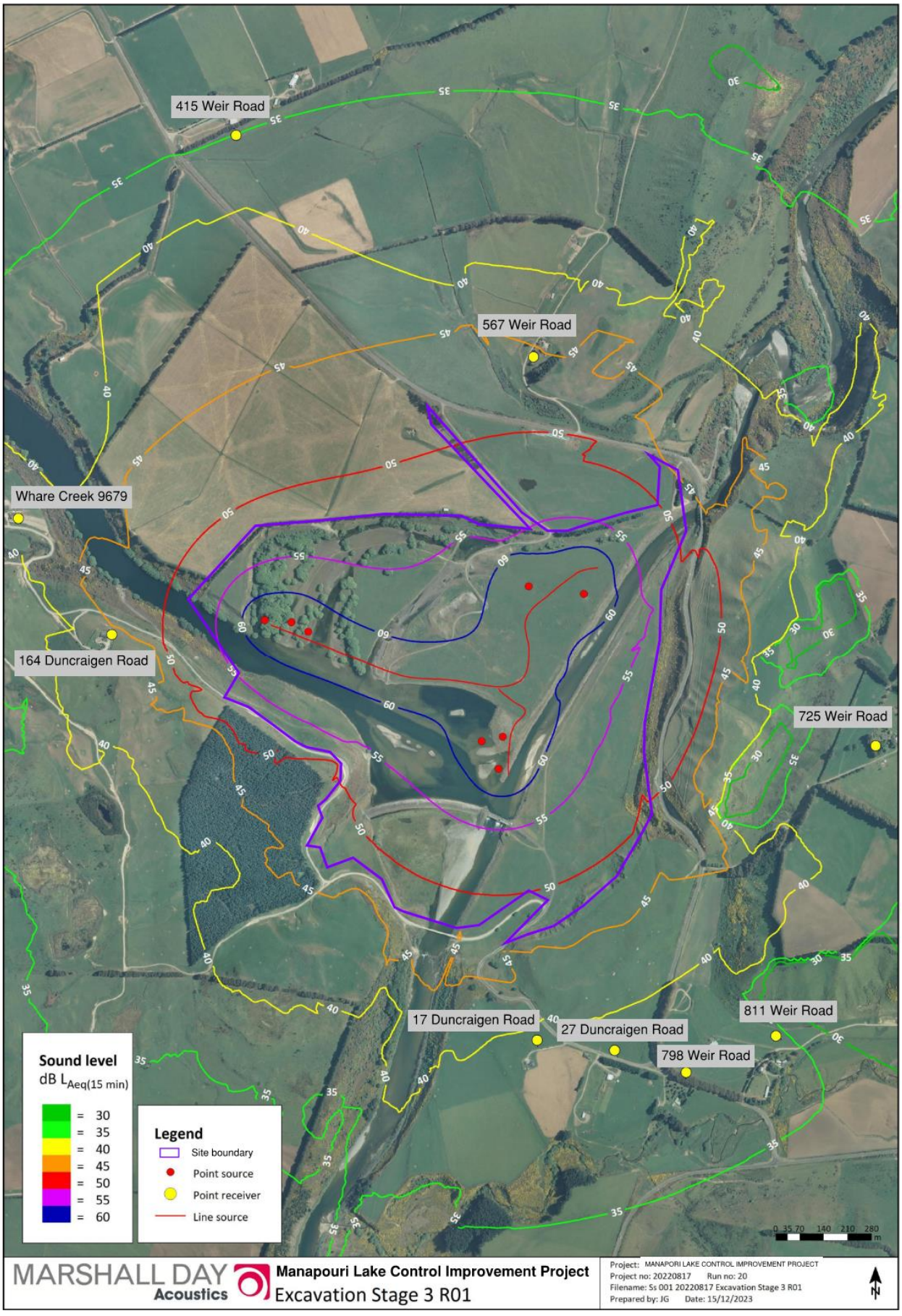
B2 Excavation Stage 1



B3 Excavation Stage 2



B4 Excavation Stage 3



B5 Site Remediation